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Peracarid Crustaceans of Central Laguna Madre Tamaulipas in the Southwestern Gulf of Mexico

Everardo Barba
El Colegio de la Frontera Sur, Mexico

Alberto J. Sánchez
Universidad Juárez Autónoma de Tabasco

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Peracarid Crustaceans of Central Laguna Madre Tamaulipas in the Southwestern Gulf of Mexico

EVERARDO BARBA AND ALBERTO J. SÁNCHEZ

A total of 6,734 of peracarid crustaceans belonging to 3 orders (Amphipoda, Mysidacea, and Isopoda), 17 families, 25 genera, and 30 species were recorded in the central region of Laguna Madre. The Amphipoda constituted 58% of total density (ind/m^2), whereas the Mysidacea and Isopoda represented 29 and 13%, respectively. The amphipods *Cymadusa compta* and *Elasmopus levis*, and the isopod *Harrieta faxoni* were the numerically dominant species. The maximum density values were recorded in submersed aquatic vegetation and sites close to the channels during the "norther" season, when the water temperature decreased.

Submerged aquatic vegetation (SAV), which includes seagrasses and macroalgae, provides critical habitats for a variety of faunal species. The increase in abundance and species richness of fauna associated with seagrass beds have been associated with the physical complexity of the seagrass canopy in terms of benefits as refuge from predators and as food supply (Kneib, 1987; Rozas and Odum, 1988; Minello and Zimmerman, 1991; Vose and Bell, 1994; Llansó et al., 1998; Corona et al., 2000). In addition, the physical nature of the seagrass canopy may affect the hydrodynamics of larval recruitment and influence the possibility of settlement by planktonic larvae (Holmquist, et al., 1989). Seasonal fluctuations in the abundance of mobile fauna have been explained in terms of the settlement of larvae, as well as of the large clutch sizes and rapid growth rates of brooding invertebrates (Bell and Westoby, 1986). The greater part (69%) of the macrofauna collected in Laguna Madre, Tamaulipas, was found in SAV. Of this macrofauna, decapods constituted 80% of the total catch (Barba, 1999).

The two Madre lagoons in Tamaulipas and Texas have similar geomorphological origin and a high degree of overlap in their faunal composition. However, the quantification of the faunal composition and of the state of health of both estuarine ecosystems cannot be estimated as long as the database of any lagoon remains incomplete, as is the case of Laguna Madre, Tamaulipas. Both systems share faunal components of open water ichthyoplankton, benthic invertebrates, and demersal fish distributed in the submerged aquatic vegetation (Quammen and Onuf, 1993; Tolan et al., 1997, Barba, 1999). In addition, the Laguna Madre is a prime wintering area for diving ducks; most notably redheads (Quammen and Onuf, 1993).

Despite the importance of this estuarine system, few faunal reports have been recently published (Barba, 1999, 2003). The purpose of this study was to obtain a checklist of peracarid crustaceans and to describe the spatial and seasonal distribution of the species with respect to SAV and unvegetated soft substrates (USS) in the central region of Laguna Madre, where these two types of habitat are common.

METHODS

Study area.—The study was conducted in the central region of Laguna Madre, Tamaulipas. This coastal lagoon is the largest estuarine system (215,160 ha) in the southwestern Gulf of Mexico (Castañeda and Contreras, 2001). Laguna Madre is a shallow estuarine system with water temperatures that reflect the summer hot season and the winter cold season. As a result of its location in a semiarid area, its restricted contact with the sea, and a minimum river runoff from the San Fernando River, Laguna Mache is hypersaline with marine conditions restricted to the areas of tidal influence near the inlets.

The central region of Laguna Mache is limited to the north by the San Fernando River, from which it receives small contributions of fresh water during the rainy season, and to the south by the inlet of Catán (Fig. 1). This region is characterized by two areas: (1) the middle area is homogeneous, hypersaline, and SAV are present; and (2) the inlets are deeper and marine, and USS habitat is dominated by sandy or muddy substrates without rooted vegetation. Drift algae, represented by *Laurencia* spp. and *Sargassum* spp., were present in the "norther" season. Submerged aquatic vegetation within the lagoon is dominated by the seagrass *Halodule wrightii* Ascherson, and the macroalgae

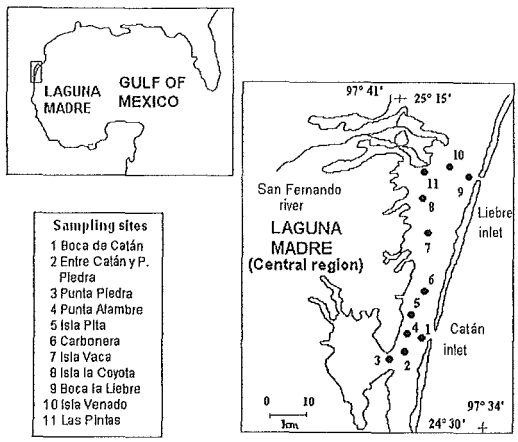

Fig. 1. Study area: central region of the Laguna Madre estuarine system, Tamaulipas, Mexico.

