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Short Communication

***Ostrea puelchana* (D'Orbigny 1842): a new host of *Tumidotheres maculatus* (Say, 1818) in northern Patagonia, Argentina**

**María del Socorro Doldan¹, Erica M. Oehrens-Kissner¹, Enrique M. Morsan¹
Paula C. Zaidman¹ & Marina A. Kroeck¹**

¹Instituto de Biología Marina y Pesquera "Almirante Storni" (IBMyPAS)
Güemes 1030, San Antonio Oeste (R8520CXV), Río Negro, Argentina

ABSTRACT. *Tumidotheres maculatus* has been reported as a commensal of *Mytilus platensis* and *Atrina seminuda* and suggested as a parasite of *Aequipecten tehuelchus* in San Matías Gulf (SMG). The native flat oyster, *Ostrea puelchana*, has been studied in SMG for decades, and no crab-oyster association has been reported. In autumn-spring 2009 and 2010, oysters were collected from four banks in SMG, and the occurrence of *T. maculatus* inside the pallial cavity of *O. puelchana* was recorded. The prevalence varied between sites, with 0-12.5% at El Sótano, 0-16.7% at Caleta de los Loros, and no crabs found in the samples from Las Grutas and Puerto Lobos. Infected oysters hosted a single crab. Oysters were infested by either one male (47.7%) or one female (15.1%). A positive but low correlation was found for male crab size and oyster size. The presence of these crabs inside the oysters could be due to the overlap of the distribution areas of *O. puelchana* and other bivalve hosts. Our findings may also be a consequence of local fishing. Commercial extraction of traditional hosts may have caused crabs to look for new hosts.

Keywords: oyster, Pinnotheridae, commensalism, San Matías Gulf, Argentina.

***Ostrea puelchana* D'Orbigny 1842 nuevo hospedador de *Tumidotheres maculatus* (Say, 1818) en el norte de Patagonia, Argentina**

RESUMEN. En el Golfo San Matías (GSM), *Tumidotheres maculatus* ha sido registrado como comensal de *Mytilus platensis* y *Atrina seminuda*, y se lo ha indicado como parásito de *Aequipecten tehuelchus*. La ostra plana nativa *Ostrea puelchana* ha sido objeto de estudio por décadas en el GSM y no existen precedentes sobre una asociación entre las ostras y el cangrejo pinotérido. Durante otoño-primavera de 2009 y de 2010 se recolectaron ostras de cuatro bancos del GSM, registrándose la ocurrencia de *T. maculatus* en la cavidad paleal de *O. puelchana*. La prevalencia varió entre los sitios: 0-12,5% en El Sótano, 0-16,7% en Caleta de los Loros; no se encontraron cangrejos en los muestreos en Las Grutas y en Puerto Lobos. Se encontró un único cangrejo por hospedador; las ostras estuvieron infestadas por cangrejos macho (47,7%), o hembras (15,1%). Se encontró una correlación positiva pero baja entre la talla de los cangrejos macho y la talla de las ostras. La presencia del cangrejo en esta ostra podría ser causada por el solapamiento de áreas de distribución de *O. puelchana* con otros bivalvos hospedadores. Por otra parte, podría representar una consecuencia de la pesca en el área. Debido a la extracción comercial, los crustáceos habrían comenzado a buscar nuevos hospedadores.

Palabras clave: ostra, Pinnotheridae, comensalismo, Golfo San Matías, Argentina.

Corresponding author: María del Socorro Doldan (msdoldan@gmail.com)

Pinnotherid crabs are a group of parasite or commensal inhabitants of bivalves, gastropods and echinoderms, plus polychets tubes (Fenucci, 1971; Williams, 1984). Frequently associated to commercial species, however, little is known about the biology of Patagonian species (Fenucci, 1971; Torres, 2006; Ocampo *et al.*, 2007). Adverse effects have been

reported on bivalve hosts of parasite crabs. Physical damage or malformations to gills, gonads and other tissues have been observed (Christensen & McDermott, 1958); interference with filtration efficiency and oxygen consumption rate have also been registered (Bierbaum & Shumway, 1988) as well as reduction on the reproductive potential and on meat

production (Tablado & López-Gappa, 1995; Narvarte & Saiz, 2004). Moreover, the presence of the crab implies an increase in processing time of bivalves from commercial catches (Narvarte & Saiz, 2004).

In San Matías Gulf (SMG), located northern Patagonia, *Tumidotheres maculatus* (= *Pinnotheres maculatus*, see Campos, 1989) has been reported as a commensal of mussels *Mytilus platensis* and naked pen shells *Atrina seminuda* (Boschi *et al.*, 1992; Ocampo *et al.*, 2007). It has also been suggested as a parasite of the Tehuelche scallop *Aequipecten tehuelchus* (Narvarte & Saiz, 2004). Fenucci (1971) reported the occurrence of a young female crab within a native oyster *Ostrea puelchana* close to *M. platensis* fishing grounds at Mar de Plata (38°02'S, 57°30'W). It was considered as a rare case, with weak evidence to confirm a commensal association. Oysters have been studied in SMG for decades; however, there are no reports of this crab-oyster association up to now.

