

Commercially Important Marine Mollusks for Human Consumption in Acapulco, México

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ABSTRACT

Acapulco, offers for international tourism a variety of mollusks that are delightful to the palate and a source of economic revenue for its residents; however there are no studies on the species consumed. Furthermore, data from the State agencies responsible for registration of these products are unclear. This work is aimed to develop an inventory of Gastropoda, Bivalvia and Polyplacophora marketed as food, to gain knowledge on the species native to Acapulco and the introduced ones. The places that sell shellfish were interviewed from 2008 to 2011 in order to determine the geographical origin of their products being offered. We identified 42 species: 15 species of gastropods are captured locally and three are introduced. On Bivalvia, seven species are caught locally and 16 are introduced. There are Bivalvia species caught locally; however, their capture is now unaffordable. It is likely that this situation is due to overfishing and/or the transmission of diseases or parasites caused by the introduction of foreign living organisms to Acapulco. Within the list of species caught locally, there are some listed as of subject protection; all of these organisms are exploited in Acapulco without control. The wealth of marine mollusks for human consumption in Acapulco is very high. The capture does not satisfy local market demand and the amount of introduced species is very high. It is necessary to make a diagnostic analysis of mollusk fishing industry in the state of Guerrero, also implement a management program, including the sanitary measures and control of introduced species, as they arrive alive and stay alive in the waters of Acapulco. A significant number of native species that have aquaculture potential should be studied for commercial culture practice as well as to conduct studies on their biology on those species that are considered over-exploited and allow recovery of the species in its habitat.

Keywords: Mollusks; Commercial; Consumption; Human; Acapulco; México

1. Introduction

The marine mollusks are very important since many of them are used as food, they also have other uses such as crafts making, to dye cotton, yarn and clothes, etc., so it is that they have received special attention and become a natural resource of economic importance.

Like any natural resource, this must be used and managed properly; otherwise it runs the risk of over exploitation and running out. For proper administration and management of a natural resource such as mollusks, there must be studies to assess biodiversity, species by location, the dynamics of populations and communities, including aspects on reproductive cycles with which to determine seasonal minimum sizes and catch volumes. These studies are the technical and scientific basis with which it must developed management plans to allow proper and sustain-

able use of these resources, and these studies should also encourage the recovery of the species and its habitat.

Acapulco's wide stretch of coastline offers beautiful beaches for tourism, and provides a variety of edible marine mollusks that are a delight to the palate and a major source of revenue for fishermen and tourist servers. Hence, marine mollusks have an important role in the economic and cultural life of the municipality of Acapulco.

For Mexico there is important literature on commercially important shellfish [1-3].

The work on mollusks for Guerrero, consists on basic studies of diversity, community structure, geographic distribution, distribution areas and associated fauna [4-12]. There is little literature on commercial species populations for the State of Guerrero [13-18] and is based on some of the species considered as the most important, as are clams *Megapitaria aurantiaca* (Sowerby, 1831), *M.*

squalid (Sowerby, 1835) and *Dosinia ponderosa* (Gray, 1838), the purple snail *Plicopurpura pansa* (Gould, 1853) and the sea cockroach *Chiton articulatus* (Sowerby, 1832).

In the case of Acapulco was not found in the literature any report on the shellfish species commonly marketed for human consumption.

On the other hand, there are government agencies responsible for monitoring and recording the products obtained from the fisheries, to regulate and monitors the introduction of fishery products coming from other states of the country and are introduced on to the State of Guerrero. The records of government agencies relating to fishing and the introduction of mollusks are quite confusing and inaccurate.

Based on the afore mentioned, this study was aimed to elaborate a diagnostic analysis that includes inventorying the species (Gastropoda, Bivalvia and Polyplacophora) marketed for human consumption in Acapulco, Guerrero, in addition learn on the species which are captured in nearby and the introduced ones; as well as serving of support to advance the construction of appropriate management plans in the shellfish fishery. On the other hand, not having control of introduced species up to now, allows the flow of diseases and parasites arriving with them. It is also aimed to provide information needed for the realization of the marine mollusk fisheries management plan in the state of Guerrero.

2. Methods and Materials

Acapulco municipality is located between 16°52' and 16°41'N and 99°29' and 100°11'W. The littoral reaches 62 km in length. Acapulco's Bahía de Santa Lucia is the most important bay in the municipality, at the same time it is the longest (13 km length), and its maximum width is six km [19].

