

Diversity, Distribution and Composition of the Bivalvia Class on the Rocky Intertidal Zone of Marine Priority Region 32, Mexico

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Abstract

The Bivalvia Class, is widely represented in marine ecosystems and is economically important; this research focused on this class and was carried out by sampling the rocky intertidal zone of seven sites located in the Marina Region Priority No. 32, Guerrero, Mexico, where the National Commission for the Knowledge and Use of Biodiversity reported lack of knowledge on marine species living there. The objectives were to examine species richness associated with the rocky intertidal zone, determine how the community is composed by the representation of families based on species richness and abundance, know the distribution of the species, analyze the structure sizes of populations and estimate the diversity index. Sampling was conducted at seven sites; the sampling unit was one square meter and the sampling area was 10 m². 32 species were identified. Four species are new records for the Mexican Pacific Transitional: one for the state of Guerrero and one for Marine Priority Region 32. Arcidae and Mytilidae Families were better represented in species richness and Chamidae Family was the best represented in abundance. *Chama coraloides* was considered to be the representative species of the area; *Striostrea prismatica* showed the greatest size. The diversity index was estimated ($H' = 3.65$ bits/individuals). Species richness is high and corresponds to that expected in a tropical area.

Keywords

Bivalvia, Distribution, Intertidal Zone, Guerrero, Mexico

1. Introduction

North America has been divided into 24 marine ecoregions, seven of which are located in Mexico. The coast

state of Guerrero is located in marine ecoregion 17, also called Mexican Pacific Transitional. Besides the Guerrero coast in this ecoregion, the coasts of the states of Jalisco, Colima, Michoacán, Oaxaca and the southern tip of Baja California Sur are included. The physiography of this ecoregion is characterized by a narrow continental shelf with an amplitude of 10 - 15 km and a slope of less than $1^{\circ}30'$, with a deep ocean trench and complex abyssal plains [1].

The coast state of Guerrero has a length of 470 km [2] and has different habitat types. The National Commission for the Conservation and Use of Biodiversity (Comisión Nacional para la Conservación y Uso de la Biodiversidad, CONABIO) reports for the state of Guerrero four priority marine regions (30, 31, 32, and 33) for the conservation and use of biodiversity (MPR) and reports that the knowledge of biodiversity in these regions is limited [3]. So it is important to conduct research that provides information about the diversity in the MPR, in addition to analyzing various aspects of ecological populations and communities of marine organisms.

The MPR 32 (Coyuca-Tres Palos) has an area of 829 km². This region is classified as an area with high biodiversity and presents problems such as modification of the environment by discharges of fresh water, chemicals and fertilizers, damage to the environment due to tourist transport, the introduction of exotic species and the current lack of regulations regarding the use of natural resources [3]. This region has large rocky intertidal areas, which are located in Acapulco. This area is exposed to constant immersion and emersion and presents a variety of conditions in which life can develop.

Mollusks are a part of the marine fauna that make up the MPR 32, and within this taxon, are the Bivalvia Class. Members of this class are diverse, abundant, have commercial importance and are also an important part of fishery production [4].

There are few reports on the Bivalvia Class in the state of Guerrero, and these are primarily concerning commercially important species [5] [6]. There are reports of mollusks in research carried out in different sites of the Mexican Pacific coast, where the Class Bivalvia is included; these refer to the diversity, structure and variation in the community over time [7]-[14]. Other reports provide information on distribution and abundance [15]-[24].

For the rocky intertidal zone of the MPR 32, there are reports based on community studies of mollusks, where the Bivalvia Class is among the classes analyzed. These studies deal with species richness, diversity, abundance and the zonation of mollusks [25]-[34].

This research was focused on the organisms of the Bivalvia Class associated with the rocky intertidal zone of the MPR 32 and the objectives were: to determine the species richness, examine the composition of the community from the representation of families and analyze the relative abundance distribution and size composition of the species in the community.

2. Methodology

2.1. Study Area

The MPR 32 is located between the lagoons Coyuca and Tres Palos (Latitude $16^{\circ}35'24''N$, $17^{\circ}28'12''W$ and Longitude $99^{\circ}25'12''N$, $100^{\circ}33'W$) [3]. Sampling was conducted at seven sites in the rocky intertidal zone of the MPR 32 (Majahua, Tlacopanocha, Parque de la Reina, Muelle, La Angosta, Manzanillo y Pie de la Cuesta). Each location was geographically referenced and described according to the following criteria: length of the sampling area, type of substrate, types of rock, substrate stability and wave exposure. The descriptions of the collecting sites were based on [35] and maps produced by the National Institute of Statistics, Geography and Informatics (Instituto Nacional de Geografía, Estadística e Informática, INEGI) and were complemented with field observations (Table 1 and Figure 1).

