The first finding of *Ostrea* cf. *puelchana* (Bivalvia) living as epibiont on *Callinectes exasperates* (Decapoda)

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ABSTRACT. This paper describes the epibiosis of *Ostrea* cf. *puelchana* on *Callinectes exasperatus* (Gerstaecker, 1856), both collected from the estuary of the Paraíba River, in the state of Paraíba, northeastern Brazil. The basibiont crab was captured using a trap installed in mangrove area at a depth of about 2 meters. The oyster was closely attached to the left side of dorsal carapace covering most of the epibranchial, mesobranchial and metabranchial regions. Possible advantages and disadvantages for both the epibiont and the basibiont are discussed. We believe that young *O. cf. puelchana* may avoid a variety of potential predators due to the considerable movement capacity of *C. exasperatus* and may also serve as a small protective shield for the basibiont. However, the oyster, which is a bivalve with an epifaunal lifestyle, is likely to be negatively affected, mainly due to burrowing activity of the crab. This is the first record of epibiosis between bivalves of the genus *Ostrea* Linnaeus, 1758 and crabs of the genus *Callinectes* Stimpson, 1860.

Keywords: Brachyura, mangrove, marine invertebrates, Mollusca, Pteriomorphia, South America.

Introduction

Epibiosis is a spatially close, facultative association between two living organisms in which the epibiont lives attached to the surface of a basibiont used as a substrate for support during the sessile period of the life cycle (Harder, 2009; Fernandez-Leborans, 2010; Romero, Brezina, Hernández, Casadio, & Bremec, 2013; Azevedo, Brandão, Abdallah, & Silva, 2014). This non-symbiotic relationship can provide a variety of potential benefits or negative impacts for the epibiont and/or basibiont (Wahl, 1989; Wahl & Mark, 1999; Fernandez-Leborans, 2010; Machado, Sanches, Fortuna, & Costa, 2013). Unlike what occurs with symbiosis, species-specific, obligate epibions are rare and the majority of epibiotic associations are therefore classified as facultative (Wahl & Mark, 1999).

Many groups of marine invertebrates (e.g., annelids, bryozoans, cnidarians, crustaceans, mollusks, polychaetes, porifera etc.) are recognized as epizoans on a wide variety of other mobile and...
sessile invertebrates, mainly crustaceans, xiphosurans and mollusks (see Mori & Manconi, 1990; Gili, Abello, & Villanueva, 1993; Key, Jeffries, Voris, & Yang, 1996; Villegas, Stotz, & Laudien, 2005; Fernandez-Leborans, 2010; Ferrarepa & Calado, 2010; Lima, Queiroz, Bravo de Laguna, & Mioso, 2014; Lima, Queiroz, Oliveira, Christoffersen, & Guimarães, 2016; Machado et al., 2013; Romero et al., 2013).

Bivalves are known to have a multitude of lifestyles: free-living (Morton, 1973; Lützen & Nielsen, 2005), commensal (Goto, Hamamura, & Kato, 2007), mutualist (Mokady, Loya, & Lazar, 1998), epizoic (Villegas et al., 2005) or parasitic (Malard, 1903). Members of the family Ostreidae Rafinesque, 1815 are among the sessile marine invertebrates that live on a variety of abiotic and biogenic substrates (Slack-Smith, 1998; Fernandez-Leborans, 2010). These bivalves have been reported specifically as epizoans on mangrove roots, gorgonians, corals (Slack-Smith, 1998), decapod crustaceans (Fernandez-Leborans, 2010) and other mollusks (Fernandez-Leborans, 2010; Farrapeira & Voris, & Yang, 1996; Villegas, Stotz, & Laudien, 2005), epizoic (Villegas et al., 2005) or parasitic (Malard, 1903). According to Slack-Smith (1998), these bivalves have a multitude of host species, including flatfish, spiny lobsters, sponges, corals, and sponges. In the literature, this epibiotic relationship is recorded for the first time herein and is known as "manzau" [see Carvalho and Couto (2011)].

