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Diversity and abundance of mangrove fiddle crabs, genus *Uca* (Decapoda, Ocypodidae) at a mangrove in Kema, North Sulawesi, Indonesia

RIANTA Pratiwi[1]*, ERNAWATI Widyastuti[1], CHEN Guangcheng[2], CHEN Shunyang[2]

[1] Research Center for Oceanography, Indonesian Institute of Sciences, Jakarta 14430, Indonesia

[2] Third Institute of Oceanography, Ministry of Natural Resources, Xiamen 361005, China

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Abstract

Mangrove ecosystems are sites with high biodiversity of benthic fauna, and fiddler crabs (genus *Uca*) are common benthic fauna in mangroves. The North Sulawesi in Indonesia has a good condition of mangrove while the information of the fiddler crabs is still limited. Manual samplings were conducted in wet, dry and transient seasons at a mangrove in Kema, North Sulawesi to investigate the species composition, density and distribution pattern of fiddler crabs. A total of 168 individuals, subjected to eight species of genus *Uca* crabs were collected at the mangrove, with *U. triangularis* having the highest abundance and *U. annulipes* having the lowest abundance. The densities of fiddle crabs were 27.56 ind./m^2, 32.89 ind./m^2 and 14.22 ind./m^2 at the seaward, middle and landward zones, respectively, and the density was higher in dry and wet seasons than in transient season.

Key words: Crustacea, genus *Uca*, species, mangrove, North Sulawesi, Indonesia

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1 Introduction

Mangrove ecosystems support a high biodiversity of benthic fauna because they provide organic matter and nutrients critical to the benthic fauna, and contribute to habitat complexity of the fauna community (Hutchings and Saenger, 1987; Chen et al., 2008). One of the benthic fauna groups which well adapts to the intertidal environment is the fiddler crabs (genus *Uca*) belonging to Ocypodid crabs. They form an important brachyuran component worldwide in the intertidal flats, especially where near mangrove forest in the tropical and subtropical regions (Sari, 2004; Zeil et al., 2006; Barnes, 2010; Naderloo et al., 2010). Numerous *Uca* spp. species have been found in a rich abundance in the mangrove habitats (Crane, 1975; Shih et al., 1999). Crane (1975) recognized a total of 59 *Uca* spp. species around the world; however, according to recent studies (Rosenberg, 2001, 2002, 2003, 2014; Beinlich and von Hagen, 2006; Ng et al., 2008; Barnes, 2010; Nabout et al., 2010), there are more than 100 *Uca* spp. species.

Most *Uca* spp. species were reported to be restricted within certain biotopes, because their diversity and abundance (especially those burrowing species) are strongly influenced by environmental factors such as the soil particle size, soil humidity, tidal regime, slope of tidal-flat and food availability (Martin, 2006; Pratiwi, 2007a; Tureli et al., 2009; Murniati, 2010, 2015; Takagi et al., 2010; Qureshi and Saher, 2012). The distribution of *Uca* spp. crabs thus has a spatial variation with habitat conditions (Geist et al., 2012).

Mangrove ecosystems are well known for their capability of adapting to the extremely coastal environments; however, these ecosystems are also vulnerable to environmental changes (Purnobasuki, 2004). The vast Indonesian archipelago with a mangrove area of 31 100 km^2, represents the world hot spot for mangrove extent, accounting 22.6% of the world wide mangrove (Giri et al., 2011). Although the mangrove area in North Sulawesi only represents 0.4% of total area in Indonesia (Pramudji, 2004), mangrove forests in this district are among the most distinctive and unusual in Southeast Asia because of the species that the forests contain. However, currently, there has been little effort to protect these fragile mangrove habitats in this region, and as a result, there has been a substantial degradation of mangroves due to the construction of shrimp ponds and local wood harvesting. The anthropogenic disturbances like conversion of mangrove to farms would result in the change in crab diversity and abundance (Pramudji, 2004; Pratiwi, 2007b) and thus the baseline information is important for the biodiversity conservation. Considering that the ecological information on the benthic fauna communities is still scarce in this region, this research was conducted to investigate the composition and abundance of fiddle crabs at a mangrove in Kema, North Sulawesi, so as to provide ecological baseline information for future decision-making to strength the local efforts for marine biodiversity conservation.

