



Natural stocks of the scallop *Argopecten circularis*, and relationships with the galateid crab *Pleuroncodes planipes* in the Pacific coast of Baja California Sur, Mexico.

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Abstract: New data have been obtained concerning the transportation and probable dispersion of the mollusc *Argopecten circularis*, by the pelagic red "crab" *Pleuroncodes planipes*. The relation of this Anomuran crab with natural beds of *A. circularis* implanted in Magdalena Bay and over the continental shelf of Baja California Sur, and its seasonal abundance, were studied on the basis of material collected with fishing nets of different lengths. The most significative variation in the abundance of *P. planipes* was observed in the range of 0-50 m depth, which corresponds to the migration cycle of the species during the reproductive period. 82 % of *P. planipes* were observed with juveniles of *A. circularis* over the chelipeds. The average size of *P. planipes* and *A. circularis* were 52.1 mm and 3.5 mm (largest diameter), respectively, with the size of the mollusc ranging from 8.5 mm to 1.0 mm. Biomass of *A. circularis* oscillated from 10.6 kg.ha⁻¹ (15 m deep) and 0.9 kg.ha⁻¹ (29 m deep). Both populations were collected over muddy-sand bottoms mixed with crushed shell, at temperatures between 14.0 to 15.8° C and salinity around 35 ‰. The establishment of exploitable banks of *A. circularis* in Magdalena Bay is linked undoubtedly to the recruitment period of this species which coincides with the migratory cycle of *P. planipes*, induced by the presence of cold waters from the California current.

Résumé : Des données nouvelles ont été obtenues sur le transport et la dispersion probable du mollusque *Argopecten circularis* par le "crabe" anomoure rouge, pélagique, *Pleuroncodes planipes*. La relation de cet anomoure avec les bancs naturels de *A. circularis* implantés dans la baie Magdalena et sur la plate-forme continentale du Sud de la Basse-Californie et son abondance saisonnière, ont été étudiées grâce à une série de récoltes faites par des chaluts de tailles variées. La variation d'abondance de *P. planipes* la plus significative a été observée dans la zone des 0 à 50 m de profondeur et correspond à un cycle migratoire de l'espèce à l'époque de la reproduction. Nous avons observé que 82 % de *P. planipes* portaient de jeunes coquilles d'*A. circularis* sur leurs pinces. Les tailles moyennes de *P. planipes* et de *A. circularis* étaient respectivement de 52,1 mm et 3,5 mm (dans leur plus grand diamètre), la taille du mollusque variant de 8,5 à 1 mm. Les biomasses de *A. circularis* fluctuent de 10,6 kg.ha⁻¹ (à 15 m de profondeur) à 0,9 kg.ha⁻¹ (à 29 m de profondeur). Les deux populations ont été récoltées sur des fonds sablo-vaseux à coquilles brisées, la température variant de 14,0 à 15,8 °C et la salinité étant d'environ 35 ‰. L'établissement de bancs exploitables de *A. circularis* dans la baie Magdalena est très probablement lié au fait que la période de recrutement de l'espèce coïncide avec le cycle migratoire de *P. planipes*, provoqué par la présence d'eaux froides amenées par le courant de Californie.

Keywords : *Argopecten circularis*, *Pleuroncondes planipes*, interspecific relationships, recruitment.

Introduction

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Argopecten circularis (Sowerby) is one of the most demanded and exploited benthic resources of the State of

Baja California Sur, Mexico (Baquero-Cardenas *et al.*, 1982; Tripp-Quezada, 1985). During 1989 and 1990 Magdalena Bay yielded 5186 t of scallop adductor muscle, valued at about 6000 \$US/t (Maeda-Martinez *et al.*, 1993). Some research on *A. circularis* has been conducted in coastal lagoons (Baquero-Cardenas *et al.*, 1981, 1982), and in aquaculture (Felix-Pico *et al.*, 1989; Tripp-Quezada, 1985; Singh-Cabanillas, 1987).

As an end result of the exploration and evaluation of marine benthic and demersal resources of the continental shelf in the west coast of Baja California Sur, important stocks banks of *A. circularis* have been located between 25°40'N - 112°12'W (Boca Santo Domingo) and 26°40'N - 113°14'W (Boca de la Laguna San Ignacio). On the other hand the presence of the galateid *Pleuroncodes planipes* (Stimpson) during winter-spring in shallow areas of the continental shelf and within the lagoonal complex of Magdalena-Almejas is induced by the California current (Aurioles-Gamboa, 1992; Serrano-Padilla & Aurioles-Gamboa, 1992). The existence of these banks and their proximity to protected bodies of water, such as Magdalena Bay, where temporal scallop banks have been recorded, created speculations about possible interactions between the two species.

