Morphometric characteristics of mungkus fish (*Sicyopterus* sp.) from several rivers in Bengkulu Province, Indonesia

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**Abstract.** Mungkus fish (*Sicyopterus* sp) is one of the freshwater fish that is caught by many people in Bengkulu Province. The mungkus fish are amphidromous and live in rocky rivers and fast-flowing rivers. This fish has a ventral sucker for sticking to rocks. The aim of this research was to determine the types of mungkus fish that can be found in Bengkulu Province waters based on morphometric characters. The research was conducted on 8 major rivers in 5 districts in Bengkulu Province including Argamakmur, Muko-Muko, Seluma, Manna, and Kaur. Based on the results, showed that the mungkus fish were characterized based on morphometric, there were 3 types of fish including *Sicyopterus squamosissimus*, *Sicyopterus cynocephalus*, and *Sicyopterus lagocephalus*. Mungkus fish found in the northern Bengkulu region tend to be smaller in size, have almost the same color pattern and darker body color than the fish found in the South Bengkulu region. The most common species found in Bengkulu is *Sicyopterus squamosissimus*. The *Sicyopterus lagocephalus* species can also only be found in rivers in the South Bengkulu region. The fish morphometric characteristics show that differences in fish habitat will affect the growth of fish and the existence of living species in nature.

1. Introduction

The mungkus fish (*Sicyopterus* sp) is a freshwater fish that is often found in Bengkulu Province which has a unique habitat, fish will lay eggs in rivers, and hatches downstream. When young fish hatches downstream, young fish will return against the current heading upstream [1]. Mungkus fish are often found in Bengkulu Province because it has a topography in the form of the upstream part to the downstream of the river adjacent to the sea. Karyadi et al. [2] stated that mungkus fish is an endemic fish in the rivers of South Bengkulu. Because the mungkus fish is much favored by the community, many people catch fish along the river uncontrolled and tend to be excessive, so that it will threaten the existence of mungkus fish and reduce the diversity of mungkus fish [3]. Based on IUCN red list data, there are mungkus (*Sicyopterus* sp) that are in the NT (Near Threatened) such as *S. stimpsoni* and *S. aiensis*, EN (Endangered) status such as *S. eudentatus* and *S. sarasini*, although most of them such as *S. cynocephalus* and *S. pugnans* are in the LC (Least Concern) status [4]. So that there is a need for immediate management action to prevent exploitation and catch fish on a large scale.

The mungkus fish have a special sucker because of the fusion of the pelvic fins. The sucker on the mungkus fish functions to climb and rapids during their upstream migration to the upper reaches of the river systems [5]. Mungkus fish live in clear water and water that continues to flow from upstream to...
downstream, so the presence of mungkus fish can be used as a bio-indicator of the condition of river waters [6].

Based on the data research, the species of mungkus fish that can be found in Indonesia are *Sicyopterus cynocephalus*, *S. longifilis*, *S. microcephalus*, *S. lagocephalus*, *S. micrurus*, and *S. hageni* [7]. Based on the research of Keith et al. [8], a new species of *Sicyopterus* sp from Sumatra and Java was found, namely *Sicyopterus squamosissimus*, and 5 new species were found from Papua and Papua New Guinea [9] namely *Sicyopterus calliochromus*, *S. erythropterus*, *S. lengguru*, *S. ocellaris* and *S. stiphodonoides*. The distribution pattern of mungkus fish species in Bengkulu is unknown, and there has been no research on types of mungkus fish species, especially in Bengkulu province. Morphometric analysis is defined as a study that deals with variations and changes in the size and shape of organisms. Because species that have similarities or close kinship will have similar traits. On the other hand, different species will also have different characteristics [10]. Based on this background, it is necessary to characterize mungkus fish in major rivers in Bengkulu Province. The aim of this research is to determine types of mungkus fish in Bengkulu Province waters based on morphometric characteristics.

2. Materials and Methods

2.1. Sampling

The samples were obtained from the catches directly from 8 rivers in Bengkulu Province that were Batang Muar river in Muko-muko District at geographical coordinates of 2°58’14″ S and 101°35’55″ E (Location 1, herein after abbreviated Loc. 1), Air Nokan river at geographical coordinates of 3°24’46″ S and 102°11’17″ E (Loc. 2) and Lubuk Banyau river in North Bengkulu District at geographical coordinates of 3°18’28″ S and 102°05’04″ E (Loc. 3), Maras river in Seluma District at geographical coordinates of 4°20’43″ S and 102°48’18″ E (Loc. 4), Air Nipis river at geographical coordinates of 4°20’18″ S and 103°07’09″ E (Loc. 5), Air Manna river at geographical coordinates of 4°28’55″ S and 102°54’43″ E (Loc. 6) and Kedurang river at geographical coordinates of 4°23’31″ S and 103°02’47″ E in South Bengkulu District (Loc. 7), and Padang Guci river in Kaur District at geographical coordinates of 4°22’55″ S and 103°18’57″ E (Loc. 8) (site location can see of Figure 1). The samples were taken during periods July-September 2020. The sample fishes were preserved in an icebox at 4°C for morphometric analysis. Morphometric were obtained from the morphology of the mungkus fish. The samples were caught a total of 450 individuals from 8 rivers in Bengkulu Province. Measurements were taken with measuring paper and vernier calipers.

