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Taxonomy and systematics

Sea slugs (Gastropoda: Heterobranchia) from two remote reefs of the Southern Gulf of Mexico: Cayo Arenas and Cayo Arcas

Babosas marinas (Gastropoda: Heterobranchia) de dos arrecifes remotos del sur del golfo de México: Cayo Arenas y Cayo Arcas

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Abstract

Two field trips were made during 2017 to Cayo Arenas and Cayo Arcas, southern Gulf of Mexico. Direct and indirect sampling methods focused on shell-less marine heterobranchs were carried out. As a result, 30 species of sea slugs are reported for the first time from these 2 remote reefs off the Yucatán Peninsula. From these, 7 species hold new distribution records for the Gulf of Mexico: *Sclerodoris worki*, *Platydoris angustipes*, *Polycera odhneri*, *Hexabranchus morsomus*, *Limenandra nodosa*, *Petalifera ramosa*, and *Hermaea cruciata*. *Hexabranchus morsomus* is a considerable west geographical range extension from the known distribution range, so far restricted to the Caribbean Sea. Nine specimens were identified up to genus level: *Cuthona* sp., *Haminoea* sp., *Petalifera* sp. and *Elysia* sp. With the present contribution, the sea slug richness in the Campeche Bank increases to 94 species.

Keywords: Inventories; Biodiversity; Coral reefs; Opisthobranchs; Mollusks; Campeche Bank

Resumen

En el 2017 se llevaron a cabo 2 muestreos en los arrecifes de Cayo Arcas y Cayo Arenas, al sureste del golfo de México. Se realizaron muestreos directos e indirectos enfocados en la búsqueda de moluscos heterobranquios sin concha. Como resultado, se registraron por primera vez 30 babosas marinas para estos 2 arrecifes lejanos a la península de Yucatán. De éstas, 7 especies son nuevos registros para el golfo de México: *Sclerodoris worki*, *Platydoris angustipes*, *Polycera odhneri*, *Hexabranchus morsomus*, *Limenandra nodosa*, *Petalifera ramosa* y *Hermaea cruciata*. *Hexabranchus morsomus* presenta una ampliación geográfica importante, ya que su distribución estaba restringida al mar Caribe. Nueve ejemplares fueron identificados a nivel de género: *Cuthona* sp., *Haminoea* sp., *Petalifera* sp.

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y *Elysia* sp. Con la presente contribución, la riqueza de babosas marinas para el Banco de Campeche se incrementa a 94 especies.

Palabras clave: Inventarios; Biodiversidad; Arrecifes de coral; Opistobranquios; Moluscos; Banco de Campeche

Introduction

The southern Gulf of Mexico has been recognized for its economic importance due to oil and gas, fisheries, and sea-transportation activities. These activities may pose serious threats to the local habitats and their species, especially to coral reefs. Specifically, the Campeche Bank is comprised of several remote coral reefs, Alacranes reef is the largest, best studied and the only marine protected area, followed by smaller reefs such as Triángulos, Cayo Arcas, and Cayo Arenas, with emerged sand and coral-rubble cays, relatively sheltered lagoons and areas that maintain semi-permanent human habitation such as lighthouse keepers or military posts, as well as Banco Nuevo, Banco Inglés, Banco Pera, and Obispos, which are submerged reefs (Tunnell et al., 2010). Cayo Arcas reef is located 167 km offshore from Puerto Progreso and includes 3 sand cays: Central, East and West (Fig. 1; Table 1), just at the border of the PEMEX oil fields exploitation restricted area (Tunnell et al., 2010). Cayo Arenas reef is 128 km offshore from Campeche and has 3 emerged cays: Northeast, West and Southeast (Fig. 1; Table 1).

Since 2008, several studies have attempted to update the species inventory in the southern Gulf of Mexico reef with a special focus on cryptic and less charismatic taxa. This inventory is steadily increasing the knowledge of the region's species diversity of several groups such as fishes (Moreno-Mendoza et al., 2011; Robertson et al., 2016; Zarco-Perelló et al., 2014), crustaceans (Duarte et al., 2014; Escobar-Briones & Jiménez-Guadarrama et al., 2010; Paz-Ríos & Ardisson, 2013; Paz-Ríos et al., 2013a, b, 2018a, 2018b; Santana-Moreno et al., 2013), echinoderms (Hernández-Díaz et al., 2013; Solís-Marín et al., 2015), cnidarians (González-Muñoz et al., 2013; Mendoza-Becerril et al., 2018), sponges (Ugalde et al., 2015) and mollusks (Ortigosa et al., 2013, 2015, 2018; Reyes-Gómez et al., 2017; Sanvicente-Añorve et al., 2012).

