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Morphometric and Meristic Analyses of Catfish (*Hemibagrus* spp.) in Sarawak

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Final Year Project Report ☑

Masters ☐

PhD ☐

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Morphometric and Meristic Analyses of Catfish (*Hemibagrus* spp.) in Sarawak.

Nisa Binti Mohamad (58886)

A final report submitted in partial fulfillment of

Final Year Project 2 (STF 3015)

Supervisor : Dr. Fazimah Aziz

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2019

DECLARATION OF AUTHORSHIP

I, Nisa binti Mohamad (58886) declare that the final year project report entitled:

Morphometric and Meristic Analyses of Catfish (*Hemibagrus spp.*) in Sarawak

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Abstract

Hemibagrus spp. is a freshwater catfish from Bagrid family which is widely distributed throughout South East Asia and Africa. Eventhough this genus have been studied since a long time ago, the data on morphometric and meristic on this genus is still scarce in Sarawak. In addition, morphological characters in distinguishing *Hemibagrus* spp. is still unclear. Hence, the purpose of this study was to provide morphometric and meristic data of *Hemibagrus* spp. as well as to distinguish between *Hemibagrus* spp. by using those data. Specimens of *Hemibagrus* spp. were obtained from Sungai Semadang (n=3) and Sungai Samunsam (n=2). Additional *Hemibagrus* spp. specimens (n=15) were taken from Unimas Aquatic Muzeum. 26 morphometric parameters were measured and 6 meristic counts were used. Morphometric data were log transformed and adjusted by using log-transform formula to standardize all the measurements. Then, the data adjusted were analyzed by using independent t-test and PCA. The results obtained revealed that there were clear separations between *H. nemurus* and *H. planiceps*. Two important morphological characters have been identified to have significant value ($P<0.05$) which represents pre-anal length and pre-dorsal length. *H. nemurus* displayed a longer PDL compared to *H. planiceps* (32.43-64.79 %SL and 30.67-54.95 %SL). *H. nemurus* also shows longer PAL compared to *H. planiceps* (71.45 ± 15.95 and 70.95 ± 11.00). However, meristic count only detected slight differences in the branching of pectoral fin rays of *Hemibagrus* spp. (I, 7-8 and I, 7-8, i).

Keyword : Morphometric, meristic, *Hemibagrus* spp., three layer net, gill net, PCA, independent t-test

Abstrak

Hemibagrus spp. ialah sejenis ikan keli air tawar daripada famili Bagrid yang banyak dijumpai di sekitar Asia Tenggara dan Afrika. Walaupun genus ini telah dikaji sejak sekian lama, masih terdapat banyak kekeliruan yang wujud dalam kajian mengenai genus ini. Tambahan pula, karakter morfologikal yang membezakan Hemibagrus spp. masih tidak jelas. Justeru, tujuan kajian ini adalah untuk menyediakan data morfometrik dan meristik mengenai Hemibagrus spp. sekaligus membezakan spesis tersebut dengan menggunakan data yang diperolehi. Spesimen Hemibagrus spp. Diperolehi daripada Sungai Semadang (n=3) dan Sungai Samunsam (n=2). Spesimen tambahan (n=15) pula diperolehi daripada Muzium Akuatik Unimas. 26 ukuran morfometrik dan 6 kiraan meristik digunakan dalam kajian ini. Data morfometrik di log-transform dengan menggunakan formula log-transform untuk menyelaraskan semua ukuran. Kemudian, data yang dilaraskan telah dianalisa dengan menggunakan "independent t-test" dan PCA. Keuputusan yang diperolehi mendedahkan bahawa terdapat perbezaan antara H. nemurus dengan H. planiceps. 2 karakter morfologikal telah dikenalpasti mempunyai jumlah signifikan ($P<0.05$) yang mewakili panjang pre-anal (PAL) dan panjang pre-dorsal (PDL). H. nemurus mempunyai PDL yang lebih panjang berbanding H. planiceps (32.43-64.79 %SL and 30.67-54.95 %SL). H. nemurus juga menunjukkan PAL yang lebih panjang berbanding H. planiceps (71.45 ± 15.95 and 70.95 ± 11.00). Walaubagaimanapun, kiraan meristik hanya mendapati sedikit perbezaan pada cabang sirip pektoral Hemibagrus spp. (I, 7-8 and I, 7-8, i).

