A SURVEY OF THE MEDUSAN (CNIDARIA) COMMUNITY OF BANCO CHINCHORRO, WESTERN CARIBBEAN SEA

Rebeca Gasca, Lourdes Segura-Puertas and Eduardo Suárez-Morales

ABSTRACT

The species composition, distribution, and abundance of the planktonic medusae collected during a plankton survey in Banco Chinchorro, an oceanic reef atoll of the western Caribbean were studied. Samples included the forereef (oceanic) zone and the reef lagoon. Highest mean medusan abundance was observed over the forereef zone and in nighttime samples, lowest abundances occurred in the reef lagoon. A total of 16 species was identified, *Aglaura hemistoma*, *Liriope tetraphylla*, and *Solmundella bitentaculata* being the most abundant. Together, they comprised up to 80% of the total numerical abundance of medusae in the sampled area. They belong to a group of medusae dominant in the oceanic and reef-related areas of the western Caribbean Sea and in the southern Gulf of Mexico. Cluster analysis revealed forereef and reef lagoon assemblages, the latter with lowest density, diversity, and species richness. The reef lagoon showed a weak oceanic influence along and across the Banco Chinchorro reef-atoll system. Dominance of oceanic forms within the reef lagoon was attributed to the effect of the across-reef tidal currents. The community structure of the reef-related medusan fauna appeared to be quite uniform despite the expected migratory behavior of these zooplankters, tidal exchange across the reef, input of oceanic species, and time of day. New surveys including the polyp hydroid together with the medusae are needed in Banco Chinchorro.

The medusan fauna of neritic and oceanic waters of the western part of the Caribbean Sea has been investigated in several surveys (Phillips, 1972, Segura-Puertas, 1991, 1992; Segura-Puertas and Ordóñez-López, 1994; Suárez-Morales et al., 1999a,b). Conversely, knowledge of the medusae of reef areas of the western Caribbean Sea is still limited (Suárez-Morales et al., 1996). Reef areas of the Caribbean commonly harbor a wide variety of species (Larson, 1982). There are only two surveys known from the barrier reef off the eastern coast of the Yucatán Peninsula (Larson, 1982; Suárez-Morales et al., 1999a), which is the world's second largest barrier reef system. A system adjacent to this barrier reef is Banco Chinchorro, an oceanic reef system whose medusan fauna has not been previously surveyed. It is an oceanic atoll lying between 18°25′and 18°45′N and 87°30′ and 87°15′W on the southern part of the Mexican coast of the Caribbean Sea (Fig. 1). Surface-water temperature is highest in July–August (32°C), and lowest in December–January (21°C). Mean annual salinity varies within the 34–36 psu range. Oceanographic conditions over this zone are influenced by the Yucatán Current, which flows northwards. This flow, coupled with tidal currents and turbulence, seems to be the most relevant hydrological phenomenon affecting the reef zooplankton in the area (Suárez-Morales and Rivera-Arriaga, 1998).

Materials and Methods

A zooplankton sampling program was carried out during September 1999 (stations 1–13) and March 2000 (stations 14–19). Stations were located and grouped together to investigate two of the main reef-related zones: the forereef (FR) (stations 1, 3, 4, 6, 7, 13, 18) and the reef lagoon (RL) (stations 2, 5, 8, 11, 15, 16, 17, 19; see Fig. 1). Most sampling was performed during the nighttime;

