# Results of the SIPCO Cruises (Southern Sinaloa, México) aboard the B/O "El Puma". Abundance and distribution of commercially exploitable mollusks

Michel E. Hendrickx, Albert M. van der Heiden and Arturo Toledano Granados
Instituto de Ciencias del Mar y Limnología, Estación Mazatlán, Universidad Nacional Autónoma de México.

(Received for publication August 16, 1983)

Abstract: Sample of commercial species of mollusks were collected by trawl during seasonal cruises at stations located along three transects on the coastal shelf of southern Sinaloa, México (SIPCO Cruises). Samples were obtamed from 27 to 117 m and included 5 species of *Anadara, Chione kellettii* and *Solenosteira gatesi* among the most abundant species. For these species, fresh weight per hour of trawl was of 2.4 kg/hour for the shallowest stations and maximum abundance was found off Teacapán. Most of the specimenswere obtained between 27 and 78 m, although *Anadara* spp. and *C. kellettii* were found at 109 and 114 m. Environmental conditions (temperature, salinity, dissolved oxygen and sediments) at the sampling localities are discussed, noting that *S. gatesi* was found on almost every type of substrate and tolerates very low levels of oxygen. *Chione kellettii* was predominantly found in clayish substrates and also tolerates very low levels of oxygen. Catch per unit area for *C. kellettii* is estimated as 12 kg/ha and would certainly increase if dredges were used.

Sea-shell harvest in the southeastern Gulf of California, México, is considerable and includes predominantly subtidal and intertidal species from the rocky environment (e.g. *Striostrea iridescens, Chiton articulatus, Pinctada mazatlanica*), bivalves found in shallow-protected bays or open coastal lagoons (e. g. *Anadara* spp., *Chione subrugosa, C. gnidia*) and occasionally some of the biggest gasteropods (e. g. *Malea ringens, Fasciolaria princeps, Strombus galeatus*). Other species are also sporadically collected on sandy beaches (e.g. *Tivela byronensis, Donax punctatostriatus*) or in mangrove channels and on mud-flats (e. g. *Crassostrea corteziensis, Mytella strigata*), but these constitute only a small fraction of the total harvest and are usually poorly accepted by local consumers. Besides, recent contamination and alteration of the mangrove systems in the area, has provoked a sharp decrease in the exploitation of shells that grow on aerial roots or on tidal flats.

For many years, a large commercial fishing fleet of shrimp trawlers based in Mazatlán, Sinaloa, has operated on the continental shelf of the southeastern Gulf of California (Edwards, 1978). Their commercial catch consists of shrimp of the genus *Penaeus*, and to a lesser extent, of other species of penaeids (*Xiphopenaeus riveti* and *Trachypenaeus similis pacificus*). The by-catch, which used to be discarded after sorting for shrimp, is now considered an important source of protein and revenues, and much more attention has recently been given to the processing of fishes and other crustaceans (Rosales, 1976; Paul and Hendrickx, 1980; Rodríguez de la Cruz, 1981).

In what concerns the mollusks, however, little is known of the fishing potential that could exist on the continental platform and reports on occurrence of commercially exploitable species are almost inexistent or remain unnoticed in general works dealing with faunistic or ecological aspects of this group of organisms (Parker, 1964; Brusca, 1980; van der Heiden and Hendrickx, 1982).

The mollusks that could be collected while trawling or dredging on the continental shelf of southern Sinaloa could well be abundant enough to justify a fishery, and should the occasion arise, contribute significantly to the local consumption of sea-shells.

This is the fourth contribution arising from the SIPCO Cruises.

