

First record on the freshwater shrimp and its ecology in Weh Island, Indonesia

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Abstract. Putra DF, Abbas MA, Siregar TN, Wowor D. 2025. First record on the freshwater shrimp and its ecology in Weh Island, Indonesia. *Biodiversitas* 26: 1991-2001. Freshwater ecosystems are important in term of biodiversity and the balance of life cycle in tropical regions. Freshwater shrimp is an important organism in its habitat, which play a crucial role in maintaining ecological balance and sustaining food chains. Weh Island, located at the tip of Sumatra Island, Indonesia, is very popular for its rich marine biodiversity, but unfortunately, studies on the ecology and the diversity of freshwater fauna in this island are very limited. Therefore, this is the first comprehensive study to report the identity, morphology, diversity, and ecological aspects of the freshwater shrimp. A total of 395 individuals of freshwater shrimp were collected from five sites of three different sampling localities, namely Pria Laot Stream (lotic), Aneuk Laot Lake, and Paya Seunara Lake (lentic). Three species of freshwater shrimp of the genus *Macrobrachium* and one species of the genus *Caridina* were first reported from this island, i.e., *Macrobrachium lar* (TL: 2.9-9.6 cm; BW: from 0.21-15.67 g), *M. lanatum* (TL: 3.0-4.5 cm; BW: 0.29-1.71 g), *M. lanchesteri* (TL: 5.0-10 cm; BW: 0.1-1.1 cm), and *Caridina serratiostris* (TL: 1.6-2.8 cm; BW: 0.03-0.28 g). Pria Laot River showed low levels of shrimp diversity, moderate Dominance Index, and fairly high species evenness, while Aneuk Laot and Paya Seunara Lake indicated low levels of shrimp diversity and evenness but high Dominance Index by *M. lanchesteri*. Although Weh Island offers a unique ecological niche for freshwater shrimp, the increasing threats from human activities, deforestation, and climate change are very real. There is a need for effective actions and prevention, which are essential for the protection of not only shrimp population but also the integrity of the entire terrestrial ecosystem. Collaborative efforts and synergy between local communities, government, and tourists are essential to implement sustainable strategies as a priceless legacy for future generations.

Keywords: Aneuk Laot, diversity, Paya Seunara, Pria Laot, Sabang

INTRODUCTION

Indonesia is a center of biodiversity known for its high diversity both freshwater and marine species (Muchlisin et al. 2017; Putra et al. 2022). The country is home to more than 4,000 species of freshwater fishes, which consists of an important part of the world's freshwater fish diversity (Dekar et al. 2018). In the ecosystem, freshwater biodiversity plays a significant role, specifically in maintaining ecological balance and resources for surrounding communities.

One of the organisms inhabiting freshwater ecosystem habitat that is less popular but has a strong role and contribution is freshwater shrimp. This species plays an important role in the tropical island ecosystem (Covich et al. 1999; Crowl et al. 2001; Snyder et al. 2016). In addition to having a strategic and significant impact on freshwater ecosystems, freshwater shrimp also have amphidromous characteristics that make estuary become a part of their life cycle (Wowor et al. 2004; Bauer 2013).

In addition to maintain the balance of freshwater ecosystems, shrimp also play a significant role in the food

chain (Wowor et al. 2004; Bentes et al. 2011; Eume et al. 2022; Annawaty and Safira 2024). The abundance and variety of freshwater shrimp in a habitat is highly dependent on the amount of vegetation remains that act as important food for shrimp (Bentes et al. 2011).

Weh Island with an area of about 121 km², located at the western tip of Sumatra Island and the Strait of Malacca, has abundant marine biodiversity and is an important area for coral reef management and conservation (Ulfah et al. 2019; Zulfahmi et al. 2022). With its abundance of natural resources, a combination of hilly and marine scenery and the beauty of its underwater nature, Weh Island is a very interesting place to visit for both local and foreign tourists. The biodiversity of this region includes some of the world's coral and reef fish species which contribute significantly to global ocean health and support local economies through fisheries and ecotourism (Zariansyah et al. 2024). The terrestrial ecosystem of Weh Island consists of flowing water ecosystems (lotic) and stagnant water ecosystems (lentic). The flowing water ecosystem on Weh Island is Pria Laot River which originates from the source of Pria Laot Waterfall. Meanwhile, the stagnant water ecosystem

on this island includes Aneuk Laot and Paya Seunara Lakes. Aneuk Laot Lake was previously known as a tectonic lake formed from a volcanic eruption in the past. The lake is now used by local people as the main source of freshwater that supports the surrounding community (DLHK 2021). Meanwhile, Paya Seunara Lake is smaller than Aneuk Laot Lake. This lake is an artificial lake that was created as a water source for agriculture and the surrounding community (DLHK 2021).

