INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 13, Issue 3, July-September 2022: 961-972 www.ijcs.ro

AN ECOLOGICAL ASSESSMENT OF CRAB'S DIVERSITY AMONG HABITATS OF MIGRATORY BIRDS AT BERBAK-SEMBILANG NATIONAL PARK INDONESIA

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Abstract

Crabs have an important role in the food chain among the habitat of migratory birds at Berbak-Sembilang National Park (BSNP), due to it is the main food for these birds' population. The purpose of this study was to record the crabs' species found among the habitat of migratory birds at BSNP. The methodology used is a survey by measuring environmental parameter data and sampling crabs, where the identification of species is carried out morphologically and analyzed with references. The results showed that there were three species of crabs found on the BSNP coast, where it was identified as a species of Uca dussumieri (Edwards, 1852) (C1), Metaplax longipes (Stimpson, 1858) (C2), and Metaplax distinct (Edwards, 1852) (C3). Habitat of crabs are found on fine muddy substrates at a depth of about 60 to 80 cm, pH 6.08 to 6.2, salinity 27 to 29 psu, temperature 29 to 30 ^oC, nitrates and phosphates in water 6.69 mg L^{-1} and 0.197 mg L^{-1}. This condition is very suitable for the growth of crabs. In the future, research should be carried out on chemical-ecological interactions of crabs and another biota.

Keywords*: Benthic; Crustacean; Migratory birds; Mud crab; Berbak-Sembilang National Park*

Introduction

Crabs are a group of crustaceans that are easily found in the Berbak-Sembilang National Park area, which is the main food source for migratory birds while in transit twice a year. The birds are reported to have originated from Siberia in the Northern Hemisphere and Australia in the Southern Hemisphere. The birds are reported to be transiting October-November from Siberia in the northern hemisphere to Australia in the southern hemisphere, and they will transit in March-April to return to the north [1]. In the transit season, the number of birds that have been reported reaches 1600 individuals for resting and foraging for food in marine life. Crabs are their main food in the intertidal area of this habitat [2-4].

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Morphologically, the crab has a very hard carapace to protect its body, it also has a pair of claws as a means of capturing prey and defense from predators. In addition, he can run quickly into the mud using four pairs of legs. It has a color and pattern adapted to the clarity of the waters or the substrate of its habitat, such as it is bright or lighter in sandy or rocky areas. Instead, it will be dark in turbid or muddy waters [5-9]. In general, the intertidal area of the Berbak-Sembilang National Park is mud-substrate, especially in the habitat of migratory birds. Therefore, these crabs are classified as mud crabs and are very suitable for their growth [10].

Based on this information, the ecological role of crabs in the food chain in the Berbak-Sembilang National Park area is very important. Therefore, this study is indispensable for a report on the crab species that feed on migratory birds, which will greatly assist further research in the area.

Experimental part

Sampling site

Habitat crabs is a transit area for migratory birds in the Berbak-Sembilang National Park, Indonesia, which is an estuary area with extensive mangrove vegetation. The migratory birds species in this area are *Calidris alpina*, *Charadrius mongolus*, *Limosa lapponica*, *Limosa limosa*, *Limonodromus semipalmatus*, *Numenius arquata*, *Tringanebularia*, and *Tringa tetanus* [11]. Besides that, stork and shorebirds were also found [12]. However, at the sampling time of 25 October 2020, there was no large flock of migratory birds due to it was not the bird's arrival season, namely November and March. This region and its surroundings have a mud substrate, is commonly covered by mangrove *Avicennia marina* species [13-15], and is directly affected by the freshwater masses from the Barong and Banyuasin rivers [16, 17]. Map of sampling location is presented on (Fig. 1).

