Lychnorhiza lucerna Haeckel (Scyphozoa, Rhizostomeae) and *Libinia ferreirae* Brito Capello (Decapoda, Majidae) association in southern Brazil [1]

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ABSTRACT. Associations between jellyfish and other organisms are frequently reported. Neverhteless, few of those records include crabs inhabiting medusae. *Lychnorhiza lucerna* Haeckel, 1888 were sampled (n = 1988) on the coast of the State of Paraná (25°20'-25°55'S, 48°10'-48°35'W), southern Brazil, from December 1997 to December 2004. Eight percent (166 individuals) of the medusae had one spider crab *Libinia ferreirae* Brito Capello, 1871 living within its subgenital porticus or on the oral arms. Megalopal stages of the same crab were also found on three jellyfish. All crabs associated with *L. lucerna* were young and smaller (< 3 cm) than solitary crabs caught on the bottom. Thus, *L. ferreirae* probably colonizes the jellyfish as a late larva and uses it as a floating nursery before becoming free-living on the ocean bottom as a typical adult crab.
KEY WORDS. Brachyura, Cnidaria, Crustacea, symbiosis.

RESUMO. **Associação entre *Lychnorhiza lucerna* Haeckel (Scyphozoa, Rhizostomeae) e *Libinia ferreirae* Brito Capello (Decapoda, Majidae) no sul do Brasil.** Associações entre medusas e diversos outros organismos são freqüentemente relatadas. Entretanto sobre caranguejos que vivem em águas-vivas apenas alguns registros foram encontrados. Entre dezembro de 1997 e dezembro de 2004, foram coletados 1988 exemplares de *Lychnorhiza lucerna* Haeckel, 1888 na costa do Estado do Paraná (25°20'-25°55'S, 48°10'-48°35'W), Sul do Brasil. Oito por cento (166 indivíduos) das medusas abrigavam um caranguejo aranha *Libinia ferreirae* Brito Capello, 1871 no interior de seu pórtico subgenital ou sobre seus braços orais. Megalopas da mesma espécie também foram encontradas em três exemplares de *L. lucerna*. Todos os caranguejos encontrados associados eram jovens e menores (< 3 cm) do que os espécimes solitários capturados no fundo. Os resultados indicam que *L. ferreirae* coloniza a água-viva em sua fase pós-larval e a usa como um criadouro flutuante, antes de se estabelecer no fundo como um caranguejo adulto típico.
PALAVRAS CHAVE. Brachyura, Cnidaria, Crustacea, simbiose.

Various organisms may associate with jellyfish, like zooxanthellae, fishes, amphipods, cestodes, trematodes, cephalopods, barnacles and others (Arai 1997). Associations between jellyfish and crabs are known only from few records (Tab. I). Extensive reviews, such as those of symbiotic relations of Crustacea (Ross 1983) or on the functional biology of the Scyphozoa (Arai 1997) contain no information on such associations, and only Franc (1994) briefly commented on the subject.

Benefits of these associations are not clearly understood. Medusa may serve as a simple means of transport, shelter and perhaps food for the crab (Corrington 1927, Vaz Ferreira 1972) and, at least in some cases, crab dispersal may be greatly enhanced by the jellyfish (Graham 1989). Mucous, waste particles, jellyfish prey (Corrington 1927) or tissues may serve as food for the crabs (Jachowski 1963, Shanks & Graham 1988).

Apparently, the relationship between jellyfish and crabs differs depending on the species involved. In some cases crabs spend a considerable portion of their early development within medusae – from megalops to young crabs. Then, they fall to the ocean bottom and continue their life cycle (Weymouth 1910 *apud* Corrington 1927, Graham 1989). In other cases, the association seems transient with crabs entering for preying on medusae while they are near the ocean floor (Phillips *et al*. 1969).

Information on these associations are scant because most of the records are based on punctual samples or short comments. Along the brazilian coast, only Moreira (1961) cited briefly the occurrence of *Libinia ferreirae* Brito Capello, 1871 associated with the Rhizostomeae *Phyllorhiza punctata* von Lendenfeld, 1884. Here, the available literature on jellyfish – crab associations is revised (Tab. I) and novel data on

Lychnorhiza lucerna Haeckel, 1888 and the spider crab *L. ferreirae* is described in coastal Paraná, southern Brazil, the first well documented record of this interaction.

