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Biometric Diversity of Chondrichthyes Caught by Bengkulu City Fishermen Observed at the Fish Auction Site (TPI) Pulau Baai Bengkulu

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ABSTRACT

Fish is an aquatic animal that has a high diversity. Baai Island Fish Auction Place (TPI) is a fish landing place used as the largest fishing center in the city of Bengkulu. The purpose of this study was to determine the diversity and morphometric characteristics of the different types of Chondrichthyes fish caught by fishermen in Baai Island, Bengkulu City. Sampling was conducted from October-November 2019 with a frequency of once a week using the direct survey method. The fish samples obtained were measured and observed for their morphology and preserved using 70% alcohol. Measurement data were analyzed using software Minitab 16 and morphological observation data were analyzed descriptively. The results showed that there were four orders, six families, seven genera and 10 species. The best PC combination to separate genera of sharks and rays is the combination of PC3 and PC4. The best combination of characters that can separate shark species (genus Carcharhinus) is a combination of PL (pradorsal length) with HL (head length), DFH (dorsal fin height) with HL (head length), DFH (dorsal fin height) with HH (head height), and HL (head length) with HH (head height). The best combination of characters that can separate stingrays (genus Himantura) is the combination of TL (total length) with HL (head length), PFL (pectoral fin length) with AFL (Abdominal fin length), and TSL (tail shaft length) with DL (disc length). In the observation of shark morphology, the most body shape found is the torpedo shape (fusiform) and the most common type of tail fin is the epicercal tail type. Whereas in the observation of the morphology of stingrays, the most body shape found was depressiform and the most common type of tail fin was long tail fin like a whip.

Keywords: *Diversity, Baai Island TPI, Morphometrics, Morphology*

1. INTRODUCTION

Fishes are aquatic animals breathing with their gills. Among vertebrata, fishes are the largest groups consisting of 25 000 species, including 483 families and 57 orde [1]. Chondrichthyes class is divided into two sub-classes, Elasmobranchii and Holocephali [2]. Elasmobranshii sub-class consists of two groups, rays and sharks [3].

Bengkulu province locates at the western coast of Sumatra sharing border with the Indian Ocean. Bengkulu City, one of the Bengkulu Province cities, is very potential to be developed fishery industry [4]. Geographically, Bengkulu city owns seashore whose area as large as that of the land. The seashore area has numerous natural resources, like fishrey resources, beach tourism, pound cultivation, and mangrove forest [5].

Bengkulu City own two Fishery Auction Places (TPI), used for fishery central market, which are Pulau Baai and Pondok Besi. One of them, TPI Pulau Baai is used for fishery landing by the fisherman, who just coming home from fishing at the ocean.

Up to now, there is no scientific research to study the biodiversity and biometric of Chondrichthyes cought by the fisherman at the TPI Pulai Baai.

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Because of which, a research to study the biodiversity and biometric character of Chondichthyes needs to be carry out. The objective of this study was to determine the diversity and morphometric characteristics of the different types of Chondrichthyes fish caught by fishermen in Baai Island, Bengkulu City.

2. MATERIAL AND METHOD

2.1. Sampling

The research was conducted from October to November 2019 at the Fishery Bidding Venue (TPI) Pulau Baai, Bengkulu City, by a direct observation of Chondrichthyes fishes, caught by the fisherman. Samples were taken from the fishes brought home from the ocean.

2.2. Sample Analysis (Identification)

Identification of the sample were done by using a reference book of [6]. When taking samples, we measured the morphometric and morphology of the fishes. Morphometric observations were carried out by measuring total length (TL), standard length (SL), head length (HL), head height (HH), pradorsal length (PL), Dorsal fin height (DFH), Pectoral fine length (PFL), prapectoral length (PPL), Abdominal fin length (AFL), Pra Abdominal length (PAL), Length of the base of the anal fin (LBF), Anal fin height (AFH)Tail shaft length (TSL), Disc length (DL), Disc wide (DW), and Stem tail height (STH). Fishes' morphology was done by observing the dorsal and ventral color of the fish, body shape, the location of the mouth, number of gills, and type of tail fin

2.3. Data Analysis

While Data on the type of Chondrichthyes varians were presented in a table and were analysed descriptively, the morphometric data were analysed by using Minitab 16 software.

