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Infestation of the surf clam *Mesodesma donacium* by the spionid polychaete *Polydora bioccipitalis*

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Abstract

The surf clam *Mesodesma donacium* is an economically important species for Chilean and Peruvian shellfisheries. This clam is often infested by *Polydora bioccipitalis*, a species belonging to the Spionidae, the most common parasitic polychaete group. To study this association, clams were sampled monthly over a one-year period in northern Chile. Collected clams covered the entire available size range and were classified into four infestation levels in order to study: (1) the relationship between prevalence of infestation (*PI*) and host size, (2) the temporal pattern of infestation events related to seasonal temperature changes, and (3) the relationship between infestation, body condition index (*BCI*) and gonado-somatic index (*GSI*). Additionally, growth rate and digging ability of clams with different infestation levels was studied. A logistic regression model best explained the relationship between *PI* and host size, with the smallest infested clam being 34 mm long and *PI* increasing steeply thereafter. Ontogenetic shifts in the habitat of the clam and ontogenetic changes, mainly in shell morphology, seem to explain the sigmoid pattern. Periods of increased shell blistering after infestation by *P. bioccipitalis* showed a similar seasonal pattern with *GSI* and *BCI* of non-infested clams, suggesting either an association between infestation ability and low condition of the clam or common environmental triggers for those factors. Heavily infested clams showed a significant lower *BCI*, growth rate and digging ability; however, given its low number, they are unlikely to be significant in terms of the local population survival. However, the infestation could play a key role in explaining mass mortality of northern populations during El Niño events, given the latitudinal differences in *PI* and the fact that infestation ability could be enhanced by increased temperature and facilitated in stressed clams.

Keywords: Surf clam; Boring polychaetes; Blister worms; El Niño; Northern Chile

1. Introduction

Spionid worms of the genus *Polydora* have a worldwide distribution (Lauckner, 1983). These so-called "blister worms" are a matter of considerable concern, as they inhabit the shells of many commercially important bivalves (see Wargo and Ford, 1993 and references therein), often causing substantial mortalities (Lauckner, 1983). While the highest number of polychaete species

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considered as parasites belong to the family Spionidae (38%; Martin and Britayev, 1998), an extensive ongoing debate exists on their parasite status, mainly due to (1) concurrent controversy in defining parasitism (e.g. Zelmer, 1998; Rohde, 2005), (2) their consideration as parasitic organisms from an anthropogenic rather than ecological point of view (Martin and Britayev, 1998) and (3) the low level of knowledge on the biology of the species involved in the association (Martin and Britayev, 1998). Beyond this debate, the study of ecological interactions between *Polydora* and their commercially important hosts is crucial in a scenario of rising global demand for good-quality seafood and the need for improved knowledge to assist in more efficient marine resource management.

The surf clam *Mesodesma donacium* has been exploited as a human food source along the South American Pacific coast since the arrival of early settlers (Sandweiss et al., 1998). It still plays an important socio-economic role for small-scale fisheries in Chile and Peru due to its extremely high biomass (Arntz et al., 1987; Defeo et al., 1993; McLachlan et al., 1996). This filter-feeder clam is distributed from Bahía Sechura (Peru, 5°S) to Isla de Chiloé (Chile, 43°S) and inhabits the swash zone of exposed high-energy intermediate and dissipative sandy beaches, where it typically burrows down to a depth around 10 cm, though can sometimes reach 25 cm, when disturbed (Tarifeño, 1980). Adult clams are primarily confined to the surf zone, while the vast majority of juveniles occurs in the swash zone (Tarifeño, 1980). The reproductive strategy of *M. donacium* changes along its geographical range according to local variability in environmental factors such as water temperature and food availability (Tarifeño, 1980; McLachlan et al., 1996). In northern/central Chile first maturity occurs at 30–40 mm shell length, with the clam reaching a maximum shell length of around 90 mm corresponding to a life span of eight years (Jerez et al., 2007a,b).

Mesodesma donacium populations are regularly devastated during El Niño events. As a consequence of El Niño 1982–1983, most populations disappeared from Peruvian beaches and withdrew seven degrees of latitude south from the previous geographic distribution (Arntz et al., 1987). Although those mortalities are most likely related to increased temperatures, several studies suggest that parasite associations may play a role in mass mortalities of clams inhabiting sandy beaches (Fiori and Cazzaniga, 1999; Ramón et al., 1999; Fiori et al., 2004). The effects of spionids on their hosts are variable and have been shown to depend on differences in the severity of infestation, host size and species involved in the association (Loosanof and Enge, 1943; Lleonart et al., 2003). Furthermore, infestations are responsive to environmental conditions, notably temperature and tidal elevation (Dorsett, 1961; Handley and Bergquist, 1997), and the health of the host (Newell and Barber, 1988; Wargo and Ford, 1993).

The spionid polychaete *Polydora bioccipitalis* has been reported as the only polychaete infesting *M. donacium* (Blake, 1983; Moreno et al., 2006) that produces a specific shell blistering around the siphon area. Shell blisters (commonly referred to as "mud-blisters") result from secretions of conchiolin and successive calcite layers that the clam produces as a mechanism to isolate the worm (Kent, 1979; Lauckner, 1983). These blisters often only appear after the mollusc reaches a certain size (Davis, 1967; Ambariyanto and Seed, 1991). Although it is difficult to evaluate the expenditure of metabolic energy linked to this extra-ordinary secretion of protective layers (and thus, to determine to what extent the performance of the host clam might be affected), the mollusc may suffer a certain degree of distress (Kent, 1979). Despite the observed prevalence and potential effects of the infestation of *M. donacium* by *P. bioccipitalis,* information on the ecology of this association is completely lacking. Therefore, this study aims to analyze (1) the relationship between the prevelance of infestation (*PI*) by *P. bioccipitalis* and the size range of *M. donacium,* (2) the temporal pattern of the infestation in relation to seasonal temperature changes and (3) the relationship between distinct infestation levels and performance of the clam (i.e. body condition index, gonado-somatic index, growth rate, and burrowing ability).

2. Materials and methods

2.1. Sampling and classification of infestation

Monthly samples of *M. donacium* were taken along a transect at the sandy beach "Hornitos" (22°54.99'S; 70°17.42'W), northern Chile between May 2005 and April 2006. The transect, perpendicular to the coastal line, included both the intertidal and the upper subtidal zone down to 1.5 m water depth covering the across-shore distribution of the *M. donacium* population. Along the transect, every 4 m three replicated sediment samples (each 0.16 m^2 and 0.30 m deep) were taken using a push-corer. After sieving through a 0.5 mm mesh clams were counted and the anterior-posterior shell length (*SL*) was measured to the nearest 0.5 mm. Two sub-samples were selected for further analysis, while remaining bivalves were released after measurements; (A) 50 clams covering the whole size range available (i.e. 5 mm to 100 mm *SL*)