MATERIAL AND METHODS

Jellyfish and crabs were collected with otter trawls at two sites on the coast of the state of Paraná, southern Brazil (25º20'-25º55'S, 48º10'-48º35'W). Two samples at 30 m depth were taken near Currais Islands, 20-25 km offshore, in July and August of 1999 with nets of 3 cm mesh. The second site, on the shoreline at the city of Guaratuba, at 8-14 m depth, 1-4 km offshore, was sampled monthly, between April 2001 and March 2002 (with the exceptions of June and August), with 3 cm mesh and between February 2003 and December 2004 (with the exception of June 2003 and March 2004), with two simultaneous trawls, mesh sizes 1 and 2 cm. Specimens were fixed in formalin 4% with seawater.

Width and height of genital ostia and the bell diameter of the medusa, carapace width (without spines) and length of the crabs were measured. Sex was determined in jellyfish by examination of gonadal tissue, and in crabs by abdominal morphology.

Spider crabs not associated with medusae were obtained from the 2003/2004 samples and by fishermen. All medusae species in the samples were identified following Mayer (1910) and Mianzan & Cornelius (1999) and crabs were identified following Melo (1996).

RESULTS

In 1988 individuals of *L. lucerna* collected, 166 (8%) had the spider crab *L. ferreirae* living within their genital porticus, clinging to their oral arms, or eventually on the exumbrela, always with only one crab per jellyfish. Megalops of *L. ferreirae* (identified following Pohle *et al*. 1999) were found in three medusae, but is very probable that they were overlooked.

Range and average dimensions of the medusae umbrelar diameter and genital ostium height and width are shown in table II. The measurements of crabs collected inside or outside the medusae (n = 271) are in table III. The carapace width of the associated crabs was always less than the genital ostium width of its host and, conversely, carapace width of crabs on the outside was greater.

About 70% of the associated crabs were smaller than 15 mm (Fig. 1). All of them were young (Tab. III), frequently moulting and they showed no preference for the sex of the host jellyfish ($\chi^2 = 1.096$, $p > 0.05$, Tab. II).

Of the 105 spider crabs collected on the outside of the medusae, 68 were males and 37 were females (of which 34 were spawning). Individuals found on the outside were larger than those on the inside (Mann-Whitney, $p < 0.01$, df = 270, Fig. 2, Tab. III) and most of them were carrying several organisms on their carapace, such as algae, polychaetes, sea anemones, hydroids, barnacles, bryozoans, etc.

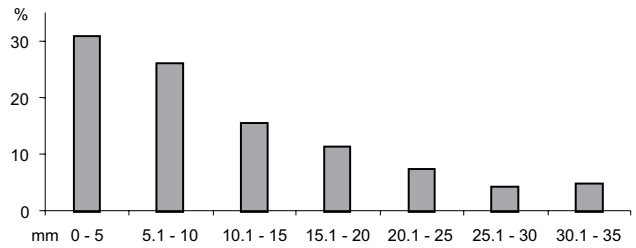

Figure 1. Size class frequency *L. ferreirae* associated with *L. lucerna* (n = 166).

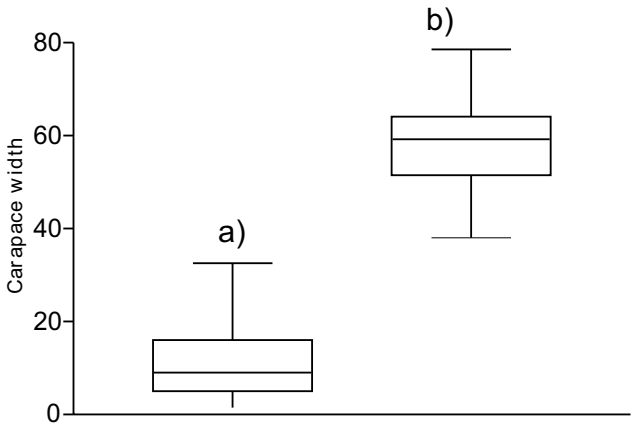

Figure 2. Comparison of *Libinia ferreirae* carapace width (in mm), living inside (a) and outside (b) *Lychnorhiza lucerna*; a and b belong to different statistical populations, Mann-Whitney, $p < 0.01$, df = 270. (–) Median; (▭) 25-75%; (⊤) range.

