ORIGINAL RESEARCH

Growth, longevity and mortality of pink shrimps *Farfantepenaeus brasiliensis* and *F. paulensis* in southeastern Brazil

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ABSTRACT. The study estimated the parameters of growth, longevity, fishing mortality (F), natural mortality (M) and total mortality (Z) and the exploitation rates (E) of the shrimps *Farfantepenaeus brasiliensis* and *F. paulensis* sampled in Ubatuba Bay from January to December 2000. Shrimps were identified by species, sexed and measured (carapace length –CL in mm). Overall, 1,231 individuals of *F. brasiliensis* and 687 of *F. paulensis* were analyzed. The mean size between sexes did not differ for both species. The estimated parameters of *F. brasiliensis* were: CL_∞ = 41.08 mm, k = 2.41 year^{-1} for males and CL_∞ = 47.32 mm, k = 2.23 year^{-1} for females; longevity of 1.91 years (males) and 2.05 years (females); M of 2.47 (males) and 2.28 (females); F of 7.97 (males) and 8.42 (females). For *F. paulensis,* the following values were observed: CL_∞ = 36.55 mm, k = 2.41 year^{-1} for males and CL_∞ = 49.24 mm, k = 2.51 year^{-1} for females; longevity of 1.91 years (males) and 1.81 years (females); M of 2.52 (males) and 2.52 (females); F of 7.64 (males) and 10.25 (females). The high values of k and F found for both species compared to those from the literature reflected the high E values, indicating that at the time, the closed season was still not responsible for stock recovery. We highlight the need for studies to assess the current status of stocks so they can be compared to the results found herein.

Key words: Artisanal fishery, Bertalanffy, closed season, exploitation rate, Penaeidae.

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Crecimiento, longevidad y mortalidad de camarones rosados *Farfantepenaeus brasiliensis* y *F. paulensis* en el sureste de Brasil

RESUMEN. El estudio estimó los parámetros de crecimiento, longevidad, mortalidad por pesca (F), mortalidad natural (M) y mortalidad total (Z) y las tasas de explotación (E) de los camarones *Farfantepenaeus brasiliensis* y *F. paulensis* muestreados en la Bahía de Ubatuba de enero a diciembre de 2000. Los camarones fueron identificados por especie, sexados y medidos (longitud del caparazón –CL en mm). En total, se analizaron 1.231 individuos de *F. brasiliensis* y 687 de *F. paulensis*. La talla media entre sexos no difirió para ambas especies. Los parámetros estimados de *F. brasiliensis* fueron: CL_∞ = 41,08 mm, k = 2,41 año^{-1} para machos y CL_∞ = 47,32 mm, k = 2,23 año^{-1} para hembras; longevidad de 1,91 años (machos) y 2,05 años (hembras); M de 2,47 (machos) y 2,28 (hembras); F de 7,97 (machos) y 8,42 (hembras). Para *F. paulensis* se observaron los siguientes valores: CL_∞ = 36,55 mm, k = 2,41 año^{-1} para machos y CL_∞ = 49,24 mm, k = 2,51 año^{-1} para hembras; longevidad de 1,91 años (machos) y 1,81 años (hembras); M de 2,52 (machos) y 2,52 (hembras); F de 7,64 (machos) y 10,25 (hembras). Los altos valores de *k* y F encontrados para ambas especies en comparación con los de de la literatura reflejaron los altos valores de E, lo que indica que en ese momento la temporada de veda todavía no era responsable de la recuperación del *stock*. Resaltamos la necesidad de estudios que evalúen el estado actual de los *stocks* para que puedan ser comparados con los resultados aquí encontrados.

Palabras clave: Pesquería artesanal, Bertalanffy, cierre de temporada, tasa de explotación, Penaeidae.

INTRODUCTION

Farfantepenaeus brasiliensis (Latreille, 1817) and *F. paulensis* Pérez-Farfante, 1967, commonly known as pink shrimps, are highly exploited fishing resources on the southern and southeastern coast of Brazil (Costa and Fransozo 1999; Teodoro et al. 2016). Both species are exploited by two fleet types during different stages of their life cycles, i.e. industrial fleets offshore exploit adults in the open sea, while artisanal fisheries reach juveniles in estuarine environments and coastal lagoons (D'Incao 1991).

Accurate information about the age of the target organisms in fisheries is essential for calculating parameters such as longevity, growth rate and mortality, which end up reflecting the human impacts on natural populations (Kilada and Driscoll 2017). The most common method for studying age in natural populations is based on the analysis of distribution of length frequencies, in which the raw data is grouped into class intervals and, subsequently, algorithms are used to obtain the normal distribution peaks (e.g. in each month of collection) (Castilho et al. 2015; Silva et al. 2015). Finally, modal groups are detected and their combination supports the final model, adjusted with the von Bertalanffy curve (1938). According to Vogt (2019), the von Bertalanffy curve makes it possible to estimate longevity from frequency data and life history.

Some growth studies have been conducted along the Brazilian coast for Penaeidae species, namely: *Artemesia longinaris* Spence Bate, 1888 (Semensato and Di Beneditto 2008), *F. brasiliensis* (Mello 1973; Vilela et al. 1997; Leite Jr and Petrere Jr 2006; Lopes 2012), *F. paulensis* (Mello 1973; D'Incao 1984; Leite Jr and Petrere Jr 2006; Lopes 2012), *Farfantepenaeus subtilis* (Pérez-Farfante, 1967) (Silva et al. 2015; Santos et al. 2020), *Litopenaeus schmitti* (Burkenroad, 1936) (Miazaki et al. 2018; Santos et al. 2020; Carvalho et al. 2021), and *Xiphopenaeus kroyeri* (Heller, 1862) (Branco et al. 1994; Grabowski et al. 2014; Lopes et al. 2014; Castilho et al. 2015; Silva et al. 2018).