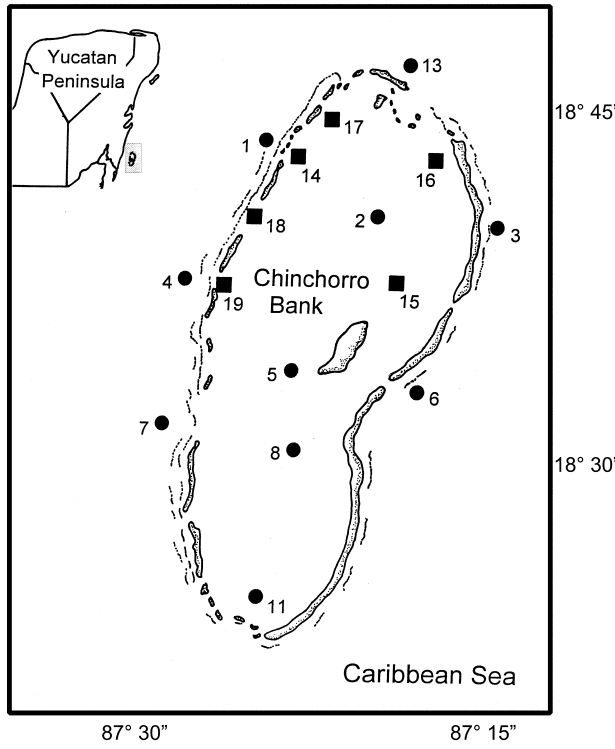

Figure 1. Surveyed area with zooplankton sampling stations, Banco Chinchorro reef zone, western Caribbean Sea.

some RF samples and one FR sample were collected during the day (see Table 1). Zooplankton was collected by surface hauls (0–5 m) using a square-mouthed (0.45 m per side) standard plankton net (0.3 mm mesh-size). This gear allowed collection of small and medium-sized medusae. A digital flowmeter was attached to the net mouth to estimate the volume of water filtered. The mean amount of water filtered during each trawl was 160 m^3. Zooplankton samples were fixed and preserved in buffered 4% formaldehyde solution (Smith and Richardson, 1979). Medusae were sorted from the entire sample and then identified and counted to obtain the species density (org/1000 m^3). Shannon-Wiener's Diversity Index was estimated (bits ind^{-1}), along with the Index of Importance Value (IVI) as a dominance measurement, and with the Bray-Curtis Similarity Index (Ludwig and Reynolds, 1988) to allow station clustering. These calculations were performed with the aid of the ANACOM software computer program (De la Cruz, 1994).

Results

Total medusan densities showed variations throughout the survey period in each of the two environments considered. The RL density averaged 122 org/1000 m^3, while the average was 920 org/1000 m^3 in the FR area. Highest mean medusan density occurred at stations 7 (1815 org/1000 m^3), 4 (1753 org/1000 m^3), and 1 (1558 org/1000 m^3), all of which were in the FR zone. Up to 68% of the total numerical abundance of the medusae collected in Banco Chinchorro occurred in these three stations.

Up to 85% of the total medusae numbers occurred in the FR zone, and only the remaining 15% in the RL. Overall, total density was 3.8 times higher in nighttime samples (612

Table 1. Density (org/1000 m^3) of the medusae collected in Banco Chinchorro in two reef environments.

	Reef Lagoon											Fore-Reef									
	2	5	8	11	14	15	16	17	19			1	3	4	6	7	13	18			
Species	D		D	D	D					**Total**	Avg.				D				**Total**	Avg.	Abund.
Aglaura hemistoma			15					34	15	64	7	1,089	91	696	272	635	257		3,039	434	3,104
Liriope tetraphylla	121	76	15					17	45	274	30	257		333	30	242	423		1,285	184	1,559
Solmundella bitentaculata												30		499		817			1,376	197	1,376
Nausithoë punctata		30								30	3	166		181		91	30		469	67	499
Vannuccia forbesii																	45		45	6	45
Amphinema rugosum														15	30				45	6	45
Porpita porpita															15				15	2	15
Clytia discoida																	30		30	4	30
Zanclea costata					262	14		289	15	580	64					15	30		45	6	625
Podocoryne minima				15						15	2	15		15					30	4	45
Pegantha triloba																15			15	2	15
Halitiara formosa														15					15	2	15
Cubaia aphrodite	30	15					15			30	3								0	0	30
Carybdea marsupialis										30	3								0	0	30
Linuche unguiculata									30	30	3								0	0	30
Rhopalonema velatum									45	45	5							29	29	4	74
Total	151	121	30	15	262	14	15	340	150	1,099	122	1,558	91	1,754	348	1,815	847	29	6,441	920	7,539

