Diversity of freshwater shrimp (decapoda) from bandealit rivers meru betiri national park, East Java, Indonesia

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Abstract: Freshwater ecosystems are habitat for macroinvertebrate, fish and reptile groups. One of the macroinvertebrates that can be found in freshwater habitat is shrimp which belongs to the class of Crustaceae, order of Decapoda. This study aims to determine diversity and the abiotic conditions of freshwater shrimp habitat. Determination of sampling locations was done by purposive sampling based on the habitat type of freshwater shrimp and followed by road sampling that takes the straight path from the designated sampling location. The tools used to catch freshwater shrimp are traps and tray nett. The results obtained in the Bandealit river of Meru Betiri National Park were five species of freshwater shrimp consisting of 2 families. The diversity index of freshwater shrimp in the Bandealit river was classified as moderate by the analysis of diversity index. Meru Betiri National Park has ideal abiotic conditions for freshwater shrimp life.

1. Introduction

Indonesia has a diversity of ecosystems consisting of terrestrial and aquatic ecosystems. Aquatic ecosystems were divided into two distinc ecosytem, namely freshwater and salt waters besed on its obvious difference that saltwater contain salt. Freshwater ecosystems consist of rivers, lakes, reservoirs, which mainly have environmental characteristics that were dominated by waters, have temperature changes that are not too extreme, lack of light penetration, and were affected by climate and weather. The quality of freshwater ecosystems has a greater risk of disturbance compared to other ecosystems caused by the presence of pollutants and invasive species, which can cause changes in the pattern of conditions and characteristics of freshwater ecosystems. This can alter extinction into the fauna of freshwater ecosystems [1].

Freshwater ecosystems are main habitat for groups of macroinvertebrate, fish and reptile. One of the macroinvertebrates that can be found in freshwater waters ecosystems is shrimp which is included in the class of Crustaceae, Order of Decapoda [2]. The river was a form of freshwater ecosystem that being used as a residence or habitat of various organisms [3]. The water quality in the upstream area of the river is very influential to its downstream. If the upstream area has poor water quality, it can be ascertained that the condition of the downstream water will be worse. One way to assess the water quality of the rivers is to study the presence of macroinvertebrates living in those river area [4].

Macroinvertebrates are fauna without a backbone that can be seen with the naked eye, found in freshwater area and commonly belong from the group of crustaceae. Shrimp is one of the

macroinvertebrate groups that has a fairly wide distribution and diversity in Indo-Malaya [5]. Crustaceae is a macroinvertebrate that has a fairly high diversity reaching up to 40,000-60,000 species [6]. The spread of freshwater shrimp starting from Sundaland (Kalimantan, Java and Sumatra) and the island of Sulawesi consisting of the Palaemonidae and Atydae families [7], [8].

The freshwater shrim from Genus Caridina has been recorded as many as 54 species and 34 species among them are endemic species of Indonesia [9]. Shrimp is a type of macroinvertebrate that indicate the quality or the balance of a freshwater ecosystem. This was stated by [10] and [11] that measuring the presence of certain macroinvertebrates can be used as a very important source of information about water quality of the river.

Freshwater shrimp is one of the invertebrates that inhabit the tropical freshwaters and its presence has an important role in the trophic structure and nutrient cycling [12], [13],[14],[15]. Freshwater shrimp species have a very broad distribution pattern. This has implications for the existence and process of adaptation to the existing environment. Changes in envionment condition at different habitats can cause bodily responses which result in variations at the species level [16]. Morphological variations occur due to the adaptation to diverse environmental conditions [17]. Freshwater shrimp inhabit all waters from swamps, lakes, to watersheds [18]. The data on freshwater fauna, especially crustaceans, is not yet available in Meru Betiri National Park. This is the basis for an inventory and identification of freshwater shrimp in various habitat types that exist in the Bandealit river of Meru Betiri National Park.

2. Materials and Methods

2.1 Sampling points

This research was conducted in the rivers of the Meru Betiri National Park, Jember Regency, East Java Province, Indonesia. which was divided based on the preference of habitats that are around the river (settlements, monoculture forests, primary forests, secondary forests, and coastal forests). The shrimp samples were obtained from 6 rivers consists of L1 : Settlement location, L2 : Monoculture Forest Location, L3 : Secondary Forest Location, L4 : Primary Forest 1 Location, L5 : Primary Forest 2 Location, L6 : Location of Coastal Forest. (Figure 1).

