

MARINE RECORD

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New records of marine decapods and stomatopods in Área de Conservación Guanacaste (ACG): four years of marine biodiversity inventoring

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Abstract

The marine area of Área de Conservación Guanacaste (ACG) contains a 43,000 ha formal marine protected area, a 732 ha special management zone in Bahía Santa Elena, and 150 km of wild protected coastline. In an effort to broaden the biodiversity knowledge of all marine taxa present in the area, an inventory was started in 2015 (BioMar-ACG Project). This initiative is being funded by the Guanacaste Dry Forest Conservation Fund (GDFCF) in collaboration with government staff at ACG, and is carried out by Centro de Investigación en Ciencias del Mar y Limnología (CIMAR, Center for Research in Marine Science and Limnology) and Museo de Zoología (Zoology Museum), both from Universidad de Costa Rica (UCR). After four years of the project, 2650 specimens of marine decapod crustaceans and stomatopods have been collected, belonging to 209 species, out of which 99 are new records for ACG, four may be new species and nine (*Cyrtoplax panamensis*, *Glyptoxanthus labyrinthicus*, *Pachyches marcortezensis*, *Petrolisthes donadio*, *Pylopagurus holmesi*, *Synalpheus pinkfloydi*, *Typton granulatus*, *Zenopontonia soror*, *Neogonodactylus pumilus*) are new records for Costa Rica. With this contribution the total number of decapods (257 spp.) and stomatopods (14 spp.) for ACG is 271 species, more than half the species reported for Costa Rica, and more than a quarter of all crustaceans reported for the eastern tropical Pacific. The high concentration of species in ACG may be attributed to the diversity of habitats, the seasonal upwelling and to the recent sampling efforts. In only four years, the BioMar-ACG has increased the number of species in these groups of crustaceans by 37% over the past 85 years of previous studies in the ACG.

Keywords: Decapods, Stomatopods, Biodiversity, Inventory, ACG

Introduction

The first study of marine decapods of Costa Rica was completed by Faxon (1895), and on stomatopods by Schmitt (1940) and Reaka and Manning (1980). Compilations of the biodiversity of marine decapod crustaceans and stomatopods in Costa Rica began with a publication by Moran and Dittel (1993), with an annotated list of anomuran and brachyuran crabs from the Pacific and Caribbean coasts. Castro and Vargas (1996) published

an annotated list of decapods and stomatopods from Golfo Dulce, while Vargas and Cortés (1997) a list of stomatopods of the country. Afterwards, two other compilations on crustaceans were published for Penaeoidea, Sergestoidea, Caridea, Astacidea, Thalassinidea and Palinura in the Caribbean (Vargas and Cortés 1999a) and in the Pacific (Vargas y Cortés 1999b). Vargas and Cortés (2006) published a compilation of the Infraorder Anomura. Some years later, compilations were published in the book “Marine Biodiversity of Costa Rica, Central America” (Wehrmann and Cortés 2009), which examines all groups of marine organisms reported for Costa Rica. Chapters include all crustacean groups known to be present in this country on the Pacific and Caribbean, including the best-known taxa: stomatopods (35 spp.)

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(Vargas 2009) and decapods (549 spp.) (Vargas and Wehrtmann 2009).

Área de Conservación Guanacaste (ACG) includes several terrestrial National Parks and Reserves and a Marine

Sector that is 43,000 ha and 150 km of protected coastline (<http://www.acguanacaste.ac.cr/acg/que-es-el-acg>).

