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Epibionts on *Aequipecten tehuelchus* (d'Orbigny, 1846) (Pectinidae) in shelf waters off Buenos Aires, Argentina

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Abstract. *Aequipecten tehuelchus* (d'Orbigny, 1846) is a commercial resource, distributed from Rio de Janeiro (Brazil) to Golfo Nuevo (Argentina), on sandy and muddy bottoms. In Argentina, the major banks of exploitation are located in the gulfs of San José and San Matías. This study represents the first ecological study of *A. tehuelchus* in shelf waters off Buenos Aires, Argentina. Eighteen epibiont taxa were registered on the individuals analyzed. Polychaetes were the most frequent epibiotic organisms (82%), including Serpulidae (Rafinesque, 1815), *Phyllochaetopterus socialis* (Claparède, 1869), *Idanthyrsus armatus* (Kingberg, 1807) and *Chaetopterus antarcticus* (Kingberg, 1866). *Ostrea puelcheana* (d'Orbigny, 1842), *Balanus* cf. *amphitrite* (Darwin, 1854) and solitary ascidians were found on less than 30% of the sampled individuals. Bryozoa and Porifera were scarcely represented. *Phyllochaetopterus socialis, I. armatus* and *Balanus* cf. *amphitrite* were most frequent on the upper (left) valve. This study nearly doubles the number of epibionts identified and mentioned on *A. tehuelchus* in Patagonian Gulfs. Three individuals of the commensal pea crab *Tumidotheres maculatus* (Say, 1818) were found inside three different specimens of *A. tehuelchus*. One left scallop valve was burrowed into by the parasitic polychaete *Polydora* (Bosc, 1802).

Key words: Epibiosis, scallop, SW Atlantic Ocean

Epibiosis, a common phenomenon in the marine environment, is the association between epibionts (organisms growing attached to a living surface) and basibionts (organisms that provide substrate to the epibionts). This association creates a complex network of benefits and disadvantages for both organisms (Wahl 1989, 2009). Filter-feeding epibionts possibly profit from the nutrient currents created by certain hosts (Laihonen and Furman 1986), but it has been suggested that energy flow between epiphytic partners may occasionally come to benefit of the host (Harlin 1973).

Frequently epibiotic cover can play a protective role (Wahl 1989) or reduce the predation of basibionts (Ward and Thorpe 1991) and in this form the danger of falling victim to predators of the substrate organism is one of the greatest hazards in an epibiont's life (Cuomo *et al*. 1985). However, fouling organisms (e.g. Porifera, Cnidaria, Serpulidae, Bryozoa) can compromise movement capabilities of hosts (Dixon *et al*. 1981, Cuomo *et al.* 1985) reducing possibilities to escape from predators (Cerrano *et al.* 2009) or reducing larval dispersal feeding on newly released larvae (Cerrano *et al.* 1998). In addition, the epibionts cause difficulty in opening and closing the valves, thus affecting the feeding and breathing in bivalves (Uribe *et al*. 2001). Epibiont organisms are often themselves filter feeders so they may compete with the hosting species for food resources (Claereboudt *et al*. 1994).

Epibiotic invertebrates encrust the valves of scallops around the world, mainly in areas with predominant soft bottoms (e.g. Ward and Thorpe 1991, Claereboudt *et al*. 1994, Rosso and Sanfilippo 1994, Sanfilippo 1994, Cerrano *et al*. 2006, Schejter and Bremec 2007a). The tehuelche scallop, *Aequipecten tehuelchus* (d'Orbigny, 1846), is a commercial resource, distributed from Rio de Janeiro (Brazil) to Golfo Nuevo (Argentina), on sandy and muddy bottoms (Olivier *et al.* 1970). In Argentina, artisanal fishery by means of diving has developed mainly at the San José and San Matías Gulfs (42° S). Numerous studies on the biology, anatomy, physiology, population dynamics and fishery have been carried out on this pectinid (see Ciocco *et al*. 2006). However, most studies were conducted in Patagonian gulfs and there are only faunistic records outside of this area (e.g. Carcelles 1944, Castellanos 1970). During 2002, a monitoring program was conducted between 39–40°S and nearly 45 m depth to locate potentially exploitable beds of tehuelche scallop. During those expeditions, heterogeneous areas were sampled, including patches with dominance of eunicid polychaetes, ascidians, mussels, and also some dominated by the tehuelche scallop (Schejter and Bremec 2007a). In this paper we aim to identify and quantify epibiotic richness on *A. tehuelchus*. This research contributes to the understanding of the benthic community structure from soft bottoms off Buenos Aires, information also useful in a fisheries context.

