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Benthic decapod crustaceans (Crustacea: Decapoda) of Cubagua Island, Venezuela

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Abstract

The crustacean decapod fauna of Cubagua Island in the Caribbean Sea, Venezuela, an island much affected by coastal upweling, was surveyed. A total of 178 species from 41 families were recorded, of which 56 species were new records for the island; eigth genera and six species were new records for Venezuela. Most species had previously been recorded from the the Caribbean province, 19.7% were endemic for the province, 64.1% had affinities to the Brazilian province, 57.3% to the Texan and Carolinian provinces and 45.5% showed continuous distributions across the provinces but showing less endemism and more affinities with Brazilian province than the general trends of distributions of decapods in the Caribbean. It appears that upwelling processes around the island hinders the development of the typical Caribbean marine ecosystems. The proximity with the northern limit of the Brazilian province also affects the biodiversity of the island.

Key words: Caribbean Sea, Crustacea, Decapoda, upwelling, biogeography

Introduction

Cubagua is a 22 km^2 desertic island situated in the southeastern Caribbean Sea 17 km off the coast of Venezuela. The island is affected by strong coastal upwelling, with surface water temperature ranges between 22–28 ºC and continuous high primary productivity (Gómez 1996; Monente 1997). Fringing coral reefs, rocky shores, *Thalassia testudium* beds, *Arca zebra* and *Pinctada imbricata* banks and sandy areas are found in shallow water (0–10 m deep). Economic activities include and artisan fishery exploited since the Sixteenth Century (Cervigón 1997).

Several studies have recorded species of decapod crustaceans for waters adjacent to Cubagua (Holthuis 1951; Haig 1956; Gore & Shoup 1968; Rodríguez 1980; Scelzo 1982; 1985; Piñango 1988; Marcano 1997; Hernández-Ávila 2002, 2004; Rodríguez *et al.* 2005; and Hernández-Ávila & Campos 2006). Information about the marine fauna of Cubagua Island was nevertheless incomplete since most of the area had not been sampled until now. The aim of the present study was to record biodiversity of crustacean decapods in Cubagua based on both new samples and published records.

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Materials and methods

A total of 282 collections were taken in 47 stations around Cubagua Island from April 2001 to June 2004 (Fig. 1). Each station was divided into five zones along the coastline between the supralitoral and 100 m (supralittoral, 0–25 m, 25–50 m, 50–75 m, 75–100 m), Rocky shores were sampled by apnea diving, specimens collected manually and substrate samples placed in plastic bags and posteriorly examined in the laboratory. Sandy and muddy beaches and *Thalassia* beds were sampled with a trawl net (30 m length x 2 m height x 1 cm mesh), and the substrate sampled with a shovel in 4 l plastic bags or with a yabby pump and examined in a 2 mm mesh sieve.