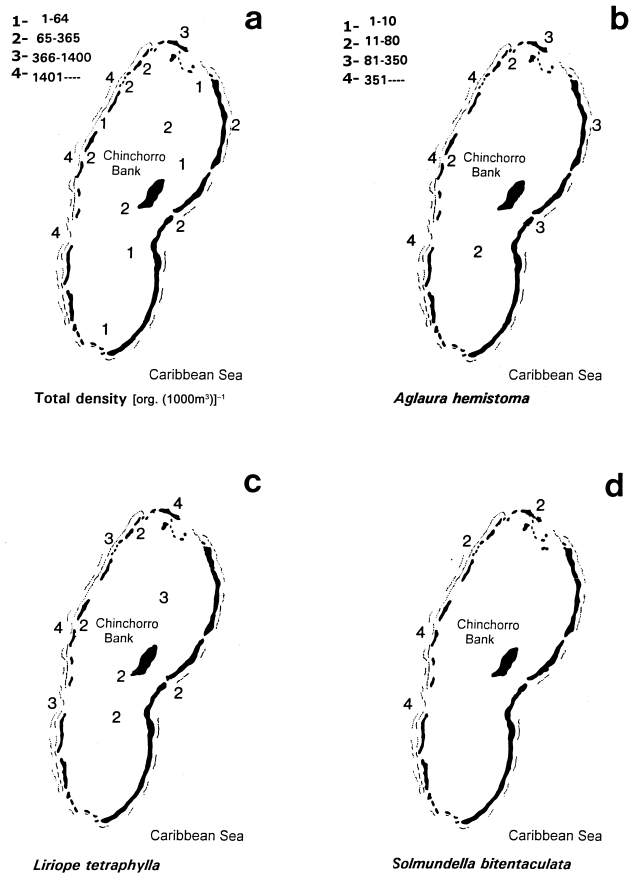

Figure 2. Distribution of A) total density of medusae, B) *Aglaura hemistoma*, C) *Liriope tetraphylla*, D) *Solmundella bitentaculata* in Banco Chinchorro. Numbers (1–4) indicate the densisty range.

org/1000 m^3) than in daylight samples (161 org/1000 m^3). Within the RL up to 41.7% of the individuals were collected during nighttime sampling, whereas 94% of the forereef samples were captured at night. On the FR density at the only daytime sample (348 org/1000 m^3) differed from the average nighttime figure (1015 org/1000 m^3).

A total of 16 medusan species were identified (see Table 1). The most abundant, *Aglaura hemistoma*, accounted for 41% of the medusae, with a mean density of 434 org/1000 m^3. It was followed by *Liriope tetraphylla* (20.6%; 184 org/1000 m^3), *Solmundella bitentaculata* (18.2%; 197 org/1000 m^3), and *Nausithoë punctata* (6.6%; 67 org/1000 m^3). These four species comprised about 86% of the total overall medusan catch. The relative abundance and estimated density of all the medusan species recorded in the area are presented by sampling site and by reef environment in Table 1. The IIV for *A. hemistoma* (59/200), *L. tetraphylla* (40/200), *S. bitentaculata* (26/200), and *Z. costata* (20/200) showed their dominance and high density in the community.

Aglaura hemistoma was most abundant at the FR; up to 98% of the total numerical abundance of the species was recorded in this environment. The same tendency was observed for *L. tetraphylla* (82% in the FR), *S. bitentaculata* (100%), and *N. punctata* (94%).

