# Diversity of freshwater shrimp in South Sumatra

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**Abstract.** South Sumatra is a unique environment because it is known as a floodplain area. When the rainy season, the river system is connected to other areas. Floodplains are created by seasonal changes that affect the freshwater environment of freshwater shrimp and promote adaptations throughout all life stages of the biota living in them. This study examined the diversity of freshwater shrimp floodplain environment in South Sumatra. The study was conducted using purposive sampling on several rivers in South Sumatra. Identification was based on morphological characteristics. The study identified nine species of freshwater shrimp, divided into two groups. The first group is amphidromous, and its species are *Macrobrachium equidens*, *Macrobrachium rosenbergii*, *Macrobrachium lar*, *Macrobrachium idea*, and *Caridina sumatrensis*. The second group is land-lock species, including *Macrobrachium lanchesteri*, *Macrobrachium cf. pilimanus*, *Macrobrachium sintangens*, and *Macrobrachium cf. nipponense*. We used the temporary name "cf" because the sample's identification results show morphological similarities to those in previous research records.

## 1 Introduction

Freshwater shrimp are decapod crustaceans living in freshwater ecosystems. Freshwater shrimps are classified under the class Malacostraca, order Decapoda, and infraorder Caridea . In Indonesia, freshwater shrimp are predominantly from the families Palaemonidae and Atyidae [1]. Species from the Palaemonidae family generally belong to the genus *Macrobrachium*, while those from the Atyidae family are typically found in the genus *Caridina*. Freshwater shrimp inhabit various environments, including rivers, lakes, rice fields, swamps, and ponds [2].

The different habitats of shrimp are caused by differences in their life cycles, namely amphidromous and land-locked. Most freshwater shrimp are part of the amphidromous group, whose larvae of these organisms develop in the sea or estuaries and then return to freshwater as adults. Some shrimp species have evolved to remain in freshwater or are land-locked [3]. Amphidromous animals migrate to interconnected regions through the sea [4]. The increase in sea levels during the late glacial period created new migration routes for amphidromous shrimp

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species through ancient rivers connecting major Southeast Asian regions [5]. One of the regions that became part of this migration route is South Sumatra.

South Sumatra is unique because it is known as a floodplain with a river system connected to other areas [6]. During the rainy season, river water overflows, creating water pools that can reach up to 4 meters in depth, and during the dry season, these pools dry up. These changes directly affect freshwater shrimp, as their habitats become isolated during the dry season. This habitat isolation drives adaptation to fully freshwater conditions and the development of a life cycle that does not require a marine larval stage [7]. These adaptations allow freshwater shrimp to produce larger eggs with more energy reserves to support the development of larvae directly into juveniles that can survive in freshwater environments [8]. During the rainy season, the entire region becomes reconnected, allowing land-locked shrimp to be found throughout South Sumatra. However, research on freshwater shrimp in South Sumatra is still limited. Therefore, the purpose of this study to assess the diversity of freshwater shrimp in South Sumatra.

## 2 Material and methods

### 2.1 Sample collection

Sampling was collected from February-July 2024. Sampling was collected in several rivers in South Sumatra (Figure 1). The sampling location was determined using the Purposive Sampling method. Furthermore, sampling was carried out using the road sampling technique. Samples were taken directly using a hand net and a shrimp trap (bubu) baited with shrimp paste. After collecting the samples, they were then fixed with 70% ethanol and continued with 96% ethanol preservation. The samples that had been preserved were documented using a camera (Canon M10).

### 2.2 Environmental data collection

The environmental conditions of the waters were assessed by measuring pH, temperature (°C), substrate type, and current type. The pH was measured using a pH meter, and the water temperature was recorded with a water thermometer. Substrate type, current type, and vegetation type were determined visually. Substrate type was categorized based on the dominant riverbed composition, such as rocks, sand, or muddy soil.

### 2.3 Identification

The sample identification and analysis process were collected at the Laboratory of the Animal Function and Behavior Division, Department of Biology, IPB University. All preserved shrimp samples were then identified morphologically by using the identification key [9]. The sample identification and analysis process were collected at the Laboratory of the Animal Biosystematics and Ecology Division, Department of Biology, IPB University.