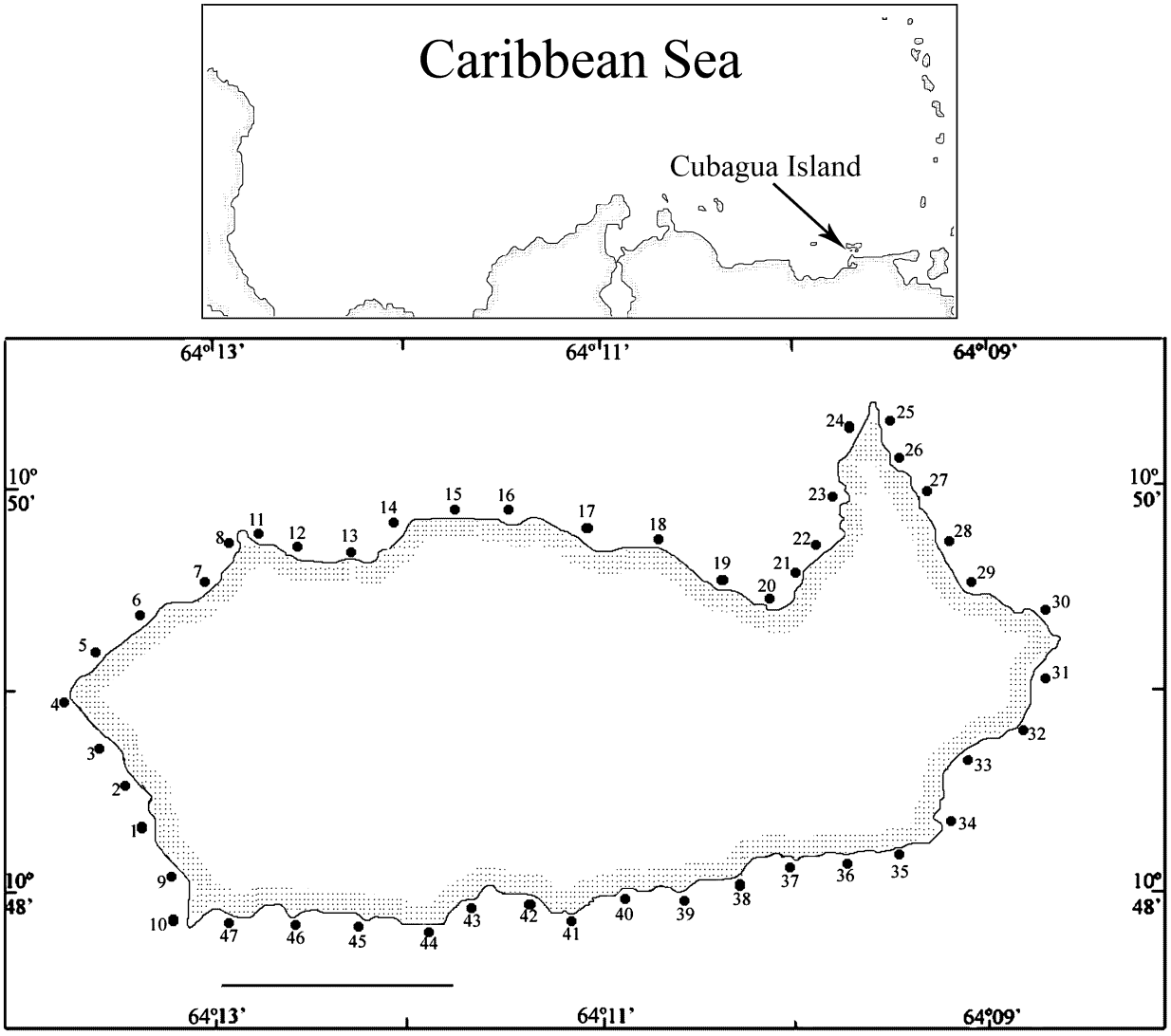

FIGURE 1. Cubagua island, showing sample stations. Scale bar 2 km.

The geografical distribution of species in the American provinces follows Boschi (2000). The following abbreviations were used for the provinces: Cal = Californian, Co = Cortes, P = Panamanian, G = Galapagos, P-C = Peru-Chilean, Ar = Argentinian, Br = Brazilian, C = Caribbean, T = Texan, Ca = Carolinian, V = Virginian, Bo = Boreal. Reference specimens are deposited in the Museo Marino de Margarita, Venezuela.

Results

The decapod crustacean fauna of Cubagua Island comprises 178 species belonging to 41 families (Table 1). Of them, 56 are new records for the island, 31.5% the total number of species. Families with the highest species diversity include Porcellanidae and Alpheidae (23 spp. each), Mitracidae and Panopeidae (10 spp. each), Palaemonidae (9 spp.), Diogenidae, Portunidae and Xanthidae (8 spp. each) and Pinnotheridae (7 spp.). Fifty species previously recorded from Cubagua were missing in our samples (see Appendix).

The benthic ecosystem of Cubagua comprises coral patches, *Thalassia testudinium* beds, sandy areas and *Arca zebra* banks. The highest species richness was observed on rocky bottom and coral substrates (71.9% of all species); other highly diverse substrates were *Thalassia* beds (12%), *Halimeda opuntia* aggregates (9%), *Arza zebra* banks (8.4%), rocky intertidal (7.8%) and sandy areas (6%). Species richness of decapod crustaceans in the Caribbean is higher in coral reefs, rocky shores and mangroves communities than in sandy and mud-sandy beaches as a result of the structural complexity of these habitats (Abele 1972, 1974; Carmona-Suárez & Conde 1996; Lira 2004). Cubagua lacks mangroves, except by the presence of two trees of *Conocarpus erectus,* wich explains the smaller number of terrestrial and semi-terrestrial decapods that have been reported on mangroves along the Venezuelan coast (Carmona-Suárez & Conde 1996; Rodríguez 1980).

Several genera are new to Venezuela: *Tyche* (Tychidae), *Teleophrys, Hemus* (Mithracidae), *Pelia* (Pisidae), *Euryplax* (Euryplacidae), *Calyptraeotheres, Austinnixa* and *Parapinnixa* (Pinnotheridae). Two former genera are recorded with undescribed species; and unclear taxa of genera *Ambidexter, Processa* (Processidae), *Alpheus, Synalpheus* (Alpheidae) and *Upogebia* (Upogebiidae) are reported. New finds for Venezuela from this study are *Tyche emarginata, Pelia mutica, Hemus cristulipes, Pinnixa floridana, Calyptraeotheres hernandezi* and *Euryplax nitida* (see Hernández-Ávila 2004; Hernández-Ávila & Campos 2006; Lira *et al. in press*).

