Revista mexicana de biodiversidad
ISSN: 1870-3453
ISSN: 2007-8706
Instituto de Biología

Hernández, Raquel; Álvarez, Fernando

Molluscs from the Puerto Morelos Reef National Park, Quintana Roo, Mexico; new records for the Mexican Caribbean

Revista mexicana de biodiversidad, vol. 90, 2019
Instituto de Biología

DOI: 10.22201/ib.20078706e.2019.90.2712

Available in: http://www.redalyc.org/articulo.oa?id=42562784052

Revista Mexicana de Biodiversidad

Revista Mexicana de Biodiversidad 90 (2019): e902712

Taxonomy and systematics

Molluscs from the Puerto Morelos Reef National Park, Quintana Roo, Mexico; new records for the Mexican Caribbean

Moluscos del Parque Nacional Arrecife de Puerto Morelos, Quintana Roo, México; nuevos registros para el Caribe mexicano

Raquel Hernández, Fernando Álvarez *

Colección Nacional de Crustáceos, Instituto de Biología, Universidad Nacional Autónoma de México, Apartado postal 70-153, 04510 México City, Mexico

*Corresponding author: falvarez@unam.mx (F. Álvarez)

Received: 24 May 2018; accepted: 22 March 2019

Abstract

A study of the coral reef associated fauna was conducted in the Puerto Morelos Reef National Park (PNAPM) in Quintana Roo, Mexico. Coral rubble was sampled at 3 sites representing different conservation conditions. A total of 653 organisms representing 120 species of molluscs were collected, of which 14 (11%) are new records for the Mexican Caribbean. The new records presented herein correspond to: 11 gastropods belonging to 11 different families, 2 bivalves from 2 different orders, and 1 polyplacophoran. A rarefaction curve adjusted using Chao 1 estimator results in a theoretical maximum of 220 species. With further studieson the mollusc fauna of the Mexican Caribbean, the recorded species richness should increase considerably in the future.

Keywords: Mesoamerican reef; Gastropoda; Bivalvia; Polyplacophora; Biodiversity

Resumen

Se realizó un estudio de la fauna asociada al arrecife de coral en el Parque Nacional Arrecife de Puerto Morelos (PNAPM) en Quintana Roo, México. Se muestreó la pedacería de coral muerto en 3 sitios que representaron diferentes niveles de conservación. Se recolectó un total de 653 organismos que corresponden a 120 especies de moluscos, de los cuales 14 (11%) son registros nuevos para el Caribe mexicano. Los registros nuevos que se presentan son: 11 gasterópodos de 11 familias, 2 bivalvos de 2 órdenes diferentes y 1 poliplacóforo. Se obtuvo una curva de rarefacción utilizando el estimador Chao 1 que resultó en un máximo teórico de 220 especies. Con nuevos estudios sobre la fauna de moluscos del Caribe mexicano, el número de especies registradas debe incrementarse considerablemente en el futuro.

Palabras clave: Arrecife mesoamericano; Gastropoda; Bivalvia; Polyplacophora; Biodiversidad

ISSN versión electrónica: 2007-8706; Universidad Nacional Autónoma de México, Instituto de Biología. https://doi.org/10.22201/ib.20078706e.2019.90.2712

https://doi.org/10.22201/ib.20078706e.2019.90.2712

Introduction

Coral reefs are threatened ecosystems world-wide due to the increased urban development of coastal areas that promote sedimentation, overfishing, macroalgal growth, low water quality, diseases and direct physical damage (Alvarez-Filip et al., 2011; Monroy-Velázquez et al., 2017). Several approaches have been developed to estimate the health status of coral reefs; one non-destructive method is to survey theabundance and diversity of cryptic fauna from coral rubble and associate them to how conserved or deteriorated the reefis (Linton & Warner, 2003; Takada et al., 2007; Monroy-Velázquez et al., 2017). However, their inclusion in such analyses is dependent upon the availability and completeness of the corresponding inventories (Thomas, 1993).In this paper, we present a list of species of molluscs found in 3 sites within the Puerto Morelos Reef National Park, and 14 new distributional records for the Mexican Caribbean. Further analyses of these data,combined with those of other invertebrate groups recorded in the same samplings, is forthcoming.

Molluscs are a dominant component of the coral reef fauna and their real diversity is still a matter of much controversy.Miloslavich et al. (2010) reported 3,032 species for the whole Caribbean Sea, based on records from major museums and the databases available at the time. González-Vallejo (2011) reported 675 species for the Mexican Caribbean, and 3 years laterCastillo-Rodríguez (2014) recorded 985 species for the same area. The large increase in number of species (310) shows that the potential for new distributional records in the area is still quite high. Further, these figures suggest that the Mexican Caribbean could host close to one-third of the total diversity of the region. Other studies that have contributed to the knowledge of the mollusc fauna in the Mexican Caribbean are those of Cruz-Abrego et al. (1995), González-Vallejo (1998) and García-Cubas and Reguero (2004, 2007). In this study, the Mexican Caribbean is considered to be the area between Cape Catoche in the northeastern tip of the Yucatan Peninsula to Xcalak, Quintana Roo, in the border with Belize, a coastline of approximately 418 km.

Materials and methods

The study was conducted in the Puerto Morelos Reef National Park (PNAPM), Quintana Roo, Mexico; which is a section of the Mesoamerican Reef (Fig. 1). Three sites were selected: *1)* Bonanza (20°57'58" N, 86°48'27" W), in recovery, located in the northern section of the marine park, now closed to recreational activities after being heavily impacted by snorkeling and diving; *2)* Puerto Morelos (20°52'50" N, 86°51'02" W), conserved, in the central portion of the marine park is in good condition although it is adjacent to the town of Puerto Morelos, and *3)* Jardines (20°50'20" N, 86°52'41" W), degraded, lies to the south in front of large resorts and golf courses with a heavy sediment load (Monroy-Velázquez &Álvarez, 2016; Monroy-Velázquez et al., 2017; Rodríguez-Martínez et al., 2010; Fig. 1). Using SCUBA equipment, 3 kg of coral rubble were sampled in each site. It is worth mentioning that although no sediment was taken with the coral rubble samples,some micromollusks associated to this substrate were collected. Samplings were conducted in March, May, August, and November 2013, and January 2014, under SAGARPA (Agriculture, Natural Resources and Fisheries Secretariat) collecting permit DGOPA.00008.080113.0006 granted to F. Álvarez.