Shell mollusks are relatively well described for this region (García-Cubas et al., 1999; González et al., 1991; Hicks et al., 2001; Kornicker et al., 1959; Rice & Kornicker, 1962; Vokes & Vokes, 1983). However, specific groups such as nudibranchs and other shell-less mollusks known as heterobranchs or marine sea slugs were poorly represented in previous literature due to the lack of specific collecting

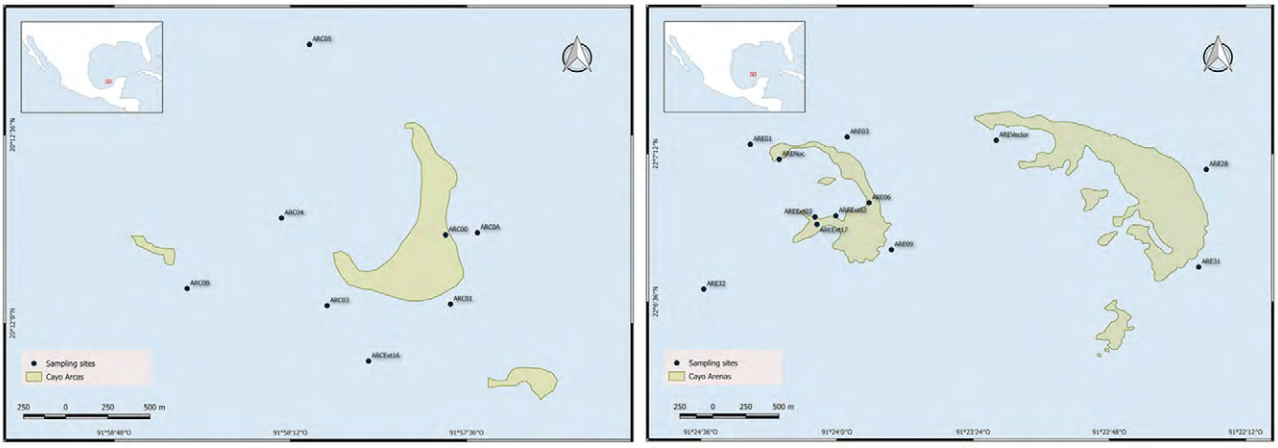

Figure 1. Cayo Arcas and Cayo Arenas, southern Gulf of Mexico.

Table 1

Main characteristics of the 2 emerged platform reefs Cayo Arcas and Cayo Arenas, Campeche Bank (based on Tunnell et al., 2010).

Reef	Lenght (m)	Wide (m)	Distance to mainland (km)	Depth (m)
Cayo Arcas	4,540	2,460	128	0-18
Cayo Arenas	3,310	850	167	0-30

methods. Recently published information comprises 84 sea slug species from 4 Campeche Bank reef localities: Alacranes (Ortigosa et al., 2015; Sanvicente-Añorve et al., 2012), Sisal, Madagascar, and Serpiente (Ortigosa et al., 2013). The main aim of the present work is to present the sea slug species inventory from Cayo Arcas and Cayo Arenas.

Materials and methods

Heterobranch specimens were collected at intertidal and subtidal areas from 19 different collecting sites (Table 2); 4 dives (281 minutes) were made during April-May 2017 at Cayo Arcas and 10 dives (1 nocturnal, 688 minutes) in June 2017 at Cayo Arenas. Sites ranged from 5.3 to 7.7 m depth at Cayo Arcas and 6.8 to 22 m at Cayo Arenas. Specimens were obtained using direct manual collecting on suitable habitats, as well as extraction of potential substrate such as algae and sponge (indirect method) (Caballer-Gutiérrez et al., 2015; Camacho-García et al., 2014; Goodheart et al., 2016). Collected substrate was split onto white trays with fresh seawater and examined after 4-6 hours looking for animals that ascend to the water surface or to the walls of the trays. Collected specimens were photographed and sedated with MgCl2 solution, then preserved in 96% alcohol and deposited at the "Colección de Moluscos de la Península de Yucatán" (CMPY), Unidad Multidisciplinaria de Docencia e Investigación Sisal (UMDI-Sisal). Taxonomic nomenclature and systematics followed Bouchet et al. (2017) and MolluscaBase (2018).

For certain species the buccal mass was dissected, and the radula and jaws were observed. Distribution range of widespread species is only allotted to the western Atlantic region. Countries are listed in alphabetical order. Previous records from the Gulf of Mexico (GM) and Caribbean Sea (CAR) in Mexico are specified.

Table 2
Sampling sites at Cayo Arcas and Cayo Arenas, west Campeche Bank, Gulf of Mexico.

Station	Date	Sampling method	Depth (m)	Time (min)	T (ºC)	Latitude (N)	Longitude (W)
Cayo Arcas							
ARC0A	21-Apr-2016	Scuba	6.7	-	-	20°12'17.3"	91°57'33.8"
ARC0B	25-Apr-2016	Scuba	7	-	-	20°12'6.69"	91°58'33.08"
ARC00	31-Mar-2017	Snorkeling	0.70	60	-	20°12'16.9"	91°57'40.3"
ARC01	03-Apr-2017	Scuba	7.5	76	26	20°12'03.7"	91°57'39.3"
ARC03	01-Apr-2017	Scuba	7.7	66	25	20°12'03.4"	91°58'04.5"
ARC04	01-Apr-2017	Scuba	6.4	71	26	20°12'20.1"	91°58'13.8"
ARC05	02-Apr-2017	Scuba	5.3	68	26	20°12'53.3"	91°58'08.1"
ARCExt16	03-Apr-2017	Floating *Sargassum*	-	-	-	20°11'52.8"	91°57'56.03"
Cayo Arenas							
ARE01	22-May-2017	Scuba	12.9	78	27	22°07'14.3"	91°24'22.9"
ARE03	26-May-2017	Scuba	20.6	67	27	22°07'16.1"	91°23'57.3"
ARE06	23-May-2017	Scuba	12.4	73	27	22°07'0.06"	91°23'51.52"
ARE09	25-May-2017	Scuba	12	72	27	22°06'48.7"	91°23'45.6"
ARE28	26-May-2017	Scuba	6.6	69	27	22°07'08.2"	91°22'22.4"
ARE31	25-May-2017	Scuba	15.5	65	27	22°06'44.5"	91°22'24.4"
ARE32	24-May-2017	Scuba	22	73	27	22°06'39.1"	91°22'35.2"
ARENoc	26-May-2017	Scuba	11.4	39	27	22°07'10.65"	91°24'15.27"
AREExt02	22-May-2017	Snorkeling	0.70	60	-	22°06'56.09"	91°24'0.28"
AREExt03	23-May-2017	Scuba	6.8	77	27	22°06'56.06"	91°24'5.78"
AREExt17	23-May-2017	Intertidal	0	-	-	22º06'54.82"	91º 24'5.27"
AREVector	21-May-2017	Scuba	8.5	54	27	22°07'15.3"	91°23'17.9"