Of the Cubagua decapods, 34 species are amphiamerican (19.1%), 114 are also recorded to the Brazilian province (64.1%) and 103 inhabit the Texan and Carolinian provinces (57.3%), 81 (45.5%), with continuous distribution between the Brazilian and Carolinian provinces, and 35 species (19.7%) are endemic to the Caribbean province.

Discussion

The decapod fauna of Cubagua Island is similar to that of others islands in or near the upwelling region off the coast of Venezuela. Of the decapods reported from Los Frailes Archipielago (Tagliafico *et al.* 2005), 80.9% were recorded in Cubagua. The decapod crustacean fauna in the upwelling region of Venezuela shows at least 20% of endemic species of the Caribbean (Hernández *et al.* 2000; Lira 2004; Muñoz & Blanco-Rambla 2000; Tagliafico *et al.* 2005).

TABLE 1. Decapod crustaceans collected in Cubagua Island, Venezuela. Abbreviations for biogeographical provinces are Cal= Californian, Co= Cortes, P= Panamanian, G= Galápagos Islands, PC= Perú-Chilean, Ar= Argentinian, Br= Brazilian, C= Caribbean, T= Texan, Ca= Carolinian, V= Virginian, Bo= Boreal. Dashes indicate continuous distribution between stations or provinces. *new records for the island.

		Habitat						
Species	Stations (specimens collected)	Rocks	Coral	*Thalassia* beds	*Halimeda* agregates	*Arca zebra* banks	Sand	Intertidal Infaunal	Distribution in American Provinces
PENAEIDAE Rafinesque, 1815									
Farfantepenaeus brasiliensis (Latreille, 1817)	3, 9, 23, 25-26, 31. (66).			•		•			Ar-C, Ca
SICYONIDAE Ortmann, 1898									
Sicyonia laevigata Stimpson, 1871	43, 46. (2).					•			P, Ar- Ca
STENOPODIDAE Claus, 1872									
Stenopus hispidus (Olivier, 1811)	18 (1).	•							P, Br-C, Ca
PASIPHAEIDAE Dana, 1852									
Leptochela serratorbita Bate, 1888*	46 (1).					•			Co, P, Ar-Ca
GNATHOPHYLLIDAE Dana, 1852									
Gnathophyllum americanum Guérin-Méneville, 1855*	7 (1).	•							C
PALAEMONIDAE Rafinesque, 1815									
Palaemon northropi (Rankin, 1898)	25 (1).	•							Ar-C
Periclimenes americanus (Kingsley, 1878)	16, 19, 22, 25, 38, 42, 45-47. (47).	•							Ar-Ca
P. iridiscens Lebour, 1949	22 (55).	•							C-Ca
P. rathbunae Schmitt, 1924	4 (1).	•							C
P. yucatanicus (Ives, 1891)	4, 16, 32, 38. (6).	•							C
Pontonia mexicana Guérin-Méneville, 1855	27 (2).			•					C
PROCESSIDAE Ortmann, 1890									
Ambidexter sp.*	26, 30, 32, 40. (5).			•					C
Processa bermudensis (Rankin, 1900)*	12, 19, 20, 39, 41. (9).			•					Br-Ca
P. fimbriata Manning & Chace, 1971*	39 (1).			•					Br-Ca
P. hemphilli Manning & Chace, 1971*	12 (1).			•					Ar-C, Ca

