Morphometric comparison of *Osteochilus spilurus* (Bleeker 1851) from Bangka and Belitung Island, Indonesia

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Abstract. *Osteochilus spilurus* is a low economic value freshwater fish in Sumatra, Kalimantan, and the Malay Peninsula. The trade for consuming identified in Belitung island. There is no study-related to their morphological characters of the Bangka and Belitung islands. In this paper, *O. spilurus* was investigated the character adaptations in different exploitation and geography separately by morphometrics and landmarks. *O. spilurus* from Bangka and Belitung island found to have a significant difference in eight morphometric characters: head length, head depth, snout length, pre-ventral length, body depth at anal, caudal pundacleqa depth, dorsal base length, and anal base length. Symmetry and Asymmetry Geometric Data (SAGE) analysis found individual variation significantly. Morphometric changes that are not accompanied by meristic changes indicate a different process of adaptation to the environment due to the isolation of thousands of years of habitat.

1. Introduction

Variations in the phenotype of freshwater fish occur as an effect of the locations. Freshwater fish get a more significant impact on its change than marine fish on geography because marine fish have the possibility of 10 to 100 times more migration between subpopulations [1]. Freshwater fish are constrained by various geographical barriers such as dams, seas, different rivers, and other barriers. Other than that, regional differences exert influence from traditional societies. Local ethnozoology makes a difference in the use of freshwater fish. Worthless fish somewhere may be of high economic value to other regions. *Osteochilus spilurus* profile was affected by the location and environment. *O. spirilus* is benthopelagic freshwater fish in the slow flow rivers [2]. *O. spilurus* was identified in Bangka regency [3], and Lenggang river, East Belitung regency [4]. The Gaspar Strait separates Bangka Island and Belitung Island. This fish, known as *Cempedik* Fish on Belitung Island and *Kepaat* Fish on Bangka Island. They have
morphological characteristics in silvery color, the forked shape of caudal fins, a pair of sunglasses at the tip of the bottom of the mouth, abdominal fins behind the pectoral fins, and a black spots on both sides of the base of the tail [5].

The trading of *O. spilurus* was absent in Bangka. In contracts, it has an economic value in Belitung. Most of the publications describe it as freshwater biodiversity that has not been considered for commercial purposes. However, consuming of *O. spilurus* happen in Belitung Island [6,7]. Almost all of this fish trade takes place at the beginning of the rainy season in East Belitung, with most of the fish caught in the gonad ripe conditions. Catching of fish in the mature status of gonad has the potential to disturb the fish's reproductive cycle. Hence, fish can fail to breed for the new generation [8].

The difference in utilization raises the potential for differential pressure on *O. spilurus* populations in the natural habitat. Differences in stressors that occur allow for fish adaptation that impacts on changes in phenotype and genotype. Differences in morphological characters were related to their adaptations to environments [9]. Nowadays, there is no study-related to morphological characters of *O. spilurus* from the Bangka and Belitung Islands. In this study, *O. spilurus* from Bangka and Belitung Island were studied by the method of morphometrics and landmarks analysis.

### 2. Method

#### 2.1. Location of the Study

Sampling was carried out from Lebak River in Bangka island and Lenggang River in Belitung island. Fish samples were landed on the jetty in Payabenua Village, Mendo Barat District, Bangka Regency (2º 4’ 38,719”; 105º 51’ 53,989”) and Lintang Village, Simpan Renggian District, East Belitung Regency (2º 54’ 28,940”; 108º 5’ 42,864”) (Figure 1).

![Figure 1. Map of the locations for fish sampling in Lebak river in Bangka Island (Sample 1) and Lenggang river in Belitung Island (Sample 2).](image-url)

Sampling in the Lenggang River was carried out in December 2018 and the Lebak River in April 2019 with the help of local fishers. The technique of preserving fish collections uses 96% alcohol and immediately taken to the laboratory for further processing.
2.2. Processing of fish samples

Individually of about Fifty (50) samples were measured manually using a digital caliper with a precision of 0.1 mm. Measurements were made on the 15 morphometric characters observed (Figure 2). Thirty-six (36) individuals of *Osteochilus spilurus* were photographed three times (tri-replicated) using a 13 MP camera on the left lateral side (Figure 3).