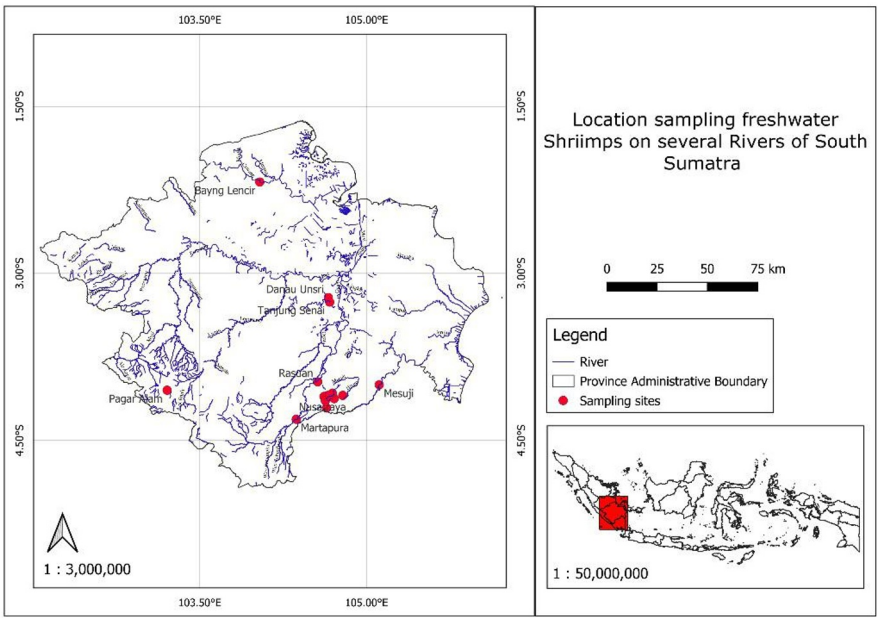


**Fig. 1.** The sampling location map in several rivers in South Sumatra, Indonesia.

# 3 Results and discussion

## 3.1 Diversity of freshwater shrimp on South Sumatra

Based on morphological identification, this study found two genera, namely *Macrobrachium* and *Caridina,* with nine species (Table 1).

**Table 1.** List of freshwater shrimp and their locations in South Sumatra

| No. | Species | Location | Life History Trait |
|---|---|---|---|
| **1** | *M. lanchesteri* (De Man, 1911) | Pagar Alam, Tanjung Senai, Lake Universitas Sriwijaya, Rasuan, Tugu Harum, Nusa Raya, Tanah Merah, Jelabat, Sumber Rahayu, Dadi Rejo, Karang Binangun, Windu Sari, Mesuji, and Martapura | Land-lock |
| **2** | *M. equidens* (Dana, 1852) | Nusa Raya, and Windu Sari | Amphidromous |
| **3** | *M. rosebergii* (De Man, 1879) | Bayung Lencir | Amphidromous |
| **4** | *M.* cf *pilimanus* (De Man, 1879) | Nusa Raya | Land-lock |
| **5** | *M. sintangense* (De Man, 1898) | Nusa Raya | Land-lock |
| **6** | *M. lar* (Fabricius, 1798) | Tanah Merah | Amphidromous |
| **7** | *M. idea* (Heller, 1862) | Windu Sari | Amphidromous |
| **8** | *M.* cf *nipponense* (De Haan, 1849) | Tanah Merah, Dadi Rejo, and Karang Binangun | Land-lock |
| **9** | *C. sumatrensis* De Man, 1892 | Tanah Merah | Amphidromous |

Five of the nine species were found to originate from river locations that flow into the sea or are directly connected to it. Several species of freshwater shrimp release their eggs in river flows leading to estuaries or the sea [4]. Once the shrimp reach the juvenile phase, they return to freshwater to grow and develop [9]. This species is classified as an amphidromous animal with a large number of eggs and a relatively small size. The number and size of these eggs can be used to determine their distribution area. The land-lock group has a small number of eggs with a relatively large egg size (length and diameter > 0.5 mm). The land-lock species found have egg sizes between 0.6-1.2 mm in length and 0.5-0.9 mm in diameter (medium to large) [10]. This group shows a unique reproductive adaptation compared to amphidromous species. The increased egg size offers a considerable energy reserve for larval development [3]. This extra energy enables the larvae to thrive in environments with limited nutrient availability or pose more challenging ecological conditions. These environments can include lakes, isolated river systems, or small streams that are not directly connected to the sea, in contrast to nutrient-rich estuarine habitats [11].