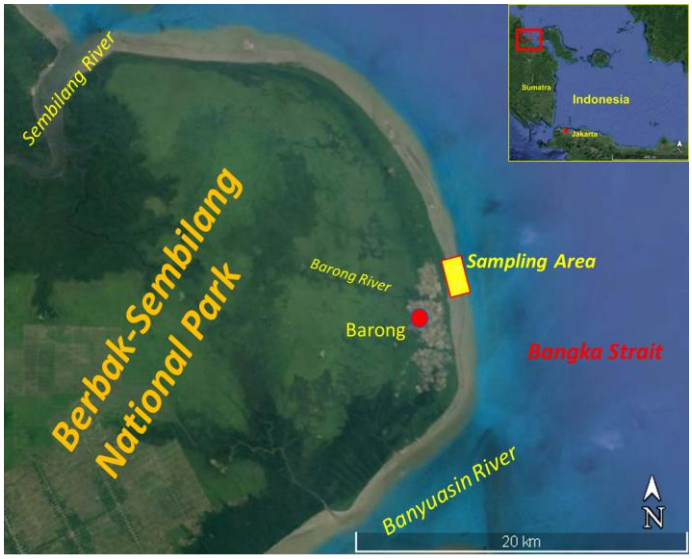

Fig. 1. Sampling site

Methods

This research was conducted using a survey method, with the location of the coordinate points 2.1638972 S and 104.9075056 ˚E. Crabs were randomly sampled by being captured in mud, washed with clean water in the plastic sample, and added with 10% formalin solution.

Environmental parameters such as salinity, temperature, pH, current, dissolved oxygen, nitrate, and phosphate are measured as supporting data.

In the laboratory, the samples were rinsed with clean water. The carapace, abdomen, legs, joints and claws were measured and weighed. Morphological identification was carried out by refer to [18-23].

Results and discussion

There were three species of crab found in the sampling location which were identified as *Uca dussumieri* (Edwards, 1852) (C1), *Metaplax longipes* (Stimpson, 1858) (C2), and *Metaplax distinct* (Edwards, 1852) (C3). The mass supply of freshwater from the Barong and Banyuasin Rivers causes the color of the water to become cloudy because it is influenced by high suspended materials (Fig. 2).

On the substrate, fine black mud was found with a depth of 60 to 100 cm. The results of the environmental parameter measured salinity was 27 to 29 psu, temperature was 29 to 30°C, pH was 6.08 to 6.2, nitrate and phosphate were 6.69 and 0.197 mg L^{-1}.

Fig. 2. Crabs habitat of migratory birds ground at Berbak-Sembilang National Park

Species of Uca dussumieri (Edwards, 1852) (C1)

There were 14 individuals coded C1-14 of the station observation. Morphologically, it looked unique in the size of the claws, which was bigger in one (Fig. 3).

Fig. 3. Details of the morphological characters *Uca dussumieri* (Edwards, 1852) species (C1) that are considered for morphometric analysis: (a) carapace, (b) cheliped, (c) leg, (d) abdomen

When the big claw is damaged or broken, it will grow back or the other claws will enlarge. It is colored bright yellowish, and rash or serrated on the surface of the dactylus, propodus and carpus. The carapace resembles a trapezoid with a wider anterior side and a pointed tip, it is called the trapezoidal carapace. It colored brownish black, dark brown and blackish orange [24]. The eyeball is black and round with a long eye shaft approaching the anterior end of the carapace. This crab has five pairs of legs, one pair in the front of the claw, and four pairs of walking legs. The abdomen is bluish in the shape of an elongated triangle.

Based on the morphological characteristics, this species is classified as a fiddler crab, it has similarities with several other species such as *Uca demani* and *Uca urvillei* [25, 26]. It can be found in muddy areas of mangrove areas [27, 28]. The results of the morphometric measurements of this species are detailed in Table 1.