A. circularis like other species of Pectinidae is widely dispersed during its larval planktonic stage, and only for short distances during adult life. During routine examination of *P. planipes* specimens previously collected in this area, the presence of juveniles *A. circularis* over the cheliped were detected. Foreseeing a zoochoric situation, scallop fixation rates over the "crab" were examined, as well as the relationships between the two species inside and outside the bay.

Study site

The studied area (Fig. 1) comprises the Magdalena-Almejas lagoonal complex, and the continental shelf in the west side of the Baja California (26°43'N - 113°35'W and 24°15'N - 111°20'W). It is bordered by the south branch of the California current, and therefore it displays a well established thermal gradient (Mathews & Druck, 1975; Lynn & Simpson 1987). It is a transition zone, with one component derived from the Californian Region, and another from the east Pacific tropical zone (Brusca & Walerstein, 1979; Bertsh, 1990).

Expected average temperatures for continental shelf waters varied from 16 to 26°C at the surface, and from 12.5 to 17°C at the bottom. Average salinity varied from 33.5 ‰ at the surface to 33.7 ‰ at the bottom. The lagoonal zone represents an anti-estuarine system during the year. Salinity and temperature gradients vary with bathymetry, displaying higher values at shallower depth (Alvarez-Borrego *et al.*,

1975). Range annual water temperatures were from 18.2 to 27.8°C at the surface, and from 16.7 to 26.9°C at the bottom. This zone has a semi-desertic climatic regime, with low precipitations, predominant winds from the N.W., and summer variations in relation to tropical storms and hurricanes.

Materials and methods

Four monthly samples with the research vessel R.V. "Marsep XVI" (April-July 1988) were carried out in the continental shelf. They comprised 20 dredged sites at depths between 13 and 55 m, using a shrimp net "semi-portuges" style, with 13.5 m frontal opening, with 3 cm mesh size, and a trawling speed of 2.2 nautical miles/h. With the research vessel "El Puma" (July 1987 to September 1990), 200 sites were dredged at depths between 30 and 230 m depth, using a net with 20 m frontal opening, and 3 cm mesh, with a trawling speed at 3 nautical miles/h. For both ships the trawling time was set at 30 minutes. At Magdalena Bay, benthic samples were collected each month during 1990 using a sampling net 7 m wide, 2.5 cm opening mesh, and trawled at an average speed of 2 nautical miles/h.

The galateid crab density (ind.m⁻²) was estimated for each season. The fresh medium weight of one specimen of *P. planipes*, from the continental shelf, was 6.0 g, and the biomass estimated at 400 g.m⁻² corresponded to 67 ind.m⁻². The total dredged area was calculated using the correction factor of 0.6 according to Arana & Ziller (1990).

At each sampling station, depth, salinity, surface and bottom temperatures were recorded using a Van Dorn bottle equipped with reversible thermometer and induction salinity meter. Substrate bottom samples were taken with an Eakman-Birge and Van Veen dredges.

Results

Six (35%) out of 17 "Marsep" sampled sites contained scallop (Fig. 1). The highest galateid abundance and frequency for the studied area (Continental shelf and Magdalena Bay) were positively related with bottom temperature between 13 and 16°C. Temperatures above or below this range are related to lower abundance and frequency of *Pleuroncodes planipes*. Average galateid "crab" density (35 to 38 ind.m⁻²) registered within Magdalena Bay could be very similar (37 ind.m⁻²) to that of continental shelf during the spring from 0 to 50 m depth (Table 1).

Seasonal distribution observations proved that *P. planipes* was carrying scallop recruits only during May. At that time on a sample of 197 "crabs", 82% (157) had at least one *Argopecten circularis* recruit for each cheliped, averaging 2 (1-4) scallops for each cheliped.