### 3.2 Taxonomy of freshwater shrimp in South Sumatra

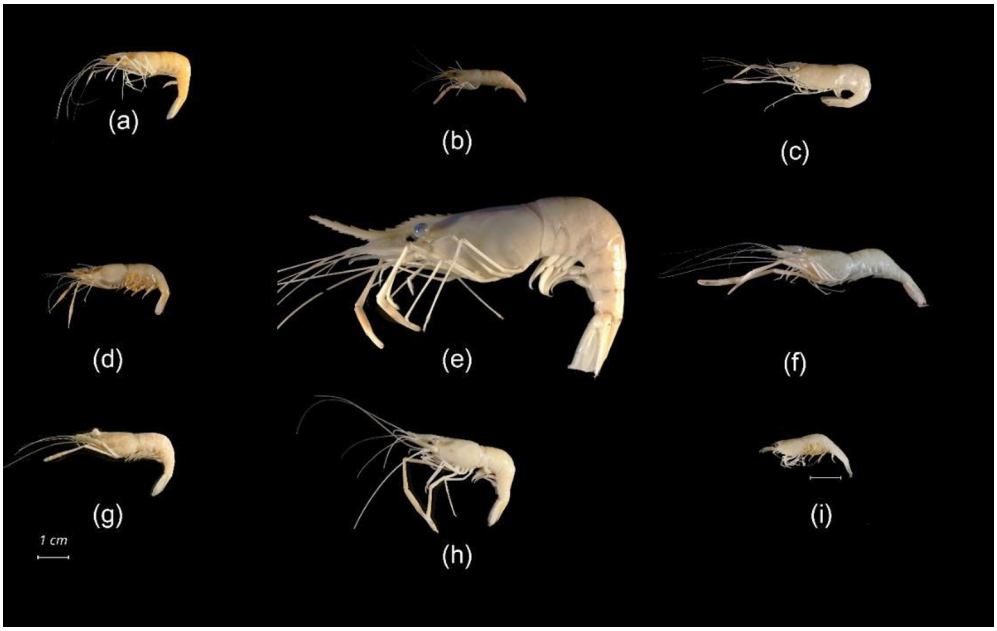


**Fig. 2.** Freshwater shrimp (a) *M. lanchesteri*; (b) *M.* cf *pilimanus*; (c) *M.* cf nipponense; (d) *M. sintangens*; (e) *M. rosenbergii*; (f) *M. lar*; (g) *M. idea*; (h) *M.* equidens; and (i) *C. sumatrensis*. Scale a-h= 1cm and i= 0,5 cm.

#### *3.2.1 Macrobrachium lanchesteri* (De Man, 1911)

Based on the description of [9]. Rostrum straight convex proximally, reaching of scaphocerite, rostrum with 1-2 postorbital teeth on the carapace, 6-7 dorsal teeth, 4-5 ventral teeth, and 1- 2 apical teeth at the tip of the rostrum that is separated from the other teeth by a visible gap. Post antennular carapace margin rounded. The second pereiopod's legs are equal in size, with the chela shorter than the carpus and the palm longer than the fingers. Pre-anal carina is present. The eggs are large, 0.6–0.7× 0.8–1.0 mm (Figure 2a). This species has a wide life span so it is

found in almost all types of habitats, such as ponds, rivers, lakes, rice fields, and dams. Therefore, this species has become an invasive species with high survival rates. In addition, this species is also supported by its ability to grow and reproduce rapidly [10].

### *3.2.2 Macrobrachium* cf *pilimanus* (De Man, 1879)

Based on the description of [9]. Rostrum short, does not reach the end of the third segment of antennular peduncle, with 12-13 dorsal teeth, 4 postorbital teeth, and 2-3 ventral teeth. Post antennular margin rounded. The second pereiopod is unequal in size; the carpus is cup-shaped and much shorter than the merus; the part of the chela is covered with pubescence, and the preanal carina is present. In this specimen, the finger bearing 18 teeth equidistant at propodus and 15 teeth equidistant at dactylus (Figure. 2b). This species is found in habitats with solid currents and hides under rocks or plant roots on the edge of the habitat.