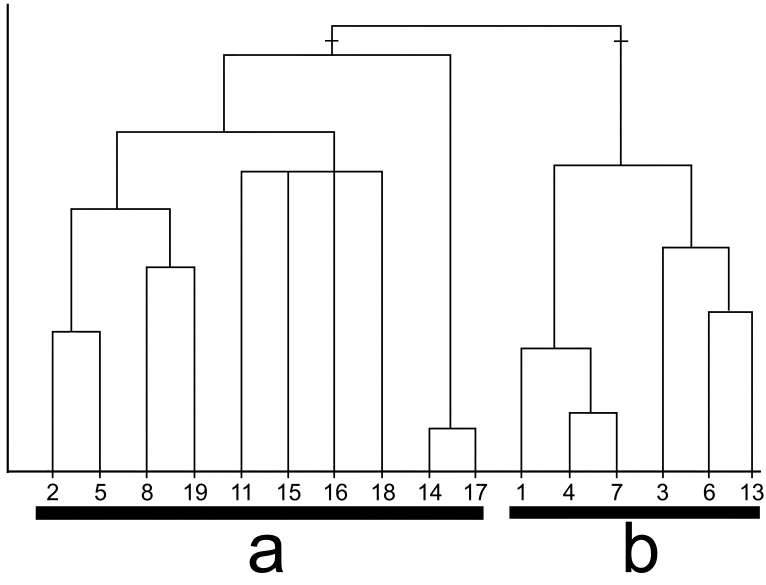

Figure 3. Dendrogram from analysis based on Bray-Curtis Index showing distribution of the clusters in the surveyed area.

Solmundella bitentaculata, *V. forbesii*, *A. rugosum*, *P. porpita*, *C. discoida*, *P. triloba*, and *H. formosa* were collected only in the FR zone (see Table 1).

The species richness was highest at the forereef, where all the medusa species were recorded. The average species richness within the RL (2.1) was lower than the figure found in the FR zone (4.4). Overall diversity (Shannon-Wiener) was highest at the FR (average: 1.2 bits ind^{-1}), the RL (0.66 bits ind^{-1}) showed lower overall diversity values.

Clustering with the Bray-Curtis Index produced a dendrogram (Fig. 3) in which two large groups of stations were defined. The first one ('A' in Fig. 3) included all the reef lagoon stations plus one FR site, and in the other one ('B' in Fig. 3) all the remaining FR (oceanic) stations were clustered.

Discussion

The taxonomic status for several genera and species of medusae is being revised by considering both the medusa and the polyp stages. For instance, the genus *Zanclea* was long considered to be monotypic, but a recent revision of this taxa by Gravili et al. (1996) and later on by Boero et al. (2000) showed that it contains several species which can be distinguished by the structure of the hydroid cnidome. Although we did not collect the hydroid phase, the medusae we obtained show the cnidocysts with two size stenoteles and some apotrichous macrobasic euryteles. There are five species of *Zanclea* with this kind of nematocyst on the medusa; however, the shape of nematocysts in our specimens of *Z. costata* is distinctly elliptic, thus confirming the presence of this species in the surveyed area.

About 60–66% of the species recorded at Banco Chinchorro have been previously reported from the reef area off Belize (Larson, 1982), from an adjacent reef barrier area (Suárez-Morales et al., 1999a), and from the oceanic waters of the western Caribbean Sea

(Suárez-Morales, 1999b); up to 55% are known from neritic and oceanic waters of the Gulf of Mexico (Phillips, 1972; Burke, 1975). Nearly 75% of the species found at Banco Chinchorro are known to occur in the Campeche Bank (Segura-Puertas, 1992; Segura-Puertas and Ordóñez-López, 1994). Up to 62 species have been recorded from neritic and oceanic waters of the Campeche Bank and the northern Mexican Caribbean (Phillips, 1972; Segura-Puertas, 1992; Segura-Puertas and Ordóñez-López, 1994; Suárez-Morales et al., 1999a). More than 20 species were found in a large embayment on the central portion of the Mexican Caribbean coast (Suárez-Morales et al., 1997). The number of species collected in this survey (16) is relatively low when compared with the medusa richness recorded in adjacent zones. This could be due to the relatively low sampling intensity developed in Chinchorro Bank, or could be related also to a low local density of benthic hydroid polyps. It is clearly important to survey the benthic hydroid polyps together with the planktic medusae.

