Diversity of decapods inhabiting the largest mangrove system of Pacific Costa Rica.

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Abstract

An inventory of the decapod diversity was performed at Térraba-Sierpe mangrove system located in southern Pacific Costa Rica. A total of ten field trips were carried out from July 2002 through July 2003 to collect decapods. Sampling stations were distributed over the whole area covering different habitats within the mangrove system; a variety of sampling techniques were applied to obtain the highest possible diversity of decapods inhabiting this site. A total of 52 species belonging to 29 genera and 16 families were identified. Ocypodidae was the predominant family with 14 species, followed by Palaemonidae comprising six species. The results are compared with those regarding the decapod fauna inhabiting other mangrove regions in Latin America and the tropics in general.

Key words: decapod crustacean, mangroves, biodiversity, Costa Rica, Pacific coast.

Introduction

Mangroves are highly productive tropical systems, representing major reservoirs of biodiversity (Hogarth, 1999). These systems are important transition zones between the land and the sea, offering nutrition and protection for numerous species (Robertson and Duke, 1987). Decapods are one of the predominant and most visible faunal elements in mangrove forests (Koch and Wolf, 2002). Only few of these species are of direct economic importance, however, especially crabs play an important role in the energy flux of mangrove ecosystems (Robertson and Daniel, 1989; Smith III *et al.*, 1991; Hartnoll *et al.*, 2002). Most studies regarding decapods inhabiting mangroves concern crabs of the families Ocypodidae and Grapsidae (Conde and Díaz 1989; Levinton *et al.* 1996, Cannicci *et al.* 1999, Rosenberg 2001, Skov *et al.* 2002). Some information is available about the taxonomic composition of the decapod fauna of Latin American mangroves; however, most of these publications refer to the Atlantic coast (Lavrado *et al.*, 2000; Ferreira and Sankarankutty, 2002). Abele (1974) provided only decapod species numbers from mangrove swamps of the Pacific and Atlantic coast of Panama.

In Costa Rica, almost 99% of the estimated area covered by mangroves occurs on the Pacific coast (Polanía, 1993). Most studies focus on the vegetation structure (Jiménez, 1994 and references therein), while published information on the macrofauna, and especially decapods, is scarce (Dittel and Epifanio, 1990; Dittel *et al.*, 1991; Wehrtmann and Dittel, 1990).

The present study was carried out at Térraba- Sierpe mangrove system, southern Pacific coast of Costa Rica (Fig. 1). It has an extension of 17 737 ha and is the largest mangrove forest in Costa Rica (Polanía, 1993). This area represents one of the most important wetlands in the Central American region, and has been declared of international importance by the Ramsar Convention (Cordero and Solano, 2000). The objective of this study was to provide a first inventory of the decapod species inhabiting this ecosystem, for better understanding of the ecological processes in these mangrove forests in Costa Rica.