Results

We found 87 specimens that were identified to 30 species, 11 at Cayo Arcas and 23 at Cayo Arenas, belonging to 19 genera and 17 families (Table 3). From these, 10 represent new species records for the region and from those, 1 is new for the GMx. For Cayo Arcas, the order Nudibranchia had the highest number of species (7 species), while Cephalaspidea, Aplysiida, Pleurobranchomorpha, and Sacoglossa had 1 species each. For Cayo Arenas, the

Table 3

Inventory of the sea slugs fauna from Cayo Arcas and Cayo Arenas reefs, west Campeche Bank, Gulf of Mexico listed in alphabetical order. For sites information see Table 2. References: [a]Hicks et al. (2001), [b]Valdés et al. (2006), [c]Sanvicente-Añorve et al. (2012), [d]Ortigosa et al. (2013).

	Taxon	Cayo Arcas	Cayo Arenas	Previous records at the Campeche Bank
1	*Aplysia dactylomela*		x	La Bocana[d]; Bajos Sisal[d]; PNAA[c,d]
2	*Aplysia parvula*		x	PNAA[c,d]
3	*Berghia stephanieae*		x	La Bocana[d]; Yucalpeten[d];
4	*Bulla occidentalis*	x	x	La Bocana[d]; Yucalpeten[d]; PNAA[c,d]
5	*Chelidonura hirundinina*		x	PNAA[c,d]
6	*Cuthona* sp.	x		
7	*Dendrodoris krebsii*	x	x	PNAA[a,c,d]
8	*Dolabrifera ascifera*		x	PNAA[c,d] (as *Dolabrifera dolabrifera*)
9	*Elysia cornigera*		x	PNAA[c] (as *Elysia timida*)
10	*Elysia crispata*	x	x	PNAA[a,c,d]
11	*Elysia flava*		x	PNAA[d]
12	*Elysia* sp.		x	
13	*Felimare bayeri*	x	x	PNAA[b,d]
14	*Felimare nyalya*		x	PNAA[d]
15	*Felimare picta*	x		
16	*Felimare ruthae*	x		PNAA[d]
17	*Haminoea* sp.		x	
18	*Hermaea cruciata*		x	
19	*Hexabranchus morsomus*		x	
20	*Limenandra nodosa*		x	
21	*Petalifera ramosa*	x		
22	*Petalifera* sp.		x	
23	*Platydoris angustipes*	x		
24	*Pleurobranchus areolatus*	x		
25	*Polycera odhneri*		x	
26	*Sclerodoris worki*		x	
27	*Scyllaea pelagica*	x		
28	*Stylocheilus striatus*		x	La Bocana[d]; PNAA[c,d]
29	*Thuridilla picta*		x	
30	*Tritonia bayeri*		x	PNAA [c]
	Total	11	23	

Nudibrachia also had the highest number of species with 9, followed by Sacoglossa with 6, Aplysiida with 5, and Cephalaspidea with 3 species.

Subclass Heterobranchia Gray, 1840
Infraclass Euthyneura Spengel, 1881
Cohort Ringipleura Kano, Brenzinger, Nützel, Wilson and Schrödl, 2016
Subcohort Nudipleura Wägele and Willan, 2000
Order Pleurobranchida Pelseneer, 1906
Superfamily Pleurobranchoidea Gray, 1827
Family Pleurobranchidae Gray, 1827
Genus *Pleurobranchus* Cuvier, 1804
Pleurobranchus areolatus Mörch, 1863

Material: ARC00, 1 specimen, 40 mm (CMPY-000386)

Distribution: Aruba, Bahamas, Barbados, Bermuda, Bonaire, Brazil, Cayman Islands, Colombia, Costa Rica, Cuba, Curaçao, Guadeloupe, Jamaica, Mexico (GM), Panama, Puerto Rico, St. Martin, St. Thomas, USA, Venezuela, Virgin Islands (Alvim & Dias-Pimenta, 2016; Caballer-Gutiérrez et al., 2015).

Orden Nudibranchia Cuvier, 1817
Superfamily Doridoidea Rafinesque, 1815
Family Discodorididae Bergh, 1891
Genus *Sclerodoris* Eliot, 1904
Sclerodoris worki (Ev. Marcus and Er. Marcus, 1967)
(Fig. 2A)

Material: AREVector, 1 specimen, 8 mm (CMPY-000638)

Distribution: Bahamas, Barbados, Costa Rica, Jamaica, Mexico (new record: GM), USA (Camacho et al., 2014; Valdés et al., 2006).

