# Morphometric Characteristics of Asian Catfish, Hemibagrus wyckii (Bleeker, 1858) (Bagridae), from the Riau Province of Indonesia

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# Research Article
# Morphometric Characteristics of Asian Catfish, *Hemibagrus wyckii* (Bleeker, 1858) (*Bagridae*), from the Riau Province of Indonesia

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## Abstract

**Background and Objective:** Asian Catfish (*Hemibagrus wyckii*) is an important fish having both food and a high price in the market. These species are categorized as a carnivorous freshwater finfish native in Indonesia and is vulnerable to endangered status. This study was carried out to identify the morphometric characteristics of *Hemibagrus wyckii* (*H. wyckii*) from the Koto Panjang Reservoir, Kampar Kanan and Kampar Kiri rivers. **Materials and Methods:** Twenty-five fish were collected from each sampling site. The morphometric characteristics were analyzed using the truss morphometric method. Twenty-nine characteristics were measured to obtain the morphometric characteristics of this species. Morphometric data of *H. wyckii* were analyzed using one-way ANOVA (SPSS version 17.0). Principal component analysis (PCA) was used to evaluate the relationship between different factors and morphometric characteristics. The distribution across different habitats was measured by component canonical analysis (CCA) and genetic distance was analyzed by hierarchical cluster. **Results:** The average standard lengths of *H. wyckii* from the Koto Panjang Reservoir, Kampar Kanan and Kampar Kiri rivers (Mean±SD) were 428±15.78, 432.52±66.11 and 425.86±50.41 mm, respectively. Twenty-nine morphometric characteristics were measured. There was a 68.96% difference obtained in samples collected at the Koto Panjang Reservoir and Kampar Kanan river. There was a 95.55% difference obtained in the Koto Panjang Reservoir, Kampar Kiri river and a 100% difference obtained in the Kampar Kanan and Kampar Kiri rivers. The main differences in morphometric characteristics included inter orbital distance, length of adipose-fin base, predorsal length, length of front dorsal fin-front pelvic and depth of caudal peduncle. The Mahalanobis distance between fish from the Koto Panjang Reservoir and Kampar Kanan river demonstrated that both types originated from a single population. **Conclusion:** It was concluded that more favorable morphometric characteristics of *H. wyckii* were found in the Kampar Kanan river compared to those from the Koto Panjang Reservoir and Kampar Kiri river.

Key words: Morphometric characteristics, environmental factors, mahalanobis distance, *Hemibagrus wyckii*, broodstock

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

*Hemibagrus wyckii* (*Bagridae*), local name geso, is a carnivorous freshwater finfish native to Indonesia.[1,2] These species live in the Koto Panjang Reservoir[3], Kampar Kanan river[4,5] and Kampar Kiri river[6]. Natural stocks have reduced due to overexploitation which causes a high price (USD per 13.33 $kg^{-1}$ body weight) in the market[2,4]. These species were identified as "least concern" in the International Union for Conservation of Nature Red list of threatened taxa. However, *H. wyckii* in the Kampar Kanan river was categorized as "vulnerable to endangered". Previous studies have indicated that the populations of *H. wyckii* have decreased due to overexploitation and environmental degradation[5,7].

Recently, the *H. wyckii* broodstock population has decreased in the rivers and reservoir due to domestication. The biology and population structure of *H. wyckii*, such as morphometric characteristics are required for proper domestication. The study of morphometric characteristics in addition to biology, ecology, evolution, behavior, conservation, water resource management, stock assessment and commercial status play a vital role in optimizing domestication[8,9]. Research on morphometric characteristics has been conducted in several species, including *Puntius sarana*[10], *Labeo calbasu*[11], *Puntius chola*, *P. conchonius*, *P. sophore*, *P. ticto*[12], *Salmo trutta fario*[13] and *Pethia shalynius*[14]. The aim of this study was to evaluate the morphometric characteristics of *H. wyckii* collected from different sites. The results of this study can help to protect the *H. wyckii* broodstock from endangered status and increase the number of candidate species for aquaculture in the future.