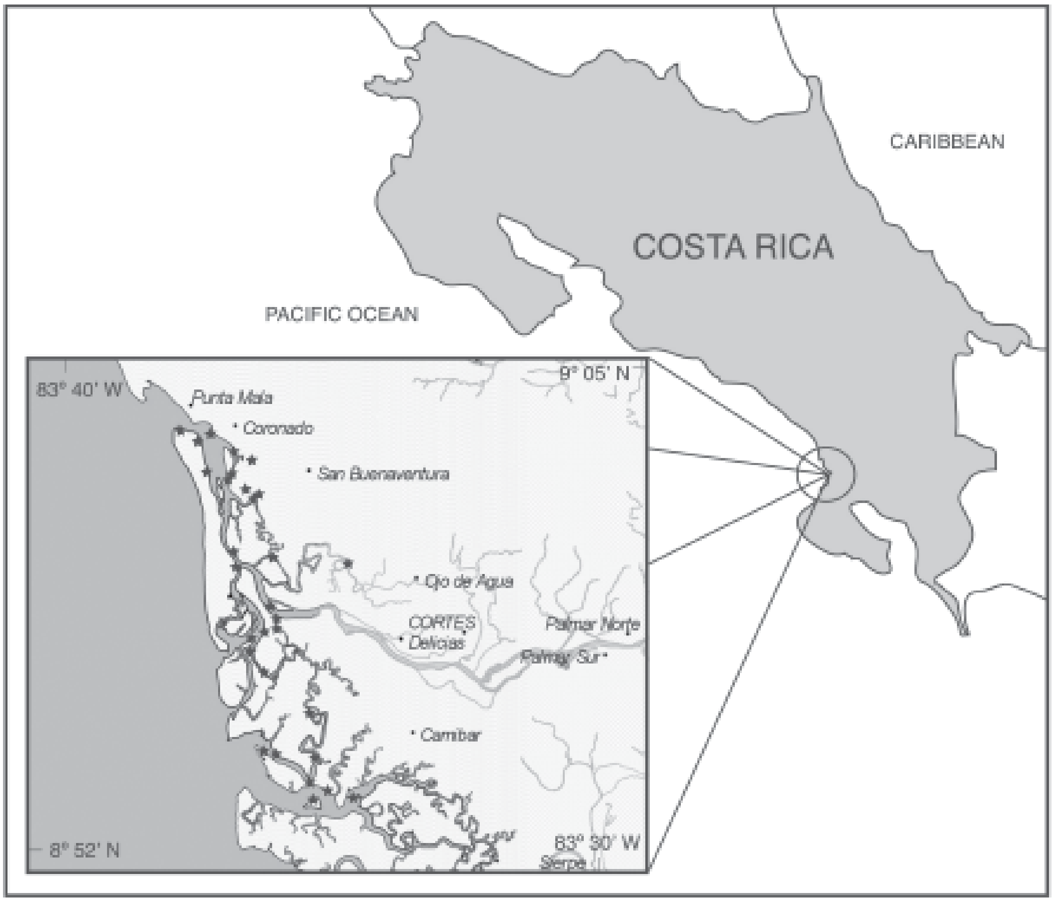

Figure 1: Study site at the southern Pacific coast of Costa Rica, Central America. Each black star indicates a sampling location.

Materials and Methods

Ten fieldtrips were conducted from July 2002 through July 2003 to collect decapods; the majority of these collections (eight) were carried out during daytime, and two at night. At each sampling site, the following information was recorded: date, time of the day, tidal condition, technique used to collect the material, and the geographical location via GPS. In addition, we measured the salinity and temperature of the water (conductivity hand-held meter WTW LF 340) as well as the type of sediment according to the following qualitative criteria: sandy, hard-muddy (compact and with little humidity), soft-muddy (fine, non-compact and moist) or a mixture of mud and sand.

Benthic decapods, such as shrimps and portunid crabs, were collected by different types of locally-used push nets. Decapods living in sediments were collected using a suction pump consisting of a plastic tube of 5.5 cm in diameter. This pump was placed on top of the burrow entrance, and the suction sample was released into a 1 mm sieve to separate the organisms. Other used technique was performed removing some mud (even when there are no visible holes) with a garden scoop and sieve the obtained sediments through the 1 mm sieve. To collect decapods living inside wood in decomposition (fallen logs), a piece of log of about 15 cm diameter and 40 cm length was taken during each fieldtrip from the mangrove floor and bagged to transport it to the laboratory. Upon arrival, the log was broken into pieces and submerged in a 5% formaldehyde solution to make sure that all the organisms were dead and out of the wood. Subsequently, all the pieces were sieved through the 1 mm mesh, and the concentrate was sorted through a dissecting microscope.

All samples were processed and the specimens were deposited at the Museum of Zoology of the University of Costa Rica, San José. The collected organisms were fixed in a 5% formaldehyde solution and subsequently stored in 70% alcohol.

Results

The material collected during the study period was composed by 52 species of decapods, representing 29 genera and 16 families (Table I). The taxonomically most diverse family of crabs and shrimps were Ocypodidae (14 species) and Palaemonidae (six species), respectively. The families Atyiidae, Upogebiidae, Hippidae, Diogenidae, Coenobitidae, and Pinnotheridae were represented just one species each. The most common genera (collected at least during three different months) were *Uca* Leach, 1814 *Callinectes* Stimpson, 1860, *Clibanarius* Dana, 1851 *Panopeus* Milne-Edwards*,* 1834 *Goniopsis* de Haan, 1833, *Macrobrachium* Bate, 1868 and *Palaemon* Weber, 1795.

Figure 2 provides an overview of families, genera and number of species collected in different types of habitats within the mangrove system studied here. The highest number of families, genera and species were encountered in tidal channels, mudflats and root sediments. Less diverse were sandy beaches, decomposing logs, and hard mud with non-mangrove vegetation.

