Diversity of Mangrove Crabs in South and South East Asia

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Abstract: Crabs are the most abundant of the mangrove macrofauna and valuable asset to the mangroves; it may belong to many different species and even families. Crabs have often been considered to be ‘keystone species’ in mangroves because of their role in carbon recycling. They keep much of the energy within the forest by burying and consuming leaf litter. Crab processed organic matter could also form the basis of a coprophagous food chain involving small invertebrates, or be re-exported as micro-particles. Species richness of mangrove brachyuran crabs parallel species richness not only of the mangrove tree species themselves but also of the total area of mangrove forest. Among the macrofauna commonly colonizing mangrove forests, brachyuran crabs are one of the most important taxa with regard to both the number of species and the total biomass and they can reach densities to about 80-90 per m². Among the more than 300 species of brachyuran crabs reported from mangroves worldwide, two families, the Grapsidae and Ocypodidae, account for over 80% of the species diversity. This paper attempts to review and evaluate the diversity, zonation and the ecological role of the mangrove crabs and discuss the implications and future prospects of such findings for mangrove crabs conservation especially in the Indo-Pacific region.

Key words: Mangrove Crabs • Diversity • Zonation • Leaf Litter Processing • Nitrogen Cycle • Carbon Excavation

INTRODUCTION

Mangrove ecosystems cover less than one percent (1%) of the Earth’s surface, but are ecologically, physically and economically important [1]. The mangrove macrobenthos- those species that live in mangrove mud or depend on mangroves for all or part of their life-cycle- encompasses a number of phyla, including Porifera (sponges), Mollusca (molluscs), Arthropoda (crabs, lobsters, prawns, etc.), Annelida (segmented worms), Nematoda (roundworms), Sipunculoidea (peanutworms), Platynhelminthes (flatworms) and Ascidians. Although species inventories exist for some groups within each of these phyla in select mangrove ecosystems around the world, there exist comprehensive global data only for some gastropod molluscs and the major families of brachyuran crabs.

Global Richness of Crab Species: Assemblages of brachyuran crabs in the family Grapsidae, subfamily Sesarminae, are common in coastal environment and a variety of other moist habitats in temperate and tropical regions worldwide. Jones [2] provided the first comprehensive review of mangrove crabs, describing the occurrence of 61 genera and sub-genera of crabs in mangrove ecosystems.

Many phylogenetic relationships within the subfamily sesarminae remain unresolved [3] and the taxonomy of this group can be confusing. Species within the genus Sesarma have been assigned to at least 20 subgenera and over 125 species, with populations found in and around both fresh and saline waters from the mountains to the edge of the sea [4, 5]. Adiwiryonon et al. [6] recorded as many as 16 species of grapsid crabs and 18 species of ocypodid crabs from the Tanjung Bungin mangrove forests, South Sumatra. Abele [7] recorded 23 species of Sesarma and Armases from America. However, only 5 species were found to be associated with mangroves. Chakraborty and Choudhury [8] reported a total of eighteen species of brachyuran crabs belonging to 11 genera and 4 families from the intertidal belt of Prentice in Sunderban mangroves of West Bengal. The study by Tan and Ng [9] represents the global peak of diversity of mangrove grapsids, recording 51 species of grapsids of...
which 44 are sesarmids, from the Peninsular Malaysia and Singapore. Ravichandran et al. [10] reported 17 species of crabs from the mangrove and oyster environment of Vellar estuary. In a recent study 45 species of brachyuran crabs including 15 species of grapsids were documented from Pichavaram mangrove environment of Southeast coast of India by [9] (Tables 1-4). As with the distribution of mangrove species, there is considerable difference in the occurrence and diversity of mangrove grapsid crab species between the eastern and western mangroves [11].

Species richness of mangrove brachyuran crabs parallel species richness not only of the mangrove tree species themselves, but also of the total area of mangrove forest in 1980; all of these metrics reach their maximum in the Indo-West Pacific. Among the macrofauna commonly colonizing mangrove forests, brachyuran crabs are one of the most important taxa with regard to both the number of species and the total biomass [9, 11] and they can reach densities to about 80-90 per m² [12]. Among the more than 300 species of brachyuran crabs reported from mangroves worldwide, two families, the Grapsidae and Ocypodidae, account for over 80% of the species diversity [3].