ALPHEIDAE Rafinesque, 1815							
Alpheus amblyonyx Chace, 1972*	14, 17. (4).	•					Br-T
A. armatus Rathbun, 1901	14, 46. (2).	•					C
A. armillatus H. Milne Edwards, 1837	4, 12, 25-28, 32-34, 37. (17).	•	•	•	•		Co-P, Ar-C
A. bouvieri A. Milne Edwards, 1878*	39, 44. (7).	•					P-G, Ar-C
A. cristulifrons Rathbun, 1900*	19. (1).	•					P, Br-T
A. normanni Kingsley, 1878*	46. (1).					•	Co-G, Ar-V
A. nuttingi (Schmitt, 1924)*	35, 37, 41, 46. (8)	•				•	Ar-C
A. schmitti Chace, 1972*	25. (6).	•					Co, C
A. viridari (Armstrong, 1949)	6. (2).	•					C
Alpheus sp.*	19, 45. (2).	•					C
Automate evermani Rathbun, 1901*	24. (1).	•					Br-Ca
Synalpheus apioceros Coutière, 1909	5, 6, 15-20, 35, 38. (27).	•	•	•			Br-C
S. fritzmuelleri Coutière, 1909	14, 30, 35, 38. (19).	•					P, Ar-Ca
S. hemphilli Coutière, 1909*	35. (1).	•					C
S. longicarpus (Herrick, 1891)*	37. (1).	•					Br-Ca
S. maclendoni Coutière, 1910*	5, 14, 17, 35. (10).	•	•				C
S. minus (Say, 1818)*	5, 7, 12, 14-20, 25-26, 31-32, 34-35, 38-39, 42, 45. (176).	•	•	•	•		Ar-C, Ca
S. pandionis Coutière, 1909*	38. (2).	•					C-T
S. townsendi Coutière, 1909	4, 14-18, 27-29, 31-32, 34-35, 38-39. (37).	•	•	•	•		Br-C, Ca
Synalpheus sp.*	38, 29. (48).		•	•			C
HIPPOLYTIDAE Dana,1852							
Hippolyte curacaoensis Schmitt, 1924	17, 26, 30, 35, 37, 45. (18).	•	•	•	•		C, Ca
H. zostericola (Smith, 1873)	22, 45. (8).		•				P, Br-V
Latreutes parvulus (Stimpson, 1866)	1, 4, 45. (4).		•	•			Ar-V
Lysmata intermedia (Kingsley, 1878)	17. (3).		•				P-PC, Br-C
L. ankeri Rhyne & Lin, 2006	8, 32, 37. (6).	•	•				C
Thor manningi Chace, 1972	15-19, 22. (109).	•	•				P, C-T
CALLIANASSIDAE Dana, 1852							
Neocallichirus cacahuate Felder & Manning, 1995*	13. (12).					•	C
UPOGEBIIDAE Borradaile, 1903							
Upogebia sp.*	11, 14, 16-17, 19, 24, 27, 39, 40. (34).	•				•	C
DIOGENIDAE Ortmann, 1892							
Calcinus tibicen (Herbst, 1791)*	8, 15-18, 25, 30, 38, 41, 47. (21).	•	•			•	Ar-T
Clibanarius antillensis Stimpson, 1858*	4, 31, 39, 42, 46. (113).	•				•	Ar-C
C. tricolor (Gibbes, 1850)	16, 17, 38, 42, 43. (121).	•	•			•	Br-C

Paguristes angustitheca McLaughlin & Provenzano, 1974	4 (1).	•					Br-C
P. hummi Wass, 1955	16 (2).		•				C-Ca
P. perplexus McLaughlin & Provenzano, 1974*	4, 14, 17, 42, 44, 45, 46. (13).		•				Br-C
Petrochirus diogenes (Linnaeus, 1758)	14. (1).	•					Ar-Ca
PAGURIDAE Latreille, 1893							
Pagurus brevidactylus (Stimpson, 1858)	4, 6, 8, 16-19, 25-26, 30, 35, 38. (41)	•	•				Ar-Ca
P. criniticornis (Dana, 1852)	4, 41, 43, 44, 46. (9).	•			•		Ar-T
P. maclaughlinae García-Gómez, 1982*	32, 37. (2).	•					C-Ca
P. stimpsoni (A. Milne Edwards & Bouvier, 1893)*	4, 8, 38-40, 42, 45, 47. (33).	•					Br-Ca
PORCELLANIDAE Haworth, 1825							
Megalobrachium mortenseni Haig, 1962*	16. (1).		•				P, Ar-C
M. poeyi (Guérin, 1855)	4, 14, 16, 17, 24. (10).	•	•				Br-C
M. roseum (Rathbun, 1901)	4. (2).	•					P, Ar-C
Minyocerus angustus (Dana, 1852)	9. (3).				•		Ar-C
Neopisosoma angustifrons (Benedict, 1901)	18. (1).	•					C-T
Pachycheles monilifer (Dana, 1852)	4-8, 14, 25, 32, 34-35, 38-39. (122).	•	•	•			P, Br-C
P. serratus (Benedict, 1901)	4, 7, 35, 38. (10).	•		•	•		C
Petrolisthes amoenus (Guérin, 1855)*	25 (1).	•					Br-C
P. armatus (Gibbes, 1850)	4, 11, 19, 25, 26, 28-47. (324).	•		•	•		Co-PC, Ar-Ca
P. bolivariensis Werding & Kraus, 2003*	15. (7).		•				C
P. galathinus (Bosc, 1801)	4-7, 14-20, 22, 24-25, 28, 35, 38-40, 42, 44. (400).	•	•	•	•		P, Ar-Ca
P. jugosus Streets, 1872	4, 38. (2).	•					C
P. magdalenensis Werding, 1978	15 (1).		•				C
P. marginatus Stimpson, 1858*	15, 16. (2).		•			•	Br-C
P. politus (Gray, 1831)	25. (2).					•	Br-C
P. tonsorius Haig, 1960	6, 14, 18, 40. (137).					•	C.
Porcellana sayana (Leach, 1820)	14. (1)	•					Ar-Ca
ALBUNEIDAE Stimpson, 1858							
Albunea paretii Guérin-Meneville, 1853*	15 (3).				•	•	C
HIPPIDAE Latreille, 1825							
Emerita brasiliensis Schmitt, 1935	1, 3, 5. (24).				•	•	Ar-C
EPIALTIDAE MacLeay, 1838							
Epialtus bituberculatus H. Milne Edwards, 1834	2, 4. (2).	•		•			PC, Ar-C
E. brasiliensis Dana, 1852	5. (2).			•			Ar-C
INACHIDAE MacLeay, 1838							
Stenorhynchus seticornis (Herbst, 1788)	16. (1).	•					Ar-Ca