It is one of the best-studied conservation areas in Central America, but previous biological research has

Table 1 Collection sites at Área de Conservación Guanacaste

Code	Collection sites	Type of environment
BEH	Bahía El Hachal	Intertidal zone
BEJ	Bajo El Jardín	Reef and algae covered coralline rocks
BEM	Bajo El Machetazo	Rocky bottom and small loose rocks
BET	Bajo El Tigre	Rocky bottom and small loose rocks
BEV	Bajo El Viejón	Rocky bottom and small loose rocks
BEJ	Bajo El Jardín	Rocky bottom and small loose rocks
BSE	Bahía Santa Elena, Pintadero, Playa Cocos	Rocky bottom and small loose rocks
BLC	Bajo Las Chavelas	Rocky bottom and small loose rocks
BLM	Bajo Los Mogotes	Rocky bottom and small loose rocks
BLR	Bajo La Rajada	Rocky bottom and small loose rocks
BLS	Bajo La Salvadita	Rocky bottom and small loose rocks
BMu	Bajo Los Muñecos	Rocky bottom and small loose rocks
BPI	Bajo Pintadero	Rocky bottom and small loose rocks
BPo	Bajo Pochote	Rocky bottom and small loose rocks
BRO	Bajo Rojo	Rocky bottom and small loose rocks
BTh	Bahía Thomas	Floating oyster baskets, rocky beach, rocky beach with sponges, live and dead <i>Pocillopora</i>
Cua	Bahía Cuajiniquíl, Playa Cuajiniquíl	Sand and mud bottoms
ICo	Isla Cocinera	Rocky intertidal zone and reefs
IDa	Isla David	Rocky bottom and small loose rocks
IGo	Isla Golondrina	<i>Pavona clavus</i> reef, dead coral
IPe	Isla Pelada	Rocky intertidal zone, rocks covered with algae
ISJ	Esquina Conchal, Playa del Maíz, Playa Cactus, Isla San José	Rocky intertidal zone and dead <i>Pocillopora</i>
ISP	Arrecife al NE de Isla San Pedrito, arrecife muerto San Pedrito, San Pedrito	Coral reef and dead coral
Jun	Playa Junquillal, Junquillal esquina norte; Islote Junquillal, Junquillal, Esquina del Tamarindo	Rocky intertidal zone, polychaete reef, and <i>Pocillopora</i>
Mat	Matapalito	Coral reef, dead coral and rocky-sandy bottom
MCu	Manglar en Bahía Cuajiniquíl, Manglar 3 Bocas, Manglar 4 x 4 Cuajiniquíl	Mangrove, mud, rubble with sponges and algae
MSE	Manglar Santa Elena	Mangrove, muddy flats
Mue	Muelle lado derecho, muelle lado izquierdo, Cástula, Tiza, Hielera	Rocky intertidal and subtidal zones, sandy bottom, rubble
PCI	Piedra Claudio	Rocky bottom and small loose rocks with barnacles
PCo	Playa Corona	Rocky intertidal zone
PdI	Puerta de Iglesia, Isla San José	Rocky bottom
PGr	Playa Potrero Grande, Estero de Potrero Grande	Rocky intertidal zone, sandy beach, estuary, mangrove
PMa	Playa Macaya	Rocky intertidal zone, subtidal live coral
PPo	Punta Pochote	Dead corals
Pre	Playa Respingue	Rocky intertidal zone
PSe	Piedra Seca	Rocky bottom and small loose rocks with barnacles
2MM	Arrecife 2MM	Coral reef

Table 2 New records of marine decapods and stomatopods from Área de Conservación Guanacaste after four years of the BioMar-ACG project. In bold type: new records for Costa Rica