The studies concerning pink shrimps, *F. brasiliensis* and *F. paulensis*, were conducted either in Santos/Guarujá (central coast of São Paulo state) or in coastal lagoons in Rio de Janeiro State (Araruama Lagoon) and Rio Grande do Sul State (Patos Lagoon). These areas differ significantly from our study area, Ubatuba Bay (northern coast of São Paulo state). Araruama Lagoon is the largest permanently hypersaline lagoon in the world (Souza et al. 2003), while Patos Lagoon is the largest coastal lagoon in the world (Kjerfve 1986). The Santos/Garujá area is located in an estuarine complex with extensive mangrove formations (Lamparelli et al. 2001). Ubatuba Bay, however, has small estuaries that are susceptible to changes in salinity forcing *Farfantepenaeus* spp. juveniles to use shallow portions of the bay as auxiliary nursing areas (Costa et al. 2008).

In addition to calculating growth parameters, it is necessary to calculate both natural and fishing mortality, monitor stocks and elaborate adequate management plans which will guarantee the long-term maintenance of these stocks (King 2007) and consider their economic, ecological and social importance (Musiello-Fernandes et al. 2017). In the southeastern region, both species are frequently targeted due to their large sizes and high commercial value. They are also captured as bycatch of the seabob shrimp *X. kroyeri* in shallow marine areas (Mantelatto et al. 2016), whose population in Ubatuba is already overexploited (Miazaki et al. 2021). We believe these factors may be influencing and shaping populational parameters of pink shrimps in the sampling area. Thus, the present study used a length frequency analysis to estimate the (i) growth and longevity; (ii) total, natural and fishing mortality; and (iii) the exploitation rates of both sexes of *F. brasiliensis* and *F. paulensis* populations occurring in Ubatuba which are intensively exploited by trawling.

MATERIALS AND METHODS

Study area

Located on the northern coast of São Paulo state (southeastern Brazil), Ubatuba Bay (23° 26′ S, 45° 01′ W) is a traditional seabob shrimp fishing area, with more than 100 small-scale trawling boats operating (IP/APTA/SAA/SP 2021). With a total area of 8 km^2, the bay is 4.5 km wide at its entrance and decreases in width towards the beach (Mantelatto and Fransozo 1999). Three water masses influence the region: Coastal Water (Temperature > 20 °C and Salinity < 36); Tropical Water (Temperature > 20 °C and Salinity > 36); and South Atlantic Central Water (Temperature < 18 °C and Salinity < 36) (Castro-Filho et al. 1987). The seasonal influence of the water masses, coupled with the several bays formed by the presence of terminal spurs of Serra do Mar (Suguio and Martin 1978), and the transition of the tropical zone to the temperate zone, make the Ubatuba region a biodiversity hotspot for several marine organisms.

Data collection

Samples were collected monthly from January to December 2000. Shrimps were captured with a fishing boat equipped (10 m) with double rig nets, with 20 mm mesh in the wings and 18 mm mesh at the cord end, towed at an average speed of 1.7 knots. Nine transects (2 km each) were trawled: four in the internal area of the Ubatuba Bay (2, 5, 10 and 15 m isobaths) and five in the external area (20, 25, 30, 35 and 40 m isobaths) (Figure 1). Each trawl was carried out for 30 min and an ecobathymeter coupled with a GPS was used to record the depth of sampling sites.

The captured shrimps were stored in labeled plastic bags and kept frozen until analysis. In the laboratory, they were identified according to Pérez-Farfante and Kensley (1997) and Costa et al. (2003) and sexed. Afterwards, the carapace length (CL in mm) of each individual was measured with a 0.01 mm digital caliper, which was the linear distance between the postero-orbital margin and the median notch of the posterior margin of the carapace. It was decided to use CL because structures like the rostrum and telson can be damaged during the capture of organisms and the abdomen is flexible (Cole and Mistakidis 1953). Individuals with carapace length less than 25 mm were considered juveniles (Costa et al. 2008).

Data analysis

The growth and longevity of each species were analyzed separately for males and females. For each sampling month, the frequency of CL was distributed in 1 mm size classes. Modes were calculated using PeakFit software (PeakFit v4.12 for Windows Copyright 2000-2003 SYSTAT Software Inc.) which fits the observed frequencies to normal distribution curves so the mode and adjusted mean are the same. The ‘Automatic peak detection and fitting (I)’ tool considering the Gaussian distribution described by the equation:

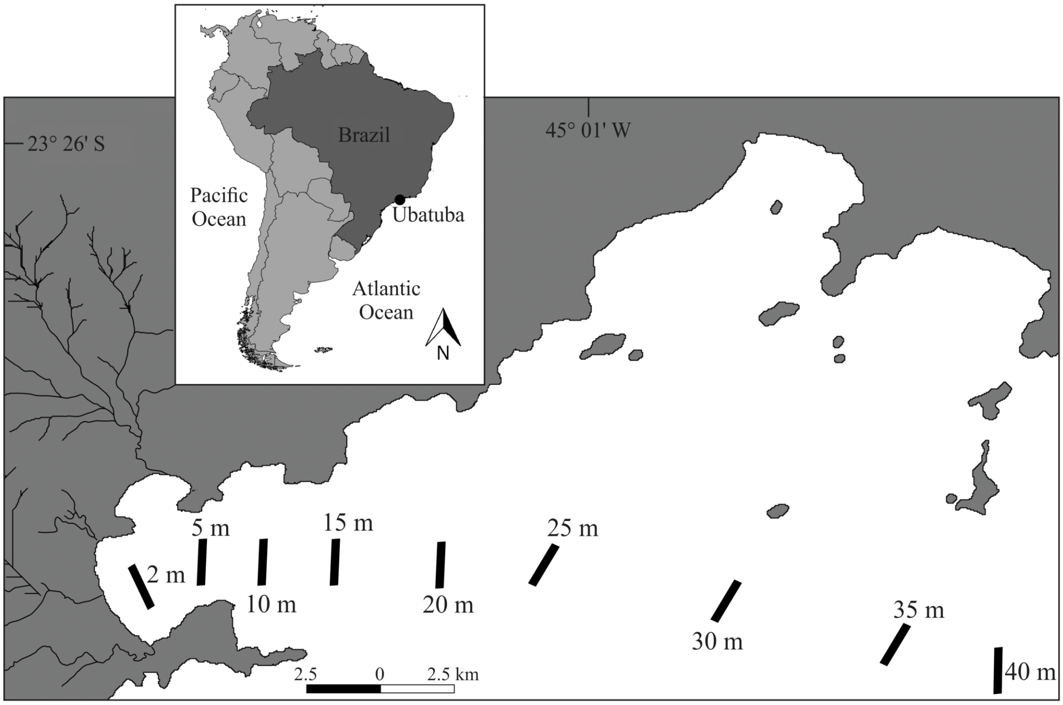


Figure 1. Map of the study area indicating the location and depth of transects.

$Y = a_0[\exp(-1/2(x-a_1)/a_2)^2]$, where a_0 is the amplitude, a_1 is the mean, and a_2 is the standard deviation was used to detect the central values of each mode. All the chosen cohorts were adjusted to the von Bertalanffy growth function (VBGF) $CL_t = CL_\infty(1-\exp^{-k(t-t_0)})$, in which CL_t is the carapace length at time (i.e. age) t; CL_∞ is the asymptotic length, k is the growth coefficient and t_0 is the theoretical age at zero length (von Bertalanffy 1938). These growth parameters were estimated for the different cohorts using Solver supplement in Microsoft Excel, varying in the equation: CL_∞, k and t_0, which minimizes the sum of residuals between the lengths observed in the field and those calculated by the von Bertalanffy model (Miazaki et al. 2021). Cohorts that presented a coherent biological rhythm in relation to longevity, k and CL_∞, were chosen. A F test ($P = 0.05$) was applied to compare growth curves between sexes, and assess if a single curve could describe these species growth (Cerrato 1990). The longevity was estimated through the von Bertalanffy inverse equation modified by D'Incao and Fonseca (1999), in which $t_0 = 0$ and $CL/CL_\infty = 0.99$ and the given longevity equation is $t = (t_0 - (1/k) \text{ Ln } (1 - CL_t/CL_\infty))$.

Length-converted catch curves: $-\text{Ln } (N/\Delta t) = a + bt'$, were used to estimate the total mortality coefficient (Z), in which b is the regression slope that estimates Z, N is the number of individuals in each size class estimated by unit effort of capture h^{-1}, Δt is the time for the growth of individuals across this size class and t is the average age of the individual in this size class (Pauly 1990). Catch curves were estimated for each sex and compared by covariance analysis (ANCOVA) (Fonseca and D'Incao 2006). Mortality coefficient (Z) was defined as the sum of the fishing mortality coefficient (F) caused by fishing operations, and the natural mortality coefficient (M) including predation, competetion, disease, and adverse environmental conditions ($Z = F + M$).

Natural mortality (M) was estimated based on the mean value found from the methods of Pauly (1980) and Taylor (1959, 1960). According to Pauly: log (M) = −0.0066 − 0.279 log (CL_∞) + 0.6543 log (k) + 0.4634 log (T), in which CL_∞ and k are the growth parameters obtained by VBGF and T is the annual average temperature (°C) of the habitat. The annual average bottom temperature was 20.91 ± 2.57 °C. Taylor correlates M, k and t_0: $M = -Ln\ [(1-0.95)/A_{0.95}]$, where $A_{0.95}$ is the age at which the individual reaches 95% of its asymptotic size and is defined by: $A_{0.95} = t_0 - (2.996/k)$. Fishing mortality (F) was calculated by the difference between Z and M (F = Z − M). The exploitation rate (E) was calculated by the ratio between F and Z: E = F/Z (Sparre and Venema 1997).

RESULTS

A total of 1,231 individuals of *F. brasiliensis* and 687 individuals of *F. paulensis* were analyzed (Table 1). For *F. brasiliensis* the CL ranged from 7.50 to 35.70 mm (19.14 ± 5.66 mm) in males, and from 6.60 to 44.90 mm (18.95 ± 6.63 mm) in females (Figure 2). As for *F. paulensis*, the CL ranged from 10.40 to 35.00 mm (17.46 ± 4.26 mm) in males, and from 9.10 to 46.60 mm (18.52 ± 6.12 mm) in females.