MITHRACIDAE Balss, 1929							
Hemus cristulipes A. Milne Edwards, 1875	16 (1).	•					Br, C, T, Ca
Macrocoeloma trispinosum (Latreille, 1825)	17, 35. (2).	•					Ar-Ca
Microphrys bicornutus (Latreille, 1825)	4-8, 11, 16, 17, 25-28, 30, 32-33, 35-41, 44-47. (92).	•	•	•	•	•	Ar-Ca
Mithraculus coryphe (Herbst, 1801)	8, 11-12, 25-27, 32, 34, 36, 38-39. (24).	•	•	•	•		Ar-C
M. forceps (A. Milne Edwards, 1875)	4-8, 11, 12, 14-22, 24-47. (1066).	•	•	•	•	•	Ar-Ca
M. ruber (Stimpson, 1871)*	11 (1).	•					C
Mithrax caribbaeus Rathbun, 1920	17, 38, 39, 45. (5).	•					C
M. verrucosus H. Milne Edwards, 1832	25, 38. (2).	•	•				Br-C, Ca
Teleophrys sp.*	8 (1).	•					
PISIDAE Dana, 1851							
Pelia mutica (Gibbes, 1850)*	16 (1).	•					C-V
TYCHIDAE Dana, 1851							
Pitho laevigata (A. Milne Edwards, 1875)	1, 4, 6, 25, 29, 32, 34. (12).			•			C, T
P. lherminieri (Schramm, 1867)	8, 11-12, 14-17, 19, 24, 26, 31, 40-42, 45-47. (47).	•		•			Ar-V
Tyche emarginata White, 1847*	39. (1).	•					Br-Ca
PORTUNIDAE Rafinesque, 1815							
Arenaeus cribarius (Lamarck, 1818)*	1, 3, 13. (14).					•	Ar-V
Callinectes ornatus Ordway, 1863	1-3, 5-7, 9-10, 12-14, 18, 21-22, 24-27, 30-33, 39-42, 46. (601).			•		•	Ar-V
Cronius tumidulus (Stimpson, 1871)*	10. (1).					•	Ar-T
Portunus spinimanus Latreille, 1819	21. (4).					•	Ar-V
MENIPPIDAE Ortmann, 1893							
Eriphia gonagra (Fabricius, 1781)	4, 47. (2).					•	Ar-Ca
Menippe nodifrons Stimpson, 1859	6, 7. (5).	•					Ar-C
OZIIDAE Dana, 1851							
Ozius reticulatus (Desbonne & Schramm, 1867)	6. (3).	•					C
PANOPEIDAE Ortmann, 1893							
Eurypanopeus abbreviatus (Stimpson, 1860)	16, 18-20, 24. (8).	•	•				Ar-Ca
E. dissimilis (Benedict & Rathbun, 1891)*	25. (1).	•					P-T
E. turgidus (Rathbun, 1930)*	35, 38. (7).	•					C-T
Eurytium limosum (Say, 1818)*	4. (2).	•					Ar-V
Dyspanopeus sayi (Smith, 1869)*	25, 38. (2).	•			•		C, Ca-Bo
Panopeus americanus Saussure, 1857*	34. (1).	•					Ar-T
P. herbstii H. Milne Edwards, 1834	4, 8, 17, 33, 35, 39, 40, 45, 46. (23).	•			•		C-V
P. occidentalis Saussure, 1857	14, 17, 19, 21, 26, 30-31, 33-34, 42, 47. (31).	•			•	•	Ar-C, Ca
P. rugosus A. Milne Edwards, 1880*	40. (1).	•					P, Ar-T
Rhitropanopeus harrisii (Gould, 1841)*	36. (1).	•					Br-Bo