![Figure 2. Morphometric characters of *Osteochilus spilurus* were observed.](image)

| No  | Character                  | Description                                                                 |
|-----|----------------------------|-----------------------------------------------------------------------------|
| 1   | Total length               | The straight-line measurement taken from tip of snout to caudal fin end      |
| 2   | Standard length            | The straight-line measurement taken from tip of snout to the last vertebra which supports the tail fin of the fish |
| 3   | Head length                | The straight-line measurement taken from front of snout to the back of the operculum (bony gill cover). |
| 4   | Head depth                 | Measured from the head to the head down                                    |
| 5   | Eye diameter               | The length of the centerline of the eye                                    |
| 6   | Snout length               | The distance between the mouth and eyes                                     |
| 7   | Pre-dorsal Length          | The straight-line measurement taken from front of snout to origin of the dorsal fin |
| 8   | Pre-ventral Length         | The straight-line measurement taken from front of snout to origin of the anal fin |
| 9   | Pre-anal Length            | The straight-line measurement taken from front of snout to origin of the anal fin |
| 10  | Body depth at dorsal fin   | Height measured at the origin of the dorsal fin                            |
| 11  | Body depth at anal fin     | Height measured at the origin of the anal fin                               |
| 12  | Caudal pundacle depth      | Height measurement at the lowest part of the tail body                      |
| 13  | Dorsal base length         | The straight-line measurement taken from the base of origin and the end of the dorsal fin meets the body |
| 14  | Anal base length           | The straight-line measurement taken from the base of origin and the end of the anal fin meets the body |
| 15  | Caudal fin length          | The straight-line measurement taken from the base to the most length end of the caudal fin |
Figure 3. Actualized digitized sample and landmark points used to describe the body shape of *Osteochilus spilurus*.

Table 2. Landmarks used to digitize the body shape of *Osteochilus spilurus*.

| Landmark Points | Location                        | Landmark Points | Location                                |
|-----------------|---------------------------------|-----------------|-----------------------------------------|
| 1               | Snout tip                       | 8               | Posterior insertion of anal fin          |
| 2               | Posterior end of nuchal spine   | 9               | Anterior insertion of anal fin           |
| 3               | Anterior insertion of dorsal fin | 10              | Dorsal base of pelvic fin                |
| 4               | Posterior insertion of dorsal fin| 11              | Ventral end of lower jaw articulation    |
| 5               | Dorsal insertion of caudal fin  | 12              | Anterior margin through midline of orbit |
| 6               | Midpoint or lateral line        | 13              | Posterior margin through the midline of orbit |
| 7               | Ventral insertion of caudal fin | 14              | Posterior of operculum (bony gill cover) |

2.3. Data analysis

Morphometric measurements data were transformed using the modification of the Schindler & Schmidt [9] formula as follows:

\[
M_{\text{trans}} = M \times \frac{100}{\text{Standard Length}} \tag{1}
\]

Note: \(M_{\text{trans}}\) = morphometric size that transformed, \(M\) = morphometric measurement results.

Furthermore, the transformation results were analyzed using the t-test to find out the morphological variation of the two fish population locations.

The photographed of the fish samples are converted to TPS files using TPSutil. The digitation process was followed by utilizing TPSdig2 [11]. Fourteen (14) anatomical landmark points (Table 2) were undertaken to the samples. Furthermore, shape analysis was also applied to the fish samples and was tri-replicated to less the measurement error. The result of TPSdig was analyzed using Symmetry and Asymmetry Geometric Data (SAGE) Software version 1.05 [12].

3. Results and discussion

*Osteochilus spilurus* samples obtained from Bangka and Belitung Islands have morphological features in the form of a silvery body, and the snout tends to cone with several small pores. The dorsal height of this fish gradually increases in the front. The anal fin is slightly rounded with a position behind the dorsal fin; the ventral fin is an abdominal type (behind the pectoral fin); and caudal forged fin shape. There is a large
black dot near the end of the tail stem. The sample also has a pair of tentacles at the lower mouth. They had fins with formulas D.3.11, A.3.5, and P.1.12, as well as a lateral line with 29-30 attached scales along the route. That characteristic is shown as _Osteochilus spilurus_ following the description of Weber and Beaufort [13]. Sample of _O. spilurus_ from Bangka and Belitung Islands shown in Figure 4. Morphometric measurements of fish samples from both islands in 15 characters shown in Table 3. A transformation of 15 morphometric measurements shown in Table 4.