*Location of SIPCO sampling stations*

| Transect | Station | Date | Time | Duration | Position | Depth |
|---|---|---|---|---|---|---|
| A | $A_1$ | 23/IV /81 | 11:29 | 18' | 22.24.3 N - 105.54.4 W | 35 - 36 m |
| | | 22/VIII/81 | 09:11 | 20' | 22.24.8 N - 105.56.0 W | 35 m |
| | | 15/I /82 | 08:34 | 30' | 22.24.2 N - 105.54.4 W | 40 m |
| | $A_2$ | 23/IV /81 | 17:49 | 31' | 22.17.6 N - 106.10.9 W | 61 - 62 m |
| | | 22/VIII/81 | 13:20 | 22' | 22.18.7 N - 106.10.3 W | 66 m |
| | | 15/I /82 | 12:29 | 31' | 22.17.4 N - 106.11.10 W | 74 m |
| | $A_3$ | 22/VIII/81 | 17:49 | 20' | 22.14.8 N - 106.16.1 W | 115 - 104 m |
| | | 15/I /82 | 16:42 | 31' | 22.15.7 N - 106.16.60 W | 114 m |
| B | $B_1$ | 25/IV /81 | 15:10 | 15' | 23.08.8 N - 106.25.4 W | 27 - 27 m |
| | | 24/VIII/81 | 14:21 | 30' | 23.11.5 N - 106.29.0 W | 34 - 32 m |
| | | 17/I /82 | 14:40 | 31' | 23.08.8 N - 106.16.60 W | 31 m |
| | $B_2$ | 25/IV /81 | 10:24 | 17' | 23.08.4 N - 106.32.5 W | 71 - 71 m |
| | | 24/VIII/81 | 11:24 | 31' | 23.08.7 N - 106.32.8 W | 78 m |
| | | 17/I /82 | 11:11 | 30' | 23.07.6 N - 106.33.0 W | 72 m |
| | $B_3$ | 24/VIII/81 | 08:16 | 30' | 23.06.0 N - 106.36.0 W | 113 - 117 m |
| | | 17/I /82 | 08:25 | 30' | 23.03.5 N - 106.35.0 W | 109 - 112 m |
| C | $C_1$ | 24/IV /81 | 10:26 | 22' | 23.37.5 N - 106.56.0 W | 40 - 41 m |
| | | 23/VIII/81 | 07:49 | 30' | 23.37.6 N - 106.54.5 W | 40 m |
| | | 16/I /82 | 09:20 | 20' | 23.37.2 N - 106.55.90 W | 45 m |
| | $C_2$ | 24/IV /81 | 16:00 | 17' | 23.34.0 N - 106.57.5 W | 66 - 66 m |
| | | 23/VIII/81 | 11:08 | 31' | 23.36.0 N - 107.02.2 W | 72 m |
| | | 16/I /82 | 12:31 | 26' | 23.32.6 N - 106.59.10 W | 76 m |
| | $C_3$ | 23/VIII/81 | 14:35 | 30' | 23.35.0 N - 107.05.8 W | 104 m |
| | | 16/I /82 | 16:10 | 30' | 23.35.8 N - 107.08.8 W | 111 - 107 m |

## MATERIAL AND METHODS

A total of 24 trawls were made along three transects on the continental platform of southern Sinaloa, in April and August 1981 and in January 1982. Samples were collected with 11.6 m otter trawl operating at depths of between 27 and 114 m (Table 1) at a speed of 1.5 to 2 knots.

All trawling operation were made aboard the B/O "El Puma" of the Instituto de Ciencias del Mar y Limnología, of the Universidad Nacional Autónoma de México, and lasted between 20 and 35 minutes. Samples were sorted immediately onboard and mollusks were weighed separately on a spring-balance (precision 0.05 kg), packed and deep-frozen. Identification and counting were performed upon return to the laboratory.

Information on environmental conditions (temperature, salinity, dissolved oxygen and sediments) were taken from Hendrickx *et al.* (1984).

