

Diversity of freshwater crab (decapoda) in meru betiri national park

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Abstract: The abundance of flora and fauna in tropical forests throughout Indonesia is very high. Indonesian fauna shows its diversity in terms of ecology found in various ecosystem types. One of them is freshwater ecosystem. Freshwater crabs have a wide habitat distribution so they can be found in various forms of freshwater. This study aimed to determine the level of diversity and determine the abiotic conditions of freshwater crab habitat. The location determination of sampling was done purposively along with road sampling. The tools used to catch freshwater crabs were bubu and tray net. The results obtained in the Meru Betiri National Park, especially in Andongrejo and Bandevalit resorts, revealed that five species of freshwater crabs consist of three families. The diversity index of freshwater crabs in both resorts is relatively low. That is because most freshwater crab species belongs to endemic animals because of their limited spreading ability, relatively low fecundity, and stenotopic habits. Meru Betiri National Park has abiotic conditions that are ideal for supporting freshwater crab life.

1. Introduction

Indonesia's tropical forests become one of the largest tropical forests in the world after Brazil on the South American continent and Congo on the African continent. The abundance of flora and fauna in tropical forests throughout Indonesia is very high and the rests which are still unknown remain unidentified [1]. Indonesian fauna shows its diversity in terms of ecology found in various ecosystem types both natural and artificial [2]. This ecosystem diversity has certainly provided diverse ecological conditions as well [3], including freshwater ecosystems.

Freshwater ecosystems are inhabited by benthic animals. One of them is a freshwater crab. Freshwater crabs are members of Decapoda Order group. The word Decapoda comes from the Greek words, Deca means "ten" and pous means "feet". Crabs include in Brachyura infra order, which both have the characteristics of five pairs of thoracic legs (Pereopod). In freshwater crabs, the first pereopod is modified as a cheliped, and the remaining four pairs are modified as walking legs. The body parts of freshwater crab consist of head, thorax and abdomen [4].

Freshwater crabs have a wide distribution of habitats so that they can be found in various forms of water ranging from waters that flow like streams in mountains and rivers, to relatively calm waters such as lakes, ponds, swamps, canals and ditches [5]. Many species of freshwater crabs that adapt to semi-terrestrial organisms, dig holes and climb trees. As long as their gill chambers are damp or have



water bubbles trapped inside, they can breathe and walk on the land. Caves with humid environmental conditions can also be an ideal habitat for freshwater crabs [6].

In the world, there are more than 6,700 known brachyuran crab species. There are a total of 238 genera and 1,476 species of freshwater crabs from 14 families (including 1,306 species of true freshwater crabs from eight families: Pseudothelphusidae, Trichodactylidae, Potamonautidae, Deckeniidae, Platythelphusidae, Potamidae, Gecarcinucidae and Parathelphusidae) [7]. In Indonesia, there are 120 species of freshwater crabs that have been found [8].

Changes in the quality of aquatic ecosystems and substrates will affect the abundance and diversity of crabs and other biota. On the other hand, the quality of freshwater ecosystems has a greater risk of disturbance compared to other ecosystems such as, human activity, climate, pollution, habitat change and invasive introduction of species. These conditions cause the fauna of freshwater ecosystems including freshwater crabs have the risk of extinction [9]. The data of fauna in Meru Betiri National Park only shows vertebrate groups. There is no information about the existence of invertebrate groups, especially freshwater crabs. This is the basis for exploration of freshwater crabs in various types of habitats in Meru Betiri National Park.

2. Sampling stations and methods

2.1 Sampling points

This research was conducted in Andongrejo and Bandalit resorts in Meru Betiri National Park, Jember Regency, East Java Province, Indonesia. The crab samples were obtained from 9 rivers. The sampling site is based on the availability of the habitat type. There were 3 sampling sites under Andongrejo (location 1 - 3) resort and 6 sampling site in Bandalit Resort (location 4-9). The following are the sampling locations (river): Location 1: settlement, Location 2: primary forest, Location 3: plantation, Location 4: settlement, Location 5: primary forest, Location 6: secondary forest, Location 7: monoculture forest, Location 8: coastal forest 1, Location 9: coastal forest 2.