Taxon	Locality
Decapoda	
Family Albuneidae	
1) <i>Albunea lucasia</i> de Saussure, 1853	PGr
Family Alpheidae	
2) <i>Alpheopsis</i> sp. nov. A	BEJ, BTh, ISJ, Cua, Mue, Jun, BLM, MSE
3) <i>Alpheopsis</i> sp. nov. B	BEJ, BTh, ISJ, Cua, Mue, Jun, BLM, MSE
4) <i>Alpheus bellimanus</i> Lockington, 1877	BRo, BLM
5) <i>Alpheus bouvieri</i> A. Milne-Edwards, 1878	ISJ, Jun, PCo, Cua, Mue, PRe, Pgr, MSE
6) <i>Alpheus</i> cf. <i>latus</i> Kim & Abele, 1988	MCu
7) <i>Alpheus colombiensis</i> Wicksten, 1988	
8) <i>Alpheus cristulifrons</i> Rathbun, 1900	ICo, Jun, ISJ, BEV, BTh, Mue, BRo
9) <i>Alpheus lottini</i> Guérin-Méneville, 1838 [in Guérin-Méneville, 1829–1838]	BTh, BEH, IDa, Jun, PMa
10) <i>Alpheus malleator</i> Dana, 1852	BTh, Jun, Mue, Cua, BEV
11) <i>Alpheus saxidomus</i> Holthuis, 1980	2MM, ISJ
12) <i>Alpheus tenuis</i> Kim & Abele, 1988	MCu, PGr,
13) <i>Alpheus websteri</i> Kingsley, 1880	IGo, ISJ, BTh, Cua, BLM, 2MM, BEJ
14) <i>Automate dolichognatha</i> de Man, 1888	Mue, PRe
15) <i>Salmones serratidigitus</i> (Coutière, 1898)	BTh, Cua
16) <i>Synalpheus</i> cf. <i>lockingtoni</i> Coutière, 1909	BTh
17) <i>Synalpheus mexicanus</i> Coutière, 1909	IGo, ISJ
18) <i>Synalpheus nobilii</i> Coutière, 1909	BTh, Cua, Jun, Mue
19) <i>Synalpheus pinkfloydi</i> Anker, Hultgren & De Grave, 2017	BTh, ISJ, 2MM
20) <i>Synalpheus sanjosei</i> Coutière, 1909	BEH, BTh, ISJ, Mue, PMa, PPO
Family Axianassidae	
21) <i>Axianassa minerii</i> Boone, 1931	Cua, Mue
Family Axiidae	
22) <i>Axiopsis baronai</i> Squires, 1977	BRo
23) <i>Neaxius vivesi</i> (Bouvieri, 1895)	Mue, ISJ
Family Cryptochiridae	
24) <i>Opecarcinus crescentus</i> (Edmondson, 1925)	BEJ, ICo, Jun
Family Diogenidae	
25) <i>Calcinus obscurus</i> Stimpson, 1859	BTh, Cua, ICo, ISJ, Jun, PCo, PGr, PMa, PRe
26) <i>Clibanarius albidigitus</i> Nobili, 1901	ICo, Jun, MCu, MSE, Mue,
27) <i>Clibanarius lineatus</i> (H. Milne Edwards, 1848)	MCu
Family Domeciidae	
28) <i>Domecia hispida</i> Eydoux & Souleyet, 1842	Mue
Family Epialtidae	
29) <i>Acanthonyx petiverii</i> H. Milne Edwards, 1834	BTh, BEM, IPe,
30) <i>Herbstia tumida</i> (Stimpson, 1871)	BRo
31) <i>Notolopas lamellatus</i> Stimpson, 1871	MCu
32) <i>Pelia pacifica</i> A. Milne-Edwards, 1875	BTh, Jun, PGr
33) <i>Tyche lamellifrons</i> Bell, 1836	BLM, ISJ, Mue
Family Grapsidae	

Table 2 New records of marine decapods and stomatopods from Área de Conservación Guanacaste after four years of the BioMar-ACG project. In bold type: new records for Costa Rica (Continued)