Hypnea cervicornis J. Agarth and *Dictyota dichotoma* (Hudson) Lamouroux (Barba, 1999).

Sampling design and data analysis.—Sampling took place bimonthly in 1989–1990, during daylight hours, at 11 sites, which were selected considering the distribution of SAV and the input of marine and fresh water. Temperature and salinity were determined at each site. The sampling design covered the spatial heterogeneity and climatic seasons of the year (dry, March–May; rainy, June–September; "norther," October–February). In the norther season the water temperature decreased due to frequent colder and northern winds, often with rain. Biological samples were collected from a boat, using a Renfro beam net (Renfro, 1962) with a 1-mm mesh size and a sampling area of 50 m^2.

Taxonomic identifications followed the conventional taxonomic criteria for mysids (Stuck et al., 1979; Escobar and Soto, 1988, 1989; Price et al., 1994), amphipods (McCain, 1968; Bousfield, 1973; Barnard and Karaman, 1991), and isopods (Schultz, 1969; Clark and Robertson, 1982; Kensley and Schotte, 1989). Density was quantified as the number of organisms collected divided by the sampling area (50 m^2). The variation in abundance was described at the spatial (sampling sites) and temporal (climatic seasons) scales. Species dominance was defined with the nonparametric association analysis of Olmstead and Tukey (Sokal and Rohlf, 1981).

Results

The order Amphipoda dominated in terms of species number (17 species) and total density (66%), whereas the orders Mysidacea and Isopoda had 19% and 15% of the total density with 5 and 10 species, respectively (Tables 1, 2). A total of 31 peracarid species were collected from USS and 14 from SAV (Table 3).

Amphipods.—A total of 72% of the amphipod density was recorded in SAV, where density values ranging from 16.3 ind·m^2 at Punta Alambre (Site 4) to 3.4 at Isla Pita (Site 5). In the USS sites, density ranging from 10.9 at Las Pintas (Site 11) to 0.42 ind·m^2 at Punta Piedra (Site 3) (Fig. 2). The maximum density values of the two dominant amphipods, *Cymadusa compta* and *Elasmopus levis,* were recorded at the SAV sites of Isla Venado (Site 10) (12.74 ind·m^2) and Punta Alambre (8.86 ind·m^2). Both species represented 93% of the total amphipod density. The minimum density value corresponded to *Batea catharinensis,* collected at the USS sites of Punta Piedra (Site 3) and Isla Vaca (Site 7) with 0.16 ind·m^2. The species *Lembos websteri, Hyale nilssoni,* and *Orchestia gammarella* were found only in Boca de Catán (Site 1), and the occasional species *Jassa falcata* and *Paracaprella pusilla* were collected at the SAV sites of Boca la Liebre (Site 9) and between Catán and Punta Piedra (Site 2). Nine species and 28% of the density were found in USS sites, whereas eight species and 72% of the density corresponded to SAV sites (Tables 2, 3).

With respect to the seasons, the greatest number of species (14 species) and 78% of the total amphipod density (61 ind·m^2) were recorded during the norther season (Fig. 3). The greatest densities of the species *C. compta* (37 ind·m^2) and *E. levis* (22 ind·m^2) were collected at this time of the year. The occasional species *Deutella californica* (0.5 ind·m^2), *L. websteri* (0.02 ind·m^2), *H. nilssoni* (0.02 ind·m^2) and *Gammarus mucronatus* (0.24 ind·m^2) were also caught during the norther season. Minimum values were obtained in the dry season (7.5 ind·m^2) for the species *J. falcata, O. gammarella,* and *Ampelisca* sp. with density values less than 0.04 ind·m^2. The species *C. compta, Batea catharinensis, Erichtonius brasiliensis, Microprotopus raneyi, E. levis,* and *Deutella abracadabra* were present throughout the year.