These sites vary in type, substrate stability and wave exposure. Substrate types were classified as: 1) massif rocks: fixed structures such as walls, cliffs, terraces, etc., 2) blocks: loose rock larger than 50 cm in diameter, made of rocks that are submerged and immovable or difficult to move about by the impact of waves, 3) boulders: loose rock with a size of less than 50 and greater than 8 cm in diameter, rocks that can be easily moved by the impact of waves, 4) gravel: loose rock no more than 8 cm in diameter, 5) artificial substrate: concrete blocks or construction waste.

The stability of the substrate was classified as: 1) high: when the substrate remains virtually unchanged by the impact of waves, 2) middle: when the impact of the waves does not change the configuration of the substrate but there is rock movement, 3) low: when the site configuration is changed by the impact of waves, most of the

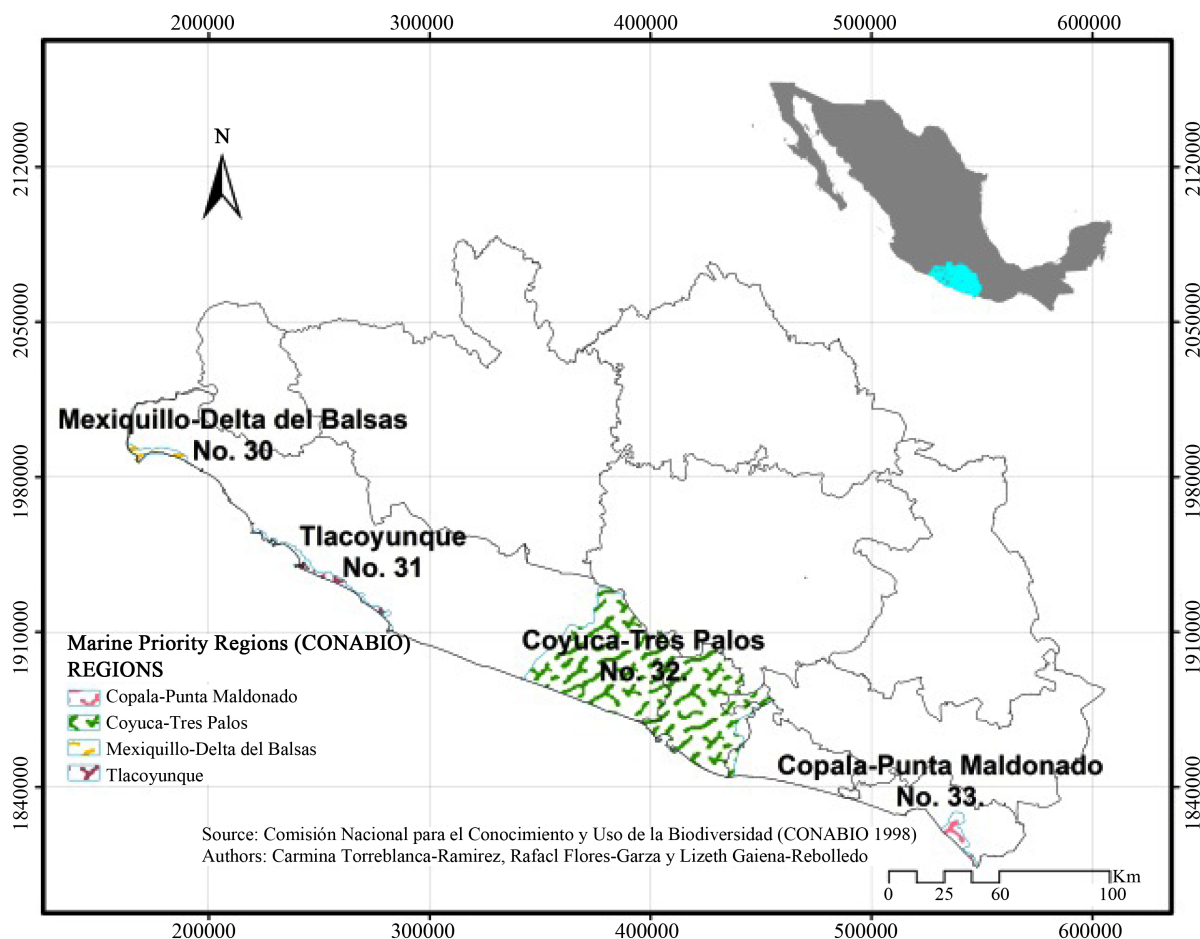


Figure 1. Marine priority regions at the state of Guerrero, México.

Table 1. Geographical location and the most relevant characteristics of the sampling sites.