During a research on the ecological status of the flat native *O. puelchana* grounds of SMG, we recorded the presence of *T. maculatus* living inside the pallial cavity of the oysters. The prevalence of crabs within oysters was estimated for each oyster ground and its effect on the host was examined.

A total of 4,754 oysters were collected by diving during the fall and spring seasons of 2009 and 2010 at four natural grounds of SMG: Las Grutas, El Sótano, Caleta de los Loros and Puerto Lobos (Fig. 1). Shell height was measured with electronic digital caliper from the umbo to the growth edge. Oysters were weighed and carefully opened. Mantle cavity and tissues were examined and the presence and position of crabs were recorded. Martins & D'Incao (1996) identification key was used to identify crab species. Sex was determined by differences in genital openings by macroscopic observation. Morphological features of the crabs were measured on pictures and analyzed with image free software Image-J ®. The distance from the frontal margin to the posterior margin was defined as the carapace length (*cl*), while maximum carapace width (*cw*) was considered as the maximum distance between lateral margins. Gill and flesh condition of the infected oysters were observed on each freshly collected animal.

Occurrence of crabs was quantified as the percentage of oysters larger than 40 mm harbouring a crab. Minimum oyster size was based on minimum size of both Patagonian mussels and scallops hosts (42 mm and 51 mm respectively) (Tablado & López-Gappa, 1995; Narvarte & Saiz, 2004). To evaluate the effect of crabs on their hosts, the relationship between the size and total weight of the oysters with and without crabs was analyzed using the one-way

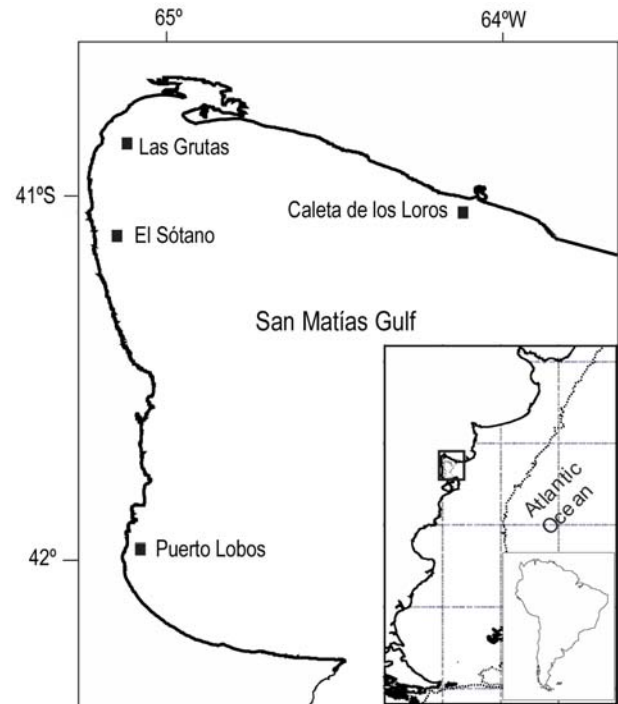


Figure 1. Map of San Matías Gulf, Northern Patagonia, Argentina, showing study sites.

Figura 1. Mapa del Golfo San Matías, Patagonia Norte, Argentina, con la ubicación de los sitios de muestreo.

analysis of variance (ANOVA), with a logarithm transformation of the data. Homoscedasticity was tested using the Levene test. The regression lines of size vs total weight of each group were compared using an analysis of covariance (ANCOVA).

The effect of crabs on oysters was also assessed by the condition index (CI), defined as weight of soft parts/total weight. For each season at each ground one-way ANOVA was used to determine the significance of differences of CI between oysters with and without crabs. Levene test was used to test homoscedasticity. A correlation between *cw* of *T. maculatus* and height of the oysters harboring them was explored.

Pinnotherid crabs appeared only in oysters bigger than 55 mm (Table 1, Fig.2). All crabs were found alive in the pallial cavity and were identified as specimens of *T. maculatus*. Infected oysters hosted a single crab; no molts were found. Oysters were infested by single male (47.7%), or single female (15.1%). Crabs in poor preservation conditions and/or in immature morphological stages were unsexed and grouped as undifferentiated crabs (36.4%).

The incidence of the crab in the oysters at each of the four sites shows markedly higher numbers of pea

Table 1. Site name, mean depth, prevalence, and measurements. Numbers in brackets represent oysters smaller than 40 mm. cl: carapace length, cw: carapace width.