Lychnorhiza lucerna size class distribution shows (Fig. 3) that about 80% of all medusae obtained in the area (n = 1988) had an umbrellar diameter less than 150 mm. A greater frequency of crabs were associated with jellyfish bigger than 150 mm in diameter.

Carapace width of *L. ferreirae* was significantly correlated with the umbrellar diameter of *L. lucerna* (Spearman, $r = 0.83$, $p < 0.01$, n = 166, Fig. 4).

Seasonal variation in the association frequencies occurred during the four years studied (Fig. 5). High frequencies were found in the spring (September and October), with the exception of May 2001, when the greatest frequency was recorded (22.7%).

Other scyphozoan and cubozoan medusae found in the samples were: *Chiropsalmus quadrumanus* (F.Müller, 1859) (n = 545), *Tamoya haplonema* F. Müller, 1859 (n = 20); *Chrysaora lactea* Eschscholtz, 1829 (n = 1553) and *Phyllorhiza punctata* von Lendenfeld, 1884 (n = 50). Among them only one specimen of *P. punctata* was associated with the spider crab *L. ferreirae*.

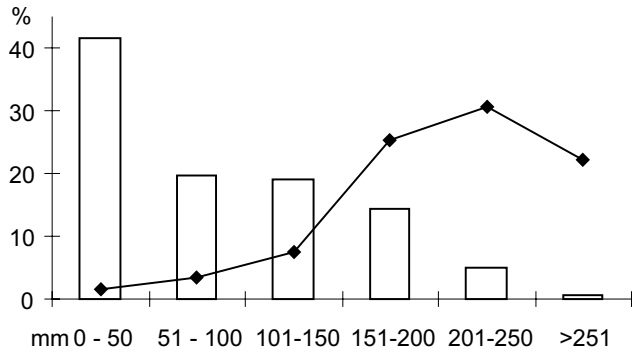

Figure 3. Size class frequency of the umbrelar diameter of *L. lucerna* and associated *L. ferreirae* frequencies. (Bars = *L. lucerna* frequencies, n = 1988; Line = frequencies of *L. ferreirae* associated on each medusa's size class; n = 166).

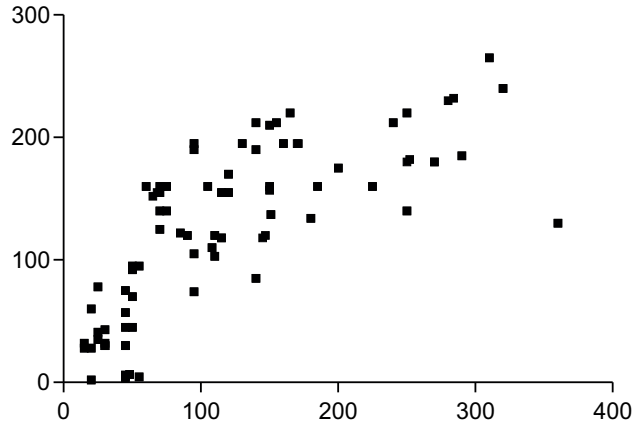

Figure 4. Dispersion graphic between the diameter of *L. lucerna* (x) and the carapace width of *L. ferreirae* (y) associated, in mm. Both variables are significantly correlated (Spearman, r = 0.83, p < 0.01, n = 166).

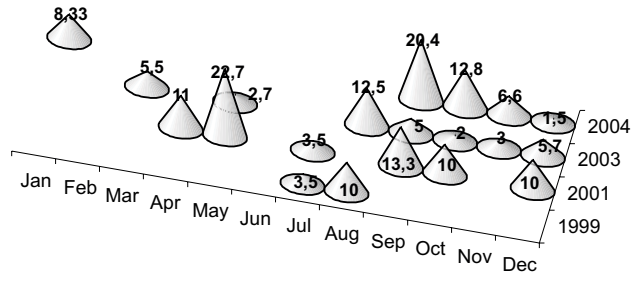

Figure 5. Temporal distribution of the frequency (%) of the association between *L. lucerna* and *L. ferreirae.* Zero frequency, months and year without samples were omitted.