## MATERIALS AND METHODS

**Collection of samples:** The samples of *H. wyckii* were collected from local fisherman from the Koto Panjang Reservoir (N: 00°14' 21.7" E: 100°17'43.1"), Kampar Kanan river (N: 00° 21' 54.7" E: 101°17'43.1") and Kampar Kiri river (N: 00° 05'37.1" E: 101°17'01.6") at the Kampar Regency in the Riau province of Indonesia. The samples were collected from February-September, 2016. The fish were caught using traditional fishing gears called "*lukah*" (trap- nets). Twenty-five fish were collected from each sampling site. The samples were transferred to the Department of Fisheries Laboratory at Riau University in Indonesia. Twenty-nine morphometric characteristics were examine based on previously described methods (Fig. 1)[15]. The standard length and morphometric characteristics of samples were measured by digital slide calipers with 1.0 mm accuracy and the weight of each fish was measured using OHAUS model CT 6000-USA.

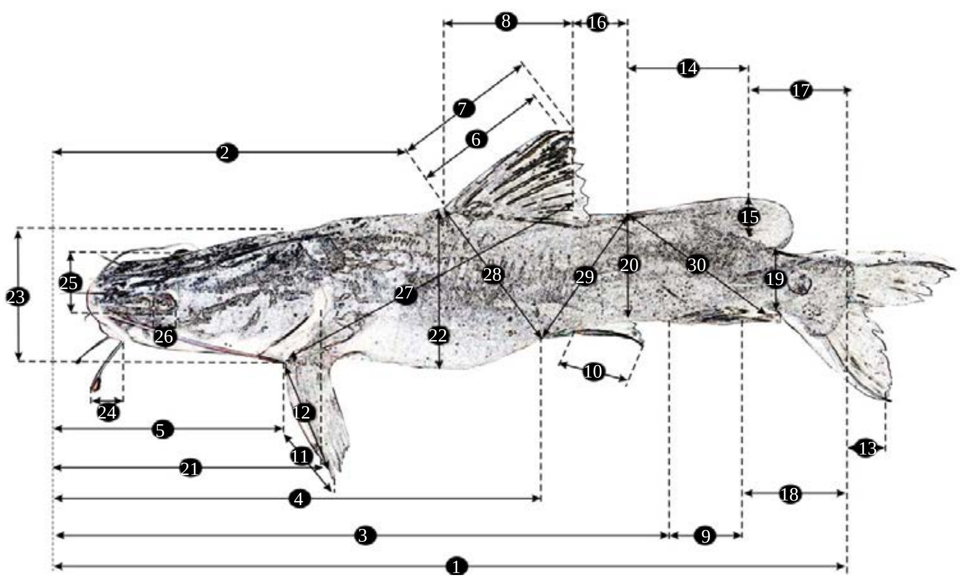

Fig. 1: Description of the truss of *H. wyckii*

1: Standard length, 2: Predorsal length, 3: Preanal length, 4: Prepelvic length, 5: Prepectoral length, 6: Dorsal-spine length, 7: Dorsal-fin length, 8: Length of dorsal-fin base, 9: Length of anal-fin base, 10: Pelvic-fin length, 11: Pectoral-fin length, 12: Pectoral-spine length, 13: Caudal-fin length, 14: Length of adipose-fin base, 15: Maximum height of adipose fin, 16: Dorsal to adipose distance, 17: Post-adipose distance, 18: Length of caudal peduncle, 19: Depth of caudal peduncle, 20: Body depth at anus, 21: Head length, 22: Body depth, 23: Head depth, 24: Snout length, 25: Inter orbital distance, 26: Eye diameter, 27: Length of prepectoral-fin base, 28: Length of front dorsal fin-front pelvic, 29: Length of pelvic fin-front adipose and 30: Length of anal fin base-front of adipose

**Water quality parameters:** The water transparency was measured using a Secchi disk. Water samples were taken at the surface (depth 0.10 m) in each habitat and used for the determinations of dissolved oxygen (DO) contents, where the work was carried out *in situ* with an oxygen meter (YSI model 52, Yellow Spring Instrument Co., Yellow Springs, OH, USA) and pH values, determined with a pH meter (Digital Mini-pH Meter, 0-14PH, IQ Scientific, Chemo-science (Thailand) Co., Ltd., Thailand). The levels of alkalinity, hardness, electrical conductivity, dissolved solids, ammonia and phosphorus of the water in each replication were measured using the standard procedures[16].

