

Mutualism between the sea anemone *Antholoba Achates* (Drayton, 1846) (cnidaria: actiniaria: actinostolidae) and the spider crab *Libinia spinosa* Milne-Edwards, 1834 (crustacea: decapoda, majidae)

Fabián H. Acuña^{1,2}, Adriana C. Excoffon¹ and Marcelo A. Scelzo^{1,2}

¹ Departamento de Ciencias Marinas. Facultad de Ciencias Exactas y Naturales. Universidad Nacional de Mar del Plata. Funes 3250. 7600 Mar del Plata. Argentina.

² CONICET

KEY WORDS : mutualism, sea anemone *Antholoba achates*, spider crab *Libinia spinosa*, Argentina.

Associations between sea anemones and other invertebrates have been widely studied (1, 2, 3, 4, 5, 6). The relationships between actinurians and spider crabs (family Majidae) are of two sorts: in some cases crabs are found on the column or among the tentacles of the sea anemones (7); in the second case the sea anemone, as well as other invertebrates and algae, are located on the spider crab carapace. Most of those studies were based on species from the northern hemisphere, and the knowledge about actinurian relationships from the austral hemisphere is scarce. BÜRGER (8) described the association between the crab *Hepatus chilensis* Milne-Edwards, 1837 and *Antholoba achates* (= *A. reticulata* Couthouy in Dana, 1846) in Chile. BOSCHI (9) and OLIVIER (10) observed the presence of sea anemones on the spider crab *Libinia spinosa* Milne-Edwards, 1834 from the southwestern Atlantic Ocean, but the actinurians were not identified, while ZAMPONI (11) mentioned the relationship between *Phlyctenanthus australis* (Carlgren, 1950) and *L. spinosa*. This note reports the association between the sea anemone *A. achates* and *L. spinosa* in the Argentinian sea with an analysis of the sea anemone's position on the spider crab, food items and the size relationships of the two species.

Material was collected from Mar del Plata (38°05'S, 57°32'W), Buenos Aires Province, Argentina, during shrimp captures by means of a beam-trawl at a 5-10 m depth on soft muddy-sand during fall 1999 and 2001, and preserved in 5% saline formaldehyde solution. In *L. spinosa*, carapace maximum width was measured and the blotted individuals weighed (without considering appendages

since most of them were incomplete or lost). Each individual was sexed and maturity condition determined from abdominal morphology. The position of each anemone on the carapace of the spider crab was recorded on three zones: anterior third, middle third and posterior third of the carapace. The diameter of the basal disk of each anemone was measured in situ using a calliper, and it was then detached, blotted and weighed. Reproductive condition was checked by examining the mesenteries for gonadal tissue. The gut contents of 167 individuals of the spider crab and 102 individuals of the sea anemone were analyzed and each piece of each food item was considered as one score.

Ninety three individuals of *A. achates* were found on 35 individuals of *L. spinosa* (Fig. 1). The anemones were mainly found on the posterior third of the carapace (55 %), 29 % in the middle and 16 % on the anterior part of the carapace. The *L. spinosa* individuals had a carapace width between 29.3 and 58.5 mm (mean of 42.56 ± 6.1 mm) and a weight between 9.57 and 67.89 g (mean of 35.42 ± 14.58

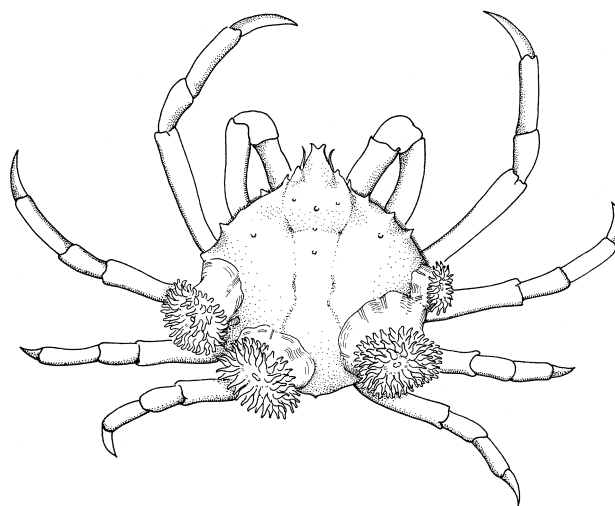


Fig. 1. – Individuals of *A. achates* on the carapace of *L. spinosa*.