2.2 Sampling techniques

The sampling was conducted on Mei 2019. Sampling is done by conducting direct observations by taking all shrimp samples along the river of the Meru Betiri National Park with reference to differences in their habitat. Determination of the sampling site is done by purposive sampling, then proceed with road sampling [19], 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 and trap were used to help facilitate the collection of shrimp with shifted it to the edge so that the shrimp in front of it entered the net. Catching by using traps was conducted by inserting bait then putting it in water till overnight. Several types of shrimp were located behind the rocks, so that the shrimp can only be harvested by hand. Sampling was carried out in stages, started at 06.00-17.00 WIB.

The abiotic factors measured were water velocity, water temperature, pH, Depth and substrat. The tools used in this research are tray net, trap (bubu), jar, container box, pH-Meter, GPS Garmin montana 860, thermometer, thermohygrometer, current meter, lux meter, stopwatch, Canon 600D DSLR camera, aquarium, tracing paper, label paper, 70% ethanol, clip plastic and aquadest.

2.3 Shrimp Identification

The identification of freshwater shrimp samples was carried out at the Zoology Laboratory of Biology Education, Jember University and verification of shrimp samples was carried out at the LIPI Cibinong Biology Laboratory, Bogor. Samples that have been preserved in a jar are placed in a Petri dish and then observed using a stereo microscope. These identification refers to [5][8] based on the shape and morphological characteristics at the species level of the genus Macrobrachium starting from observing

its body size, there are interior orbital shapes in the lower part of the carapace eye, number of rostrum teeth, second periopod size, and the presence of preanal carina in the endopod section . Morphological characteristics at the species level of the genus Caridina are relatively small body size, the tip of the rostrum to the tip of the schapocerite, the rostrum teeth are spread evenly, the shape of the rostrum is flat. The remaining doubtful species of freshwater shrimps were taken to LIPI Cibinong Bogor for re-identification.

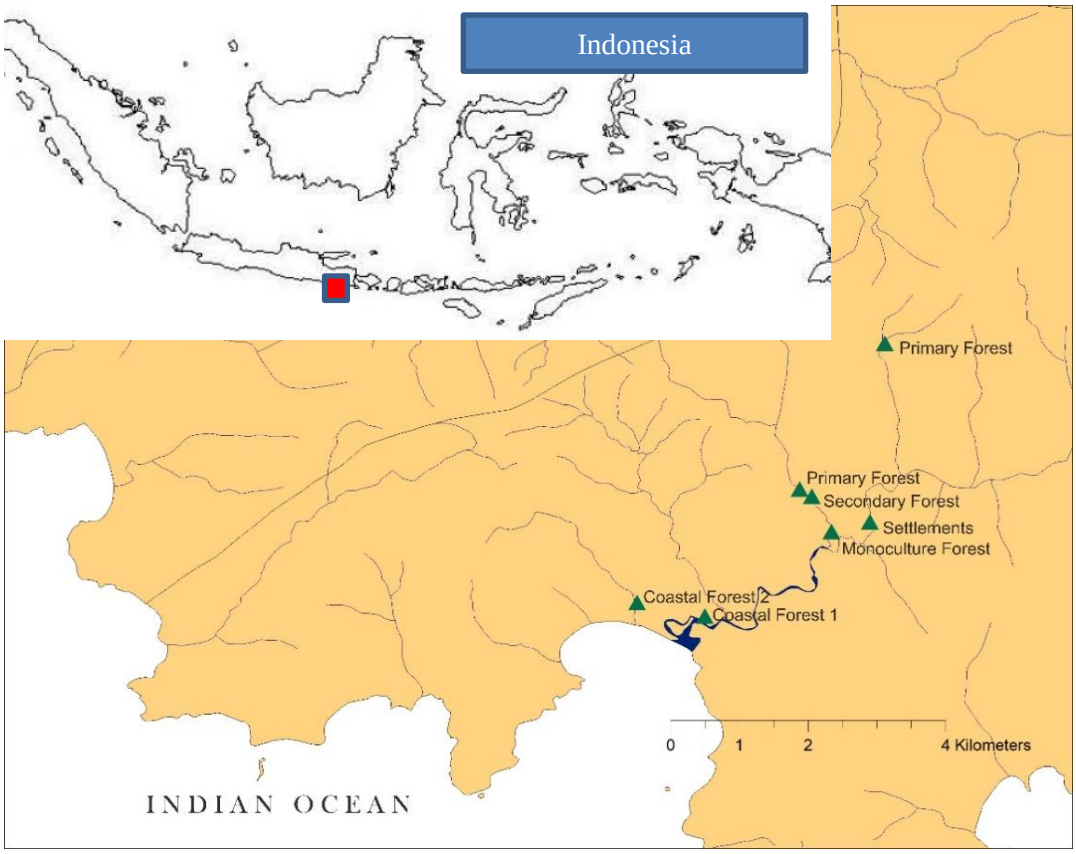

Figure 1. The point of sampling location at the Bandealit Resort.