Tan and Ng [8] reported 44 species of Sesarminae alone from Singapore and Peninsular Malaysian mangroves. Similar high species richness has also been recorded for grapsid and sesarmine crabs from mangroves in Hong Kong - 926 species of mangrove-associated sesarmines and Australian - 37 species [9].

### Table 1: Diversity of grapsid and sesarmine crabs associated with mangroves

<table>
<thead>
<tr>
<th>Locality</th>
<th>No. grapsid spp.</th>
<th>No. sesarmine spp.</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. Pacific</td>
<td>50</td>
<td>11</td>
<td>Stimpson (1907)</td>
</tr>
<tr>
<td>Selangor, Malaysia</td>
<td>13</td>
<td>12</td>
<td>Sasekumar (1974)</td>
</tr>
<tr>
<td>Australian Mangroves</td>
<td>45</td>
<td>37</td>
<td>Davie (1982)</td>
</tr>
<tr>
<td>Malaysian-Singapore Mangroves</td>
<td>51</td>
<td>44</td>
<td>Tan and Ng (1994)</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>31</td>
<td>26</td>
<td>Lee (1998)</td>
</tr>
<tr>
<td>Sunderban, India</td>
<td>6</td>
<td>4</td>
<td>Chakraborty and Choudhury (1994)</td>
</tr>
<tr>
<td>Pichavaram, India</td>
<td>15</td>
<td>8</td>
<td>Ravichandran and Kannupandi (2007)</td>
</tr>
</tbody>
</table>

### Table 2: Common Moreton Bay mangrove crab species from two dominant families (Andrew, 2004)

<table>
<thead>
<tr>
<th>Family</th>
<th>Species Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grapsidae</td>
<td>Australoplax tridentata</td>
<td>Furry-clawed crab</td>
</tr>
<tr>
<td></td>
<td>Paracleistostoma wardi</td>
<td>Ward’s hairy-legged crab</td>
</tr>
<tr>
<td></td>
<td>Helograpsus haswellianus</td>
<td>Haswell’s shore crab</td>
</tr>
<tr>
<td></td>
<td>Parasesarma erythrodactyla</td>
<td>Red-fingered marsh crab</td>
</tr>
<tr>
<td></td>
<td>Perisesarma messa</td>
<td>Maroon mangrove crab</td>
</tr>
<tr>
<td></td>
<td>Neosarmatium trispinosum</td>
<td>Scarlet mangrove crab</td>
</tr>
<tr>
<td></td>
<td>Metapograpsus frontalis</td>
<td>Broad-fronted mangrove crab</td>
</tr>
<tr>
<td>Ocypodidae</td>
<td>Heloecius cordiformis</td>
<td>Semaphore crab</td>
</tr>
<tr>
<td></td>
<td>Uca coarctata</td>
<td>Orange-clawed fiddler crab</td>
</tr>
<tr>
<td></td>
<td>Uca longidigita</td>
<td>Grey-clawed fiddler crab</td>
</tr>
<tr>
<td></td>
<td>Uca vomeris</td>
<td>Two-toned fiddler crab</td>
</tr>
<tr>
<td></td>
<td>Uca polita</td>
<td>Pink-clawed fiddler crab</td>
</tr>
<tr>
<td></td>
<td>Uca perplexa</td>
<td>Yellow-clawed fiddler crab</td>
</tr>
</tbody>
</table>