Mean length, for *P. planipes* and *A. circularis*, were 62.5 mm and 3.52 mm respectively, with the scallop ranging

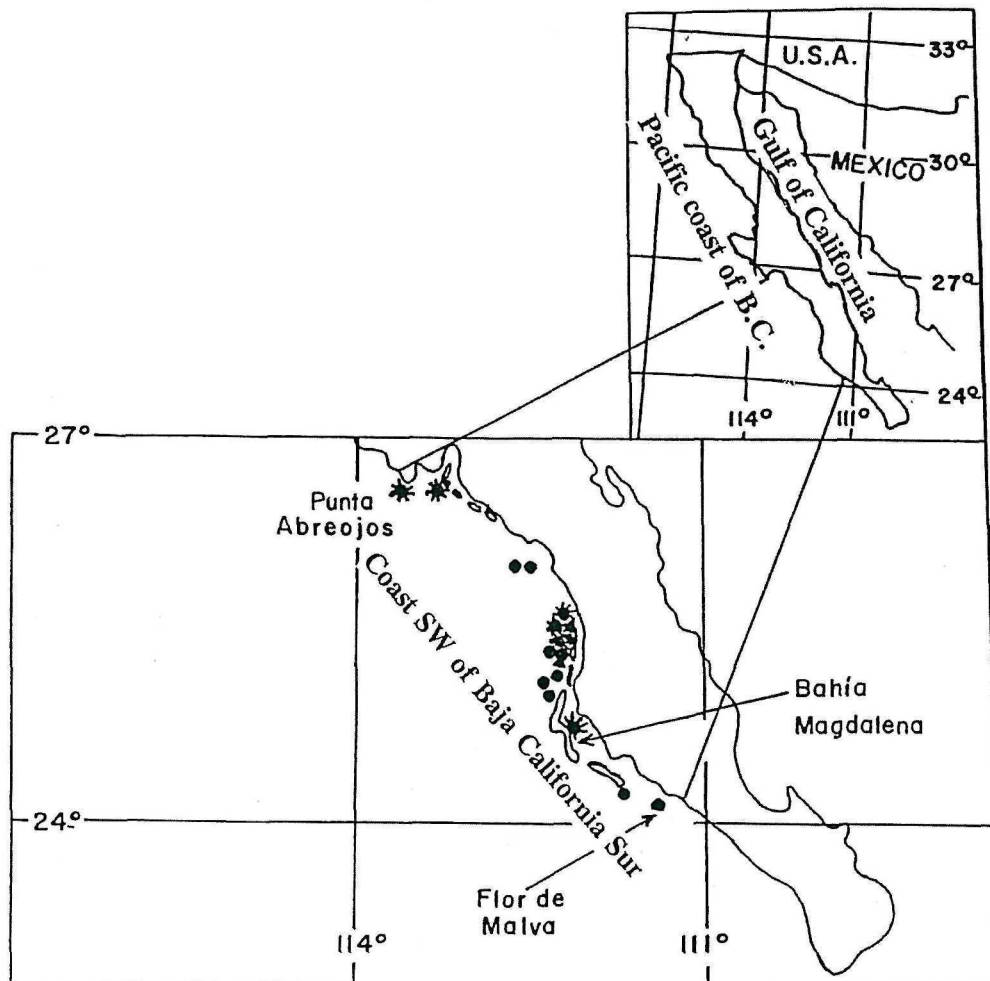


Figure 1. Localization of the stations with *Argopecten circularis* (*) in the sampling area. Stations without *A. circularis* (●)
Figure 1. Emplacement des stations avec *Argopecten circularis* (*) dans l'aire d'étude. Localités sans *A. circularis* (●)

Table 1. Seasonal variation in the average density of *Pleuroncodes planipes* at different depths in the continental shelf of Baja California Sur and in the Magdalena Bay.

Tableau 1. Variation saisonnière de la densité moyenne de *Pleuroncodes planipes* à différentes profondeurs sur la plate-forme continentale du Sud de la Basse-Californie et dans la Baie de Magdalena.

DEPTH STRATUS (m)	ANNUAL STATION DENSITY IN THE CONTINENTAL SHELF (Ind.m ⁻²)				DENSITY FOR MAGDALENA BAY (Ind.m ⁻²) Winter-Spring
	Spring	Summer	Fall	Winter	
000-050	37	0	0	25	35 a 38
051-100	118	62	37	42	
101-150	50	100	37	25	
151-200	42	100	37	42	

from 1 mm to 8.5 mm. The sex ratio for the "crabs" was 44.8% of males (86 specimens) and 55.2% of females (106 specimens).

Dredging for scallops during 30 min produced 10.6 kg.ha⁻¹ in shallow areas (15 m deep) and 0.9 kg.ha⁻¹ in greater depths (29 m deep). Capture of *A. circularis* on the continental shelf indicated that this species was associated with temperatures ranging between 14.0 and 15.9°C, with a

salinity of approximately 35 ‰, and with mud-sandy and sand-crush shell mixed sediments (Table 2). *P. planipes* at Magdalena Bay was associated with temperatures ranging from 14.0 to 15.3°C and fine sand sediments (Table 3). The total area dredged with the "Marsep XVI" was estimated at 108 hectares, 33 hectares of which with the presence of scallops.