MATERIALS AND METHODS

The study material comes from six benthic community samples taken in 2002 between 39°01′–39°40′S and 58°40′–60°21′W on board the FV "Erin Bruce" with otter trawls. Additionally two other samples collected with dredges at 38°26′S–57°40′W and 38°28′S–57°41′W in 2004 by the RV "Capitán Cánepa" INIDEP were analyzed (Fig.1). All samples were frozen on board and then preserved in 5% formaldehyde. Two hundred and twenty seven scallop individuals of different sizes were examined. In the laboratory, the epibionts on *Aequipecten tehuelchus* were identified to the lowest possible taxonomic level. Presence-absence and quantitative data of epibionts were recorded for lower (right) and upper (left) valves. The McNemar test for paired proportions (Sokal and Rohlf 1979) was used to establish preferences of the epibionts for any of the scallop valves.

Valves were arbitrarily divided into seven areas to establish the preference of the epibionts for any region following the procedure modified after Ward and Thorpe (1991) and Sanfilippo (1994) by Schejter and Bremec (2007a) (Fig. 2A). For this analysis, the individuals greater than 50 mm were considered; maximum shell height was measured with calipers to the nearest mm.

RESULTS

Scallops ranged from 40 to 88 mm total shell height (average = 73mm). Eighteen epibiont taxa were registered on the individuals analyzed (Table 1; Fig. 2). Ninety one percent of the examined tehuelche scallops showed epibionts. Polychaetes were the most frequent epibiotic organisms (82%). *Serpula* sp. was present on 75% of the sampled scallops, followed by Spirorbinae (28%), *Phyllochaetopterus socialis* (21%), *Idanthyrsus armatus* (11%) and *Chaetopterus antarcticus* (0.4%). *Serpula* sp. encrusted both valves, *P. socialis* and *I. armatus* showed a preference for the upper (left) valve (McNemar test: left $\chi^2 = 6.56$ and $\chi^2 = 5.5$ respectively, $P < 0.05$), while Spirorbinae was more frequent on the lower valve (right) (McNemar test: right $\chi^2 = 13.13$, $P < 0.05$) (Fig. 3).

In general, polychaetes frequently settled on the seven regions of the valves. *Idanthyrsus armatus* presented low frequency of occurrence, 4.35%, in regions 6 and 7 (auricular area) and *Phyllochaetopterus socialis* showed 7.9% in region 4 (Fig. 4).

Solitary ascidians were found on 27.7% of the sampled scallops, in both valves and in all regions (Figs. 3, 4).

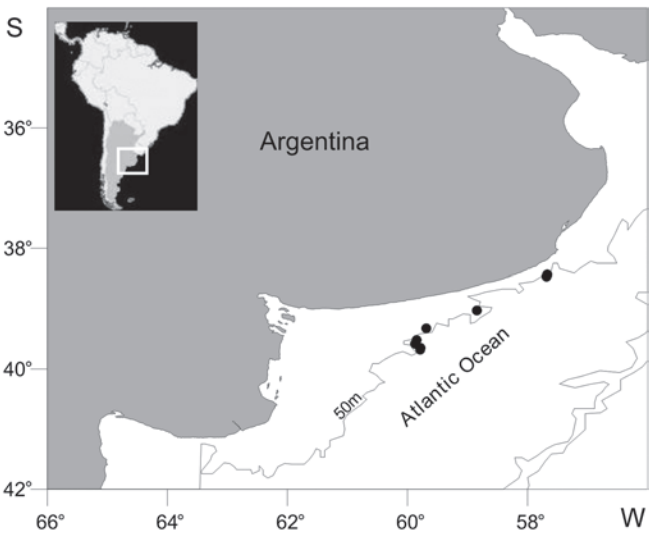

Figure 1. Map of the sampling area, Argentina. The dots (●) represent the trawling sites.