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1.0 Introduction

Catfish from family Bagridae is considered as the world's oldest catfish species. Their distribution is mainly throughout Asia and Africa. Catfish from genus *Hemibagrus* are large riverine catfish that can be found in all river drainages from Godavari river, India to the south of Changjjang (Yangtze) river drainage in China (Ng and Kottelat, 2013). There are 41 *Hemibagrus* spp. altogether around the world, and 14 species can be found in Malaysia (FishBase, 2018).

Bleeker (1862) established this taxon to include species with depressed heads, rugose head shields not covered by skin, slender occipital process as well as moderately long adipose fins. *Hemibagrus* members including *H. nemurus* and *H. planiceps* can be commonly found in brackishwater and freshwater habitat (Ng and Kottelat, 2013). They occupies a wide range of habitat, ranging from near estuarine to high altitude fast-flowing streams (Dodson and Lecomte, 2015).

According to Ng and Kottelat (2013), catfish of *Hemibagrus* are valuable for protein sources in South East Asia. Some species have large size which can be more than 1 meter in length, making it precious for its rich flesh. Hence, *Hemibagrus* have been cultured to fulfill the needs to be commercialized as well as for research purposes.

Animals with same characteristics are believed to be in the same species. Hence, it is very important to perform the morphometric and meristic. According to Sajina *et al.* (2013) , a morphometric trait were proven to be the most effective and cost-wise method for species identification.

Due to poor data documentation in the past, there were limited information regarding *Hemibagrus* spp. especially in Borneo. Therefore, the objective for this study were :

1. To document morphometric and meristic data of *Hemibagrus* spp. found in Sarawak.
2. To distinguish *Hemibagrus* spp. found in Sarawak using morphometric analysis.

2.0 Literature Review

2.1 Genus of *Hemibagrus* spp.

Hemibagrus spp. is categorized under family Bagridae, order Siluriformes. Fishes from Bagridae family can be easily identified by the presence of a layer of bud enriched epithilium covering their 4 paired barbells (Chakravorty *et al.*, 2015). Bagrid catfish also does not bear scales and have large adipose dorsal fin.

Hemibagrus spp. can be commonly found in South East Asia region including Peninsular Malaysia, Sumatra, Java and Borneo (Fishbase, 2018). Locally, *Hemibagrus* species are known as "ikan Baung". This genus comprises of large-sized bagrid catfish that can reach up to 800mm for standard length.

2.2 Nomenclature evolution

Hemibagrus Bleeker, 1862 was among the genera that has been revalidated, which was previously considered as junior synonym of *Mystus* Scopoli, 1777 or *Macrones* Dumeril, 1856 by Weber and de Beaufort (1913). Some *Hemibagrus* species such as *Hemibagrus nemurus and Hemibagrus planiceps* have been validated as a new nomenclature where previously, they were all known as *Mystus*. Although some of the *Mystus* species have been renamed as *Hemibagrus*, there are still some other species remain as *Mystus*. However, *Macrones* or also known as broad mouthed fishes is no longer nomenclaturally valid.