g); both variables correlated ($R^2= 0.87$, $F= 304.29$, $p<0.05$ after \log_{10} transformation). Eighty percent of them were males; only one immature female and six immature males were found. Individuals of *L. spinosa* carried one to seven specimens of *A. achates* on the carapace with an average of three. The mean basal disc diameter of the actinarians, varied from 4 to 37 mm (mean of 16.03 ± 7.86 mm), and weight varied between 0.02 and 12.74 g (mean of 1.69 ± 2.12 g). The regression analysis between basal diameter and wet weight of sea anemones, after \log_{10} transformation, showed a good linear fit ($R^2= 0.947$ $F= 1568.15$, $p<0.05$). All individuals of *A. achates* were immature.

There was no relation between the number of anemones and the size of the crabs (Fig. 2), but there was a moderate correlation between the size (weight) of the anemones and the size (weight) of the crabs ($R^2= 0.449$; $F= 26.12$, $p<0.05$), indicating that the larger crabs carried the larger anemones. This can be expected, since the larger the crab, the longer the intermoult, and the longer the period during which the anemone can grow on the crab.

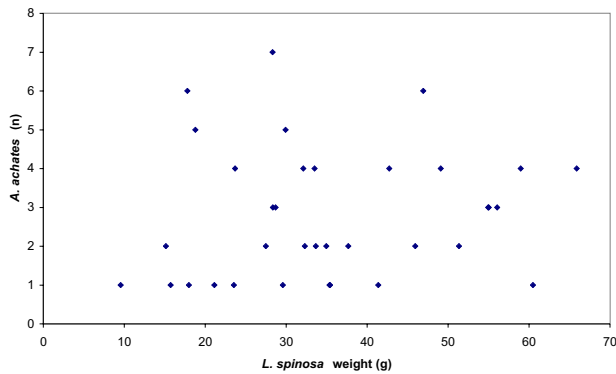


Fig. 2. – Relationship between number of sea anemones and the weight of spider crabs.

The contents of the stomach of *L. spinosa* and of the gastro-vascular cavity of *A. achates* were similar in the kind of food items, but the proportions differed. In the spider crab stomachs (Fig. 3) we mainly found unidentifiable detritus, pieces of crustaceans such as the shrimp *Artemesia longinaris* Bate, 1888; the prawn *Pleoticus muelleri* (Bate, 1888); hermit crabs *Pagurus exilis* Benedict, 1892, *P. criniticornis* Dana, 1852 and *Loxopagurus loxochelis* (Moreira, 1901); harpacticoid copepods; juvenile gastropod molluscs such as *Buccinanops monilifer* (Kiener, 1834) and *Adelomelon brasiliiana* (Lamarck, 1811); valve pieces of bivalve molluscs; scales and vertebrae of bony fish, hydropolyps and pieces of macroalgae. The main content of the sea anemone gastral cavities (Fig. 3) was composed of unidentified flesh material (probably molluscs) and also pieces of crustaceans, mainly penaeid shrimps and scales of bony fish. Some nematodes were also present.

Ectosymbioses between sea anemones and decapod crustaceans may be commensal or mutualistic in nature. In some cases, host and guest demonstrably protect each other from predators, and some anemones are fed by their mu-