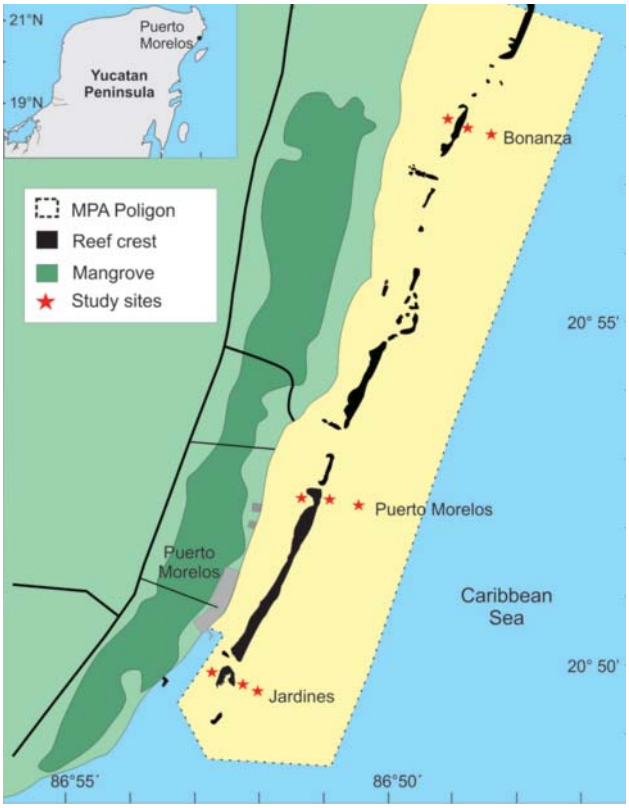

Figure 1. Map of the Puerto Morelos Reef National Park, Quintana Roo, Mexico, showing the collecting sites for this study: Bonanza, Puerto Morelos and Jardines.

Samples were placed in plastic bags and transported to the lab for sorting. All organisms were extracted from the dead coral matrix and preserved in 70% EtOH. The identification guides used were Abbott (1974),Redfern (2001), García-Ríos (2003), Mikkelsen and Bieler (2008)

https://doi.org/10.22201/ib.20078706e.2019.90.2712

and Tunnell et al. (2010). The synonymies were checked in Abbott and Dance (1982), Tunnell et al. (2010), Redfern (2001, 2013), Rosenberg et al.(2009) and Horton et al. (2018); the last 2 references were used to verify current accepted names. The taxonomic list is presented following Horton et al. (2018) for gastropods; Bieler and Mikkelsen (2006) for bivalves, Kaas and Van Belle (1987) for polyplacophorans, Scarabino (2008) for scaphopods, and Young et al. (2018) for cephalopods.

Specimens representing the new records of less than 2 mm in total length were photographed in an Axio Zoom V16 Zeiss microscope, and larger specimens in a Z16 APO-A Leica microscope. No taxonomic comments are included since all the species agree well with the original descriptions. All specimens representing the new distributional records are deposited in the "Colección Malacológica Dr. Antonio García-Cubas" (COMA) of the Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de Mexico (UNAM). All the remaining specimens are deposited in the "Colección Nacional de Moluscos" (CNMO) of the Institutode Biología, UNAM.

A rarefaction curve was obtained based on the observed data using EstimateS 9.1 software and Chao 1 estimator (Colwell, 2016). The curve was plotted in Statistica v10.0.1011 with the model S = (a*v1)/(1+(b*v1)), where "a" is the rate at which new species are incorporated at the beginning of the sampling and "b" a parameter related to the shape of the curve (Jiménez-Valverde & Hortal, 2003). The asymptote of the curve, the theoretical maximum number of species, is equal to a/b.

Results

A total of 653 organisms from 120 species were collected. Gastropoda was represented by 80 species in 60 genera and 38 families, Bivalvia by 26 species in 24 genera and 16 families, Polyplacophora by 12 species in 5 genera and 3 families, and Scaphopoda and Cephalopoda by 1 species each (Table 1).

The values obtained for the model used to construct the rarefaction curve (a = 0.397, b = 0.0018) result in a theoretical maximum number of species of a/b = 220.55 (Fig. 2; curve obtained with Chao 1 estimator), 100 more than what was obtained (Fig. 2; curve constructed with the observed values). This result suggests that the number of rare species, or species that occur with low numbers, can make up for more than half of the mollusc community in the area.

Three species in the family Phasianellidae were collected, of which *Eulithidium bellum* (M. Smith, 1937) was the most abundant gastropod with 122 (18%) individuals. The gastropods *Columbella mercatoria* (Linnaeus, 1758), *Cerithium litteratum* (Born, 1778) and *Eulithidium bellum* were present in all samples. The gastropod family Rissoinidae was the most diverse group in the sampling with 5 species. *Barbatia cancellaria* (Lamarck, 1819) was the most abundant bivalve with 27 individuals. The polyplacophoran genus *Acanthochitona* was the most diverse with 4 species. *Acanthochitona zebra* Lyons, 1988 was the most abundant chiton species with 29 individuals, followed by *Ischnochiton erythronotus* (C.B. Adams, 1845) with 25 individuals. The classes Scaphopoda and Cephalopoda were represented by 1 species each (Table 1).

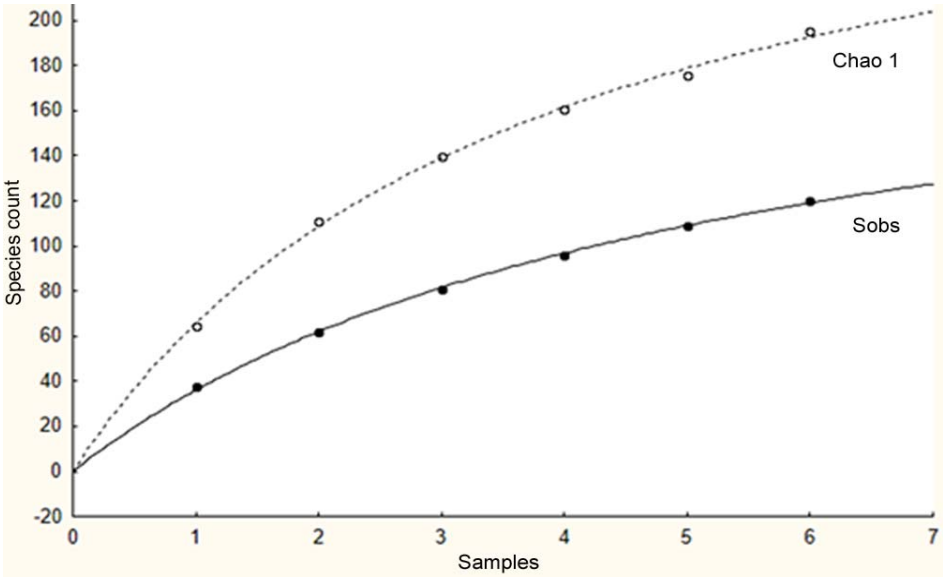

Figure 2. Rarefaction curve based on the Puerto Morelos mollusc data using Chao 1 estimator (Sobs = number of species observed; Chao1 = projected number of species under this estimator).

https://doi.org/10.22201/ib.20078706e.2019.90.2712

Table 1

Abundance of molluscs'species collected in the Puerto Morelos Reef National Park by date (month/year). Species in bold represent new distributional records for the Mexican Caribbean.