Nine modal groups were selected for each sex of *F. brasiliensis* (Figure 3). The pooled growth curves for males resulted in estimates of CL_∞ = 41.08 mm, k = 0.198 $month^{-1}$ (2.41 $year^{-1}$), t_0 = - 0.062, and for females of CL_∞ = 47.32 mm, k = 0.183 $month^{-1}$ (2.23 $year^{-1}$), t_0 = - 0.376 (Figure 4).

Maximum longevity (t_{max}) was estimated at 697 days (1.91 years) for males and 748 days (2.05 years) for females. Statistical comparison (*F* test) between estimated curves for both sexes showed significant differences ($F_{calc} = 56.10 > F_{tab} = 2.72$; GL = 76; $P < 0.001$).

For *F. paulensis*, modal groups for males and five for females were selected. The pooled growth curve of each sex resulted in estimates of CL_∞ = 36.55, k = 0.198 $month^{-1}$ (2.41 $year^{-1}$), t_0 = - 0.356 for males and CL_∞ = 49.24 mm, k = 0.207 $month^{-1}$ (2.51 $year^{-1}$), t_0 = - 0.269 for females (Figure 5). The t_{max} was estimated at 697 days (1.91 years) for males and 660 days (1.81 years)

Table 1. Abundance of *Farfantepenaeus brasiliensis* and *F. paulensis* individuals per isobath captured from January to December 2000 in Ubatuba region.

Isobath (m)	*Farfantepenaeus brasiliensis*	*Farfantepenaeus paulensis*
2	249	149
5	522	441
10	14	16
15	57	2
20	14	6
25	31	30
30	101	16
35	220	20
40	23	7
Total	1,231	687

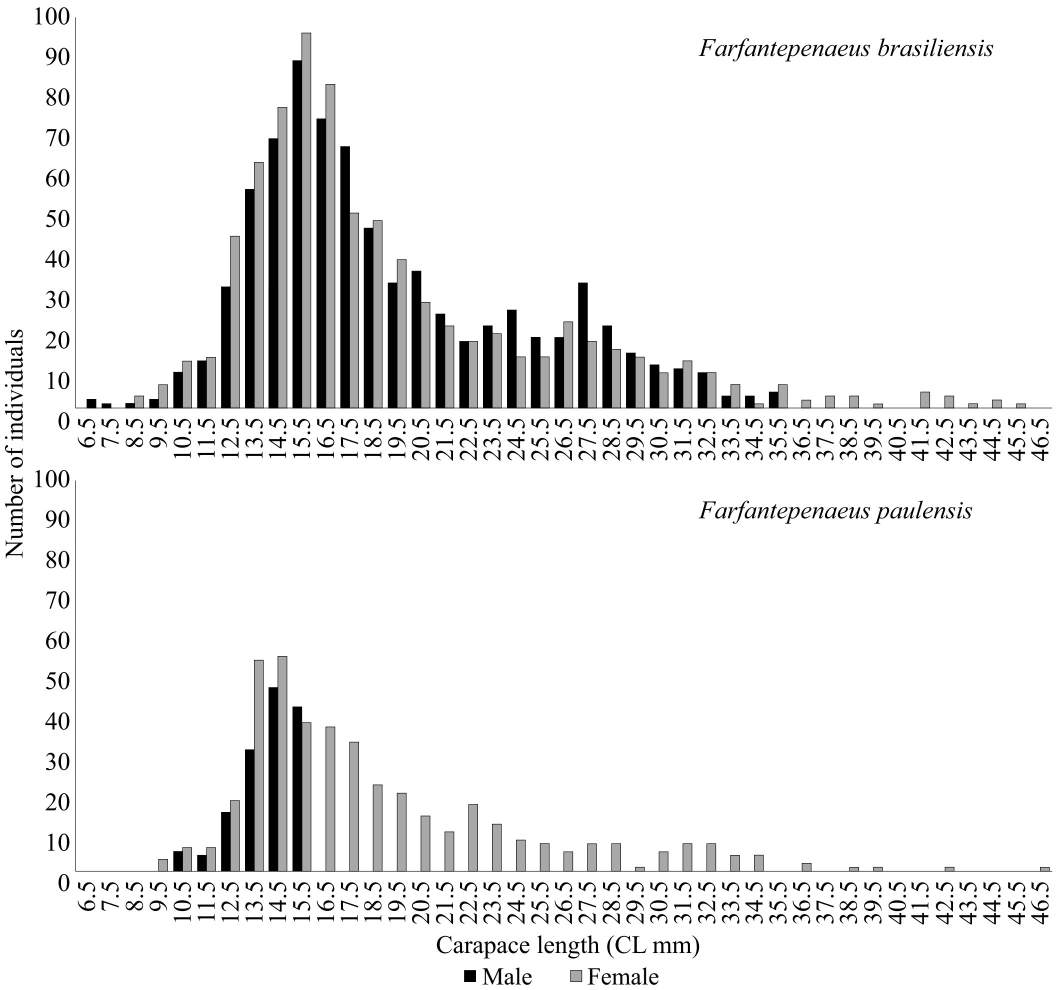


Figure 2. Size frequency distribution of males and females of *Farfantepenaeus brasiliensis* and *F. paulensis* sampled monthly, from January to December 2000, in Ubatuba region.

for females. Statistical comparison (*F* test) between estimated curves for both sexes showed significant differences ($F_{calc} = 304.62 > F_{tab} = 2.80$; GL = 48; $P < 0.001$).