Taxon	Locality
34) <i>Goniopsis pulchra</i> (Lockington, 1877)	MCu
Family Hippolytidae	
35) <i>Thor algicola</i> Wicksten, 1987	BTh, BRo, ISJ, IGo, Jun, Cua, PGr
36) <i>Thor</i> sp. nov.	PSe
Family Hymenoceridae	
37) <i>Hymenocera picta</i> Dana, 1852	BTh, 2MM
Family Inachidae	
38) <i>Coryrhynchus vestitus</i> (Stimpson, 1871)	BTh, BEJ, BLM, Cua, Jun, Mue, PCI
Family Leucosiidae	
39) <i>Persephona townsendi</i> Bell, 1855	ICo
40) <i>Uhlia ellipticus</i> Stimpson, 1871	BTh, ICo, ISJ
Family Menippidae	
41) <i>Menippe obtusa</i> Stimpson, 1859	Mue
Family Ocypodidae	
42) <i>Leptuca beebei</i> (Crane, 1941)	Cua, MCu, MSE
43) <i>Leptuca musica</i> (Rathbun, 1914)	PGr
44) <i>Uca princeps</i> (Smith, 1870)	MSE
45) <i>Uca stylifera</i> (H. Milne Edwards, 1852)	MSE
46) <i>Ucides occidentalis</i> (Ortmann, 1897)	MCu, PGr
Family Oziidae	
47) <i>Eupilumnus xantusii</i> (Stimpson, 1860)	BTh, BEM, ISJ, Mue
48) <i>Ozius perlatus</i> Stimpson, 1860	ICo, Jun
Family Paguridae	
49) <i>Pagurus nanodes</i> Haig & Harvey, 1991	BTh, IDa, Jun, Mue
50) <i>Phimochirus roseus</i> (Benedict, 1892)	BTh
51) <i>Pylopagurus holmesi</i> Schmitt, 1921	ICo, ISP
Family Palaemonidae	
52) <i>Ascidonia pusilla</i> (Holthuis, 1951)	BTh
53) <i>Harpliopsis depressa</i> (Stimpson, 1860)	BEH, BTh, IDa, Jun, PMa
54) <i>Palaemon Ritteri</i> Holmes 1895	BTh, Cua, ICo, ISJ, Mue, PCo, PRe, PGr
55) <i>Palaemonella holmesi</i> (Nobili, 1907)	BTh, BLC, Bro, BEV, ISJ, Mat, Mue
56) <i>Pontonia mexicana</i> Guérin-Méneville, 1855 [in Guérin-Méneville, 1855–1856]	BEJ
57) <i>Pseudocoutierea elegans</i> Holthuis, 1951	BET
58) <i>Pseudoveronina laevifrons</i> (Holthuis, 1951)	BET
59) <i>Typton granulatus</i> Ayon-Parente, Hendrickx & Galvan-Villa, 2015	BTh, BEV, Mue, MCu, PGr
60) <i>Zenopontonia soror</i> (Nobili, 1904)	BEH, BTh, IPe, Mue
Family Panopeidae	
61) <i>Acantholobulus mirafloresensis</i> (Abele & Kim, 1989)	BTh, BLR, Cua, Mue, MCu, PGr
62) <i>Lophopanopeus maculatus</i> Rathbun, 1898	ISJ
63) <i>Panopeus purpureus</i> Lockington, 1877	BTh, Cua, MCu, MSE, PGr
64) <i>Prionoplax ciliata</i> Smith, 1870	MCu, MSE, PGr
Family Parthenopidae	
65) <i>Heterocrypta colombiana</i> Garth, 1940	Cua, Mue

Table 2 New records of marine decapods and stomatopods from Área de Conservación Guanacaste after four years of the BioMar-ACG project. In bold type: new records for Costa Rica (*Continued*)