Site	Coordinates		Length (m)	Type of substrate	Type of rock	Substrate stability	Wave exposure
	Latitude	Longitude					
1 Majahua	16°47'40.49"	99°50'30.29"	600	Blocks and boulders	Metamorphic	High	Low
2 Tlacopanocha	16°50'41.53"	99°54'25.02"	200	Blocks and gravel	Artificial substrate and igneous	Middle	Middle
3 Parque de la Reina	16°51'2.27"	99°54'01.70"	66.74	Boulders and gravel	Artificial substrate and igneous	Low	Middle
4 Muelle	16°50'56.86"	99°54'02.39"	60	Blocks and boulders	Metamorphic and artificial substrate	Middle	Middle
5 La Angosta	16°60'29.86"	99°54'55.70"	48.14	Massif rock and boulders	Metamorphic	High	High
6 Manzanillo	16°50'27.90"	99°54'38.14"	22.87	Boulders and gravel	Metamorphic and artificial substrate	Low	Low
7 Pie de la Cuesta	16°52'25.64"	99°56'34.64"	66	Massif rock and boulders	Metamorphic	High	High

rocks are moved.

The wave exposure was classified as: 1) high: when the wave hits the substrate in a free manner, usually the sites that have this type of waves are outside of the protection of barriers such as bays or hooks, 2) middle: when the impact of the wave on the substrate is hindered by barriers or smoothing, as can occur at sites that are in front of the entrance of bays or at a distance from a wall of hooks, it also happens in places where subtidal rocky

substrate emerges or is shallow and reduces the direct impact of the waves to the substrate, 3) low: when the wave does not directly hit the substrate, since the sites are protected by different types of barriers [36].

2.2. Collection of Samples

Three samplings were conducted per site between 2009 and 2012. Each sampling was performed during the hours of low tide and new moon days, the sampling area was 10 m² and sampling unit was 1 m². Sampling was systematic. The starting point of the sample was randomly selected in the rocky intertidal zone and the sampling unit was delimited using a 1 m² frame made of PVC pipe. A rope 30 m in length, was placed next to the PVC frame, which extended parallel to the coast over the rocky intertidal zone, in order to define the transect on which sampling would be carried out.

All bivalve specimens found alive within the sampling unit, were collected and placed into a plastic container filled with seawater and protected from direct sunlight. The following sampling unit was placed along the transect two meters from the first sampling unit. This procedure was repeated to complete 10 m². The specimens were placed in bottles containing 96% ethyl alcohol and taken to the laboratory to be identified and quantified.

2.3. Laboratory Work and Data Analysis

The identification of specimens and the update of the nomenclature, required confirmation in the laboratory, using literature such as [37]-[39].

The collected specimens were measured in length and width (mm). Species richness was assessed based on the number of species found in the samples. The community composition was analyzed using the representation of families, which was evaluated based on species richness and abundance of organisms per family and expressed as percentage. Relative abundance was measured as the percentage of each species with respect to the total number of specimens. The geographical distribution was evaluated using on the frequency of occurrence of species per site as follows: broad (frequency of 6 to 7 sites), regular (frequency of 3 to 5 sites) and limited (frequency of 1 to 2 sites).

The composition analysis of the sizes of the populations of bivalve was considered by measuring the length and width, and obtaining the descriptive statistical values such as maximum, minimum, mean and standard deviation for the species whose abundances were higher than 2 specimens. The diversity was measured using the Shannon-Wiener index (H') and Pielou index (J').

3. Results

1178 specimens were examined and found to that the Bivalvia Class associated with the rocky intertidal zone of MPR 32, is composed of 12 families, 21 genera and 32 species. The Mytilidae Family was the best represented in species richness, representing seven genera and eight species, followed by the Arcidae Family making up three genera and seven species. The site with the highest species richness was Manzanillo, which represented 78% of the total bivalve species associated with rocky intertidal zone of the MRP 32. Tlacopanocha ranked second in species richness representing 50%. Sites with lower species richness were Parque de la Reina and Pie de la Cuesta (**Table 2**).

Barbatia illota (Sowerby, 1833), *Modiolus tumbezensis* (Pilsbry & Olsson, 1935), *Ctena clarionensis* (Herzstein & Strong, 1946) and *Martesia (Martesia) striata* (Linnaeus, 1758) were identified as new records for the Mexican Pacific Transitional. *Cardites laticostatus* (Sowerby, 1833), was a new record for the state of Guerrero and *Barbatia (C.) reeveana* (d'Orbigny, 1846) a new record for the MRP 32 (**Figure 2**).

In relative abundance, Chamidae Family was the best represented with 35.82% of the total abundance, followed by the Family Mytilidae with 22.41%. These two families were found in all sampling sites. Family Arcidae found at six sites, only in Pie de la Cuesta was not found. Species with wide distribution in the study area were registered in Mytilidae, Chamidae and Carditidae Families.