**Statistical analyses:** The morphometric characteristics were measured against a standard of fish length. The mean values for morphometric characteristics, main differences of morphometric characters, distribution of population and water quality parameters from different habitat were analyzed by one-way ANOVA, followed by Duncan's new multiple range test. A value of p<0.05 was used to indicate significant difference. All statistical analyses were performed using SPSS software (Version 16.0 for Windows, SPSS Inc, Chicago IL). The standard deviation of each characteristic and parameter was determined and expressed as the Mean±SD. Genetic distance was analyzed by hierarchical cluster analysis (PAST Software 3.14).

## RESULTS

In the present study, the morphometric characteristics of *H. wyckii* show in Table 1. The dominant morphometric characteristics of *H. wyckii* across different habitats were significantly different (p<0.05). There was a 68.96% difference across samples collected at Koto Panjang Reservoir and Kampar Kanan river. 95.55% difference across samples collected at the Koto Panjang Reservoir and Kampar Kiri river and a 100% difference across samples collected at the Kampar Kanan river and Kampar Kiri river.

Table 1: Morphometric characteristics of *Hemibagrus wyckii* (n = 25, Mean±SD)

| Measurement (mm) | Variable code | Koto Panjang Reservoir | Kampar Kanan River | Kampar Kiri River |
|---|---|---|---|---|
| Standard length | 1 | 428±15.78 | 432.52± 66.11 | 425.86±50.41 |
| Predorsal length | 2 | $0.42±0.02^a$ | $0.44±0.02^b$ | $0.71±0.00^c$ |
| Preanal length | 3 | $0.72±0.02^a$ | $0.73±0.02^b$ | $0.54±0.00^c$ |
| Prepelvic length | 4 | $0.54±0.02^a$ | $0.54±0.04^b$ | $0.26±0.00^c$ |
| Prepectoral length | 5 | $0.25±0.03^a$ | $0.25±0.01^a$ | $0.13±0.00^c$ |
| Dorsal-spine length | 6 | $0.15±0.01^a$ | $0.13±0.01^b$ | $0.18±0.00^c$ |
| Dorsal-fin length | 7 | $0.31±0.05^a$ | $0.17±0.01^b$ | $0.13±0.01^c$ |
| Length of dorsal-fin base | 8 | $0.15±0.01^a$ | $0.12±0.02^b$ | $0.10±0.00^c$ |
| Length of anal-fin base | 9 | $0.10±0.01^a$ | $0.09±0.01^b$ | $0.12±0.00^c$ |
| Pelvic-fin length | 10 | $0.10±0.02^a$ | $0.012±0.01^b$ | $0.15±0.00^c$ |
| Pectoral-fin length | 11 | $0.18±0.03^a$ | $0.15±0.00^b$ | $0.11±0.00^c$ |
| Pectoral-spine length | 12 | $0.15±0.03^a$ | $0.13±0.01^b$ | $0.15±0.00^a$ |
| Caudal-fin length | 13 | $0.26±0.02^a$ | $0.14±0.02^b$ | $0.20±0.00^c$ |
| Length of adipose-fin base | 14 | $0.17±0.01^a$ | $0.19±0.01^b$ | $0.15±0.00^c$ |
| Maximum height of adipose fin | 15 | $0.05±0.01^a$ | $0.05±0.00^a$ | $0.10±0.00^c$ |
| Dorsal to adipose distance | 16 | $0.08±0.01^a$ | $0.11±0.01^b$ | $0.14±0.00^c$ |
| Post-adipose distance | 17 | $0.16±0.01^a$ | $0.14±0.01^b$ | $0.17±0.00^c$ |
| Length of caudal peduncle | 18 | $0.17±0.02^a$ | $0.16±0.01^b$ | $0.09±0.00^c$ |
| Depth of caudal peduncle | 19 | $0.08±0.01^a$ | $0.08±0.01^a$ | $0.18±0.00^c$ |
| Body depth at anus | 20 | $0.14±0.02^a$ | $0.15±0.04^a$ | $0.30±0.00^c$ |
| Head length | 21 | $0.30±0.02^a$ | $0.29±0.01^a$ | $0.25±0.01^c$ |
| Body depth | 22 | $0.19±0.01^a$ | $0.22±0.01^b$ | $0.15±0.00^c$ |
| Head depth | 23 | $0.14±0.01^a$ | $0.14±0.01^a$ | $0.10±0.00^c$ |
| Snout length | 24 | $0.09±0.01^a$ | $0.09±0.01^a$ | $0.08±0.00^c$ |
| Inter orbital distance | 25 | $0.09±0.01^a$ | $0.08±0.00^b$ | $0.02±0.00^c$ |
| Eye diameter | 26 | $0.03±0.00^a$ | $0.02±0.00^a$ | $0.02±0.00^c$ |
| Length of prepectoral-fin base | 27 | $0.36±0.01^a$ | $0.34±0.01^b$ | $0.22±0.00^c$ |
| Length of front dorsal fin-front pelvic | 28 | $0.35±0.02^a$ | $0.21±0.01^b$ | $0.18±0.00^c$ |
| Length of pelvic fin-front adipose | 29 | $0.15±0.00^a$ | $0.18±0.01^b$ | $0.17±0.01^c$ |
| Length of anal fin base-front of adipose | 30 | $0.29±0.01^a$ | $0.26±0.00^a$ | $0.16±0.00^c$ |