Several previous studies on the diversity and ecology of aquatic animals in Weh Island are limited in relation to marine water resources like investigations on commercial reef fish (Fadli et al. 2020; Zulfahmi et al. 2022), coral reef conditions and management (Utama and Hadi 2018; Aldyza et al. 2022; Sidauruk et al. 2022; Mulya et al. 2023), as well as the production and identity of several freshwater fish (Nurfadillah et al. 2022a, b). Although Weh Island is known for its richness in marine diversity and marine conservation, unfortunately, studies related to the identity and ecology of freshwater shrimp are very limited. The lack of data and information on the diversity and ecology of freshwater shrimp on Weh Island is one of the challenges encountered in efforts to manage freshwater ecosystem resources on the island. Therefore, this study is very important and it is the first record on the exploration of the diversity, the distribution, and the ecological significance of freshwater shrimp found in lotic and lentic ecosystems on the island.

MATERIALS AND METHODS

Sampling procedure

The sampling of freshwater shrimp was carried out in the lotic and lentic habitats of Weh Island, in August 2022 (Figures 1 and 2). The lentic area is a stagnant water on the island which includes two sampling sites, i.e., Aneuk Laot and Paya Seunara Lakes. The sampling activities were carried out by purposive technique. The shrimp samples were captured using scoop nets (30 cm diameter and 0.5 mm mesh size) and trap nets (95 cm diameter, 20 holes and 3 mm mesh size).

The first sampling site was a natural area adjacent to tree vegetation around the lake and far from residence areas. While the second area was carried out close to human settlements such as tourist areas and docks. At each sampling point, sample collection was carried out 3 to 4 times. The determination of the sampling point was by considering the differences between areas with human intervention and those undisturbed natural environments. Meanwhile, the shrimp sampling in the lotic area is by sweeping the edge of the river to upstream of Pria Laot Creek (waterfall), about ± 500 m long. The description and field conditions of all sampling points are presented in Table 1.

The samples were preserved in 96% alcohol and taken to the Aquaculture Health and Biotechnology Laboratory of the Faculty of Marine and Fisheries, Universitas Syiah Kuala, Aceh, Indonesia, for further analysis. The procedure for handling these animals adheres to the Research Ethics Guideline of Universitas Syiah Kuala No. 958/2015.

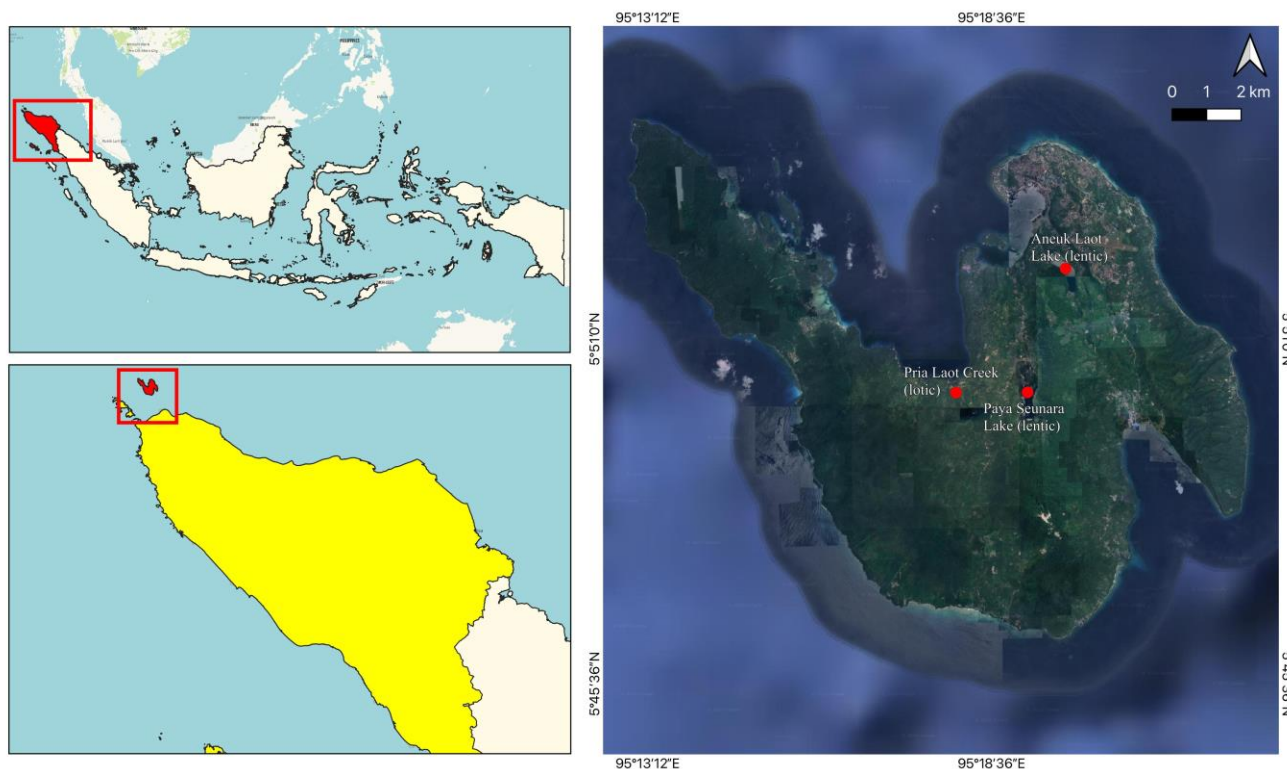


Figure 1. Map of sampling locations on Weh Island, Indonesia



Figure 2. Representative of freshwater shrimp habitat on Weh Island, Indonesia. A. Pria Laot River from the middlestream to waterfall; B. Aneuk Laot Lake west part and east part; C. Paya Seunara Lake

