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Molluscs associated with artificial substrate in Tenacatita bay, Jalisco, Mexico (2002-2004)

Moluscos asociados a sustrato artificial en bahía de Tenacatita, Jalisco, México (2002-2004)

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Abstract

During 2002-2004, the seasonal settlement and reproduction periods of mollusks were analyzed in artificial reefs in Tenacatita Bay, Jalisco. Eight metal structures were placed at the edge of the reef, with eight ceramic slabs measuring 20 x 20 cm each, covering a total artificial substrate area of 8.96 m^2. The mollusks settled days after the substrate was prepared with a biofilm. A total of 1240 individuals and 55 species of mollusks were obtained, of which 37 species belong to 19 families of Gastropoda, 12 species to eight families of Bivalvia and six species to three families of Polyplacophora. The greatest richness and abundance was of gastropods (67 and 92% respectively). The Kruskal-Wallis analysis showed variations in abundance during the annual cycle (H = 11.87, P = 0.03), increasing in April and June and decreasing in January and September. The families with the most species were Calyptraeidae (6) and Columbellidae (5) and 73% of the richness was concentrated in three species of the Vermetidae family (*Petaloconchus* sp., *Serpulorbis margaritaceus* and *Serpulorbis* sp.). The shallow depth and large current flow facilitated the settlement of mollusks and other taxonomic groups during the study.

Bivalves, Substrate, Settlement, Biofilm, Succession

Resumen

Durante 2002-2004 se analizó el asentamiento estacional y periodos de reproducción de moluscos, en arrecifes artificiales en la bahía de Tenacatita, Jalisco. Se colocaron ocho estructuras metálicas al borde del arrecife, con ocho losas de cerámica de 20 x 20 cm cada una, cubriendo un área total de sustrato artificial de 8.96 m^2. Los moluscos se asentaron días después de ser preparado el sustrato con un biofilm. Se obtuvo un total de 1240 individuos y 55 especies de moluscos, de los cuales 37 especies pertenecen a 19 familias de Gastropoda, 12 especies a ocho familias de Bivalvia y seis especies a tres familias de Polyplacophora. La mayor riqueza y abundancia fue de los gasterópodos (67 y 92% respectivamente). El análisis de Kruskal-Wallis mostró variaciones en la abundancia durante el ciclo anual (H = 11,87, P = 0,03), incrementando en abril y junio y disminuyendo en enero y septiembre. Las familias con más especies fueron Calyptraeidae (6) y Columbellidae (5) y el 73% de la riqueza se concentró en tres especies de la familia Vermetidae (*Petaloconchus* sp., *Serpulorbis margaritaceus* y *Serpulorbis* sp.). La poca profundidad y gran flujo de corriente facilitaron el asentamiento de moluscos y otros grupos taxonómicos durante el estudio.

Bivalvos, Sustratro, Asentamiento, Biofilm, Sucesión

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Introduction

Succession patterns of marine benthic invertebrates have been studied in the field and in the laboratory to understand various aspects such as: changes in community composition, temporal variation in abundance, population structure and dynamics, competition, predation, the degree of disturbance in coastal areas, as well as the settlement and recruitment processes of ecologically or economically important species, with the aim of understanding their limitations (Rodríguez *et al*., 1993).

Some studies focused on succession processes are carried out with artificial substrate to monitor behaviour, seasonality of settlement, reproduction periods, among other issues (Chalmer, 1982, Carreira-Flores *et al*., 2023). A clear example of this is the use of artificial substrates to quantify the recruitment of commercially important mollusc species, estimate reproductive activity and identify the profitability of their culture (Nuñez *et al*., 2006, Valencia-Martínez *et al*. 2023).

In Mexico, studies of this type are scarce, and in general, they are focused on the capture of bivalve mollusc seed for subsequent growth in suspended line systems near the coast (Torres Ortiz 2002; Murtaugh and Hernández, 2014; Durand Acosta, 2023). However, its usefulness is necessary, since on the one hand it allows us to identify the colonisation of unwanted species, problems in maricultures such as the alteration of the environment due to excessive nutrient increases in fish farms (David *et al*., 2009); on the other hand, it allows us to identify the diversity of macrofauna in the region, increasing our knowledge of succession processes (Rule and Smith, 2007).