Variable code refers to Fig. 1, Mean values in similar row with different letters are significantly different (p<0.05)

Table 2: Principal component loading and degree of divergence in quantitative traits among samples (Qst) of the morphometric characteristics

| Measurement (mm) | Variable code | PC1 | PC2 | PC3 | Qst |
|---|---|---|---|---|---|
| Predorsal length | 2 | -0.981 | 0.102 | 0.085 | 0.980 |
| Preanal length | 3 | 0.950 | -0.226 | 0.107 | 0.964 |
| Prepelvic length | 4 | 0.965 | -0.176 | 0.059 | 0.966 |
| Prepectoral length | 5 | 0.950 | -0.113 | 0.073 | 0.920 |
| Dorsal-spine length | 6 | -0.728 | 0.545 | 0.180 | 0.860 |
| Dorsal-fi n length | 7 | 0.736 | 0.580 | -0.174 | 0.909 |
| Length of dorsal-fin base | 8 | 0.802 | 0.485 | -0.147 | 0.900 |
| Length of anal-fin base | 9 | -0.755 | 0.320 | 0.022 | 0.672 |
| Pelvic-fin length | 10 | -0.750 | -0.078 | 0.408 | 0.735 |
| Pectoral-fin length | 11 | 0.808 | 0.263 | 0.488 | 0.959 |
| Pectoral-spine length | 12 | -0.016 | 0.522 | 0.807 | 0.923 |
| Caudal-fin length | 13 | 0.137 | 0.948 | -0.042 | 0.919 |
| Length of adipose-fin base | 14 | 0.954 | -0.265 | -0.025 | 0.981 |
| Maximum height of adipose fin | 15 | -0.962 | 0.095 | -0.029 | 0.935 |
| Dorsal to adipose distance | 16 | -0.805 | -0.434 | 0.101 | 0.846 |
| Post-adipose distance | 17 | -0.151 | 0.736 | -0.144 | 0.585 |
| Length of caudal peduncle | 18 | 0.942 | -0.054 | -0.071 | 0.895 |
| Depth of caudal peduncle | 19 | -0.977 | 0.140 | 0.039 | 0.975 |
| Body depth at anus | 20 | -0.937 | 0.113 | -0.067 | 0.896 |
| Head length | 21 | 0.887 | -0.025 | 0.227 | 0.839 |
| Body depth | 22 | 0.728 | -0.566 | 0.114 | 0.863 |
| Head depth | 23 | 0.901 | -0.298 | 0.063 | 0.905 |
| Snout length | 24 | 0.739 | 0.092 | -0.147 | 0.577 |
| Inter orbital distance | 25 | 0.993 | -0.041 | 0.065 | 0.992 |
| Eye diameter | 26 | -0.960 | 0.200 | 0.021 | 0.962 |
| Length of prepectoral-fin base | 27 | 0.986 | 0.020 | 0.028 | 0.974 |
| Length of front dorsal fin-front pelvic | 28 | 0.756 | 0.634 | 0.047 | 0.977 |
| Length of pelvic fin-front adipose | 29 | -0.379 | -0.826 | 0.228 | 0.878 |
| Length of anal fin base-front of adipose | 30 | 0.634 | 0.751 | 0.035 | 0.966 |