PILUMNIDAE Samouelle, 1819								
Pilumnus caribaeus Desbonne & Schramm, 1867*	38, 39, 41, 42. (15).	•						Ar-C
P. dasypodus Kingsley, 1879	4-8, 11, 14, 16-20, 22, 24-26, 30, 32, 35-39, 42, 44-45. (168).	•	•	•	•	•		Ar-Ca
P. gemmatus Stimpson, 1860	11, 17, 20, 29, 35, 37. (10).	•			•			C
P. lacteus Stimpson, 1871*	28, 39, 45. (4).	•			•			C-Ca
P. reticulatus Stimpson, 1860*	17, 18, 46. (4).	•			•			P, Ar-C
P. sayi (Say, 1818)*	14, 17, 18, 24. (8).	•						C-Ca
XANTHIDAE MacLeay, 1838								
Cataleptodius floridanus (Gibbes, 1850)	8, 11, 14, 16-18, 20, 24-34, 37, 39, 40, 42-44, 47. (83).	•	•	•	•			Ar-T
C. parvulus (Fabricius, 1793)*	35. (1).	•						C
Chlorodiella longimana (H. Milne Edwards, 1834)	5, 7, 16, 17, 19. (7).	•						C
Heteractea ceratopus (Stimpson, 1860)	5-6, 8, 11, 14-17, 22, 25, 30-31. (39).	•	•	•				C
Platypodiella spectabilis (Herbst, 1794)	16, 41. (2).	•	•					Br-T
Xanthodius denticulatus (White, 1847)	25. (2).	•					•	Br-T
EURYPLACIDAE Stimpson, 1871								
Euryplax nitida Stimpson, 1859*	1. (1).							Ar-Ca
PINNOTHERIDAE De Haan, 1833						•		
Austinixa sp.*	13. (10).						•	C
Calyptraeotheres hernandezi Hernández-Ávila & Campos, 2006*	4, 16, 36, 41, 46, 47. (9).				•			C
Clypeasterophilus stebbingi (Rathbun, 1918)	18. (6).			•				Br-T
Parapinnixa sp.*	26-28, 34, 36, 39, 42. (9).	•		•	•			C
Pinnixa floridana Rathbun, 1918*	36, 42. (2).			•				Br-Ca
P. sayana Stimpson, 1860*	4, 14. (2).						•	Ar-V
OCYPODIDAE Ortmann, 1894								
Ocypode quadrata (Fabricius, 1787)	10. (1).						•	Ar-V
GRAPSIDAE Dana, 1851								
Grapsus grapsus (Linnaeus, 1758)	1, 2, 4, 11, 14, 19, 24, 40. (17).						•	Cal-PC, Br-T
Pachygrapsus transversus (Gibbes, 1850)	31, 47. (2).						•	Cal-PC, Br-T

TABLE 2. Number of species of decapod crustaceans recorded in Caribbean and in some south Caribbean localities and percentage of species included in adjacents provinces

Locality	Total species recorded	Species included in Brazilian province (%)	Species included in Texan and Carolinian provinces (%)	Species endemic to Caribbean province (%)
Caribbean Province[1]	1058	481 (45.5)	504 (47.6)	327 (30.90)
Caribbean Province [Brachyura][1]	450	246 (54.7)	268 (59.6)	87 (19.3)
Puerto Rico and Virgin Islands [Brachyura][2]	199	128 (64.3)	116 (58.3)	40 (20.1)
Cartagena (Colombia) [Brachyura][3]	93	69 (74.2)	55 (59.1)	17 (18.3)
Isla de Aves (Venezuela) [Brachyura][4]	27	18 (66.7)	14 (51.9)	6 (22.2)
Los Roques Archipielago (Venezuela)[5]	87	36 (41.4)	34 (39.1)	28 (32.2)
La Blanquilla Island (Venezuela)[6, 7]	82	52 (63.4)	41 (50)	24 (29.3)
La Tortuga Island (Venezuela)[8]	111	64 (57.7)	55 (47.7)	32 (28.8)
Los Frailes (Venezuela)*[9]	68	47 (69.1)	38 (55.9)	16 (23.5)
Las Marites Coastal Lagoon (Venezuela)*[10]	61	50 (82)	46 (75.4)	3 (4.9)
El Obispo Coastal Lagoon (Venezuela)*[11]	29	23 (79.3)	17 (59.6)	1 (3.4)
Cubagua Island (Venezuela)*[12]	178	115 (64.6)	103 (46.1)	34 (19.1)
Cubagua Island (Venezuela) *[12] [Brachyura]	88	62 (70.5)	62 (70.5)	12 (13.6)

[1]Boschi (2000), [2]Rathbun (1933), [3]Lemaitre (1981), [4]García *et al.* (1998), [5]Rodríguez (1986), [6]Scelzo and Varela (1988), [7]Rodríguez *et al.* (2004), [8]Lira (2004), [9]Tagliafico *et al.* (2005), [10]Hernández *et al.* (2000), [11]Muñoz and Blanco-Rambla (1999), [12]present study.
*Venezuelan upwelling region.