### *3.2.3 Macrobrachium* cf *nipponense* (De Haan, 1849)

Based on the description of [6]. Rostrum is nearly straight, barely reaching or falling slightly short of the anterior end of the antennal scale, and armed with 10 – 13 dorsal teeth, including 2-3 postorbital teeth and 2-3 ventral teeth. Post antennular margin straight. Second pereiopods are sub-equal and similar in shape, covered with small spinules on almost the entire length, chela longer than carpus, and palms slightly longer than carpus. The size egg is large (Figure 2c). *M. nipponense* is reportedly distributed in Japan, Korea, Taiwan, and Myanmar. This species is found in South Sumatra, with a moderate current habitat and sand and rocky substrate. Based on the description, the most visible difference between this species and *M. nipponense* is in the second pereiopod. This species has a wider palm so that it looks tubular, fingers longer than the palm, and fingers gaping.

### *3.2.4 Macrobrachium sintangense* (De Man, 1898)

Based on the description of [9]. Rostrum convex and tapering at the end, reaching or extending beyond the edge of scaphocerite, rostrum with 9-17 dorsal teeth, 2-4 postorbital teeth, and 3-5 ventral teeth. Post antennular carapace margin rounded. The second pereiopod legs are long and have similar shapes but different lengths, the merus is shorter than the carpus, the carpus is longer than the palm, the palm is longer than the fingers, the fingers have pubescence and two small teeth are located at the tips of the fingers. On each side of the dactylus are equipped with tubercles. Mobile spine on uropodal diaeresis longer than outer angle. Pre-anal carina is absent. intermediate-sized eggs 1.0–1.1 x 1.5–1.8 mm (Figure 2d).

### *3.2.5 Macrobrachium rosenbergii* (De Man, 1879)

Based on the description of [11]. Rostrum very long extending beyond edge of scaphocerite; rostrum curves anteriorly higher than posteriorly; rostrum with 8-12 dorsal teeth, 2-3 postorbital teeth, and 6-15 ventral teeth; second pereiopods are similar in shape, equal in size, long, slender; carpus longer than chela and merus, Pre-anal carina is present (Figure 2e). In Indonesia, this species has high economic value and is spread almost throughout Indonesia, from Sumatra to Papua. This species is usually found in downstream rivers or estuaries because this species is amphidromous (has a life cycle that migrates to estuaries to reproduce) [10].

### *3.2.6 Macrobrachium lar* (Fabricius, 1798)

Based on the description of [11]. Rostrum straight or slightly sinuous, reaching the distal end of the third segment of the antennular peduncle, rostrum with 9-10 dorsal teeth, one post orbital tooth, and 2-6 ventral teeth; post antennular carapace margin rounded. The second pereiopod is slender, long, equal in shape, and similar in size; chelae longer than the carpus; fingers gaping, with one or two pairs of large teeth both on the proximal of fingers; pre-anal carina is present (Figure 2f). *M. lar* is distributed in the western Indo-Pacific region, in Indonesia this species has previously been reported in Halmahera and Sulawesi [3]. This species is found on plant roots with muddy and slightly sandy substrates with moderate water currents.

### *3.2.7 Macrobrachium idae* (Heller, 1862)

Based on the description of [11]. The rostrum is slightly sinuous, with 2-3 post-orbital teeth, 6-9 dorsal teeth, and 3-4 ventral teeth. Post antennular margin is straight or concave. second pereopods are similar in form but not usually equal in length, chela shorter than carpus, palm subcylindrical, the fingers covered with pubescence, especially either side of the proximal part of opposable margins, fingers not gaping, palm longer than the finger. The mobile spine on uropodal diaresis is shorter than the outer angle (Figure 2g).

### *3.2.8 Macrobrachium equidens* (Dana, 1852)

Based on the description of [9]. Rostrum curving upwards anteriorly, reaching to or slightly extending beyond edge of scaphocerite; rostrum with 8-10 dorsal teeth, 2-4 postorbital teeth, 4-7 ventral teeth. Post antennular carapace margin staight. Second pereopods are unequal in length and dissimilar in form; second pereopod with palm compressed, chela longer than carpus, and palm longer than finger. The finger is not gaping. Mobile spine on uropodal diaeresis longer than outer angle. Pre-anal carina is absent (Figure 2h). This species is found in swamps with leaf litter and dead wood substrates. This species itself is spread across the Indo-West Pacific. while in Indonesia, this species is spread from Sumatra to Ambon [14].

