Comparative analysis of the distribution and morphological sexual maturity of *Persephona lichtensteinii* and *P. punctata* (Brachyura, Leucosiidae) in Ilhéus, BA, Brazil

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Abstract

In order to analyze the distribution and size of morphological maturation of *Persephona lichtensteinii* Leach, 1817 and *P. punctata* (Linnaeus, 1758) in the Ilhéus coast, Bahia, Brazil, monthly collections were performed between January and December 2004 in three locations in the Ilhéus coast: Olivença, Pontal and São Domingos. The distribution and sexual maturity results of *P. punctata* and *P. lichtensteinii* show different reproductive strategies and habitat selection among these species in Ilhéus coast. We captured 183 individuals of *P. lichtensteinii* and 58 individuals of *P. punctata.* Both species occurred in all stations and sampling sites. However, we found differences in the distribution of species. *Persephona lichtensteinii* was more abundant in Olivença and *P. punctata* was recorded mostly in São Domingos. Both were most abundant in autumn. The size at onset of maturity (W_{50}), was estimated as 22.1 mm in males and 21.4 mm in females of *P. lichtensteinii.* For *P. punctata* the W_{50} in males was estimated at 27.6 mm and for females as 25.5 mm. Although no evident difference was observed in W_{50} between males and females, the species showed a notable difference between them.

Key words: Decapoda, reproductive strategies, crab.

Introduction

The composition and distribution of brachyuran crab communities show high variation according to the study area and may be influenced by several physical and chemical characteristics of the environment. However, intra- and interspecific interactions and aspects of life history must also be considered, as they may be related to the distribution and abundance of different species that make up the community.

In Ilhéus coast, four leucosiid species are recorded: *Persephona lichtensteinii* Leach, 1817, *P. mediterranea* (Herbst, 1794), *P. punctata* (Linnaeus, 1758) e *Iliacantha liodactylus* Rathbun, 1898 (Almeida *et al.,* 2007). *Persephona* species are commonly caught as bycatch of marine shrimp fisheries (Branco and Fracasso, 2004).

The analysis of leucosid population dynamics, covering topics such as distribution, sexual maturity, reproductive period, time of recruitment, among others are still scarce. Studies on distribution and reproductive biology of organisms caught as bycatch in trawl fisheries are fundamental to the assessment of possible impacts of this activity and contribute for the mitigation measures.

The onset of sexual maturity is an important biological event, marked by morphological and physiological changes that can vary considerably between individuals of the same population and between populations of the same species (Hartnoll, 1985; Fonteles-Filho, 1989). Maturity must be analyzed in terms of the relationship between costs and benefits of reproduction in a certain age. The benefits appear as a immediately rise in fertility and the costs may appear either as a reduction in survival in old age, a reduction in fecundity of reproductive future episodes, or both (Hartnoll, 1985; Llodra, 2002; Begon *et al.,* 2007).

In crustaceans, morphological sexual maturity has been identified by the appearance of second-

ary sexual characteristics that appear and grow at different rates during the transition from juvenile to adult stage. These changes may or may not be coincident with the physiological maturity (Haefner, 1990; Sastry, 1983).

Although the *Persephona* species are commonly found in the Brazilian coast, there are few studies on its biology (Coelho and Torres, 1980; Negreiros-Fransozo *et al.,* 1989; Bertinni *et al.,* 2001, 2010). This study aimed to compare the distribution and size of morphological maturation of *P. lichtensteinii* and *P. punctata,* captured as bycatch during sea-bob shrimp fishery in Ilhéus coast, Bahia, Brazil.

Material and Methods

The specimes was captured as bycatch during sea-bob (*Xiphopenaeus kroyeri*) shrimp fishing in the Ilhéus coast, Bahia, Brazil. Monthly collections were performed between January and December 2004 in three sites: Olivença (14°56'S, 38°59'W), Pontal (14°49'S, 39°00'W) and São Domingos (14°43'S, 39°01'W), at a depth of about 16 m (Fig. 1).