### Table 3: Mangrove leaf litter turnover exerted by grapsid crabs in the Indo-Pacific region

<table>
<thead>
<tr>
<th>Crab sp.</th>
<th>Mangrove sp.</th>
<th>Consumption rate</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesarma erythrodactyla</td>
<td>Avicennia marina, Bruguiera gymnorrhiza, Rhizophora stylosa</td>
<td>1.4-3.6 g dwt day⁻¹</td>
<td>Camillero (1984)</td>
</tr>
<tr>
<td>Sesarma + Cleistoceoloma</td>
<td>Mixed spp.</td>
<td>20-30%</td>
<td>Leh and Sasekumar (1986)</td>
</tr>
<tr>
<td>Sesarma messa</td>
<td>Rhizophora spp.</td>
<td>&gt; 28%</td>
<td>Robertson (1986)</td>
</tr>
<tr>
<td>Neosarmatium smithii</td>
<td>Ceriops tagal</td>
<td>4.62 mg wwt g⁻¹ Crab wwt day⁻¹</td>
<td>Giddens et al. (1986)</td>
</tr>
<tr>
<td>Perisesarma bidens Parasesarma affinis</td>
<td>Kandelia candel</td>
<td>&gt; 57%</td>
<td>Lee (1989)</td>
</tr>
<tr>
<td>Neopisesarma + Chiromantes</td>
<td>Rhizophora apiculata</td>
<td>&gt; 100%</td>
<td>Poovachiranon and Tantichodok (1991)</td>
</tr>
<tr>
<td>Sesarma meiniierii</td>
<td>Avicennia marina</td>
<td>44%</td>
<td>Emmerson and McGwynne (1992)</td>
</tr>
<tr>
<td>Sesarma meiniierii</td>
<td>Bruguiera gymnorrhiza</td>
<td>0.0137-0.3683 0.0366-0.3420 g dwt g⁻¹ crab dwt day⁻¹</td>
<td>Steinke et al. (1993)</td>
</tr>
</tbody>
</table>

Consumption rates are given either as percentage of leaf litter production or in units specified.
Diversity of Mangrove Crabs: The diversity of the mangrove grapsids is also demonstrated by the large variety of habitats, especially the many microhabitats they use and even their diet [14]. A few species are arboreal, e.g. *Aratus pisonii* of the Americas grazes on live mangrove leaves in the canopy [15], *Sesarma leptosoma* migrates vertically along mangrove tree trunks [16]. The diversity of the mangrove grapsid crabs is also exemplified by their wide feeding habits (Table 1). While most species of Sesarmidae are either grazers or shredder-detritivores dependent on mangrove biomass, many species of the larger grapsids (notably species of *Metopograpus* and *Helice*) are predatory on other crabs. Some even feed on insects in the mangrove, e.g. *Metopograpus latifrons* has been recorded to prey on the cicada *Meimuna iwasakii* [17]. It is, however, unlikely that the crabs routinely use such highly mobile prey as a major food source. Consumption of mangrove propagules or leaf litter by grapsid crabs has profound ecological consequences to ecosystem structure and function but the mechanism of the process itself is also intriguing.

Andrew Prosser [3] investigated the vertical distribution of grapsid crabs in the mangrove Dieback in Moreton Bay. Grapsid crabs are restricted to the mid-upper intertidal regions of the mangrove forest. *Parasesarma erythrodactyla* distributions were reduced in the oil affected regions but *P. messa* is absent in these areas. Interestingly, *Helograpsus haswellianus* has extended its distribution towards the creek.

More than 20 species of mangrove crabs inhabit Moreton Bay (Table 2). Among these, 3 species are most abundant [18]. The herbivorous Red-fingered marsh crab (*Parasesarma erythrodactyla*) is a medium sized grapsid crab abundant in the upper intertidal zone of mangrove forests, which feeds upon mangrove products (e.g. leaves, propagules) and is believed to have a highly important role in nutrient cycling in subtropical mangrove ecosystems [19]. Haswell’s shore crab (*Helograpsus haswellianus*) is distributed throughout saltmarshes that is back mangrove forests and is subsequently believed to be adapted to the physiological constraints found in saltmarsh areas [20].

One major finding of the ecological and taxonomic investigations conducted in Indo-West-Pacific mangrove ecosystems in the past decade is the profound importance of crabs, mostly of the sub-family Sesarmidae, to the structure and function of the mangroves [21]. The sesarmines attain extreme diversity and richness in the Indo-Pacific mangroves. The account by Jones [14], which must now be considered grossly outdated, first discussed the taxonomic diversity and potential ecological importance of brachyuran crabs in mangrove ecosystems. More recent works have pointed to much higher taxonomic diversity and confirmed the ecological significance of crabs, in especially in the Indo-Pacific mangroves. Environmental change in the area is affecting the local crab population, both positively and negatively, through the creation or destruction of habitats necessary for the diversity of these species.

Zonation of Mangrove Crabs: The structural complexity influences the density and diversity of marine organisms and contributes to Zonation [22]. Some of the recent studies reported the maximum number of crab species in the neritic zone and the minimum number of species in freshwater zone of Pichavaram mangrove environment of India [8, 24, 9]. Similarly in the *Avicennia* zone (*Avicennia* dominated regions) more number of species were recorded and least number of crabs in the slightly or non-saline zone.