In the present work, visits were made at different places where mollusks are sold in the municipality of Acapulco for sampling organisms and interviewing people in charge of captures and/or mollusks trading. Site selection was based on the quantity and variety of mollusks that are sold and the frequency with which the site was found giving service to the public. Also were interviewed the fisherman that capture and sell mollusks directly to the consumer, whom traded their sale mainly at the beaches where they land with their capture, besides sampling directly the specimens they sold.

Samplings were made from 2008 to 2011 in 19 places where mollusks trading occurs, located at Centro, Hornos, Playa la Angosta, Caleta, Caletilla, Pie de la Cuesta, and Puerto Marqués (Table 1). In each site specimens were collected that according to the interviewed fishermen and traders were the most demanded for human consumption. All of the sampled material were labeled and placed individually in plastic bags.

Table 1. Sites where samples of marine mollusks of commercial importance for human consumption were harvested in Acapulco, Guerrero, Mexico.

Zone	Station	Coordinates
Centro	La Noria	N16°51'14.3" W099°54'11.3"
	Buzos II	N16°51'14.3" W099°54'11.3"
Hornos	El Muelle	N16°51'06.2" W099°54'02.0"
La Angosta	Perla del Mar	N16°50'31.8" W099°54'50.7"
	Candy Mar	N16°50'30.9" W099°54'50.1"
Caleta	El Navegante	N16°49'53.3" W99°54'18.8"
	La Esperanza	N16°49'53.3" W99°54'18.8"
	Dragón de Oro	N16°49'53.3" W99°54'18.8"
	Maria Bonita	N16°49'53.3" W99°54'18.8"
	Capullo	N16°49'53.3" W99°54'18.8"
	El Mariachi	N16°49'53.3" W99°54'18.8"
	Bambú	N16°49'53.3" W99°54'18.8"
	Mar Paraíso	N16°49'53.3" W99°54'18.8"
	Bocamar	N16°49'53.3" W99°54'18.8"
	Poseidón	N16°49'53.3" W99°54'18.8"
Caletilla	La Roqueta	N16°49'53.3" W99°54'18.8"
	Rompe Olas	N16°49'53.3" W099°54'10.0"
Pie de la Cuesta	La Cabaña	N16°49'55.2" W099°54'12.0"
	El Derrumbe	N16°52'09.3" W099°56'06.2"

The times of visits to a sampling site were as many as considered needed for gathering a representative sample of organisms. A sample was considered representative when, by visiting the site, no new information was gained than what was recorded in previous occasions.

To establish the geographical origin of the species, an interview was applied to current people at sampling intake, which consisted in four open questions; the first one was for knowing if the harvested species was captured in Acapulco or if it had its origin in another place and then introduced to the municipality. The second question was realized only if the harvested species was introduced, and consisted in knowing its place of origin. The third one had the objective of knowing if the introduced species that was currently being harvested, had being captured previously in Acapulco. The fourth question was followed only if the answer to question three was that the harvested spe-

cies was indeed captured previously in Acapulco, and it had the objective of knowing, under the interviewed person's opinion, the possible causes why that species is not captured anymore in Acapulco. The interview and all the collected information were recorded in a field book.

When finished harvesting, preservation of specimens was made by placing the labeled bagged specimens in bottles with 96% ethyl alcohol and subsequently, transported to the laboratory for their identification. Accurate taxonomical id required a confirmation phase in laboratory through qualified staff and the use of specialized literature [20-24], taxonomical actualizations were made [25,26]. After specimens were identified, they were placed in the malacology collection of "Unidad Académica de Ecología Marina de la Universidad Autónoma de Guerrero".

3. Results

Forty-two species of marine mollusks that are commercialized in Acapulco for human consumption were found, from which, 18 were Gastropoda, 23 Bivalvia, and one was Polyplacophora.

From the overall total, 23 are captured in Acapulco, 17 are species introduced to the municipality to be sold as food, and two species are local captured and at the same time are being introduced from other places of the Republic into the municipality for its commercialization.

For Gastropoda, 15 species are captured in Acapulco for its commercialization and three species are introduced. The best represented family was Muricidae, presenting seven species from which, all seven are captured locally (**Table 2**).