Family	Genus	Species	03/ 2013	05/ 2013	08/ 2013	11/ 2013	01/ 2014	05/ 2014
Class Gastropoda								
Eoacmaeidae	*Eoacmaea*	*pustulata* (Helbling, 1779)			1	2	2	2
Fissurellidae	*Diodora*	*dysoni* (Reeve, 1850)			1		1	3
		minuta (Lamarck, 1822)			2			2
		variegata (G. B. Sowerby II, 1862)					1	
	Fissurella	*angusta* (Gmelin, 1791)				1		
	Lucapina	*philippiana* (Finlay, 1930)			2			
Chilodontaidae	*Euchelus*	*guttarosea* Dall, 1889			3			1
Trochidae	*Synaptocochlea*	*picta* (d'Orbigny,1847)						3
	Pseudostomatella	*erythrocoma* (Dall, 1889)						1
Tegulidae	*Tegula*	*fasciata* (Born, 1778)						4
		gruneri (Philippi, 1849)					1	1
Areneidae	*Arene*	*cruentata* (Megerle von Mühlfeld, 1824)		1	1		1	
Phasianellidae	*Eulithidium*	*adamsi* (Philippi, 1853)	1		7		24	41
		bellum (M. Smith, 1937)	5	43	13	2	30	29
		thalassicola (Robertson, 1958)					2	2
Turbinidae	*Lithopoma*	*americanum* (Gmelin, 1791)				2		
Neritidae	*Smaragdia*	*viridis* (Linnaeus, 1758)				2		
Cerithidae	*Cerithium*	*atratum* (Born, 1778)		1	2	4	2	6
		eburneum Bruguière, 1792	1		9		3	3
		litteratum (Born, 1778)	6	3	4	3	5	4
Planaxidae	*Fossarus*	*orbignyi* P. Fisher, 1864						1
Rissoidae	*Alvania*	*faberi* De Jong & Coomans, 1988						2
	Simulamerelina	*caribaea* (d'Orbigny, 1842)			1		1	1
Rissoinidae	*Ailinzebina*	*elegantissima* (d' Orbigny, 1842)				1		
	Phosinella	*cancellata* (Philippi, 1847)		1				1
	Rissoina	*pulchra* (C. B. Adams, 1850)		1				
	Zebinella	*decussata* (Montagu, 1803)						1
		princeps (C. B. Adams, 1850)					1	
Zebinidae	*Schwartziella*	*bouryi* (Desjardin, 1949)					*1*	
		bryerea (Montagu, 1803)		1	1	1	2	1
	Stosicia	*aberrans* (C. B. Adams, 1850)			2			2
	Zebina	*browniana* (d'Orbigny, 1842)			1			
		vitrea (C. B. Adams, 1850)					3	1
Vitrinnellidae	*Circulus*	*semisculptus* (Olsson & McGinty, 1958)					1	
Tornidae	*Parviturboides*	*interruptus* (C. B. Adams, 1850)					1	
Eratoidae	*Hespererato*	*maugeriae* (J. E. Gray, 1832)						1

Table 1
Continued

Family	Genus	Species	03/ 2013	05/ 2013	08/ 2013	11/ 2013	01/ 2014	05/ 2014
Epitoniidae	*Epitonium*	*turritellula* (Mörch, 1875)					2	
Eulimidae	*Melanella*	*eburnea* (Megerle von Mühlfeld, 1824)					1	
Cerithiopsidae	*Cerithiopsis*	*flava* (C. B. Adams, 1850)	2					
		fusiformis (C. B. Adams, 1850)					1	
		lata (C. B. Adams, 1850)						1
	Seila	*adamsii* (H. C. Lea, 1845)	1	2		1	2	3
Newtoniellidae	*Retilaskeya*	*bicolor* (C. B. Adams, 1845)					1	
Triphoridae	*Cosmotriphora*	*ornata* (Deshayes, 1832)		1				
	Iniforis	*turristhomae* (Holten, 1802)					1	3
	Triphora	*elvirae* De Jong & Coomans, 1988				1		
Muricidae	*Coralliophila*	*galea* (Dillwyn, 1823)		1				
	Dermomurex	*pauperculus* (C. B. Adams, 1850)					2	
Columbellidae	*Astyris*	*lunata* (Say, 1826)					1	1
	Columbella	*mercatoria* (Linnaeus, 1758)	2	3	6	3	4	4
	Mitrella	*nycteis* (Duclos, 1846)					1	
	Steironepion	*maculatum* (C. B. Adams, 1850)			1			
		moniliferum (G. B. Sowerby I, 1844)					2	1
Nassariidae	*Phrontis*	*alba* (Say, 1826)					1	1
		antillarum (d'Orbigny, 1847)		1				
Bellolividae	*Jaspidella*	*blanesi* (Ford, 1898)			1			
Olividae	*Olivella*	*acteocina* Olsson, 1956					1	
		exilis (Marrat, 1871)					1	5
		bullula (Reeve, 1850)						2
Cystiscidae	Gibberula	*lavalleeana* (d'Orbigny, 1842)			10			1
Costellariidae	*Vexillum*	*moniliferum* (C. B. Adams, 1850)			1			
	Mitromica	*foveata* (G. B. Sowerby II, 1874)					1	
Pseudomelatomidae	*Crassispira*	*fuscescens* (Reeve, 1843)					1	
Marginellidae	*Hyalina*	*pallida* (Linnaeus, 1758)		1	1			
	Volvarina	*ceciliae* Espinosa & Ortea, 1999	1	1		1		
		avena (Kiener, 1834)		1				
		subtriplicata (d'Orbigny, 1842)			1			2
Mangeliidae	*Tenaturris*	*inepta* (E. A. Smith, 1882)			1		1	2
		dysoni (Reeve, 1846)						1
	Granoturris	*padolina* Fargo, 1953			1			
Rissoellidae	*Rissoella*	*caribaea* Rehder, 1943		1				3
Pyramidellidae	*Chrysallida*	*nioba* (Dall & Bartsch, 1911)		1				
	Odostomia	*laevigata* (d'Orbigny, 1841)						1
	Pseudoscilla	*babylonia* (C. B. Adams, 1845)					1	

Table 1
Continued

Family	Genus	Species	03/ 2013	05/ 2013	08/ 2013	11/ 2013	01/ 2014	05/ 2014
	Triptychus	*niveus* (Mörch, 1875)					1	1
Bullidae	*Bulla*	*occidentalis* A. Adams, 1850					1	
Haminoeidae	*Atys*	*sharpi* Vanatta, 1901						1
Tornatinidae	*Acteocina*	*candei* (d'Orbigny, 1841)			3			1
		liratispira (E. A. Smith, 1872)	1					2
Volvatellidae	*Ascobulla*	*ulla*(Er. Marcus & Ev. Marcus, 1970)			1			
Class Bivalvia								
Nuculidae	*Ennucula*	*delphinodonta* (Mighels & C. B. Adams, 1842)			1			
Solemyidae	*Solemya*	*occidentalis* Deshayes, 1857			1			12
Arcidae	*Barbatia*	*domingensis* (Lamarck, 1819)				1	3	1
		cancellaria (Lamarck, 1819)		5		1	11	11
Noetiidae	*Arcopsis*	*adamsi* (Dall, 1886)				1		
Mytilidae	*Lithophaga*	*antillarum* (d'Orbigny, 1853)				1		
		nigra (d'Orbigny, 1853)		1				
	Leiosolenus	*bisulcatus* (d'Orbigny, 1853)	2	1			1	
	Musculus	*lateralis* (Say, 1822)				1		
	Botula	*fusca* (Gmelin, 1791)					1	
Pteriidae	*Pinctada*	*longisquamosa* (Dunker, 1852)						1
Limidae	*Lima*	*caribaea* d'Orbigny, 1853		1	5	1		1
Pectinidae	*Caribachlamys*	*ornata* (Lamarck, 1819)			2			
Lucinidae	*Ctena*	*orbiculata* (Montagu, 1808)					1	
	Lucina	*pensylvanica* (Linnaeus, 1758)						1
Condylocardiidae	*Carditopsis*	*smithii* (Dall, 1896)					1	1
Ungulinidae	*Diplodonta*	*notata* (Dall & Simpson, 1901)			1			
	Phlyctiderma	*semiaspera* (Philippi, 1836)			1			1
Chamidae	*Pseudochama*	*cristella* (Lamarck, 1819)			1			
Cardiidae	*Americardia*	*guppyi* (Thiele, 1910)			2	1		
	Laevicardium	*mortoni* Conrad, 1831)				1		
Veneridae	*Chioneryx*	*pygmaea* (Lamarck, 1818)					2	1
	Petricola	*lapicida* (Gmelin, 1791)			2			1
Gastrochaenidae	*Lamychaena*	*hians* (Gmelin, 1791)		1				
	Spengleria	*rostrata* (Spengler, 1783)			2		4	
Thraciidae	*Bushia*	*elegans* (Dall, 1886)				1		
Class Polyplacophora								
Ischnochitonidae	*Ischnochiton*	*erythronotus*(C.B. Adams, 1845)		1	6	11	6	1