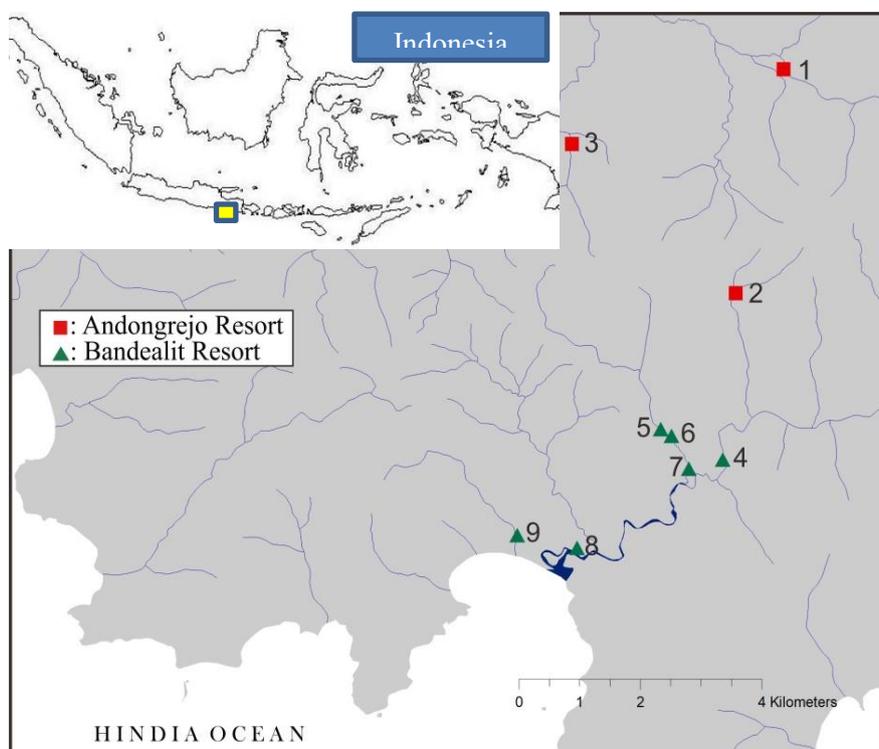


Figure 1. Sampling Points.

2.2 Sampling techniques

The Sampling was conducted based on the preference of freshwater crab habitat, such as rivers passing through settlement areas, plantation areas, secondary forests, and primary forests. The sampling was conducted on Maret 2019. Determination of the sampling zone was conducted by purposively at a predetermined location followed by road sampling [10], 200 meters long for each sampling site. The tools used to catch freshwater crabs in the water using tray net (40 x 60 cm) and trap (bubu). The tray net was positioned at the bottom of the river then shifted it to the edge so that the crab in front of it entered the net. Catching by using traps was conducted by inserting bait in the form of fish and worms into the trap then putting it in water till overnight. Crabs in riparian areas were taken directly by using bare hands.

The collected samples were preserved in 70% ethanol to keep the specimens in good condition and they are stored in the Zoological Laboratory, Biological Education, University of Jember. The abiotic factors measured were water current velocity, water temperature, Air humidity, water pH, depth and substrat.

2.3 Crab Identification

The samples were identified based on morphological characters according to Ng, PKL [11] based on the shape and morphological characteristics at the species level of *Parathelphusa* genus, starting from observations on the feet like the presence of thorns in the ambulatory meri, the direction of the postorbital crista, the shape of the carapace and the shape of the fourth line of the abdomen. The character used to determine the species of *Geosesarma* genus was the shape of chelipeds, the number of tubercles at the top of the dactylus and the shape of the terminal segment. The characters were checked by using Nikon SMZ745 stereo microscope.

2.4 Diversity Index Calculation

The calculation of diversity and crab population numbers was done by using Shannon-Wiener diversity index formula [12].

$$H' = - \sum pi \ln pi, pi = ni / N$$

Note:

ni : The number of individuals for the species observed

N : Total number of individuals

H' : Shannon-Wiener diversity index

Criteria for diversity result (H') are as follows:

$H' < 1$: Low diversity

$1 < H' \leq 3$: Medium diversity

$H' > 3$: High diversity

3. Result

3.1 Freshwater Crab Identification

Based on the identification of freshwater crabs that have been collected in Meru Betiri National Park, 5 species were found consisting of 3 families (Table 1). The existence of each species of freshwater crab was spread in a variety of different habitats.