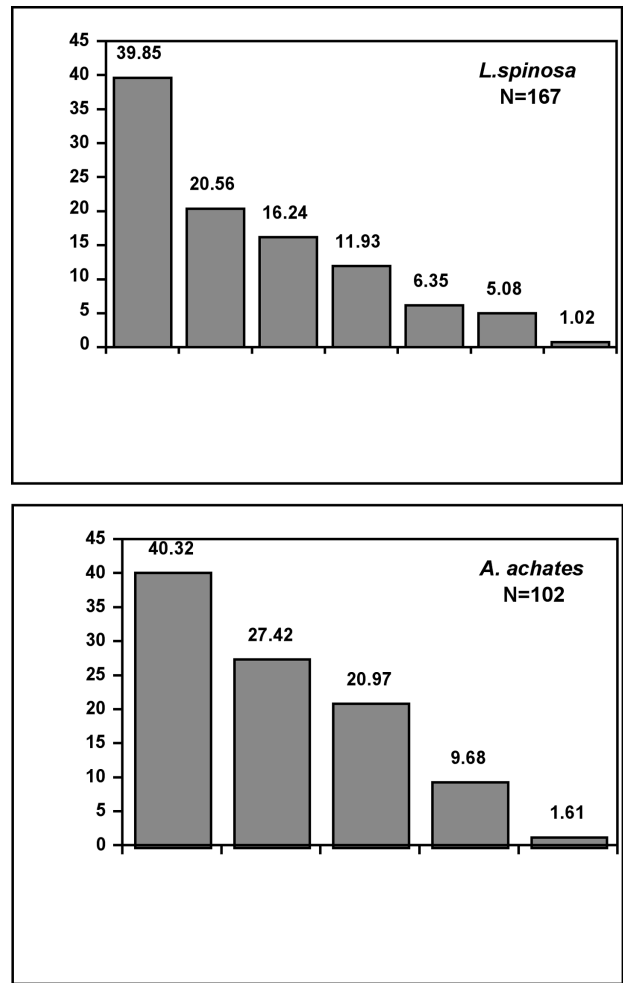


Fig. 3. – Percentage of food items in the spider crab *L. spinosa* and the sea anemone *A. achates*.

tualistic partners (12). In our study, specimens of *A. achates* were located mainly on the posterior part of carapace, so it is improbable that they have any benefit from the crab feeding, and the food items we found in the guts were quite different. According to the analysis of food items, the spider crab *L. spinosa* may be classified as detritivorous-omnivorous and the sea anemone *A. achates* as a polyphagous opportunist (13).

The relationship between *A. achates* and *L. spinosa* is probably mutualistic. The crab is camouflaged by the anemones and protected by the anemone’s cnidocysts. The carapace of the spider crab forms a hard substrate where the sea anemone can attach, important for the anemone, since the specimens were captured in a sandy-muddy, soft substrate. The anemone also acquires a greater mobility with additional benefits such as food availability and also gains protection against predators (such as aeolidians).

However, this association is not specific nor obligatory and may be temporary. In captivity, the sea anemone moved from the carapace of the spider crab to the glass wall of the aquarium, but no direct action of the spider crab was observed involving direct transference as does happen in other majid species during the decorating activities (14).

A. achates occurs frequently on gastropods and other substrates (15). Many other actiniarian species are known to change attachment site, and e. g. the site of larval settlement usually differs from the habitats eventually settled by adults (16). In the studied association, anemones were generally small and all immature, so the relationship clearly starts at the earliest stages of *A. achates*. CHINTIROGLOU et al. (17) observed that the sea anemone *Sagartiogeton undatus* (Mueller, 1778) establishes symbiotic relationships with pagurids at an early age, while CHRISTIDIS et al. (18) found a similar behaviour in *Calliactis parasitica* (Couch 1838) living on anomuran crabs.

As far as we know, *L. spinosa* is the only crab living in the Argentine Sea that carries sea anemones on its carapace. Its association with *A. achates* is mutualistic, probably temporary and restricted to the young stages of the anemone. Future studies with experimental designs will allow us to establish the mechanism by which the mutualistic relationships begin, and the role of both species.