Variable code refers to Fig. 1, Extraction method: Principal Component Analysis (PCA)

In the PCA, the first principal component (PC1) accounted for 58.62% of the total morphometric characteristics and positively correlated with all linear dimensions of size, which indicated a size effect on the morphometric characteristics of the analyzed populations. However, the 2nd and 3rd PCs accounted for 37.93 and 68.96% of the total variation, respectively (Table 2). The PC1, PC2 and PC3 were positively correlated with some variables and negatively correlated with others. Low allometric shape contributions from diagonal body measurements (length of front dorsal fin-front pelvic, length of front dorsal fin-front pelvic and length of anal fin base-front of adipose) to the 1st canonical functions were observed (Table 2). Plotting of PC1 and PC2 showed that samples from the Koto Panjang Reservoir, Kampar Kanan river and Kampar Kiri river were highly isolated (Fig. 2).

The discriminant functions analyses (DFA) produced 2 DFs (the 1st and 2nd DFs) for morphometric characteristics measurements. For morphometric measurements, the 1st DF accounted for 55.17%, the 2nd DF accounted for 44.83% of among group variability and together they explained 100% of the total among-group variability. Pooled within group

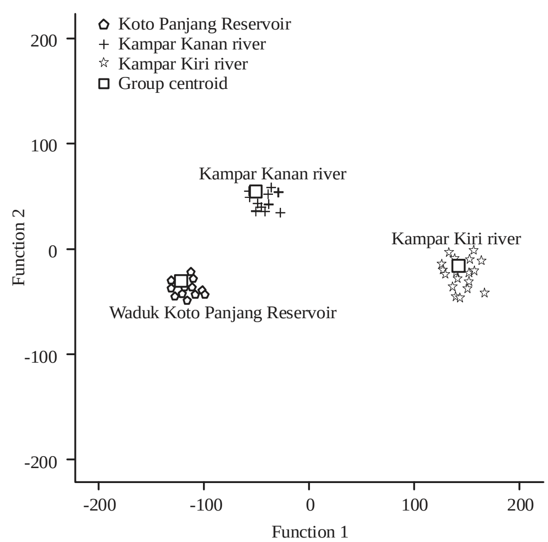


Fig. 2: Sample centroids of the discriminant function scores based on morphometric measurements

correlations between discriminant variables and DFs revealed that among the 29 morphometric measurements, 10 measurements (variable code; 7, 8, 11, 12, 13, 15, 16, 21, 28

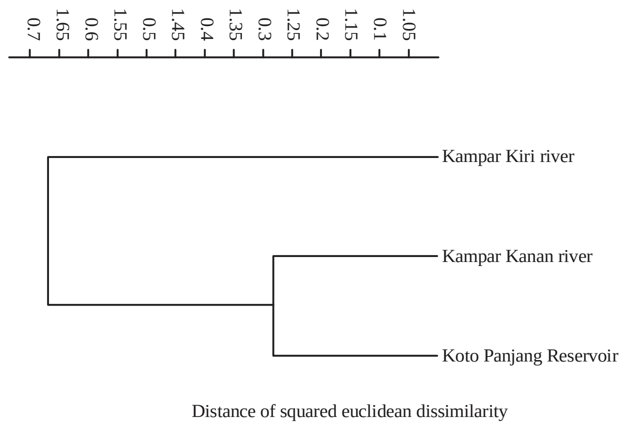


Fig. 3: Dendrogram based on morphometric characters and landmark distances of the Koto Panjang Reservoir, Kampar Kanan river and Kampar Kiri river