The present study was a further result of the evaluation of larval (planula) uptake of hermatypic corals on artificial substrate (ceramic slabs) in a coral community of Pocillopora sp. species developed at the Playa Mora site at the northern tip of Tenactita Bay, Jalisco, Mexico. This study identified the presence of mollusc species on artificial substrate (ceramic slabs), seeking as far as possible to determine the seasonality of settlement and/or colonisation between October 2002 and June 2004.

Materials and methods

Study area

The present study was carried out in the cove of Playa Mora, located in the northwestern end of Tenacatita Bay in the Mexican Pacific, whose geographical location is 19° 16' N and 104° 52' S. Playa Mora has a coastal coral reef made up of two bars arranged in an east-west orientation, with a sand bar in the centre separating them. The reef is basically composed of the branch-shaped coral *Pocillopora damicornis* (Linnaeus, 1758) y *P. capitata* (Verrill, 1864).

Figure 1 Map of the study area locating the Mora beach site in Tenacatita Bay, Jalisco, Mexico

Field work

In October 2002, eight metal structures were placed on the edge of the reef bars at two different depths, four were located in the shallow area (< 3 m) and the other four at a depth > 3 m. Eight 20 x 20 cm ceramic slabs were placed on each structure, covering a surface area of 0.32 m^2 ; the total number of slabs during the study was 224, with a total area of artificial substrate of 8.96 m^2 (Figure 2).

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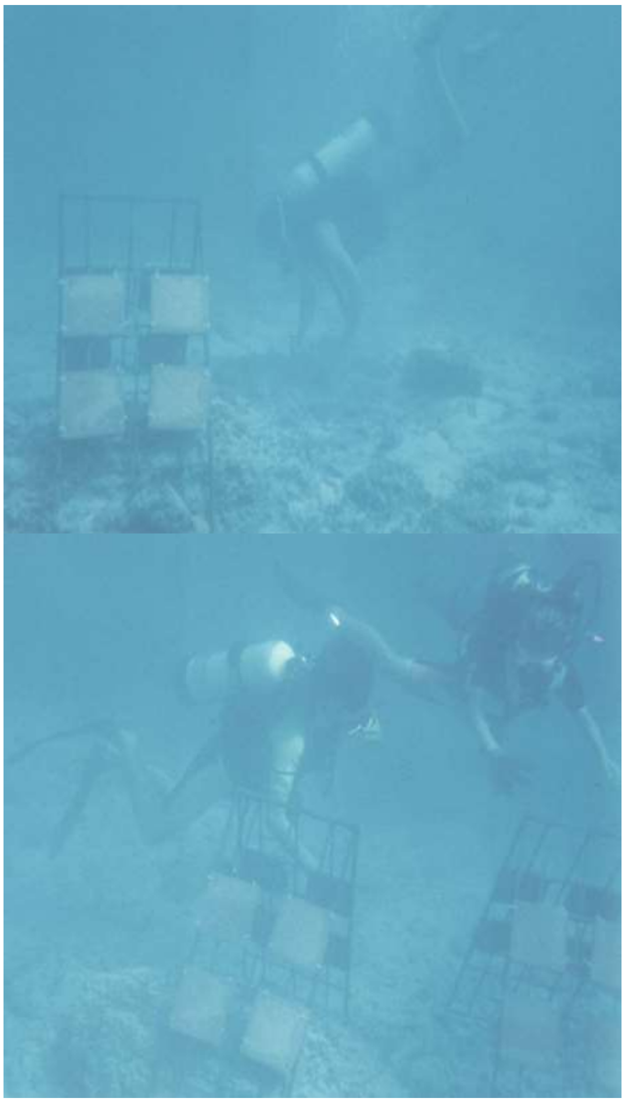

Figure 2 Placement of metal structures with ceramic slabs (artificial substrate) on the bottom of Mora beach, Tenacatita Bay, Jalisco, Mexico.

Sampling (slab removal and replacement) was carried out in July, September and November 2003, and in January, April and June 2004. Four slabs were extracted from each structure, two from the inner side. Molluscs were determined using traditional taxonomic keys and the support of the biological reference collection of the Marine Ecosystems and Aquaculture Laboratory of the University of Guadalajara. The presence of molluscs on the depth gradient, their position on the slab faces (internal and external) and the time of colonisation and/or settlement (succession process) on the artificial substrate were evaluated (Figure 3).