3. RESULT AND DISCUSSION

3.1. Type of Chondrichthyes Caught by Fisherman in TPI Pulau Baai, Bengkulu City.

We found 4 orders, 6 families, 7 genera, and 10 species of Chondricthyes caught by Bengkulu fisherman as observed at TPI Pulai Baai (Table 1). The largest species found at TPI Pulau Baai was Carcharhinidae and Dasyatidae, having 3 species from each family. On the other hand, Sphyrnidae, Hemigaleidae, Hemiscyllidae, and Rhynchobatidae only got one species from each family.

Four orders found at TPI Pulau Baai were Carcharhiniformes, Orectolobiformes, Myliobatiformes, and Rhinobatiformes (Figure 1A). The largest type of fishes found was from Carcharhiniformes order (49.98%), consisting of three family Carcharhinidae, Sphyrnidae, and Hemigaleidae. Furthermore, the other orders only showed one family for each order, like Orectolobiformes (Hemiscyllidae), Myliobatiformes (Dasyatidae), and Rhinobatiformes (Rhynchobatidae), each of which only contributed 16.66%.

Table 1. Types of Chondrichthyes caught by Bengkulu fishermen as observed at TPI Pulai Baai

No	Ordo/Famili	Spesies	Indonesian Name
1.	Carcharhiniformes		
	- Carcharhinidae	*Carcharhinus amblyrhynchos*	Hiu Lonjor
		Carcharhinus brevipinna	Hiu Merak Bulu
		Carcharhinus melanopterus	Hiu Sirip Hitam
	- Hemigaleidae	*Hemigaleus microstoma*	Hiu Kacang
	- Sphyrnidae	*Sphyrna lewini*	Hiu Martil
2.	Myliobatiformes		
	- Dasyatidae	*Himantura gerrardi*	Pari Bintang
		Himantura uarnak	Pari Macan
		Taeniura lymma	Pari Totol
3.	Orectolobiformes		
	- Hemiscyllidae	*Chiloscyllium punctatum*	Hiu Batu
4.	Rhinobatiformes		
	- Rhynchobatidae	*Rhynchobatus australiae*	Hiu Lontar

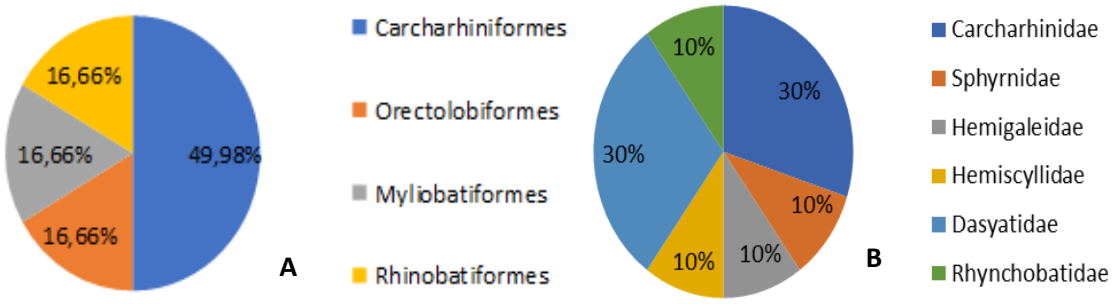

Figure 1. Diagram of: A. Ordo percentage based on the number of family of each ordo; B. Family percentage based on the number of species observed at TPI Pulau Baai, Bengkulu City.

Two largest family of fish found at the TPI Pulai Baai Bengkulu City were Carcharhinidae and Dasyatidae (30%), consisting of 3 spesies of each famiy. From Carcharhinidae, we found *Carcharhinus brevipinna*, *Carcharhinus melanopterus*, and *Carcharhinus amblyrhynchos.* Furthermore, we found *Himantura uarnak*, *Himantura gerrardi*, and *Taeniura lymma* from Dasyatidae. The rest are four families, each of which contributed only 10% to the figure and comprosed of one species each. They were Sphyrnidae (*Sphyrna lewini*), Hemigaleidae (*Hemigaleus microstoma)*, Hemiscyllidae (*Chiloscyllium punctatum)*, and Rhynchobatidae *Rhynchobatus australiae)*.