Table 3: Water quality parameters recorded in different habitats (Mean±SD)

| Parameters | Koto Panjang Reservoir | Kampar Kanan river | Kampar Kiri river |
|---|---|---|---|
| Water transparency (m) | $4.00\pm0.50^{a}$ | $2.30\pm0.30^{b}$ | $0.50\pm0.02^{c}$ |
| Dissolved oxygen ($mg\ L^{-1}$) | $6.30\pm0.35^{a}$ | $4.87\pm0.78^{b}$ | $4.97\pm0.06^{b}$ |
| Temperature (°C) | $29.00\pm2.00^{a}$ | $28.00\pm1.00^{a}$ | $27.00\pm1.00^{a}$ |
| pH | $7.80\pm0.50^{a}$ | $7.20\pm0.40^{b}$ | $5.20\pm0.20^{c}$ |
| Alkalinity ($mg\ L^{-1}$) | $84.32\pm3.32^{a}$ | $67.53\pm2.44^{b}$ | $42.97\pm1.35^{c}$ |
| Hardness ($mg\ L^{-1}$) | $51.53\pm23.26^{a}$ | $53.32\pm2.44^{a}$ | $104.83\pm0.65^{c}$ |
| Electrical conductivity ($\mu s\ cm^{-1}$) | $0.24\pm0.01^{a}$ | $0.24\pm0.01^{a}$ | $0.33\pm0.02^{c}$ |
| Dissolved solids ($mg\ L^{-1}$) | $37.33\pm2.65^{a}$ | $40.91\pm2.73^{a}$ | $108.45\pm3.53^{c}$ |
| Ammonia ($mg\ L^{-1}$) | $0.35\pm0.03^{a}$ | $0.23\pm0.04^{b}$ | $0.26\pm0.05^{c}$ |
| Total phosphorus ($mg\ L^{-1}$) | $0.75\pm0.06^{a}$ | $0.55\pm0.07^{b}$ | $0.60\pm0.03^{c}$ |

Mean values in similar row with different letters are significantly different ($p<0.05$)

and 30) dominantly contributed to the 1st DF, while the remaining 5 measurements (variable code; 2, 13, 17, 22 and 27) contributed to the 2nd DF.

A dendrogram based on morphometric and landmark distance data was constructed for the Koto Panjang Reservoir, Kampar Kanan river and Kampar Kiri river populations. The distances of squared Euclidean dissimilarity values were nearest between the Koto Panjang Reservoir and Kampar Kanan river populations. The Kampar Kiri river population was isolated from the other 2 populations (Fig. 3). The water quality parameters in Koto Panjang Reservoir, Kampar Kanan and Kampar Kiri rivers show in Table 3.

## DISCUSSION

The results obtained from morphometric characteristics in this work indicate the existence of three morphologically differentiated groups of *H. wyckii.* There is a difference of lower morphometric characters in samples collected in Koto Panjang Reservoir and Kampar Kanan river rather than samples collected in Koto Panjang Reservoir and Kampar Kiri river. High differences were collected in the Kampar Kanan and Kampar Kiri rivers. This phenotypic variability may be related to the geography, ecology and water quality parameters (Table 3). Water quality parameters in the Koto Panjang Reservoir were significantly $p<0.05$ lower than in the Kampar Kanan river. However, water quality parameters in the Kampar Kiri river were significantly $p<0.05$ higher than in the Koto Panjang Reservoir and Kampar Kanan river. According to a previous study, the different morphometric characteristics of the endangered *Labeo calbasu* revealed a high isolation of stock.[11] The morphometric characteristics of *Mystus cavasius*, *M. vittatus* and *M. bleekeri-Bagridae* are influenced by varied geographical, climatic and nutritive factors in their habitat[17] and the different morphometric characteristics of *Channa lucius*, *Hemibagrus nemurus* and *Osteochilus vittatus* are influenced by ecology and human activities[18-20]. On the other hand, morphometric variation among the three groups of the oriental river prawn (*Macrobrachium nipponense*) in Taiwan are derived from evolutionary origins, geographic events or environment adaption[21].

