

“LOOKING FOR A HOME”: THE ECOLOGICAL ASSOCIATION BETWEEN THE CHITONS *Ischnochiton striolatus* (GRAY, 1828) AND OTHER MOLLUSCS SPECIES

“Procurando um lar”: a interação interespecífica entre os quítons *Ischnochiton striolatus* (Gray, 1828) e outras espécies de moluscos

Beatriz C. Lopes^{1*}, Ellano J. da Silva², Inês X. Martins³

¹ Laboratório de Moluscos, Universidade Federal Rural do Semi-árido (Ufersa)

² Laboratório de Zoobentos, Instituto de Ciências do Mar, Universidade Federal do Ceará

³ Laboratório de Moluscos, Universidade Federal Rural do Semi-árido (Ufersa)

* E-mail para correspondência: beatriizz.lopes@gmail.com

ABSTRACT

The present note reports, for the first time, species of Polyplacophora found as inquilines in the gastropod Tubinella laevigata as well as documenting the same relationship with other species of mollusks in the Brazilian coast.

Keywords: *Tubinella laevigata, inquilinism, Polyplacophora.*

RESUMO

A presente nota registra, pela primeira vez, o inquilinismo de espécies de Polyplacophora no gastrópode *Tubinella laevigata*, além de relatar essa relação com outras espécies de moluscos na costa brasileira.

Palavras-chave: *Tubinella laevigata, inquilinismo, Polyplacophora.*

Throughout evolution organisms have developed strategies to maximise their survival. Interaction among species is the foundation for various properties and processes of ecosystems. Such interactions are difficult to measure and define because of the evolutionary context and environmental conditions in which organisms live (Lang &

Recebido em: 14/10/2019

Aprovado em: 21/1/2019

Publicado online em: 20/3/2020

Benbow, 2013). The Mollusca phylum participate in several interspecific ecological associations, such as: gastropods with cnidarians (Robertson, 1980; Mercier & Hemel, 2008) and with bryozoans (Morris *et al.*, 1991); bivalves with echinoderms (Goto; Ishikawa & Hamamura, 2016; Goto & Ishikawa, 2016), with annelids (Silina & Zhukova, 2012) and with crustaceans (Gonzalez & Jaramillo, 1991; Nara; Akiyama & Itane, 2008); and polyplacophora with macroalgae (Correia; Coelho & Sovierzoski, 2015), with rocks (Kaas & Van Belle, 1990; Kaas; Van Belle & Strack, 2006), with cnidarians (Tod *et al.*, 2009) and with crustaceans (Berthegar, 1968).

Polyplacophora are molluscs that occupy a wide variety of habitats such as sandstone reefs, rocky shores, seaweeds (Otaíza & Santelices, 1985; Moreira; Chapman & Underwood, 2007), marine angiosperms (Barros *et al.*, 2013), from intertidal to the supratidal zones, places that provide protection against predators and desiccation (Schill *et al.*, 2002). Nevertheless, the relationships these animals as inquilines is not well documented. Even though Boyle (1970) reports the adherence of *Sypharochiton pelliserpentis* (Quoy & Gaimard, 1835) and *Acanthochiton zelandicus* (Quoy & Gaimard, 1835) within and between the edges of oyster shells, data on the association between Polyplacophora and other molluscs is still scarce in the literature.

The present note reports the *Ischnochiton striolatus* (Gray, 1828) species of polyplacophoran found as an inquiline in the gastropod *Turbinella laevigata* (Anton, 1839) for the first time (Fig. 1A) through a year-long monitoring at Baixa Grande beach in the Northeast of Brazil. This note also reports punctual observations of the aforementioned Polyplacophora associated with the following molluscs: *Pugilina tupiniquim* (Abbate & Simone, 2015) (Fig. 1B), *Anomalocardia flexuosa* (Linnaeus, 1767) (Fig. 1C), *Voluta ebraea* (Linnaeus, 1758) (Fig. 1D) and *Crassostrea* sp. (Fig. 1F) in northeastern beaches (Table I).