![Figure 4](image_url)

**Figure 4. Osteochilus spilurus** from Bangka island (above) and Belitung island.

| Morphometric Characteristics | Belitung Island | Bangka Island |
|------------------------------|-----------------|--------------|
| Total length (mm)            | 49.43 ± 2.21    | 49.27 ± 9.46 |
| Standard length (mm)         | 39.58 ± 2.41    | 38.93 ± 8.04 |
| Head length (mm)             | 8.74 ± 0.56     | 10.30 ± 1.73 |
| Head depth (mm)              | 6.79 ± 0.65     | 7.44 ± 1.42  |
| Eye diameter (mm)            | 2.98 ± 0.26     | 2.91 ± 0.48  |
| Snout length (mm)            | 2.52 ± 0.30     | 2.98 ± 0.65  |
| Pre-dorsal Length (mm)       | 17.93 ± 1.17    | 18.12 ± 3.48 |
| Pre-ventral Length (mm)      | 20.25 ± 1.75    | 20.88 ± 4.33 |
| Pre-anal Length (mm)         | 28.78 ± 1.43    | 29.38 ± 6.70 |
| Body depth at dorsal fin (mm)| 10.72 ± 0.68    | 10.84 ± 2.53 |
| Body depth at anal fin (mm)  | 6.68 ± 0.47     | 7.51 ± 1.94  |
| Caudal pundacle depth (mm)   | 4.50 ± 0.32     | 5.21 ± 1.15  |
| Dorsal base length (mm)      | 8.40 ± 0.84     | 11.62 ± 2.89 |
| Anal base length (mm)        | 3.18 ± 0.41     | 3.91 ± 0.87  |
| Caudal fin length (mm)       | 10.38 ± 0.69    | 10.60 ± 1.82 |

** (p ≤ 0.01) – highly significant; * (p ≤ 0.05) – significant; ns – non significant
There are significant differences in eight morphometric characters. The difference is in the head section (head length, head depth, snout length) and the rear body (pre-ventral length, body depth at anal, caudal pundacle depth). Dorsal base length and anal base length also show significant differences. Does the separation of millions of years ago affect the different adaptations of the same fish species? Or different habitat conditions adapted to survive? Morphological differences from Osteochilus from different islands are possible due to phenotypic variations in individuals. Table 4 illustrates that there are significant variations between individuals in the sample population of the Bangka and Belitung islands.

**Table 4.** Procrustes ANOVA of symmetry and asymmetry geometric analysis.

| Effect                | Sum Of Squares | Degrees of Freedom | Mean of Squares | P-Value |
|-----------------------|----------------|--------------------|-----------------|---------|
| Individuals           | 0.26735        | 420                | 0.00063655      | 0**     |
| Sides                 | 1.1036e-34     | 12                 | 9.1967.10^{-36} | 0.51243 ns |
| Individuals x Sides   | 4.1351e-33     | 420                | 9.8455.10^{-36} | 1 ns    |
| Measurement error     | 0.064424       | 1728               | 3.7282.10^{-05} | -       |

**—** significant levels of fluctuating asymmetry of *Osteochilus spilurus* (p < 0.005)

ns — not significant

Plants on the edge of a river become a protection place for steady water flow. The small body size of fish dealing with the water flow. Morphological of freshwater fish differences among different species are characters related to swimming and feeding behavior and are the results of their adaptations to different environments [9]. Fish in waters with the little flow, like lake fish, have more posteriorly positioned first dorsal and pelvic fins and shorter second dorsal fin bases [14]. Habitat-associated morphological divergence is widespread in fishes, including intraspecific differences attributable to lentic and lotic conditions. Physical characteristics of rivers with dam may determine evolutionary and ecological conditions driving changes in the morphological characteristics of resident fish populations [15].

Both rivers have also been influenced by illegal tin mining because both islands have become the world's largest tin producers since hundreds of years ago. Illegal mining is one of the causes of damage to river water quality. Supervision of the implementation of regional regulations that prohibit mining in watersheds is a critical point in river water quality management. Rivers on Bangka Island are affected by the influence of tin mining to show mild to moderate levels of pollution [3].

The next cause of morphometric differences is geographic isolation. At present, the islands of Bangka and Belitung separated by the ocean. Those conditions are predicted to have lasted thousands of years ago. The islands of Bangka and Belitung have been separated for longer than the islands of Bangka and Sumatra [16]. The separation of the mainland of Bangka Island and Belitung occurred at a depth of 30 m, so it is predicted to have been separated since 9600 years ago [17]. The similarity of ancient rivers in the past made the same fish species on both islands. The river is predicted to be the ancient North Sundanese river [18]. Habitat isolation that has taken place thousands of years ago is thought to have a role in morphometric differences. Differences in adaptation to the environment both types of food and physical chemistry of waters allegedly have a stake in fish growth.

**4. Conclusion**

*Osteochilus spilurus* from Bangka and Belitung island found to have a significant difference in eight morphometric characters: head length, head depth, snout length, pre-ventral length, body depth at anal, caudal pundacle depth, dorsal base length, and anal base length. Symmetry and Asymmetry Geometric Data (SAGE) analysis found individual variation significantly. Morphometric changes that are not
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