Platydoris angustipes (Mörch, 1863)
(Fig. 2B)

Material: ARC0B, 1 specimen, 50 mm.

Distribution: Aruba, Barbuda, Brazil, Cayman Islands, Costa Rica, Cuba, Dry Tortugas, Grenada, Honduras, Jamaica, Martinique, Mexico (new record: GM, CAR), Panama, Puerto Rico, St. Barthelemy, St. Lucia, St. Martin, St. Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos, Virgin Islands (Alvim & Dias-Pimenta, 2016; Valdés et al., 2006)

Superfamily Polyceroidea Alder and Hancock, 1845
Family Polyceridae Alder and Hancock, 1845
Genus *Polycera* Cuvier, 1816
Polycera odhneri Er. Marcus, 1955
(Figs. 2C)

Material: ARE09, 1 specimen, 2 mm (CMPY-000633); ARE28, 1 specimen, 3 mm (CMPY-000642).

Distribution: Aruba, Bahamas, Barbados, Bermuda, Bonaire, Brazil, Cuba, Curaçao, Guadeloupe, Mexico (new record: GM), USA, Venezuela (Caballer-Gutiérrez et al., 2015; Valdés et al., 2006).

Superfamily Chromodoridoidea Berth, 1891
Family Chromodorididae Bergh, 1891
Genus *Felimare* Ev. Marcus and Er. Marcus, 1967
Felimare nyalya (Ev. Marcus and Er. Marcus, 1967)
(Fig. 2D)

Material: ARE01, 4 specimens, 4-12 mm (CMPY-000620; CMPY-000621; CMPY-000630; CMPY-000631).

Distribution: Bahamas, Cuba, Martinique, Mexico (GM), USA (Ortigosa et al., 2015; Valdés et al., 2006).

Felimare ruthae (Ev. Marcus and Hughes, 1974)
(Fig. 2E)

Material: ARC01, 2 specimens, 1.4, 20 mm (CMPY-000405, CMPY-000406)

Distribution: Bahamas, Barbados, Costa Rica, Cuba, Guadeloupe, Jamaica, Mexico (GM, CAR), Panama, Venezuela (Caballer-Gutiérrez et al., 2015; Valdés et al., 2006).

Felimare bayeri Ev. Marcus and Er. Marcus, 1967
(Fig. 2F)

Material: ARC05, 1 specimen, 15 mm (CMPY-000407); ARE01, 2 specimens, 12-16 mm (CMPY-000613; CMPY-000615); AREExt03, 1 specimen, 30 mm (CMPY-000616).

Distribution: Belize, Cuba, Mexico (GM, CAR), Panama, USA (Ortigosa et al., 2015; Valdés et al., 2006).

Felimare picta (Schultz in Philippi, 1836)
(Fig. 2G)

Material: ARC01, 1 specimen, 11 mm (CMPY-000710).

Distribution: Amphiatlantic. Western Atlantic: Brazil, Mexico (GM), Puerto Rico, USA, Venezuela (Almada et al., 2016; Caballer-Gutiérrez et al., 2015; Valdés et al., 2006).

Family Hexabranchidae Bergh, 1891
Genus *Hexabranchus* Ehrenberg, 1828
Hexabranchus morsomus Ev. Marcus and Er. Marcus, 1962
(Fig. 2H)

Material: ARENoc, 1 specimen, 45 mm (CMPY-000672)

Distribution: Antigua, Aruba, Cayman Islands, Colombia, Costa Rica, Grenada, Guadeloupe, Honduras, Martinique, Mexico (new record: GM), Panama, Puerto Rico, St. Lucia, St. Martin, St. Vincent and the Grenadines,

Trinidad and Tobago, USA, Venezuela, Virgin Islands (Caballer-Gutiérrez et al., 2015; Goodheart et al., 2016; Valdés et al., 2006).

Superfamily Phyllidoidea Rafinesque, 1814
Family Dendrodorididae O´Donoghue, 1814
Genus *Dendrodoris* Ehrenberg, 1831
Dendrodoris krebsii (Mörch, 1863)
(Fig. 2I)

Material: ARC03, 1 specimen, 10 mm (CMPY-000408); ARC04, 1 specimen, 15 mm (CMPY-000402); AREExt02, 2 specimens, 12-32 mm (CMPY-000665; CMPY-000629); ARE32, 1 specimen, 10 mm (CMPY-000622); ARENoc, 1 specimen, 20 mm (CMPY-000681).

Distribution: Antigua, Bahamas, Barbados, Belize, Bonaire, Brazil, Cayman Islands, Colombia, Costa Rica, Cuba, Dominican Republic, Grenada, Guadeloupe, Honduras, Jamaica, Martinique, Mexico (GM, CAR), Panama, St. Christopher, St. Kitts, St. Lucia, St. Martin, St. Vincent and the Grenadines, USA, Venezuela, Virgin Islands (Caballer-Gutiérrez et al., 2015; Goodheart et al., 2016; Valdés et al., 2006).

Suborder Cladobranchia William and Morton, 1984
Superfamily Tritonioidea Lamarck, 1809
Family Tritoniidae Lamarck, 1809
Genus *Tritonia* Cuvier, 1798
Tritonia bayeri Ev. Marcus and Er. Marcus, 1967
(Fig. 2J)

Material: ARE03, 1 specimen, 8 mm (CMPY-000625).