2 Materials and methods

2.1 *Study area*

The North Sulawesi has a typical equatorial climate, and the

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*Corresponding author, E-mail: pratiwiafriadi@gmail.com

temperatures vary from 20°C to 28°C throughout the region and throughout the year. Tides in this area are mixed and mainly semi-diurnal, and fluctuate slightly with an annual tidal range of 2.4 m. Field samplings were conducted at a mangrove located in Kema, under good conditions with a dense canopy (1°23′02.40″N, 125°05′46.32″E) in North Sulawesi (Fig. 1). The mangrove site was ~200 m from the landward edge to the seaward edge, and samplings were undertaken at the stations with different distances from the land edge, i.e., the landward station (LW), middle zone (MZ) and seaward station (SW). The LW station was dominated by *Xylocarpus mollucensis* and *Rhizophora apiculata* also contributed a substantial proportion of trees, while the MZ and SW stations were dominated by *R. apiculata*.

2.2 *Crab sampling*

Field studies were carried out during the low tide period in January (wet season), August (dry season) and October (transient season) in 2015 at three sampling stations. Fiddle crabs were collected by a manual catching method in 15 min in three 0.5 m× 0.5 m quadrats at each station. Crabs on the floor including those escaping from the plots were rapidly caught by hand, and those hiding in burrows were digged out using a shovel. The crabs from the same quadrat were rinsed and then reserved gradually in 40% and 70% alcohol in the bottle for later identification. The *Uca* spp. crabs were counted and identified in laboratory according to the identification keys described by Allen (2010), Crane (1975), Davie and Kasuge (1995), George and Jones (1982), Murniati and Pratiwi (2015), Poore (2004), Rahayu and Setyadi (2009) and Rosenberg (2000).

3 Results

There was a total of 168 individuals of *Uca* spp. crabs collected at the Kema mangroves throughout the study, and we identified eight species, such as *U. triangularis*, *U. annulipes*, *U. coarctata*, *U. vocans*, *U. triangularis*, *U. chlorophthalmus*, *U. dussumieri* and *U. vomeris* (Table 1, Fig. 2). Most of these species were found at all of the three stations, expect *U. vocans* and *U. vomeris* which were not collected at the middle zone (Table 1).

Among the eight species, *U. triangularis* had the highest abundance and the total number collected was 77. The total individual numbers of other three species, *U. coarctata*, *U. vomeris* and *U. chlorophthalmus* were close and ranged from 19 to 25, while the numbers of *U. dussumieri*, *U. vocans* and *U. annulipes* were less than 10.

The abundance of *Uca* spp. crabs were higher at the SW and MZ stations than the LW station and *U. triangularis* also had higher abundances at the SW and MZ stations (>30 individuals collected). The MZ station had the highest *U. coarctata* number among the three stations. The respective densities of *Uca* spp. crabs were 27.56 ind./m^2, 32.89 ind./m^2 and 14.22 ind./m^2 at the SW, MZ and LW stations, respectively, and the mean density was 24.89 ind./m^2 at the Kema mangrove (Table 2). We recorded the highest abundances of *Uca* spp. crabs in the dry season with a total of 72 individuals collected, and *U. triangularis* and *U. vomeris* also had their highest abundances in the dry season (Table 3).