Table 1. Identification results of freshwater crab species at Andongrejo and Bandealet resorts

No	Family	Genus	Species
1	Gecarcinucidae	<i>Parathelphusa</i>	<i>Parathelphusa convexa</i>
2	Gecarcinucidae	<i>Parathelphusa</i>	<i>Parathelphusa bogoriensis</i>
3	Sesarmidae	<i>Geosesarma</i>	<i>Geosesarma</i> sp.
4	sesarmidae	<i>Parasesarma</i>	<i>Parasesarma</i> sp.
5	Varunidae	<i>Varuna</i>	<i>Varuna litterata</i>

3.1.1 *Parathelphusa convexa* (De Man, 1897)

Parathelphusa convexa was only found in the settlement habitat of Andongrejo Resort. This crab was found behind rocks in a shallow river section. *Parathelphusa convexa* is a crab that spends more time in humid places in riparian areas and river banks, but sometimes they are also in the water. This species has characteristics on the first to fifth pereiopod merus consisting of sharp spines. Carapace is like Trapezoid-shaped with convex sides and surfaces. *Parathelphusa convexa* has relatively small eye characteristics compared to its body size and does not reach the side edges of carapace. The carapace of *Parathelphusa convexa* is brown in color and there are three anterolateral teeth on the edges. Maximized all three tightly closed without any gaps. The abdomen in male individuals shaped like T [13]. The ambulatory meri in *Parathelphusa convexa* has a space between the merus and carpus segments [14].

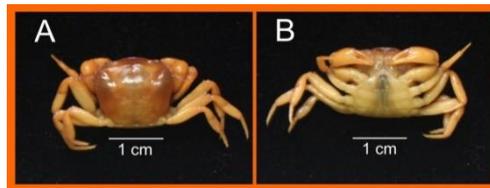


Figure 2. *Parathelphusa convexa* (A) Dorsal (B) ventral.

3.1.2 *Parathelphusa bogoriensis* (Bott, 1970)

Parathelphusa bogoriensis was found in primary forest habitat and settlement Resort Andongrejo. They hide behind rocks in the water. *Parathelphusa bogoriensis* is a crab that is always in the water. They have characteristics that are almost similar to *Parathelphusa convexa*. The distinguishing feature is that in *Parathelphusa bogoriensis* on the first to fifth pereiopod merus there are no thorns. *Parathelphusa bogoriensis* has a more flat carapace compared to *Parathelphusa convexa* and the merus and carpus segments of the ambulatory meri have no gaps [14]. *Parathelphusa* can be found in habitats with diverse substrate types such as rocks, sand and mud [13].

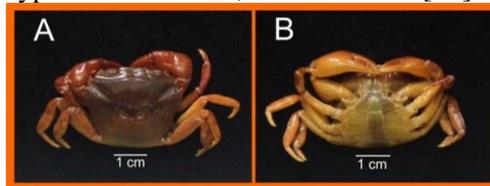


Figure 3. *Parathelphusa bogoriensis* Dorsal (A) and ventral (B).

3.1.3 *Geosesarma* sp. (De Man, 1892)

Geosesarma sp. was only found in the primary forest habitat of the Andongrejo Resort. They are more on land with humid conditions than in water. In addition, rocks that are on the banks of the river become an ideal habitat for this species. *Geosesarma* sp. is characterized by carapace shape that tends to be rectangular, flat surface, relatively large eyes, abdomen parabolic, telson tapered, composed of 5 segments, the first pleopod has a gap in the middle, there are hairs at the ends. The second pleopod has a larger and longer size than the first pleopod with no hair at the end. The third maxilliped is in convex-shaped, there is a gap in the middle, there is a rounded flagellum backward, the mandibular palpus has one lobe, haired, ambulatory meri has fine spines, a gap between the merus and carpus segments [14].



Figure 4. *Geosesarma* sp. Dorsal (A) and Ventral (B).