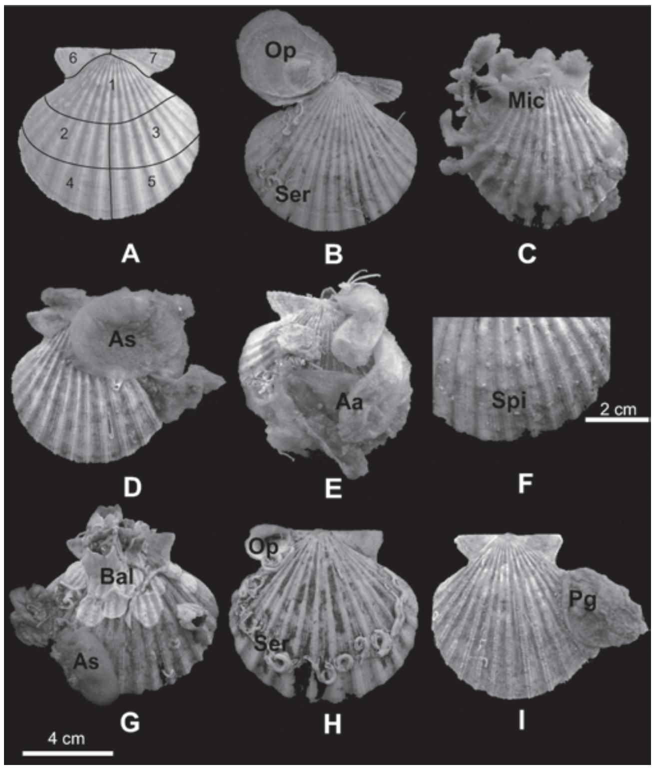

Figure 2. *Aequipecten tehuelchus* epibionts in the study site. **A**, diagram showing the division of each valve into 7 arbitrary regions. **B**, one individual of *Ostrea puelchana* (**Op**) and some *Serpula* sp. tubes (**Ser**). **C**, Microcionidae (**Mic**). **D**, Ascidiacea (**As**). **E**, several individuals of *Ascidiella aspersa* (**Aa**). **F**, several tubes of Spirorbinae (**Spi**). **G**, *Balanus* cf. *amphitrite* and Ascidiacea. **H**, *Ostrea puelchana* and *Serpula* sp. tubes. **I**, *Paramolgula gregaria* (**Pg**).

Table 1. List of epibionts on *Aequipecten tehuelchus* in the study site.

Taxa
PORIFERA
Microcionidae
Dictyoceratida
ANNELIDA
Eunice juvenile
Chaetopterus antarcticus Kingberg, 1866
Phyllochaetopterus socialis Claparède, 1869
Idanthyrsus armatus Kingberg, 1807
Polydora sp.
Serpula sp.
Spirorbinae
MOLLUSCA
Ostrea puelchana d'Orbigny, 1842
ARTHROPODA
Tumidotheres maculatus (Say, 1818)
Balanus cf. *amphitrite* Darwin, 1854
BRYOZOA
Bryozoa unidentified
CHORDATA
Paramolgula gregaria (Lesson, 1830)
Cnemidocarpa robinsoni Hartmeyer, 1916
Ascidiella aspersa (Müller, 1776)
Pyura legumen (Lesson, 1830)
Ascidiacea