Total mortality (Z) for *F. brasiliensis* was estimated as 10.44 $year^{-1}$ and 10.71 $year^{-1}$ for males and females, respectively, and estimated at 10.16 $year^{-1}$ for males and 12.77 $year^{-1}$ for females of *F. paulensis*. There were no statistical differences in Z between sexes of both species and between the species (ANCOVA, $P > 0.05$) (Table 2; Figure 6). The estimated values for the natural (M) and fishing (F) mortality coefficients and exploitation rates (E) by sex and species are in Table 2. Estimates of E for both sexes and for both species were higher than 0.5 (Table 2).

DISCUSSION

In terms of growth, mortality and stock exploitation, congeners *F. brasiliensis* and *F. paulensis* presented similar values for these

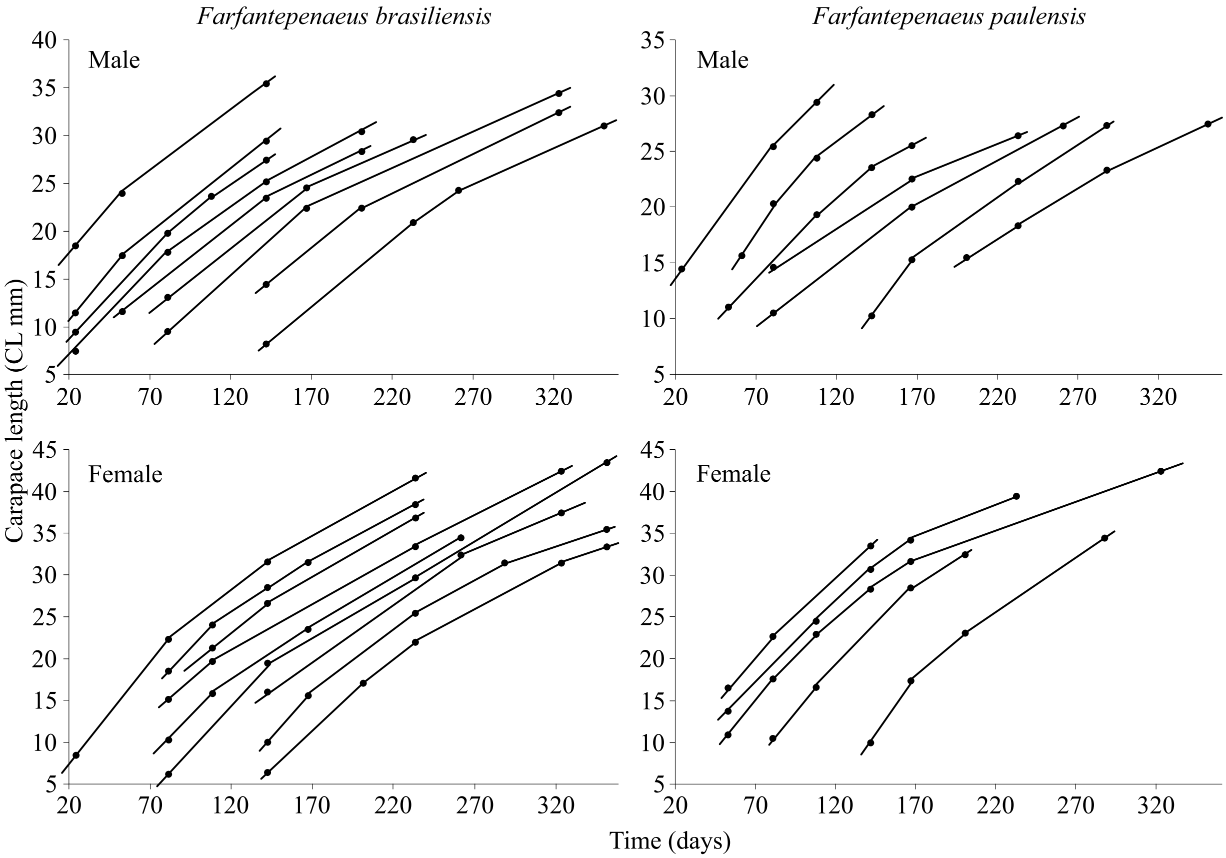
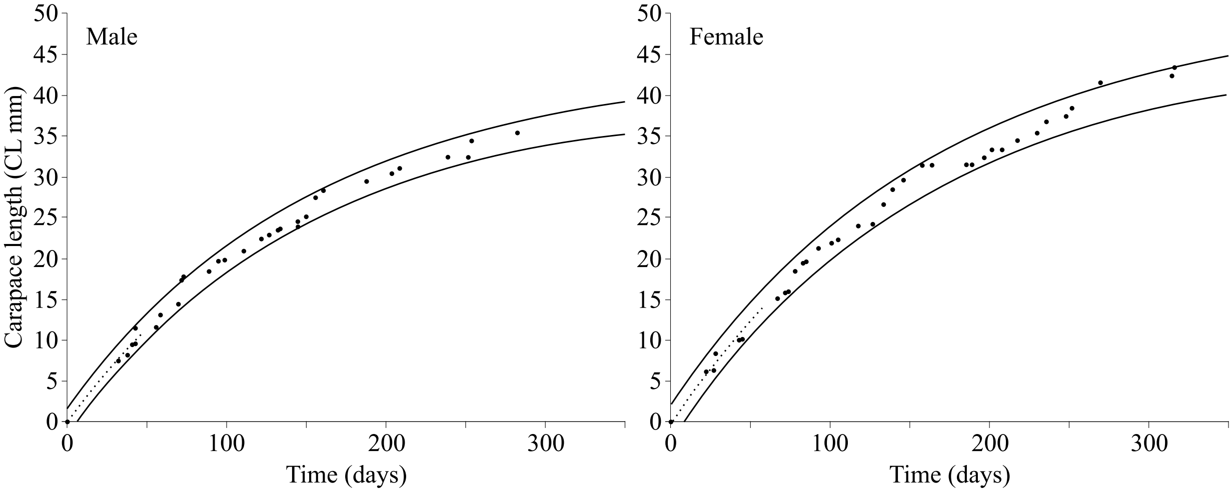