The reef-related medusa fauna recorded off Belize by Larson (1982) and that recorded in Mahahual a reef system off the southern coast of the Mexican Caribbean (Suárez-Morales et al., 1999b) can be compared with the results of Banco Chinchorro; the former two belong to the same barrier-reef system. Larson recorded 71 species, of which 80% were recorded in the forereef and 64% in the reef lagoon. In Mahahual 88% were collected at the forereef, 27% at the channel zone, and only 20% at the reef lagoon (see Suárez-Morales, 1999b). The figures for Banco Chinchorro are 50% in the reef lagoon and 81% in the forereef. It is clear that the forereef is the environment harboring the highest species diversity of medusae in both the barrier reef and the Banco Chinchorro atoll in the western Caribbean Sea. It is relevant to note at this point that other works in tropical areas have yielded a larger number of species (see Bouillon, 1978a–c). This is due to the consideration of the bottom-living polyp forms present in the area and to a more intense sampling effort. A future faunistic work on the Banco Chinchorro medusae should include a higher number of samples and stations, and a survey of the hydroid stages and their laboratory-released medusae. Most probably, these efforts will increase the number of hydromedusae species in the area.

Medusan densities are commonly low in reef environments (Sanmarco and Greenshaw, 1984; Morales and Murillo, 1996), particularly in the reef lagoon. Within the reef lagoon Larson (1982) reported a density close to 41 org/1000 m^3; the corresponding value in the same environment was 167 org/1000 m^3 in Mahahual (Suárez-Morales et al., 1999a). The figure reported for Banco Chinchorro (122 org/1000 m^3) is, as in the former two other cases, lower than that found in the forereef. The overall mean density recorded at Mahahual reef by Suárez-Morales et al. (1999a; 830 org/1000 m^3) and by Larson (1982) in Carrie Bow Cay off Belize (925 org/1000 m^3) are both higher than the overall density average figure for Banco Chinchorro (471 org/1000 m^3).

Larson (1982) and Suárez-Morales et al. (1999a,b) recognized a group of several species as dominant in the reef and oceanic areas of the western Caribbean Sea. This group includes *L. tetraphylla, A. hemistoma, S. bitentaculata, C. aphrodite,* and *N. punctata*. These species were among the most abundant medusae in Banco Chinchorro. Although the number of species is higher in adjacent areas of the western Caribbean, the environmental distribution of the species richness, the overall density and the abundance of the dominant species is similar in the different reef-related areas. All the dominant species have a wide distribution in the tropical waters of the northwestern Atlantic.

In the oceanic waters off the Caribbean (Suárez-Morales et al., 1999a) *A. hemistoma* and *L. tetraphylla* were the most abundant species. The oceanic influence in the entire FR area of Banco Chinchorro, although weak is probably best proofed by the high density and dominance of these species. Segura-Puertas and Ordóñez-López (1994) reported six species (*A. hemistoma*, *L. tetraphylla*, *N. punctata*, *R. velatum*, *Eutima gracilis* and *Z. costata*) as being the most common in the Campeche Bank and the oceanic Mexican Caribbean Sea. Our results and those of Larson (1982) and of Suárez-Morales (1999b) show that *L. tetraphylla* and *A. hemistoma* are also successful in reef environments (Table 2). *Aglaura hemistoma* has been reported as highly abundant in other tropical and subtropical environments (Gili and Pagés, 1987; Gili et al., 1988). *Linuche unguiculata* aggregates seasonally (March–May) along the reef barrier along the eastern coast of the Yucatán Peninsula and in this period its occurrence seems to be a distinctive and dominant feature of the western Caribbean neritic and near-oceanic zooplankton (Larson 1982; Suárez-Morales et al., 1998). This species occurred in March in Banco Chinchorro but in one station only and with low density, showing that conditions around the bank are probably not suitable for the aggregation of this species.