Table 1
Continued

Family	Genus	Species	03/ 2013	05/ 2013	08/ 2013	11/ 2013	01/ 2014	05/ 2014
		hartmeyeri Thiele, 1910			3	1	1	
	Stenoplax	*bahamensis* Kaas & Van Belle, 1987		4	2	5	3	1
		boogii (Haddon, 1886)			1	3		
		floridana (Pilsbry, 1892)			1			
Lepidochitonidae	*Lepidochitona*	*liozonis* (Dall & Simpson, 1901)	1	2	5	2	3	
		rosea Kass, 1972				1		
Acanthochitonidae	*Acanthochitona*	*lineata* Lyons, 1988			1	1		
		roseojugum Lyons, 1988	1		2	5	2	
		zebra Lyons, 1988		5	15	8		1
		andersoni Watters, 1981			1	2		
	Cryptoconchus	*floridanus* (Dall, 1889)			1			
Class Cephalopoda								
Octopodidae	*Octopus*	*maya* Voss & Solís, 1966				3		
Class Scaphopoda								
Dentaliidae	*Antalis*	*antillaris* (d'Orbigny, 1853)					3	1
Total			24	85	133	73	154	184

Class Gastropoda Cuvier, 1795
OrderLittorinimorpha Golikov & Starobogatov, 1975
Superfamily Truncatelloidea Gray, 1840
FamilyVitrinellidae Bush, 1897
Genus *Circulus* Jeffreys, 1865
Circulus semisculptus (Olsson & McGinty, 1958)
(Fig.3a)

Taxonomic summary

Synonymy:Vitrinella semisculpta Olsson & McGinty, 1958.

Material examined: 1 individual; Jardines, PNAPM; 14-I-2014; COMA-0000001771.

*Distribution:*USA (Florida), throughout the Caribbean including the Greater Antilles, Costa Rica, Panama andColombia (Abbott, 1974; Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009).

FamilyZebinidae Coan, 1964
Genus *Schwartziella*G. Nevill, 1881
Schwartziella bouryi (Desjardin, 1949) (Taxon inquirendum)
(Fig.3b).

Taxonomic summary

Original name:Rissoina bouryi Desjardin, 1949

*Material examined:*1 individual;Puerto Morelos, PNAPM; 14-I-2014; COMA-0000001832.

*Distribution:*USA(Florida), Bahamas and Cuba (Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009).

Order Caenogastropoda Cox, 1960
Superfamily Epitonioidea Berry, 1910
Family Epitoniidae Berry, 1910 (1812)
Genus *Epitonium*Röding, 1798
Epitonium turritellula (Mörch, 1875)
(Fig. 3c)

Taxonomic summary

Synonymy:Scala turritellula var. *riisei* Mörch, 1875; *Scala turritellula* Mörch, 1875; *Scala stylina* Dall, 1889; *Scala rushi* var *stylina* Dall, 1889; *Epitonium turritellulum*(Mörch, 1874);*Epitonium* (*Asperiscala*) *turritellulum.*

Material examined: 2 individuals, Puerto Morelos, PNAPM; 14-I-2014; COMA-0000001826.