In Pichavaram mangrove the highest crab species was found to be distributed in the Chinnavaikal region. Chinnavaikal is a neritic zone, which promotes crab diversity. Sesarmid crabs are common in all the islands but they are abundant in Peryakadvau which is a dense mangrove area. Interestingly *Portunus* sp., *Podaphthalmus* sp., *Ocypode* sp., *Dorippa* sp. and *Dotilla* sp. were observed only in the Chinnavaikal region which has more neritic influence (Fig. 2).

Salinity and temperature along with substrate suitability were reported to be the factors controlling zonation of crabs [23]. Griffin [14] studied the zonation of grapsid and ocypodid crabs in relation to the wave action and the length of time during the particular zones were uncovered by water. Distribution and zonation of crabs are based on the substratum, water level and floral distribution. The Ghost crab, *Ocypode macrocera*, preferred sandy substratum, whereas *Macrophithalmus* species preferred only muddy substratum. *Uca* species was found in dry or grassy, elevated and muddy substratum [9]. The *Ocypode* was found above the high water mark, while members of the sub family Ocypodidae were dwellers in the mud below high water neap [25].

Based on vegetation, Pichavaram mangrove can be broadly divided into the following zones viz. *Rhizophora* zone, *Avicennia* zone, back mangrove zone and non-saline or slightly saline zone. Among these
zones, *Avicennia* zone was found to have more number of crab species (22) and very less number (1) of crabs in the non-saline zone. *Cardisoma carnifex* was found commonly in all the zones except in *Rhizophora* zone while *Thalamita*, *Charybdis* and *Psychognathus* species were seen only in the *Rhizophora* zone [26]. In Jamaica mangrove swamp [27] observed the self-constructed burrows to be occupied by the ocypodids, *Uca rapax* and *U. thayeri* and the gecardinids, *Cardisoma guanhumi* and *Ucides cordatus*. Warner also categorized Portal Royal Swamp into five different zones.

Vannini *et al.* [28] reported the zonation of the crabs across the disturbed part of the mangrove forest at Nogmeni, on the seaward edges of the creek outside the mangrove canopy, there were *Uca urvillei* and *Macrophthalmus depressus*. In the zone where mangrove had not been cleared it was observed that *U. urvillei* and *M. depressus* had extended their distribution into the mangroves. These species were as common in the mangroves as on the seaward edges without mangrove cover.

Chakraborty and Choudhury [8] reported the zonation of brachyuran crabs in a Virgin mangrove island of Sundarbans. They found the mid-littoral zone (50-500m) harbour maximum number of brachyuran species. The dominant representative of this zone was found to be sesarmid group of mangrove crab. This group includes four species of which *Sesarma longiceps* and *S. pictum* are very rarely noticed. The dominant species of the genus *Sesarma*, are *S. taeniolatum* and *S. chiromantes bidens*. *Uca acuta* another dominant mangrove crab species, because of its abundance and surface activity, is also encouraged in this zone. The other species of mangrove crabs recorded from this zone are *Dotillopsis brevitarsis, Uca triangularis bengali, Euricarcinus grandidieri, Metaplex intermedia, M. indica, Metapograpsus messor, M. maculatus*.

Zonation of the biomass can be caused by difference in predation pressure, food supply and habitability of the substratum. Besides, the pattern of distribution of individuals’ species seems to be dictated of individual’s species seems to be inundation and exposure and desiccation must exert prejudicial impact on the existence of benthic fauna in those severely stressed habitats.

Various factors influencing the distribution and abundance of *Uca* spp., the most important are the substratum, salinity and competition in the biotic system. The fluctuating temperature, salinity variation, water availability and rain fall might be an important factor for regulating the distribution pattern of crabs. As the temperature within the burrow of crabs does not fluctuate in relation to the temperature of air and soil, the temperature is not supposed to play a great role in the zonation of crabs.

**Role of Mangrove Crabs:** Crabs are the most abundant of the mangrove macro-fauna and are a valuable asset to the mangrove ecosystem. Mangrove crabs are crabs that live among mangroves and may belong to many different species and even families. Crabs feed omnivorously on both lower (e.g., leaves, decaying organic matter) and higher tropic levels (insects, mollusces, fish). Crabs have often been considered to be ‘keystone species’ [29] in mangroves because of their role in carbon recycling [30]. They have been shown to be ecologically significant in many ways. They keep much of the energy within the forest by burying and consuming leaf litter. Furthermore, their feces may form the basis of a coprophagous food.
chain contributing to mangrove secondary production [31, 32]. As mentioned [33] crab larvae are the major source of food for juvenile fish inhabiting the adjacent waterways, indicating that crabs also help near shore fisheries.