3.1.4 *Parasesarma* sp. (De Man, 1895)

Parasesarma sp. was only found in the coastal forest habitat 1 of Bandalit Resort. They are on land with mud as a substrate. These crabs usually make holes in mud or soil as a place to hide. Generally, *Parasesarma* sp. live in brackish waters. But sometimes they are also found in fresh waters close to the estuary. They have a square carapace, protruding eyes, and second to fifth pleopods are flat.



Figure 5. *Parasesarma* sp. Dorsal (A) and Ventral (B).

3.1.5 *Varuna litterata* (Fabricius, 1789)

Varuna litterata was found in all sampling locations. They are a type of crab that has a wide salinity tolerance range. *Varuna litterata* is always in the water and never rises to land. They have the characteristics of brown carapace which tend to be square with a smooth surface and straight on the front edge. *Varuna litterata* is a species of katadromus crab whose larval stage requires seawater but develops into adults in brackish / fresh water [15]. On the side of the carapace there are three antero-lateral teeth on each side. The three maxilliped form the rhomboidal cleft structure. The abdomen in male individuals is elongated in shape. The distinctive feature of *Varuna litterata* is the dactylus / finger, propodus and flat carapets, there is a long, tight seta at the edges [13].



Figure 6. *Varuna litterata* Dorsal (A) and ventral (B).

3.2 Diversity of freshwater crab

Based on the calculation data, the index value of the diversity of freshwater crabs in Andongrejo and Bandalit Resort Meru Betiri National Park is relatively low. Diversity index values were calculated using Shannon-Wiener diversity index formula (H'). Data from the diversity calculation of freshwater crabs can be seen in the following table.

Table 2. Calculation of freshwater crab diversity in Andongrejo Resort

No	Species	Total	Pi	$\frac{n(n-1)}{N(N-1)}$	LN Pi	PiLN Pi	H'
1	<i>Varuna Litterata</i>	10	0,156	88,593	-1,856	-0,290	0,290
2	<i>Parathelphusa</i>	8	0,125	55,125	-2,079	-0,259	0,259

3	<i>convexa</i>	42	0,656	1695,093	-0,421	-0,276	0,276
	<i>Parathelphusa</i>						
4	<i>bogoriensis</i>	4	0,062	11,812	-2,772	-0,173	0,173
	<i>Geosesarma</i> sp.						
Total		64	1	1850,625	-7,129	-0,999	0,999

Based on Table 2 above, it is known that Andongrejo Resort has a low level of freshwater crab diversity with a value of 0.999. The next is the diversity calculation of freshwater crabs in Bandalit Resort which can be seen in Table 3 below.

Table 3. Calculation of freshwater crab diversity in Bandalit Resort

No	Species	Total	Pi	$\frac{n(n-1)}{N(N-1)}$	LN Pi	PiLN Pi	H'
1	<i>Varuna litterata</i>	25	0,833	580	-0,182	-0,151	0,151
2	<i>Parasesarma</i> sp.	5	0,166	19,333	-1,791	-0,298	0,298
Total		30	1	599,333	-1,974	-0,450	0,450

Based on Table 3 above, it revealed that the freshwater crab diversity in Bandalit Resort is relatively low with a value of 0.450.

3.3 Abiotic Condition of Sampling Location

The abiotic conditions of each location can be seen in Table 4 below. The Bandalit Resort has a lower level of freshwater crab diversity than the Andongrejo Resort. Each sampling location has different abiotic conditions both in Andongrejo and Bandalit Resort.

Table 4. Abiotic conditions of sampling locations

Locati on	Water velocity (m/s)	Water Temp (°C)	Air humidity (%)	Water pH	Depth (m)	Substrat
1	0,24	27	75	7,5	0,25	Big rocks, sand
2	0,48	27	81	6,7	0,8	Big rocks, gravel, soil
3	0,87	26	77	7,2	1,2	Big rocks, gravel, soil
4	0,93	26	78	7,4	1,3	Soil, gravel
5	0,37	26	81	6,8	0,4	Big rocks, sand, soil
6	1,1	25	82	6,9	1,2	Big rocks, sand, soil
7	0,41	26	82	6,7	1,3	Big rocks, soil
8	0,79	27	70	6,9	0,5	Mud
9	0,73	26	71	7,1	1,4	Mud, leaf litter

4. Discussion

Measurement of species diversity was calculated by using Shannon-Wiener index. The results of diversity index calculation (H') of freshwater crabs at Andongrejo Resort were 0.999 and 0.540 at Bandalit Resort. The diversity of freshwater crabs in both resorts is relatively low. Species diversity can be used to measure the stability of a community, like the ability of a community to keep itself stable despite interference from its components [16].