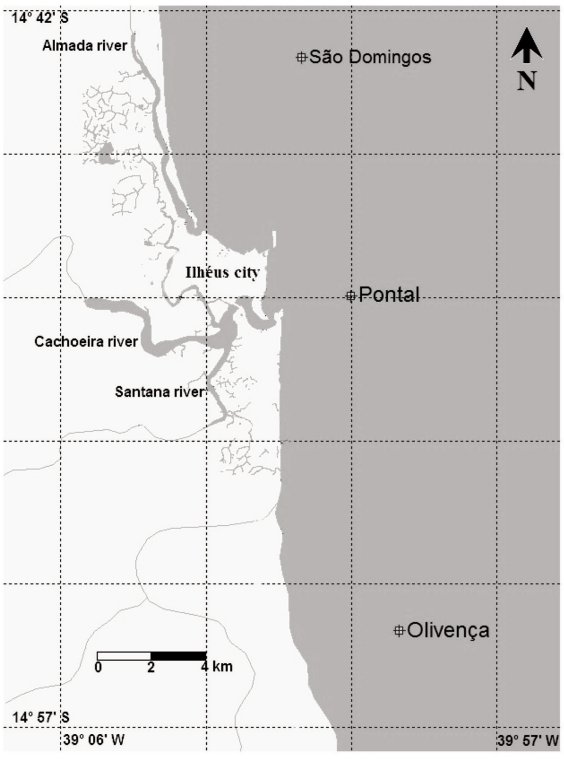

Figure 1. Location of collection sites in the study area.

Specimens were caught using a 0.55 × 1.00 m bottom trawl net, with 22 mm stretch mesh in the body and wings and 16 mm bar mesh at the cod end. It was pulled for 30 min using a boat 8 m long and with 20 HP. Individuals collected were kept in properly identified containers with ice and were later fixed in 10% formalin. At the laboratory each specimen was identified according to Melo (1996), measured (carapace width) and checked for sex and stage of morphological maturation. Morphological maturity was determined through form and adherence of abdominal somites to thoracic sternites. Adults females were considered as being those without abdominal somites adhered to sternites, with rounded shape and covering most of the ventral region. Adults males were considered as being those without abdominal somites adhered to sternites and had fully developed gonopods (Taissoun, 1969; Williams, 1974).

The size at the onset sexual maturity, defined as the size at which 50% of individuals are mature (W_{50}), was estimated by interpolation of a logistic function fitted to the percentage of adults in each size class. The fit was performed using the method of least squares.

Analysis of variance (ANOVA) ware performed to verify possible differences in the environmental variables (bottom water temperature and salinity), among seasons and collection sites and the average size of adults in relation to species and sex. ANOVA also was used for compare individuals' size among seasons. The chi-square test was performed to compare the abundance of both species at each site and season. Yates correction was

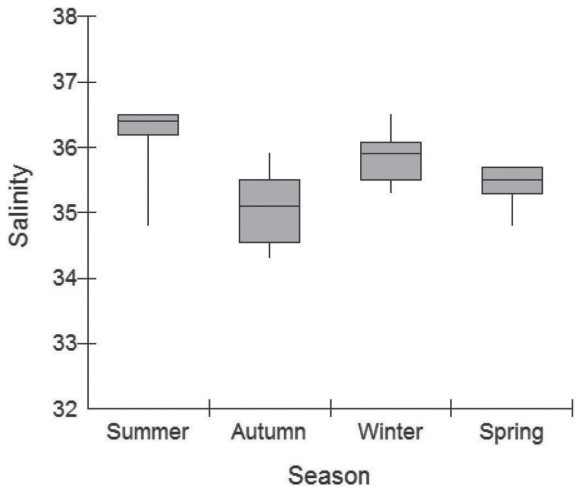

Figure 2. Seasonal rang of bottom water salinity values in Ilhéus coast.

used when appropriate. Significance level of 0.05 was assumed in all analysis. The statistical tests were performed using R software (version 2.11).

Results

No significant water temperature difference was found among collection sites (p = 0,83) and seasons (p = 0,06). Also no difference was recorded in salinity among collection sites (p = 0,71). However, significant salinity difference in relation to seasons was found (p < 0,01; Fig. 2).

We captured 183 individuals of *P. lichtensteinii* (108 males and 75 females) and 58 individuals of *P. punctata* (33 males and 25 females). *Persephona lichtensteinii* was more abundant than *P. punctata* in all seasons except winter, when no significant difference was found between the abundance of the species. Both were most abundant in the autumn. The lowest abundance of *P. lichtensteinii* occurred in winter and spring, while *P. punctata* showed lowest abundance in summer and spring. (Fig. 3).

Both species occurred in all sampling sites. *Persephona lichtensteinii* was more abundant in Olivença and Pontal, being caught mainly in Olivença. In São Domingos the predominant species was *P. punctata* (Fig. 4).