The Families Lucinidae, Pholadidae, Anomiidae and Pteridae are each represented by one species, were presented in one site and only one or two specimens were collected.

The highest relative abundance per site was recorded in Majahua (25.63%) followed by Pie de la Cuesta (23.34%). Both sites they accounted for just under 50%. Parque de la Reina had the lowest value in relative abundance (2.46%), followed by La Angosta (6.02%).

Table 2. Species richness, abundance and distribution of bivalve associated with the rocky intertidal zone at the MPR 32, Acapulco, Mexico.

Families (RA)/species	N	Sites							dt
		A	B	C	D	E	F	G	
MYTILIDAE (22.41%)									
<i>Brachidontes adamsianus</i> (Dunker, 1857)	21	2	4	2	1	6	2	4	W
<i>Brachidontes puntarenensis</i> (Pilsbry & Olsson, 1935)	21			4	3	6		8	RE
<i>Brachidontes semilaevis</i> (Menke, 1848)	2					2			L
<i>Septifer zeteki</i> (Hertlein & Strong, 1946)	2		2						L
<i>Choromytilus palliopunctatus</i> (Carpenter, 1857)	151							151	L
<i>Lithophaga (Myoforceps) aristata</i> (Dillwyn, 1817)	36	1			3	6	23	3	RE
<i>Modiolus capax</i> (Conrad, 1837)	30		18	1		1	10		RE
<i>Modiolus tumbezensis</i> (Pilsbry & Olsson, 1935)	1						1		L
ARCIDAE (3.05%)									
<i>Acar gradata</i> (Broderip & Sowerby, 1829)	8		2			2	4		RE
<i>Acar pusilla</i> (Sowerby I, 1833)	2		2						L
<i>Acar rostrata</i> (Berry, 1954)	8	8							L
<i>Arca mutabilis</i> (Sowerby, 1833)	4		2				2		L
<i>Barbatia lurida</i> (Sowerby, 1833)	6	3	1				2		RE
<i>Barbatia illota</i> (Sowerby, 1833)	3					1	2		L
<i>Barbatia reeveana</i> (d'Orbigny, 1846)	5				1		4		L
PTERIIDAE (0.16%)									
<i>Pinctada mazatlanica</i> (Hanley, 1856)	2						2		L
ISOGNOMONIDAE (8.14%)									
<i>Isognomon janus</i> (Carpenter, 1857)	96	16	27			20	6	27	RE
OSTREIDAE (17.82%)									
<i>Saccostrea palmula</i> (Carpenter, 1857)	107	81	1				25		RE
<i>Striostrea prismatica</i> (Gray, 1824)	103	82			5		16		RE
ANOMIIDAE (0.16%)									
<i>Pododesmus foliatus</i> (Broderip, 1834)	2		2						L
PLICATULIDAE (2.71%)									
<i>Plicatula penicillata</i> (Carpenter, 1857)	18	4	4				10		RE
<i>Plicatulostrea anomioidea</i> (Keen, 1958)	14	3	4				7		RE
LIMIDAE (2.80%)									
<i>Limaria pacifica</i> (d'Orbigny, 1846)	33	5	4	2			22		RE
LUCINIDAE (0.08%)									
<i>Ctena clarionensis</i> (Hertlein & Strong, 1946)	1						1		L
CARDITIDAE (6.70%)									
<i>Cardites grayi</i> (Dall, 1903)	69	7	39	6	1	1	15		W
<i>Cardites laticostatus</i> (Sowerby, 1833)	1						1		L
<i>Carditamera affinis</i> (Sowerby, 1833)	9			3		2	4		RE
CHAMIDAE (35.82%)									
<i>Chama coralloides</i> (Reeve, 1846)	324	84	38	11	75	20	34	62	W
<i>Chama echinata</i> (Broderip, 1835)	13				3	1	9		RE
<i>Chama mexicana</i> (Carpenter, 1857)	51				13	3	15	20	RE
<i>Chama sordid</i> (Broderip, 1835)	34	6	25		1		2		RE
PHOLADIDAE (0.08%)									
<i>Martesia (Martesia) striata</i> (Linnaeus, 1758)	1						1		L
Total abundance	1178	302	175	29	106	71	220	275	

N = number of organisms. Sites: A: Majahua, B: Tlacopanocha, C: Parque de la Reina, D: Muelle, E: La Angosta, F: Manzanillo, G: Pie de la Cuesta. dt = distribution type, W = broad, RE = regular, L = limited.