https://doi.org/10.22201/ib.20078706e.2019.90.2712

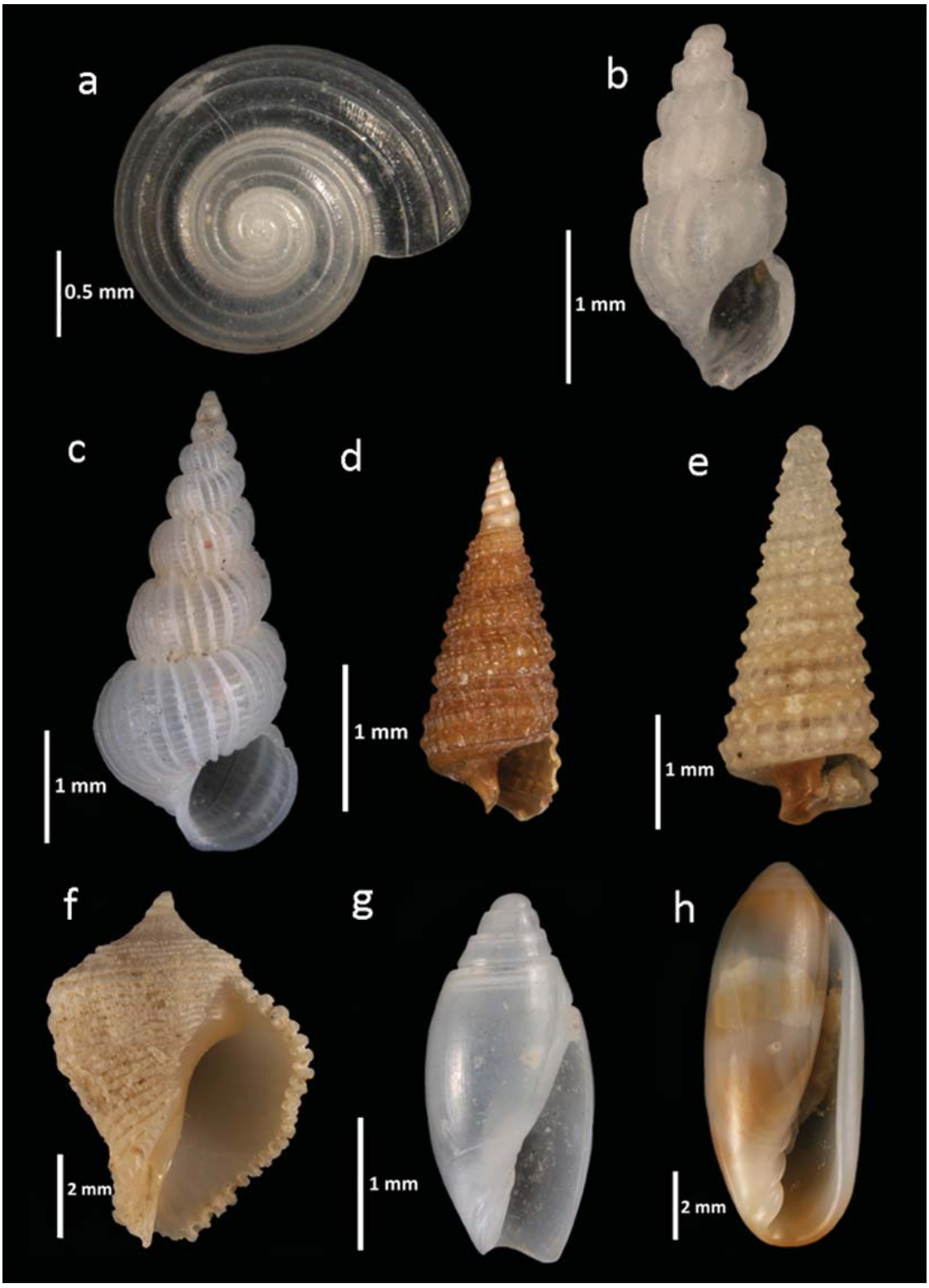

Figure 3. New records of molluscs from the PNAPM: a, *Circulus semisculptus*; b, *Schwartziella bouryi*; c, *Epitonium turritellula*; d, *Cerithiopsis flava*; e, *Retilaskeya bicolor*; f, *Coralliophila galea*; g, *Olivella acteocina*; h, *Volvarina ceciliae*.

*Distribution:*USA (Texas), Cuba, Jamaica, Dominican Republic, Puerto Rico,U.S. Virgin Islands, Aruba, Bonaire, Curaçao, Venezuela andBrazil(Miloslavich et al., 2010; Rosenberg, 2009; Tunnell et al., 2010; Warmke & Abbott, 1962).

Superfamily Triphoroidea Gray, 1847
Family Cerithiopsidae H. Adams & A. Adams, 1853
Genus*Cerithiopsis*Forbes & Hanley, 1850
Cerithiopsis flava (C.B. Adams, 1850)
(Fig.3d)

Taxonomic summary

Synonymy:Cerithium flavum C. B. Adams, 1850; *Cerithiopsis flavum* (C. B. Adams, 1850); *Bittium flava*(C.B. Adams, 1850);*Cerithiopsis hero* Bartxch, 1911.

Material examined: 2 individuals; Jardines, PNAPM;6-III-2013; COMA-0000001829.1 individual; Puerto Morelos, PNAPM; 7-V-2014; COMA-0000001836.

*Distribution:*USA (Florida,Louisiana, Texas), Cuba, Belize, Jamaica, U.S. Virgin Islands, Aruba, Bonaire and Curaçao (Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009; Tunnell et al., 2010).

Family Newtoniellidae Korobkov, 1955
Genus*Retilaskeya*B.A. Marshall, 1978
Retilaskeya bicolor (C.B. Adams, 1845)
(Fig.3e)

Taxonomic summary

Synonymy:Cerithium bicolor C. B. Adams, 1845; *Cerithiopsis bicolor* (C. B. Adams, 1845); *Bittium bicolor* (C. B. Adams, 1845); *Bittium major* Mörch, 1876; *Cerithiopsis binoda* Usticke, 1969; *Cerithiopsis subulata* Montagu, 1808; *Cerithiopsis emersoni* C. B. Adams, 1839; *Eumetula emersoni* C. B. Adams, 1839.

Material examined: 1 individual; Bonanza, PNAPM; 14-I-2014;COMA-0000001810.

*Distribution:*USA (Massachusetts,Florida,Texas), Cuba, Jamaica, Puerto Rico, Mexico (Yucatan), Belize, Costa Rica, Panama, Colombia,Venezuela, Lesser Antilles and Brazil (Abbott, 1974; Miloslavich et al., 2010; Rosenberg, 2009; Tunnell et al., 2010).

OrderNeogastropoda Wenz, 1938
Superfamily Muricoidea Rafinesque, 1815
Family Muricidae Rafinesque, 1815
Genus *Coralliophila* H. Adams & A. Adams, 1853
Coralliophila galea (Dillwyn, 1823)
(Fig.3f)

Taxonomic summary

Synonymy:Murex galea Dillwyn, 1823; *Coralliophila abbreviata* Lamarck, 1816; *Rhizochilus abbreviata* Lamarck, 1816; *Purpura abbreviata*Lamarck, 1816; *Coralliophila deformis* Lamarck, 1822; *Coralliophila nodulosa* H.Adams & A. Adams, 1864; *Coralliophila undosa* H. Adams & A. Adams, 1864; *Purpura miocenica* Guppy, 1873.

Material examined: 1 individual; Jardines, PNAPM;6-V-2013;COMA-0000001805.

*Distribution:*Bermuda, USA (North Carolina, Florida, Texas), Mexico (Yucatan), Belize, Cuba, Jamaica,Cayman Islands, Costa Rica, Panama, Colombia, Aruba, Bonaire, Curaçao and Brazil(Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009).

Superfamily Olivoidea Latreille, 1825
Family Olividae Latreille, 1825
Genus *Olivella* Swainson, 1831
Olivella acteocina Olsson, 1956
(Fig.3g)

Taxonomic summary

Material examined: 1 individual; Puerto Morelos, PNAPM; 14-I-2014; COMA-0000001831.

Distribution: Mexico(Yucatan),Cuba, Puerto Rico, Panama, Bahamas(Grand Bahama Island, New Providence), St. Vincent and the Grenadines, Colombia, Aruba, Bonaire and Curaçao(Abbott, 1974; Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009; Vokes & Vokes, 1983; Warmke & Abbott, 1962).

Family Marginellidae Fleming, 1828
Genus *Volvarina*Hinds, 1844
Volvarina ceciliae Espinosa & Ortea, 1999
(Fig.3h)

Taxonomic summary

*Material examined:*1 individual; Bonanza, PNAPM; 6-V-2013; COMA-0000001715.1 individual, Puerto Morelos, PNAPM; 7-XI-2013; COMA-0000001751. 1 individual; Puerto Morelos, PNAPM; 6-III-2013; COMA-0000001752.

Distribution: Cubaand Cayman Islands(Miloslavich et al., 2010; Rosenberg, 2009).

Superfamily Conoidea Fleming, 1822
FamilyMangellidae P. Fischer, 1883
Genus *Granoturris* Fargo, 1953
*Granoturris padolina*Fargo, 1953
(Fig.4a)

Taxonomic summary

Synonymy:Kurtziella padolina (Fargo, 1953).

*Material examined:*1 individual; Bonanza, PNAPM; 6-VIII-2013; COMA-0000001812.1 individual, Puerto Morelos, PNAPM; 7-V-2014; COMA-0000001833.

Distribution: USA (Florida, Texas), Bahamas and Brazil (Ríos, 1994; Rosenberg et al., 2009).

Superfamily Pyramidelloidea Gray, 1840
Family Pyramidellidae Gray, 1840
Genus *Chrysallida* Carpenter, 1857
Chrysallida nioba (Dall & Bartsch, 1911)
(Fig.4b)

Taxonomic summary

Synonymy:Odostomia niobaDall & Bartsch, 1911; *Menestho nioba*(Dall & Bartsch, 1911).

Material examined: 1 individual, Jardines, PNAPM; 6-III-2013; COMA-0000001830.

*Distribution:*Bermuda,USA (Florida, Texas) and Cuba (Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009).