2.3 Taxonomy of *Hemibagrus* in Malaysia

Taxonomy of *Hemibagrus* spp. based on FishBase (2018):

Kingdom : Animalia

Phylum : Chordata

Class : Actinopterygii

Order : Siluriformes

Family : Bagridae

Species : *Hemibagrus baramensis*
Hemibagrus bongan
Hemibagrus chrysops
Hemibagrus divaricatus
Hemibagrus fortis
Hemibagrus furcatus
Hemibagrus gracilis
Hemibagrus hoevenii
Hemibagrus johorensis
Hemibagrus nemurus (Figure 2.1)
Hemibagrus planiceps (Figure 2.2)
Hemibagrus sabanus
Hemibagrus semotus
Hemibagrus wyckii

Figure 2.1: *Hemibagrus nemurus*

Figure 2.2: *Hemibagrus planiceps*

2.4 Problems in identification and classification

According to Kottelat *et al.* (1994), *Hemibagrus hoevenii* has been particularly confused with *Hemibagrus nemurus*. This confusion happened due to poor data organisation where the specimens found displayed a similar characteristics. *H. hoevenii* can be distinguished by having a black-edged caudal fin with tapering lobes while *H. nemurus* have caudal fin without black edges and fairly rounded lobes. Therefore, in December 1994 a proposal on designation of a new neotype which is *Hemibagrus hoevenii* (Bleeker, 1846) was made by Kottelat *et. al.*, (1994).

Dodson *et al.* (1995) stated that *H. nemurus* is divided into three regional groups which are Indochinese, Sundaic and Sarawak group mainly based on the genetic and morphological evidence. The most genetically and morphologically distinct is Sundaic clade which mainly distributed in Kapuas river (west Borneo), east Sumatra and south Peninsular Malaysia.

2.5 Morphometric measurements

Morphometric measurements is a method used to quantify the significant evolutionary trait. Also, by detecting the distinct shape in an organism, the ontogeny and evolutionary relationships of a species can be assumed (Ambily, 2016). The size and shape of an organism are unique to particular species. According to Zubia *et al.* (2015), morphology of fishes is an alternative method of fish identification instead of the molecular studies on DNA and protein sequences which is more costly and involve meticulous procedure. Furthermore, morphometric variations was also used to examine the stock structure (Elliott *et al.*, 1995).

2.6 Meristic counts

Meristic features are mainly the observation of fish characters such as body segments, fin rays and scales. Those characters may differ within and among species which are useful in providing description and identifying fishes. Measurable traits can change continuously along with age and size but meristic counts usually become stable in number during growth. (Gogoi and Goswami, 2015).

Table 2.6 shows the meristic counts of two *Hemibagrus* spp., *H. nemurus* and *H. planiceps* reported in previous study by Jayaram and Anuradha (2003) and also Ng and Kottelat (2013).

Table 2.1: Range of meristic counts for *Hemibagrus* spp. (Jayaram and Anuradha, 2003) and Ng and Kottelat, 2013)

	H. nemurus		*H. planiceps*	
	Ng and Kottelat, 2013 (n=20)	Jayaram and Anuradha, 2003 (n=5)	Ng and Kottelat, 2013 (n=20)	Jayaram and Anuradha, 2003 (n=2)
Dorsal-fin rays	II, 7	I, 7-8	II,7	I, 7
Anal-fin rays	iii-iv, 8-9	ii, 9-10	iii-iv, 7-11	Ii, 9-10
Caudal-fin rays	i, 7, 8, i	7, 8	i, 7, 8, i	Damaged
Pectoral-fin rays	I, 8 or I, 8, i or I, 9	I, 7-8	I, 8 or I, 8, i or I, 9 or I, 9, i	I, 9
Pelvic-fin rays	i, 5	i, 5	i, 5	i, 5
Branchiostegal rays	11 -13	-	8-12	-

3.0 Materials and Method

3.1 Fieldwork

3.1.1 Sampling site

Specimens were collected at Sungai Semadang and Sungai Samunsam with GPS coordinate as shown in Figure 3.1 and Table 3.1. Three layer net (4cm x 14cm x 4cm) and gill net with different mesh size (1 inch, 2 inch and 3 inch) were set up at 4 different stations along Sungai Semadang while 3 stations along Sungai Samunsam.