## RESULTS

Abundance: During the survey, a total of 154 species of mollusks were collected, of which only two edible species (*Chione kellettii*, Veneridae, and *Solenosteira gatesi*, Buccinidae) and one edible genus containing several species (*Anadara*, Arcidae) were abundant. For these species only, a total of 806 specimens were obtained (Table 2) totalizing 21.6 kg of fresh weight. Fresh weight per hour of trawling averaged 2.0 kg/hour when all sampling stations

TABLE 2

*Total number of specimens of each species collected for each sampling area during the three cruises*

| Transect | Number of specimens | | Total |
|---|---|---|---|
| Off Teacapán | *Solenosteira gatesi* | 299 | 553 |
| | *Chione kellettii* | 161 | |
| | *Anadara* spp. | 93 | |
| Off Mazatlán | *Solenosteira gatesi* | 46 | 159 |
| | *Chione kellettii* | 99 | |
| | *Anadara* spp. | 14 | |
| Off Punta Piaxtla | *Solenosteira gatesi* | 57 | 94 |
| | *Chione kellettii* | 28 | |
| | *Anadara* spp. | 9 | |

are considered. This value, however, increases to 2.4 kg/hour for the shallowest stations (27 to 78 m) where most of the shells were trawled (Table 3).

Maximum abundance was recorded off Teacapán, where as much as 68% of the specimens were collected. Second in abundance was the area off Mazatlan, with approximately 20% of total capture, and the rest, or 12% , was trawled off Punta Piaxtla. Of all species, *Solenosteira gatesi* was by far the most frequently collected and it turned out to be present in 16 of the 24 trawls. The genus *Anadara* was found in 14 samples only, which makes it second in frequency of occurrence while *Chione kellettii* was collected in 13 trawls.

Maximum capture (fresh weight) for a unique species was obtained for *C. kellettii*, with 8.8 kg corresponding to 136 specimens (average of 65 g per shell).

**Bathymetric range**: The Bathymetric range for the different species was found to be considerably wide. *Solenosteira gatesi* was collected at depths between 27 and 78 m, *Chione kellettii* from 27 to 114 m and the species of *Anadara* were trawled between 33 and 109 m.

Considering all species, the majority of the specimens (92% ) was obtained from depths inferior to 78 m. The vast majority of *S. gatesi* was trawled between 35 and 72 m and accounted for as much as 95% of all specimens of this species collected during the survey. The species of *Anadara* were obtained mainly from 35 to 61 m (78% of the total); *Anadara biangulata,* although the less abundant, was collected from a much wider depth range of 35 to 109 m. *Chione kellettii* also occurred at a wide depth range but appeared to be more abundant from 66 to 104 m, where 90% of the specimens were collected.

**Distribution**: *Solenosteira gatesi* was found all over the survey area, except at depths superior to 78 m, i.e. the species was not found at stations A3, B3 and C3. It is, however, the most widely distributed species and it was collected all year long, although it seems to be less abundant off Punta Piaxtla. *Chione kellettii* was also collected in all sampling areas, but less frequently; it occurred once at station C3, at a depth of 104 m.

TABLE 3

*Numbers of specimens obtained in each trawl. Numbers in brackets are fresh weights in grams*