Table 1. Description of freshwater shrimp habitat in lentic and lotic areas on Weh Island, Indonesia

Locality	Sampling site	Coordinate points	General description of Habitat
Pria Laot Creek (lotic)	Along the river for about 500 m till the foot of the waterfall.	5°50'5.70"N, 95°18'9.41"E to 5°49'49.64"N, 95°18'13.23"E	The water is moderately flowing, in form of a small creek with altitude 64 m asl, water depth ~0.2 m, mixture of rocks and sandy bottom with shrubs, and Moraceae or Arecaceae dominant trees along the bank of the creek.
Aneuk Laot Lake (lentic)	Two sampling points covered one site in the west side and one site in east side	5°52'11.22"N, 95°19'32.05"E and 5°52'4.54"N, 95°19'53.92"E	Stagnant and isolated water body, muddy bottom, altitude 22.9 m asl, some parts were surrounded by mahogany trees, and the other parts by human settlement.
Paya Seunara Lake (lentic)	Two sampling points covered one site in the west side and one site in east side	5°50'12.71"N, 95°19'1.86"E and 5°50'12.70"N, 95°19'18.45"E	A man-made dam, muddy bottom, surrounded by human settlement.

Sample identification and morphology

Morphometry and identification of the samples were carried out using a stereo microscope (Olympus SZ61) with several references (Cai and Ng 2002; Cai et al. 2004; Wowor et al. 2004). The measurement of the samples was carried out using a digital calliper (Mitutoyo CD-6CS, standard errors: 0.01 mm). The total length of shrimp was measured from the tip of the rostrum to the tip of the telson. While the characters and rostral formulas adhere to the guidelines of von Rintelen and Cai (2009). The samples were stored in the Laboratory of the Faculty of Marine Affairs and Fisheries and the Museum Zoologicum Bogoriense (MZB), Research Center for Biosystematic and Evolution, National Research and Innovation Agency (BRIN), Cibinong, Indonesia.

Environmental parameters

Observations of freshwater shrimp ecological parameters such as water quality measurements including pH were carried out using a pH meter (Hanna HI 98107), temperature (°C) using a digital thermometer, current speed (m/s) using the Floating grade and Stopwatch methods, watercolor with visual observation, several chemical parameters, microhabitat, and substrate. Current speed parameters are divided into 5 classifications according to Welch and Naczk (1992): namely very slow (<0.10 m/second), slow (0.10-0.25 m/second), moderate (0.25-0.50 m/second), fast (0.50-1.00 m/second), and very fast (>1.00 m/second).

Biodiversity indicator and data analysis

Shrimp bioDiversity Index analysis was carried out using several parameters refers to Shannon-Wiever (1964):

$$H' = - \sum p_i \ln p_i$$

$$p_i = n_i/N$$

Where, H: Diversity Index; n_i : Number of species per plot (importance value for each species); p_i : Number of species; N: Total number of species (total importance value). Diversity Index criteria include: $H' > 3.0$: High diversity; $1 < H' < 3$: Moderate diversity; $H' < 1$: Low diversity.

Species density index with the formula: $D = \text{Shrimp density (ind/m}^2\text{), Ni: Number of individuals of species, A: Area of sampling plot (m}^2\text{)}$.

Evenness Index was calculated using the formula:

$$E = H'/\ln S$$

Where, E: Evenness Index; H' : Diversity Index; S: Number of species. The Evenness Index value ranges from 0-1. Furthermore, the Evenness Index value is categorized as follows: $E \leq 0.4$: Low species evenness; $0.4 < E \leq 0.6$: Medium species evenness; $E > 0.6$: High species evenness.

Additionally, the species Dominance Index was calculated using the formula, namely C: Dominance Index, P_i : Proportion of the number of individuals in species I: 1,2,3...n.

The index value ranges from 0-1 with the following categories: $0 < C < 0.5$: Low dominance; $0.5 < C \leq 0.75$:

Medium dominance; $0.75 < C \leq 1.0$: High dominance (Odum 1971; Magurran 2004; Southwood and Henderson 2000; Krebs 2013). Quantitative data analysis includes shrimp length and weight, distribution, diversity, and environmental parameters presented in the form of tables and images and then explained descriptively.

RESULTS AND DISCUSSION

Identification and morphology of freshwater shrimp

The five sampling locations including two points in Aneuk Laot Lake, two in Paya Seunara Lake, and one at Pria Laot Flow towards the upstream (waterfall). From all sampling locations, freshwater shrimps were identified at only two sampling locations. A total of 395 freshwater shrimp species were collected, belonging to two families, i.e., Palaemonidae and Atyidae, consisted of two genera, *Macrobrachium* and *Caridina*. The genus *Macrobrachium* is consisted of three species, namely *M. lar*, *M. lanatum*, and *M. lanchesteri* and the genus *Caridina* is consisted of one species, i.e., *C. serratiostris* (Table 2, Figure 3). In Aneuk Laot Lake, there was no freshwater shrimp found but only a young freshwater crayfish, *Cherax quadricarinatus* (Figure 8). *Macrobrachium lar* species has a total length ranging from 2.9-9.6 cm, and a total weight ranging from 0.21-15.67 g. *Macrobrachium lanatum* has a total length of 3.0-4.5 cm and a total weight of 0.29-1.71 g. While the total length of *C. serratiostris* ranges from 1.6-2.8 cm with a total weight range of 0.03-0.28 g and finally *M. lanchesteri* has a total length ranging from 5.0-10 cm and a total weight of 0.1-1.1 cm (Table 3).