Distribution: Barbados, Belize, Cayman Islands, Guadeloupe, Honduras, Mexico (GM), Panama, USA, Virgin Islands (Goodheart et al., 2016; Sanvicente-Añorve et al., 2012; Valdés et al., 2006).

Superfamily Dendronotoidea Allman, 1845
Family Scyllaeidae Alder and Hancock, 1855
Genus *Scyllaea* Linnaeus, 1758
Scyllaea pelagica Linnaeus, 1758
(Fig. 2K)

Material: ARCExt16, 7 specimens, 15-40 mm (CMPY-000385).

Distribution: cosmopolitan in temperate warm waters. Western Atlantic: Aruba, Bahamas, Bermuda, Bonaire, Brazil, Costa Rica, Curaçao, Mexico (GM), USA, Venezuela (Caballer-Gutiérrez et al., 2015; Valdés et al., 2006).

Superfamily Fionoidea Gray, 1857
Family Cuthonidae Odhner, 1934
Genus *Cuthona* Alder and Hancock, 1855
Cuthona sp. (as *Cuthona* sp. B in Redfern, 2013; probably as *Cuthona* sp. in Edmunds & Just, 1983).
(Fig. 2L)

Material: ARC05, 2 specimens, 3 mm (CMPY-000403).

Distribution: Bahamas, Barbados, Mexico (new record: GM) (Edmunds & Just, 1983; Redfern, 2013).

Superfamily Aeolidioidea Gray, 1827
Family Aeolidiidae Gray, 1827
Genus *Berghia* Trinchese, 1877
Berghia stephanieae (Valdés, 2005)
(Fig. 3A)

Material: ARE31, 1 specimen, 9 mm (CMPY-000624).

Distribution: Mexico (GM), USA (Carmona et al., 2014; Ortigosa et al., 2013; Valdés et al., 2006).

Genus *Limenandra* Haefelfinger and Stamm, 1958
Limenandra nodosa Haefelfinger and Stamm, 1958

Material: AREExt03, 1 specimen, 10 mm (CMPY-000643).

Distribution: Amphiatlantic. Western Atlantic: Bahamas, Belize, Costa Rica, Curaçao, Honduras, Mexico (new record: GM; CAR), St. Vincent and the Grenadines (Carmona et al., 2013; Valdés et al., 2006).

Cohort Tectipleura Schrödl, Klussmann-Kolb and Wilson, 2011
Subcohort Euopisthobranchia Jörger, Stöger, Kano, Fukufa, Knebelsberger and Schrödl, 2010
Order Cephalaspidea P. Fischer, 1883
Superfamily Bulloidea Gray, 1827
Family Bullidae Gray, 1827
Genus *Bulla* Linnaeus, 1758
Bulla occidentalis A. Adams, 1850
(Fig. 3B)

Material: 12 specimens found at both reefs. All the specimens observed were empty shells (CMPY-003199, CMPY-003200).

Distribution: Antigua, Bahamas, Barbados, Barbuda, Belize, Bermuda, Brazil, Colombia, Costa Rica, Cuba, Dominicana, Grenada, Guadeloupe, Honduras, Jamaica, Martinique, Mexico (GM, CAR), Panama, St. Lucia, St. Martin, St. Vincent and the Grenadines, Surinam, Trinidad and Tobago, USA, Uruguay, Venezuela, Virgin Islands (Caballer-Gutiérrez et al., 2015; Malaquias & Reid, 2008).

Superfamily Philinoidea Gray, 1850
Family Aglajidae Pilsbry, 1895
Genus *Chelidonura* A. Adams, 1850
Chelidonura hirundinina (Quoy & Gaimard, 1833)
(Fig. 3C)

Material: ARE01, 1 specimen, 0.5 mm (CMPY-000626); ARE06, 2 specimens, 10, 14 mm (CMPY-000619; CMPY-000646).

Figure 2. Species from Cayo Arcas and Cayo Arenas. A. *Sclerodoris worki* (Ev. Marcus and Er. Marcus, 1967), B. *Platydoris angustipes* (Mörch, 1863), C. *Polycera odhneri* Er. Marcus, 1955, D. *Felimare nyalya* (Ev. Marcus and Er. Marcus, 1967), E. *Felimare ruthae* (Ev. Marcus and Hughes, 1974), F. *Felimare bayeri* Ev. Marcus and Er. Marcus, 1967, G. *Felimare picta* (Schultz in Philippi, 1836), H. *Hexabranchus morsomus* Ev. Marcus and Er. Marcus, 1962, I. *Dendrodoris krebsii* (Mörch, 1863), J. *Tritonia bayeri* Ev. Marcus and Er. Marcus, 1967, K. *Scyllaea pelagica* Linnaeus, 1758, L. *Cuthona* sp.

Distribution: Aruba, Bahamas, Bonaire, Cayman Islands, Cuba, Curaçao, Guadeloupe, Jamaica, Mexico (GM, CAR), Puerto Rico, USA, Venezuela (Caballer-Gutiérrez et al., 2015).

Superfamily Haminoeoidea Pilsbry, 1895
Family Haminoeidae Pilsbry, 1895
Subfamily Haminoeinae Pilsbry, 1895

Genus *Haminoea* Turton and Kingston, 1830
Haminoea sp.
(Fig. 3D)

Material: AREExt03, 1 shell, 12 mm (CMPY-000546).