Figure 1A - Specimens of *I. striolatus* in the siphonal canal of *Turbinella laevigata*; B - Specimens of *I. striolatus* associated with *Pugilina tupiniquim*; C - unidentified Polyplacophora on the bivalve *Anomalocardia flexuosa* (Photo: Ítala Oliveira); D - *I. striolatus* on the body of the gastropod *Voluta ebraea*; E - Substrate found in the survey area of Baixa Grande beach where this study was performed; F - Specimens of *I. striolatus* associated with *Crassostrea* sp. shell (dead)

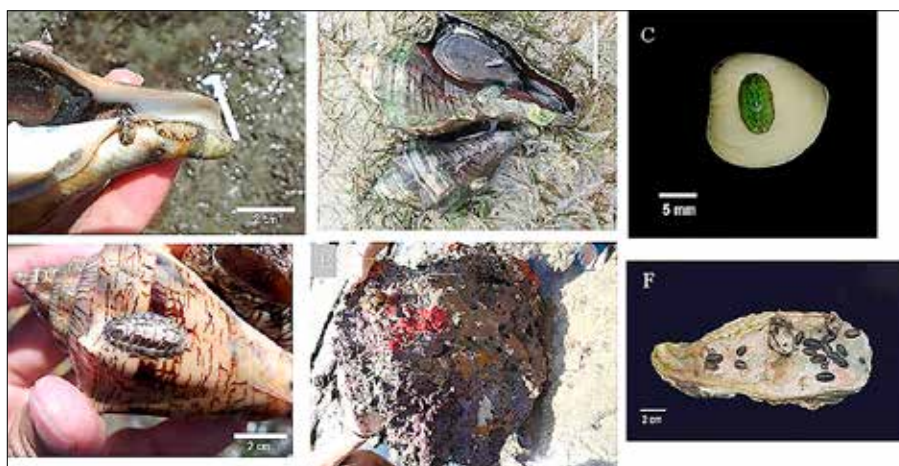


Table I – Host species of *I. striolatus* and information on the environment, substrate and location where the surveys took place and the inquilinism association was observed. Only living specimens were considered in this table

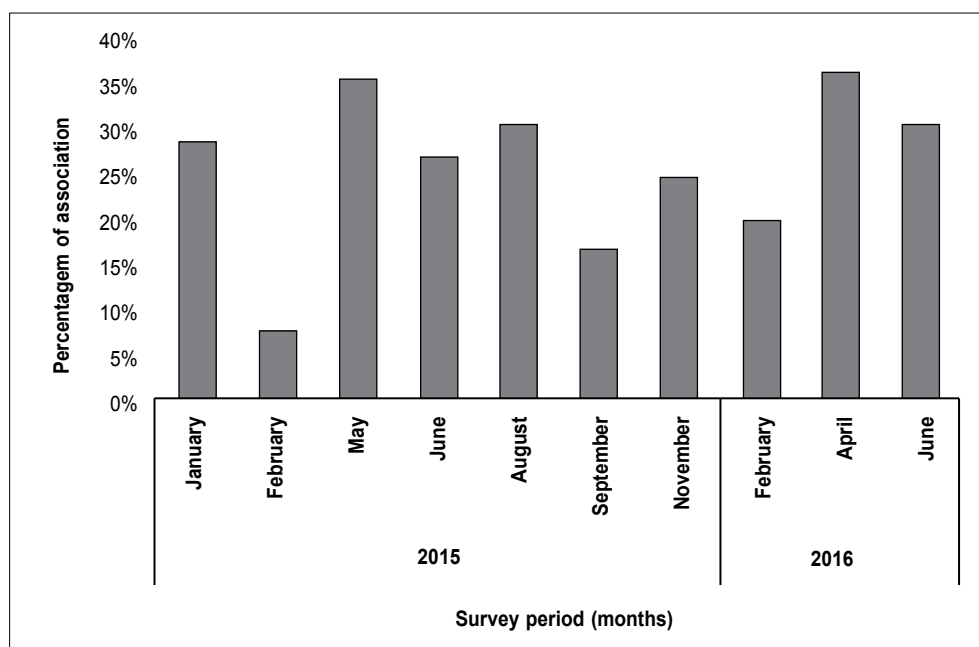
Host species	Environment	Substrate	Location
<i>Anomalocardia flexuosa</i>	Estuary	Sandy-muddy	Timonha/Ubatuba – PI
<i>Turbinella laevigata</i>	Beach	Consolidated sandstone	Ponta do Mel – RN Baixa Grande – RN Picos beach – CE
<i>Voluta ebraea</i>	Beach	Consolidated sandstone	Ponta do Mel – RN
<i>Pugilina tupiniquim</i>	Estuary	Muddy	Grossos – RN

The survey was carried out on Baixa Grande beach, in the Northeast of Brazil (4°55'45.37" S 37°4'45.12" W) between January 2015 and June 2016. The methodology employed was that of visual survey, where three researchers carried out an intense visual search for the gastropod *T. laevigata* on a sandstone reef (Area = 28.500 m²; Perimeter = 885 m). During low spring tides some sandstone reefs become fully exposed, which facilitates sampling.