### *3.2.9 Caridina sumatrensis* De Man, 1892

Based on the description of [9]. The Rostrum does not extend beyond the edge end of the scaphocerite; the dorsal margin is horizontal and turned upward at the tip. armed with 18-20 dorsal teeth, including 5-6 post-orbital teeth and 3-7 teeth. Suborbital angle indistinguishably fused with antennal spines. Pterygostomian margin with a spinule; the right side is missing in one female. Eyes well developed. Uropodal diaeresis with 18-22 mobile spinules. Eggs (0.40-0.42) × (0.22-0.25) mm in diameter (Figure 2i). This species is spread across Sumatra, Borneo, Malaysia, Palawan and India.

### 3.3 Environmental conditions of sampling locations

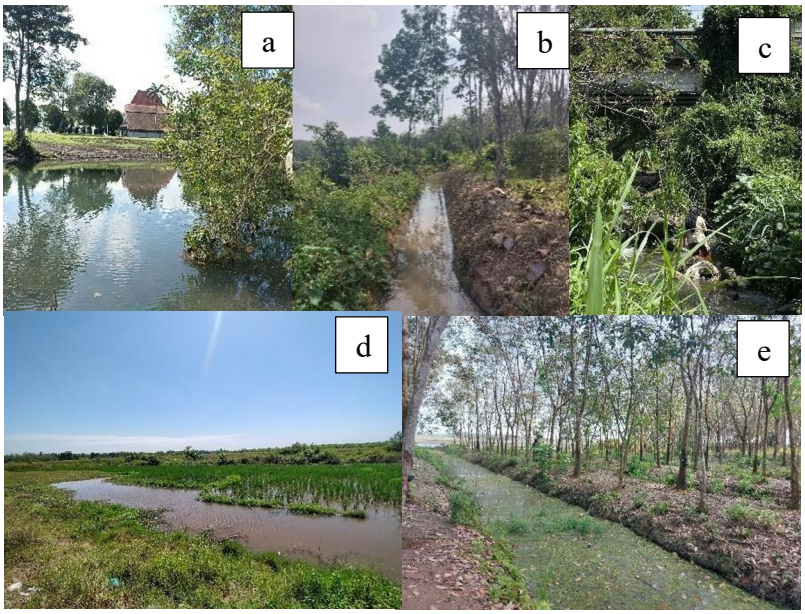


**Fig. 3.** Type of sampling habitats: a-lake. b- irrigation. c-river. d-flood plain. e-swamp

Freshwater ecosystems in South Sumatra have various environmental conditions. Some of the environmental conditions observed include a substrate, the presence of aquatic plants, water temperature, water pH, and water current. The 15 sampling locations included swamps, floodplains, rivers, irrigation, and lakes (Figure 3). The results of environmental observations around the sampling locations were residents' settlements, rubber plantations, rice fields, and universities. In areas near rice fields and rubber plantations, four out of nine species were identified in the study. However, in residential areas, only one or two species were found. This variation is influenced by the different adaptation abilities, habitat preferences, and food sources of each freshwater shrimp species [12].

Each species of freshwater shrimp has different microhabitat preferences. Previous research in Selat Panjang Island, Riau Province, Indonesia, suggested that substrate type affects the abundance of freshwater shrimp [13]. Some species of freshwater shrimp were found in habitats with leaf litter substrates. The substrate with leaf litter provides food and serves as a hiding place for the shrimps [13]. However, some species are found in rocky substrates, such as *M.* cf *pilimanus*. Shrimp prefer shallow, muddy areas for feeding and shelter, while deeper areas are designated for reproduction [14].

The presence of aquatic plants at the sampling site indicates the presence of freshwater shrimp Some freshwater shrimps prefer locations where there are aquatic plants in the water body because they can support their survival rate [3]. The dominant aquatic plants are hydrilla and *Spirogyra sp.* Aquatic plants in the waters benefit freshwater shrimp because they are an excellent place to settle and hide. Freshwater shrimp families Palaemonidae and Atyidae can occupy various aquatic habitats, such as lakes, rivers, swamps, ponds, and underground rivers with fast to slow water speeds [9]. Freshwater shrimp in this study were found at temperatures of 25 °C-31 °C and pH from 4 to 8.3. Previous research reported that the optimal temperature for shrimp survival ranges from 28 to 31 °C, and the ideal pH for freshwater ranges from 6.50 to 8.50 [15].