Figure 1. The site location of Mungkus fish (*Sicyopterus* sp.) sampling

2.2. Morphometric characters
The morphometric characters of Mungkus fish consist of 21 characters i.e. total length, standard length, heights of the head, midbody, caudal peduncle, lengths of the bases of the pectoral fin, first and second dorsal fin, anal fin; eye diameter, preorbital and postorbital length, widths of the pectoral fin, first and second dorsal fin, anal fin lengths of the head, trunk, tail, and pectoral fin; widths of the head and of the body at the mid trunk and anal pore; and the length and width of the pelvic sucker (Table 1). The twenty-one characters were chosen because these parts easily observable parts of the mungkus body (detail description can be seen in Figure 2). The measurement was performed using the Image-J application. The measurement of morphometric characters of mungkus fish was carried out on 9 groups based on morphological characters of *Sicyopterus* sp. (Figure 3).

**Figure 2.** Morphology of Mungkus Fish (*Sicyopterus* sp.)

| Group | Species |
|-------|---------|
| S1    | ![Image of S1] |
| S2    | ![Image of S2] |
| S3    | ![Image of S3] |
**Figure 3.** Group of sample Mungkus fish (*Sicyopterus* sp.)
3. Result and Discussion

Based on the results of observations of morphological characteristics of mungkus fish in general from 8 rivers in Bengkulu Province, mungkus fish has a distinctive fusiform body shape consisting of two equal sides, has stenoid-shaped scales, and has a tail shape that tends to be rounded. Mungkus fish has a characteristic that is it has two dorsal fins, first and second fin, and has a ventral fin in the form of a sucking claw to attach.

In this research, the identification of morphology by looking at the morphological characteristics of the species is generally in the form of morphometric analysis. Morphometric analysis is usually used on species to study kinship relationships [11]. This is because closely related species will have similar characters through quantitative measurements and skeletal analysis [12]. Sara et al. [13] also confirmed, morphometric characters are commonly used in taxonomy to identify fish species.

The morphological characteristics of mungkus fish group can be seen in Figure 3. The mungkus fish are found to have unique characteristics from each river, one of which is the different colors and motifs on their bodies, tail colors are also different. The color of the mungkus fish eyes is also different, some are light, but some are black. As well as under the eyes, some mungkus fish have black marks under the eyes and some fish do not have black marks.

| Morphometric characteristic | Code | Morphometric characteristic | Code |
|-----------------------------|------|-----------------------------|------|
| Total Length                | A    | Ventral Fin Length          | L    |
| Standar Length              | B    | Head Depth                  | M    |
| Body Depth                  | C    | Pre Orbital Length          | N    |
| Head Length                 | D    | Post Orbital Length         | O    |
| Eye Diameter                | E    | First Dorsal Fin Height     | P    |
| Pre Dorsal Length           | F    | Second Dorsal Fin Height    | Q    |
| First Dorsal Fin Length     | G    | Pectoral Fin Height         | R    |
| Second Dorsal Fin Length    | H    | Anal Fin Height             | S    |
| Pectoral Fin Length         | I    | Caudal Fin Height           | T    |
| Anal Fin Length             | J    | Ventral Fin Height          | U    |
| Caudal Fin Length           | K    |                             |      |

Based on the results of the morphometric analysis (Table 2), the measurement results are very varied. For the total body length of mungkus fish ranged from 8.37 cm-13.2 cm; body standard length 6.93 cm-10.4 cm; fish body depth 1.36 cm-2.05 cm; head length 1.3 cm-2 cm; head height 0.97 cm-1.9 cm; eye diameter 0.3cm-0.43cm; predorsal or distance between the front head to before the first dorsal fin 2.27 cm-3.55 cm; pre-orbital length 0.35 cm-0.8 cm; post-orbital length 0.6 cm-0.95 cm; first dorsal fin length 1.37 cm-2.03 cm; second dorsal fin length 1.87 cm-2.75 cm; pectoral fin length 1.37 cm-2.2 cm, anal fin length 1.7 cm-2.45 cm, caudal fin length 1.7 cm-2.7 cm; pelvic fin length 0.73 cm-1.3 cm; first dorsal fin height 1.7 cm-2.93 cm; second dorsal fin height 1.1 cm-1.63 cm; pectoral fin height 0.6 cm-1.4 cm; anal fin height 0.7 cm-1.3 cm; caudal fin height 1.57 cm-2.85 cm; and the width of the pelvic fins 0.92 cm-1.57 cm.