Mysids.—These peracarids were restricted primarily to the lagoon inlets in coarse sand substrates and euryhaline water. The greatest values of density (81% of the total) and all species were recorded in USS sites, particularly when drift algae were present, in the inlet of Catán (Site 1) and La Liebre inlet (Site 9) with 15.5

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TABLE 1. Peracarid Composition and numerical dominance in Laguna Madre (classification following Bowman and Abele, 1982).

Taxa	Source	LM_{MX}	LM_{TX}	SM and SLA	LT
Order Mysidacea	Boas 1883				
Mysidopsis swiftii	Bacescu 1969	a			
Americamysis bahia	Molenock 1969	r			X
Americamysis almyra	Bowman 1964	r			X
Bowmaniella floridana	Holmquist 1975	r			X
Bownaniella brasiliensis	Bacescu 1968	r			X
Order Amphipoda	Latreille 1803				
Suborder Caprellidea					
Caprella sp.	Lamarck 1801	r			
Deutella californica	Mayer 1890	f	X	X	
Deutella abracadabra	Mayer 1890	f			
Paracaprella pusilla	Mayer 1890	r	X	X	
Suborder Gammaridea					
Cymadusa compta	Mayer 1890	d	X	X	X
Batea catharinensis	Muller 1865	f			
Gammarus mucronatus	Say 1818	r	X	X	X
Atylus minikoi	Walter 1905	r	X	X	X
Ericthonius brasiliensis	Dana 1853	f	X	X	X
Cerapus tubularis	Say 1818	f			
Microprotopus raneyi	Wingley 1966	f			
Lembos websteri	Bate 185	r			
Hyale nilssoni	Rathke 1843	r			
Jassa falcata	Montagu 1818	r			
Elasmopus levis	Smith 1873	d		X	X
Orchestia gammarella	Pallas 1766	r			
Ampelisca sp.	Kroyer 1842	r			
Order Isopoda	Latreille 1817				
Aegathoa medialis	Richardson 1905	r			
Ancinus depressus	Say 1818	r			
Cymothoa oestrum	Linnaeus 1793	r			
Erichsonella attenuata	Harger 1873	f	X		
Erichsonella filiformis	Say 1818	f			
Exosphaeroma productatelson	Menzies and Glynn 1968	r			
Harrieta faxoni	Richardson 1905	d			
Rocinela americana	Schioedte and Meinert 1879	r			
Sphaeroma quadridentatum	Say 1818	r			
Ligia exotica	Roux 1828	r			

LM_{MX} = Laguna Madre this study, LM_{TX} = Laguna Madre, Texas (Minello and Zimmerman, 1991; Clark and Robertson, 1982), SM = Soto la Marina (Cházaro-Olivera *et al.*, 2002), SLA = Sistema lagunar de Alvarado (Winfield *et al.*, 2001), and LT = Laguna de Términos lagoon (Corona *et al.*, 2000; Ledoyer, 1986; Escobar and Soto, 1989). d = dominant, a = abundant, f = frequent, r = occasional.

TABLE 2. Density values (ind/m^2) of peracarids in unvegetated substrates (USS) and submerged aquatic vegetation (SAV) Laguna Madre.

Density	Amphipods	Isopods	Mysids
USS	28%	28%	81%
SAV	72%	72%	19%
Total by order	66%	15%	19%

and 3.8 ind·m^2, respectively (Fig. 2). The numerical dominant *Mysidopsis swiftii* (15.5 ind·m^2) was the only species collected at the inlet of Catán, when the drift algae were present (Site 1). The other two dominant species were *Bowmaniella floridana* (1.7 ind·m^2) and *Bowmaniella brasiliensis* (1.7 ind·m^2) from SAV sites and in drift algae (Table 3). These three species were present only during the dry season, whereas *Americamysis bahia* (0.42 ind·m^2) and *Americamysis almyra* (0.22 ind·m^2) from the la Liebre inlet (Site 9) were collected only in

TABLE 3. Species composition of peracarids in unvegetated substrates (USS) and submerged aquatic vegetation (SAV) in Laguna Madre

Habitat	Amphipods	Isopods	Mysids
USS	*Ampelisca* sp.	*Aegathoa medialis*	*Americamysis bahia*
	Orchestia gamarella	*Cymathoa oestrum*	*Americamysis almyra*
	Paracaprella sp.	*Rocinella americana*	*Mysidopis swiftii*
	Caprella sp.	*Ligia exotica*	
	Jassa falcata	*Ancinus depressus*	
	Hyale nilssoni	*Exosphaeroma productatelson*	
	Lembos websteri		
	Atylus minikoi		
	Deutella californica		
SAV	*Cymadusa compta*[a]	*Harrieta faxoni*[a]	*Bowmaniella floridana*[a]
	Elasmopus levis[a]	*Erichsonella attenuata*[a]	*Bowmaniella brasiliensis*[a]
	Gammarus mucronatus[a]	*Erichsonella filiformis*[a]	
	Erichtonius brasiliensis[a]	*Sphaeroma quadridentatum*[a]	
	Batea catharinensis[a]		
	Microprotopus raneyi[a]		
	Deutella abracadabra[a]		
	Cerapus tubularis		
Total species	17	10	5