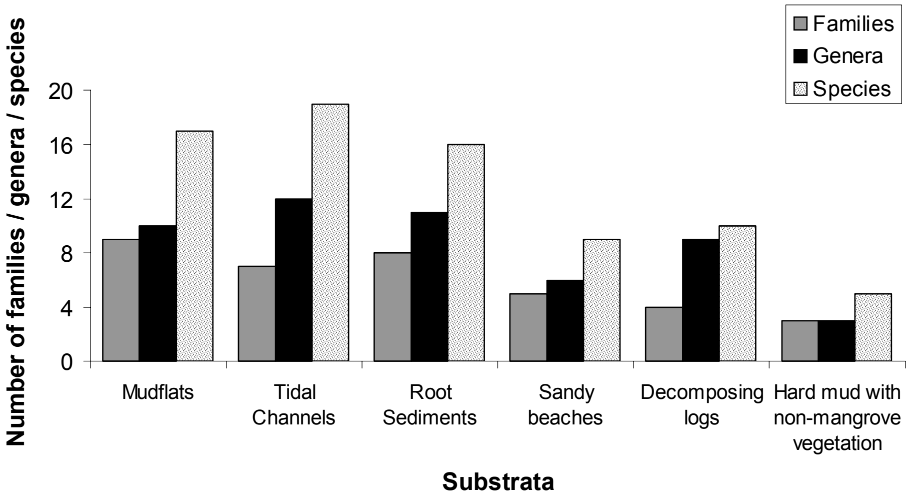

Figure 2: Number of families, genera and species of decapods per substratum collected from July 2002 through July 2003 at Térraba-Sierpe, Pacific Costa Rica.

Table I: Results of the decapod inventory at Térraba-Sierpe, Pacific Costa Rica. Part I Penaeoidea, Caridea and Thalassinidea.

Penaeoidea	Caridea	Thalassinidea
Penaeidae	**Atyidae**	**Upogebiidae**
-*Farfantepenaeus brevirostris* (Kingsley, 1878)	-*Potimirim glabra* Kingsley, 1878	-*Upogebia maccraryae* Williams, 1986
-*Litopenaeus stylirostris* (Stimpson, 1874)	**Palaemonidae**	
-*Litopenaeus vannamei* (Boone, 1931)	-*Macrobrachium panamense* Rathbun, 1912	
-*Trachysalambria brevisuturae* (Burkenroad, 1934)	-*Macrobrachium transandicum* Holthuis, 1950	
	-*Palaemon ritteri* Holmes, 1895	
	-*Palaemon gracilis* (Smith, 1871)	
	-*Palaemon hancocki* Holthuis, 1950	
	-*Palaemonetes schmitti* Holthuis, 1950	
	Alpheidae	
	-*Alpheus bouvieri* Milne-Edwards, 1878	
	-*Alpheus hamus* King & Abele, 1988	
	-*Alpheus mazatlanicus* Wicksten, 1983	
	-*Alpheus tenuis* King & Abele, 1988	

Table I: Results of the decapod inventory at Térraba-Sierpe, Pacific Costa Rica. Part II Anomura and Brachyura.

Anomura	Brachyura	
Porcellanidae -*Petrolisthes zacae* Haig, 1968 -*Petrolisthes robsonae* Glassell, 1945 **Hippidae** -*Emerita rathbunae* Schmitt, 1935 **Coenobitidae** -*Coenobita compressus* Milne-Edwards, 1837 **Diogenidae** -*Clibanarius panamensis* Stimpson, 1859	**Portunidae** -*Callinectes arcuatus* Ordway, 1863 -*Callinectes toxotes* Ordway, 1863 **Goneplacidae** -*Prionoplax ciliata* Smith, 1870 -*Cyrtoplax schmitti* Rathbun, 1935 **Xanthidae** -*Acantholobulus miraflorescensis* (Abele & King, 1989) -*Hexapanopeus nicaraguensis* (Rathbun, 1904) -*Panopeus chilensis* Milne-Edwards & Lucas, 1844 **Pinnotheridae** -*Pinnixa valerii* Rathbun, 1931 **Gecarcinidae** -*Gecarcinus lateralis lateralis* (Freminville, 1835) -*Gecarcinus quadratus lateralis* Saussure, 1853 -*Ucides occidentalis* (Ortmann, 1854) -*Cardisoma crassum* Smith, 1870 **Grapsidae** -*Sesarma rhizophorae* Rathbun, 1906 -*Sesarma aequatoriale* Ortmann, 1894 -*Armases occidentale* (Smith, 870) -*Goniopsis pulchra* (Lockington, 1876) -*Aratus pisonii* (Milne-Edwards, 1853)	**Ocypodidae** -*Ocypode gaudichaudii* Milne-Edwards & Lucas, 1843 -*Ocypode occidentalis* Stimpson, 1860 -*Uca festae* Nobili, 1902 -*Uca galapagensis herradurensis* Bott, 1954 -*Uca argillicola* Crane, 1941 -*Uca stenodactylus* (Milne-Edwards & Lucas, 1843) -*Uca stylifera* (Milne-Edwards, 1852) -*Uca heteropleura* (Smith, 1870) -*Uca oerstedi* Rathbun, 1904 -*Uca thayeri umbratila* Crane, 1941 -*Uca princeps princeps* (Smith, 1870) -*Uca saltitanta* Crane, 1941 -*Uca inaequalis* Rathbun, 1935 -*Uca zacae* Crane, 1941

Discussion

Abele (1974) revised the species diversity of decapod crustaceans in tropical marine habitats, and concluded that the rocky intertidal (Caribbean, Panama: 67 spp.; Pacific Panama: 78 spp.) and corals (Pacific Panama: 55 spp.) contained the highest number of species. Mangrove species diversity was relatively low (Caribbean of Panama: 17 spp.; Pacific Panama: 20 spp.), and only sandy beaches, sand-mud beaches and *Spartina*-communities inhabited less decapod species. Results of our study clearly demonstrate that decapod species diversity is considerably higher at Térraba-Sierpe than in Panama (Abele, 1974); considering the 52 species collected in the study area, this diversity would place the mangroves close to corals.