Table 1. Morphometric data of *Uca dussumieri* (Edwards, 1852) species (C1)

Data	Number Code (C1)	Sample Size (mm) Min - Max	Average
Carapace Data			
Anterior carapace width (ACW)	1	12.8 – 25	18.15
Posterior carapace width (PCW)	2	5.5 – 14.27	9.92
Internal carapace width (ICW)	3	9.85 – 25	13.86
Carapace length (CL)	4	6.66 – 11.83	9.08
Eye stalk length (ESL)	5	4.72 – 9.59	6.98
Cheliped Data			
Dactyl major length (DML)	6	20.38 – 54.82	34.71
Dactyl minor length (DmL)	6	11.25 – 21.11	16.71
Propodus major width (PMW)	7	6.01 – 12.1	8.9
Propodus minor width (PmW)	7	1.72 – 2.81	2.1
Walking Leg Data			
1st Leg length (1LL)	8	14.13 – 28.23	20.98
2nd Leg length (2LL)	8	12.69 – 31	22.3
3rd Leg length (3LL)	8	12.72 – 28.08	21.05
4th Leg length (4LL)	8	11.15 – 24.45	17.73
Abdomen Data			
Abdomen length (AL)	9	5.21 – 12.83	8.43
Abdomen width (AW)	10	5.6 – 11	8.29

Spesies Metaplax longipes (Stimpson, 1858) (C2)

Only one individual was obtained at the sampling site, it had a dark brown carapace, but lighter carapace color elsewhere was also found (Fig. 4). The carapace is a rounded square with a shorter underside or is called a squarish or subquadrate carapace. This species has a pair of claws that are the same size and longer than four pairs of walking legs. The claws are orange-brown, while other features are the very long propodus part, short dactyl, and the cheliped surface is quite smooth [26]. The eyeball is black with the length of the eye shaft extending to the anterior end of the carapace.This crab has five pairs of legs consisting of one pair of claws and four walking legs. The second and third walking feet are longer than the first and fourth legs. The abdomen is light brown, and has an elongated triangular shape. The genus of this species is Metaplax from the family Varunidae. Based on the morphology and phylogenetic tree, this species has similarities with *Metaplax takahashii*, *Cyclograpsus granulosus*, *Helice wuana*, and *Eriocheir japonica* [26, 29]. Almost all species of this genus are found in muddy habitats near mangrove ecosystems, they are also found in sandy substrate dominated by seawater [29-31]. The results of the morphometric measurements of this species are detailed in Table 2.