Morphology

The results of morphological identification showed that *M. lar* has a short rostrum that reaches the distal end and the third part of the antennular handle (Figure 4). The rostral teeth formula is 1+7/2-6 with a circular carapace margin on the post-antennular (post-antennular/back of the antenna). The walking legs (pereiopod) of this species are slender and they are of same size, shape, and length, all of which are covered with spines. Based on the size of the chelae, it is longer than the carpus and densely covered with spined at outer margin. The carpus, in comparison, is typically shorter than the palm and has conical shape. Meanwhile, *M. lanatum* has relatively short rostrum whose tip approaches or slightly passes the third segment of the antennular but does not reach the tip of the scaphocerite. The distal four-fifths of the minor cheliped (minor cheliped/small claw feet) exceed the tip of the scaphocerite on the second walking leg (pereiopod). Spinules and spines are abundant on all segments except most of the distal part of the palm and the proximal three-quarters of the fingers are densely covered with long, velvety setae on the main cheliped (Figure 5).

Macrobrachium lanchesteri has a relatively long rostrum, the tip extending distal end of third segment of antennular peduncle or slightly extending beyond distal end of scaphocerite. This species has slender and long body with rostrum teeth formula of 3+5/3. The length of the

carpus of the second walking leg is longer than the merus and chela, this species also has 2 pairs of spines on the telson that are parallel (Figure 6). While *C. serratiostris* has a typical body size of the genus *Caridina*, which is relatively small. The rostrum is usually straight and the tip extends the end segment of antennular peduncle. The length of the rostrum is 0.4-0.6 times the carapace with rostrum tooth formula of 7-9+13-16/4-7. The size of the carpus of the first walking leg (pereiopod) is shorter than those of the second walking leg. The size of the carpus of the second walking leg is very slim and longer than the chelae. The third pereiopod walking leg has 5 spiniform setae on the flexor margin and ends with a single spine (Figure 7).

Ecological parameters

The results of the observed ecological parameter showed lower temperature range in Pria Laot Stream, which was around 27.8-29.3°C compared to the temperature range in Aneuk Laot and Paya Seunara Lakes, which showed a relatively similar range, i.e., 31.2-31.5°C and 30-31.2°C, respectively. The pH water of the three sampling locations showed same range, i.e., 7-7.2. Water current in Pria Laot Stream was 0.09 m/s. The range of water alkalinity at the three locations showed a range of 100-180 (Table 4).

Macrobrachium lar was often found hiding under small rocks to large mountain rocks. In general, this shrimp lives in slow water flow at depth of 10-40 cm (Figure 2) with sandy substrate. *Macrobrachium lanatum* was often found under tree roots, branches, or fallen tree trunks and rocks with slow water flow at depth of 10-30 cm (Figure 2). Meanwhile, *C. serratiostris* was found in a small river with moderate flow and depth of 10-30 cm (Figure 2). This species was often found clinging on tree roots and macrophytes imerged in the water with sandy bottom. While the species *M. lanchesteri* is often found in non-flowing lakes with depth of 0.20-1.0 m with muddy substrate.

Biodiversity of freshwater shrimp

The highest density of freshwater shrimp community in Weh Island was in Paya Seunara Lake with an average abundance of 3.68 individuals/m² and the lake is dominated by the invasive shrimp, *M. lanchesteri*. The lake has low diversity and Evenness Indexes (Table 2). In addition, in the flowing water area (lotic), the most abundant is *M. lar* with an average abundance value of 0.18 individuals/m² followed by *M. lanatum* 0.05 individuals/m² and *C. serratiostris* 0.04 individuals/m² (Figure 4); the Diversity Index is low (0.7), Evenness Index is high (0.79), and the dominance moderate (0.50) (Table 2 and Figure 9).