Taxon	Locality
66) <i>Pilosclampus triangulus</i> (Stimpson, 1860)	BTh
Family Penaeidae	
67) <i>Penaeus stylirostris</i> Stimpson, 1871	BTh
68) <i>Penaeus vannamei</i> Boone, 1931	BTh
Family Pilumnidae	
69) <i>Pilumnus limosus</i> Smith, 1869	BTh, BEV, MCu, Mue
70) <i>Pilumnus stimpsoni</i> Miers, 1886	BLM, BRo, BLS, BEV, IGo, ISP, Mue, PSe
Family Pinnotheridae	
71) <i>Austinixa</i> sp. indet	Jun
72) <i>Pinnixa</i> sp. indet	Mue
73) <i>Pinnotheres</i> sp. indet	PGr
74) <i>Tumidothere</i> sp. indet	BTh
Family Plagusidae	
75) <i>Plagusia immaculata</i> Lamarck, 1818	BTh, PRé, PGr
Family Porcellanidae	
76) <i>Megalobrachium erosum</i> (Glassell, 1936)	BTh, Cua
77) <i>Neopisosoma mexicanum</i> (Streets, 1871)	Jun, PGr
78) <i>Pachycheles calcosus</i> Haig, 1960	Jun
79) <i>Pachycheles marcortezensis</i> Glassell, 1936	BTh
80) <i>Pachycheles spinidactylus</i> Haig, 1957	ISJ, Jun, 2MM
81) <i>Petrolisthes donadio</i> Hiller & Werding, 2007	BTh, BLM, IGo, ISJ, ISP, Jun, Mat, Mue, Pse, PPO
82) <i>Polyonyx confinis</i> Haig, 1960	Jun, Mue
83) <i>Ulloaia perpusillia</i> Glassell, 1938	BLR
Family Portunidae	
84) <i>Achelous tuberculatus</i> Stimpson, 1860	BTh, ISJ, MSE
Family Processidae	
85) <i>Processa peruviana</i> Wicksten, 1983	Cua, ISJ, Mue
Family Pseudorhombilidae	
86) <i>Cyrtoplax panamensis</i> Ziesenhenné in Garth, 1940	MSE
Family Raninidae	
87) <i>Raninoides benedicti</i> Rathbun, 1935	PGr
Family Rhynchocinetidae	
88) <i>Cinetorhynchus</i> sp. nov.	BTh
Family Sesarmidae	
89) <i>Sesarma sulcatum</i> Smith, 1870	MCu
Family Trapeziidae	
90) <i>Trapezia digitalis</i> Latreille, 1828	BEH, BTh, IDa, Jun, Mat, PMA
Family Upogebiidae	
91) <i>Upogebia thistlei</i> Williams, 1986	BTh, BSE, Jun, Mue
Family Xanthidae	
92) <i>Glyptoxanthus labyrinthicus</i> (Stimpson, 1860)	BLS
93) <i>Lipaesthesius leeanus</i> Rathbun, 1898	BEJ, BEM, BEV, BLM, BPo, PCI
94) <i>Lipkemedaeus spinulifer</i> (Rathbun, 1898)	BTh, BEM, BEV, BLR, BLS, BPi, BRo, PSe

Table 2 New records of marine decapods and stomatopods from Área de Conservación Guanacaste after four years of the BioMar-ACG project. In bold type: new records for Costa Rica (*Continued*)

Taxon	Locality
95) <i>Platypodiella rotundata</i> (Stimpson, 1860)	BTh, BEM, BRo, Cua, ICo, IGo, ISJ, Jun, MCu, Mue, PGr
Stomatopoda	
Family Gonodactylidae	
96) <i>Neogonodactylus pumilus</i> (Manning, 1970)	ISJ
97) <i>Neogonodactylus stanschi</i> (Schmitt, 1940)	BEV, Mat
Family Squillidae	
98) <i>Cloridopsis dubia</i> (H. Milne Edwards, 1837)	BTh
99) <i>Meiosquilla dawsoni</i> Manning, 1970	MSE

focused primarily on the terrestrial part. In order to expand the knowledge of marine biodiversity in this region, the project entitled “Marine Biodiversity of Área de Conservación Guanacaste” (BioMar-ACG) was launched in 2015. The project has been funded by the Guanacaste Dry Forest Conservation Fund (GDFCF), and carried out by the Centro de Investigación en Ciencias del Mar y Limnología (CIMAR) and Museo de Zoología, both from Universidad de Costa Rica (UCR) (Cortés & Joyce in prep). The project has also received necessary support from the government staff of ACG, local marine “parataxonomists” supported by GDFCF and private foundations.

Following the compilation on marine biodiversity in ACG published by Cortés (2017), this paper presents an update of the inventory of marine decapod crustaceans and stomatopods, with new records for ACG as well as new records for the country. This is the result of work from mid 2015 to early 2019 by the BioMar-ACG project.

Methodology

Sixty sites were visited in ACG, from Punta Descartes to Islas Murciélago (Table 1), including rocky beaches (most common) and muddy beaches, shallow and deep reefs, shallow and deep rocky areas, estuaries, mangroves and areas deeper than 45 m. The location, geographic coordinates, depth and substrate type were registered.