Distribution: Mexico (present study: GM).

Order Aplysiida
Superfamily Aplysioidea Lamarck, 1809

Family Aplysiidae Lamarck, 1809
Subfamily Aplysiinae Lamarck, 1809
Genus *Aplysia* Guilding in Mörch, 1863
Aplysia parvula Mörch, 1863

Material: AREExt02, 1 specimen, 1 mm (CMPY-000623); ARE09, 1 specimen, 0.8 mm (CMPY-000645); ARE28, 1 specimen, 0.5 mm (CMPY-000637).

Distribution: Circumtropical. Western Atlantic: Anguilla, Aruba, Bahamas, Bermuda, Bonaire, Brazil, Cayman Islands, Costa Rica, Cuba, Curaçao, Guadeloupe, Jamaica, Mexico (GM, CAR), Puerto Rico, St. Vincent and the Grenadines, USA, Venezuela, Virgin Islands (Caballer-Gutiérrez et al., 2015; de la Cruz-Francisco et al., 2017; Valdés et al., 2006).

Aplysia dactylomela Rang, 1828
(Fig. 3E)

Material: AREExt02, 1 specimen, 40 mm (CMPY-000648).

Distribution: Amphiatlantic. Western Atlantic: Anguilla, Aruba, Bahamas, Barbados, Belize, Bermuda, Bonaire, Brazil, Cayman Islands, Colombia, Costa Rica, Cuba, Curaçao, Guadeloupe, Jamaica, Martinique, Mexico (GM, CAR), Panama, Puerto Rico, St. Christopher, St. Kitts, St. Martin, USA, Venezuela, Virgin Islands (Caballer-Gutiérrez et al., 2015).

Subfamily Dolabriferinae Pilsbry, 1895
Genus *Dolabrifera* Gray, 1847
Dolabrifera ascifera (Rang, 1828)
(Fig. 2G)

Material: AREExt17, 1 specimen, 95 mm (CMPY-000675).

Distribution: Western Atlantic: Jamaica, Mexico (GM), USA, Venezuela (Valdés et al., 2017).

Petalifera ramosa Baba, 1959
(Fig. 2H)

Material: ARC0A: 2 specimens, 12 mm (CMPY-000533).

Distribution: Circumtropical. Western Atlantic: Bahamas, Belize, Colombia, Costa Rica, Cuba, Guadeloupe, Honduras, Jamaica, Martinique, Mexico (new record: GM, CAR), Puerto Rico, USA, Venezuela (Caballer-Gutiérrez et al., 2015; Valdés et al., 2006).

Petalifera sp.
(Fig. 2I)

Material: AREExt02, 2 specimens, 30 mm (CMPY-000678; CMPY-000654).

Distribution: Mexico (present study: GM).

Subfamily Notarchinae Eales, 1925
Genus *Stylocheilus* Gould, 1852
Stylocheilus striatus (Quoy & Gaimard, 1832)
(Fig. 3F)

Material: ARE03, 2 specimens, 20, 23 mm (CMPY-000632; CMPY-000635); ARE06, 1 specimen, 25 mm (CMPY-000641); AREExt02, 3 specimens, 20-30 mm (CMPY-000652; CMPY-000661; CMPY-000659).

Distribution: Circumtropical. Western Atlantic: Aruba, Bahamas, Barbados, Bermuda, Bonaire, Brazil, Cayman Islands, Colombia, Costa Rica, Cuba, Curaçao, Guadeloupe, Jamaica, Mexico (GM), Puerto Rico, USA, Venezuela (Caballer-Gutiérrez et al., 2015; Valdés et al., 2006).

Subcohort Panpulmonata Jörger, Stöger, Kano, Fukuda, Knebelsberger and Schrödl, 2010
Order Sacoglossa Ihering, 1876
Superfamily Plakobranchoidea Gray, 1840
Family Plakobranchidae Gray, 1840
Genus *Elysia* Risso, 1818
Elysia crispata Mörch, 1863
(Fig. 3J)

Material: ARC04, 1 specimen, 10 mm (CMPY-000387); ARE28, 10 specimens, 10-25 mm (CMPY-000617; CMPY-000683; CMPY-000614).

Distribution: Bahamas, Barbados, Belize, Bermuda, Brazil, Cayman Islands, Colombia, Costa Rica, Cuba, Guadeloupe, Haiti, Honduras, Jamaica, Mexico (GM, CAR), Panama, St. Martin, St. Vincent and the Grenadines, Trinidad and Tobago, USA, Venezuela, Virgin Islands (Caballer-Gutiérrez et al., 2015; de la Cruz Francisco et al., 2017; Krug et al., 2016; Valdés et al., 2006).

Elysia flava Verrill, 1901
(Fig. 3K)

Material: ARE09, 1 specimen, 7 mm (CMPY-000639).

Distribution: Amphiatlantic. Western Atlantic: Belize, Bermuda, Brazil, Costa Rica, Cuba, Curaçao, Guadeloupe, Jamaica, Mexico (GM), Panama, Puerto Rico, Venezuela (Caballer-Gutiérrez et al., 2015; Krug et al., 2016; Ortigosa et al., 2015).

Elysia cornigera Nutall, 1989

Material: AREExt02, 3 specimens, 2-4 mm.

Distribution: Bahamas, Cayman Islands, Jamaica, Mexico (GM), USA (Krug et al., 2016).

