DISTRIBUTION AND ECOLOGY OF ISOPODS (CRUSTACEA: PERACARIDA: ISOPODA) OF THE PACIFIC COAST OF MEXICO

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ABSTRACT

The Pacific coast of Mexico extends from 32° 27' N to 14° 32' N, including warm temperate, subtropical and tropical waters. Considering the 200 nautical miles limit, the Mexican Pacific covers approximately 2364200 km² of marine and oceanic environment from estuaries and intertidal to over 2000 m depth. An exhaustive review of published literature and intensive sampling along the coast of the Mexican Pacific and offshore allow us to report a total of 120 species of Isopoda for the area. These species belong to 8 of the 10 currently recognized suborders of Isopoda. Almost half of the species (54) are Flabellifera, while Microcerberidea and Gnathiidea are represented by only one known species each. As expected, there is a clear bathymetric segregation from one group of species to the other. Gnathiidea, Microcerberidea and Oniscidea (10 spp.) are found exclusively in the intertidal, among rocks and on sandy beaches, often associated with algae or decaying material. Anthuridea (10 spp.), Asellota (5 spp.) and Valvifera (20 spp.) occur from the intertidal to 200 m depth, in sandy, muddy or mixed habitats or as commensals. Flabellifera also occur from the intertidal but range to deeper water, with a maximum depth record of 2214 m (*Rocinella belliceps* (Stimpson, 1864)); these are either free-living or parasites and are found in a wide variety of habitats. Epicaridea (21 spp.) are all parasites. Without any doubt, the least studied suborders are Anthuridea (10 known species and at least 2 undescribed species) as well as Gnathiidea and Microcerberidea due to their small size, difficulty in sampling and complexity of available related literature. Contrary to what has been observed with other groups of crustaceans, the diversity of isopods appears to be much higher in Mexican temperate waters, where 59.1% of all known species occur (California Current area), than in the SW tropical coastal area (only 26.7% of the species are registered there). The Gulf of California, on the contrary, features an unusual (relative) richness with up to 73.3% of Mexican species recorded. It should be stressed, however, that most of the collecting effort of the last 30 years has been done in the Gulf of California and along the west coast of Baja California.

I. INTRODUCTION

Isopods are among the most common crustaceans in the tropical and subtropical seas. Marine and brackish water species are part of the more than 9500 species known to date for this order of Crustacea (Brusca pers. comm., April 2000). As a group, marine isopods are one of the most important elements in the marine energy flow for their ability to process decaying organic matter, making it available to other trophic levels. They also represent a factor of economical imbalance; wood-burrowing species can destroy human build structures (e.g., genus *Limnoria* Leach, 1813) and parasitic species affect market quality of fish (Brusca 1981, Markham 1985). The high diversity and success of this group is reflected by their presence in virtually every marine and brackish water habitat, including hard and

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soft bottoms, seagrass, algae, mangrove roots and coral reefs (Schultz 1961, Dexter 1972, 1974, 1976, Ribi 1981, Delaney 1984, Kang and Yun 1988, Ellison and Farnsworth 1990, Arrontes and Anadón 1990, Taylor and Moore 1995).

The Mexican Pacific coast, with a total length of about 7150 km (Moreno-Casasola and Castillo 1992) and its adjacent offshore waters, encompasses four currently recognized zoogeographic provinces: the southern portion of the Californian Province (northern border to Magdalena Bay), the Cortez Province (Gulf of California and SW tip of Baja California), the Mexican Province (Corrientes Cape to Tangola Tangola Bay) and the northernmost part of the Panamic Province (Tangola Tangola Bay to southern border) (Fig. 1) (see Brusca and Wallerstein 1979, Hendrickx 1992). The area extends from 32° 27' N to 14° 32' N and covers a total of 2364200 km², from the coastline to the 200 nautical miles offshore limit (Hendrickx 1993), including several oceanic islands. Maximum depth is 6000 m in the Tehuantepec Trench. Considering the entire area, which includes temperate, subtropical and tropical water, isopods find a vast array of habitats suitable for colonization.