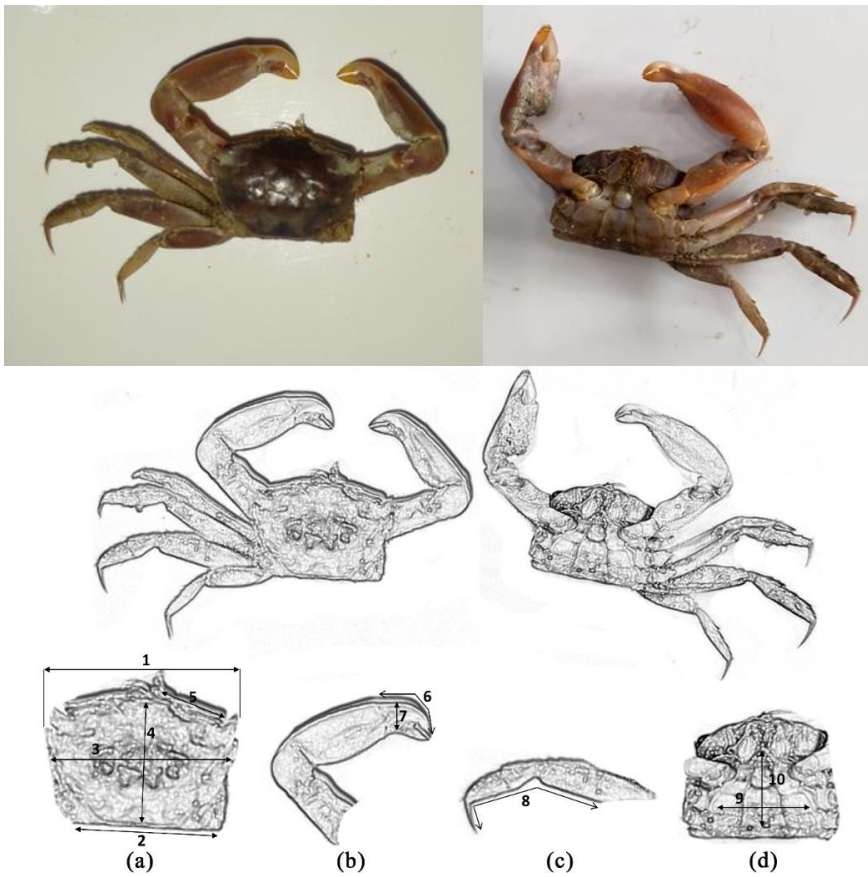

Fig. 4. Details of the morphological characters *Metaplax longipes* (Stimpson, 1858) (C2) species that considered for morphometric analysis:
(a) carapace, (b) cheliped, (c) leg, (d) abdomen

Table 2. Morphometric data of *Metaplax longipes* (Stimpson, 1858) (C2) species

Data	Number Code (C2)	Sample Size (mm)	Average
Carapace Data			
Anterior carapace width (ACW)	1	11	11
Posterior carapace width (PCW)	2	6	6
Internal carapace width (ICW)	3	8.92	8.92
Carapace length (CL)	4	6.16	6.16
Eye stalk length (ESL)	5	3.35	3.35
Cheliped Data			
Dactyl length (DL)	6	22.3	22.3
Propodus width (PW)	7	5.7	5.7
Leg Data			
1st Leg length (1LL)	8	15.2	15.2
2nd Leg length (2LL)	8	19.87	19.87
3rd Leg length (3LL)	8	19.99	19.99
4th Leg length (4LL)	8	12.76	12.76
Abdomen Data			
Abdomen length (AL)	9	7.22	7.22
Abdomen width (AW)	10	2.57	2.57

Species of Metaplax distinct (Edwards, 1852) (C3)

Two individuals were captured in the sampling location (Fig. 5). The carapace is rectangular with slightly rounded sides and a lower side that is shorter than the top which is called a subquadrate or squarish. The carapace is predominantly dark brown color, with both anterior sides tapering. The claws of this species are short and small compared to the walking legs, this indicates the sex of the female, because this female species has a pair of claws that are shorter and smaller than the male species [32, 33]. The claws are predominantly blackish red with orange dactyls. The two eyeballs are round black with a stem that extends almost to the outer side of the anterior. There are five pairs of legs, one pair of claws and four pairs of walking legs. The sizes of the second and third walking legs are longer than the first and fourth walking legs. This species is female, with a broad and rounded triangular abdomen [34]. This species has similarities with *Metaplax gocongensis* and *Metaplax indica* [7]. It is classified in the Varunidae family, also called crabs with muddy estuarine habitats, found mostly in mangrove areas and sandy beaches [31, 35]. The results of the morphometric measurements of this species are detailed in Table 3.