Diversity of freshwater crabs especially in Indonesia has been done before. A research in a river flowing upstream from Mount Salak, Bogor, West Java found three species of freshwater crabs [17].

Then a research in Batanghari Regency and Sorolangun Regency in Jambi Province found 5 species of freshwater crabs [14]. Further research the diversity of crabs in the Opak river, Yogyakarta Special Region states that it found five species freshwater crabs scattered along the river with the condition of species composition in the estuary area higher than in the upstream to downstream areas [13]. The research in Gunung Palung National Park Panti Branch Park area in West Kalimantan stated that the number of freshwater crabs successfully obtained consisted of two families, with three species [18].

Based on the results of freshwater crab exploration conducted at Andongrejo Resort and Bandalit TNMB compared to the trend of freshwater crab research in other locations, the results of the trend of diversity tend to be low. This is caused by internal factors and external factors. The internal factors are because most freshwater crab species are endemic animals due to their limited spreading ability, relatively low fecundity, and stenotopic habits, which caused a low level of diversity. While the external factors are caused by the quality of freshwater ecosystems having a greater risk of disturbance compared to other ecosystems so that freshwater biota including freshwater crabs are affected by changes in water conditions.

Andongrejo and Bandalit Resort have a water pH range of 6.7-7.5. The ideal pH for freshwater biota life is 6.80 - 8.50. A very low degree of acidity (pH) can lead to greater solubility of metals in water which is toxic to aquatic organisms, while high pH can increase the concentration of ammonia in water which is also toxic to aquatic organisms [19]. Data obtained from the measurement of abiotic conditions reveals that in Meru Betiri National Park it has the lowest pH value of 6.7 in primary forest at Andongrejo and monoculture forest at Bandalit and the highest pH of 7.5 is Andongrejo settlement habitat type. These conditions indicate that freshwater crabs still have a tolerance with a pH of 6.7-7.5. Low pH is caused by high levels of carbon dioxide caused by the respiration of aquatic biota.

The water temperatures at Andongrejo and Bandalit Resort range from 25-27°C. Water temperature plays a role in the life of crabs especially freshwater crabs or other aquatic organisms including respiration, stability of feed consumption, metabolism, growth, behavior, reproduction and survival [20]. The lowest water temperature of 25°C was in secondary forest at Bandalit Resort with close to vegetation, while the highest water temperature value was 27°C in the primary forest habitat and settlement of Andongrejo Resort and Bandalit 1 Resort as the condition indicates that freshwater crabs are still has a tolerance of water temperature between 25-27°C.

The water velocity at Andongrejo and Bandalit waters varies. Rivers classified based on current flows into five categories: very fast (> 100 cm / sec), fast (50-100 cm / sec), medium (25-50 cm / sec), slow (10- 25 cm / sec), and very slowly (<10 cm / sec) [21]. Based on the data obtained from the water velocity at Bandalit and Andongrejo Resort fast into the very slowly category. The highest water velocities (> 5 m / sec) can reduce the types of organisms that remain so that only attached species survive the flow [22]. Freshwater crabs are more commonly found in waters with lower current velocities, because generally freshwater crabs do not have swimming leg.

Air humidity has no effect on most freshwater crab species because freshwater crabs are generally in the water. But some freshwater crab species spend much of their time inland; one of them is *Geosesarma* sp. which was found in Andongrejo's primary forest habitat type. In order to survive offshore, *Geosesarma* sp. should be in a damp place. The primary forest habitat condition at Andongrejo has an air humidity value of 81%. These conditions are ideal for the life of *Geosesarma* sp.

5. Conclusion

The diversity of freshwater crabs in Meru Betiri National Park especially at Bandalit and Andongrejo resort is low. The diversity index values at Andongrejo and Bandalit Resort are 0.999 and 0.450, respectively. The diversity of freshwater crabs at Bandalit Resort is lower than Andongrejo Resort. The abiotic conditions at Meru Betiri National Park refer to an ideal place for freshwater crab life. Water temperature ranges from 25 - 27°C, water velocity from 0.24 -1.1 m/s and slow category, water pH ranges from 6.7 to 7.5, air humidity ranges from 70-82 %, and depth ranges between 0.25-1.4 meters.