## 4 Conclusion

This study found nine species consisting of two families, Palaemonidae and Atyidae, which are spread across various habitats in South Sumatra. We also found eight *Macrobrachium* species from the Palaemonidae family and one *Caridina* species from the Atyidae family. We also concluded that amphidromous species were dominant. Environmental factors and habitat types affect the presence of freshwater shrimp species.

## 5 Acknowledgment

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## References

1. R. T. Bauer, Amphidromy and Migrations Of Freshwater Shrimps. I. Costs, Benefits, Evolutionary Origins, And An Unusual Case Of Amphidromy, New Front. Crustac. Biol. **15**, 145–156 (2011)
2. Y. Cai, P. K. ,L. Ng., The Freshwater Decapod Crustacea of Halmahera Indonesia. J. Crustac. Biol. **21(1)**, 665–695 (2001)
3. R. T. Bauer, Amphidromy in shrimps: A life cycle between rivers and the sea. Lat. Am. J. Aquat. Res. **41(4)**, 633–650 (2013). doi: 10.3856/vol41-issue4- fulltext-2
4. V. de Mazancour, J. Ravaux, Amphidromous shrimps (Decapoda: Caridea): current knowledge and future research. J. Crustac. Biol. **44(1)**, 1–15 (2024). doi:10.1093/jcbiol/ruae003
5. T. Solihuddin, A Drowning Sunda Shelf model during Last Glacial Maximum (LGM) and Holocene: A review. Indones. J. Geosci. **1(2)**, 99–107 (2014). doi:10.17014/ijog.v1i2.182
6. J. Miksic, Classical Archaeology in Sumatra. 43–66 (1980). doi:https://doi.org/10.2307/3350825
7. J. Fujita, K. Nakayama, Y. Kai, M. Ueno, Y. Yamashita, Comparison of genetic population structures between the landlocked shrimp, neocaridina denticulata denticulata, and the amphidromous shrimp, caridina leucosticta (decapoda, atyidae) as inferred from mitochondrial DNA sequences. Crustac. Monogr., **15**, 183–196, (2011). doi:10.1163/ej.9789004174252.i-354.132
8. C. C. Han, C. S. Chang, I. M. Cheng, L. S. Fang, K. S. Tew, Population dynamics of a landlocked and amphidromous freshwater shrimp, Caridina gracilipes (Decapoda: Caridea) in subtropical waters. J. Crustac. Biol. **31(2)**, 278–285 (2011). doi:10.1651/10-3331.1
9. D. Wowor, Y. Cai, P. K. Ng, Crustacea: Decapoda, Caridea. Freshwater Invertebrates of the Malaysian Region. Malaysian Academy of Sciences. 337-357 (2004)
10. D. Wowor, V. Muthu, R. Meier, M. Balke, Y. Cai, P. K. L. Ng, Evolution of life history traits in Asian freshwater prawns of the genus Macrobrachium (Crustacea: Decapoda: Palaemonidae) based on multilocus molecular phylogenetic analysis. Mol. Phylogenet. Evol. **52(2)**, 340–350 (2009). doi:10.1016/j.ympev.2009.01.002.
11. S. De Grave and C. Fransen, Carideorum Catalogus: The Recent Species of the Dendrobranchiate, Stenopodidean, Procarididean and Caridean Shrimps ( Crustacea :

Decapoda ), (Leiden: NCB Naturalis, 2011)

12. M. Saito, T. Yamashiro, T. Hamano, K. Nakata, Factors affecting distribution of freshwater shrimps andprawns in the Hiwasa River, southern central Japan. Crustac. Res. **40**, 27–46 (2021)
13. L. Purnamasari, D. Perwitasari-farajallah, D. Wowor, A. Farajallah, New Record of A Freshwater Prawn Macrobrachium sundaicum in Selat Panjang Island , Riau Province, Indonesia. Journal of Tropical Biodiversity and Biotechnology. **9(3)**, 1–6 (2024). doi:10.22146/jtbb.90449
14. A. Dos Santos, L. Hayd, K. Anger, new species of Macrobrachium Spence Bate, 1868 (Decapoda, Palaemonidae), M. pantanalense, from the Pantanal, Brazil. Zootaxa, **3700(4)**, 534–546 (2013). doi:10.11646/zootaxa.3700.4.2
15. D. Sandriliana, The freshwater prawns and shrimps (Crustacea: Decapoda: Caridea) from Lombok Island, West Nusa Tenggara. Ph.D. thesis, IPB (Bogor Agricultural University) (2018)