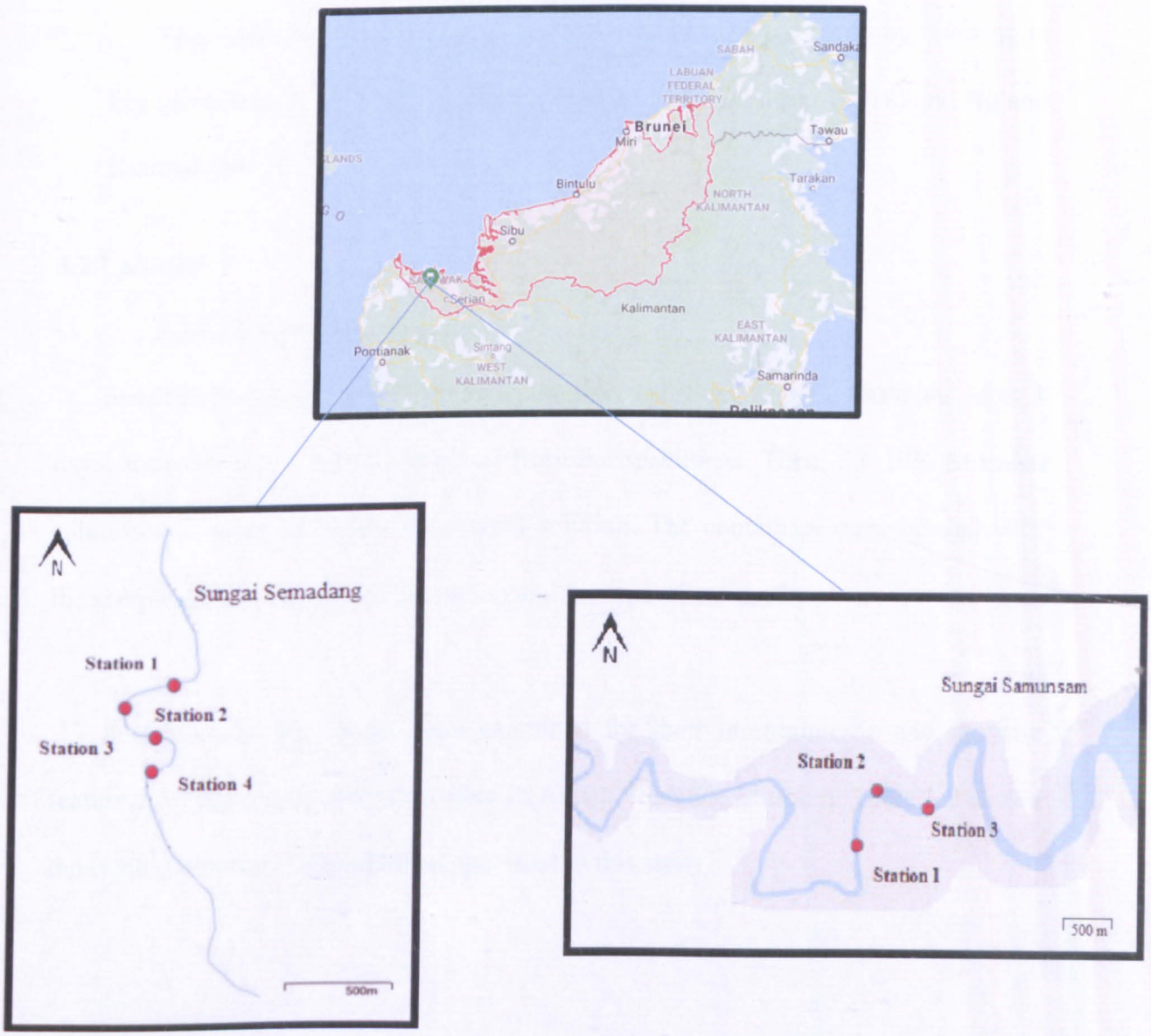

Figure 3.1: Map of sampling site.