Our knowledge of isopods has increased significantly in recent years. This is reflected in the availability of a wide variety of recent researches dealing with large taxonomic groups of isopods or with isopod fauna of selected geographic areas (e.g., Brusca 1980, Wilson 1980, Poore 1984a, 1984b, 1996, Brusca and Iverson 1985, Bruce 1986a, Kensley and Schotte 1989, Brusca et al. 1995, Wetzer and Brusca 1997). In the

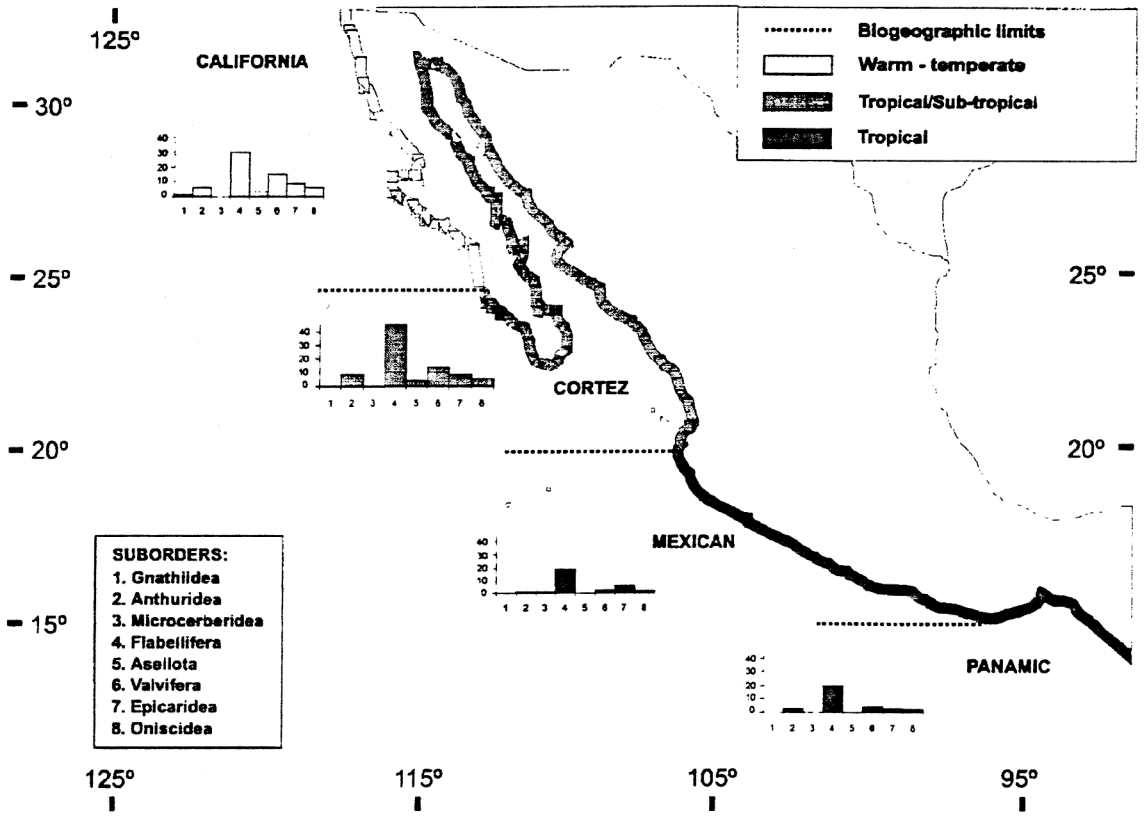

Figure 1. *Number of species of marine and brackish water isopods known from the four biogeographic provinces of the Mexican Pacific (by suborder).*

case of the Mexican Pacific there are few works of synthesis available. Apart from the above-mentioned studies that deal, at least in part, with this area, most papers have focused on the description of new taxa or on autecologic aspects (e.g., Kensley and Kaufman 1978, Carvacho 1983, Carvacho and Hassmann 1984, Wägele 1984, Lombardo 1988, Ruiz and Madrid 1992, Campos et al. 1992, Román-Contreras 1993, 1996, Alvarez and Flores 1997, Hendrickx and Espinosa-Pérez 1998a, 1998b).