While on Bivalvia, seven species was captured in Acapulco and 14 introduced from other regions of the country for human consumption. Two species, *Hytotissa hyotis* (Linnaeus, 1758) and *Crassostrea prismatica* (Gray, 1825), were captured in Acapulco and are as well introduced to the municipality for its trading.

The best represented families were Veneridae and Arcidae, each with five species. Meanwhile on Veneridae, all species are introduced and come from states located on the north of the Republic; and for Arcidae, three species are introduced and two captured locally (**Table 3**).

From Polyplacophora only one species was found harvested, *Chiton articulatus* (Sowerby, 1832), which is captured locally (**Figure 1**).

Places from where mollusks are being introduced most frequently into Acapulco for human consumption were Costa Chica from the State of Guerrero, and from the states of Baja California Sur, Sinaloa, Sonora, Oaxaca, Nayarit, and Veracruz.

The clams *Chione undatella* (Sowerby, 1835), *Periglypta multicostata* (Sowerby, 1835), *Megapitaria squalida* (Sowerby, 1835), and *M. aurantiaca* (Sowerby, 1831)

were captured and commercialized in Acapulco, however, lately the populations have decreased to a level where there are not enough specimens to make it profitable and its exploitation is unaffordable.

Pinctada mazatlanica (Hanley, 1856), *Spondylus calCIFer* Carpenter, 1757, and *Plicopurpura pansa* (Gould, 1853) are recorded at the statute of "Norma Oficial Mexicana NOM-059-SEMARNAT-2010" [27] and are under special protection, in spite of that, these species are exploited in Acapulco for human consumption without any control (**Figure 2**).

Table 2. Origin of families and species of gastropods (local and introduced) found in Acapulco, Guerrero, Mexico, that were commercialized for human consumption.

Species	Origin	Provenance
Muricidae		
<i>Muricanthus radix</i> (Gmelin, 1971)	Local	Acapulco
<i>Muricanthus princeps</i> (Broderip, 1833)	Local	Acapulco
<i>Chicoreus</i> (<i>P.</i>) <i>erythrostomus</i> (Swainson, 1831)	Local	Acapulco
<i>Chicoreus</i> (<i>P.</i>) <i>regius</i> (Swainson, 1831)	Local	Acapulco
<i>Neoropana muricata</i> (Broderip, 1832)	Local	Acapulco
<i>Mancinella speciosa</i> (Valenciennes, 1832)	Local	Acapulco
<i>Plicopurpura pansa</i> (Gould, 1853)	Local	Acapulco
Fascioliariidae		
<i>Opeatostoma pseudodon</i> (Burrow, 1815)	Local	Acapulco
<i>Fasciolaria</i> (<i>P.</i>) <i>princeps</i> Sowerby, 1825	Introduced	Costa Chica, Guerrero and Oaxaca
<i>Leucozonia cerata</i> (Wood, 1828)	Local	Acapulco
Strombidae		
<i>Strombus</i> (<i>T.</i>) <i>galeatus</i> Swainson, 1823	Introduced	Costa Chica, Guerrero and Oaxaca
<i>Strombus peruvianus</i> Swainson, 1823	Introduced	Costa Chica, Guerrero and Oaxaca
<i>Strombus</i> (<i>S.</i>) <i>gracilior</i> Sowerby, 1825	Local	Acapulco
Vasidae		
<i>Vasum caestus</i> (Broderip, 1833)	Local	Acapulco
Calyptraeidae		
<i>Crucibulum scutellatum</i> (Wood, 1828)	Local	Acapulco
<i>Crucibulum umbrella</i> (Deshayes, 1830)	Local	Acapulco
Melongenidae		
<i>Melongena corona</i> (Gmelin, 1791)	Local	Acapulco
Fissurellidae		
<i>Fissurella</i> (<i>C.</i>) <i>gemmata</i> Menke, 1847	Local	Acapulco

Table 3. Origin of families and species of Bivalvia and Polyplacophora (local and introduced) found in Acapulco, Guerrero, Mexico, that were commercialized for human consumption.