4 Discussion

Fiddle crabs is a common macrobenthos group in mangroves because they are able to adapt well to the environmental settings of the ecosystems (Ashton et al., 2003; Murniati, 2010), while their distributions are limited to the intertidal habitats. According to Soedibjo and Aswandy (2007), the crustacean species are closely associated with various environmental factors in the intertidal areas. Crane (1975) mentioned that *Uca* crabs can survive in environments with low salinity rather than high salinity. In addition to the salinity, substrate textureis an other factor that substantially influences the distribution of the *Uca* spp. crab (Macintosh, 1988; Lim, 2005). Lim (2005) suggested that more crabs were found in the muddy substrate than in the sand substrate. Apparently there was only one species *U. annulipes* that was found in the sandy substrate while the other species inhabited in the soft substrate in this study (Table 4). This could be because the soft substrate could provide better food sources than the sandy substrate (Lim, 2005; Murniati, 2009). Murniati (2009) also reported that *U. annulipes*, *U. triangularis* and *U. coarctata* that inhabit mangroves were subjected to different substrate types. *Uca annulipes* crabs inhabit holes and graze on the sandy substrate, while they are also found in the muddy substrate. The

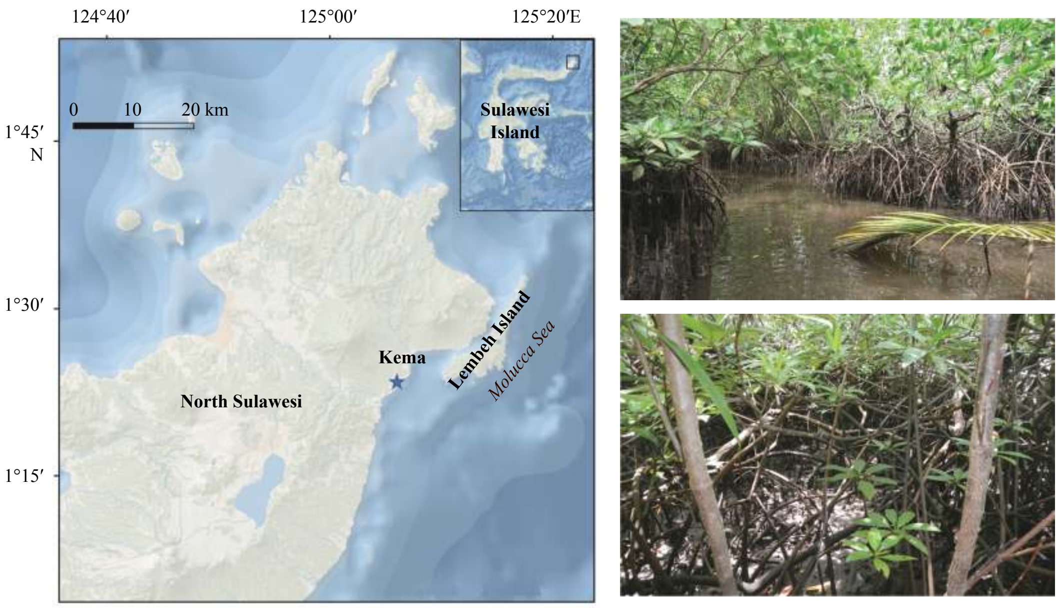

Fig. 1. Location of Kema mangroves in North Sulawesi, Indonesia, and the typical scenes of mangrove canopy.