In Banco Chinchorro, most of the non-dominant medusan species occurred in low numbers, which is a common feature of the medusan communities (Gili and Pagés, 1987). The arrival of these mostly oceanic forms effects a local enrichment of species, but does

Table 2. Previous western Caribbean Sea and southern Gulf of Mexico records of the medusae collected in this survey at Banco Chinchorro.

	Banco Chinchorro (this survey)	Southern Gulf (2, 3, 4)	Western Caribb. (1,2, 5, 6, 7.8)	Belize (1)
Amphinema rugosum	×	×	×	×
Zanclea costata	×	×	×	
Solmundella bitentaculata	×	×	×	×
Liriope tetraphylla	×	×	×	×
Aglaura hemistoma	×	×	×	×
Rhopalonema velatum	×	×	×	×
Caribdea marsupialis	×		×	×
Podocoryne minima	×	×	×	
Halitiara formosa	×	×	×	
Cubaia aphrodite	×		×	×
Vannuccia forbesi	×	×	×	×
Nausithoë punctata	×	×	×	×
Porpita porpita	×	×		
Clytia discoida	×		×	×
Pegantha triloba	×	×	×	×
Linuche unguiculata	×	×	×	×

Key for numeric references in Table 1.- Larson (1982), 2.- Phillips (1972), 3.- Segura-Puertas (1992), 4.- Segura-Puertas and Ordóñez-López (1994), 5.- Zamponi and Suárez-Morales (1991), 6.- Suárez-Morales et al. (1995), 7.- Suárez-Morales et al. (1999a), 8.- Suárez-Morales et al. (1999b).

not produce a major increase in the overall number of individuals. This pattern agrees with parallel results of Gili et al. (1988) in the western Mediterranean.

The offshore hydrographic structure along the Caribbean coast of Mexico is related to the flow of the Yucatán current moving northwards (Merino 1986) from the Caribbean Sea. Its influence would explain the high affinity of the Banco Chinchorro medusan fauna with that of the Campeche Bank and the southern Gulf of Mexico (Phillips, 1972; Segura-Puertas and Ordóñez-López, 1994), and the relatively lower affinity with the adjacent Belizean reef, which lies to the south (Larson, 1982).

Communities of planktonic cnidarians are frequently dominated by a few of the commonest species (Gili and Pagés, 1987). Our results in Banco Chinchorro and probably in the reef areas of the Western Caribbean reef show the same pattern. Uniformity in the distribution of planktonic cnidarian species is related to their high adaptability (Gili et al., 1988). This would explain, at least partially, the wide distribution of these medusae in the reef and oceanic areas of the western Caribbean Sea.

Suárez-Morales et al. (1999b) reported a strong influence of the oceanic fauna in the Mahahual reef area, as reflected in the dominance of oceanic forms and the high species richness over the forereef. This effect has been described also in the general reef zooplankton community at Carrie Bow Cay (Ferraris, 1982). In the reef lagoon of Banco Chinchorro the oceanic influence is weak, with low density, diversity and species richness. This is confirmed by the Bray-Curtis clustering of stations. This could be related to the geomorphology of Chinchorro Bank, by which the current moves along its lateral margins and not across the bank.

The main difference between the forereef and the reef lagoon medusa communities is the species richness, all the area(s) being dominated by a few oceanic species. Migration and exchange of water into and out of the reef lagoon (Kjerfve et al., 1982; Kjerfve, 1982) seem to be relatively unimportant in determining the across-reef medusa community structure.

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Literature Cited

Boero, F., J. Bouillon and C. Gravili. 2000. A survey of *Zanclea*, *Halocoryne* and *Zanclella* (Cnidaria, Hydrozoa, Anthomedusae, Zancleidae) with description of new species. Ital. J. Zool. 67: 93–124.

Bouillon, J. 1978a. Hydromeduses de l'archipel des Séchelles et du Mozambique. Rev. Zool. Afr. 92: 117–172.

_____. 1978b. Hydroméduses de la mer de Bismarck (Papouasie, Nouvelle Guinée. Partie I. *Anthomedusae Capitata* (Hydrozoa-Cnidaria). Cah. Biol. Mar. 19: 249–297.