The composition of the Cubagua decapod fauna shows some differences with that of the Caribbean province. According to Boschi (2000) Caribbean decapods show a similar ratio of species in common with the Brazilian (45.6%) and Texan-Carolinian (47.6%) provinces, but nevertheless the Caribbean has the highest number of endemic species on the American Atlantic coast (31.9%). Some Caribbean localities show similar ratios of species in common with the Brazilian and Texan-Carolinian provinces while around 30% of the species are endemics of the Caribbean as happen in La Tortuga Island, Venezuela (Lira 2004), La Blanquilla Island, Venezuela (Scelzo & Varela 1988; Rodríguez *et al.* 2004) and with the shrimp fauna of Los Roques Archipielago, Venezuela (Rodríguez 1986). The brachyuran crabs recorded for Puerto Rico and the Virgin Islands (Rathbun 1933), Cartagena, Colombia (Lemaitre 1984) and for Isla de Aves, Venezuela (García *et al.* 1998) show less endemism (18.3–22.2%) but this is similar to the ratio of endemic brachyurans in the Caribbean (Table 2). Cubagua, however, shows a lower endemism and a higher number of species of wide and continuous distribution.

Studies on the mollusk fauna (Díaz 1995; Salazar-Vallejo 2000) support the subdivision of the Caribbean province in subprovinces. Studies on the decapods fauna by Briggs (1974), which proposed the division of the Caribbean into different regions, however, is not justified (Carmona-Suárez & Conde 1996; Boschi 2000; Rodríguez *et al.* 2005), althougth Werding *et al.* (2003) suggested differences between the Southern Caribbean and West Indian provinces based on the Porcellanidae. Rodríguez *et al.* (2005), based on the revision of same group, concluded that the West Indian province of Briggs is a indistinguishable component of the Caribbean province. The distributional range of shallow water decapods has been associated with marine currents (Lemaitre 1981; Lemaitre & Álvarez-León 1992), ecological barriers (Boschi 2000), depletion of habitat, or their tolerance to physical parameters (e.g. temperature, salinity, etc). Upwelling along the northeastern Venezuelan coast is associated with high primary productivity and a poor development of coral reefs (Weill 2003),

a higher content of organic matter in sediments (Miró 1974), which are factors associated with a decrease in species richness (Margalef 1974). These factors may offer better conditions to widely distributed species showing wide tolerances.

The particular biogeographical affinities of the decapod crustaceans of the islands in the Venezuelan upwelling region, and the differences with the general distribution of Caribbean decapod crustaceans support considering this region as a separate ecoregion, as previously suggested by Cervigón (2005) and Miloslavich *et al.* (2003, 2005).

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Appendix. Checklist of species of decapod crustaceans previously recorded from Cubagua Island that were not collected during the present study