| | SIPCO I APRIL 1981 | | | | SIPCO II AUGUST 1981 | | | | SIPCO III JANUARY 1982 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | STATION | NUMBER (Fresh Weight g) | | | STATION | NUMBER (Fresh Weight g) | | | STATION | NUMBER (Fresh Weight g) | | |
| TRANSECT | (Depth m) | *S. gatesi* | *C. kellettii* | *Anadara spp.* | (Depth m) | *S. gatesi* | *C. kellettii* | *Anadara spp.* | (Depth m) | *S. gatesi* | *C. kellettii* | *Anadara spp.* |
| Off Teacapán | $A_1$ (35) | 144 (2000) | – | 44 (100) | $A_1$ (35) | 6 (50) | 7 (150) | 1 * | $A_1$ (40) | 32 (400) | 7 (100) | 11 (50) |
| | $A_2$ (61) | 62 (800) | – | 29 (1000) | $A_2$ (66) | 40 (250) | 10 (250) | 5 (150) | $A_2$ (74) | 15 (200) | 136 (8800) | 3 (100) |
| | – | – | – | – | $A_3$ (114) | – | – | – | $A_3$ (114) | – | 1 * | – |
| Off Mazatlán | $B_1$ (27) | 9 (300) | 7 (50) | – | $B_1$ (33) | 7* | – | 4* | $B_1$ (31) | 3 (50) | 5 (150) | – |
| | $B_2$ (71) | 8 (250) | – | 1* | $B_2$ (78) | 1* | 55 (2800) | 5 (250) | $B_2$ (72) | 18 (50) | 32 (1500) | 4 (300) |
| | – | – | – | – | $B_3$ (110) | – | – | – | $B_3$ (110) | – | – | – |
| Off Punta Piaxtla | $C_1$ (40) | 26 (250) | 1* | 2* | $C_1$ (40) | – | – | – | $C_1$ (45) | 24 (150) | – | 4* |
| | $C_2$ (66) | 4* | 3 (250) | – | $C_2$ (72) | 3* | 2 (50) | 1* | $C_2$ (76) | – | – | – |
| | – | – | – | – | $C_3$ (104) | – | 22 (800) | – | $C_3$ (109) | – | – | 2 (100) |

* Fresh weight inferior to 50 g.

**Environmental conditions**: The near-shore bottom waters of the coastal shelf of southern Sinaloa undergo seasonal fluctuations of temperature, dissolved oxygen and, to a minor extent, of salinity (Hendrickx *et al*, 1984). Due to the proximity of several rivers that empty into the Gulf of California, average surface salinities in close-to-shore localities can be lower than 15% during the rainy season (Poli, 1983). The SIPCO Cruise stations were located at least 4.6 km offshore and the effect of dilution by river discharge was consequently reduced, although still detectable. During the survey, minimum surface salinity was of 33.01% (rainy season). At the bottom, however, fluctuations were found to be much reduced (less than 1%variation) and show no real significance for marine benthos.

Dissolved oxygen profiles obtained during the cruises show very significant seasonal fluctuations to occur in the sampling area. The highest oxygen levels in the water column were observed in August (SIPCO II) and the lowest in April (SIPCO I). The most important feature for benthic organisms consistsin the presence of a minimum oxygen layer whose depth varies throughout the year. Nearshore temperatures were found to be the lowest in April, except in the area of Punta Piaxtla, where an upwelling was detected in January. Seasonal fluctuations of near-bottom temperatures were much higher in shallow water (up to 10 $^{o}$C at depths of 27 to 45 m) than at the deepest stations (1.8 $^{o}$C at 104-110 m) (Hendrickx *et al.*, 1984).

Near-bottom temperatures and dissolved oxygen concentrations at stations where commercial mollusks were found are given in Table 4 together with information on sediments (provided by the Laboratorio de Geología, Estación Mazatlán, ICML, UNAM) and on the catch per species (g/hour of trawl). Each species (or genus) occurred under a very wide range of environmental conditions, and in some cases in extreme conditions of oxygenation. Thus, *Solenosteira gatesi* was collected on almost every type of sediments, ranging from compact sediments of clay and silt to coarse sand; no clear preference for sediments could be detected, although big catches usually came from sandy bottoms. Temperature at which this species was collected ranged from 13.4 to 27.2 $^{o}$C and dissolved oxygen at the sampling stations from 4.17 to an extremely low 0.39 ml/l. The biggest catch for *S. gatesi* occurred at very low oxygen concentration (e.g. 6700 g/hour trawl at 0.39 ml/l). *Chione kellettii* was predominantly found in substrates with high proportions of silt and clay, but also ocurred in coarse to fine sand, at temperatures (13.2 to 27.2 $^{o}$C) and of dissolved oxygen concentrations (0.39 to 4.17 ml/l).