In the rocky beaches during low tide, rocks were lifted to collect the organisms that live beneath them and the substrate was dug up to collect the organisms that live buried in the sediments. In the muddy beach areas, organisms were also collected from the mud. To collect the organisms that live within coral reefs, an indirect method was used: dead coral rocks were brought to the surface and broken apart to collect the organisms that mutually live inside. A similar method was used areas of rocky ocean floor, where collected specimens were brought to the surface. In the mangroves, specimens

were collected during walks in the forest and intertidal zone, and they were taken from the roots and ground. Using a shovel, the substrate was dug up and sifted to look for those organisms that live buried in the mud. In the external part of the mangrove, a similar process was followed, but also fallen leaves and tree trunks were examined for organisms. Deep dredging sampling (down to 50 m depth) was carried out with a Van Veen dredge with a 25 × 25 cm opening. Other organisms were

manually collected during dives, and some samples of crustaceans were associated with octocorals.

Collected specimens were placed in plastic containers with a net and then submerged in a bucket filled with seawater. Afterwards, the organisms were photographed in an improvised lab, a code was assigned to each specimen, a preliminary identification was provided and a sample of tissue was taken for barcoding. Once this process was finished, the organisms were sent to the

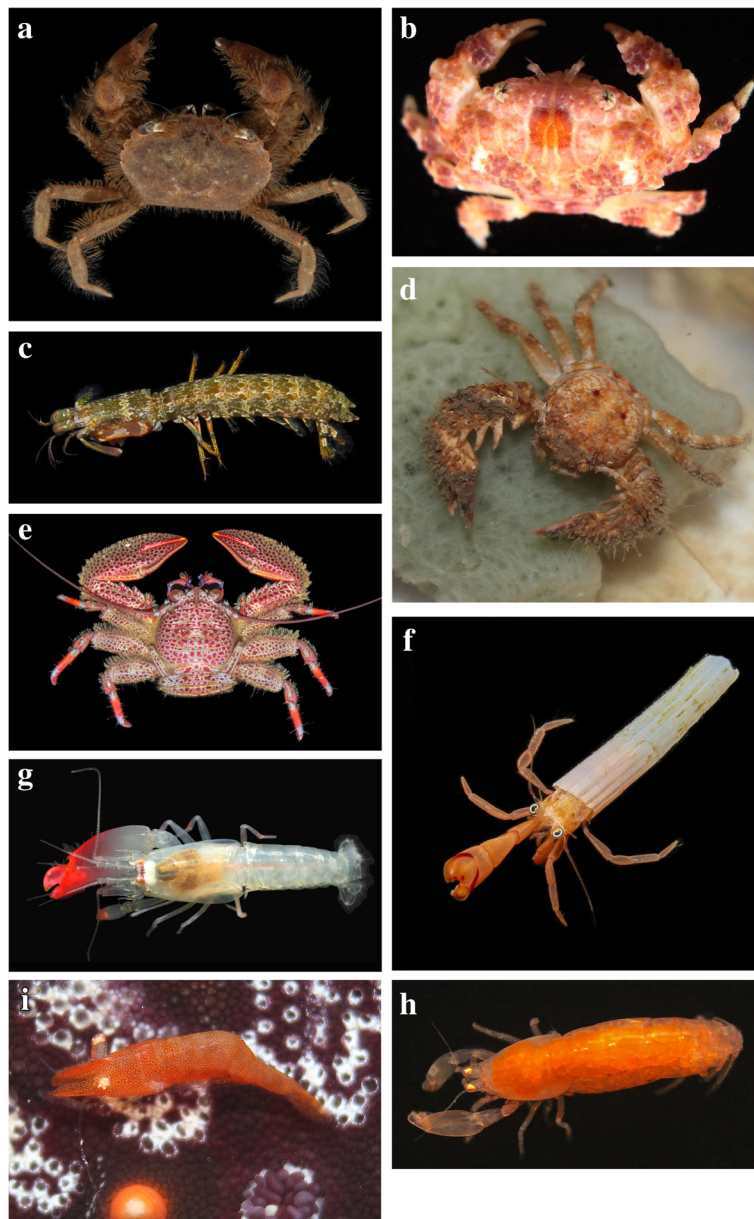


Fig. 1 New records of crustaceans for Costa Rica, with their BioMar-ACG sample code: **(a)** *Cyrtoplax panamensis*, 17-BMACGRV-02644-ACG001862; **(b)** *Glyptoxanthus labyrinthicus*, 16-BMACGRV-02104-ACG005676; **(c)** *Neogonodactylus pumilus*, 16-BMACGRV-02407-ACG006086; **(d)** *Pachyches marcortezensis*, 15-BMACGRV-00507-ACG006967; **(e)** *Petrolisthes donadio*, 16-BMACGRV-02177-ACG009006; **(f)** *Pylopagurus holmesi*, 16-BMACGRV-02414-ACG007167; **(g)** *Synalpheus pinkfloydi*, 16-BMACGRV-02245-ACG003908; **(h)** *Typton granulosus*, 16-BMACGRV-01941-ACG001783, and **(i)** *Zenopontonia soror*, 15-BMACGRV-00590-ACG009037

Zoology Museum at Universidad de Costa Rica, where a definite identification was provided and the samples were catalogued and stored. The names of the species used are as in WoRMS (<http://www.marinespecies.org>).

Results and discussion