_____. 1978c. Hydroméduses de la mer de Bismarck (Papouasie, Nouvelle Guinée. Partie II. Limnomedusa, Narcomedusa, Trachymedusa et Laingiomedusa (sous-classe nov.). Cah. Biol. Mar. 19: 473–483.

Burke, W. D. 1975. Pelagic Cnidaria of Mississippi Sound and adjacent waters. Gulf Res. Rep. 5: 23–38.

Castellanos, I. and E. Suárez-Morales. 1997. Observaciones sobre el zooplancton de la zona arrecifal de Mahahual, Quintana Roo (Mar Caribe Mexicano). An. Inst. Biol., Univ. Nac. Autón. Méx., Ser. Zool. 68: 237–252.

De la Cruz, G. 1994. ANACOM. Sistema para el análisis de comunidades. versión 3.0. Manual del usuario. CINVESTAV-IPN. Mérida, Mexico. 99 p.

Ferraris, J. D. 1982. Surface zooplankton at Carrie Bow Cay, Belize. *In* K. Rützler and I. G. McIntyre, eds. The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize. 1. Structure and communities. Smithson. Contr. Mar. Sci. 12: 143–151.

Gili, J. M., F. Pagés, A. Sabatés and J. D. Ros. 1988. Small scale distribution of a cnidarian population in the western Mediterranean. J. Plankton Res. 10: 385–401.

_____ and _____. 1987. Distribution and ecology of a population of planktonic cnidarians in the western Mediterranean. Pages 157–169 *in* J. Bouillon, F. Boero, F. Cicogna and P.F. Cornelius, eds. Modern trends in the systematics, ecology, and evolution of hydroids and hydromedusae. Oxford University Press, Oxford.

Gravili, C., F. Boero and J. Bouillon. 1996. *Zanclea* species (Hydroidomedusae, Anthomedusae) from the Mediterranean. Sci. Mar. 60: 99–108.

Greer, J. E. and B. Kjerfve. 1982. Water currents adjacent to Carrie Bow Cay, Belize. *In* K. Rützler and I. G. McIntyre, eds. The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize. 1. Structure and communities. Smithson. Contr. Mar. Sci. 12: 53–58.

Jordán, E. 1993. Atlas de los arrecifes coralinos del Caribe Mexicano. Inst. Cienc. Mar Limnol.UNAM/Centro de Investigaciones de Quintana Roo, Mexico. 110 p.

Kjerfve, B. 1982. Water exchange across the reef crest at Carrie Bow Cay, Belize. *In* K. Rützler and I. G. McIntyre, eds. The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize. 1. Structure and communities. Smithson. Contr. Mar. Sci. 12: 59–63.

_____ Rützler and G. H. Kierspe. 1982. Tides at Carrie Bow Cay, Belize. *In* K. Rützler and I. G. McIntyre, eds. The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize. 1. Structure and communities. Smithson. Contr. Mar. Sci., 12: 47–51.

Larson, J. R. 1982. Medusae (Cnidaria) from Carrie Bow Cat, Belize. *In* K. Rützler and I.G. McIntyre, eds., The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize. 1. Structure and communities. Smithson. Contr. Mar. Sci., 12: 253–258.

Ludwig, J. A. and J. F. Reynolds. 1988. Statistical ecology: A primer on methods and computing. John Wiley, New York. 337 p.

Mayer, A. G. 1910. Medusae of the world. Vols. 1 & 2. Carnegie Foundation, Washington, D.C. 735 p.

Merino, M. 1986. Aspectos de la circulación costera superficial del Caribe Mexicano con base en observaciones utilizando tarjetas de deriva. An. Inst. Cienc. Mar Limnol., Univ. Nac. Autón. Méx. 13: 31–46.

Morales, A. and M. M. Murillo. 1996. Distribution, abundance and composition of coral reef zooplankton, Cahuita National Park, Limon, Costa Rica. Rev. Biol. Trop. 44: 619–630.