Elysia sp.
(Fig. 3L)

Material: ARE09, 4 specimens, 10-13 mm (CMPY-000647; CMPY-000644; CMPY-000634).

Distribution: Mexico (present study: GM).

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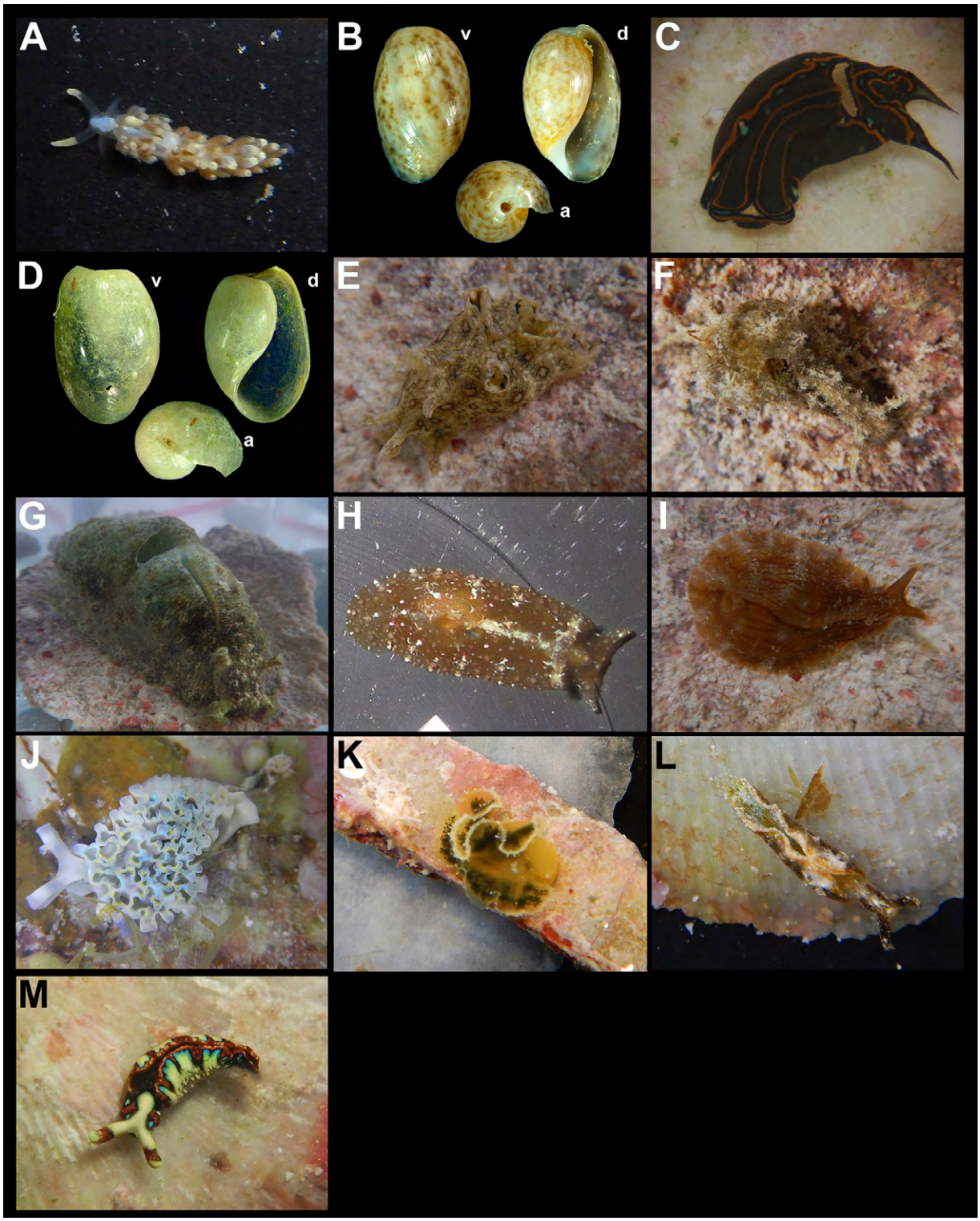

Figure 3. Species from Cayo Arcas and Cayo Arenas. A. *Berghia stephanieae* (Valdés, 2005), B. *Bulla occidentalis* A. Adams, 1850, C. *Chelidonura hirundinina* (Quoy and Gaimard, 1833), D. *Haminoea* sp., E. *Aplysia dactylomela* Rang, 1828, F. *Stylocheilus striatus* (Quoy and Gaimard, 1832), G. *Dolabrifera ascifera* (Rang, 1828), H. *Petalifera ramosa* Baba, 1959, I. *Petalifera* sp., J. *Elysia crispata* Mörch, 1863, K. *Elysia flava* Verrill, 1901, L. *Elysia* sp., M. *Thuridilla picta* (A. E. Verrill, 1901).

Genus *Thuridilla* Bergh, 1872
Thuridilla picta (A. E. Verrill, 1901)
(Fig. 3M)

Material: ARE28, 1 specimen, 10 mm (CMPY-000628).

Distribution: Amphiatlantic. Western Atlantic: Bahamas, Bermuda, Costa Rica, Curaçao, Jamaica, Mexico (GM), USA (Camacho et al., 2014; de la Cruz Francisco et al., 2017; Valdés et al., 2006).