Persephona lichtensteinii showed average size of 23.12 mm ± 2.66 mm for males and 24.58 mm ± 2.64 mm for females. In *P. punctata,* the average carapace width was 32.00 mm ± 3.63 mm in males and 31.50 mm ± 2.06 mm in females. The average size of adult individuals showed significant differences between the species (p < 0,01). *Persephona*

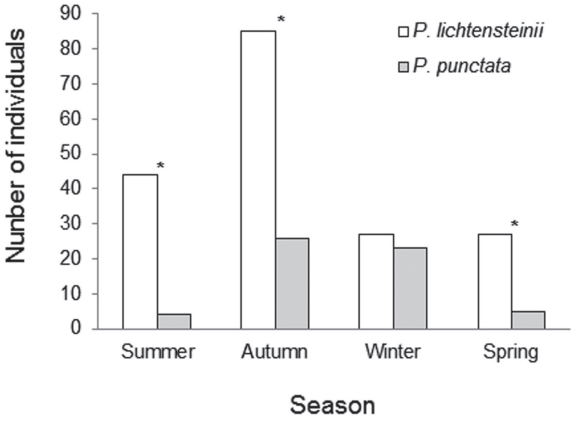

Figure 3. Number of individuals of *P. lichtensteinii* and *P. punctata* in each season in Ilhéus. Asterisks indicate significant differences between species abundance in the season.

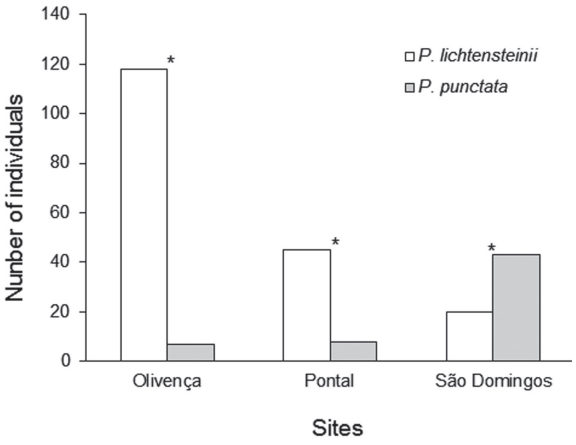

Figure 4. Number of individuals of *P. lichtensteinii* and *P. punctata* in each collection sites in Ilhéus. Asterisks indicate significant differences between species abundance in the collection site.

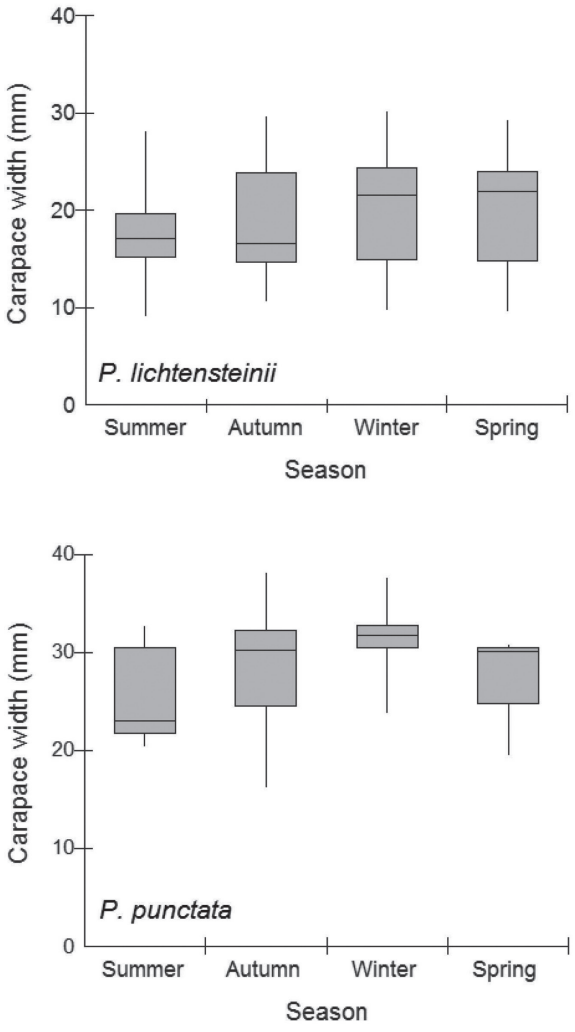

Figure 5. Carapace width of *P. lichtensteinii* and *P. punctata* in each season in Ilhéus.

punctata showed carapace width significantly greater than *P. lichtensteinii*. There was no significant difference in carapace width of adults between the sexes (p = 0,40) or interaction between species and sex in relation to this variable (p = 0,09). The individuals' size showed significant seasonal variation in both *P. lichtensteinii* (p = 0.04) as in *P. punctata* (p = 0.02). The summer and autumn were the months with greater participation of smaller individuals of *P. lichtensteinii*. For *P. punctata,* the greater proportion of smaller individuals was recorded in summer (Fig. 5).