PENAEIDAE Rafinesque-Schmaltz, 1815
Litopenaeus schmitti (Burkenroad, 1936) [Ar, Br, C] (Marcano 1997)
Metapenaeopsis smithi (Schmitt, 1924) [C] (Marcano 1997)
Xiphopenaeus kroyeri (Heller, 1862) [Ar, Br, C] (Marcano 1997)
STENOPODIDAE Claus, 1872
Stenopus scutellatus Rankin, 1898 [Br, C, Ca] (Marcano 1997)
PALAEMONIDAE Rafinesque, 1815
Leander tenuicornis (Say, 1818) [Ar, Br, C, T, Ca, V, B] (Marcano 1997)
Periclimenaeus bermudensis (Armstrong, 1940) [Br, C] (Marcano 1997)
Periclimenes pauper Holthuis, 1951 [C] (Holthuis 1951)
ALPHEIDAE Rafinesque, 1815
Alpheus bahamensis (Rankin, 1898) [C] (Marcano 1997)
Alpheus ridleyi Pocok, 1890 [Br, C] (Marcano 1997)
Alpheus viridari (Armstrong, 1949) [C] (Marcano 1997)
PALINURIDAE Latreille, 1803
Panulirus argus (Latreille, 1804) [C, T, Ca] (Marcano 1997)
Panulirus guttatus (Latreille, 1804) [Br, C] (Marcano 1997)
Panulirus laevicauda (Latreille, 1817) [Br, C] (Marcano 1997)
DIOGENIDAE Ortmann, 1892
Dardanus fucosus Biffar and Provenzano, 1972 [Br, C, Ca] (Piñango 1988)
PAGURIDAE Latreille, 1893
Iridopagurus caribbensis (M.Edwards & Bouvier, 1893) [C, T, Ca] (Piñango 1988)
PORCELLANIDAE Haworth, 1825
Clastotoechus nodosus (Streets, 1872) [C] (Haig 1956, Scelzo 1982)
Clastotoechus vanderhorsti (Schmitt, 1924) [C] (Haig 1956, Scelzo 1982)
Neopisosoma curacaoense (Schmitt, 1924) [C] (Haig 1956; Scelzo 1982)
Pachycheles susanae Gore and Abele, 1973 [C] (Scelzo 1982)
Petrolisthes quadratus Benedict, 1901 [C] (Haig 1956; Scelzo 1982)
Petrolisthes tridentatus Stimpson, 1858 [P, C] (Haig 1956)
HIPPIDAE Latreille, 1817
Hippa testudinaria (J. F. W. Herbst, 1791) [C] (Marcano 1997)
DROMIIDAE De Haan, 1833
Dromia erythropus (G. Edwards, 1771) [Ar, Br, C, T] (Marcano 1997)
Moreiradromia antillensis (Stimpson, 1858) [Ar, Br, C, T, Ca] (Marcano 1997)
CALAPPIDAE De Haan, 1833
Calappa cinerea Holthuis, 1958 [C] (Marcano 1997)
HEPATIDAE Stimpson, 1871
Hepatus pudibundus (Herbst, 1785) [Ar, Br, C, T, Ca] (Marcano 1997)
EPIALTIDAE MacLeay, 1838
Acanthonyx petiverii H. Milne Edwards, 1834 [P, G, P-C, Ar, Br, C, T] (Marcano 1997)
INACHIDAE MacLeay, 1838
Podochela macrodera Stimpson, 1860 [Br, C, T] (Marcano 1997, Marcano & Bolaños 2001)
INACHOIDIDAE Dana, 1851
Pyromaia cuspidata Stimpson, 1871 [C, T, Ca] (Marcano 1997)
Pyromaia tuberculata (Lokington, 1876) [O, Cal, Co, P, G, P-C, Ar, C] (Marcano & Bolaños 2001)
MITHRACIDAE Balss, 1929
Stenocionops furcata coelata (Olivier, 1791) [Ar, Br, C, T, Ca] (Marcano 1997; Marcano & Bolaños 2001)
PISIDAE Dana, 1851
Chorinus heros (Herbst, 1790) [Br, C] (Marcano & Bolaños 2001)
PARTHENOPIDAE MacLeay, 1838
Leiolambrus nitidus Rathbun, 1901 [Br, C, T] (Marcano 1997)
Leiolambrus punctassimus (Owen, 1839) [Co, P, C] (Marcano 1997)
Parthenope (*Parthenope*) *agona* (Stimpson, 1871) [Ar, Br, C, T, Ca] (Marcano 1997)
PORTUNIDAE Rafinesque, 1815

Callinectes marginatus (A. Milne Edwards, 1861) [Ar, Br, C, T, Ca, V] (Marcano 1997)
Portunus floridanus Rathbun, 1930 [Br, C, Ca] (Marcano 1997)
Portunus ordwayi (Stimpson, 1860) [Ar, Br, C, T, Ca, V] (Marcano 1997)
Portunus spinicarpus (Stimpson, 1871) [Ar, Br, C, T, Ca, V] (Marcano 1997)

XANTHIDAE MacLeay, 1838

Domecia hispida Eydoux and Souleyet, 1842 [P, G, C] (Marcano 1997)
Etisus maculatus (Stimpson, 1860) [C] (Marcano 1997)

PINNOTHERIDAE De Haan, 1833

Tumidotheres maculatus (Say, 1818) [Ar, Br, C, T, Ca, V] (Marcano 1997)

OCYPODIDAE Ortmann, 1894

Uca rapax (Smith, 1870) [Ar, Br, C, T] (Marcano 1997)

GECARCINIDAE MacLeay, 1838

Cardisoma guanhumi Latreille, 1825 [P, G, P-C, Ar, Br, C, T] (Marcano 1997)

GRAPSIDAE Dana, 1851

Geograpsus lividus (H. Milne Edwards, 1837) [P, G, P-C, Ar, Br, C, T] (Marcano 1997)
Goniopsis cruentata (Latreille, 1803) [P, Ar, Br, C, T] (Marcano 1997)

PLAGUSIIDAE Dana, 1851

Percnon gibbesi (H. Milne Edwards, 1853) [P, G, P-C, Ar, Br, C, Ca] (Marcano 1997)
Plagusia depressa (Fabricius, 1775) [Br, C, T, Ca] (Marcano 1997)

SESARMIDAE Dana, 1851

Armases ricordi (H. Milne Edwards, 1853) [Br, C, T] (Marcano 1997)

VARUNIDAE H. Milne Edwards, 1853

Cyclograpsus integer H. Milne Edwards, 1837 [Ar, Br, C, T] (Marcano 1997)