Since 1990, an institutional project aimed at the study of the marine and brackish isopods of the Pacific coast of Mexico was initiated. Preliminary results include a review of the distribution of the species occurring in the entire eastern tropical Pacific (Espinosa-Pérez and Hendrickx 2000), new records (Espinosa-Pérez and Hendrickx 1997) and species descriptions (Hendrickx and Espinosa-Pérez 1998a, 1998b, Espinosa-Pérez and Hendrickx 2001). Part of the results that were obtained during this study allow us to present a synthesis of the biodiversity, habitat and geographic distribution by taxonomic group of all isopods known to occur along the Pacific coast of Mexico.

II. MATERIALS AND METHODS

Isopod records included in this study were derived from an exhaustive review of literature dealing mostly with the eastern Pacific and from unpublished data obtained from recent collections along the Pacific coast of Mexico (intertidal to 120 m). A total of 5812 specimens were collected and identified and 1417 specimens were available from three national collections: the Reference Collection of the Laboratorio de Invertebrados Bentónicos, Instituto de Ciencias del Mar y Limnología, UNAM, in Mazatlan; the National Collection of Crustaceans of the Instituto de Biología, UNAM, in Mexico City; and the Crustacean Collection of the Naval Oceanography Department, Secretaría de Marina, Mexico City.

All species records were incorporated into a data base including distribution, depth and substrate data. Biotic substrates include algae, mangroves, sponges and corals; abiotic substrates of mineral origin were divided into gravel, sand and mud. In addition to this, humus (detritus of organic origin) was considered as a separate substrate. In the case of associations with other organisms, three categories were used: commensal, parasite and facultative parasite.

The classification used herein follows Brusca and Wilson (1991). Total number of suborders included in the Isopoda is therefore 10 (Calabozoidea Van Lieshout, 1983, and Phreatoicidea Stebbing, 1893, have no representatives in the Mexican Pacific); some authors, however, believe that the family Gnathiidae Leach, 1814, the only family included in the Gnathiidea Leach, 1814, should form part of the Flabellifera.

III. RESULTS

Species richness

A total of 120 species were recognized for the study area, including nine undescribed species. These species belong to 8 of the 10 currently established suborders of Isopoda (Table 1). Almost half (45%) of the registered species belong to the Flabellifera, and correspond to 8 of the 15 presently recognized families of this suborder. Flabellifera is the largest suborder of Isopoda and contains almost 3000 species (Wetzer and Brusca 1997). They live in a wide variety of habitats, often in shallow water (Brusca and Iverson 1985), and their capture is easier than for other groups due to their relatively large size and abundance (Schultz 1969). Valvifera and Epicaridea represent 20 and 21% of the total number of species, respectively. The high representation of Epicaridea (20 Bopyridae and one species of Dajidae) along the Pacific coast of Mexico is remarkable although the group has not yet been intensively studied in this area. Comparatively, up to 1983, no species of Epicaridea had been reported for the entire Pacific coast of Costa Rica (Brusca and Iverson 1983). On the contrary, Caribbean Epicaridea are much more diverse, with 53 known species (Kensley and Schotte, 1989). Suborders with fewer species are Microcerberidea and Gnathiidae (only one recorded species each). The organisms of these suborders are minute; *Coxicerberus mexicanus* (Pennak 1958), the only Microcerberidea registered in the Mexican Pacific, is only 0.925 mm long (Pennak 1958). If selective sampling with emphasize on small organisms is done, the number of species in these two suborders will certainly increase.