The species *T. laevigata* was chosen because it is the most common gastropod (Beatriz C. Lopes, personal observation) and it is easy to visualise due to its contrasting colour (between cream and white) against that of the sandstone reef. After being located, *T. laevigata* specimens were examined in search of chitons inhabiting their shells. After this procedure, all animals were replaced exactly where they had been found and the number of chitons was recorded.

In total, 179 specimens of *T. laevigata* were found, of which, 45 presented at least one specimen of *I. striolatus* on their shell. The number of *I. striolatus* ranged from 1 to 4 per gastropod with a mean of $1.31 \pm (0.69)$. On average, 25.14% of the *T. laevigata* found during the survey had chitons occupying their shells (Fig. 2).

Figure 2 – Percentage of *Turbinella laevigata* with *Ischnochiton striolatus* on their shell, throughout the sampling period (2015-2016) in Baixa Grande Beach – RN, Brazil



Although consolidated sediment is reported by several authors as the preferred habitat by these animals (Joger *et al.*, 2008; Smith & Otway, 1997), chitons had not been found in malacofauna surveys associated with consolidated sediment in the region (Fig. 1E), this is possibly explained by *I. striolatus* preference for medium sized pebbles (Rodrigues & Absalão, 2005). Another possibility is related to the three hypothesis for polymorphic distribution mechanisms and the use of habitat by chitons elaborated by Mendonça *et al.* (2014): presence of algae that are part of the chiton's, use of rock substrate as shelter, and shape and colour of the rock substrate.

Table II - Number of Polyplacophora and Gastropods, Mean percentage of association and maximum number of chitons occupying Gastropod's shell in Baixa Grande Beach - RN, Brazil, from 2015 to 2016

Total number of <i>T. laevigata</i>	179
Total number of <i>I. striolatus</i>	62
Association percentage	25.14%
Maximum number of chitons per gastropod	4
Average (\pm SD) chitons per gastropod	1.31 \pm 0.69

We have made suggestions as to what kind of relationship was taking place between these molluscs. The following observations lead us to the conclusion that the association in question is inquilinism:

- 1) Although this relationship can be classified as commensalism, because there is a species that benefits (*I. striolatus*) from it, without causing damage to its host. The term commensalism, described by Van Beneden (1869) means "table companion". Therefore, such relationship is motivated by, or associated to the search for food. In this study, however, the host gastropods are carnivorous and the *I. striolatus* species feed on algae and diatoms, scraping the epibenthic film formed on the substrate (Piercy, 1987; Langer, 1983). Thus, this association is not motivated by the search for food, being a non-commensal relationship.
- 2) The frequent association of Polyplacophora with other molluscs may be motivated by the necessity of a suitable substrate for adhesion. On the beach where the survey took place there is no smooth surface, which would be ideal for a better adhesion. Chitons of the genus *Ischnochiton* are habitat-specialist, having specific requirements, such as pebble surfaces, in their choice of habitat (Grayson & Chapman, 2004; Rodrigues & Absalão, 2005).
- 3) The hosts' shell may serve as protection against predation and light. The host species have a habit of burying themselves in the substrate, and Polyplacophora have negative phototaxis (Kaas, Van Belle & Strack, 2006).

Inquilinism, a term coined by Gudger (1932), is defined as the regular association between different species that live together with no detriment to either of them, and without the implication of interdependence or parasitism (Fraaye & Jäger, 1995; Landman *et al.*, 2014). The same type of association was recently found among native Brazilian gastropods (Lima *et al.*, 2016): *Stramonita brasiliensis* (Claremont & D. Reid, 2011) associated with *Pugilina tupiniquim* (Abbate & Simone, 2015).

Polyplacophora are specialised in using pebbles as a microhabitat, but can adhere to other types of substrate in their absence. Compared to other intertidal or subtidal

environments, these molluscs have been found to be more frequently associated with pebbles (Grayson & Chapman, 2004). However, Barros *et al.* (2013) have observed chitons adhered to the marine angiosperm *Halodule wrightii*, rather than to the rocky substrate, and linked this to the fact that *H. wrightii* banks work as a feeding and nursery area. Mollusc shell is likely to work as an adequate substrate for Polyplacophora when their preferred substrate is not found in the environment.