## DISCUSSION

Several species of *Anadara* have been reported for the southern Gulf of California. Parker (1964) reported 5 species for the southern Gulf continental shelf (11 to 120 m), while van der Heiden and Hendrickx (1982) reported 9 species (coastline to 90 m). During this survey, 5 species of *Anadara* were found, of which *A. esmeralda* is the largest. *Chione kellettii* was found throughout the sampling area, sometimes in large quantities; it has been reported as the dominant species in clay bottoms on the outer shelf of the southern Gulf (Parker, 1964), distributed from the Gulf of California to northern Perú at 46 to 73 m (Keen, 1971). Specimens from the SIPCO Cruises were found predominantly in clayish substrates at depth of 72 to 114 m, although they also occurred in sandy bottoms in shallow water (27 to 66 m). *Solenosteira gatesi* was found at almost every sampling station shallower than 78 m (89% ) and on almost every type of sediment. It is reported by Keen (1971) from Guaymas, Sonora, to Mazatlán (the type-locality), Sinaloa, to 27 m, and by Ortea-Rato and Llera-González (1980) from Isla Isabel, Nayarit.

Oxygen consumption and respiratory rates in mollusks. particularly intertidal species, have been studied by various authors. Mollusks are known to have low oxygen requirements and, in some cases, they present impressive anaerobic capacities (Ghiretti, 1966; Hochachka and Somero, 1976). Some species have a respiratory pigment with low unloading oxygen tension and are therefore able to survive in oxygen deficient environments (Ghirett, 1966; Newell, 1970; Newell and Branch, 1980). As in other poikilotherms, the metabolic rate is generally related to temperature and a sharp increase of oxygen consumption is observed for increasing temperatures. Little is known, however, of the optimum respiratory rate and

TABLE 4

*Sampling conditions (sediments, dissolved oxygen and water temperature) at bottom and catch per hour of trawl per species (grams)*

| Cruise | Station | Sediments | $O_2$ (ml/l) | T (°C) | Catch per hour Species in grams *S. gatesi* | *C. kellettii* | *Anadara* |
|---|---|---|---|---|---|---|---|
| SIPCO I | $A_1$ | Coarse sand | 0.39 | 16.2 | 6 700 | – | 300 |
| | $A_2$ | Fine sand | 0.44 | 14.5 | 1 500 | – | 1 900 |
| | $B_1$ | Silty sand | 1.90 | 17.2 | 1 200 | 200 | – |
| | $B_2$ | Clay/silt | 1.60 | 15.4 | 900 | – | 50 |
| | $C_1$ | Fine to coarse sand | 1.70 | 14.2 | 680 | < 50 | < 50 |
| | $C_2$ | Fine sand | 3.36 | 15.4 | < 50 | 900 | – |
| SIPCO II | $A_1$ | Coarse sand | 4.10 | 26.4 | 150 | 450 | < 50 |
| | $A_2$ | Fine sand | 3.30 | 20.6 | 700 | 680 | 680 |
| | $B_1$ | Silty sand | 3.80 | 27.2 | < 50 | – | < 50 |
| | $B_2$ | Silt/clay | 3.50 | 19.5 | < 50 | 5 400 | 500 |
| | $C_2$ | Silty sand | 4.17 | 27.0 | < 50 | 50 | < 50 |
| | $C_3$ | Clay/silt | 0.37 | 15.6 | – | 1 600 | – |
| SIPCO III | $A_1$ | Coarse sand | 2.73 | 17.0 | 800 | 200 | 100 |
| | $A_2$ | Clay/silt | 1.68 | 13.8 | 390 | 17 000 | 190 |
| | $A_3$ | Clay/silt | 0.86 | 13.7 | – | < 50 | – |
| | $B_1$ | Coarse sand | 1.47 | 16.4 | 90 | 280 | – |
| | $B_2$ | Clay/silt | 1.12 | 13.4 | 100 | 3 000 | 600 |
| | $C_1$ | Coarse sand | 1.36 | 15.6 | 450 | – | < 50 |
| | $C_3$ | Clay/silt | 0.51 | 13.2 | – | – | 200 |

some warm-temperate species present a decrease in their oxygen uptake when temperature becomes too high (Ghiretti, 1966).