Occurrence by depth and habitat

All Epicaridea are parasites of other crustaceans (Brusca and Iverson 1985, Kensley and Schotte 1989). The rest of the suborders are usually found in several habitats (Fig. 2). *Gnathia steveni* Menzies, 1962,

the only species registered for the suborder Gnathiidea, inhabits the intertidal zone of sandy beaches, between algae and sponges (Menzies 1962). The suborder Anthuridae is represented by intertidal and shelf species. One species, *Haliophasma geminatum* Menzies and Barnard, 1959, is registered to about 500 m (Fig. 3). Anthurids of the Pacific coast of Mexico have been registered in sandy substrate, among green and calcareous algae and humus (Fig. 2). The only Microcerberidea, *Coxicerberus mexicanus*, lives in intertidal sandy substrate (Fig. 2). Members of the Asellota are found from the intertidal to at least 200 m (Fig. 3). They do not show a strong affinity for a specific substrate and they have been recorded in six substrates in the area; some are even commensal (e.g., *Maresiella brevicornis* (Carvacho 1983), found in the bivalve *Spondylus calcifer* Carpenter, 1857) (Fig. 2). Records in the literature refer to Asellota as intertidal, shallow water and deep sea organisms (Setubal Pires 1985, Muller 1991, Piertney and Carvalho 1996, Wilson 1997). They are, however, most successful and diverse in the deep sea (Wilson 1989). Little is known of the Mexican Pacific Asellota, particularly because so few deep sea surveys for smaller crustaceans are available for the study area. Two species of Munnidae are reported, including one undescribed species. Most of the Valvifera sampled belong to the family Idoteidae; these are mainly found in the intertidal and to 50 m (at least one record in this bathymetric range exist for 85% of the species) with a maximum depth record for this group of 82 m. As far as habitat is concerned, algae is a favorite hiding place,

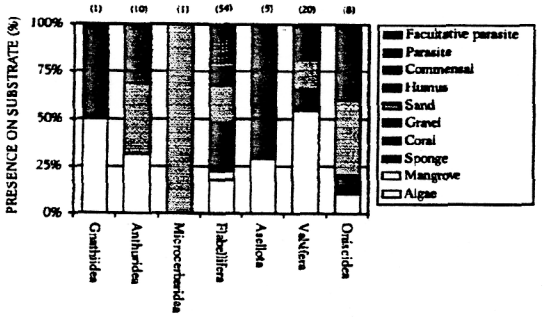

Figure 2. *Species/habitat relationship of marine and brackish water isopods known from the Mexican Pacific (by suborder). Number in parentheses corresponds to number of species in each suborder.*

Table 1. *Number of species of marine and brackish water isopods known from the Mexican Pacific (by suborder).*

Suborder Isopoda	Number of species and % of total
Gnathiidea Leach, 1814	1 (0.8%)
Anthuridea Leach, 1814	10 (8.3%)
Microcerberidea Lang, 1961	1 (0.8%)
Flabellifera Sars, 1882	54 (45.0%)
Asellota Latreille, 1803	5 (4.2%)
Valvifera Sars, 1882	20 (16.7%)
Epicaridea Latreille, 1831	21 (17.5%)
Oniscidea Latreille, 1803	8 (6.7%)

especially algae of the genus *Sargassum* that are used both as habitat and food supply (Brusca and Wallerstein 1979b). The 20 species of Valvifera recorded from the area occupy 6 different habitats (Fig. 2). The Oniscidea are inhabitants of the intertidal zone and are also associated with sand and humus, the latter used as food and hiding place by species of this group (Kensley and Schotte 1989). The largest group of isopods, the Flabellifera, are distributed from the intertidal zone to a depth of 2214 m (Fig. 4). Flabellifera have been collected in ten different types of substrates (Fig. 2), including on temporary (Aegidae, Corallanidae) or permanent hosts (Cymothoidae). They also include species with commensal relationships (Sphaeromatidae). The 0-10 m depth range contains species of all seven families recorded in the area, while the 11-100 m range includes six families. Aegidae feature the widest bathymetric distribution range, from intertidal to over 2000 m (Figure 4).

Geographic distribution

The information available on the distribution of each species allow us to propose a general pattern of zoogeographic affinities for each group of isopods registered along the Pacific coast of Mexico. Considering the 120 species registered for the area, 71 (59.1%) are found in the Mexican portion of the warm temperate California Province, 88 species (73.3%) occur in the Cortez Province (Gulf of California, s.l.) and 32 species (26.7%) are found in both the Mexican Province and the Mexican portion of the Panamic Province.