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2.6 Diversity Index Calculation

Shrimp diversity data can be calculated using mean and percentages per time period and the diversity index was calculated using the Shannon-Wiener diversity index (H') [20]. The diversity can be calculated using the Shannon-Wiener index. Analysis of species diversity index according to Shannon and Wiener is as follows:

$$H' = -\sum pi \ln pi \qquad pi = \frac{ni}{N}$$

Information :
H′ = Shannon-Wiener diversity index
ni= Number of species per plot (importance value for each species)
N = Total number of types (total importance)
pi = Opportunity of interests for each type of Ni/N
N = Number of species
Diversity index criteria include:
H′ > 3,0 : represents high diversity
1 < H′ < 3 : moderate diversity
H′ < 1 : low diversity

3. Results And Discussion

3.1 Results

Based on the morphology identification, 5 species freshwater shrimp was found in the 5 habitats of the Bandealit Resort. These freshwater shrimp species are belong to the order of decapoda, consisting of 2 families, 2 genera and 5 species of freshwater shrimp (Table 1.)

Table 1. Results of freshwater shrimp species identification in the Bandealit river

Order	Family	Genus	Species
Decapoda	Palaemonidae	*Macrobrachium*	*Macrobrachium latydactylus* (Thallwitz, 1891)
			Macrobrachium lar (JC Fabricius, 1798)
			Palaemon carcinus (Linnaeus, 1758)
	Atydae	*Caridina*	*Caridina serratirostris* (De Man, 1892)
			Caridina brachydactyla (De Man, 1908)

Above table shows that the freshwater shrimp species belonging to the Palaemonidae family are these 3 species, *Macrobrachium latydactylus, Macrobrachium lar* and *Palaemon carcinus.* While two freshwater shrimp species belonging to the Atydae family, order of Caridina are 2 species *Caridina serratirostris* and *Caridina brachydactyla.*

3.1.1 *Macrobrachium latydactyus* (Thallwitz, 1891)
Macrobrachium latydactylus is a type of freshwater shrimp found in setlement habitat types, monoculture forests and primary forests 1. *M latydactylus* has morphological characteristics in the form of aninterior orbital shape at the end of the carapace at the bottom of the eye. Little sharp *Ocular beak* were under the rostrum and has epistome located at the base of the antenna. Rough or slippery abdominal pleuron and abdominal sternite are found in pleopod sections 1, 2, and 3. It does not have preanal carina and the second periopod has a different shape and size.

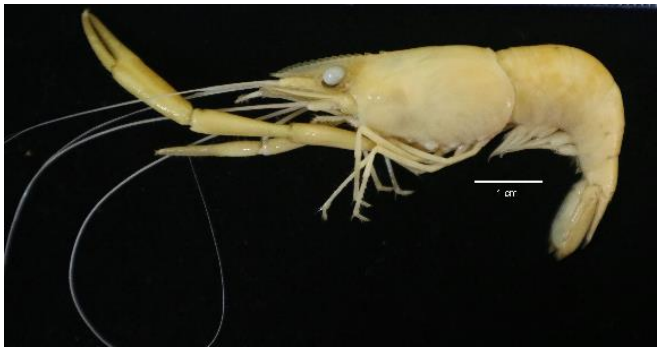

Figure 2. *Macrobrachium* latydactylus.

3.1.2 *Macrobrachium Lar* (J. C. Fabricius, 1798)
Macrobrachium lar is a type of freshwater shrimp found in primary forest area 2, found on rocks type habitat a muddy and sandy substrate. *Macrobrachium lar* has morphological characters, such as a rounded orbital interior shape and ocular beak. This shrimp epistome and thoracic sternite are round shaped. Abdominal pleuron is slippery, whereas females do not have slippery abdominal sternite. Having a thin shaped and tall preanal carina, both periopod have the same size and shape. *Macrobrachium lar*, have two large and tenuous thorn on its upper and lower rostrum, the end of the rostrum does not reach the upper third segment of the pedalcle nor the end of the scapocerite.