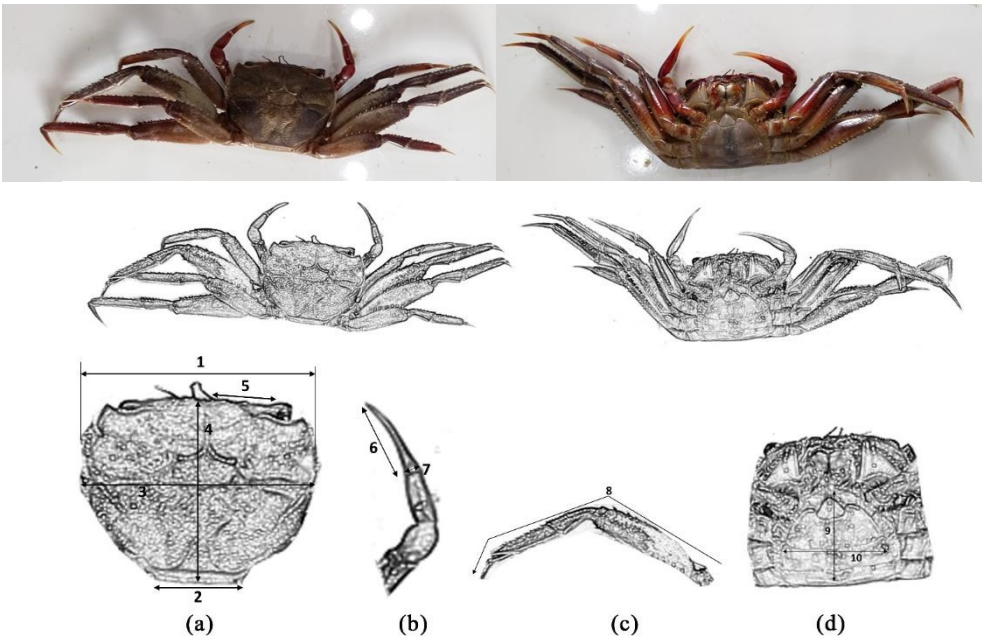

Fig. 5. Details of the morphological characters *Metaplax distinct* (Edwards, 1852) (C3) species that considered for morphometric analysis:
(a) carapace, (b) cheliped, (c) leg, (d) abdomen

Table 3. Morphometric data of *Metaplax distincta* (Edwards, 1852) (C3) species

Data	Number Code (C3)	Sample Size (mm) Min-Max	Average
Carapace Data			
Anterior carapace width (ACW)	1	24.05 - 24.98	24.52
Posterior carapace width (PCW)	2	11.62 – 11.79	11.71
Internal carapace width (ICW)	3	22.41 – 22.42	22.42
Carapace length (CL)	4	11.04 – 12.29	11.67
Eye stalk length (ESL)	5	5.87 – 6.24	6.06
Cheliped Data			

Data	Number Code (C3)	Sample Size (mm) Min-Max	Average
Dactyl length (DL)	6	28.33 – 28.85	28.59
Propodus width (PW)	7	3.37 – 3.46	3.42
Leg Data			
1st Leg length (1LL)	8	37.76 - 38.85	38.31
2nd Leg length (2LL)	8	49.93 – 50.09	50.01
3rd Leg length (3LL)	8	54.96 – 55.18	55.07
4th Leg length (4LL)	8	41.59 - 45.55	43.57
Abdomen Data			
Abdomen length (AL)	9	17.29 – 17.41	17.35
Abdomen width (AW)	10	15.71 – 16.34	16.03

Discussion

The identification of crab species is determined based on its morphological shape. Several parts of the crab body are used as references in identification, such as the shape and pattern of the carapace, the shape and color of the claws, the shape of the eyes, the shape and number of legs, and the pattern of the abdomen [18, 36]. The carapaces of the three crab species found at the sampling location show the trapezoidal and squarish shapes, these correspond to the 14 carapace forms described by [23], the crab carapace shape is divided into 14 parts, namely longitudinally rectangular, transversely rectangular, squarish, trapezoidal, pentagonal, hexagonal, transversely hexagonal, transversely ovate, longitudinally ovate, transversely subovate, triangular, circular, subcircular, and pyriform.

Uca dussumieri (Edwards, 1852) (C1) species is unique in a pair of claws of different sizes, one larger than the other, but the shape and pattern of the claws are shown to be the same. Several studies have reported the uniqueness of the crab *Uca dussumieri* (Edwards, 1852) species. The uniqueness of the claws in this species, if there is damage or breakage, it will grow back to its original state. The process of growing a claw can be done in two ways, namely: first, it grows in the part where it is broken, and second, it grows on the part of the smallest claw that becomes enlarged [37-40]. *Uca dussumieri* (Edwards, 1852) is a fiddler crab from the Ocypodidae family [41, 42].