On the coastal shelf of southern Sinaloa, low oxygen concentrations were usually combined with low temperatures (i.e. from 13.2 to 16.2 °C; (Table 4), when oxygen requirements are reduced. Nevertheless, it should be stressed that near-bottom oxygen concentrations were sometimes dramatically low, e.g. as little as 0.37 ml/l at 15.6 °C (less than 7% saturation); still, living mollusks were abundant: up to 1 600 g/hour trawl of *Chione kellettii* at 0.37 ml/l $O_2$, and up to 6 700 g/hour trawl of *Solenosteira gatesi* at 0.39 ml/l $O_2$.

The question of knowing whether or not a fishery for coastal shelf mollusks would be profitable along the coast of southern Sinaloa is difficult to answer. A part of the mollusks caught by shrimpers during the *Penaeus* fishing season is locally consumed. This includes species like *Argopecten circularis* (Pectinidae), *Pinna rugosa* and *Atria maura* (Pinnidae) which are found in shallow waters (10 to 50 m) where most of the trawling activities occur (Rosales, 1976). However, there are no official records for these occasional captures. During this study the optimal catch corresponded to *Chione kellettii*, with 17 kg/hour trawl; this is roughly equivalent to a catch per unit area of 12 kg/ha, assuming that the area covered by the otter trawl is approximately 1.43 ha/hour trawl at an average ship's speed of 1.75 knots during the haul. It is important to note, however, that *C. kellettii* is a member of the endofauna and that the harvest could yield larger quantities of shells if scallop or *Murex* dredges were used (see: FAO, 1975).

## ACKNOWLEDGEMENTS

The authors wish to express their gratitude

TABLE 5

*Number of specimens of each species of* Anadara *collected at each sampling stations*

| Species | Cruise | Station | Depth (m) | Number |
|---|---|---|---|---|
| *A. biangulata* | SIPCO I | $A_1$ | 35 | 1 |
| | SIPCO II | $C_2$ | 72 | 1 |
| | SIPCO III | $A_2$-$B_2$-$C_3$ | 72-110 | 1-1-2 |
| *A esmeralda* | SIPCO II | $A_2$ | 66 | 4 |
| | SIPCO III | $A_2$-$B_2$ | 72 - 74 | 2-3 |
| *A nux* | SIPCO II | $B_1$ | 33 | 1 |
| *A. reinharti* | SIPCO I | $A_1$-$C_1$ | 35 - 41 | 44-1 |
| | SIPCO II | $A_1$ -$B_1$ | 33 - 35 | 1-3 |
| | SIPCO III | $A_1$-$C_1$ | 40 - 45 | 11 -4 |
| *A. concinna* | SIPCO I | $B_2$ | 71 | 1 |
| | SIPCO II | $A_2$ | 66 | 1 |
| *Anadara* spp. | – | – | – | 34 |

to all scientists, students and crew members that took an active part in collecting the material during the SIPCO Cruises.

## RESUMEN

Muestras de moluscos de importancia comercial se obtuvieron en los arrastres efectuados en tres transectos en la plataforma continental del Sur de Sinaloa, México (Campañas SIPCO), entre 27 y 117 m de profundidad. Las especies más abundantes fueron *Chione kellettii, Solenosteira gatesi* y cinco especies de *Anadara.* El peso fresco por hora de arrastre para estas especies alcanzó 2,4 kg/hora en las estaciones más someras (27 a 78 m). Especímenes de *Anadara* y *C. kellettii* se colectaron también en profundidades de hasta 109 y 114 m respectivamente. Se analizó las condiciones ambientales (temperatura, salinidad, oxígeno disuelto y sedimentos) en cada estación de muestreo, observándose que *S. gatesi* fue colectada en una gran variedad de sustratos y en condiciones de oxigenación a veces muy bajas; *Chione kellettii* fue colectada principalmente en sustrato arcilloso y en condiciones de oxigenación similares. Se estimó la captura por unidad de área de *C. kellettii* en 12 kg/ha. Sin embargo, en caso de utilizar dragas de arrastre, la captura podría aumentar considerablemente.