Table 3.1: GPS coordinate of the sampling stations.

Station	Sungai Semadang	Sungai Samunsam
1	N01°14'44.3" E110°15'15.6"	N01°55'50.2" E109°36'03.6"
2	N01°14'42.9" E110°15'10.4"	N01°56'07.8" E109°36'04.4"
3	N01°14'43.0" E110°15'10.1"	N01°56'07.8" E109°36'04.4"
4	N01°14'43.5" E110°15'11.9"	

3.1.2 Fish identification

Specimens caught at the sampling site were identified directly by referring to key identification by Fishbase (2018), Fricke and Eschemeyer (2018) and Ng and Kottelat (2013).

3.2 Labwork

3.2.1 Fish preservation

Specimens obtained were kept in a container and fixed in 10% formalin. After 3 days, formalin solution was rinsed off from the specimens. Then, the 10% formalin solution was replaced with 70% ethanol solution. The containers were labeled with the sampling location, date of collection and the type of net used.

A total of 21 specimens were examined for their morphometric and meristic features. All specimens were deposited in Aquatic Science Museum. Table 3.2 shows the catalog number of *Hemibagrus* spp. used in this study.

Table 3.2: The catalog number of fish specimens examined.

Species	Catalog number	Locality
Hemibagrus nemurus	ASD02571	Sg. Jaau, Balui
	ASD02557 ASD02558 ASD02259	Batang Air, Sri Aman
	ASD02568	Sg. Batang Ai
	ASD02549 ASD02550 ASD02551	Sg. Jaau, Balui
	ASD00704	Sg. Wat, Long Murum
	ASD02780	Sg. Samunsam
Hemibagrus planiceps	ASD00682	Sg. Sekatang
	ASD00708	Sg. Miah, Belaga
	ASD02555	Sg. Jaau, Balui
	ASD02560 ASD02561 ASD02562	Sg. Simapo, Belaga
	ASD02776	Sg. Semadang
	ASD02777	
	ASD02778	
	ASD02779	Sg. Samunsam

ASD : Aquatic Science Department

3.2.2 Morphometric measurements and meristic counts

For morphometric, the measurements were taken by using a Mitutoyo dial calipers to the smallest scale of 0.01 mm and 0.02 mm. There are twenty-six (26) morphometric measurements (Table 3.3) (Figure 3.2) and five (6) meristic counts (Table 3.4) were used according to Ng and Kottelat (2013). After taking the measurements, the data were recorded and analysed.

Table 3.3: Characteristic and description for morphometric analysis (Ng and Kottelat, 2013)

No.	Character	Description	Acronyms
1.	Standard length	Tip of the upper jaw to the tail base	SL
2.	Pre-dorsal length	Front of the upper lip to the origin of the dorsal fin	PDL
3.	Pre-anal length	Front of the upper lip to the origin of the anal fin	PAL
4.	Pre-pelvic length	Front of the upper lip to the origin of the pelvic fin	PPVL
5.	Pre-pectoral length	Front of the upper lip to the origin of the pectoral fin	PPCL
6.	First dorsal spine length	From base to tip of the first dorsal spine	LDS1
7.	Dorsal fin length	From base to the tip of longest dorsal-fin ray	DFL
8.	Length of dorsal fin base	From base of first dorsal spine to base of last dorsal ray	LDFB
9.	Length of anal fin base	From base of first anal spine to base of last anal ray	LAFB
10.	Pelvic-fin length	From base to the longest pelvic ray	PVFL
11.	Pectoral-fin length	From base to the tip of the pectoral fin	PFL
12.	Pectoral-spine length	From base to the tip of spine	PSL
13.	Caudal-fin length	From tail base to the tip of caudal fin	CFL
14.	Length of adipose-fin base	From tip to the posteriormost of adipose-fin base	LAB
15.	Max. height of adipose-fin	From base to the uppermost adipose-fin	MHAF
16.	Dorsal to adipose distance	From base of dorsal-fin to tip of adipose-fin	DAD
17.	Post-adipose distance	From end of adipose-fin to middle base of adipose fin	PAD
18.	Length of caudal peduncle	From base of the last anal fin ray to middle of caudal fin fold	LCP
19.	Depth of caudal peduncle	The least depth of the tail base	DCP
20.	Body depth at anus	Maximum depth measured from the base of the dorsal spine	BD
21.	Head length	From the front of the upper lip to the posterior end of the opercular membrane	HL
22.	Head width	Widest point of head	HW
23.	Head depth	From the base of supraoccipital	HD
24.	Snout length	The front of the upper lip to the fleshy anterior edge of the orbit	SNL
25.	Interorbital distance	Narrowest distance between orbital rims	ID
26.	Eye diameter	Greatest horizontal length of eyeball	ED