Table 2. Structure of freshwater shrimp community on Weh Island, Indonesia

Species	Habitat	Average abundance (ind/m ²)	Species composition (ind)	Diversity (H')	Evenness (E)	Dominance (C)
<i>Macrobrachium lar</i>	Pria Laot Stream	0.18	18	0.87 (low)	0.79	0.50
<i>Macrobrachium lanatum</i>	(lotic area)	0.05	5		(high)	(medium)
<i>Caridina serratiostris</i>		0.04	4			
<i>Macrobrachium lanchesteri</i>	Paya Seunara Lake (lentic area)	3.68	368	0 (low)	0.00	1.00 (high)

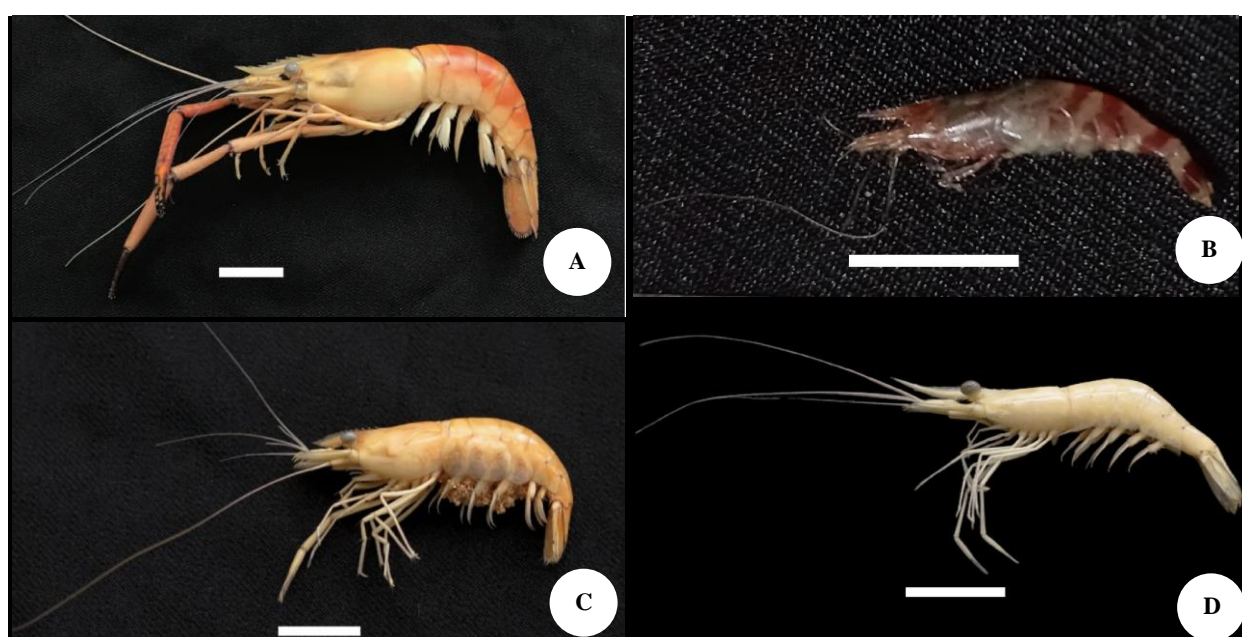


Figure 3. Freshwater shrimps found during the study. A. *Macrobrachium lar*; B. *Caridina serratiostris*; C. *Macrobrachium lanatum*; D. *Macrobrachium lanchesteri*. Scale: 1 cm

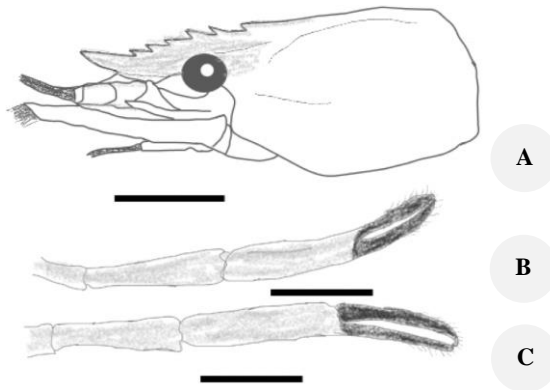


Figure 4. Illustration of the morphology of *Macrobrachium lar*. A. Carapace; B. Major second pereiopod; C. Minor second pereiopod. Scale: 1 cm

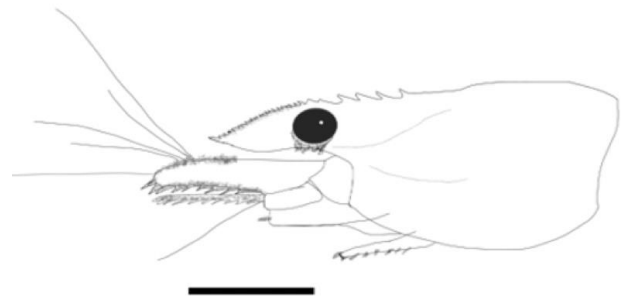


Figure 5. Illustration of the morphology of *Macrobrachium lanatum* (Carapace)

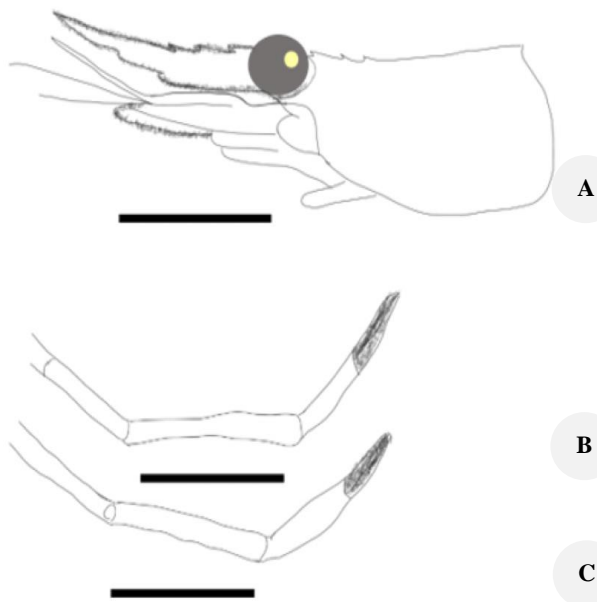


Figure 6. Illustration of the morphology of *Macrobrachium lanchesteri*. A. Carapace; B. Major second pereiopod; C. Minor second pereiopod. Scale: 1 cm