Order Sacoglossa Ihering, 1876
Family Volvatellidae Pilsbry, 1895
Genus *Ascobulla* Ev. Marcus, 1972
Ascobulla ulla (Er. Marcus & Ev. Marcus, 1970)
(Fig.4c, d)

Taxonomic summary

*Synonymy:Cylindrobulla ulla*Er. Marcus & Ev. Marcus, 1970

Material examined: 1 individual;Puerto Morelos, PNAPM; 6-VIII-2013; COMA-0000001827.

*Distribution:*Bermuda, Bahamas (Grand Bahama Island), USA(Florida), Mexico, Belize, Turks and Caicos, Cayman Islands,U.S. Virgin Islands, Venezuela, Lesser Antilles and Brazil(Pernambuco, Abrolhos Islands, Sao Paulo)(Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009).

Class Bivalvia Linnaeus, 1758
Subclass Heterodonta Neumayr, 1884
Order Carditoida Dall, 1889
Family Condylocardiidae Bernard, 1896
Genus*Carditopsis* E.A. Smith, 1881
Carditopsis smithii (Dall, 1896)
(Fig.4e, f)

Taxonomic summary

Synonymy:Carditella smithii Dall, 1896; *Condylocardia floridensis* Pilsbry & Olsson, 1946.

*Material examined:*1 individual; Puerto Morelos, PNAPM; 7-V-2013; COMA-0000001835. 1 individual; Puerto Morelos, PNAPM; 14-I-2014; COMA-0000001834.

*Distribution:*Bermuda, USA (Florida, Texas),Bahamas, Mexico (Yucatan), Cuba, Colombia,Aruba, Bonaire, Curacao and Brazil (Abbott,1974; Merlano & Hegedus, 1994; Ríos, 1994; Mikkelsen &Bieler, 2008; Miloslavich et al., 2010; Rosenberg et al., 2009; Tunnellet al.,2010).

Order Veneroida H. Adams & A. Adams, 1856
Family Gastrochaenidae Gray, 1840
Genus *Spengleria* Tryon, 1861
Spengleria rostrata (Spengler, 1793)
(Fig.4g)

Taxonomic summary

Synonymy:Chaena rostrata Spengler, 1793;*Gastrochaena callosa* Philippi, 1845; *Gastrochaena chemnitziana* d'Orbigny, 1854.

Material examined: 4 individuals; Puerto Morelos, PNAPM; 14-I-2014; COMA-0000001736.1 individual; Puerto Morelos, PNAPM; 6-VIII-2013;COMA-0000001765.1 individual; Puerto Morelos, PNAPM; 6-VIII-2013; COMA-0000001801.

*Distribution:*Bermuda, USA (North Carolina, Florida, Alabama),Cuba, Puerto Rico, Jamaica, Cayman Islands, Lesser Antilles, Costa Rica, Colombia and Brazil (Abbott, 1974; Abbott & Dance, 1982; Mikkelsen & Bieler, 2008; Miloslavich et al., 2010; Rosenberg, 2009; Rosenberg et al., 2009; Warmke & Abbott, 1962).

Class Polyplacophora Gray, 1821
Order Chitonida Thiele, 1909
Family Ischnochitonidae Dall, 1889
Genus *Ischnochiton* Gray, 1847
Ischnochiton hartmeyeri Thiele, 1910
(Fig.4h)

Taxonomic summary

*Material examined:*1 individual; Jardines, PNAPM; 7-XI-2013; COMA-0000001792. 1 individual; Puerto Morelos, PNAPM;14-I-2014;COMA-0000001793. 3 individuals;Puerto Morelos, PNAPM; 6-VIII-2013; COMA-0000001828.

*Distribution:*USA (Florida),San Salvador, Jamaica, Cayman Islands, Belize, Puerto Rico, U.S. Virgin Islands, British Virgin Islands, Aruba, Curaçao and Brazil (Lagoas, Isla Guataquaz) (Ferreira, 1987; García-Ríos, 2003; Kaas, 1972; Lyons,1980, 1989; Lyons & Moretzsohn, 2009).

https://doi.org/10.22201/ib.20078706e.2019.90.2712

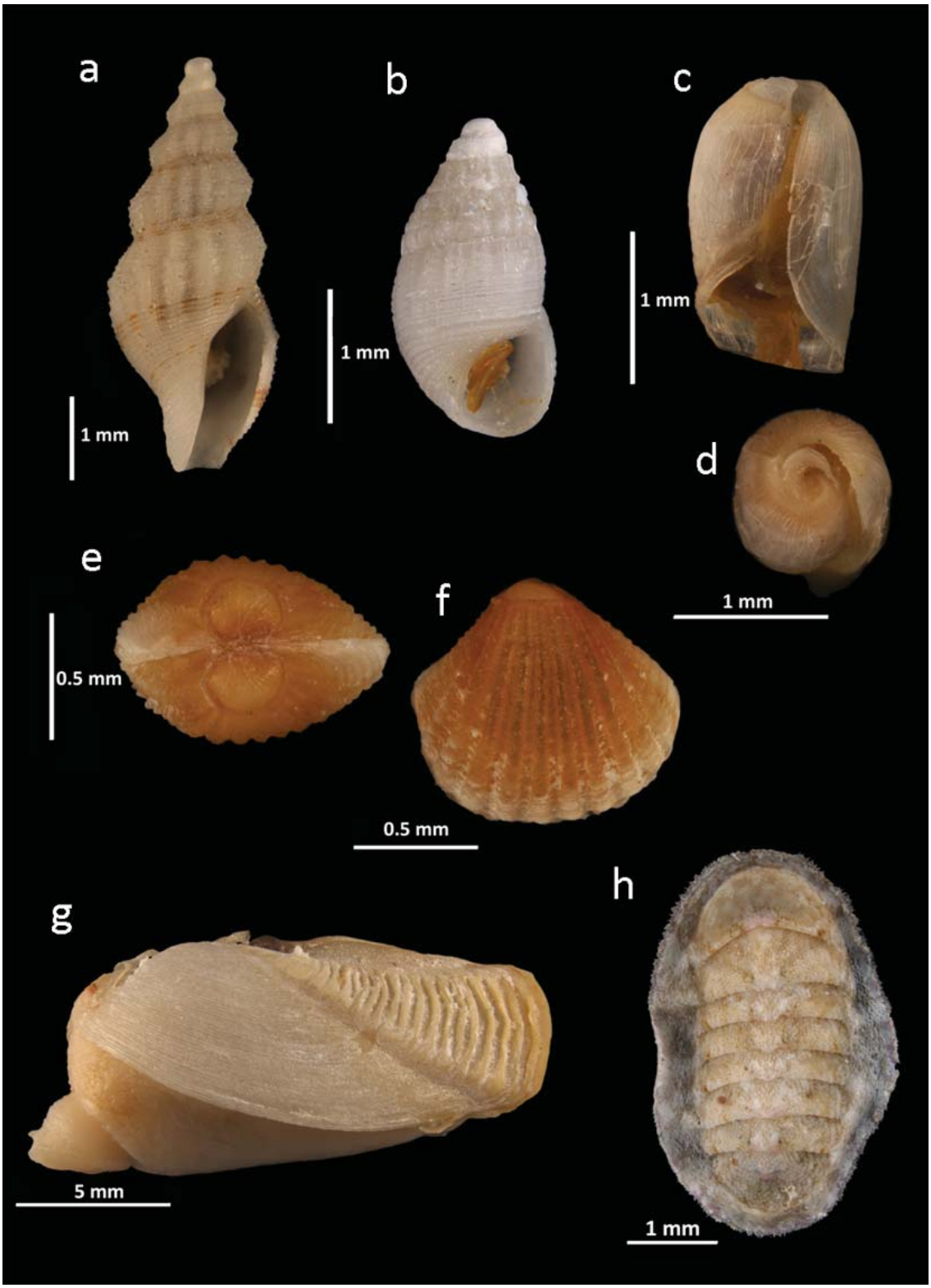

Figure 4. New records of molluscs from the PNAPM: a, *Granoturris padolina*; b, *Chrysallida nioba*; c, d, *Ascobulla ulla*; e, f, *Carditopsis smithii*; g, *Spengleria rostrata*; h, *Ischnochiton hartmeyeri*.