(1) *Brachidontes adamsianus* (2) *B. puntarenensis* (3) *B. semilaevis* (4) *Septilifer zeteki* (5) *Choromytilus palliopunctatus* (6) *Lithophaga aristata* (7) *Modiolus capax* (8) *M. tumbezensis* (9) *Acar gradata* (10) *A. pusilla* (11) *A. rostrae* (12) *Arca mutabilis* (13) *Barbatia Lurida* (14) *B. illota* (15) *B. reeveana* (16) *Martesia striata* (17) *Carditamera affinis* (18) *Cardites grayi* (19) *C. laticostatus* (20) *Pinctada mazatlanica* (21) *Isognomon janus* (22) *Saccostrea palmula* (23) *Striostrea prismatica* (24) *Plicatula penicillata* (25) *Plicatulostrea anomioides* (26) *Lima pacifica* (27) *Pododesmus foliatus* (28) *Ctena clarionensis* (29) *Chama coralloides* (30) *C. echinata* (31) *C. mexicana* (32) *C. sordida*.

(*) New records.

Pictures of the collection of marine invertebrates. Unidad Academica de Ecologia Marina. Universidad Autonoma de Guerrero.

Photos: V.I. López-Rojas, C. Torreblanca-Ramirez, L. Galeana-Rebolledo y R. Flores-Garza.

Figure 2. Bivalve species associated with rocky intertidal zone of MPR 32, Acapulco, Mexico.

The species that showed the highest abundance in the rocky intertidal zone of the MPR 32 was *Chama coralloides* (Reeve, 1846) and represented 27.50% of the total abundance, followed by *Choromytilus palliopunctatus* (Carpenter, 1857) (12.81%), *Saccostrea palmula* (Carpenter, 1857) (9.08%) and *Striostrea prismatica* (Gray,

1824) (8.74%). These species together account for just over 58% relative abundance. The minimum value in abundance was presented at *Modiolus tumbezensis* (Pilsbry & Olsson, 1935), *Cardites laticostatus* (Sowerby, 1833), *Ctena clarionensis* (Hertlein & Strong, 1946) and *M. (M.) striata*.

C. coralloides was found to be the most abundant species in five sites (Majahua, Parque de la Reina, Muelle, La Angosta and Manzanillo). In the other two sites it ranked in second place in relative abundance. In Tlacapanocha, the species that had the highest abundance values was *Cardites greyi* (Dall, 1903). This species ranked second in abundance in Parque de la Reina. *C. palliopunctatus* was the most abundant species P. de la Cuesta (was only found on this site). In La Angosta, *Isognomon janus* (Carpenter, 1857), shared first place in abundance with *C. coralloides* (Table 3).

9.37% of the species were found to have broad distribution, 56.22% have regular distribution and 43.75% limited distribution. *C. coralloides* and *Brachidontes adamsianus* (Dunker, 1857) were present at all sites and *C. greyi* was presented at six sites (not found in Pie de la Cuesta). Ten species were found in one place, most of these species have very low values of relative abundances, however of these species *C. palliopunctatus* is found, recorded as the second in relative abundance in the MPR 32.

S. prismatica had the greatest average length, followed by *B. reeveana* and *C. coralloides*. *S. palmula* was registered the greatest average width, followed by *Plicatulostrea anomioides* (Keen, 1958). *B. adamsianus* and *Brachidontes puntarenensis* (Pilsbry & Olsson, 1935), had the lowest average length, followed by *Lithophaga (Myoforceps) aristata* (Dillwyn, 1817) (Table 4).

The value of the diversity index of Shannon-Wiener (H') calculated for the MPR 32 was $H' = 3.65$ bits/individuals and the value of Pielou index (J') was $J' = 0.73$.

4. Discussions and Conclusions

In the area of the rocky coast of Michoacan, 19 species of bivalves were recorded [12]. This research is in

Table 3. Number of species, relative abundance and most abundant bivalve species associated with rocky intertidal sampling sites in MRP 32, Acapulco, Mexico.

Site	NS	RA	Most abundant species	n	RAb-sp
Majahua	13	25.6	<i>C. coralloides</i>	84	27.81
			<i>S. prismatica</i>	82	27.15
			<i>S. palmula</i>	81	26.82
Tlacapanocha	16	14.9	<i>C. greyi</i>	39	22.28
			<i>C. coralloides</i>	38	21.71
P. de la Reina	7	2.46	<i>C. coralloides</i>	11	37.93
			<i>C. greyi</i>	6	20.68
Muelle	10	8.99	<i>C. coralloides</i>	75	70.75
			<i>C. mexicana</i>	13	12.26
La Angosta	13	6.02	<i>C. coralloides</i>	20	28.16
			<i>I. janus</i>	20	28.16
Manzanillo	25	18.7	<i>C. coralloides</i>	34	15.45
			<i>S. palmula</i>	25	11.36
P. de la Cuesta	7	23.3	<i>C. palliopunctatus</i>	151	54.9
			<i>C. coralloides</i>	62	22.54

NS = number of species, RA = relative abundance (%), n = number of organisms per species, RAb-sp = relative abundance of each species per site.