Sampling and treatment of samples

A total of 21 crabs were captured using traps known locally as “manzau" [see Carvalho and Couto (2011)]. Five traps were linearly installed on the bed of a small affluent at a depth of approximately 2 m in the mangrove area at low tide. Each trap contained 100 g of bait consisting of a mixture of beef (90%) and fish (10%). The traps were examined every 24 hours for three days and captured specimens were removed. An oyster found cemented to the carapace of a crab was photographed immediately after collection (Figure 2). All specimens, including the basibiont, were placed in plastic recipients with seawater, stored in a cold container and then fixed in 70% ethanol for subsequent identification. In the laboratory, the oyster was removed from the crab carapace. Crab is housed in the Paulo Young Invertebrate Collection, Department of Systematics and Ecology of the Universidade Federal da Paraíba (UFPB CRUSTACEA 6165 ♀), João Pessoa, Paraíba, Brazil and oyster is deposited in the mollusc collection, Museu de Zoologia, Universidade de São Paulo (MZSP 131977), São Paulo, Brazil.

Results

The carapace of Callinectes exasperates served as a favorable, sufficiently large, firm substrate for the opportunistic occupation of Ostrea cf. puelchana. The carapace is heavily armored, dorsoventrally flattened and relatively rough, composed of numerous small tubercles that offer favorable conditions as a biogenic surface for the settlement and growth of the oyster. The specimen of O. cf. puelchana had a wet weight of 0.81 g and a shell length of 27 mm, with the shell occupying an area of 4.3 mm². The specimen of C. exasperates had a wet weight of 53.5 g.
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and a carapace width of 104 mm. The epibiont covered about 20% of the dorsal surface of the carapace (Figure 2). The oyster was closely attached to the left side, covering 60 to 70% of the epibranchial surface and about 90% of the mesobranchial and metabranchial regions. The antero-ventral and postero-ventral parts of the left valve of the oyster were completely cemented to the carapace of the crab, while the antero-dorsal and postero-dorsal parts of the valve (except part of the submedian margins) were not cemented, and only loosely covered the carapace.

Discussion

Information on oysters as epibionts on recent mobile marine invertebrates is scarce (Winter & Masunari, 2006; Eschweile & Buschbaum, 2011). However, fossil records seem not to be uncommon (Cope, 1968; Bishop, 1981; Tshudy & Feldmann, 1988; Fernandez-Leborans, 2010; Paul & Simms, 2012; Zell et al., 2014). Such records include Liostrea roemeri (Quenstedt, 1843) attached to the shells of ammonites in the Jurassic to Cretaceous periods in northeastern Mexico (Zell et al., 2014) and Pycnodonta vesiculosa (Sowerby, 1823) living on the lobster Hoploparia stokesi (Weller, 1903) in the Cretaceous period in Antarctica (Tshudy & Feldmann, 1988). This is the first record of epibiosis between bivalves of the genus Ostrea Linnaeus, 1758 and crabs of the genus Callinectes Stimpson, 1860.

The case of epibiosis found here in the current stage of the species is obviously favorable to the epibiont and also seems to be advantageous to the basibiont. The considerable capacity for movement of the basibiont may be advantageous to the epibiont with regard to the avoidance of predators and the obtainment of nutrients. Oysters are predated by a number of marine invertebrates, such as platyhelminthes (Littlewood & Marsbe, 1990; O’connor & Newman, 2001), crustaceans (Elner & Lavoie, 1983; Eggleston, 1990), polychaetes (Sabry & Magalhães, 2005;Radashevsky, Lana, & Nalesso, 2006) and other mollusks (Carriker, 1955; Herbert, Dietl, Fortunato, Simone, & Sliko, 2009). Studies suggest that an epizoitic lifestyle is beneficial by hindering the approach of sedentary predators due to the movements or defensive shield of certain basibionts (Wahl, 1989; Abelló, Villanueva, & Gili, 1990). Epibiont invertebrates (e.g., hydroids, polychaetes and barnacles) on decapods may also benefit from resuspended debris (Williams & Moyse, 1988) or the diet of the host (Bowers, 1968; Abelló et al., 1990).
Conversely, settling on a crustacean could be a poor option. The carapace of *Callinectes exasperates* is an available hard substrate for the attachment of Ostrea cf. *puelchana* mainly in a predominantly soft sediment environment. However, some aspects of the biology of crustaceans and the ecology of *C. exasperates* may negatively affect an epibiont. Ecdysis (molting) makes the carapace of crustaceans only a semi-permanent substrate for epizoans (Ross, 1983; Wahl, 1989; Gili et al., 1993). As a result, there are few reports of epibiosis between bivalves and crustaceans (Gili et al., 1993; Villegas et al., 2005). *Ostrea* cf. *puelchana* may also be negatively affected by stressful environmental conditions due to the burrowing activity of *C. exasperates* (Abelló et al., 1990; Fernandez-Leborans, 2010).