Although these animals play an important role in the intertidal environment, studies on Polyplacophora are still scarce, especially in Northeast Brazil. This note sheds light on a relationship that is commonly observed, but only now documented. It is still necessary to investigate, in depth, which factors actually motivate *I. striolatus* to become an inquiline of other molluscs, using, for example, tests of preference for different substrates and micro biofouling associated with the host molluscs and their role in food intake by the Polyplacophora.

Acknowledgments - We would like to thank Ítala A. Oliveira (Labomar/UFC) and Geferson Mario (UFERSA) for the pictures of symbiotic relationships outside the state of RN. Alisson Matos (Labomar/UFC) for the valuable suggestions to the manuscript and Jaime Jardim (MZUSP) for confirming the identification of *I. striolatus*.

BIBLIOGRAPHIC REFERENCES

- Barros, K.V.S.; Jardim, J. & Rocha-Barreira, C.A. Ecological observations on polyplacophora in a *Halodule wrightii* Ascherson meadow and new records for northeast and Brazilian coast. *Revista Nordestina de Zoologia*, Recife, v. 7, n.1, p. 27- 40, 2013.
- Boyle, R.P. Aspects of the ecology of a littoral chiton, *Sypharochiton pellisekpentis* (Mollusca: Polyplacophora). *New Zealand Journal of Marine and Freshwater Research*, v. 4, p. 364-384, 1970.
- Brattegard, T. On an association between *Acanthopleura granulate* (Polyplacophora) and *Dynamene* ssp. (Isopoda). *Sarsia. Marine Biological Investigations in the Bahamas*, v. 1, p. 11-20, 1968.
- Correia, M.D.; Coelho, C.A & Sovierzoski, H.H. Polyplacophora (Mollusca) de ecossistemas de recifes e associações com macroalgas na costa de Alagoas, no Nordeste do Brasil. *Zoologia (Curitiba) [on-line]*, v. 32, n. 4, p. 289-295, 2015.
- Fraaye, R & Jäger, M. Decapods in ammonite shells: examples of inquilinism from the Jurassic of England and Germany. *Paleontology*, v. 8, n. 1, p. 63-75, 1995.
- Gonzalez, M. & Jaramillo, E. Asociacion entre *Mulinia edulis* (Mollusca, Bivalvia) y *Edotea magellanica* (Crustacea, Isopoda) en el sur de Chile. *Revista Chilena de Historia Natural*, v. 64, p. 37-51, 1991.
- Goto, R.; Ishikawa, H. & Hamamura, Y. Symbiotic Association of the Bivalve *Tellimya fujitaniensis* (Galeommatoidea) with the Heart Urchin *Echinocardium cordatum* (Spatangoida) in the Northwestern Pacific. *Zoological Science*, v. 33, p. 434-440, 2016.
- Goto, R. & Ishikawa, H. *Borniopsis mortoni* sp. n. (Heterodonta, Galeommatoidea, Galeommatidae sensu lato), a new bivalve commensal with a synaptid sea cucumber from Japan. *ZooKeys*, n. 615, p. 33-45, 2016.