[a] collected occasionally in drift algae.

the norther season. The dry season provided 84% (32 ind·m^2) of total mysid density, the norther season only 16% (6 ind·m^2), and no mysids were collected in the rainy season (Fig. 3).

Isopods.—A total of 72% of the isopod density was recorded at SAV sites, with values ranging from 0.04 ind·m^2 at Carbonera (Site 6) to 5.9 ind·m^2 at Isla Venado (Site 10). In the USS sites, density ranged from 0.1 at Boca la Liebre (Site 9) to 6.18 ind·m^2 at Catán inlet (Site 1). The numerically dominant species with respect to density was *Harrieta faxoni* from Catán inlet (site 1) (2.22 ind·m^2) and frequent species were *Erichsonella attenuata* (0.14 ind·m^2) and *Erichsonella filiformis* (0.18 ind·m^2), with their greatest values in Catán inlet (Fig. 2). These three species were associated with drift algae in SAV sites. The rare species *Cymothoa oestrum, Rocinela americana,* and *Ligia exotica* were collected at the USS sites (Table 3) of Punta Piedra (Site 1) and Las Pintas (Site 11). The norther season provided the greatest density values with 80% (14.4 ind·m^2), followed by the rainy season with 15.3%, and finally, the dry season with 4.6% (Fig. 3). The dominant species *H. faxoni* and the two frequent species *E. filiformis* and *E. attenuata* were present through-

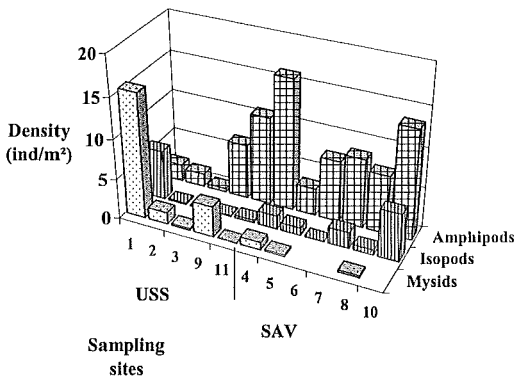

Fig. 2. Spatial abundance distribution of peracarid crustaceans in Laguna Madre. SAV, submersed aquatic vegetation substrates; USS, unvegetated substrates.

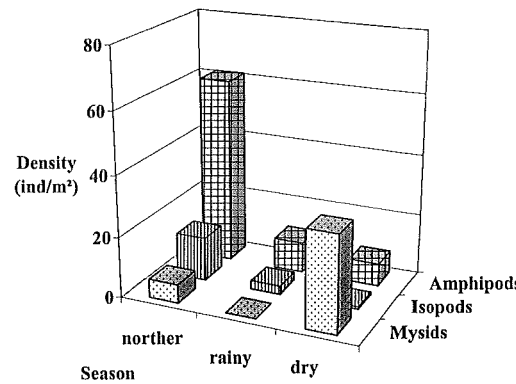

Fig. 3. Seasonal distribution of peracarid abundance in Laguna Madre.

out the year in SAV as well as in drift algae (Table 3).

Discussion

Peracarid crustaceans are a numerically important component of SAV habitats where they constitute an available food supply and represent a link between primary producers and higher trophic levels. This group of mesoherbivores (Brawley, 1992) includes amphipods, isopods, gastropods, and caridean shrimp. Mesoherbivores regulate epiphytic growth on macroalgae and seagrasses (Stoner, 1980; Zimmerman, et al., 1990; Barba et al., 2000), and recycle nutrients through fecal pellet production (Jerkanoff and Nielsen, 1996; Jerkanoff et al., 1996; Barba et al., 2000). Seagrasses and peracarid crustaceans are the two basic components that maintain the trophic structure via detritus in the central region of Laguna Madre (Barba, 2003). An increase of peracarids in SAV habitats has been explained by an increase of physical refuge, feeding sources, and protection against predation (Corona, et al., 2000). However, physiological tolerance to salinity and temperature is also a factor that may regulate the distribution of estuarine fauna (Sánchez and Raz-Guzman, 1997). In Laguna Madre, most of the amphipods (62% of the species) and isopods (40% of the species) were collected in SAV habitats where both groups represented 71% of the total peracarid density (Table 2). The dominant amphipods *E. levis* and *C. compta,* and the isopods *H. faxoni, E. attenuata,* and *E. filiformis* were found preferentially associated with SAV substrates in euhaline-hypersaline conditions in this study. These species have been recorded as estuarine residents associated with SAV habitats of *Thalassia testudinum, Halodule wrightii,* and *Syringodium filiforme,* with a wide distribution throughout the estuarine systems of the Gulf of Mexico (Minello and Zimmerman, 1991; Escobar and Soto, 1998; Cházaro-Olvera et al., 2002).