REFERENCES

- ROSS, D.M. (1967). Behavioral and ecological relationships between sea anemones and other invertebrates. *Ocean. Mar. Biol. Ann. Rev.*, 5: 291-316.
- ROSS, D.M. (1974a). Behavior patterns in associations and interactions with other animals. In: *Coelenterate Biology: Reviews and New Perspectives*. MUSCATINE, L. & H. LENHOFF (Ed.). Academic Press, New York: 281-312.
- ROSS, D.M. (1974b). Evolutionary aspects of associations between crabs and sea anemones. In: *Symbiosis in the Sea*. VERNBERG, W. B. (Ed.). University of South Carolina Press, Columbia: 111-125.
- ROSS, D.M. (1983). Symbiotic relations. *The Biology of Crustacea, vol. 7, Behavior and Ecology*. VERNBERG, F.J. & W.B. VERNBERG (Eds.). Academic Press, New York: 163-212.
- CUTRESS, C., D.M. ROSS & L. SUTTON (1970). The association of *Calliactis tricolor* with its pagurid, calappid, and majid partners in the Caribbean. *Can. J. Zool.*, 48: 371-376.
- GUINOT, D., D. DOUMENC & C.C. CHINTIROGLOU (1995). A review of the carrying behaviour in brachyuran crabs, with additional information on the symbioses with sea anemones. *Raff. Bull. Zool.*, 43: 377-416.
- PATTON, W.K. (1979). On the association of the spider crab, *Mithrax* (*Mithraculus*) *cinctimanus* (Stimpson) with Jamaican sea anemones. *Crustaceana*, Suppl.5:55-68.
- BÜRGER, O. (1903). Ueber das Zusammenleben von *Antholoba reticulata* Couch. und *Hepatus chilensis* Milne Edwards. *Biol. Central bl.*, 23: 678-679.
- BOSCHI, E.E. (1964). Los crustáceos decápodos Brachyura del litoral Bonaerense (R. Argentina). *Bol. Inst. Biol. Mar.*, 6: 1-100.
- OLIVIER, S.R. (1976). *Elementos de Ecología*. Editorial Sur, Buenos Aires.
- ZAMPONI, M.O. (1977). La anemonofauna de Mar del Plata y localidades vecinas. I. Las anémonas Boloceroidea y Eudomyaria, Coelenterata, Actiniaria. *Neotrópica*, 23: 133-136.
- SHICK, J.M. (1991). *A Functional Biology of Sea Anemones*. Chapman & Hall, London.
- ACUÑA, F.H. & M.O. ZAMPONI (1996). Trophic ecology of the intertidal sea anemones *Phymactis clematis* Dana, 1849; *Aulactinia marplatensis* (Zamponi, 1977) and *A. reynaudi* (Milne-Edwards, 1857) (Actiniaria: Actiniidae): relationships between sea anemones and their preys. *Ciencias Marinas*, 22: 397-413.
- WICKSTEN, M.K. (1979). Decorating behavior in *Loxorhynchus crispatus* Stimpson and *Loxorhynchus grandis* Stimpson (Brachyura, Majidae). *Crustaceana*, 5: 37-46.
- SEBENS, K.P., & R.T. PAINE (1978). Biogeography of anthozoans along the west coast of South America: habitat, disturbance, and prey availability. *Proc. Inter. Symp. Mar. Biog. Evol. South. Hem.* (NZDSIR Info. Ser. 137), Auckland, 1: 219-237.
- RIEMANN-ZÜRNECK, K. (1998). How sessile are sea anemones? A review of free-living forms in Actinaria (Cnidaria: Anthozoa). *P.S.Z.N.: Marine Ecology*, 19: 247-261.
- CHINTIROGLOU, C.C., D. DOUMENC & D. KOUTSOUBAS (1991). Allométrie d'une nouvelle association entre le Décapode Anomoure *Pagurus alatus* (Fabricius, 1775) et l'Actinie Acontiaire *Sagartiogeton undatus* (Müller, 1788). *Crustaceana*, 62: 1-12.
- CHRISTIDIS, J., C.C. CHINTIROGLOU & M.B. CULLEY (1997). A study of the populations of *Calliactis parasitica* (Couch, 1842) in symbiosis with anomuran decapods in Thermaikos Gulf (N. Aegean Sea). *Crustaceana*, 70: 227-238.

Received: ???

Accepted: ???