Table 3.4: Characteristic and description for meristic analysis (Ng and Kottelat, 2013)

Characteristics	Description	Acronyms
Dorsal fin ray	Number of soft fin rays in dorsal fin	DFR
Anal fin ray	Number of soft fin rays in anal fin	AFR
Caudal fin ray	Number of caudal fin rays	CFR
Pectoral fin ray	Number of soft fin rays in pectoral fin	PCFR
Pelvic fin ray	Number of soft fin rays in the pelvic fin	PVFR
Branchiostegal rays	Number of branchiostegal rays	BR

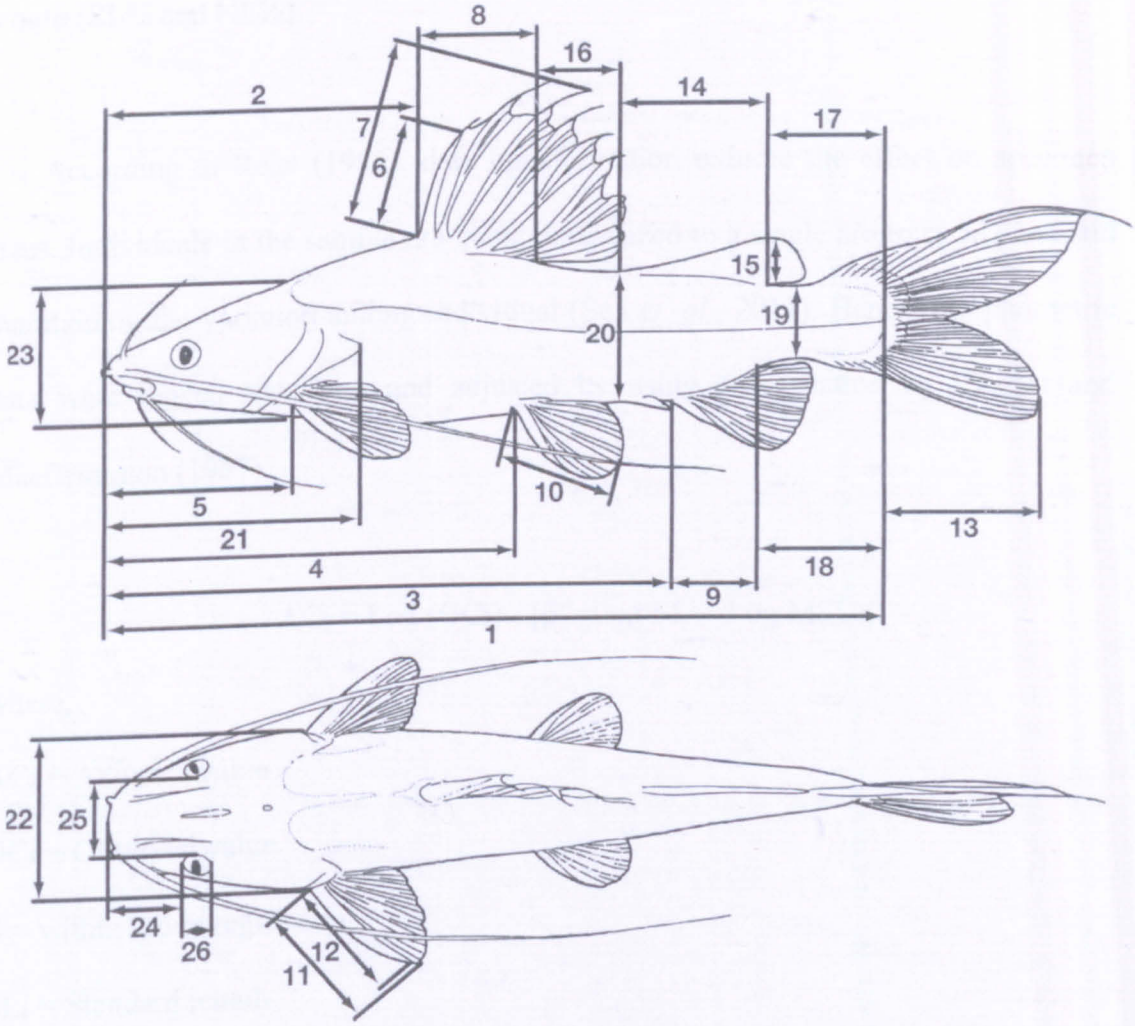

Figure 3.2: Method of morphometric measurements (Ng and Kottelat, 2013)

3.3 Statistical Analysis

All morphometric measurements were expressed according to their reference length (SL% and HL%).

According to Reist (1985), data transformation reduces the effect on specimen sizes. Individuals in the sample are being normalized to a single arbitrary size but still maintaining the variation among individual (Sen *et. al.,* 2011). Hence, morphometric data were logged transform and adjusted by using the equation by Claytor and MacCrimmon (1987).

$$ACi = Log\ (OCi) - [\beta^* (Log\ SLi - Log\ MSL)]$$

where,

ACi = Adjusted value

OCi = Observed value

β = within group regression

SLi = Standard length

MSL = Overall mean standard length

Then, the transformed data were analyzed by using principal component analysis (PCA) in PAST version 3.11 to extract the most important characteristics for differentiating species. The relative importance of discriminating functions were determined on the basis of three components, which consist of value of principal component loading, relative percentage of eigenvalue and percent of variance existing in the discriminating values.