## LITERATURE CITED

Brusca, R.C. 1980. A handbook to the common intertidal invertebrates of the Gulf of California. Univ. Arizona Press, Tucson. 513 p.

Edwards, R.R.C. 1978. The fishery and fisheries biology of penaeid shrimp on the Pacific coast of México. Oceanogr. Mar. Biol. Ann. Rev., 16: 145-180.

FAO. 1975. Catalogue of small-scale fishing gear. FAO-Fishing News, Ltd., 191 p.

Ghiretti, F. 1966. Respiration, p. 175-232. *In* K. M. Wilbur and C.M. Yange. (eds.). Physiology of Mollusca, Vol. 2, Academic Press, New York. 645.

Hendrickx, M.E., A. M. van der Heiden & A. Toledano Granados. 1984. Resultados de las Campañas SIPCO. III. Hidrología y composición de las capturas efectuadas en los arrastres. An. Inst. Cienc. del Mar y Limnol. Univ. Nal. Autón. México.

Hochachka, P.W., & G. N. Somero. 1976. Enzyme and metabolic adaptations to low oxygen p. 279-314. *In* R.C. Newell (ed.). Adaptation to environment: Essays on the physiology of marine animals. Butterworths, London.

Keen, A. M. 1971. Sea shells of tropical West America: marine mollusks from Baja California to Perú, 2nd. Ed. Stanford Univ. Press, Stanford. 1064.

Newell, R.C. 1970. Biology of intertidal animals. Paul Elek, Ltd. London. 555 p.

Newell, R.C. & G.M. Branch. 1980. The influence of temperature on the maintenance of metabolitic energy balance in marine invertebrates. Adv. Mar. Biol. 17: 329-396.

Ortea Rato, J.A. & J. M. Llera González. 1980. Moluscos marinos de la Isla Isabel, Nayarit, México. *In* Resumen II Congr. Nac. Malac., Barcelona, 1980: 27.

Parker, R. H. 1964. Zoogeography and ecology of macroinvertebrates, particulary mollusks, in the Gulf of California and the continental slope off México. Vidensk. Medd. Fra. Dansk. Naturhist. Foren., 126: 1-178.

Paul, R. K. G. & M. E. Hendrickx. 1980. Crustaceans in the shrimp by-catch from off the coast of Sinaloa and Nayarit. México. Bull. Southern Calif. Acad. Sci., 79 79: 109-111.

Poli, C.R. 1983. Patrón de inmigración de postlarvas de *Penaeus* spp. (Crustacea: Decapoda: Penaeidae) en la boca del Río Baluarte, Sinaloa, México. Tesis Doctoral. Inst. Cienc. del Mar y Limnol. Univ. Nal. Autón. México. 130 p.

Rodríguez de la Cruz, M.C. 1981. Aspectos pesqueros del camarón de alta mar en el Pacífico Mexicano. Ciencia Pesquera. Inst. Nal. Pesca. Depto. Pesca, México, 1:43-55.

Rosales, F. J. 1976. Contribución al conocimiento de la fauna de acompañamiento del camarón en alta mar, frente a la costa de Sinaloa, México. Mem. Reunión sobre los Recursos de Pesca Costera de México, Veracruz, Nov. 1976: 25-80.

van der Heiden, A.M., & M. E. Hendrickx. 1982. Inventario de la Fauna Marina y Costera del Sur de Sinaloa. Segundo Informe de Avance. Estación Mazatlán, Inst. Cienc. del Mar y Limnol. UNAM. 135 p.