By early 2019, 2650 specimens have been collected (Table 2), corresponding to 209 species, 99 of which are new records for ACG, four could be new undescribed species, and nine are also new records for Costa Rica: *Cyrtoplax panamensis* (Fig. 1a), *Glyptoxanthus labyrinthicus* (Fig. 1b), *Neogonodactylus pumilus* (Fig. 1c), *Pachyches marcortezensis* (Fig. 1d), *Petrolisthes donadio* (Fig. 1e), *Pylopagurus holmesi* (Fig. 1f), *Synalpheus pinkfloydi* (Fig. 1g), *Typton granulatus* (Fig. 1h) and *Zenopontonia soror* (Fig. 1i). Cortés (2017) reported 172 species from ACG, 162 decapods and 10 stomatopods. In this study 209 species have been collected so far, 200 decapods and 9 stomatopods. Of the decapod species reported by Cortés (2017), 57 species of decapods and 5 species of stomatopod have not been collected yet. These belong mainly to organisms commonly found at depths greater than 40 m, that were collected by dredging. Taking this into account, the total number of species found in the area is 271, which includes 257 decapods and 14 stomatopods. During the last four years since the BioMar-ACG project started, 99 new records have been added to the known species from ACG (Table 2) This represents an increase of 37% over the almost 85 years of previous studies in the region.

The number of species of decapods and stomatopods reported for ACG (271) is the highest number found in Costa Rica and among the highest reported in the eastern tropical Pacific ETP (Table 3). The ETP extends from the Gulf of California to southern Ecuador and

include several oceanic islands (Robertson and Kramer 2009). ACG has more than half the species reported for Costa Rica and about a quarter of decapods and stomatopods crustaceans reported for the ETP (Boschi 2000; Cortés et al. 2017) (Table 3). The high diversity of decapods and stomatopods at ACG may be due to the diversity of habitats: beaches of different wave and sediment regimes, islands and continental shorelines, mangrove forests, seagrass beds, coral reefs (live and dead), intertidal and submerged rocky platforms, sandy and muddy bottoms and deep areas (Cortés 2017). The region is exposed to season upwelling, with temperatures ranging from 15° to 30 °C (Cortés et al. 2014). And finally, the sampling effort makes a difference in how many species are reported from an area, as demonstrated in this paper.

Up to now 60 sites have been sampled, with many more still to explore, such as the coastal area of Península Santa Elena, south of Playa Naranjo and offshore, as well as some habitats such as sandy beaches, and deep rocky and muddy bottoms. Definitely more species of decapods and stomatopods will be found increasing the biodiversity of crustaceans in Área de Conservación de Guanacaste.