Species	Origin	Provenance
Bivalvia		
Veneridae		
<i>Megapitaria aurantiaca</i> (Sowerby, 1831)	Introduced	La Paz BCS, Sinaloa, Sonora
<i>Megapitaria squalida</i> (Sowerby, 1831)	Introduced	La Paz BCS, Sinaloa
<i>Chione undatella</i> (Sowerby, 1835)	Introduced	Baja California Sur, Sinaloa
<i>Periglypta multicostata</i> (Sowerby, 1835)	Introduced	La Paz BCS, Sinaloa
<i>Chione californiensis</i> (Broderip, 1835)	Introduced	Baja California Sur
Arcidae		
<i>Anadara (R.) formosa</i> (Sowerby, 1833)	Local	Acapulco
<i>Anadara (L.) grandis</i> (Broderip & Sowerby, 1829)	Introduced	Sinaloa, Nayarit & Baja California Sur
<i>Anadara (L.) multicostata</i> (Sowerby, 1833)	Introduced	Baja California Sur
<i>Anadara (A.) tuberculosa</i> (Sowerby, 1833)	Introduced	Baja California Sur
<i>Barbatia reeveana</i> (Linnaeus, 1758)	Local	Acapulco
Pectinidae		
<i>Argopecten circularis</i> (Sowerby, 1835)	Introduced	Baja California Sur
<i>Nodipecten subnodosus</i> (Sowerby, 1835)	Introduced	Baja California Sur
Pinnidae		
<i>Pinna rugosa</i> Sowerby, 1835	Local	Acapulco
Pteriidae		
<i>Pinctada mazatlanica</i> (Hanley, 1856)	Local	Acapulco
Chamidae		
<i>Chama (C.) coralloides</i> (Olson, 1971)	Local	Acapulco
<i>Chama (C.) mexicana</i> Carpenter, 1857		
Ostreidae		
<i>Crassostrea gigas</i> Thunberg 1793	Introduced	Sonora and Veracruz
<i>Crassostrea prismatica</i> (Gray, 1825)	Local and Introduced	Costa Chica de Guerrero & Acapulco
<i>Crassostrea virginica</i> (Gmelin, 1791)	Introduced	Veracruz
Mytilidae		
<i>Modiolus capax</i> (Conrad, 1837)	Introduced	Veracruz
Gryphaeidae		
<i>Spondylus calcifer</i> Carpenter, 1757	Local	Acapulco
<i>Hytissa hyotis</i> (Linnaeus, 1758)	Local and Introduced	Acapulco
Psammobidae		
<i>Gary (G.) maxima</i> (Deshayes, 1855)	Local	Acapulco
Polyplacophora		
Chitonidae		
<i>Chiton articulatus</i> (Sowerby, 1832)	Local	Acapulco

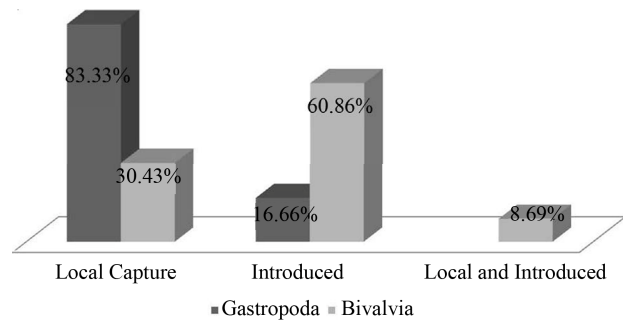


Figure 1. Percentage of species Gastropoda and Bivalvia that are captured locally and the introduced ones for human consumption in Acapulco, Guerrero.

4. Discussion and Conclusion

Species richness of marine mollusks for human consumption found in Acapulco is very high, in order to the grand existing demand of these species, above all being Acapulco a national and internationally touristic harbor of such importance where part of the attraction services are its beautiful beaches and the rich variety on its cuisine of dishes made basically out of mollusks and seafood items.

The amount of introduced species for its commercialization for human consumption is very high and represents 40.47% from total of species found in this present research.

Introduced species is something that would be expected to be found in a study of this matter, given that mollusks demand by tourists and by its local inhabitants is very high, and local capture could not satisfy market demand.

To satisfy this demand in Acapulco, the mollusks fishery in the municipality is artisanal and mainly for auto-consumption, local trading in restaurants, for direct sale from fisherman to consumers and in some cases to the market; it is based on the exploitation of natural banks; it is a riparian and a rustic activity. All the aforementioned reduces significantly the possibility for increment on the production.

On the other hand, there are no aquaculture units that produce mollusks in the municipality, whereby attempts for satisfaction of the local market demand, drives to the introduction of species collected abroad.