In this study, examination of the contribution of each morphometric character to discriminant functions does not imply any strong association on any part of the body. On the other hand, the inter orbital distance characteristic (Code No.25) strongly contributed to the 1st discriminant function and played a role in discriminating the fish from the Koto Panjang Reservoir, Kampar Kanan and Kampar Kiri rivers. The character length of adipose-fin base (Code No.14), is the most important in the description of population differentiation in the 2nd discriminant function and plays a role to differentiate the Koto Panjang Reservoir, Kampar Kanan and Kampar Kiri rivers populations. Moreover, mouth length strongly contribute to the 1st discriminant function and plays a role in discriminating stocks of Bluefish (*Pomatomus saltatrix*) in the Black, Marmara, Aegean and Northeastern Mediterranean Seas[22]. The results are similar to *Chitala lopis* (*Siluridae*), which are differentiated by snout length and body depth[23]. The *Notopterus notopterus* and *Channa lucius* species are differentiated by snout length, whereas *Hemibagrus nemurus* and *Osteochilus vittatus* are differentiated by the dorsal fin length[18,20,24]. In addition, the Papda Catfish (*Ompok pabda*) species in each habitat (Tentulia, Baleswer, Payra and Halda rivers) from the Southern Coastal Waters of Bangladesh have morphometric variations that are likely due to genetic differences among the populations[25]. Phenotypic variability may be related to the geography, ecology, human activities and genetic diversity of the population[26]. Bilih fish (*Mystacoleucus padangensis*) in the Lake Singkarak and Anai river of West Sumatera of Indonesia are due to environmental factors, especially the current velocity of the water[27]. Meanwhile, Pacific sardine (*Sardinops sagax*) are differentiated due to the distribution of sea surface temperature[8].

The discriminant analysis showed three groups of population distribution of *H. wyckii* (Fig. 2). Function 1-indicates that populasi of *H. wyckii* in the Koto Panjang Reservoir and Kampar Kanan river showed almost the same morphometric character. While the populations of *H. wyckii* in the Kampar Kiri river has its own morphometric character. The 1st DF accounted for much more of the among group variability (55.17%) than did the 2nd DF (44.83%). It is obvious that the 2nd DF explains much less of the variance than does the 1st DF. The 2nd DF is therefore, much less informative in explaining differences among the stocks. The 1st and 2nd DF values of *Labeo calbasu* were 75.5 and 24.5%, respectively[10].

Dendogram analysis (Fig. 3) shows that the population of *H. wyckii* from the Koto Panjang Reservoir is closely linked to the population from the Kampar Kanan river. Furthermore, the Mahalanobis distance between Koto Panjang Reservoir and Kampar Kanan river populations showed that these fish originated from a single population and the Kampar Kiri river population in another. According to one study, the morphometric characteristics of Bluefish (*Pomatomus saltatrix*) populations are not significantly associated with their geographical distances[22]. Other studies found that the *Ompok padda* population from the Baleswer, Halda and Payra rivers originate from one population and the Tentulia population is from another population[25]. The different morphometric characteristics between Tentulia and other populations are likely due to environmental changes and genetic deviations[25].

*Hemibagrus wyckii* broodstock in the Riau province is nearly endangered due to environmental degradation and overexploitation by the local people.[5] Due to the decreasing population of *H. wyckii* in the wild, it is necessary to cultivate this species as a source of food in the future. According to one study identifying optimal morphometric characteristics parameters can be used to help with the appropriate management of the the population in the future.[28] In the present study, it was determined that the more favorable characteristics of the *H. wyckii* broodstock came from the population from the Kampar Kanan river. Therefore, for further conservation collection of fish from that region is recommended.

## CONCLUSION

It is concluded that *H. wyckii* from the Kampar Kanan river had more favorable morphometric characteristics compared to those from the Koto Panjang Reservoir and Kampar Kiri river. The broodstock of *H. wyckii* from the Kampar Kanan river is therefore recommended for domestication purposes.

## SIGNIFICANCE STATEMENTS

The finding of this study will benefit to broodstock assesment and fishery management of *H. wyckii* which are categorized as vulnerable to endangered species in the Riau province, Indonesia. The identification of morphometric characteristic will provide a framework for the better understanding of domestication purposes and aquaculture activities of *H. wyckii* in the future. Therefore, further domestication collection of broostock from Kampar Kanan river is recommended.

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