Table I. Available literature on symbiotic relationships between crabs and medusae.

Medusae	Crab	Place	Reference
Unindentified	*Cancer gracilis* Dana, 1852	Puget Sound, USA	Weymouth (1910 *apud* Corrington 1927)
Stomolophus meleagris L. Agassiz, 1862 *	*Libinia dubia* Milne Edwards, 1834	South Carolina, USA	Corrington (1927)
S. meleagris *	*L. dubia*	North Carolina, USA	Gutsell (1928), Shanks & Graham (1988)
Phyllorhiza punctata von Lendenfeld, 1884 *	*L. ferreirae* Brito Capello, 1871	SE Brazil	Moreira (1961)
Aurelia aurita (Linnaeus, 1758)	*L. dubia*	Chesapeake Bay, USA	Jachowski (1963)
S. meleagris *	*L. dubia*	Mississipi Sound, USA	Phillips *et al.* (1969)
Chiropsalmus quadrumanus (Müller, 1859)	*L. dubia*	Mississipi Sound, USA	Phillips *et al.* (1969)
Chrysaora quinquecirrha (Desor, 1848)	*L. dubia*	Mississipi Sound, USA	Phillips *et al.* (1969)
C. quinquecirrha	*Callinectes sapidus* Rathbun, 1896	Mississipi Sound, USA	Phillips *et al.* (1969)
Lychnorhiza lucerna Haeckel, 1888 *	*L. spinosa* Milne Edwards, 1934	Uruguay	Vaz Ferreira (1972)
Catostylus mosaicus (Quoy & Gaimard, 1824) *	*L. dubia*	New South Wales, Australia	Coleman (1977 *apud* Browne & Kingsford 2005)
Chrysaora melanaster Brandt, 1838	*Cancer* sp.	Monterey Bay, USA	Graham (1989)
Chrysaora sp. **	*Cancer* sp.	California Bight, USA	Martin & Kuck (1991)
L. lucerna *	*L. spinosa*	Argentina	Zamponi (2002)
C. mosaicus *	Portunidae crabs	New South Wales, Australia	Browne & Kingsford (2005)
L. lucerna *	*L. ferreirae*	S Brazil	This study

* Species of Scyphozoa , Rhizostomeae; ** This *Chrysaora* species was latter named *Chrysaora achlyos* Martin, Gershwin, Burnett, Cargo & Bloom, 1997.

Table II. Summary of measurement data obtained for *L. lucerna* (in mm).

L. lucerna	Umbrelar diameter		Genital ostium height		Genital ostium width		Sex			N
	Range	Mean	Range	Mean	Range	Mean	Young	Male	Female	
Without crab	12-330	94.72	Not measured		Not measured		Not analyzed			1822
With crab	15-255	113.06	4.3-25.0	13.88	6.8-37.5	23.29	50	55	61	166

Table III. Summary of measurement data obtained for *L. ferreirae* (in mm).

L. ferreirae	Carapace width		Carapace length		Sex			N
	Range	Mean	Range	Mean	Young	Male	Female	
Inside medusa	1.5-36.2	11,4	2-33	10.11	166	0	0	166
Outside medusa	39.8-72.5	57.7	41.2-76.5	61.30	0	68	37	105

DISCUSSION

The frequency of the association of *L. lucerna* and *L. ferreirae* was low (8%). Perhaps the number of associated crabs was influenced by the collecting methods. However we do not believe this to be the case. First, crabs in association are smaller than free-living crabs, with no size overlap between the two groups (Fig. 5). Second, free-living crabs were larger than the genital ostia of the medusa, which prevents them from entering the porticus. Third, the associated crabs had a strong tendency to grasp and remain on the jellyfish, even when these are stranded, holding tightly on its host by means of the sharp and strongly curved ends of their legs, or they hid within when perturbed. Finally, some crabs may have left the medusa when they were netted, causing an underestimation of the crabs in association. Thus, while 8% association seems small, it is apparently a common, adaptive association.