According to Wahl and Mark (1999), epibiosis may negatively affect basibions by increasing weight and friction, decreasing flexibility, shading basibions from light and access to dissolved nutrients or inflicting 'shared doom'. On the other hand, basibions may benefit from the presence of epibions due to effects such as optical and chemical camouflage, reduced friction, protection against desiccation and harmful irradiation or associational defense. The continued growth of an epibiont oyster to adulthood on the carapace of *Callinectes exasperates* could adversely affect the buoyancy and locomotion of the latter, making the crab more vulnerable to predation. A similar harmful pattern has been seen involving the oyster *Crassostrea gigas* (Thunberg, 1793), which impaired the mobility of the gastropod *Littorina littorea* (Linnaeus, 1758). Villegas et al. (2005) report that the epibiont mussel *Seminnitulus algosus* (Gould, 1850) is apparently unfavorable to the basibiont *Emerita analoga* (Stimpson, 1857) by increasing its mass and damaging the surface of the carapace as well as reducing the growth and buoyancy of this sand crab. However, the specimen of *Ostrea* cf. *puelchana* in the juvenile stage described in the present study likely did not have a negative effect on the basibiont *C. exasperates* as the oyster (weight: 0.81 g) was attached to only about 20% of the dorsal carapace and did not overlap any appendage or other articulated structure on the carapace and therefore probably did not impair movement, flexibility or the function of organs in the basibiont. The same pattern has been reported in other cases of epibiosis among marine invertebrates (Overstreet, 1983; Wahl, 1989; Cadée, 1991; Wahl & Mark, 1999; Fernandez-Leborans, 2010). Furthermore, no injuries were found on the carapace of the crab after the removal of the oyster. Another important point is that the shell of this ostreid may offer additional protection from potential predators of the crab. There are many examples of epibions that may discourage predation on basibions (Feifarek, 1987; Laudien & Wahl, 1999; Marin & Belluga, 2005).

The specimen of *Ostrea cf. puelchana* was able to grow on the carapace of *Callinectes exasperates* enough to reach about half its adult size (27 mm in shell length) without being affected by the process of ecdysis. Thus, the oyster may have been between three and four months of age (based on growth rate of other ostreids, such as *Crassostrea gigas*) (Acosta Ruiz & Gutiérrez Wing, 1996) and the basibiont was an adult crab in terminal an ecdysis, thereby providing a rather stable substrate for the epibiont. The carapace width of the crab studied herein was within the estimated size (61 to 160 mm) for first gonadal maturation, based on data from congeners (Tagatz, 1968; Branco & Masunari, 1992; Branco & Lunardon-Branco, 1993; Severino-Rodrigues, Musiello-Fernandes, Moura, Branco, & Caneo, 2013; Sumer, Teksam, Karatas, Beyhan, & Aydin, 2013), which live between 2.3 and 4 years (Tagatz, 1968; Williams, 1974; Ferreira & D’incao, 2008;
Keunecke, D’Incao, Moreira, Silva, & Verani, (2008). However, biological data on 
*C. exasperates* are practically non-existent, likely due to low abundance 
of the species. Furthermore, oysters are filter feeding 
ivalves adapted to a sessile epifaunal lifestyle in marine or brackish waters and are dependent on 
hard substrates (Amaral & Simone, 2014).

### Conclusion

This study expands knowledge on the diversity of epibiosis among marine invertebrates through the 
record of the bivalve *Ostrea cf. puechhana* attached to the 
crab *Callinectes exasperates* on the coast of Brazil. The case epibiosis found apparently not adversely 
affected both epibiont and basibiont. However, future studies on the biology and life cycle of the 
crab and oyster will be decisive to the determination of factors that are either favorable or unfavorable.

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