Ecology of crabs in a mangrove ecosystem was studied [34] for the first time. It appears that crab diversity may be positively correlated with mangrove diversity [35], but confirmation of such a relationship still awaits further comprehensive surveys of mangrove crab assemblages over wider latitudinal gradients. While a reliable method for estimating crab density in mangroves has yet to be devised, surveys using pitfall traps [36] and visual counts [35] suggest high abundances throughout the Indo-Pacific mangroves.

**Leaf Litter Processing:** The flux of energy in mangroves is essentially a two-step process; the first being the transfer of fixed synthesized energy to the benthic environment in the form of leaf litter (Table 3). The second step consists of the breakdown of this litter to a form fit for heterotrophy. Submersion in water results in the rapid leaching of nutrients from mangrove leaves, which can then be broken down by microbial action, macrofauna such as crabs, or the physical impact of tides [37]. By consuming leaf litter, mangrove crabs substantially reduce export, shorten decomposition time and enhance nutrient cycling [31, 38]. More importantly, their bioturbation activities help to retain organic matter and nutrients within the mangrove ecosystem [39].

Mangrove crabs are believed to be a highly significant link in the detritus food web, facilitating nutrient transport to other forest organisms that would otherwise be lost via tidal export in the increase in crab mortality and also in the reduction to survivors’ health (e.g. their moulting frequency and reproductive capacity) caused by the limited supply of nutrients [40]. *Neosarmatium meinerti* lives in the landward *Avicennia marina* in the mangrove fringe of Kenya. Like many sesarmid crabs, *N. meinerti* is considered to be mainly herbivorous and it probably plays an important role in the process of leaf degradation and thus in biogeochemical cycles.

Many species of mangrove crabs are known to be herbivorous. These crabs probably play an important role in the process of leaf degradation, making mangrove leaves more rapidly available to meiofauna (Fig. 4). Ocypodid species can feed on mangrove pneumatophores, eat bark and macro-algae. While the herbivorous crabs are strongly linked to roots and mangrove leaves, some predators, such as *Scylla serrata* (Forskal) and *Goniopsis cruenata* (Latreille) and other species of Grapsidae have been reported to feed mostly on plant matter in situ, but also on dead crabs and fishes in captivity.

**CONCLUSION**

Mangrove ecosystems have both detritus-based food webs based on decaying plant tissue (leaf litter and coarse woody debris) and production-based food webs based on living mangrove tissue. Arthropods and gastropods occur in the middle of each of these food webs. For example, littorinid snails graze on fungi or algae that grow on leaves and trunks whereas cerithids and elobiids are detritivores. Some crabs (e.g., *Sesarma brockii*; *Aratus pisonii*) consume living leaves and propagules, whereas others (e.g., *Ucides cordatus*, *Scylla serrata*, *Goniopsis cruenata*, *Latreille*), and other species of Grapsidae have been reported to feed mostly on plant matter in situ, but also on dead crabs and fishes in captivity.

**Fig. 4:** Comparison of plant materials in the gut content of some mangrove crabs

![Graph of plant materials in the gut content of some mangrove crabs](image)
Perisesarma messa) remove and shred leaf litter. Prawns are omnivorous, with diets consisting of bacteria, algae, protozoa, copepods, nematodes and other meiofauna living on sediment surfaces.

As animals grow, the benefits of a particular habitat can change. It may become advantageous for those animals to migrate to different habitats, disguising initial settlement patterns. Crabs feed omnivorously on both lower (e.g., leaves, decaying organic matter) and higher tropic levels (insects, mollusks and fish). Crabs have often been considered to be ‘keystone species’ in mangroves because of their role in carbon recycling. Mangroves are threatened by pollution, mariculture and changes in the sea level and salinity. The global impact of threats has been poorly understood, as mangrove ecology and conservation are usually approached at a local rather than a global scale. A global approach to research on mangrove taxa can provide a more complete view of the factors responsible for the observed patterns of differentiation and will be useful to future efforts to conserve mangrove forests.

ACKNOWLEDGEMENT

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