Table 4. Length and width of the bivalve species associated with the rocky intertidal zone of MPR 32, Acapulco, Guerrero.

Species	Length (mm)					Width (mm)			
	N	Min	Avg	Max	SD	Min	Avg	Max	SD
<i>Brachidontes adamsianus</i>	21	2.2	3.5	6.7	1.2	21	3.6	5.7	10.6
<i>Brachidontes puntarenensis</i>	21	2.4	3.5	7.9	1.1	21	2.1	5.9	8.6
<i>Choromytilus palliopunctatus</i>	151	2.2	11.5	20.9	3.4	151	2.4	20.4	40.2
<i>Lithophaga aristata</i>	36	0.9	3.7	30.9	5.8	36	1.5	5.0	10.3
<i>Modiolus capax</i>	30	7.4	19.3	36.0	7.2	30	12.1	35.6	68.1
<i>Acar gradata</i>	8	2.6	8.2	16.5	6.6	8	5.2	6.3	8.4
<i>Acar rostrata</i>	8	14.1	19.8	24.37	3.55	8	5.58	10	12.7
<i>Arca mutabilis</i>	4	2.7	9.7	19.6	6.3	4	5.2	15.6	29.0
<i>Barbatia lurida</i>	6	10.2	19.3	23.25	5.7	6	8.4	13	15.9
<i>Barbatia illota</i>	3	7.5	13.1	21.3	7.2	3	4.8	9.0	15.4
<i>Barbatia reeveana</i>	5	12	25.2	36.45	11.3	5	6.7	12.5	17.7
<i>Isognomon janus</i>	96	3.5	8.6	17.0	2.8	96	4.8	10.9	30.2
<i>Saccostrea palmula</i>	107	6.8	20.8	36.3	5.7	107	13.1	28.9	50.3
<i>Striostrea prismatica</i>	103	12	36.7	82.5	20.8	103	8.3	35.1	84.6
<i>Plicatula penicillata</i>	18	5.5	11.1	23.1	4.1	18	7.7	14.7	34.0
<i>Plicatulostrea anomioides</i>	14	10	21.9	33.4	7.0	14	12.7	21.6	35.6
<i>Lima pacifica</i>	33	4.3	10.4	19.2	3.5	33	8.2	17.2	30.9
<i>Cardites grayi</i>	69	5.8	19.0	36.9	7.8	69	5.1	18.2	39.2
<i>Carditamera affines</i>	9	3.7	18.0	31.2	8.2	9	6.7	9.9	12.9
<i>Chama coralloides</i>	324	3.4	25.0	65.4	12.8	324	6.1	25.4	54.9
<i>Chama echinata</i>	13	7.2	19.9	40.3	9.5	13	7.4	24.3	48.5
<i>Chama mexicana</i>	51	2.4	13.2	36.1	6.7	51	3.0	15.4	54.2
<i>Chama sordida</i>	34	7.3	18.4	58.9	9.4	34	9.4	20.0	44.5

N = number of specimens measured, Min = minimum, M = average, Max = maximum, SD = standard deviation.

agreement with six of the species reported in Michoacan: they are *Brachidontes semilaevis* (Menke, 1848), *C. palliopunctatus*, *Modiolus capax* (Conrad, 1837), *Pinctada mazatlanica* (Hanley, 1856), *Chama mexicana* (Carpenter, 1857) and *Limaria pacifica* (d'Orbigny, 1846). [21] reported 24 species of bivalves in the rocky intertidal zone of Navachiste islands in Sinaloa. Our results are in agreement with the findings of *I. janus*, *S. palmula*, *C. grayi* and *C. laticostata* [40], who reported 11 species of bivalves in the coral reef of Tenacatita, Jalisco, of which this research found *Acar gradata* (Broderip & Sowerby), *B. adamsianus*, *M. capax*, *P. mazatlanica*, *Carditamera affines* (Sowerby, 1833), and *Chama sordida* (Broderip, 1835) in the study area. Study of bivalve community in the Mazatlan Bay [24] reported 26 families and 89 species; the work was carried out in two areas of intertidal and shallow subtidal sandy and rocky sites. This research found 10 families and 21 species similar to those reported in Mazatlan.