One motn

Two months

Four months

Figure 3 Appearance of the ceramic slab surface at three immersion times at the bottom of Mora beach, Tenacatita Bay, Jalisco, Mexico

Community structure was determined using Shannon-Weaver's ecological indices of diversity, Pielou's evenness and Jaccard's similarity.

Results

A total of 1,240 individuals and 55 mollusc species were obtained, of which 37 species correspond to 19 families of the Class Gastropoda, 12 species correspond to eight families of the Class Bivalvia and six species are located in three families of the Class Polyplacophora (Table 1). The only report of molluscs in Playa Mora, Tenacatita Bay is by Landa Jaime *et al*. (2013), who report 123 species in various natural substrates rock, sand, stony coral of the genus Pocillopora, involving a direct sampling of almost ten years (2001 to 2010) in different months of each year. Our work coincides with eight genera and 13 species, including gastropods and polyplacophorans, since the class Bivalvia, we report species different from those reported by these authors.

Class Bivalvia
Family
Mytilidae
Septifer zeteki Hertlein & A. M. Strong, 1946
Mytilus sp Récluz, 1848
Pteriidae
Pteria sterna (A. Gould, 1851)
Pteria sp Scopoli, 1777
Isognomonidae
Isognomon recognitus (Mabille, 1895)
Isognomon sp [Lightfoot], 1786
Ostreidae
Saccostrea palmula (P. P. Carpenter, 1857)
Ostrea sp Linnaeus, 1758
Plicatulidae
Plicatula penicillata P. P. Carpenter, 1857
Chamidae
Chama buddiana C. B. Adams, 1852
Lasaeidae
Kellia suborbicularis (Montagu, 1803)
Pholadidae
Barnea subtruncata (G. B. Sowerby I, 1834)
Clase Polyplacophora
Chitonidae
Chiton articulatus G. B. Sowerby I, 1832
Chiton sp1 Linnaeus, 1758
Chiton sp 2 Linnaeus, 1758
Ischnochitonidae
Ischnochiton sp J. E. Gray, 1847
Stenoplax sp P. P. Carpenter, 1879
Lepidochitonidae
Lepidochitona sp Gray, 1821
Clase Gastropoda
Fissurellidae
Fissurella sp Bruguière, 1789
Lottiidae
Lottia sp 1 Gray, 1833
Lottia sp 2 Gray, 1833
Lottia sp 3 Gray, 1833
Lottia sp 4 Gray, 1833
Phasianellidae
Eulithidium perforatum (R. A. Philippi, 1849)
Rissoinidae
Rissoina excolpa Bartsch, 1915
Architectonicidae
Heliacus caelatus (Hinds, 1844)
Turritellidae
Turritella sp Lamarck, 1799
Vermetidae
Petaloconchus macrophragma P. P. Carpenter, 1857
Petaloconchus sp H. C. Lea, 1843
Thylacodes margaritaceus (Rousseau, 1844)
Eulimidae
Melanella micans (P. P. Carpenter, 1865)
Cerithiidae
Rhinoclavis gemmate (Hinds, 1844)
Cerithium sp Bruguière, 1789
Hipponicidae
Pilosabia trigona (Gmelin, 1791)
Calyptraeidae
Bostrycapulus aculeatus (Gmelin, 1791)
Crepidula lessonii (Broderip, 1834)
Crepidula sp Lamarck, 1799
Crucibulum scutellatum (W. Wood, 1828)
Crucibulum spinosum (G. B. Sowerby I, 1824)
Crucibulum sp Schumacher, 1817
Naticidae
Natica sp Scopoli, 1777
Velutinidae
Lamellaria diegoensis Dall, 1885
Muricidae
Acanthais triangularis (Blainville, 1832)
Vasula speciosa (Valenciennes, 1832)
Morula sp Schumacher, 1817
Buccinidae
Pusio elegans (J. E. Gray, 1833)
Columbellidae
Columbella fuscata G. B. Sowerby I, 1832
Columbella sp Lamarck, 1799
Mitrella sp 1 Risso, 1826
Mitrella sp 2 Risso, 1826
Steironepion piperatum (E. A. Smith, 1882)
Conidae
Conus nux Broderip, 1833
Bullidae
Bulla sp Linnaeus, 1758
Goniodorididae
Okenia cochimi Gosliner & Bertsch, 2004
Tergipedidae
Cuthona sp Alder & Hancock, 1855

Table 1 List of species of the three classes of molluscs associated with an artificial substrate at Playa Mora, Tenacatita Bay (October 2002-June 2004)

Gastropods showed the highest specific richness (67%) and abundance (92%), followed by bivalves (22% and 6% respectively), and polyplacophorans accounted for only 11% of the richness and 2% of the abundance (Figure 4).