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References

- [1] Purba C P, S Nanggara, M Ratriyono, I Apriani, L Rosalina, N Sari, dan A Meridian 2014 A Portrait of the State of Indonesia's Forests 2009 - 2013 Bogor: Forest Watch Indonesia.
- [2] Sastrapadja, 1989 Biodiversity for the Nation's Survival Bogor: *Puslitbang Bioteknologi Lipi*
- [3] Adisoemarto, Soenartono 2006 Application and use of taxonomy to utilize regional fauna *Zoo Indonesia* 15 (2): 87 – 100
- [4] Ng, PKL 1988 The Freshwater Crabs of Peninsular Malaysia and Singapore Singapore: Department of Zoology, National University of Singapore *Shinglee Press* Pp 1–156
- [5] Riady R, Radith M, dan Windarti 2014 Freshwater Crab Inventory in Kampar Utara District, Kampar Regency, Riau Province *Jom Fmipa* 1 (2): 471-479
- [6] Ng PKL 2004 Crustacea: Decapoda, Brachyura. Freshwater Invertebrates of The Malaysian Region *Kuala Lumpur, Academy of Science Malaysia*: 311-336
- [7] Yeo DCJ, PKL Ng, N Cumberlidge, C Magalhaes, SR Daniels, and MR Campos 2008 Global Diversity of Crabs (Crustacea: Decapoda: Brachyura) in Freshwater *Hydrobiologia*. 595: 275-286
- [8] BAPPENAS 2016 Indonesian Biodiversity Strategy and Action Plan 2015-2020 Indonesia: Kementrian Perencanaan Pembangunan Nasional
- [9] Nillson C, CA Reidy, Dynesius dan Revenga MC 2005 Fragmentation and Flow Regulation of The World's Large River Systems *Science*. 308: 405-408
- [10] Garton E O, Ratti J T and Giudice J H 2005 Research and experimental design Techniques for wildlife investigations and management *Bethesda: The Wildlife Society*. pp 43–71.
- [11] Ng PKL 1998 Crabs FAO species identification guide for fishery purposes The living marine resources of the Western Central Pacific vol 2 Cephalopods, crustaceans, holothurians and sharks eds K E Carpenter and V H Niem Rome: FAO pp 1045–1155
- [12] Magurran AE 2004 Measuring Biological Diversity United Kingdom: *Blackwell Science Ltd*.
- [13] Eprilurahman R, Wahyu TB, Trijoko 2015 Diversity of Freshwater Crab (Decapoda: Brachyura) in Opak River Daerah Istimewa Yogyakarta *Jurnal Ilmiah Biologi*. 3 (2): 100-108
- [14] Susilo VE 2013 Diversity of Freshwater Crab (Crustacea: Decapoda: Brachyura) in Jambi Province *Thesis Bogor Agricultural University Bogor*
- [15] Martin J.W, Crandall KA dan Felder DL 2009 Decapod Crustacean Phylogenetics USA: *Taylor & Francis Group*. p 502
- [16] Indriyanto, 2006 Ecology of Forest Jakarta *Penerbit PT Bumi Aksara*
- [17] Nasokha, A 2012 Diversity of Freshwater Crab in from Salak Mountain Bogor, West Java *Departemen Biologi. Fakultas MIPA Institut Pertanian Bogor Bogor*
- [18] Idola I, Junardi, TR Setyawati 2018 Inventory of Freshwater Crab (Brachyura) in Panti National Palung Mountain West Kalimantan *Protobiont*. 7 (3): 135 –142
- [19] Tatangin, Frits, O Kalesaran, R. Rompas 2013 Study of Water Chemical Physics Parameters in the Fish Farming Area in Lake Tondano, Paleloan village, Minahasa District *Budidaya Perairan*.1 (2): 8-19
- [20] Fuad 2005 Strategy and Fisheries Agro-Industry Research Program *Puslibangkan*. Jakarta
- [21] Mason CF 1981 Biology of freshwater pollution. London: *Longman Group Limited*