Species diversity of decapods associated with the mangrove system of Térraba-Sierpe is very high (52 species, 29 genera and 16 families) when compared to the results obtained in other areas of Latin America: Félix Pico (pers. com.) found 20 species, 17 genera and 11 families in mangroves of Baja California Sur (Mexico); Hendrickx (1984) reported 31 species, 19 genera and 12 families in a mangrove on the mainland side of the Gulf of California (Sinaloa, Mexico); Coelho (1965) studied different mangroves in northwestern Brazil and reported a total of 38 species, 23 genera and 14 families. Ferreira and Sankarankutty (2002) listed a total of 69 decapod species; however, their study comprised two estuarine systems in northern Brazil, thus not only mangroves.

Perhaps the most extensive species list of decapods in mangroves concerns the Pacific coast of Colombia: the list published by von Prahl *et al.* (1990) comprises a total of 106 species, 51 genera and 22 families, combining the available information from all mangroves along the Colombian Pacific coast, including islands. From these 106 species, 37 have been found in Térraba-Sierpe. With a relatively short sampling period spent in this work and only one mangrove system sampled, almost 50% of the number of species reported for the entire Pacific coast of Colombia was registered in Costa Rica. Regarding east African mangroves, Cannicci (unpubl. data) combined the results of his personal observations during ten years of mangrove research in this area with published literature reports, and found a total of 47 species, 30 genera and 10 families. In comparison with the results from mangroves in Latin America and east Africa, Térraba-Sierpe can be considered as a mangrove system with a very high diversity of decapod species.

Ocypodidae and Grapsidae were the most diverse crab families (14 and five species, respectively) in our study area, which compares favorable with the results of other investigations carried out in Latin America (Coelho, 1965; Jones, 1984; Macintosh, 1988; von Prahl *et al.*, 1990; Cobo *et al.*, 1994; Oshiro *et al.*, 1998) and east Africa (Jones, 1984; Hartnoll *et al.*, 2002 and references cited therein; Cannicci, unpubl. data).

Brachyuran crabs are considered as predominant organisms in mangrove communities (Macintosh, 1988). However, the second most diverse group in our study area was palaemonid shrimps with six species (Table I). Species lists from other mangrove systems confirm the numerical importance of Palaemonidae and Penaeidae within this habitat (von Prahl *et al.*, 1990). It should be stressed, however, that most studies refer exclusively to brachyuran crabs (Jones, 1984; Pita *et al.*, 1985; Branco, 1990; Cobo *et al.*, 1994; Vergara-Filho, 1994; Oshiro *et al.*, 1998; Salgado-Barragán and Hendrickx, 2002). This situation may have lead to a sub-estimation of the taxonomic diversity of non-brachyuran decapods inhabiting mangroves.

Tidal channels contained the highest species number, followed by mudflats and root sediments; the other substrata studied here had a considerably lower diversity of decapod species (Fig. 2). Abele (1974) differentiated the mangroves of Panama in different substrata; however, he did not provide species diversity per substratum. According to Coelho (1965), tidal channels (12 spp.) and root sediments (9 spp.) were the most diverse substrates in mangrove systems studied in northeastern Brazil. These authors listed also decapod species associated with decomposing logs; their number (five spp.) is substantially lower compared to the results of the present study (10 spp.; Fig. 2). Although we found more species than reported for Brazilian mangroves, our results of the distribution of species diversity per substratum compare favorable to the findings of Coelho (1965).

In terms of species per substrata, we encountered similar results than those reported by Jones (1984): portunids were typical for drainage channels, *Uca* spp. for mudflats, panopeids for decaying wood logs, sesarmids for mangrove floor, and *Aratus pisonii* was a characteristic representative for tree canopies.

Even though the Térraba-Sierpe area cannot be considered as an undisturbed site, the present results clearly demonstrate that a single mangrove area can serve as an important reservoir of decapod species. We assume that the relatively large extension and the high complexity of the mangrove system favor the high species diversity observed here. Any plan to modify this system should be studied carefully to avoid negative effects on species composition and diversity.

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