Table 2. Abiotic parameters registered in the continental shelf of Baja California Sur, on R.V. "Marsep XVI" (S = surface; B = bottom).

Tableau 2. Paramètres abiotiques enregistrés sur la plateforme continentale du Sud de la Basse-Californie, avec le N.O. "Marsep XVI" (S = surface ; B = fond).

DEPTH (m)	TYPE OF SEDIMENTS (Dominant)	TEMPERATURE (°C)		SALINITY (‰)	
		S	B		
35	Fine sand	17.5	15.0	34.7	34.8
37	Sand crush shell mixed	17.0	15.9	34.6	34.7
47	Mud sandy	16.9	13.4	34.9	34.9
52	Mud sandy	18.0	14.0	34.9	34.9
52	Mud sandy	17.5	14.5	34.9	34.9
47	Mud sandy	17.8	14.0	34.9	35.3
46	Mud sandy	17.5	15.0	34.8	34.8
66	Fine sand mud mixed	17.0	15.0	34.6	34.9
52	Fine sand mud mixed	16.1	14.8	35.0	34.9

Table 3. Abiotic parameters registered in May 1990 in Magdalena Bay (S = surface; B = bottom).

Tableau 3. Paramètres abiotiques enregistrés en mai 1990 dans la Baie de Magdalena (S = surface ; B = fond).

DEPTH (m)	TYPE OF SEDIMENTS (dominant)	TEMPERATURE (°C)	
		S	B
7.0	Fine Sand	17.2	15.2
29.0	Fine Sand	17.0	15.0
23.5	Fine Sand	16.0	15.2
15.3	Fine Sand	15.3	14.0

Discussion

For the first time the presence of massive banks of *A. circularis* is reported on the continental shelf off the Pacific shores of the Baja California Sur, Mexico, although its normal range has been reported from Cedros Island and the Gulf of California southward to Peru (Baquero-Cardenas *et al.*, 1982). Beds of *A. circularis* and its physical habitat monitored in this report are similar to those reported by Hendrickx (1985) and Reguero & Garcia-Cubas (1989) for the Gulf of California and Nayarit State continental shelf.

The data reported here are in agreement with the

mentioned literature:

- 1) *A. circularis* is the scallop species most often reported within the continental shelf.
- 2) It is more abundant at a depth of 15-30 m (Table 3).
- 3) Its captures represent 3-8% of trials.
- 4) Associated malacological fauna is represented by the genera *Anadara*, *Dosinia*, *Chione* and *Solenosteira*.
- 5) Salinity ranged from 34.5 to 35.0 ‰.
- 6) Predominant sediments were fine sand-silt.

A. circularis is a scallop that breeds all the year round, with two well defined peaks, one during March-May, and a

second peak at September-December season, as reported by Baqueiro-Cardenas *et al.* (1981), and by Maeda-Martinez *et al.* (1993). Within hours, the gametes develop into planktonic veliger larvae, which are carried by surface currents during a 15-day period. Later they become pediveliger larvae, and a month later become juveniles fixed to the bottom (Maeda-Martinez *et al.* 1993).

A. circularis reproductive behaviour has not been described from the continental shelf, but it is expected to be similar at Magdalena Bay because environmental conditions are very similar. This is supported by the relationship between juveniles of *A. circularis* and the populations of *P. planipes*, that is, settlement of the scallop and the zoochoric transportation on the cheliped of the "crab", that moves up to shallow waters of the continental shelf during winter-spring time, under the influence of the California current, and as an effect of its migratory cycle (Aurioles-Gamboa, 1992). This process of dispersion is of major importance for *A. circularis* populations. This scallop has also been reported fixed on the cheliped of *P. planipes* during abnormal oceanographic conditions (El Niño) at California's coast (Glynn, 1961). With the report of Glynn (1961) the scallop distribution would extend several degrees North, in shallow bodies of water, by taking advantage of *P. planipes* migratory cycle, both in latitude and depth. This zoochoric phenomenon can be established because of the synchronous reproductive cycle of the scallop (during spring), and the anomuran ocean-shore migration during winter-spring time.

The scallop strategy of settlement on *P. planipes* and its transportation, could represent a capability to establish new banks, or re-seeding the ones already established at the coastal lagoons of the Baja California Sur.

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