A detailed analysis of the distribution of the suborders of isopods in the four provinces (Fig. 1) indicates a rather balanced distribution, with an expected dominance of the more abundant groups (e.g., Flabellifera, Valvifera, Epicaridea).

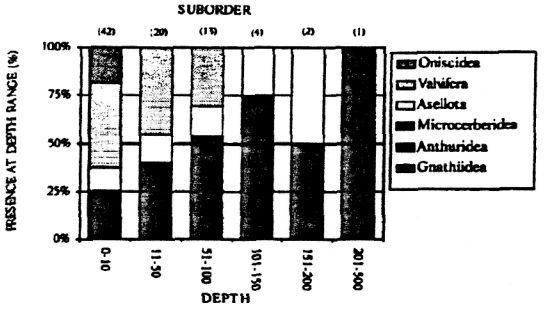

Figure 3. *Species/depth relationship of marine and brackish water isopods known from the Mexican Pacific, by suborder (except Flabellifera). Number in parentheses corresponds to number of species in each depth interval.*

Gnathia steveni, the only Gnathiidea reported for the area, is restricted to the warm-temperate zone (California Province). This actually represents the only record for the genus in the Mexican Pacific (Wetzer et al. 1991). The Anthuridea are slightly better represented in the Cortez Province, despite the fact that they have been considered uncommon in the tropical and subtropical regions (Brusca and Iverson 1985). The species of Flabellifera are well distributed throughout the four biogeographic provinces; their occurrence is higher in the tropical/subtropical Cortez Province. Asellota have only been reported in the warm-temperate and subtropical zones (California and Cortez Provinces), although they are considered cosmopolitan (Cohen and Poore 1994) (Fig. 1). Valvifera, particularly well represented by the Idoteidae, are recorded predominantly in the northern provinces (California and Cortez). Epicaridea and Oniscidea are distributed all along the Mexican Pacific, although the number of species is significantly higher in the warm-temperate and subtropical zones (California and Cortez) (Fig. 1).

Oceanic island species

Oceanic islands are defined here as islands surrounded by water deeper than 200 m, that are located at a distance from the continent that would make non-accidental, sustained recruitment questionable or impossible (see Garth 1946, Vermeij 1978, Hendrickx 1992).

Analysis of the isopods present in oceanic islands of the eastern tropical Pacific and in Mexican Guadalupe Island and Alijos Rocks (both located in the warm temperate California Province) indicates that the Mexican Pacific has no oceanic island endemics. Of the 120 species reported herein, 22 species have been reported in shallow water surrounding at least one island (Table 2). These species belong to six families of Flabellifera, Valvifera and Oniscidea. The highest number of species ocurring in the Mexican Pacific and also present on islands is found in the Galapagos, Ecuador (9 species) and Guadalupe, Mexico (8 species) islands. Only a few species have been recorded on more than one island: *Elthusa menziesi* (Brusca, 1981) and *Ligia exotica* Roux, 1828 occur on two islands; *Rocinela signata* Schiödte and Meinert, 1879 and *Eurydice caudata* Richardson, 1899 have been reported on three islands.

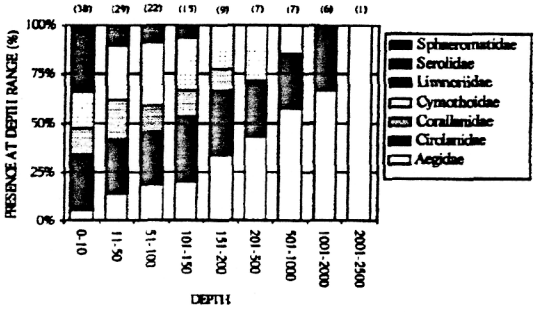

Figure 4. *Species/depth relationship of marine and brackish water isopods known from the Mexican Pacific (suborder Flabellifera). Number in parentheses corresponds to number of species in each interval.*

IV. DISCUSSION

The apparent absence of Asellota and Gnathiidae in the tropical Mexican Pacific may be due to unsuitable sample strategies (see Wetzer and Brusca 1997). On the other hand, the wide distribution of Mexican Flabellifera agrees with previous biogeographic analysis of this group (Brusca 1980, Delaney 1989). Valvifera are mostly found in the California and Cortez Provinces; this agrees with a previous report by Brusca and Wallerstein (1979b), who recognized the group as inhabitants of cold and temperate waters.