It is possible that the relative abundance of the two species explains the low rate of the association. While *L. lucerna* was one of the most common medusae at the study site, the spider crab was relatively rare in our samples. This may also explain why only one crab per medusa while other authors have found two (Vaz Ferreira 1972, Zamponi 2002). However, it must be considered that if only medusae bigger than 150 mm is taken into account, the frequency is considerable higher (26.45%).

The association of *L. lucerna* with another species of *Libinia* Leach, 1815, *L. spinosa*, was very common in Argentina (Zamponi 2002). However, that conclusion was based on only four specimens of the jellyfish. Still, *L. spinosa* is abundant in Argentina (Boschi *et al*. 1992) and the jellyfish is rare near the coast (Zamponi 2002), so the young crabs may have colonized all the available jellyfish in that area.

Associated crabs were young and more than 70% of them were smaller than 15 mm. Several species of fish prey on these crabs (Vaz Ferreira 1972, Boschi *et al*. 1992). Staying inside the medusae when smaller and more vulnerable, due to several molts, may provide an important survival advantage. Also, no smaller crabs were captured as free-living forms on the ocean floor. This data was contrary to Phillips *et al*. (1969), who found *Libinia dubia* Milne Edwards, 1834 inside and outside *Stomolophus meleagris* L. Agassiz, 1862 within the same size range.

The correlation between *L. lucerna* and *L. ferreirae* sizes, and the presence of megalops suggests that the crab colonizes the medusa at a post-larval stage. They grow together for some time, until young crabs attain about 3 cm. Then, they fall to the ocean floor and become free-living as a typical adult Brachyura. Similar trends were found by Weymouth (1910 *apud* Corrington 1927) and by Graham (1989) for *Cancer* spp.

Associations were more common usually in spring. Population biology of this crab is unknown, but recruitment most likely occurs during the spring, when *L. lucerna* is abundant and large. Larger medusae are more spacious and more efficient in protecting the crab, and this is supported also by the higher frequency of association with the bigger ones. The greater association frequency in May 2001 was anecdotal and the cause is uncertain.

Libinia ferreirae have been reported in association with the Rhizostomeae *P. punctata* collected in the coast of the state of São Paulo, Brazil (Moreira 1961). In our observations, however, the only occurrence seemed occasional, since several other stranded and living specimens of this medusae were seen and no crabs were found. No other abundant medusae species, including the scyphozoan *C. lactea* and the cubozoan *C. quadrumanus* had crabs.

In addition to this study, 16 records on associations between crabs and medusae were found in the literature, including at least seven species of crabs associated with nine species of jellyfish (Tab. I). Although associations between crabs and medusae are apparently not species-specific, three species of *Libinia* appeared mainly with four Rhizostomeae jellies (eight records). These results agree with this work where *L. ferreirae* was found on Rhizostomeae only, which are usually larger and less harmful medusae, possibly due to the presence of epidermal cnidae only in the oral arms (tentacles are absent in

Rhizostomeae). Although nothing is known about *L. ferreirae* immunity to nematocysts, it is likely that they are immune or can tolerate their stings,,which may give additional protection, such as demonstrated in the spider crab *L. dubia* and the jellyfish *S. meleagris* (Shanks & Graham 1988). Cnidae resistance in *L. ferreirae* can also be noted by the high frequncy of sea anemones found on the adults living outside the medusae. This may indicate that the tolerance of cnidae lasts through its entire life cycle and to types of toxins from different taxa of Cnidaria (Scyphozoa and Anthozoa).

With respect to the type of association, we consider it probably only beneficial to the crab (Corrington 1927, Vaz Ferreira 1972, Zamponi 2002). The association could even be harmful to *L. lucerna*, if the crab feeds on parts of its host tissue, a trend not observed in this study, but reported for *L. dubia* associated with *A. aurita* (Linnaeus, 1758) and *S. meleagris*, respectively by Jachowski (1963) and Shanks & Graham (1988).

CONCLUSIONS

Associations among different taxa are important in community structure and the evolution of ecosystems. The development of the young spider crab *L. ferreirae* probably is dependent upon the jellyfish *L. lucerna* that works as a floating nursery area in the studied site.

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