Figure 3. Modal groups selected for males and females of *Farfantepenaeus brasiliensis* and *F. paulensis* sampled monthly, from January to December 2000, in Ubatuba region. The lines represent the modal groups.

parameters in Ubatuba Bay. Overall, females of both species reached larger asymptotic sizes than males. This sexual dimorphism is common for Penaeidae (Dall et al. 1990) and has been observed in *F. subtilis* (Santos et al. 2020), *L. schmitti* (Miazaki et al. 2018) and *Penaeus merguiensis* de Man, 1888 (Saputra et al. 2018). It is related to the family reproductive strategy, pure searching. As these shrimps live aggregated in high densities, males do not guard females or territories prior to mating, so most of their energy may be allocated in developing faster in order to reproduce (Bauer 2010). As for females, they grow larger because the need to allocate their ovaries and other reproductive structures (Crisp et al. 2017).

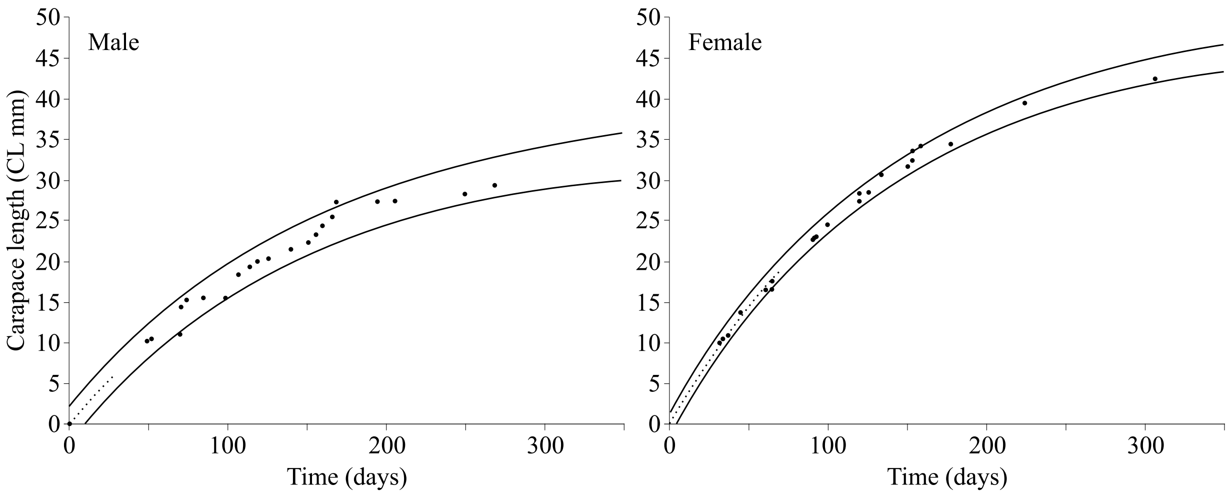
The values in our study regarding CL_∞ were smaller compared with previous studies with the same species. We found values of CL_∞ of 41.08 mm for males and 47.32 mm for females of *F. brasiliensis*; and 36.55 mm for males and 49.24 mm for females of *F. paulensis*. Leite Jr and Petrere Jr (2006) found for *F. brasiliensis* values of CL_∞ of 50.15 mm for males and 45.91 mm for females, and for *F. paulensis* values of 71.07 mm for males and 61.74 mm for females. It is important to highlight that as we sampled in a coastal bay (up to 20 m deep) and in its adjacent marine area (up to 40 m deep) on the northern coast of the São Paulo state, Leite Jr and Petrere Jr op. cit. obtained data from the fishing fleet located on the state's southern coast, which



CL_{∞} = 41.08 [1-exp$^{-0.0066(t-0.062)}$]
Age = 1.91 years (697 days)
r^2 = 0.97

CL_{∞} = 47.32 [1-exp$^{-0.0061(t-0.376)}$]
Age = 2.05 years (748 days)
r^2 = 0.98

Figure 4. Growth curves and parameters of von Bertalanffy equation estimated separately for males and females *Farfantepenaeus brasiliensis* sampled monthly from January to December 2000 in Ubatuba region. The centerline is the mean and outer lines are prediction intervals (95%).



CL_{∞} = 36.55 [1-exp$^{-0.0066(t-0.356)}$]
Age = 1.91 years (697 days)
r^2 = 0.96

CL_{∞} = 49.24 [1-exp$^{-0.0069(t-0.269)}$]
Age = 1.81 years (660 days)
r^2 = 0.95

Figure 5. Growth curves and parameters of von Bertalanffy equation estimated separately for males and females *Farfantepenaeus paulensis* sampled monthly from January to December 2000 in Ubatuba region. The centerline is the mean and outer lines are prediction intervals (95%).

Table 2. Annual estimates (year^{-1}) of natural mortality (M), fishing mortality (F), total mortality (Z), exploitation rates (E) and Standard Deviation (SD) by sex for *Farfantepenaeus brasiliensis* and *F. paulensis*.