In research carried out in the state of Guerrero, [15] in Zihuatanejo, recorded 37 species of Class Bivalvia. The research was conducted in sandy and rocky sites, in the intertidal and subtidal zones. This study is in agreement with the report in which 14 species are cited including *A. gradata*, *Acar rostrata* (Berry 1954), *Arca mutabilis* (Sowerby, 1833), *B. reeveana*, *B. semilaevis*, *Septifer zeteki* (Hertlein & Strong, 1946), *L. aristata*, *M. capax*, *P. mazatlanica*, *I. janus*, *L. pacifica*, *C. affines*, *Chama echinata* (Broderip, 1835) and *C. mexicana*. [14] reported nine species of the Class Bivalvia for the rocky intertidal zone of the State of Guerrero, which agree with our findings: *A. mutabilis*, *B. semilaevis*, *C. palliopunctatus*, *S. palmula*, *S. prismatica*, *I. janus*, *C. affinis*

and *C. echinata*.

In reports regarding Acapulco, [31] recorded 11 species of the Class Bivalvia; [30] recorded 13 bivalves; [32] reported nine species; [33], eight species and [34] recorded 21 species. Our findings agree with those of the authors mentioned above regarding all species, except the report on *Pseudochama inermis* (Dall, 1871).

In this study, four new records for the Mexican Pacific Transitional are reported: one for the state of Guerrero and one for the MPR 32 (Table 5).

This research provides important information about the Class Bivalvia in the rocky intertidal zone of the MPR 32 where CONABIO noted the lack of information on marine diversity.

The Class Bivalvia is well represented in the rocky intertidal zone of the MPR 32; the above is verified by species richness found. This research reports the highest value in bivalve species richness associated with the rocky intertidal zone of the state of Guerrero.

The differences in observed species richness compared to other research conducted in the rocky intertidal zone of the state of Guerrero, are attributed to greater sampling effort, easy access to the sites, a meticulous review of the area and variability features of the substrate sites, the set of sampled sites, and represent the entire variety of substrate types that make up the rocky intertidal zone of the MPR 32 and this research sampling efforts focused on the Class Bivalvia.

The number of known species in the study area has increased.

The species richness found, corresponds to that expected in the rocky intertidal zone located in a tropical zone, which is comprised of sites that have various types of rocky substrates, and are different in wave exposure.

In the study area, Families Chamidae, Arcidae and Mytilidae have been reported as the best represented in species richness [30]-[34]. This research found the same result.

The greatest species richness was found at sites with medium or low stability of the substrate, formed by blocks of rock, boulders or gravel and protected from direct wave impact. Sites with lower species richness have substrate with a high degree of stability and the impact of the waves is direct on the substrate. [41] reported that there is a direct correlation between the stability of the beaches and the type of species and [42] found greater species richness in sites that are substrates of pebbles compared to sites with firm substrate such as cliffs. [14] analyzing the biodiversity of mollusks distributed in nine sites on the coast of the State of Guerrero, reported that species richness is associated with habitat stability and wave intensity at each site. Unstable sites, formed by boulders and with less intensity wave, had higher species richness. Sites with stable substrates and greater wave exposure had lower species richness.

New records of species of bivalves are reported, which show that much remains to be learned about marine fauna resources for the state of Guerrero, hence the importance in conducting research for marine fauna.

Mytilidae and Chamidae Families had the best representation in abundance. Similar results are reported by [24], in Mazatlán Bay and [32]-[34], to Acapulco.

The Chamidae, Arcidae and Mytilidae Families turned out to be better represented in species richness, abundance and distribution which are considered as the representative families of MPR 32.

Lucinidae, Pholadidae, Anomiidae and Pteridae Families are considered rare in the rocky intertidal zone of the MPR 32.

C. coralloides, has been reported as the longest species in the MPR 32 [31]-[34]. *C. sordida* and *C. grayi* are also reported by the majority of the research as representative or dominant. This research also found these species as dominant.

For values of abundance and distribution, *C. coralloides* was considered to be the representative species of the rocky intertidal zone of the MPR 32, and also can be considered representative of this area—*S. palmula*, *S. prismática* and *C. grayi*, with the exception of sites whose substrate is entirely exposed to the impact of the waves as in Pie de la Cuesta. Also *B. adamsianus* for its distribution (found everywhere) is considered to be representative of the area. It was determined that *C. pallopunctatus* is a highly specialized species and represents the highest energy sites in the MPR 32.

On the low values of abundance and limited distribution, *Acar pusilla* (Sowerby I, 1833), *B. semilaevis*, *S. zetekii*, *M. tumbezensis*, *P. mazatlanica*, *Pododesmus foliates* (Broderip, 1834), *C. laticostatus*, *C. clarionensi* and *M. striata* are considered rare species in the rocky intertidal zone of MPR 32.

C. coralloides, has been reported as the species with the larger MPR 32 [32]-[34]. In this research, *S. prismática* recorded the greatest size; however *C. coralloides* is recorded having the greatest length among the species.

Table 5. New records in the Mexican Pacific Transitional, the state of Guerrero and the Marine Priority Region No. 32.