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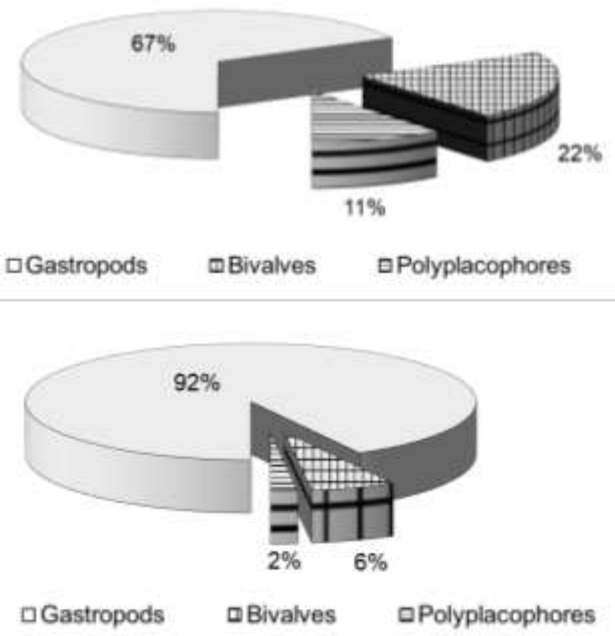

Figure 4 Percentage of the number of species (top) and number of individuals (bottom) of the three classes of molluscs associated with an artificial substrate at Playa Mora, Tenacatita Bay (October 2002-June 2004)

The months with the highest species richness were June (34 species) and April (23 species); the lowest richness was recorded in July and November. The Kruskal-Wallis analysis of variance showed variations in relative abundance during the annual cycle ($H = 11.87$; $P = 0.03$), confirming April and June 2004 as the months of highest abundance, while September and January showed the lowest values (Figure 5).

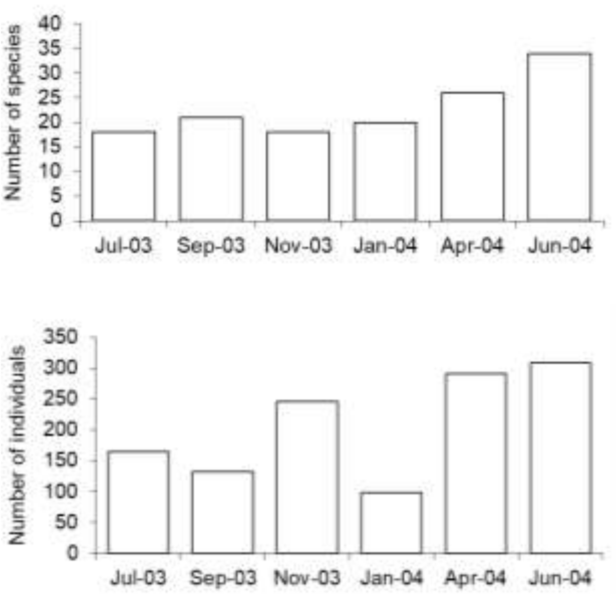

Figure 5 Number of species (top) and individuals (bottom) of molluscs recorded on artificial substrate on the sampling dates

Within the Playa Mora inlet, molluscs were significantly more abundant towards shallow (< 3 m) than deep (> 3 m) areas ($t = 6.87$; $p < 0.001$). These molluscs were represented by sessile gastropods of the family Vermetidae, which preferentially inhabit the intertidal and shallow sublittoral, newly hatched larvae of this family would be under pressure to find immediately available substrate, due to the continuous and intense swell in the inlet, favouring a greater settlement in shallower areas. Between the outer and inner face of the slab, molluscs had similar abundance according to the Mann-Whitney test ($W= 800$; $P = 0.62$) (Figure 6). The orientation and arrangement of the substrate has an effect on the settlement and colonisation of the encrusting flora and fauna, i.e., the depth and direction of currents in the area to be studied (Want *et al*., 2023).