Species	Sex	M	F	Z	E
Farfantepenaeus brasiliensis	Male	2.47	7.97	10.44	0.76
	Female	2.28	8.42	10.71	0.79
	Mean ± SD	2.38 ± 0.13	8.20 ± 0.32	10.58 ± 0.19	0.78 ± 0.02
Farfantepenaeus paulensis	Male	2.52	7.64	10.16	0.75
	Female	2.52	10.25	12.77	0.80
	Mean ± SD	2.52 ± 0	8.95 ± 1.85	11.47 ± 1.85	0.78 ± 0.04

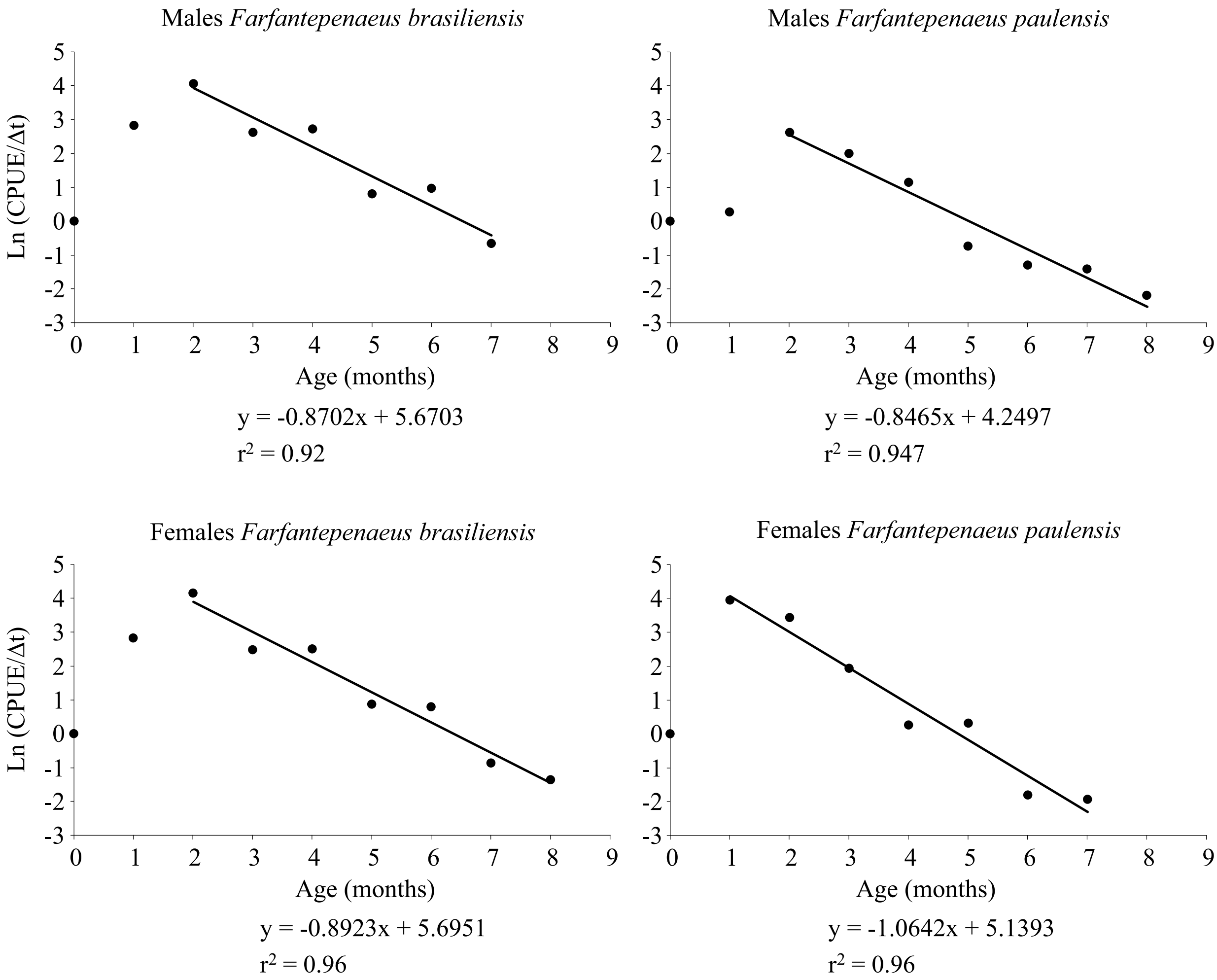


Figure 6. Length-converted catch curves estimated separately for males and females of *Farfantepenaeus brasiliensis* and *F. paulensis* sampled monthly from January to December 2000 in Ubatuba region.

usually operates in greater depths and captures larger individuals. The estimation of L_∞ is heavily influenced by the maximum length of the species in the sample and therefore by the sampling area (Froese and Binohlan 2000).

According to Vogt (2019), the average longevity of Penaeidae is 2.1 years. In our study, we found longevities of 1.91 years for males and 2.05 years for females of *F. brasiliensis*, and 1.91 years for males and 1.81 years for females of *F. paulensis*. While males of both species presented the same longevity, there was a considerable discrepancy for females. Females of *F. brasiliensis* may live up to three months longer than males in general, but females of *F. paulensis* live a month less than males. This is especially concerning for the species in the area if these females are captured in their reproductive period before spawning. Close values of longevity were obtained in northeastern Brazil by Silva et al. (2015) and Santos et al. (2020) for *F. subtilis* and by Nwosu (2009) for *Farfantepenaeus notialis* (Pérez-Farfante, 1967) in Nigeria.