Discussion

In spite of the abundance and diversity of molluscs in coastal and reef environments, relatively few studies have been conducted in the Mesoamerican Reef, especially in the Mexican portion of it. Castillo-Rodríguez (2014) estimated at 2,067 the number of species of molluscs for the Mexican coast of the Gulf of Mexico and Mexican Caribbean, while 2,567 species are known for the Pacific coast. If the projections of number of species to be found in the Mexican Caribbean are realistic, then the total number of species for the eastern coast of Mexico will be greater than that for the Pacific coast. Indirect support for this idea could be the estimation of Miloslavich et al. (2010) who placed the "western Caribbean" region, which includes Mexico, as contributing with only 10% of the total mollusc diversity for the whole Caribbean Sea, suggesting that the regional diversity in this area is still underestimated.

Although a total of 653 molluscs were collected, belonging to 120 species, all the species presented here as new distributional records were represented by 1 to 6 individuals only, indicating that they are naturally rare in this area. Nine of the 14 species were collected only once, 2 were collected twice and 3 were collected 3 times; only 4 species were collected in more than 1 site (Table 1). Further, it is relevant to note that most of the new records of species (10 out of 14, 71%) and the highest number of its organisms (21 out of 30, 70%) came from the Puerto Morelos site, the most conserved one (Monroy-Velázquez &Álvarez, 2016; Monroy-Velázquez et al., 2017; Rodríguez-Martínez et al., 2010; Table 1). Taxonomically, the new records are dominated by the gastropods with 11 species, followed by bivalves with 2 species and 1 polyplacophoran. The "degraded" and "in recovery" localities had 5 and 3 of the new records, respectively (Table 2).

Overall, mollusc diversity of the PNAPM is underestimated, as intensive sediment sampling, or sampling with several different methods has not been conducted yet. Other studies that have used several sampling techniques, including suction sampling on hard and soft bottoms, have found thousands of species of molluscs in one reef (Bouchet et al., 2002). When the sampling in a reef environment focuses on micromolluscs, the results can yield several hundred species, with a large proportion of them undescribed (Albano et al., 2011). Future efforts along the Caribbean coast of Mexico should focus on this particular component of the mollusc fauna using several collecting techniques.

Many species of marine molluscs in Mexico are being impacted by: urban wastewater, hydrocarbons, pesticides, competition with introduced species and overexploitation; factors that are modifying their distribution patterns and abundance. The IUCN has assessed the conservation status of about 10% of the described species of molluscs, and one-fourth of those are threatened (IUCN, 2019). In Mexico, the NOM-059 (the Mexican Red List of Endangered Species) includes only 17 species, a figure that clearly shows the lack of studies on this fauna.

Table 2

Collection site and number of specimens collected of each of the species representing a new distributional record for the Mexican Caribbean.

	Jardines Degraded	Puerto Morelos Conserved	Bonanza In recovery
Circulus semisculptus	1		
Schwartziella bouryi		1	
Epitonium turritellula		2	
Cerithiopsis flava	2	1	
Retilaskeya bicolor			1
Coralliophila galea	1		
Olivella acteocina		1	
Volvarina ceciliae		2	1
Granoturris padolina		1	1
Chrysallida nioba	1		
Ascobulla ulla		1	
Carditopsis smithii		2	
Spengleria rostrata		6	
Ischnochiton hartmeyeri	1	4	

Acknowledgements

To the Posgrado en Ciencias Biológicas, UNAM.The funding through DGAPA-PAPIIT-UNAM grant IN205314 and through Conabio LH010 to F. Álvarez is gratefully acknowledged. Susana Guzmán from Instituto de Biología, UNAM, offered advice regarding the photographs used in this paper. Rosa E. Rodríguez-Martínez from Unidad Académica de Sistemas Arrecifales, Instituto de Ciencias del Mar y Limnología, UNAM, Puerto Morelos, Quintana Roo, produced figure 1.

References

Abbott, R. T. (1974). *American seashells: the marine Mollusca of the Atlantic and Pacific coasts of North America*. New York: Van Nostrand Reinhold Company.

Abbott, R. T., & Dance, S. P. (1982). *Compendium of seashells*. El Cajon, California: Odyssey Publishing.

Albano, P. G., Sabelli, B., & Bouchet, P. (2011). The challenge of small and rare species in marine biodiversity surveys: microgastropod diversity in a complex tropical coastal environment. *Biodiversity and Conservation*, *20*, 3223–3237. https://doi.org/10.1007/s10531-011-0117-x

Alvarez-Filip, L., Gill, J. A., Dulvy, N. K., Dulvy, A. L., Watkinson, A. R., & Coté, I. M. (2011). Drivers of region-wide declines in architectural complexity on Caribbean reefs. *Coral Reefs*, *30*, 1051. https://doi.org/10.1007/s00338-011-0795-6

Bieler, R., & Mikkelsen, P. M. (2006). Bivalvia —a look at the branches. *Zoological Journal of the Linnean Society*, *148*, 223–235. https://doi.org/10.1111/j.1096-3642.2006.00255.x

Bouchet, P., Lozouet, P., Maestrati, P., & Heros, V. (2002). Assessing the magnitude of species richness in tropical marine environments: exceptionally high numbers of molluscs at a New Caledonia site. *Biological Journal of the Linnean Society*, *75*, 421–436. https://doi.org/10.1046/j.1095-8312.2002.00052.x

Castillo-Rodríguez, Z. G. (2014). Biodiversidad de moluscos marinos en México. *Revista Mexicana de Biodiversidad*, *85 (Supl.)*, S419–S430. https://doi.org/10.7550/rmb.33401093

Colwell, R. K. (2016). EstimateS 9.1.0: statistical estimation of species richness and shared species from samples. Retrieved on 01 March 2018, from: http://viceroy.eeb.uconn.edu/EstimateS

Cruz-Abrego, F. M., Espinosa, J., Flores-Andolais, F., & Toledano-Granados, A. (1995).Nuevos registros de moluscos prosobranquios (Mollusca: Gastropoda) del Caribe mexicano. *Revista de la Sociedad Mexicana de Historia Natural*, *46*, 83–86.

Ferreira, A. J. (1987). Two new species of *Ischnochiton* (Mollusca: Polyplacophora) in the western central Atlantic. *Bulletin of Marine Science*, *6*, 153–160.