Uca dussumieri (Edwards, 1852) (C1) species is strongly suspected to be the *Uca dussumieri* (Edwards, 1852) species. Based on the shape and color of the carapace, this species is shown to be trapezoidal and blackish brown, while the claws are yellowish white [21]. The *Uca dussumieri* (Edwards, 1852) species is included in the crab that lives in the mud. This is also reported by [25]. Habitat of *Uca dussumieri* (Edwards, 1852) (C1) was collected around the muddy substrate mangrove area of Berbak-Sembilang National Park. This has a similarity to the *Uca dussumieri* (Edwards, 1852) habitat found by [43].

The *Metaplax longipes* (Stimpson, 1858) (C2) species have a squarish or subquadrate carapace form [26]. The carapace is dark brown with two sharp serrations on the anterior end. It has a pair of pincers the same size, cheliped this species is very long, especially the propodus, but the dactyl is relatively short and orange brown. Morphologically, this species is quite confusing to identify, but it is suspected as a species of *Metaplax longipes* (Stimpson, 1858). This species belongs to the family Varunidae is also known as the Thoracotrematan crabs family [44, 45]. The morphology of *Metaplax longipes* (Stimpson, 1858) is very similar to that of the Sesarmidae from the Grapsidae family, but the phylogenetic results are grouped into Varunidae [26, 29, 30], and it belongs to the deposit feeder crab class [46, 47].

Morphologically, *Metaplax distinct* (Edwards, 1852) (C3) has a subquadrate carapace shape, like a box and the posterior carapace tends to be rounded, is dark brown-black in color

and the claws colori s reddish-black with an orange chela. This carapace is the same as the species of the Varunidae group, but differs in the shape of the smaller claws, this indicates that it is a female type, where the species of the Varunidae group have a very small pair of claws compared to the male species. In addition, the abdomen is triangular shape [37, 48]. This species can live in habitats on muddy to sandy beaches [35]. It is also found in mangrove or estuary areas [4, 49]. In some cases, this species is found with a lighter carapace color, this is due to the environment in which it lives [50, 51]. Darker carapaces are found in muddy areas, while lighter carapaces are found in substrate areas that tend to be sandy [52].

Overall, the crabs found in this study are thought to belong to the small crabs from the Ocypodidae and Varunidae families. The two families also have something in common, as reported [53], that some of the Metaplax in the Varunidae group have the same behavioral characteristics as the Ocypodidae. The morphology and way of life also have similarities with the Macrophtalmus genus of Ocypodidae. All species found have habitats in the muddy mangrove ecosystem. Crabs have a role as a food source for several predators such as shorebirds and fish [54, 55], while in the Berbak-Sembilang National Park area as feeding ground migratory birds.

The three types of crabs found sare an important analysis in the future. Furthermore, this crab data can be used to explore bioactive compounds and also to correlate the benefits and disadvantages of migratory birds as a typical organism that crosses the Berbak-Sembilang National Park area.

Conclusions

Three types of crabs caught around migratory bird habitats in Berbak-Sembilang National Park were identified as *Uca dussumieri* (Edwards, 1852), *Metaplax longipes* (Stimpson, 1858) and *Metaplax distinct* (Edwards, 1852). The environmental parameter conditions are very suitable for the growth of these crabs. In addition to the fine mud substrate habitat, this is the first reported in the region, and it is also found to be a major source of food by migratory birds. In the future, research should be carried out on ecological interactions and compound content in crabs and other biota.

Acknowledgments

The research of this article was funded by Ministry of Research, Technology, and Higher Education of the Republic of Indonesia (Grant Number: 245/E5/PG.02.00.PT/2022). We thank you for surveying team to N.P Sari, A.W Walen, Novrialdi, Agung, K. Pangestu and all assistants of Marine Bioecology Laboratory for giving supports to accomplish this work.

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Received: May 12, 2021
Accepted: August 2, 2022