- Grayson, E.J. & Chapman, M.G. Patterns of distribution and abundance of chitons of the genus *Ischnochiton* in intertidal boulder fields. *Austral Ecology*, v. 9, p. 363-373, 2004.
- Gudger, E.W. Animal associations the living together of fishes and other animals in varying degrees of dependence. *Bull New York Zool. Soc.*, v. 74, 1932.
- Jörger, K.M.; Meyer, R. & Wehrtmann, I.S. Species composition and vertical distribution of chitons (Mollusca: Polyplacophora) in a rocky intertidal zone of the Pacific coast of Costa Rica. *Journal of the Marine Biological Association of the UK*, v. 88, p. 807-816, 2008.
- Kaas, P. & Van Belle, R.A. Catalogue of Living Chitons (Mollusca, Polyplacophora). *Leiden, Backhuys Publishers*, v. 5, 1998.
- Kaas, P. & Van Belle, R.A. Monograph of Living Chitons (Mollusca: Polyplacophora). *Leiden, E.J. Brill Press*, v. 4, 1990.
- Kaas, P.; Van Belle R.A. & Strack, H.L. Monograph of Living Chitons (Mollusca: Polyplacophora). *Leiden-Boston, E.J. Brill Press*, v. 6, 2006.
- Landman, N.H.; Fraaije, R.H.B., Klofak, S.M., Larson, N.L., Bishop, G.A. & Kruta, I. Inquilinism of a baculite by a dynomenid crab from the Upper Cretaceous of South Dakota. *American Museum Novitates*, v. 3818, p. 1-16, 2014.
- Lang, J.M. & Benbow, M.E. Species interactions and competition. *Nature Education Knowledge*, v. 4, n. 4, p. 8, 2013.
- Langer, P.D. Diet analysis for three subtidal coexisting chitons from the Northwestern Atlantic (Mollusca: Polyplacophora). *The Veliger*, v. 25, p. 370-372, 1983.
- Lima, S.F.B.; Queiroz, V.; Oliveira, G.S.P.; Christoffersen, M.L. & Guimarães, C.R.P. *Stramonita brasiliensis* (Gastropoda: Muricidae) living as inquiline on the shell of *Pugilina tupiniquim* (Gastropoda: Melongenidae). *Bulletin Marine Science*, v. 92, n. 3, p. 371-376, 2016.
- Mercier, A. & Hamel, J-F. Nature and role of newly described symbiotic associations between a sea anemone and gastropods at bathyal depths in the NW Atlantic. *Journal of Experimental Marine Biology and Ecology*, v. 1, p. 57-69, 2008.
- Misra, A. & Ghatak, S.S. On some symbiotic association between different species of marine animals. *Proc. Symp. Host. Environ. Zool. Surv. India*, p. 117-134, 1983.
- Moreira, J.; Chapman, M.G & Underwood, A.J. Maintenance of chitons on seawalls using crevices on sandstone blocks as habitat in Sydney Harbour, Australia, *Journal of Experimental Marine Biology and Ecology*, v. 347, p. 134-143, 2007.
- Morris, P.J.; Linsley, R.M. & Cottrell, J.F. A Middle Devonian symbiotic relationship involving a gastropod, a trepostomatous bryozoan. and an inferred secondary occupant. *Lethaia*, v. 24, p. 55-67, 1991.
- Nara, M.; Akiyama, H. & Itani, G. Macrosymbiotic association of the myid bivalve *Cryptomya* with thalassinidean shrimps: examples from modern and Pleistocene tidal flats of Japan. *Palaeoclimatology, Palaeoecology*, p. 100-104, 2008.
- Otaíza, R.D. & Santelices, B. Vertical distribution of chitons (Mollusca: Polyplacophora) in the rocky intertidal zone of central Chile. *Journal of Experimental Marine Biology and Ecology*, v. 86, p. 229-240, 1985.
- Piercy, R.D. Habitat and food preferences in six Eastern Pacific chiton species (Mollusca: Polyplacophora). *The Veliger*, v. 29, p. 388-393, 1987.

Robertson, R. *Epitonium millicostatum* and *Coralliophila clathrata*: Two Prosobranch Gastropods Symbiotic with Indo-Pacific *Palythoa* (Coelenterata: Zoanthidae). *Pacific Science*, v. 34, n. 1, 1980.

Schill, R.O.; Gayle, P.M.H. & Köhler, H.R. Daily stress protein (hsp70) cycle in chitons (*Acanthopleura granulata* Gmelin, 1791) which inhabit the rocky intertidal shoreline in a tropical ecosystem. *Comparative Biochemistry and Physiology, Part C*, v. 131, p. 253-258, 2002.

Silina, A.V. & Zhukova, N. V. The benthic association between a bivalve and a shell boring polychaete and their potential food sources. *Oceanology*, v. 52, n. 5, p. 646-654, 2012.

Smith, K.A. & Otway, N.M. Spatial and temporal patterns of abundance and effects of disturbance on under-boulder chitons, *Molluscan Research*, v. 18, p. 43-57, 1997.

Todt, C.; Cárdenas, P.; Tore, R. & Hans. The chiton *Hanleya nagelfar* (Polyplacophora, Mollusca) and its association with sponges in the European Northern Atlantic. *Marine Biology Research*, v. 4, p. 408-411, 2009.

Van Beneden, M.P. Le commensalisme dans le regne animal. *Bull. Acad. r. Beige, Ser. 2*, n. 28, p. 621-648, 1869.