Growth rates (*k*) for *F. brasiliensis* and *F. paulensis* remained above 1.8 a year as suggested by Garcia and Le Reste (1981) for peneids. The *k* of females of both species were very close to the values found by Mello (1973) in São Paulo state (23° S), from 2.52 year^{-1} for *F. brasiliensis* and 2.4 year^{-1} for *F. paulensis*. However, we found much higher *k* values for males than Mello op. cit., from 1.62 year^{-1} for *F. brasiliensis* and 1.25 year^{-1} for *F. paulensis*. Considerably higher *k* values were found herein than those found by D'Incao (1984) for both sexes of *F. paulensis* (1.03 year^{-1} for females and 1.25 year^{-1} for males) in Lagoa dos Patos, Rio Grande do Sul state (31° S), and by Leite Jr and Petrere Jr (2006) in Santos, São Paulo state (23° S) for both species, which were 0.9 year^{-1} for females and 0.84 year^{-1} for males of *F. brasiliensis* and 1.1 year^{-1} for females and 0.83 year^{-1} for males of *F. paulensis*. Values found in our study were probably higher than those found by Leite Jr and Petrere Jr op. cit. because they obtained data from fishery terminals, which usually discard small individuals with little economic value. We also sampled during the closed season; therefore, more juvenile individuals were included in the analysis.

An organism's growth rate can vary due to both intrinsic (genetic effects) and extrinsic reasons, e.g. variation in food availability, temperature, oceanographic phenomena (Alford and Jackson 1993), as well as from fishing pressure. According to D'Incao (1984), results revealed by Mello (1973) were probably due to the increased fishing fleet in São Paulo state coinciding with its sampling period, thus the increase in fishing may be associated with the reduced number of individuals reaching adulthood, consequently decreasing the individual length of catches. This is also probably occurring in our study area.

Natural mortality (M) was slightly higher for males, which is probably a reflex of their smaller sizes, since smaller individuals are more likely to be predated (Fonteles-Filho 2011). Fishery mortality (F) was higher in females. Overall, F varies with total length of individuals and is directly related to the effort and choice of fishing gear (Fonteles-Filho 2011). However, since males of both species are smaller, they present lower F values compared to females. The F values found in this study were higher than those found by Leite Jr and Petrere Jr (2006), who recorded 3.8 year^{-1} for males and 2.8 year^{-1} for females of *F. brasiliensis*, and 4.7 year^{-1} for males and 3.4 year^{-1} for females of *F. paulensis* in the Santos region, on the south-central coast of São Paulo. Nwosu (2009) studied exploited stocks of *F. notialis* and found an F of 6.44 year^{-1}. Considering that the majority of individuals sampled were juveniles (i.e. CL < 25 mm) (Figure 2), such a high F is extremely prejudicial to the stock's maintenance.

Globally speaking, Penaeid fisheries are responsible for high fishing mortality rates contributing to the high Z values found for populations of economic valuable species (Garcia and Le Reste 1981). Many stocks of targeted shrimps in tropical fisheries have been over-exploited. According to Gulland (1970) and Francis (1974) the optimum exploitation rate (E) for a fishery stock is around 0.5 when Fopt = M. Studies available in the literature, such as Niamaimandi et al. (2007) on *Penaeus semisulcatus* De Haan, 1844, Safaie (2015) on *P. merguiensis*, Saputra et al. (2019) on *P. indicus* H. Milne Edwards, 1837, and De Carvalho et al. (2019) on *L. schmitti*, resulted in high estimates of Z and all stocks were explored over the optimum sustainable yield.

In our study, F values were considerably higher than M values. During the sampling period, E values were higher than 0.7 for both sexes of both species. Therefore, pink-shrimp stocks were over-exploited in the Ubatuba region. It is important to consider that, due to the small estuaries, *F. paulensis* finishes its juvenile growth in the bays of Ubatuba. On the other hand, F. brasiliensis does not enter the estuaries and completely develops in shallower portions (Costa et al. 2008). Therefore, juveniles and pre-adults who have not yet migrated to the adult stock and have not reproduced are vulnerable to the seabob fisheries, which occur at up to 20 m deep, especially if the closed season is not suitable for the species. Miazaki et al. (2021) recorded a high exploitation rate for *Xiphopenaeus* spp. in the same area, reinforcing pink shrimps' vulnerability.

Seasonal closures are an important measure adopted by many tropical and subtropical shrimp fisheries to control fishing effort and prevent over-exploitation (Watson and Restrepo 1995). After 20 years of closed seasons, there still have been no recent studies about the area regarding the growth, longevity and mortality of pink shrimps. Such studies are urgently needed since several adjustments of fishing closure that occurred in the Southeast and South of Brazil (IBAMA 2008) in 2008 are still being enforced today. Data obtained from the IP/APTA/SAA/SP (2022), show that landings of pink shrimps captured in Ubatuba in the past 20 years ranged from 1.357 t in 2006 to 86 t in 2018, with annual averages of 50.308 ± 21.430 t. In 2000, 40.661 t of pink shrimp were captured in the area, while in 2021, similar values were registered, at 42.180 t. Thus, our results are of paramount importance and necessary not only to make comparisons with the current stock situation but also to reinforce the importance of regulations that control fishing activities, seeking to prevent further collapses of natural stocks, minimize the impacts caused by fishing and maintain ecologically sustainable level of stocks.

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