The onset of morphological sexual maturity (W_{50}) in *P. lichtensteinii* was at 22.1 mm for males and 21.4 mm for females. Males of the species *P. punctata* reach sexual maturity with 27.6 mm and females with 25.5 mm (Fig. 6).

Discussion

The distribution and sexual maturity results of *P. punctata* and *P. lichtensteinii* show different reproductive strategies and habitat selection among these species in Ilhéus coast.

Seasonal variations in species abundance may be related to oceanographic changes in the region, as the entry of different water masses. In this study, the only significant variation in the water variables was a seasonal salinity change. There was an expressive reduction in the salinity of the summer to autumn that may have influenced the *P. lichtensteinii* distribution.

Bertinni *et al.* (2001) reported no evident seasonal variation in the Ubatuba region, São Paulo state, although the Southern Atlantic Central Water (SACW) causes strong changes in water temperature. The Ilhéus coast is not influenced by SACW (Eça, 2009) and is located in a tropical region. Thus, the water temperature without large fluctuations should not represent an important environmental variable in the local *Persephona* distribution. In other hand, coastal waters are subjected the greatest variation in salinity due to river inflow, and this may influence the distribution of species. Similar behavior has been observed in other brachyuran species in an estuarine area of the region (Carvalho and Couto, 2010).

Seasonal fluctuations in species abundance may also be related to events in the life cycle.

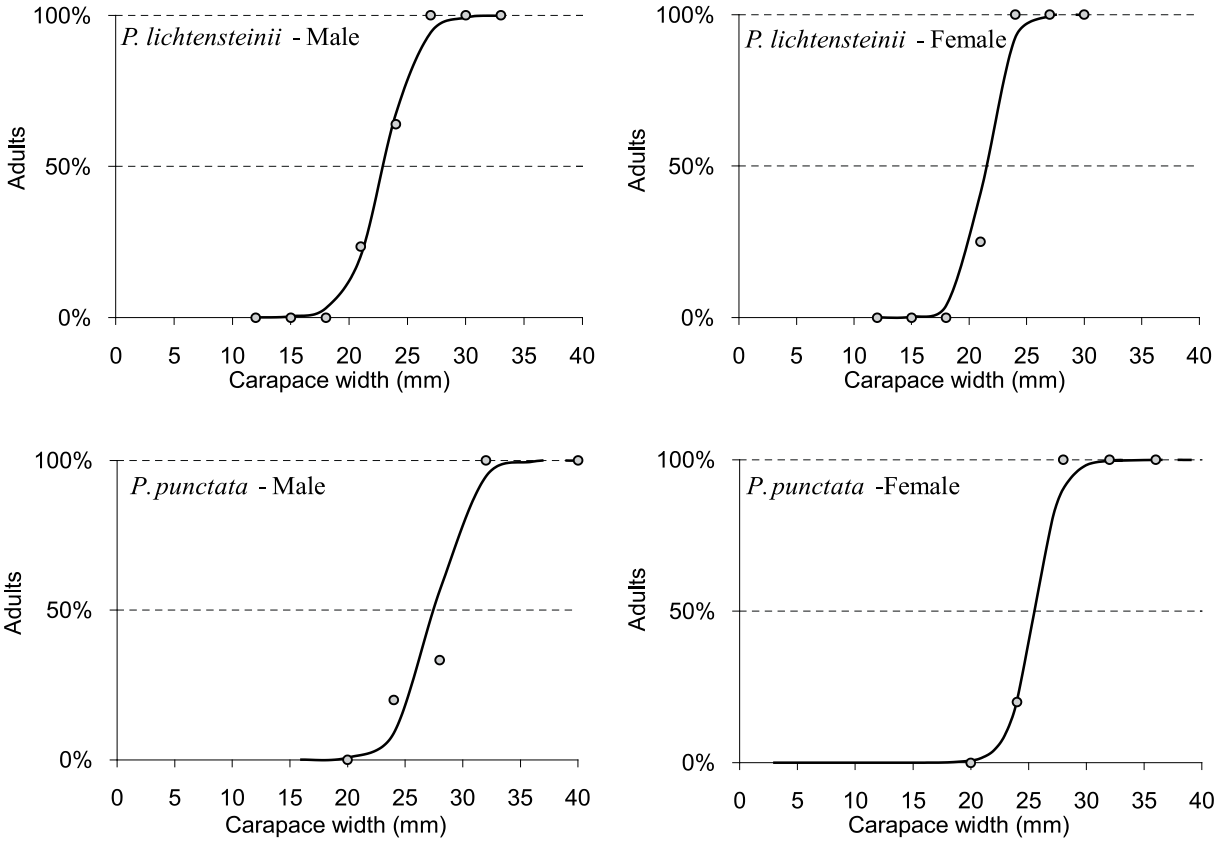

Figure 6. Morphological maturation curve for males and females of *P. lichtensteinii* and *P. punctata* in Ilhéus.