Family Hermaeidae H. Adams and A. Adams, 1854
Genus *Hermaea* Lóven, 1844
Hermaea cruciata Gould, 1870 (Fig. 3I)

Material: AREExt03, 1 specimen, 5 mm (CMPY-000711).

Distribution: Brazil, Costa Rica, Mexico (new record: GM), Trinidad and Tobago and USA (Valdés et al., 2006).

Discussion

Present results describe the heterobranch fauna from 2 remote coral reefs: Cayo Arcas and Cayo Arenas in the Campeche Bank, for the first time. The accumulated species richness is comprised by 30 species, 10 of which represent new species records for the region. These Campeche Bank Reefs turned out to be an unexplored area, such as other marine areas in the Caribbean with a potential to increase our knowledge of heterobranchs species distribution (Camacho et al., 2014). For example, the finding of *Hexabranchus morsomus* at Cayo Arenas represents an important geographical range extension within its Atlantic distribution being the first record within the Gulf of Mexico. Six other species are also new records for the Gulf of Mexico (*Sclerodoris worki*, *Platydoris angustipes*, *Polycera odhneri*, *Hexabranchus morsomus*, *Limenandra nodosa*, *Petalifera ramosa*, and *Hermaea cruciata*).

Nine specimens could not be identified to species, since they did not match any of the species previously recorded for the Atlantic coast of Mexico, and represent potential new species, or considerable phenotypic variation within described species for the region. The 2 specimens attributed to *Cuthona* resemble in size, shape and color the specimen figured in Redfern (2013) as *Cuthona* sp. B. He also proposed that his 2 specimens named as *Cuthona* sp. B were the same species of Edmunds and Just (1983) from Barbados, who avoided describing it as a new species because they had only a single animal. On the other hand, from the 41 valid species of the genus *Haminoea* Turton and Kingston, 1830 distributed in temperate and tropical waters (MolluscaBase, 2018), only 4 have been recorded within the Gulf of Mexico (Rosenberg et al., 2009). The shape, color and proportions of the shell within the genus are very similar among the different species, which complicates the identification (Malaquias & Cervera, 2005). The shell found at Cayo Arenas lacks the spiral grooves that cover the body whorl of *Haminoea elegans* (Gray, 1825), and although it is as smooth as *Haminoea antillarum* (d'Orbigny, 1841), *Haminoea glabra* (A. Adams, 1850), and *Haminoea succinea* (Conrad, 1846), is considerably less globose than any of those 3 species and therefore it was conservatively considered as *Haminoea* sp. The genus *Petalifera* has 6 described species but only 2 had been registered in the Caribbean: *P. petalifera* and *P. ramosa* (Valdés et al., 2006). The specimens found at Cayo Arenas agrees with *Petalifera*, but it lacks the opaque white pigment of *P. petalifera* and the conical pink tubercles with the terminal papilla of *P. ramosa* (Valdés et al., 2006). Its shape, color and size also resemble *Phyllaplysia lafonti* (Fischer, 1870) from the Mediterranean Sea, Atlantic coast of Europe and Indo-West Pacific in having concentric bands of light and dark pigmentation. Nevertheless, Pruvot-Fol (1954) states that this species lacks a shell and the collected specimens did present a shell. Redfern (2013) states that the specimen figured by Valdés et al. (2006) as *P. petalifera* from Martinique is, indeed, a specimen of *P. lafonti.*

The remaining specimens were identified as *Elysia* sp. This genus has been recently studied by Krug et al. (2016), who identified specific morphological characters from the now described 90 species. However, the same authors also claimed that the species description is not complete since over 40 candidate species have not yet been matched to existing descriptions. The specimens found at Cayo Arenas resemble the specimen figured by Valdés et al. (2006) as *Elysia scops* Ev. Marcus & Er. Marcus, 1967 originally described from Florida. Nevertheless, the status of this species could not be analyzed by Krug et al. (2016), as the photographed specimen disappeared. Furthermore, the presence of small white papillae and the dark band on the parapodial margin, the presence of more than 2 dorsal vessels and light blue speckles at the dorsum, partially match *Elysia papillosa* Verril, 1901 and *Elysia taino* Krug, Vendetti and Valdés, 2016 although its reliable identification, according to Krug et al. (2016), can only be determined through molecular analysis.

Recently, Valdés et al. (2017) studied the molecular and morphological systematics of the genus *Dolabrifera*. According to their results, there are 2 species within the Caribbean region: *Dolabrifera virens* Verrill, 1901 and *Dolabrifera ascifera* (Rang, 1828). *Elysia crispata* is a common species at both reefs, as well as other areas of the Gulf of Mexico such as Veracruz (Zamora-Silva & Ortigosa, 2012) and Alacranes reef (Ortigosa et al., 2015; Sanvicente-Añorve, 2012). Nevertheless, it is important to notice that in reefs close to the continental shelf such as Madagascar, Serpiente and Sisal, it has not yet been detected (Ortigosa et al., 2013).

Cayo Arcas is adjacent to Mexico's most important offshore oil and gas production zone, and despite that sector slowdown during the last 10 years, it is still prone to an oil-spill disaster as well as vulnerable to the intense industry-related, national and international shipping transit with the potential for invasive species introduction and coral reef ship groundings. If we add the risk of extreme weather events that both reefs are exposed to, it becomes clear how important it is to describe these reefs species richness and diversity to foster the understanding of the processes that maintain such diversity. So far, the relative remoteness of these reefs has helped their conservation but has also delayed their study.

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