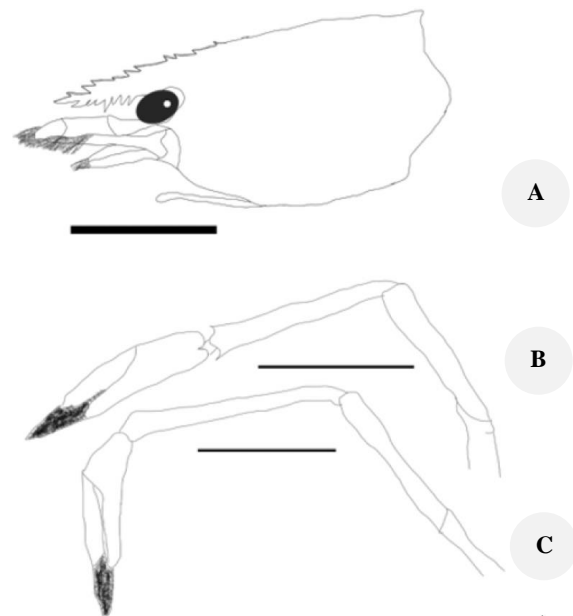


Figure 7. Schematic illustration of *Caridina serratiostris* morphology. A. Carapace; B. Major second pereiopod; C. Minor second pereiopod. Scale: 1 cm

Table 3. Total length and body weight of freshwater shrimp obtained during the study

Species	Total length (Mean±SD) (cm)	Body weight (Mean±SD) (g)
<i>Macrobrachium lar</i>	2.9-9.6 (4.96±2.08)	0.21-15.67 (3.09±4.66)
<i>Macrobrachium lanatum</i>	3-4.5 (3.9±0.65)	0.29-1.71 (0.754±0.56)
<i>Caridina serratiostris</i>	1.6-2.8 (2.05±0.57)	0.03-0.28 (0.11±0.11)
<i>Macrobrachium lanchesteri</i>	5.0-10 (7.93±1.49)	0.1-1.1 (0.54±0.29)

Table 4. Environmental parameters at the lentic and lotic study locations in Weh Island, Indonesia

Parameter	Pria Laot Stream (lotic)	Aneuk Laot Lake (lentic)	Paya Seunara Lake (lentic)
Temperature	27.8-29.3°C	31.2-31.5°C	30-31.2°C
pH	7-7.2	7-7.2	7-7.2
Current	0.09 m/s	0	0
Alkalinity (ppm)	180	100-120	95
Nitrite	0	0	0
Nitrate	0	0	0
Chlorine	25	0,3	0
Hardness	250	50	50
Bromine	1	0.3	0



Figure 8. Young freshwater crayfish, *Cherax quadricarinatus* found in Aneuk Laot Lake, Weh Island, Indonesia. Scale: 1 cm

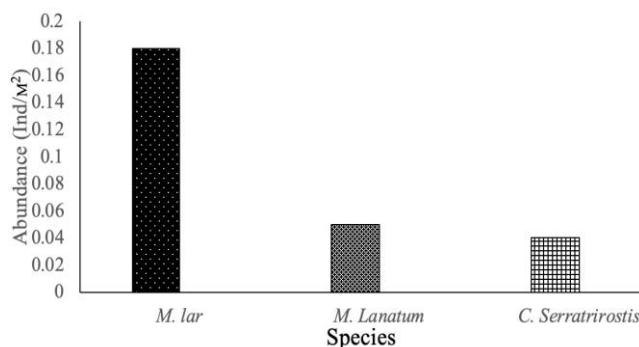


Figure 9. Average abundance value of freshwater shrimp found in Pria Laot River, Weh Island, Indonesia

Discussion

Weh Island is located at the western tip of Indonesia and has volcanic mountains and freshwater shrimp resources that are not yet widely known. According to geological history, this island was once connected to Sumatra but was separated by a volcanic eruption during the Pleistocene era (Wikipedia 2025). The aquatic environment of Weh Island, Aceh, ranging from freshwater bodies such as rivers and lakes to coastal mangrove ecosystems, provides a variety of ecosystems suitable for various types of freshwater shrimp. The diverse aquatic habitats, have given rise to a variety of freshwater shrimp species thrive in this unique environment. A total of three species of freshwater shrimp have been reported for the first time from this island, such as *M. lar*, *M. lanatum*, and *M. lanchesteri*. The three species are a small part of the 281 species known belong to the genus *Macrobrachium* worldwide (WoRMS Editorial Board 2025a). While *C. serratrirostris* is one out of the 349 *Caridina* species of the world (WoRMS Editorial Board 2025b) (Figure 3). The combination of hilly areas, volcanic mountains, and the relatively small area of freshwater ecosystems, as well as the intervention of human activities, affect the diversity of the shrimp on this island.