Next, selected morphometric characters from PCA were tested in independent t-test to determine the significant difference between two *Hemibagrus* species. Independent t-test were analyzed by using Statistical Package for Social Science (SPSS) version 24.0. In this study, 95% confidence interval was used to obtain the significant value and F value.

4.0 Results

4.1 Morphometric measurements

Table 4.1 displays the range, mean and standard deviation of morphometric measurements for *Hemibagrus* spp. expressed as percent of standard length (SL%) and head length (HL%). 10 specimens of *Hemibagrus nemurus* and 11 specimens of *Hemibagrus planiceps* were examined.

Independent t-test revealed that there were several morphometric characters that showed significant difference ($P < 0.05$) between two species. *H. nemurus* have longer pre-dorsal length (PDL) compared to *H. planiceps* (32.43-64.79 %SL and 30.67-54.95 %SL, respectively). In contrast, pre-anal length (PAL) of *H. nemurus* is shorter than *H. planiceps* (53.15-110.05 vs. 56.72-87.92).

H. nemurus has longer dorsal to adipose distance (DAD) with range of (8.27±24.17 %SL) compared to *H. planiceps* (6.25±20.89 %SL). Pre-pelvic length (PPVL) of *Hemibagrus* spp. showed significant difference of $P < 0.05$ where *H. nemurus* have smaller mean value compared to *H. planiceps* (52.97±10.62 and 54.47±13.17, respectively).