Figure 3. *Macrobrachium lar.*

3.1.3 *Palaemon carcinus* (Linnaeus, 1758)
Palaemon carcinus is the only freshwater shrimp species of that can only be found in the coastal forest areas. This species can generally be found in upstream brackish freshwater. The morphological characteristics of this shrimp are the clear white body, with males can be distinguished from female by looking at the fifth periopod on this shrimp that is wide and separate.

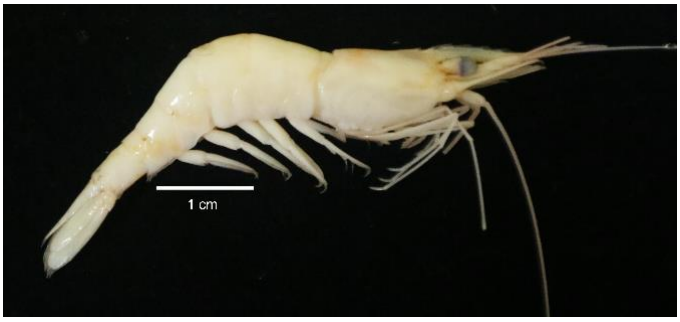

Figure 4. *Palaemon carcinus.*

3.1.4 *Caridina serratirostris* (De Man, 1892)
Caridina serratirostris is a freshwater shrimp found in setlement areas and monoculture forest. The morphological character of this shrimp is that there are 5 teeth located behind the eyes, at the tip of the rostrum to the end of the scapocerite. The teeth on the rostrum are spread evenly and the rostrum is flat. Has black, orange, blue and red elements in its body parts.

Figure 5. *Caridina serratirostris.*

3.1.5 *Caridina brachydactyla* (De Man, 1908)
Caridina brachydactyla is a type of freshwater shrimp that can be found in setlement areas, monoculture forests, secondary forests and primary forests 1. The morphological characters of this freshwater shrimp are a long and oval shape of rostrum. There are more than 12 dorsal teeth and 3 rostrum teeth in the back of the eye on its rostrum. It also have thorn at the preanal carina.

Figure 6. *Caridina brachydactyla.*

Based on the results of the freshwater shrimp identification it can be then analyzed using the diversity index (Shannon Wiener). Calculation results can be seen in Table 2.

Table 2. Analysis of Freshwater Shrimp Diversity in Bandealit River

Loct	Species	n	pi	n(n-1)/N(N-1)	ln pi	pilnpi	H'
L1	*Macrobrachium latydactylus*	9	0,23	70,105	-1,440	0,341	0,341
	Caridina Serratirostris	2	0,05	1,947	-2,944	0,154	0,154
	Caridina brachydactyla	2	0,05	1,947	-2,944	0,154	0,154
L2	*Caridina brachydactyla*	4	0,10	11,684	-2,251	0,236	0,236
	Caridina Serratirostris	2	0,05	1,947	-2,944	0,154	0,154
	Macrobrachium latidactylus	2	0,66	1,947	-0,405	0,270	0,270
L3	*Caridina brachydactyla*	3	0,07	5,842	-2,538	0,200	0,200
L4	*Macrobrachium latydactylus*	1	0,02	0	-3,637	0,095	0,095
	Caridina brachydactyla	4	0,10	0,947	-2,251	0,236	0,236
L5	*Macrobrachium lar*	6	0,15	29,210	-3,691	0,582	0,582
L6	*Palaemon carcinus*	3	0,07	5,842	-2,538	0,200	0,200
	N	38	1,61	131,42	-25,74	2,33	2,33

Based on Table 2, the freshwater shrimp diversity index (Shannon Wiener) in the Bandealit river was 2.33, categorized as the medium category. The sampling point location have different abiotic factors, that can be seen in Table 3 below.