Tabla 1. Sitios, profundidad media, prevalencia, y mediciones. Los números entre paréntesis representan las ostras menores a 40 mm. cl: largo del caparazón, cw: ancho del caparazón.

Year	Site name	Mean depth (m)	Sampled oysters (n)	Prevalence (%)	Host size (mm) Mean \pm SD	Crab	
						c range (mm)	cw range (mm)
2009 Fall sample	Caleta de los Loros	18	159 (10)	3.2	79.5 \pm 14.4	3.24 - 5.26	3.4 - 5.29
	Las Grutas	6	146 (43)	0	-	-	-
2009 Spring sample	Caleta de los Loros	20	293 (22)	1.4	92.6 \pm 5.7	4.14 - 4.37	3.64 - 5.23
	Las Grutas	8	60 (9)	0	-	-	-
	El Sótano	14.7	1197 (259)	0 - 12.5	77.1 \pm 16.7	1.95 - 6.74	1.9 - 6.18
	Puerto Lobos	15	243 (5)	0	-	-	-
2010 Fall sample	Caleta de los Loros	15	234 (20)	1.3	74.8 \pm 7.85	2.91 - 7.95	2.8 - 8.71
	Las Grutas	8	215 (33)	0	-	-	-
	El Sótano	15	98 (7)	7.1	83.6 \pm 8.2	1.67 - 2.9	1.63 - 2.86
	Puerto Lobos	15	242	0	-	-	-
2010 Spring sample	Caleta de los Loros	20	1023 (78)	0 - 16.7	76.7 \pm 16.8	2.33 - 6.22	2.2 - 6.71
	Las Grutas	10	60	0	-	-	-
	El Sótano	15	58 (1)	0	-	-	-

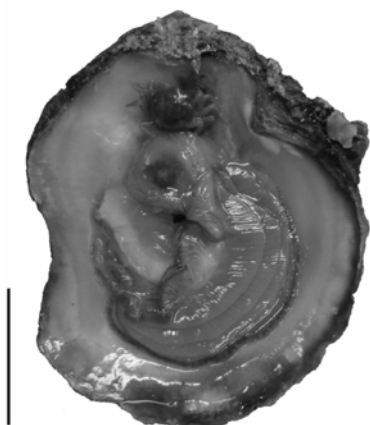


Figure 2. Female *Tumidotheres maculatus* found in the pallial cavity of *Ostrea puelchana* at Caleta de los Loros ground, northern Patagonia, Argentina. Scale bar = 20 mm.

Figura 2. Ejemplar hembra de *Tumidotheres maculatus* encontrado en la cavidad paleal de *Ostrea puelchana* en el banco de Caleta de los Loros, Patagonia Norte, Argentina. Escala de la barra = 20 mm.

crabs in spring samples of El Sótano (ES) and Caleta de los Loros grounds (CL) (Table 1). Probably the higher incidence is related to the big numbers in those samples.

Examination of the infected oysters showed no damage or shortness of the gills. The size-weight

relationships in each group of oysters were significant (infested oysters: weight = 0.31 x size + 3.07, $P < 0.01$; non-infested oysters: weight = 0.27 x size + 3.21, $P < 0.01$). Homocedasticity among the regression lines was tested ($P = 0.27$). The size-weight relationship showed differences between groups ($P = 0.014$, Table 2), however the slope in both relationships showed no significant differences ($P = 0.066$, Table 2).

For site at each season no differences were found between variances of CI ($p_{CLfall} = 0.239$; $p_{ESfall} = 0.065$; $p_{CLspring} = 0.387$; $p_{ESspring} = 0.766$). The CI of oysters with and without crabs showed significant differences for the fall samples in CL ($P < 0.01$) and for the spring sample at ES ($P = 0.008$). However, no significant differences were found for the other samples ($p_{ESfall} = 0.879$; $p_{CLspring} = 0.322$).

In several studies a positive correlation between the sizes of infesting crab and its host has been observed (Christensen & McDermott, 1958; Kane & Farley, 2006) and shelter size seems to influence adult crab size. This trend appears to be more apparent among female crabs (Kane & Farley, 2006, Tablado & López-Gappa, 1995) which are lifelong endosymbionts. Male are free-ranging and move among hosts. We did find a positive but low correlation for male crabs ($R^2 = 0.211$, $P = 0.017$). Small crabs were found in large oysters but the opposite was not the case.

The occurrence of *T. maculatus* inside *O. puelchana* is significant since it is a recently observed

Table 2. Results of ANCOVA applied to the *ln* (size) vs *ln* (weight) relationship between oysters with and without crabs.

Tabla 2. Resultados del ANCOVA aplicado a la relación entre el *ln* (talla) vs *ln* (peso) entre ostras con y sin cangrejos.