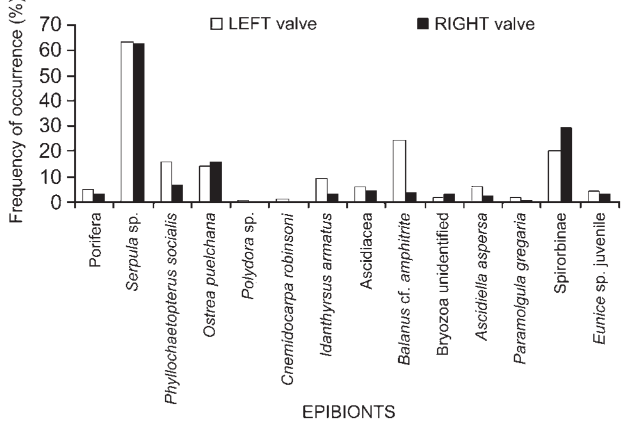

Figure 3. Frequency of occurrence of epibionts in both valves of *Aequipecten tehuelchus*, Buenos Aires, Argentina.

Oysters, *Ostrea puelchana* (d'Orbigny, 1842), were found on 24.7% of the sampled individuals, in all regions, and showed similar occurrence on both valves (14% on left valve and 16% on right valve) (Figs. 3, 4).

Cirripeds were found on 24% of the sampled scallops; they were present on 47 (24.5%) upper valves and on only 7 (3.65%) lower valves (Fig. 3). *Balanus* cf. *amphitrite* showed a preference for the upper (left) valve (McNemar test: left $\chi^2 = 30.42$; $P = 0.05$), with presence in all regions, conspicuously in region 1 (Fig. 4).

Bryozoa (3.5%) and Porifera (7.9%) were uncommon epibionts and were present on both valves and all regions. Region 1 was conspicuously encrusted by Porifera (81%) (Fig. 4).

Two males (6.5–6.6 mm carapace length) and one female (11 mm carapace length) of the pea crab *Tumidotheres maculatus* (Say, 1818) were found inside three different specimens of *Aequipecten tehuelchus*. One left scallop valve was burrowed into by the parasitic polychaete *Polydora* sp.

DISCUSSION

In the present study 91% of the *Aequipecten tehuelchus* examined off Buenos Aires province between 38–39°S and 45–50 m depth showed epibionts and the number of epibiotic taxa associated was 18. Previous information on the same scallop species from San Matías Gulf (41–42°S) at 50 m depth, mentions 10 taxa on almost all individuals (98%) (Olivier *et al.* 1970). In general, the main invertebrate groups encrusting *A. tehuelchus* are coincident in both areas, mainly serpulids, barnacles and oysters, however algae were found only in San Matías gulf. The species richness of epibionts associated with the scallops and the pattern of colonization reflects the life habits of scallops and varies between the pectinid species (Rosso and Sanfilippo 1991, Cerrano *et al.* 2006, Schejter and Bremec 2007a, b). We analyzed 227 individuals of tehuelche scallop and found 18 epibiotic taxa. Preliminary results considering only 158 individuals of tehuelche scallop showed the same number of epibiont taxa (Souto *et al.* 2008). Compared with studies in other pectinids around the world, *A. tehuelchus* presented a relatively low number of epibionts. Forty-nine taxa were associated with *Placopecten magallanicus* (Gmelin, 1791) in the lower Bay of Fundy (Canada), the sediment in this area is made up of a mixture of sand, clay, pebbles, boulders and cobbles (Fuller *et al.* 1998). At least 43 taxa were associated with *Adamussium colbecki* (Smith, 1902) in Antarctica (Bertolino 2004), region where seabed is characterized by pebbles of various sizes in shallow waters, changing to fine-grained, muddy sediments below 40–50 m in depth (Cerrano *et al.* 2006). Seventy epibiotic taxa were associated with *Zygochlamys patagonica* (King, 1832) in several banks distributed in soft bottoms of the Argentine Continental shelf (Schejter and Bremec 2007b, Lopez Gappa and Landoni 2009).