García-Cubas, A., & Reguero, M. (2004). *Catálogo ilustrado de moluscos gasterópodos del golfo de México y mar Caribe*. México D.F.: Universidad Nacional Autónoma de México.

García-Cubas, A., & Reguero, M. (2007). *Catálogo ilustrado de moluscos bivalvos del golfo de México y mar Caribe*. México D.F.: Universidad Nacional Autónoma de México.

García-Ríos, C. (2003). *Los quitones de Puerto Rico*. San Juan: Isla Negra Editores.

González-Vallejo, N. E. (1998). Moluscos de la expedición del R/V Edwin Link en las costas del Caribe mexicano. *Revista de Biología Tropical*, *46*, 625–631.

González-Vallejo, N. E. (2011). Moluscos marinos. In Pozo, C. (Ed.), *Riqueza biológica de Quintana Roo. Un análisis para su conservación*. Tomo 2. México D.F., Campeche, Chetumal, San Cristóbal: El Colegio de la Frontera Sur/ Conabio/ Gobierno del Estado de Quintana Roo/ Programa de Pequeñas Donaciones.

Horton, T., Kroh, A., Ahyong, S., Bailly, N., Boury-Esnault, N., Brandão, S. N. et al. (2018). *World register of marine species*. Retrieved on 02 August 2018, from: http://www.marinespecies.org

IUCN (International Union for the Conservation of Nature). (2019). Summary statistics.

Retrieved on 11 March 2019, from: https://www.iucnredlist.org/resources/summary-statistics#SummaryTables

Jiménez-Valverde, A., & Hortal, J. (2003). Las curvas de acumulación de especies y la necesidad de evaluar la calidad de los inventarios biológicos. *Revista Ibérica de Aracnología*, *8*, 151–161.

Kaas, P. (1972). Polyplacophora of the Caribbean region. *Studies on the Fauna of Curacao*, *41*, 1–162.

Kaas, P., & Van Belle, R. A. (1987). *Monograph of living chitons (Mollusca: Polyplacophora). Vol. 3. Suborder Ischnochitonidae. Chaetopleurinae and Ischnochitoninae. Addition to Vols. 1 and 2.* Leiden, The Netherlands: Brill-Backhuys.

Linton, D. M., & Warner, G. F. (2003). Biological indicators in the Caribbean coastal zone and their role in integrated coastal management. *Ocean and Coastal Management*,*46*, 261–276. https://doi.org/10.1016/S0964-5691(03)00007-3

Lyons, W. G. (1980). Polyplacophora of Dry Tortugas, Florida with comments on *Ischnochiton hartmeyeri* Thiele, 1910. *Bulletin of the American Malacological Union*, *1980*, 34–37.

Lyons, W. G. (1989). Nearshore marine ecology at Hutchinson Island, Florida: 1971-1974. XI. Mollusks. *Florida Marine Research Publications*, *47*, 1–131.

Lyons, W. G., & Moretzsohn, F. (2009). Polyplacophora (Mollusca) of the Gulf of Mexico. In D. L. Felder, & D. K. Camp (Eds.), *Gulf of Mexico origin, waters and biota*. College Station, Texas: Texas A&M University Press.

Merlano, J. M. D., & Hegedus, M. P. (1994). *Moluscos del Caribe mexicano. Un catálogo ilustrado*. Bogotá: Fundación Natura, Invemar.

Mikkelsen, P. M., & Bieler, R. (2008). *Seashells of southern Florida, living marine mollusks of the Florida Keys and adjacent regions, Bivalves*. Princeton, New Jersey: Princeton University Press.

Miloslavich, P., Díaz, J. M., Klein, E., Alvarado, J. J., Díaz, C., Gobin, J. et al. (2010). Marine biodiversity in the Caribbean: regional estimates and distribution patterns. *Plos One*, *5*, e11916. https://doi.org/10.1371/journal.pone.0011916

Monroy-Velázquez, L. V., & Álvarez, F. (2016). New records of isopods (Crustacea: Peracarida: Isopoda) from the Mesoamerican Reef at Puerto Morelos, Quintana Roo, Mexico. *Check List*, *12*, 1–10. http://dx.doi.org/10.15560/12.4.1938

Monroy-Velázquez, L. V., Rodríguez-Martínez, R. E., & Álvarez, F. (2017). Taxonomic richness and abundance of cryptic peracarid crustaceans in the Puerto Morelos

Reef National Park, Mexico. *PeerJ*, *5*, e3411. https://doi.org/10.7717/peerj.3411

Redfern, C. (2001). *Bahamian seashells, a thousand species from Abaco, Bahamas.* Boca Raton, Florida: Bahamian seashells Inc.

Redfern, C. (2013). *Bahamian seashells, 1161 species from Abaco, Bahamas.* Boca Raton, Florida: Bahamian seashells Inc.

Ríos, E. C. (1994). *Seashells of Brazil*. Rio Grande, Brazil: Fundacao Universidade do Rio Grande.

Rodríguez-Martínez, R. E., Ruíz-Rentería, F., Van Tussenbroek, B., Barba-Santos, G., Escalante-Mancera, E., Jordán-Garza, G. et al. (2010). Environmental state and tendencies of the Puerto Morelos CARICOMP site, Mexico. *Revista de Biología Tropical*, *58*, 23–43. https://doi.org/10.15517/rbt.v58i0.20039

Rosenberg, G. (2009). Malacolog Version 4.1.1. A database of Western Atlantic marine Mollusca. Retrieved on 02 August 2018, from: http://www.malacolog.org/

Rosenberg, G., Moretzsohn, F., & García, E. F. (2009). Gastropoda. In D. L. Felder, & D. K. Camp (Eds.), *Gulf of Mexico origin, waters and biota*. College Station, Texas: Texas A&M University Press.

Scarabino, V. (2008). New species and new records of scaphopods from New Caledonia. *Mémoires du Muséum National d'Histoire Naturelle*, *196*, 215–268.

Takada, Y., Abe, O., & Shibuno, T. (2007). Colonization patterns of mobile cryptic animals into interstices of coral rubble. *Marine Ecology Progress Series*, *343*, 35–44. https://doi.org/10.3354/meps06935

Thomas, J. D. (1993). Biological monitoring and tropical biodiversity in marine environments: a critique with recommendations, and comments on the use of amphipods as bioindicators. *Journal of Natural History*, *27*, 795–806.

Tunnell, J. W., Andrews, J., Barrera, N. C., & Moretzsohn, F. (2010). *Encyclopedia of Texas seashells. Identification, ecology, distribution and history*. College Station, Texas: Texas A&M University Press.

Vokes, H. E., & Vokes, E. H. (1983). *Distribution of shallow-water marine Mollusca, Yucatán Peninsula, Mexico.* Mesoamerican Ecology Institute Monograph 1. Middle American Research Institute Publication 54. New Orleans: Tulane University.

Warmke, G. L., & Abbott, R. T. (1962). *Caribbean seashells*. New York: Dover Publications, Inc.

Young, R. E., Vecchione, M., & Mangold, K. M. (2018). Cephalopoda Cuvier 1797. Octopods, squids, nautiluses, etc. Retrieved on 20 February 2018, from http://tolweb.org/Cephalopoda/19386/2018.02.20