Several factors, such as recruiting, research for suitable sites for mating and spawning, among others, could cause seasonal variations in species abundance in a particular location (Branco and Masunari, 2000; Mantelatto, 2000; Carvalho and Couto, 2010). Thus, the greater abundance of *P. lichtensteinii* in summer and autumn may be related to recruitment events in the area, since the participation of smaller individuals was higher in those seasons. On the other hand, the same pattern was not observed *in P. punctata.*

The predominant species varied according to the collection site. This pattern, already reported in previous studies with *Persephona* species, is common when the distribution of sympatric congeneric brachyuran species are compared and may be related to the presence of competitors and predators, prey availability, substrate characteristics and water variables (Sánchez and Raz-Guzmán, 1997; Atrill *et al.,* 1999; Bertini *et al.,* 2001; Braga *et al.,* 2005; Carvalho and Couto, 2010).

There was no significant difference in salinity and temperature between the collection sites. However, Olivença region shows substrate characterized by coarser fractions of sediment, while in São Domingos region dominates finer fractions (*personal observation*). Thus, the difference in the relative abundance of species in relation to the sampling sites may be related to characteristics of the substrate, as observed by Bertinni *et al.* (2001) in the Ubatuba region. This pattern may be related to the burying behavior of leucosiids and the availability of different prey between these two more distant areas.

Persephona punctata and *P. lichtensteinii* did not show sexual dimorphism in relation to carapace width. However, Bertini *et al.* (2010) reported dimorphism in relation to this variable in *P. mediterranea.* Sexual dimorphism, which occurs after the puberty molt, is observed in several brachyuran species and may be related to the maximize size male need in order to their reproductive strategy success, the food handling and territory and females defence. (Mantelatto and Fransozo, 1992, 1994, 1996 and 1999; Pinheiro and Fransozo, 1998, Baptista *et al.* 2005).

The largest maturity size displayed by *P. punctata* compared to *P. lichtensteinii* can be caused by a greater investment of *P. punctata* for growth at the expense of reproduction in early ages. This strategy can be reflected in the average size of individuals, since the carapace width of adults *P. punctata* proved to be significantly greater than those of *P. lichtensteinii.*

Both growth and reproduction are life history components that compete for energy resources. Increase on a component is associated with a decrease in the other, characterizing the relationship known as trade-off (Hartnoll, 1985; Haefner and Spaargaren, 1993; Llodra, 2002; Begon, *et al.,* 2007). Thus, the resources distribution for growth and reproduction should be optimized over the life so it has a higher reproductive success.

The lack of significant difference in maturation size between the sexes in *Persephona* species reported in this study was also observed in *P. mediterranea* by Bertini *et al.* (2010). However, differences in W_{50} between males and females were recorded in several brachyuran. Some species such as *Callinectes ornatus* Ordway, 1863 (Mantelatto and Fransozo, 1996; Baptista *et al.,* 2003), *C. danae* (Smith, 1869) (Branco and Masunari, 2000) and *Goniopsis cruentata* (Latreille, 1803) (Moura and Coelho, 2004), males acquire the sexual maturity in larger size than that of females. However, *Hepatus pudibundus* (Herbst, 1785) (Reigada and Negreiros-Fransozo,1999), *Necora puber* (Linnaeus, 1767) (González-Gurrirán and Freire, 1994) and *Maja squinado* (Herbst, 1788) (Sampero *et al.,* 1999), were not recorded evident differences in maturity size between the sexes. Females can reach maturity at a smaller size than males when they invest more energy to eggs production and males allocate more energy for somatic tissue production (Mantelatto and Fransozo, 1996).

Small changes in W_{50} can be caused by individual genetic variations, food availability, presence of competitors, predators, among other factors existing in the habitat. In contrast, the occurrence of significant variations between sexes and congeneric species may be due to differences in reproductive strategy of organisms (Hartnoll, 1985; Llodra, 2002; Begon *et al.,* 2007).

Thus, one can suggest that in the study area, the species have different distribution and reproductive strategies, with *P. lichtensteinii* present a larger investment for early breeding and *P. punctata* present higher investment in growth. However, the analysis of physiological maturity and comparative studies on somatic growth, longevity, reproductive cycle, and carrying out similar studies in other areas are needed to examine whether such result is a response to some local factor or a pattern between the two species.

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