The number and composition of epibionts found in *Aequipecten tehuelchus* is coincident with that found in *Flexopecten felipponei* (Dall, 1922) by Schejter and Bremec (2007a) in the same sampling area. However the presence of

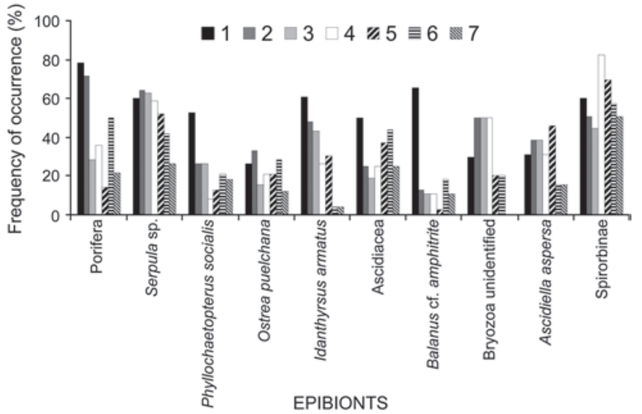

Figure 4. Frequency of occurrence of epibionts on each region of the valves of *Aequipecten tehuelchus*, Buenos Aires, Argentina.

Porifera was only recorded in the present study. Although sponges were found in few individuals (7.9%), when present, they reached important shell coverage. Sponges were scarcely recorded (< 5%) in the faunistic composition of the study area. Their presence on *A. tehuelchus*, but not on *F. felipponei* (Schejter and Bremec 2007a), could be related to the higher relative abundance of the former species in the study area. However, presence/absence of any kind of chemical compound, shell structure, competition and other interactions among epibionts could not be discarded as possible explanations of epibiotic taxa found (Wulff 2006). *Aequipecten tehuelchus* presents prominent ribs and riblets ornamented by lamellae, while the surface of *F. felipponei* is smooth.

Among other shell traits that affect potential colonization by epibiont organisms, shell size is particularly important. Larger shells usually support more individuals of a given fouling species (Rosso and Sanfilippo 1991, Gutierrez *et al.* 2003) and a greater richness of fouling species than smaller ones (Ward and Thorpe 1991). The total surface encrusted tends to increase progressively from the small scallops to the large ones (Rosso and Sanfilippo 1991). In our study, we analyzed 25 individuals ranging from 11 to 26mm. Most of these specimens showed both valves free of epibionts, with the exception of a few with low coverage of cirripeds on the upper valve. These scallops came from the northern sampling locations populated by *Mytilus edulis platensis* (d'Orbigny, 1846) banks and associated invertebrates species (Bremec and Roux 1997), while the heavily encrusted and bigger ones came from the southern sampling stations where the dominant species were *Aequipecten tehuelchus, Mytilus edulis platensis,* Ascidiacea *(Paramogula gregaria, Ascidiella aspersa, Cnemidocarpa robinsoni*) and *Eunice magellanica* (Schejter and Bremec 2007a). The variability of the sublittoral sediment types off Buenos Aires, with dominant soft bottoms and patches of hard substrates, establishes the existence of different benthic assemblages (Roux *et al.* 1993), all of them with a huge number of invertebrates capable of colonizing the surface of scallops (Bremec and Roux 1997, Schejter and Bremec, 2007a). Therefore, in agreement with previous studies, the low degree of epibiosis found in the present sampling of small scallops can be attributed to the small shell height of the specimens. Regarding the life habit of this species, the tehuelche scallop may do quick and brief swimming movements as escape responses to predators or other disturbances, but no information on the burrowing ability is available (Ciocco *et al*., 2006). According to our results, this ability in *A. tehuelchus* seems to be reduced or absent, because epibionts heavily encrust the valves in high proportions.