Most of species that are fished in Acapulco for human consumption belong to class Gastropoda, and most of the species introduced to Acapulco for its commercialization are from class Bivalvia. Within Gastropoda, family Muricidae is the best represented and all species are captured locally. In class Bivalvia two families were the best represented, both with five species each. From the 10 species that represent both families, only two are fished in Acapulco for human consumption, *Anadara formosa* (Sowerby, 1833) and *Barbatia reeveana* (Linnaeus, 1758). There are species of Bivalvia that were used to be



Pictures collection of marine invertebrates. Unid Académica de Ecología Marina. Universidad Autónoma de Guerrero

(a) *Maninella speciosa*; (b) *Plicopurpura pansa*; (c) *Leucozonia cerata*; (d) *Opeatostoma pseudodon*; (e) *Chicoreus erythrostomus*; (f) *Muricanthus princeps*; (g) *Muricanthus radix*; (h) *Chicoreus regius*; (i) *Neoropanna muricata*; (j) *Vasum caestus*; (k) *Strombus gracilior*; (l) *Melongena corona*; (m) *Crucibulum scutellatum*; (n) *Crucibulum umbrella*; (o) *Fissurella gemmata*; (p) *Anadara formosa*; (q) *Barbatia reeveana*; (r) *Gary maxima*; (s) *Pinctada mazatlanica*; (t) *Chama coralloides*; (u) *Chama mexicana*; (v) *Crassostrea primatica*; (w) *Pinna rugosa*; (x) *Chiton articulatus*.

Figure 2. Local species of Gastropoda, Bivalvia and Polyplacophora found in Acapulco, Guerrero, Mexico, that were commercialized for human consumption.

captured locally for its market; nonetheless nowadays its capture is unaffordable given its population scarcity. It is worth to mentioned that in both fisherman's and mollusks merchant's interviews, all agreed that clams *Megapitaria aurantica*, *M. squalida*, *Periglypta multicostata*, and *Chione undatella* were previously fished in riparian waters of Acapulco's municipality, but currently their population has been reduced to such grade that it is not possible to capture them for commercial matters.

A hypothesis about population diminishment is overexploitation of these species, but this is not possible to confirm because of the inconsistencies on the data that governmental departments are responsible of recording

from the mollusks fisheries on the State of Guerrero.

Moreover it is known that, at least for 20 years given that high tourism seasons arriving to the harbor in great quantities for holidays, and thus local capture could not satisfy market demand, clams have been introduced coming from several states located north of the Republic. This clam introduction has been since that day until today and it has been occurring without neither regard nor health control. The issue of clam introduction sharpens above all because they arrive alive into Acapulco and to keep them alive they are placed on the seabed of shallow places in cages or sacs, these places are near the place where mollusks are commercialized. Hence, the possi-

bility is that there could have been a transmission of parasites or diseases that had caused or enhanced mortality over native population beside the overexploitation theory.

On the other hand, the information records about mollusks sale in governmental agencies is confusing or lacking, thus it is in great needed to make a fishery diagnosis of marine mollusks in the State of Guerrero, besides establishing control over introduced species and develop adequate management program and strategies for marine mollusks fisheries of commercial importance populations, this management should include record of the species that are introduced and their amounts, origin, and health control given that they arrive alive and are kept alive in Acapulco's marine waters.

We are in accordance with Ríos-Jara *et al.* (2008) that an important quantity of species such as the clam *Anadara (L.) grandis* (Broderip and Sowerby, 1829), the oyster *Crassostrea prismatica* (Gray, 1825), the *Spondilus calcifer* and the gastropods of the genera *Muricanthus* and *Chicoreus*, that are native species have an important aquaculture potential and are considered species with commercial culturing potential.

These species and others that are native should be studied for their commercial culture potential, thus it is important to recommend the start of pilot crops where tested technology is applied to similar or same species.

It is important to remark the necessity for implementing several programs by the municipality of Acapulco in relation to mollusks of commercial importance for human consumption, among them the studies of fisheries biology for those species that are considered to be overly exploited, and on the issue of efficient on obtaining and ordering data to consolidate fisheries management schemes, beside those skemes and strategies that will allow the species recovery in their habitats and to conduct self sustainable fisheries.

Some species in the statute and bylaws of the "Norma Oficial Mexicana NOM-059-SEMARNAT-2010 (Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo)" are recorded as protected species, and are commercialized in Acapulco for human consumption with no control or guarding, for what was observed in the harbor during the time of this project was conducted.

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