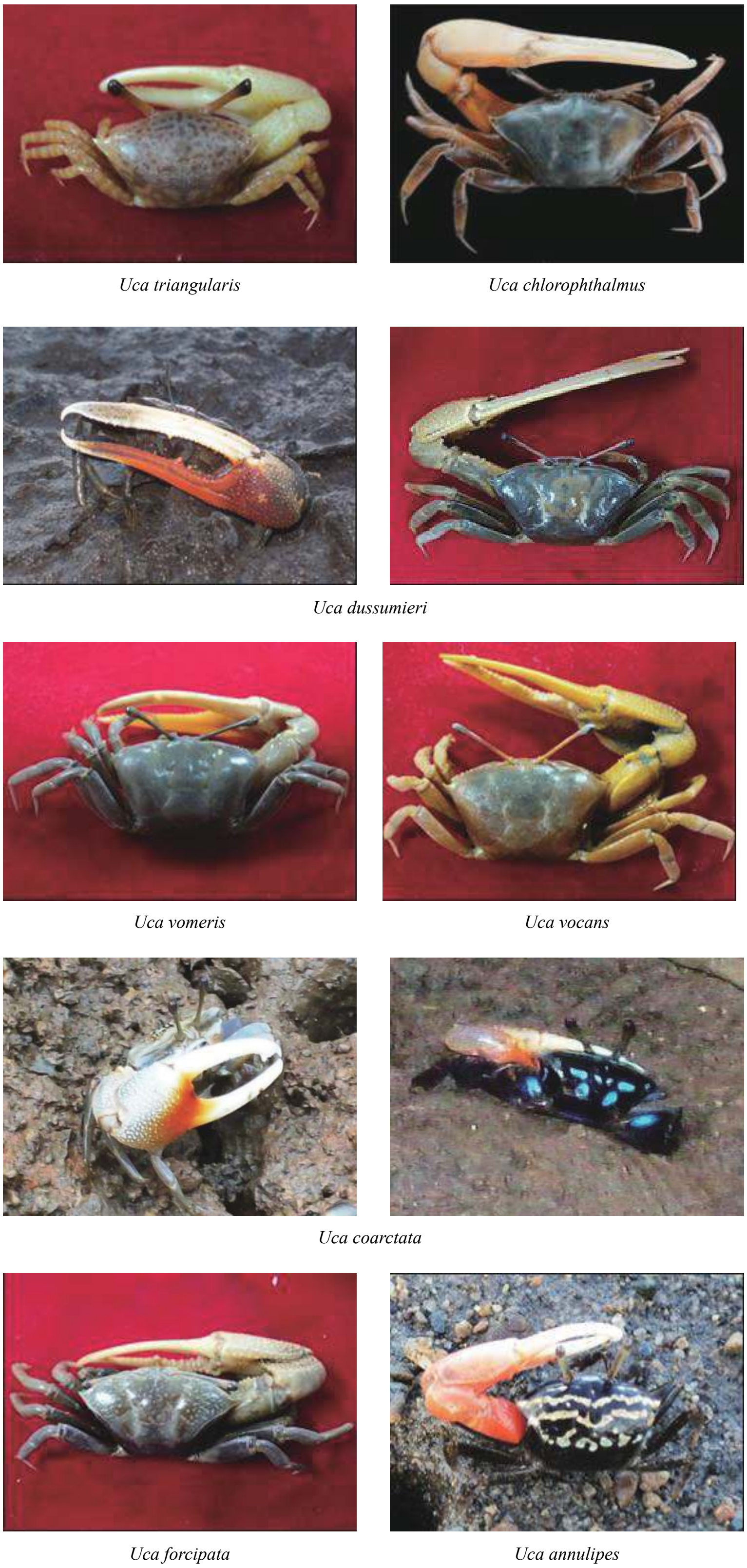

Fig. 2. Pictures of the eight species of genus *Uca*.

U. triangularis and *U. coarctata* crabs are often found in muddy substrate with a high water content (Murniati, 2009).

In additional to *U. triangularis*, *U. chlorophthalmus*, *U. coarctata* and *U. vomeris* were also found at the three different stations (SW, MZ and LW). Each station has different habitat, i.e., the SW station was the fringe site and more exposed to the tidal flooding while the LW station was likely to have a higher tidal elevation and less flooded. The results in this study suggested that these four fiddler crab species had a highly adaptive capability or high tolerance to different habitat conditions, which has also

Table 1. Total number and species of *Uca* crabs collected at the three stations at Kema mangrove, North Sulawesi, Indonesia

Species	SW	MZ	LW	Total
Uca annulipes	3	0	1	4
Uca chlorophthalmus	12	5	2	19
Uca coarctata	4	15	6	25
Uca dussumieri	3	2	1	6
Uca forcipata	3	6	2	11
Uca triangularis	33	32	12	77
Uca vocans	2	0	4	6
Uca vomeris	2	14	4	20
Total individuals	62	74	32	168
Total species	8	6	8	–

Note: SW represents seaward, MZ middle zone, and LW landward.