In our study area, *Aequipecten tehuelchus* is one more example of the important role of mollusks as ecosystem engineers (Gutiérrez *et al.* 2003, Cerrano *et al.* 2006, Schejter and Bremec 2007a, b). This area of the Argentine Sea is frequently subjected to coastal hydrodynamic phenomena that remove sediments (see Bremec and Roux 1997). As a consequence, scallops provide substrate for the settlement and variety of niches available for different species of benthic invertebrates. In this sense, habitat heterogeneity is important for maintaining high species richness, given that a landscape of different habitat types should contain more species than homogeneous one (McLean 1983, Sousa 1985).

A preference for any valve was also detected in some epibionts. Spirorbinae was more frequent on the right valve, while the polychaetes *Idanthyrsus armatus* and *Phyllochaetopterus socialis* and cirripeds were more common on the left (upper) valves. This condition was observed in other pectinids and in general, differences could be attributed to competitive interactions, different strategies of colonization developed by the different groups, adaptations to the physical abrasion effects, and/or feeding strategies (Rosso and Sanfilippo 1991, Ward and Thorpe 1991, Sanfilippo 1994, Schejter and Bremec 2007a). *Idanthyrsus armatus* and *Balanus* cf. *amphitrite* showed similar and high frequency in all regions, except in valve regions 6 and 7; the small auricular areas would not be appropriate for the development of these relatively large species. Regions 2, 3 and 4 were conspicuously encrusted by Bryozoa. The same pattern was observed by Ward and Thorpe (1991) in *Chlamys opercularis* (Linnaeus, 1758), which presented a greater frequency of occurrence and coverage of Bryozoa in the central and peripheral regions of the valves. Sanfilippo (1994) observed that the distribution of Spirorbinae *Protolaeospira lebruni* (Caullery and Mesnil, 1897) was not homogeneous on the right valve of the Patagonian scallop, showing a greater concentration in the umbonal regions, since these areas are available for colonization for a longer period than the younger peripheral parts of the shell. Also, this epibiont was the unique that incrusted the shells with a size less than 35 mm. In our study, although not the only taxa on the auricles, Spirorbinae reached the highest frequency of occurrence in this region. This small settlement surface allows the development of relatively small species better than of larger ones.

One of the main problems in shellfish aquaculture and fisheries is the plague caused by the polychaete family Spionidae (McGladdery *et al.* 2006). The most common and harmful damage that they cause is called “mud blister”, weakness in the valves and making them less resistant to predators and other pests (Ciocoo 1990). Spionidae infestation in valves of *Aequipecten tehuelchus*, reported for areas of North-Patagonian gulfs, reached percentages of occurrence greater than 10% (Diez *et al.* 2003). In Buenos Aires, the frequency of occurrence of Spionidae on *A. tehuelchus* was less than 1%, similar to the values found in *Flexopecten felipponei* (Schejter and Bremec 2007a). In addition, two valves with perforations caused by non-identified boring organisms were found. There are several marine organisms (algae, fungi, sponges, bivalves, polychaetes) that show an important bio-erosion activity on carbonate substrates in diverse habitats (e.g. Cerrano *et al*. 2001, McGladdery *et al*. 2006).

Crabs of the family Pinnotheridae occur in some commercially important bivalve mollusks and are often described as commensal or parasitic. In *Aequipecten tehuelchus*, the relationship with this pinnotherid is not commensal but parasitic and deleterious effects have been observed in infested scallops (Narvarte and Saiz 2004). In our study, only three crabs (two males and one female) were found inside three different specimens of *A. tehuelchus*

This study represents the first ecological study of *Aequipecten tehuelchus* in shelf waters off Buenos Aires, Argentina. Furthermore, we increased to nearly double the number of epibionts identified and mentioned on *A. tehuelchus* in Patagonian gulfs (Olivier *et al.* 1970).

The study sites have been prospected to assess bivalves standing stocks, mainly *Mytilus edulis platensis* and *A. tehuelchus.* Although commercial fishery of those species is not developed due to unprofitable catches, the area is currently subjected to fish and prawn demersal fisheries. This research gives additional information on benthic biodiversity and contributes to the understanding of the community structure from soft bottoms off Buenos Aires.

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