	OCEANIC ISLAND								
	GP	RA	IM	RV	CL	CP	CO	MA	GL
FLABELLIFERA Sars, 1882									
Aegidae Dana, 1853									
Rocinela angustata Richardson, 1904	*				*				
Rocinela belliceps (Stimpson, 1864)									
Rocinela hawaiiensis Richardson, 1903	*								
Rocinela signata Schiödte & Meinert, 1879			*	*	*				*
Cirolanidae Dana, 1853									
Anopsilana oaxaca Carvacho & Hassmann, 1984						*			
Cirolana harfordi (Lockington, 1877)	*								
Cirolana parva Hansen, 1890									*
Eurydice caudata Richardson, 1899	*		*	*			*		
Metacirolana costaricensis Brusca & Iverson, 1985									*
Corallanidae Hansen, 1890									
Excorallana houstoni Delaney, 1984									*
Excorallana truncata (Richardson, 1899)									*
Cymothoidae Leach, 1818									
Ceratothoa gaudichaudii (H. Milne-Edwards, 1840)									*
Cymothoa exigua Schiödte & Meinert, 1884									*
Elthusa menziesi (Brusca, 1981)	*	*							
Livoneca bowmani Brusca, 1981			*					*	
Nerocila acuminata Schiödte & Meinert, 1881			*						*
VALVIFERA Sars, 1882									
Holognathidae Thompson, 1904									
Cleantioides occidentalis (Richardson, 1899)									*
Idoteidae Milne-Edwards, 1840									
Colidotea findleyi Brusca & Wallerstein, 1977	*								
Colidotea wallersteini Brusca, 1983	*								
Idotea resecata Stimpson, 1857		*							
ONISCIDEA Latreille, 1803									
Ligiidae Brandt, 1814									
Ligia exotica Roux, 1828	*								
Ligia occidentalis Dana, 1853			*			*			

Table 2. *Presence of isopods species known from the Pacific coast of Mexico on east Pacific oceanic Islands. GP, Guadalupe; RA, Alijos Rocks; IM, Marias; RV, Revillagigedo; CL, Clarion; CP, Clipperton; CO, Coco; MA, Malpelo; GL, Galapagos.*

Five species of isopods have so far been reported from the Tres Marias Islands, in the SE Gulf of California. These islands are considered too close to the continent to be recognized as truly oceanic and might be reachable by continental benthic species with pelagic larvae. They are isolated by water deeper than 200 m from the continental shelf of western Mexico. In the case of isopods, however, the criteria of recruitment through pelagic larvae riding with currents does not apply as they feature direct development. Only in the case of isopods that are obligate or facultative parasites of widely distributed pelagic species (i.e., fishes, pelagic shrimps) or highly mobile benthic species with a wide bathymetric range (*Glyphocrangon spinulosa* Faxon, 1893; *Nematocarcinus agassizzi* Faxon, 1893; *Sclerocrangon procax* Faxon, 1893), and isopods that are rafting on floating algae (i.e., *Synisoma wetzerae* Ormsby, 1991), might one expect a wider dispersal potential through the adult isopods.

As far as our present knowledge goes, the Mexican Pacific isopod fauna shows a clear subtropical affinity with a strong warm-temperate component. This, however, is probably due to a larger sampling effort in northern latitudes (northern and Central Gulf of California and west coast of Baja California) by scientists from the US combined with a much more comprehensive taxonomic study of isopods collected in this area in the last 30 years or so. A more intensive sampling effort and adequate analysis of the collected specimens along the SW coast of Mexico will undoubtedly bring new data on species distribution and basic knowledge of their ecology.

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