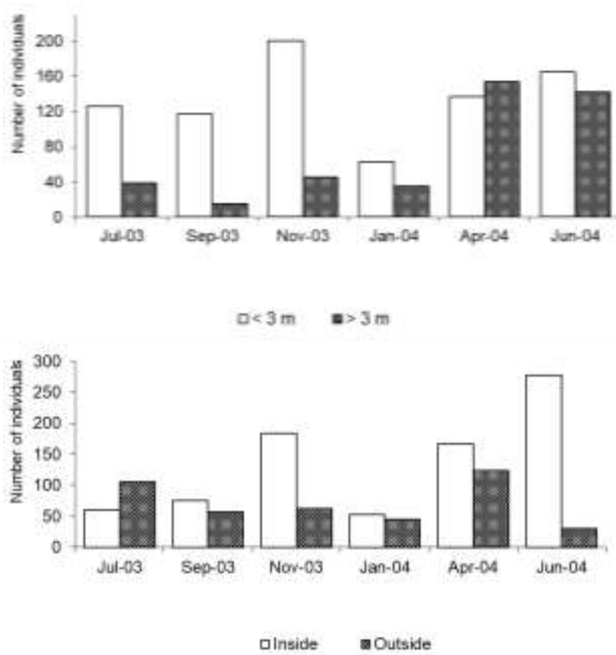

Figure 6 Abundance of molluscs recorded on an artificial substrate with respect to depth gradient (top) and slab face (bottom) during the sampling dates

The families with the highest number of species were Calyptraeidae (6) and Columbellidae (5), both of the Class Gastropoda. Three species of the family Vermetidae (Petaloconchus sp., Serpulorbis margaritaceus and Serpulorbis sp.) and one species of the family Calyptraeidae (Crucibulum sp.) accounted for 73 % of the relative abundance; the next 33 species had values between 34 and 2 individuals, while the remaining 18 species had only one individual during the study (rare species).

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The mollusc community varied depending on the time of year (Carreira-Flores *et al*., 2023), according to the ecological indices (Table 2). September 2003 and April 2004 were the months with the highest diversity according to the Shannon index, while July 2003 recorded the lowest value. April and June 2004, however, stand out for recording the highest richness and presence of rare species, above 50% in June alone.

This trend has been observed during the temperate-dry season (February-June) of temperate-cold water and no rainfall in the study area, where the specific richness and abundance increased for the fish community (Galván-Villa, 2006) and molluscs present in the branches of stony corals (López-Uriarte and Velarde-Nuño, 2007). This is closely associated with the increase in primary productivity and its effects at this time of year for the Mexican central Pacific (Blanco and Madrid, 2004), where larvae and juveniles have the greatest amount of food available (Briseño-Avena, 2004; Silva-Segundo *et al*., 2008).

	Jul-03	Sep	Nov	Jan	Aph	Jun-04
S (# especies)	18	21	18	20	26	34
H' (decits/ind)	0.83	0.93	0.74	0.84	0.93	0.85
J'	0.66	0.70	0.58	0.64	0.65	0.55

Table 2 Values of the Shannon-Weaver diversity index (H'), Pielou evenness (J'), calculated for the mollusc community associated with an artificial substrate on each sampling date

Jaccard's coefficient grouped April and June 2004, with a similarity of 0.501, while the rest of the months showed values below the significance level (0.5). This confirms the trend observed in the ecological indices presented above, where the specific richness and abundance of molluscs was similar between these months, associated with both the dominant species and the number of rare species. The first colonising species were Petaloconchus sp. and Serpulorbis sp. of sessile habit and Crucibulum sp. of non-sessile habit, together with Balanus sp. and Spirorbis sp. These molluscs, as any pioneer species, settled days after the substrate was prepared with the biofilm (microalgae layer), as suggested by the succession process in benthic environments (Rodríguez *et al*., 1993, Want *et al*., 2023). The local conditions, a shallow inlet with high current flow and tropical latitude light, facilitated the settlement of molluscs and other taxonomic groups during the study.

Conclusions

The results obtained in the present work suggest that depending on the time of the year in which a new (artificial) substrate supply is exposed, the composition of the malacofauna will be different, and that environmental factors (physical-chemical and substrate) and biological interactions have an important effect in the shallow sublittoral of the Mexican central Pacific.

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