Pagés, F. and J. M. Gili. 1992. Influence of Agulhas waters on the population structure of planktonic Cnidarians in the southern Benguela region. Sci. Mar. 56: 109–123.

Phillips, P. J. 1972. The pelagic Cnidaria of the Gulf of Mexico: zoogeography, ecology and systematics. Ph.D. Diss., Texas A&M University, College Station, Texas.

Pugh, P. R. and G. A. Boxshall. 1984. The small-scale distribution of plankton at a shelf station off the northwest African coast. Cont. Shelf Res. 3: 399–423.

Renon, J.-P. 1977. Zooplancton du lagon de l'atoll de Takapota (Polynésise Francaise). An. l'Inst. Océan. 53: 217–236.

Raymont, J. E. G. 1983. Plankton and productivity in the oceans. Vol 2. Zooplankton. Pergamon Press, London. 824 p.

Sanmarco, P. W. and H. Greenshaw. 1984. Plankton community dynamics of the Central Great Barrier Reef Lagoon: Analysis of data from Ikeda et al. Mar. Biol. 82: 167–189.

Segura-Puertas, L. 1991. New records of two species of hydromedusae (Cnidaria) from the Mexican Caribbean. An. Inst. Cienc. Mar Limnol., Univ. Nac. Autón. Méx. 18: 132–135.

_____. 1992. Medusae (Cnidaria) from the Yucatán Shelf and Mexican Caribbean. Bull. Mar. Sci. 51: 353–359.

_____. and U. Ordóñez-López. 1994. Análisis de la comunidad de medusas (Cnidaria) de la región oriental del Banco de Campeche y el Caribe Mexicano. Carib. J. Sci. 30: 104–115.

Smith, P. E. and S. L. Richardson. 1979. Técnicas modelo para prospecciones de huevos y larvas de peces pelágicos. F.A.O. Documento Técnico de Pesca 175: 1–107.

Suárez-Morales, E. y E. Rivera-Arriaga. 1998. Zooplancton e hidrodinámica en zonas litorales y arrecifales de Quintana Roo, México. Hidrobiológica 8: 19–32.

_____ and R. Gasca. 1996. Planktonic copepods of Bahia de la Ascension, Caribbean coast of Mexico, a seasonal survey. Crustaceana 69: 162–174.

_____, L. Segura-Puertas y and R. Gasca. 1995. Medusas (Cnidaria: Hydrozoa) de la Bahía de Chetumal, México (1990–1991). Carib. J. Sci. 31: 243–251.

_____, M. O. Zamponi and R. Gasca. 1997. Hydromedusae (Cnidaria: Hydrozoa) of Bahia de la Ascension, Caribbean coast of Mexico: a seasonal survey. Proc. 6th Inter. Conf. Coel. Bio., 1995, National Natuurhistorisch Museum, Leiden, The Netherlands, 465–472.

_____, L. Segura-Puertas and R. Gasca. 1999a. Medusan (Cnidaria) assemblages off the Caribbean coast of Mexico. J. Coast. Res. 15: 140–147.

_____, L. Segura-Puertas and R. Gasca. 1999b. A survey of the reef-related medusa (Cnidaria) community in the western Caribbean Sea. Gulf. Res. Rep. 11: 23–31.

Zamponi, M. O. and E. Suárez-Morales. 1991. Algunas medusas del Mar Caribe mexicano con la descripción de *Tetraotoporpa siankaanensis* gen. et sp. nov. (Narcomedusae: Aeginidae). Spheniscus 9: 41–46.

Addresses: (R.G., E.S.-M.) *El Colegio de la Frontera Sur-Unidad Chetumal, P.O. Box 424, Chetumal 77000, Quintana Roo, Mexico*; (L.S.-P.) *Instituto de Ciencias del Mar y Limnología, (U.N.A.M.) P.O. Box 1152, Cancún, Quintana Roo 77500, Mexico. E-mail: <rgasca@ecosur-qroo.mx>*.