Table 2. Densities (ind./m²) of fiddle crabs at the Kema mangrove, North Sulawesi

Species	SW	MZ	LW	Whole forest
Uca annulipes	1.33	0.00	0.44	0.59
Uca chlorophthalmus	5.33	2.22	0.89	2.81
Uca coarctata	1.78	6.67	2.67	3.71
Uca dussumieri	1.33	0.89	0.44	0.89
Uca forcipata	1.33	2.67	0.89	1.63
Uca triangularis	14.67	14.22	5.33	11.41
Uca vocans	0.89	0.00	1.78	0.89
Uca vomeris	0.89	6.22	1.78	2.96
Total	27.56	32.89	14.22	24.89

Table 3. Total number and species of *Uca* crabs collected in the three seasons at Kema mangrove, North Sulawesi, Indonesia

Species	Wet	Dry	Transient	Total
Uca annulipes	2	2	0	4
Uca chlorophthalmus	7	8	4	19
Uca coarctata	10	11	4	25
Uca dussumieri	0	2	4	6
Uca forcipata	3	5	3	11
Uca triangularis	21	30	26	77
Uca vocans	6	0	0	6
Uca vomeris	5	14	1	20
Total individuals	54	72	42	168
Total species	8	7	6	–

Table 4. Microhabitat conditions of each *Uca* species collected at the Kema mangroves, North Sulawesi, Indonesia

Species	Substrate	Microhabitat
Uca annulipes	sandy	burrowing at sandy area and close to the creek
Uca coarctata	muddy	in the open area, close to the creek
Uca chlorophthalmus	muddy	–
Uca dussumieri	muddy	interior area of the mangrove
Uca forcipata	muddy	interior area of the mangrove
Uca triangularis	muddy	interior area of the mangrove with dense canopy and far from the creek
Uca vocans	muddy	interior area of the mangrove
Uca vomeris	muddy	interior area of the mangrove

been suggested by Pratiwi (2009).

As was suggested, the shade provided by mangrove vegetation adversely affected the distribution of *Uca* spp. crabs and complex structures of vegetation also impacted their communication by visual signaling or waving, burrowing and refuge from predators in mangroves (Chen et al., 2007). The densities of *Uca* spp. crabs obtained in this study were lower than those reported by Chen et al. (2007) at an estuarine mangrove, suggesting that the dense and oceanic mangrove in Kema did not provide a habitat as good as the estuarine habitat. Among the eight species recorded, *U. triangularis* had the highest abudance, suggesting that this species was more adaptive to the dense mangrove environment than the other speices. *Uca triangularis* was found to be more abundantat areas with a dense vegetation and far away from the waterway, while *U. coarctata* was generally distributed in open area out of the mangrove and close to the waterway (Murniati, 2009). There was also a spatial variation of *Uca* spp. abundance among the three sampling stations in this study, with a low density measured at the landward zone than other two stations. We suspected that the lower abundance of *Uca* spp. crabs was due to that the buttress roots developed by *X. mollucensis* trees limited the burrowing activities and movements of *Uca* spp. crabs.

Pratiwi (2007b) suggested that some *Uca* spp. species can coexist in the same area, but they usually had different behavior patterns and biological characteristics, and these differences were related to their ecological niche and microhabitat characteristics. In this study, the *U. triangularis* population was the largest population among all species with a smaller size compared to other species. However, the presence of *U. triangularis* did not exclude the occurrence of other *Uca* spp. species and it was found in the same habitat as those of other species. *Uca* spp. crabs are deposit-grazing on the mangrove floor using maxilipeds, so the difference in their habitat was related to their morphological differences (Bezerra et al., 2006; Murniati, 2009). The cover areas of the spoon tipped setae on second maxiliped of each *Uca* spp. species could partially account for their adaptions to habitat conditions (Murniati, 2009). Bezerra et al. (2006) and Maitland (1990) suggested that second maxiliped played an important role in separating food particles from the sediment. The coarse particles could be separated by spoon tipped setae to avoid being sent into the mouth. This suggested that those species with large cover spoon tipped setae on the second maxilliped could live in a substrate with more coarse particles, while for those living in muddy substrate, the second maxiliped had fewer spoon tipped setae and more pulmose setae.

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