Table 3. Condition of Abiotic Factors at the Sampling Point Location

Location	Water velocity (m / s)	Water temperature (ºC)	water pH	Depth (m)	Substrate
L1	0.93	26	7.4	1.3	Rocky, muddy, sandy and riparian by the river
L2	0.41	26	6.7	1.3	Rocky, sandy and riparian
L3	1.1	25	6.9	1.2	Rocky and sandy
L4	0.37	26	6.8	0.4	Big rocky, sandy and on the edge of a muddy river
L5	0.48	27	6.7	0.8	Big rocky, sandy and muddy
L6	0.73	26	7.1	1.4	Muddy, rocky and lots of leaf litter

Information:
L1 : Settlement location
L2 : Monoculture Forest Location
L3 : Secondary Forest Location
L4 : Primary Forest 1 Location
L5 : Primary Forest 2 Location
L6 : Location of Coastal Forest

4. Discussion

Measurement of species diversity can be calculated using the Shannon-Wiener index [8],[20]. The results of the freshwater shrimp diversity index (H′) in Bandealit Resort were 2,33. Freshwater shrimp diversity found in Bandealit Resort was classified as moderate. Species diversity can be used to measure the ability of a community to maintain their stability againts the changes of ecosystem or interference with other ecological components. The characteristics of freshwater shrimp that are found in Indonesia are very diverse from the *Palaemonidae, Atydae* and *Alpheidae families* [21].

Freshwater shrimp diversity in the Bandealit Resort exists in different habitat types ranging from primary forests, secondary forests, monoculture forests, mountains, coastal forests and setlement

areas. Each type of habitat have freshwater ecosytem in form of the rivers. Meru Betiri National Park (TNMB) has many rivers that are types of habitat for various freshwater shrimps..

Shrimp diversity at the Bandealit resort can be said that the Bandealit river is still natural and less polluted by chemicals or waste. Bandealit River has water pH range of 6,7 -7.5. The optimum pH for freshwater shrimp ranges from 6,5 to 8.5 [22]. The water pH greatly affects the biochemical processes of freshwater ecosystem. Bandealit River has the lowest pH level of 6,7 which is located in primary forest 2, while the highest pH level is 7.4 in a setlement area.

The rivers water temperature is a limiting factor for some aquatic organisms [23],[24]. Water temperature affects the distribution of aquatic organisms in these watersheds [25]. Freshwater shrimp have a good range toleration of water temperature, ranging from 28 to 31 °C. The lowest water temperature in the Bandealit river was 25 ºC located in the secondary forest area, while the highest temperature was 27 ºC, located in primary forest 2.

Water velocity is very important to be observed because it is a limiting factor for the presence of some freshwater organisms [23]. Water velocity fluctuates (0,09 -1.40 m/sec) which is slowing downstream. The gravity factor, the width of the river and the material carried by the water make the greater velocity of the upstream. Water velocity in the upstream, middle and downstream are 0.58 - 1.40 m/s, 0.13 m/s - 1.0 m/s and 0.09 - 0.27 m/s, respectively. Macrobrachium shrimps is the freshwater shrimp that can inhabit a faster flowing current and take shelter in rocks, while the types of shrimp that inhabit a calm streams and take shelter in riparians are the Atydae and Caridina groups. The lowest water velocity in the Bandealit river was observed at 0.37 m / s in the primary forest area 1, while the heaviest current velocity was observed at 1.1 m / s in the secondary forest area. Shrimp distribution has a different pattern between types (Table 3). *Macrobrachium latydactylus, Caridina brachydactyla* can be found in all habitat type from lowland until higland. The distribution on both species influenced by the ablity migration to varios location. Its means they have ability to adaptation for varios ecological condition and have large home range and territory. *Caridina Serratirostris* only found in 2 location (L1 and L2) that have mix ecological condition that inlfluence by human activity such as plantation and houshold activities. They cant migration to habitat type that more higher. *Macrobrachium lar* have special conditions because they can only in primary forest that have pure or natural condition. *M. Lar* have specific home range because they can only found be alone which distinguishes from other types found in one community or one habitat type. *Palaemon carcinus* can olny be found in coastal habitat, because they specifis estuari habitat that can not migration to pure freshwater.

5. Conclusion

Freshwater shrimp diversity in the Bandealit Resort river shows that there are 5 species of freshwater shrimp in the Bandealit river . Freshwater shrimp consists of 5 species, 2 families and 2 genera. Where the species obtained include *Macrobrachium latidactylus, Macrobrachium lar, Caridina serratirostris, Caridina brachydactyla* and *Palaemon carcinus. The* total diversity index (H ‘) of freshwater shrimps from all habitat types reaches 2,33 so that it can be said that the diversity of freshwater shrimp in the Bandealite river is classified as moderate.

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