	Source of variation				
	df	SS	MS	F	P
With vs without crabs	1	0.035	0.035	6.042	0.014
Error	1361	7.891	0.006		

phenomenon. It has a lower incidence than those of other hosts of the area (56% in *A. tehuelchus*, Narvarte & Saiz, 2004; 15-74% in *Atrina seminuda*, Soria unpublished data; more than 80% in *M. platensis*, Morsan unpublished data), but it is comparable to the incidence of crabs in *Zygochlamys patagonica* when it was first detected in 1984 at San José Gulf grounds (range of prevalence: 1.19-12.2%; Gómez-Simes, 1993). Similar values (7-16%) were found for *M. platensis* in Necochea grounds in 1970 (Fenucci, 1971). Since actual occurrence of *T. maculatus* in *O. puelchana* reaches 16.7% on SMG grounds (Table 1), we conclude that an interspecific relationship is established between the two species. Particularly, a commensal relationship is established between crabs that feed on food filtered by flat oysters. Although no deleterious effect on gills was observed, we found differences in CI for same samples. If there is an energetic disadvantage relative to the presence of the crab as found in other species (Bierbaum & Shumway, 1988), in this species is unknown.

SMG oyster grounds have been surveyed since 1970, and no precedent of this commensal association had been reported before. Two hypotheses can explain our findings. One hypothesis arises from an ecological perspective. The presence of the crabs inside flat oysters represents evidence of a colonization process. *O. puelchana* larvae frequently set on *A. seminuda* or on *M. platensis*, therefore intraspecific relationships between these species take place. The overlapping of distribution areas of *O. puelchana* and those of traditional and highly-infected hosts in SMG may have played a key role in the onset of this process. The second hypothesis refers to fishing activities. Our findings may represent a consequence of disturbance caused by fishing to the benthic ecosystem. Due to commercial extraction of traditional hosts crabs may have started looking for new hosts. It has been demonstrated that *T. maculatus* can choose host (Kruczynski, 1973), therefore their distribution is not

controlled by host abundance. *O. puelchana* rests on the sea bed with the bowl-shaped (right) valve downwards and the flat (left) valve upwards. Despite the shells slightly open for filtration, it is likely that *T. maculatus* enters when the aperture is exposed. The presence of pea crabs within specimens of *Pododesmus* sp. that occurred in our samples supports the hypothesis of the search of new hosts.

Although oysters were mainly infested by male crabs, no (definite) pattern can be recognized. Seasonality in crab occurrence has been reported for several hosts (Christensen & McDermott, 1958; Alves & Pezzuto, 1998; Narvarte & Saiz, 2004; Sun *et al.*, 2005; Asama & Yamaoka, 2009). In SMG, seasonal variation of the incidence of crabs was reported for *A. seminuda* (Soria, unpublished) and for *A. tehuelchus*, where gravid females were observed in February and November (Narvarte & Saiz, 2004). The incidence of infestation of *T. maculatus* within *O. puelchana* along the year, i.e. if the occurrence of crabs remains at constant levels or if it has peak periods of invasions, has not been evaluated. Moreover, reproductive season of these crabs remains unknown. A careful check made throughout the year may reveal the annual recruitment pattern. On the other hand, the conditions that regulate this type of commensalism have to be elucidated. Whether crab densities, distribution of receptive crab females, food availability, salinity or other factors are controlling this intraspecific relationship remains unknown.

Additionally, *T. maculatus* range size (Table 1) was lower than those of *A. tehuelchus* (1-16 mm, Narvarte & Saiz, 2004) or of *M. platensis* (1.2-10 mm, Fenucci, 1971; 3.8-9.5 mm, Boschi *et al.*, 1992). Differences in crab prevalence between grounds are also intriguing considering the spatial distribution of oyster beds. The occurrence of *T. maculatus* within *O. puelchana* may reflect an expansion of crab distribution to shallow waters. *O. puelchana* and *A. tehuelchus* with crabs are found at shallow waters (less than 25 m deep; Table 1), while previously reported hosts are distributed from 40 up to 120 m depth (Fenucci, 1971; Gómez-Simes, 1993; Tablado & López-Gappa, 1995). The difference in crab size between bivalve hosts, and the absence of *T. maculatus* in the shallowest oyster grounds (Las Grutas) may also reflect this fact. Furthermore, as males change hosts frequently, a correlation between sizes is not expected (Tablado & López-Gappa, 1995), which is consistent with our findings. Female crabs might not be entering slightly open shells of *O. puelchana* due to their carapace size.

In further studies, special considerations should be given to the sex-ratio and the crab-host size

relationship, which might be related to host size, and to the time that the bivalve remains closed. In the future, a study will be conducted that combines ecological data with the morphological feature of the crabs inhabiting this and other bivalve species from SMG.

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