Resumen

El sector marino del Área de Conservación Guanacaste (ACG) posee 43,000 ha y 150 km de costa, en su mayoría poco estudiada. En un esfuerzo por conocer mejor la biodiversidad de todos los taxones marinos presentes en el área, se inició en el 2015 un inventario (Proyecto BioMar-ACG). Esta iniciativa está siendo sustentada por la Guanacaste Dry Forest Conservation Fund (GDFCF) y desarrollada por el Centro de Investigación en Ciencias del Mar y Limnología (CIMAR) y el Museo de Zoología, ambos de la Universidad de Costa Rica (UCR).

Table 3 Richness of stomatopods and decapods in the eastern tropical Pacific (ETP)

	Stomatopoda	Decapoda	Total	References
México	28	1029 ^a		Hendrickx 2005a, 2005b; M.E. Hendrickx, personal communication, 2019
Eastern Pacific	53	825 ^b	878	Boschi 2000; Cortés et al. 2017; Salgado-Barragán & Hendrickx 2010
Costa Rica	29	437	466	Vargas 2009; Vargas & Wehrtmann 2009
Colombia	11	378	389	Lemaitre & Álvarez-León 1992; López & Jaimes 2014
ACG, Costa Rica	14	257	271	This study
Oaxaca, México	15	197	212	Bastida-Zavala et al. 2013
Galápagos, Ecuador	5	205	210	Hickman & Zimmermn 2000
Clipperton, France	4	190	194	Poupin et al. 2009
Isla del Coco, Costa Rica	6	139	145	Vargas-Castillo & Wehrtmann 2008; Cortés 2012
Bahía Culebra, Costa Rica	3	99	102	Cortés et al. 2012
Golfo Dulce, Costa Rica	2	71	71	Morales-Ramírez 2011; Castro & Vargas 1996

^aIncludes pelagic and deep and shallow water species (M.E. Hendrickx, personal communication, 2019)

^bIncludes only shallow water species

Transcurridos cuatro años del proyecto, se han recolectado 2650 especímenes de crustáceos decápodos y estomatópodos marinos pertenecientes a 209 especies, de las cuales 99 son nuevas para el ACG, cuatro podrían ser nuevas especies para la ciencia y nueve (*Cyrtoplax panamensis*, *Glyptoxanthus labyrinthicus*, *Pachyches marcortezensis*, *Petrolisthes donadio*, *Pylopagurus holmesii*, *Synalpheus pinkfloydi*, *Typton granulatus*, *Zenopontonia soror* y *Neogonodactylus pumilus*) son ampliaciones de ámbito y nuevos informes para el país. Con esta contribución aumenta el número de decápodos a 257 spp. y de estomatópodos a 14 spp. para un total de 271 spp. para ACG. Esto es más de la mitad las especies conocidas de estos grupos para Costa Rica y más una cuarta parte de las especies conocidas para el Pacífico Tropical Oriental. En cuatro años el proyecto BioMar-ACG ha aumentado el número de especies de decápodos y estomatópodos del ACG en 37% más que lo que se conocía a partir de estudios en los últimos 85 años.

Conclusions

The model for marine biodiversity inventory developed with the BioMar-ACG project, the partnership between government, academia, private funding and local parataxonomists, accelerates the rate of species discovery and reporting. It also makes species information and project results available in an open access format. In only for years of the project the number of decapods and stomatopods of ACG increased by 37% over the past 85 years of previous studies, for a total of 271 species. This number represents more than half the species reported for Costa Rica, and more than a quarter of all decapods and stomatopods reported for the eastern tropical Pacific.

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Authors' contributions

RV collected and identified the specimens, wrote a first draft of the manuscript. JC, conceived the main project, helped with logistics and obtaining the funds, wrote some sections of the paper, helped prepared the images and the final draft of the paper. All authors read and approved the final manuscript.

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Availability of data and materials

Data will be made available in the project website. The specimens are deposited in the Museo de Zoología, Universidad de Costa Rica, and can be checked there.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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