Independent t-test also revealed that pre-pectoral length (PPCL) has high significant difference with value of $P < 0.005$. With a range of 18.77-36.63 %SL, *H. nemurus* has longer pre-pectoral length compared to *H. planiceps* with range of 17.47-27.08 %SL.

Table 4.1: Morphometric measurements of *Hemibagrus* spp. Range, mean, standard deviation, F value and significant value of *Hemibagrus* spp. found in Sarawak.

Characters	*Hemibagrus nemurus* (n=10)	*Hemibagrus planiceps* (n=11)	F value	Significant value
SL	107.11-216.53 (139.28±30.81)	134.46-194.72 (161.56±21.56)	-	-
% SL				
HL	21.78-43.02 (28.53±5.94)	20.85-31.37 (27.56±3.49)	0.158	0.006
PDL	32.43-64.79 (42.04±9.43)	30.67-54.95 (41.79±7.22)	0.106	0.000*
PAL	53.15-110.05 (71.45±15.95)	56.72-87.92 (70.95±11.00)	0.481	0.020*
PPVL	40.99-77.88 (52.97±10.62)	39.22-87.93 (54.47±13.17)	0.058	0.002
PPCL	18.77-36.63 (24.75±4.87)	17.47-27.08 (23.78±3.16)	0.057	0.022
LDS1	9.04-21.94 (13.54±3.83)	9.80-18.77 (12.58±2.78)	-	-
DFL	17.62-33.35 (24.49±4.96)	15.76-28.46 (23.85±4.00)	0.259	0.943
LDFB	13.12-20.46 (16.10±2.64)	13.98-17.76 (15.67±1.19)	5.986	0.010
LAFB	9.90-15.94 (12.69±1.84)	11.22-15.72 (13.01±1.45)	0.103	0.000
PVFL	12.01-22.67 (15.79±3.22)	11.51-17.11 (14.79±1.78)	0.684	0.020
PFL	13.69-31.53 (20.78±5.01)	14.10-23.81 (19.60±2.97)	0.324	0.130
PSL	13.39-31.13 (18.19±5.31)	13.42-23.7 (17.09±3.47)	-	-
CFL	15.42-34.53 (22.18±5.52)	20.20-30.23 (23.88±3.69)	1.835	0.017
LAB	13.42-18.97 (16.29±1.92)	13.01-19.41 (16.27±2.15)	0.001	0.253
MHAF	3.38-9.90 (5.95±1.87)	3.97-7.81 (5.71±1.27)	0.802	0.255
DAD	8.27-24.17 (12.21±4.46)	6.25-20.89 (12.43±4.14)	1.199	0.567
PAD	12.62-31.26 (16.79±5.40)	11.53-22.31 (16.26±3.56)	0.000	0.226
LCP	12.90-28.33 (18.48±4.09)	13.74-20.25 (17.04±2.51)	0.467	0.002
DCP	6.08-12.39 (9.66±2.25)	6.53-11.03 (8.94±1.37)	1.234	0.799
BD	10.09-21.19 (15.66±3.37)	10.27-20.02 (15.62±2.99)	0.005	0.667
% HL				
HW	50.48-95.99 (65.65±16.97)	48.59-84.42 (65.37±12.37)	0.629	0.612
HD	33.79-57.74 (46.36±8.58)	27.26-63.93 (49.41±11.86)	0.795	0.824
SNL	24.95-50.35 (34.38±7.43)	25.80-43.09 (35.27±5.45)	0.238	0.024
ID	23.92-50.92 (34.23±7.62)	27.67-45.18 (35.56±5.96)	0.087	0.103
ED	14.92-24.41 (20.22±3.04)	15.45-22.37 (18.57±2.49)	0.027	0.384

* highest significant difference ($p<0.05$)