The biological structure of a community is expressed through species diversity (Indices and River 2018). The species diversity of an ecosystem indicates stability and an indication of good environmental conditions (Khalaf et al. 2024). Community structure data shows that freshwater shrimp species in Pria Laot Stream have low diversity, moderate dominance levels, and fairly high species evenness (Table 2). Pria Laot Stream is a narrow river, measuring between 2 to 4 meters in width, with a sandy bottom and a moderately gentle current. Along its banks, tree roots and fallen trunks are visible, some of which have submerged into the riverbed. Further upstream, the river is increasingly filled with large rocks until it reaches the location of the waterfall. These habitat characteristics, low water current with substrate consisted of a mixture of sand and mud are preferred by the three species, i.e., *M. lar*, *M. lanatum* and *C. serratrirostris* (Wowor et al. 2009; Hernawati et al. 2020; Annawaty et al. 2022). The food habit of these shrimp are generally scavengers and detritus eaters, hence, these shrimp have an important role as

recyclers of organic matter in river ecosystems (Wowor et al. 2004, 2009).

Based on field observations, there was plastic waste from food waste along the river until it reached the waterfall. This is due to loitering by tourists since this area is also a tourist area in Weh Island. If the local government does not take preventive measures in terms of supervision and implementation of sanctions, this will have a serious impact on the river ecosystem and freshwater shrimp diversity in particularly. Subsequently, shrimp habitat and life are very vulnerable to disturbances and interventions from humans such as waste disposal, overfishing, pollution, or river damming, and if this problem occurs consistently and for a long time, shrimp will be threatened with extinction (Wowor et al. 2004; Zieritz et al. 2024). In terms of reproduction, the three shrimp species, *M. lar*, *M. lanatum*, and *C. serratrirostris*, have many small-sized eggs, which will hatch into zoea (shrimp larvae) that swim freely and will later spend some of their larval development in brackish water or salt water. After the organs are fully developed, young shrimp will gradually return to freshwater rivers to grow until they reach adulthood (Wowor et al. 2004; Wowor et al. 2009; Hoarau 2018). The amphidromous freshwater shrimp spend some phases of their life in brackish or salt water to spawn (Atkinson 1977; Wowor et al. 2009). The unobstructed flow of river water from upstream to the river mouth is crucial for freshwater shrimp that inhabit lotic environments.

The analysis of the community structure in Paya Seunara Lake showed low levels of diversity, and species evenness, but high dominance and abundance of *M. lanchesteri* (Table 2). The discovery of *M. lanchesteri* was the first time to be reported from Weh Island. The high dominance of *M. lanchesteri* shows a worrying condition of the lake health ecosystem because *M. lanchesteri* is an invasive animal that can affect the existence of the original species. In addition, in Aneuk Laot Lake, no single freshwater shrimp was found but only a small crayfish *Cherax* sp. (Figure 5). The invasion of *Cherax* sp. in Aneuk Laot Lake has been previously reported (DLHK 2021). Crayfish is an invasive animal that has tolerance and adaptation and is competitive in obtaining food and space (Hasuba et al. 2024). It is believed that due to competition for food and habitat, forcing other shrimp species to

relocate to specific areas, making this species less detectable in the lake. Alien or invasive animals are non-native animals in an environment or ecosystem (Gotesman et al. 2018; Šimková et al. 2019; O'Mara et al. 2023; Patonai et al. 2024). In general, the presence of these animals can occur through direct or indirect introduction through eggs or shrimp larvae attached to fish that will be released. Invasive animals typically exhibit characteristics such as rapid reproduction, high fecundity, resilience to extreme environmental conditions, and strong competitiveness in securing food resources (Annawaty and Safira 2024). This ability can threaten the biodiversity of an environment, damage habitats and ecosystems, harm the economy, and have the potential to disrupt human health (Maulina et al. 2020; Annawaty and Safira 2024; Hasuba et al. 2024). The beginning of the spread of the two-alien species *M. lanchesteri* and crayfish, *Cherax* sp. on Weh Island is not known for sure. However, field observations and previous studies indicate that the local government has been introducing non-native fish species into Lake Aneuk Laot and Paya Seunara Lake for an extended period. This practice may have contributed to the dispersal of shrimp eggs to the mainland of Weh Island (DLHK 2021; Nurfadillah et al. 2022a, b). Recommendations for further studies in the future are needed in analyzing the population sources and distribution time of the two invasive species, *M. lanchesteri* and *Cherax* sp., on Weh Island.