Samples of groups 1 and 2 of mungkus fish were found in Muko-muko and North Bengkulu districts, while groups 3 to 9 were found in South Bengkulu, Kaur, and Seluma district. Based on the results of characterization and identification, the most common species found in Bengkulu in this research was the Sicyopterus squamosissimus species which was only identified in 2015 by Keith et al. which was only found in Java and Sumatra. This species is characterized by a combination of two lateral slits on the wrinkled upper lip, a second dorsal fin with one spine and 10 segmented fingers, a second and third dorsal fin filamentous, more lateral, predorsal, and transverse dorsal scales, and a reddish caudal fin on
males with a few blue stripes on the top and bottom that appear in sample groups 1, 3, 5, and 9. This type of *S. squamosissimus* is spread in the northern and southern of Bengkulu, but there are color differences in fish found in the southern region, which have a pattern that tends to be diverse and brighter. This can also be caused by the physicochemical content of the water, namely, in the northern region it is different from the southern [7].

Table 2. Morphometric characteristic measurements

| Code | S1 (mm) | S2 (mm) | S3 (mm) | S4 (mm) | S5 (mm) | S6 (mm) | S7 (mm) | S8 (mm) | S9 (mm) |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| A    | 8,37±0,60 | 10,75±1,2 | 12,07±3,34 | 11,2±0,42 | 12,3±0,71 | 13,2±0,15 | 10,82±0,81 | 10,55±1,20 | 11,57±0,56 |
| B    | 6,93±0,61 | 8,3±1,13 | 10,07±2,74 | 9±0,52 | 10,3±0,76 | 10,4±0,31 | 7,8±0,83 | 8,5±1,27 | 8,43±0,60 |
| C    | 1,36±0,21 | 1,5±0,28 | 1,73±0,25 | 1,9±0,21 | 1,9±0,03 | 1,9±0,43 | 1,8±0,22 | 1,5±0,14 | 1,87±0,06 |
| D    | 1,33±0,23 | 1,85±0,07 | 1,73±0,58 | 1,7±0,07 | 1,5±0,04 | 2±0,05 | 1,7±0,13 | 1,35±0,35 | 1,63±0,11 |
| E    | 0,33±0,06 | 0,35±0,07 | 0,43±0,06 | 0,3±0 | 0,4±0 | 0,4±0,01 | 0,3±0 | 0,3±0 |
| F    | 2,27±0,15 | 3,55±0,21 | 3,3±0,95 | 3,3±0,04 | 3,4±0,13 | 3,8±0,04 | 2,6±0,18 | 2,9±0,07 | 2,93±0,35 |
| G    | 1,37±0,12 | 1,95±0,35 | 2,03±0,42 | 1,7±0,35 | 2,2±0,14 | 1,9±0,12 | 1,3±0,14 | 1,2±0 | 1,47±0,21 |
| H    | 1,87±0,15 | 2,7±0,57 | 2,73±0,75 | 2,5±0,21 | 2,9±0,35 | 2,9±0,31 | 2,6±0,13 | 2,5±0,07 | 2,5±0,1 |
| I    | 1,37±0,11 | 2±0,14 | 2,17±0,42 | 2,2±0,21 | 2,2±0,41 | 1,8±0,21 | 1,7±0,03 | 1,8±0,14 | 2±0,26 |
| J    | 1,7±0,4 | 2,45±0,21 | 2,3±0,5 | 2,3±0,07 | 2,1±0,03 | 2,7±0,34 | 2,3±0,24 | 2,3±0,14 | 2,3±0,1 |
| K    | 1,43±0,15 | 2,55±0,07 | 2,27±0,55 | 2,5±0,35 | 2,4±0,51 | 2,3±0,16 | 2,2±0,17 | 2,3±0,14 | 2,3±0,15 |
| L    | 0,73±0,21 | 0,95±0,03 | 1,03±0,53 | 1,3±0,61 | 1,3±0,31 | 1,1±0,15 | 0,9±0,05 | 0,89±0,37 | 0,93±0,04 |
| M    | 0,97±0,42 | 1,9±0,14 | 1,57±0,40 | 1,63±0,07 | 1,42±0,07 | 1,7±0,02 | 1,3±0,08 | 1,25±0,07 | 1,37±0,12 |
| N    | 0,7±0,51 | 0,65±0,07 | 0,8±0,17 | 0,5±0,14 | 0,5±0,07 | 0,7±0,21 | 0,4±0,003 | 0,35±0,07 | 0,47±0,06 |
| O    | 0,67±0,15 | 0,95±0,07 | 0,83±0,11 | 0,7±0,14 | 0,7±0,13 | 0,7±0,31 | 0,7±0,09 | 0,7±0,14 | 0,67±0,06 |
| P    | 1,8±0,92 | 2,85±0,46 | 2,93±0,31 | 1,9±0,17 | 1,6±0,21 | 2,4±0,46 | 1,7±0,82 | 2,6±0,69 | 1,93±0,25 |
| Q    | 1,6±1,22 | 1,4±0,65 | 1,3±0,6 | 1,1±0,35 | 1,2±0,62 | 1,8±0,13 | 1,02±0,18 | 1,3±0,28 | 1,03±0,21 |
| R    | 0,77±0,29 | 1,3±0,35 | 1,2±0,35 | 1±0,14 | 1,2±0,21 | 1±0,03 | 0,7±0,32 | 0,85±0,07 | 0,87±0,15 |
| S    | 0,7±0,15 | 1,25±0,07 | 0,7±0,1 | 1,2±0,28 | 1,3±0,03 | 1,1±0,21 | 1,4±0,15 | 0,95±0,07 | 1,33±0,12 |
| T    | 1,57±0,59 | 2,8±0,21 | 2,5±0,7 | 2,1±0,21 | 2,8±0,53 | 2,7±0,42 | 2,3±0,05 | 1,9±0,07 | 2,3±0,25 |
| U    | 0,92±0,03 | 1,05±0,04 | 1,17±0,54 | 1,2±0,12 | 1,03±0,17 | 1,2±0,17 | 1,05±0,61 | 0,94±0,04 | 1,12±0,18 |