The spatial density of peracarids showed that 81% of the mysids and 28% of both amphipods and isopods were associated with USS sites (Table 3). The high density values and number of peracarid species in USS sites (Table 3) is linked to the occasional drift algae presence in the channels. The 20 occasional species (Table 1) were recorded in euhaline conditions in the deeper, clearer water of the inlets, and associated with currents and northern winds. These species are the mysids *A. bahia, A. almyra,* and *M. swifti;* the amphipods *Ampelisca* sp., *O. gamarella, Paracaprella* sp., *Caprella* sp., *J. falcata, H. nilssoni, L. websteri,* and *Atylus minikoi;* and the isopods *C. oestrum, R. americana, L. exotica, Ancinus depressus, Exosphaerona productatelson, R. americana,* and *Sphaeroma quadridentatum.* The mysids are characterized by high mobility and nocturnal and horizontal movements in response to light, temperature changes, and currents (Bourdillon and Castelbon, 1983; Webb and Woolldridge, 1990), and have been recorded as an important component in the diets of commercial fish associated with estuarine conditions and USS substrates (Bourdillon and Castelbon, 1983; Webb and Woolldridge, 1990).

Studies on peracarid crustaceans have been few and focused on density and diversity (Escobar and Soto, 1989; Winfield et al. 2001; Cházaro-Olvera et al., 2002). The distribution of peracarids in the biggest estuarine systems of the Gulf of Mexico is limited to the central area of the Mexican coast and to the estuaries in Texas (Minello and Zimmerman, 1991; Cházaro-Olvera et al., 2002). The presence of a variety of environmental conditions in a number of estuaries favors the availability of a variety of habitats for epifaunal species. A total of 21% of the species collected in this study and, in particular the species *Caprella* sp., *Deutella* sp., *C. compta, G. mucronatus, E. levis,* and *Ampelisca* sp. were found in Texan estuarine systems (Minello and Zimmerman, 1991) (Table 1).

Other estuaries in the southwestern Gulf of Mexico include Río Soto la Marina in Tamaulipas, where only 15% of the species were found in USS sites (Cházaro-Olvera, et al., 2002), Camaronera lagoon in Veracruz with 12.5% of the species from SAV sites (Winfield, et al., 2001; Cházaro-Olvera, et al., 2002), and Terminos lagoon in Campeche with 28% of the species (Ledoyer, 1986; Escobar and Soto, 1989; Corona, et al., 2000) (Table 1). Notwithstanding the hypersalinity, the diversity and abundance of crustaceans and juvenile fish are high in comparison with that in the lagoons of Términos, Tamiahua, and Alvarado (Reséndez and Kobelkowski, 1991; Alvarez et al., 1996; Raz-Guzman and Sánchez, 1996; Sánchez et al., 1996; Sánchez and Raz Guzman, 1997; Barba, 1999; Raz-Guzman et al., 2004).

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(EB) EL COLEGIO DE LA FRONTERA SUR (ECOSUR). KM 15.5 CARRETERA A REFORMA, RANCHERÍA EL GUINEO SEGUNDA SECCIÓN, VILLAHERMOSA, TABASCO, MEXICO; AND CP 86280, AP 1042, AND ADMÓN DE CORREOS NO. 2, COL. ATASTA, VILLAHERMOSA, TAB. MÉXICO. CP 86100. (AJS) DIVISIÓN ACADÉMICA DE CIENCIAS BIOLÓGICAS. UNIVERSIDAD JUÁREZ AUTÓNOMA DE TABASCO, 0.5 KM CARRETERA VILLAHERMOSA-CÁRDENAS. VILLAHERMOSA, 86039, TABASCO, MÉXICO. Send reprint requests to BE. Date accepted May 12, 2005.