Family/Species	N	Long (mm)				Known Distribution	New Distribution
		Min	Avg	Max	SD		
Mexican Pacific Transitional							
ARCIDAE J. E. Gray, 1854 <i>Barbatia illota</i> (Sowerby, 1833)	3	7.5	13.1	21.3	7.2	Mexico: Gulf of California (Isla Angel de la Guarda, Puertecitos and San Felipe), Baja California Sur (Concepcion Bay), Sonora (Puerto Peñasco), Nayarit (San Blas) and Sinaloa (Mazatlan Bay). In an Island of Honduras. Panama: Coiba Island, Hato Island, Bays of Panama and Venado. Colombia. Ecuador: Galapagos Islands and Salinas. Peru: Lobitos. Brazil: Balneario of Camboriu, Nearitajai, Santa Catarina. (Keen, 1971, Skoglund, 2001, World Register of Marine Species, WMSDB-Worldwide Mollusk Species Data Base, DISCOVER LIFE and Ezqueda-González <i>et al.</i> , 2014).	Manzanillo 16°50'27.90"N, 99°54'38.14"W La Angosta 16°47'39.62"N, 99°50'29.02"W
MYTILIDAE Rafinesque, 1815 <i>Modiolus tumbezensis</i> (Pilsbry & Olsson, 1935)	1	6.1				Mexico (Nayarit). (Reguero y García-Cubas, 1988 and World Register of Marine Species).	Manzanillo 16°50'27.90"N, 99°54'38.14"W
LUCINIDAE J. Flaming, 1828 <i>Ctena clarionensis</i> (Hertlein & Strong, 1946)	1	9.7				Mexico: On the West Coast, Clarion Island, Gulf of California, Rocas Alijos Rocks, San Carlos Bay, Sonora); Costa Rica: Cocos Island. Ecuador: Galapagos Islands. (Keen, 1971, Skoglund, 2001, World Register of Marine Species and WMSDB-Worldwide Mollusk Species Data Base).	Manzanillo 16°50'27.90"N, 99°54'38.14"W
PHOLADIDAE Lamarck, 1809 <i>Martesia (M) striata</i> (Linnaeus, 1758)	1	13.7				Mexico: On the Shores of the Pacific (Baja California and Sonora), Caribbean Sea, Gulf of Mexico. Costa Rica. Cuba. Puerto Rico. Tasmania. Lesser Antilles. United Kingdom. South Africa. Thailand and East China Sea. (Keen, 1971, Skoglund, 2001 and World Register of Marine Species and DISCOVER LIFE).	Manzanillo 16°50'27.90"N, 99°54'38.14"W
State of Guerrero							
CARDITIDAE Férussac, 1822 <i>Cardites laticostatus</i> (Sowerby I, 1833)	1	16.7				Mexico: Sinaloa (Navachiste Islands), Colima (Revillagigedo Islands); El Salvador. Panama (Panama Bay, Governor Island, Cebaco Islands Puna Island, Gulf of Montijo and Venado Islands); Costa Rica (Cocos Island); Ecuador (Galapagos Islands). (Skoglund, 2001, Keen, 1971, Ortiz-Arellano and Flores-Campaña 2008, WMSDB-Worldwide Mollusk Species Data Base and DISCOVER LIFE).	Manzanillo 16°50'27.90"N, 99°54'38.14"W
Marine Priority Region 32							
ARCIDAE J. E. Gray, 1854 <i>Barbatia (C) reeveana</i> (d'Orbigny, 1846)	5	11.99	25.20	36.45	11.31	Mexico: Rocas Alijos, Gulf of California (Puertecitos), Baja California Sur (Bahía Concepción) and Guerrero (La barrita and Zihuatanejo). Panama. Costa Rica (Cocos Island). Colombia (Mal Pelo Islands). Ecuador (Galapagos Islands) and Peru (South of lobitos). (Salcedo <i>et al.</i> , 1988, World Register of Marine Species, WMSDB-Worldwide Mollusk Species Data Base and DISCOVER LIFE).	Manzanillo 16°50'27.90"N, 99°54'38.14"W Muelle 16°50'58.27"N, 99°54'01.85"W

N = number of specimens tested, Min = minimum, Avg = average, Max = maximum, SD = standard deviation.

B. adamsianus has been reported as the smallest species in the MPR 32 [33] [34], also *L. (M) aristata* [32]. This research also found these species as among those with the smallest recorded length.

The values of diversity and equity for mollusks, which have been reported by other research conducted at sites that are located in the MPR 32 [33] [34] are high. We also found high values, which correspond to a tropical area.

The high values of diversity and uniformity found in the study area indicate that the studied region is a highly diverse area and corresponds to well-established benthic ecosystems, which have very stable environmental conditions.

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