In the samples of groups 7 and 8, it was a type of mungkus fish that was only found in the southern region, which was characteristic of *Sicyopterus lagochealus*. This fish has a special characteristic, namely, the body is blue and the tail is orange to reddish, so it is often called the red-tailed goby. Males become very colorful during the rainy season, with bluish to greenish sides, while females are brownish to greyish with a white belly. This type of fish is found in the Indian and Pacific Oceans with a maximum length of up to 15 cm. Adult fish live in fast-flowing rivers with rocky layers while the larvae live in the sea. This species is not found in the north, it can also be caused by the area of distribution. In groups 2, 4, and 6 there are characteristics of *Sicyopterus cynocephalus* which is also spread in the northern and southern regions. This type of fish can be found in Indonesia and the Philippines. Characteristics of this species in the form of a whitish or brown body color (males are usually darker and have spots on the dorsal, have dark lines under the eyes, red irises while females are white-brown with striped pectoral fins, and have no spots on the back). *S. cynocephalus* can also have a maximum body length of 16.5 cm.

Based on the measurement results, it shows that there are morphometric variations of mungkus fish. Mungkus fish from the Southern region tend to be larger in size and vary in color or body pattern compared to the mungkus fish samples from the Northern area. Fish have different sizes, depending on age, sex, and habitat conditions. Morphometric characters influenced by genetic diversity. Environmental factors that can affect fish life include food, pH, temperature, and salinity. These factors
have a very large influence on the growth of fish. Thus, fish that have the same age but absolute size and characteristics can also be different. Based on research by Roesma et al. [14], shows that environmental conditions play a very important role in determining the phenotype of a species. Larvae exhibited markedly higher survival rates when reared at intermediate salinities compared to freshwater or seawater, suggesting estuaries may play an essential role as nursery grounds for bluegill bully and other amphidromous fish [15]. The common goby population is sensitive to both temperature and salinity changes [16]. Pasisingi et al. [17] state that temperature more than a 3°C increase caused significant population decreases. So that the presence of fish that is not evenly distributed can also be caused by the large number of fish larvae caught so that the number and types are reduced in nature. As well as the environmental conditions of the waters will affect the distribution and presence of fish species in nature. The morphometric characters related to the genetic (species) and their habitats.

4. Conclusion
Based on the morphometric characteristics of mungkus fish (Sicyopterus sp) that can be found from 8 rivers in Bengkulu Province are Sicyopterus lagocephalus which is only found in the southern region, especially the South Bengkulu district, Sicyopterus cynocephalus and Sicyopterus squamosissimus which can be found in the northern and southern region. Sicyopterus squamosissimus is the most common species of mungkus fish found in Bengkulu.

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