The founding of *M. lar* in Weh Island gives new contribution to the distribution of this species in the world. Previously this species is known from East Africa, Iraq, and Bangladesh to the Marquesas Islands (Wowor et al. 2009; Ghazi 2021; Hasan et al. 2021; Oyama et al. 2021). While the distribution of *M. lar* in Indonesia has been reported by several studies with the same habitat type, such as in Batambean River, Labobo Island (Rahayu and Annawaty 2019), Bandalit River, East Java (Susilo et al. 2020) and Beringin Kencana River, South Kalimantan (Mirza 2021). *Macrobrachium lanatum* is distributed from Myanmar up to Papua New Guinea (Cai and Ng 2009; Wowor et al. 2009) while the distribution of this species in Indonesia can be found in West Sumatra region and Java Island (Wowor et al. 2009). *Caridina serratiostris* has relatively wide distribution in Indo-West Pacific, from South Africa, Mozambique, Madagascar (Richard and Clark 2010), Fiji, Jepang, Malaysia (Zitzler and Cai 2006; Cai and Ng 2007), and Solomon Islands (de Mazancourt et al. 2020). While in Indonesia the distribution of *C. serratiostris* is found in Java, Bali, and Sulawesi (Hernawati et al. 2020; Annawaty et al. 2022). *Macrobrachium lanchesteri* is a freshwater shrimp whose entire life cycle is in fresh water, specifically in stagnant areas (Samuel et al. 1988). *Macrobrachium lanchesteri* is distributed in Myanmar, Bangladesh, Thailand, and Malaysia (Hasan et al. 2021; Hoshan et al. 2022; Tongnunui et al. 2022; Chaowvieng et al. 2024). Meanwhile, the distribution area of *M. lanchesteri* in Indonesia includes Bolago Toga Lake and Toranda River, Central Sulawesi (Mangesa et al. 2016; Annawaty and Safira 2024), Lido and Cibinong Lakes, West Java (Aprila et al. 2020; Mayasari et al. 2022), Palangkaraya, South

Kalimantan (Maulina et al. 2020), and Ulu Ngarak River, West Kalimantan (Hurriyani et al. 2022).

Freshwater shrimp are highly dependent on environmental conditions, both physical, chemical, and biological (Shekk and Astafurov 2023). The physical and chemical characters of a water body are very distinctive, indicating varying environmental conditions, causing shrimp living in the waters to have their characteristics (Wowor et al. 2009). The lower the ecological parameter score of an ecosystem, the lower the level of shrimp diversity. Moreover, it can threaten the habitat of shrimp that can cause the extinction of the species. Based on observations in the field, the condition of Pria Laot Stream is still quite good, although visually there is a lot of plastic waste from tourists' activities at the waterfall. On the other hand, the condition of Aneuk Laot and Paya Seunara Lakes are quite clean from plastic waste. However, Paya Seunara Lake shows sedimentation at several points. The water current at the sampling points can be categorized as slow current (0.09 m/second) (Welch and Nacz 1992), hence, Aneuk Laot Stream is still suitable as the habitat of the three shrimp species, i.e., *M. lar*, *M. lanatum* and *C. serratiostris*.

The general water quality condition in the three lotic and lentic sampling locations still show optimal tolerance for the development and life of freshwater shrimps. The low temperature in Aneuk Laot Lake (27.8-29.3°C) is due to the presence of water flow and riverbanks are surrounded by tall trees, which blocks the penetration of the sunlight into the water (Figure 2). In contrast to Aneuk Laot and Paya Seunara Lakes, where the water body is stagnant and not shadowed by the canopy of the trees (Figure 2), show higher temperatures 31.2-31.5°C and 30-31.2°C, respectively. The pH and alkalinity of the water bodies also show optimal range for the live of the freshwater shrimp. Environmental parameters such as pH, temperature, and dissolved oxygen play a significant role in determining the suitability of freshwater shrimp environment (Su et al. 2020). If there is a fluctuation, it can cause shrimp stress, reducing productivity and causing disease (Nath and Haldar 2020). Similarly, if there is pollution from chemicals such as heavy metals or other organic contaminants, they will cause negative impact on the shrimp health and potentially pose a risk to humans who consume them (Aytekin et al. 2019; Albuquerque et al. 2020; Acharya et al. 2023).

In conclusion, there were 4 species of freshwater shrimp found in lentic and lotic systems on Weh Island, i.e., *M. lar*, *M. lanatum*, and *M. lanchesteri*, and *C. serratiostris*. They belong to 2 families, i.e., Palaemonidae and Atyidae, and 2 genera, *Macrobrachium* and *Caridina*. The genus *Macrobrachium* consists of 3 species, i.e., *M. lar*, *M. lanatum*, and *M. lanchesteri*. and the genus *Caridina* contains 1 species, i.e., *C. serratiostris*. Pria Laot River showed a low level of shrimp species diversity, moderate Dominance Index, and fairly high species evenness. Meanwhile, Aneuk Laot and Paya Seunara Lakes indicated a low level of shrimp species diversity and evenness but dominated by *M. lanchesteri*. Effective freshwater management through the physical, chemical,

and biological parameters interaction are needed to be developed to create a suitable freshwater environment for the living of the shrimps. Although Weh Island offers a unique ecological niche for freshwater shrimp, the increasing threats due to human activities such as loitering, deforestation, and climate change are very real. Early action and prevention are essential to protect not only the shrimp population but also the integrity of the entire terrestrial ecosystem. Collaborative efforts and synergy between local communities, government, and tourists are essential to implement sustainable strategies as a priceless legacy for future generations.

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