3.2. Analysis of Main Component (PCA) of Morphometric Characteristic of Shark

Morphometric character analysis was done by using principal component analysis. PCA analysis was used to simplify the data by reducing the unimportant variables [6]. In addition, PCA analysis was also used for reducing the data so that it would be interpretated those data. The result of PCA analysis was presented in Table 2 and Table 3.

Table 2. Commulative score of the main component (PC) based on the Eigen score/values

Eigen Analysis and Correlation Matrix					
	PC1	**PC2**	**PC3**	**PC4**	**PC5**
Eigen Value	7,4200	2,3100	1,7074	0,6724	0,4083
Proportion	0,571	0,178	0,131	0,052	0,031
Commulative	0,571	0,748	0,880	0,932	0,963

Note: PC1: Principal component 1; PC2: Principal component 2; PC3: Principal component 3; PC4: Principal component 4; PC5: Principal component 5.

Based on the Eigen value of PC3 (88.6%) and PC4 (93.8%), we could use the data for differentiating between the genus of shark (Table 2). [7] explained that commulative combination among PC representing >75% of the data meant that those components could explain the values of total variability.

Table 3. Score and Variability Proportion of Five Principal Components

Morphometric Component	***Principal Components***				
	PC1	**PC2**	**PC3**	**PC4**	**PC5**
TL	0,025	**-0,572**	0,283	-0,143	0,212
PL	0,134	**-0,514**	-0,294	0,284	-0,224
DFH	0,279	0,003	**0,446**	0,216	0,135
HL	**0,345**	0,176	-0,036	0,109	-0,155
HH	**0,311**	-0,011	0,188	**0,469**	**-0,347**
PPL	**0,341**	0,207	-0,022	0,056	-0,176
PAL	0,228	**0,419**	0,208	**-0,379**	0,131
PFL	**0,357**	0,052	-0,093	-0,150	0,028
APL	**0,343**	0,047	-0,220	0,044	-0,055
AFH	0,299	-0,259	-0,071	**-0,474**	-0,102
LBF	**0,306**	-0,229	-0,180	**-0,367**	-0,045
STH	0,212	-0,179	**0,500**	0,098	**0,327**
TSL	0,216	0,045	**-0,458**	0,283	**0,755**

Note:
TL: Total length; PFL : Pectoral fin length; PL: Pra dorsal length; APL: Pelvic fin length; DFH: dorsal fin height; AFH: Anal fin height; HL: Head length; LBF: Base length of anal fin; PPL: pra pectoral length; STH: Stem tail height; PAL: Pra pelvic length; TSL: Tail shaft length

Based on PC combination obtained, the best combination separating between Shark genus were PC3 and PC4 (Figure 2A). PC3 and PC4 were used as the best combination because PC3 and PC4 formed the best scoring plot figure compared to the other PC combinations. In addition, no overlapping genus distribution for PC3 and PC4.

3.3. Analysis of Principal Component (PCA) Morphometric Character of Stingray

Table 4. Commulative score of principal components based on Eigen values

Eigen Analysis from Correlation Matrix					
	PC1	**PC2**	**PC3**	**PC4**	**PC5**
Eigen value	3,8669	2,9298	2,0621	0,5181	0,2871
Proportion	0,387	0,293	0,206	0,052	0,029
Commulative	0,387	0,680	0,886	0,938	0,966

Note: PC1: Principal component 1; PC2: Principal component 2; PC3: Principal component 3; PC4: Principal component 4; PC5: Principal component 5.

Analysis of morphometric character used principal component analysis (PCA) to simplify the data and reduce the unimportant data [6]. The result of PCA analysis on Ray morphometric character were presented in Table 4 and Table 5.

Based on the Eigen value of PC3 (88.6%) and PC4 (93.8%), we could use the data for differentiating between the genus of Stingrays (Table 4). [7] explained that commulative combination among PC representing >75% of the data meant that those components could explain the values of total variability.

Based on the PC combination, we found that the best combination to separate between genus of Ikan Pari were PC3 and PC4 (Figure 2B). These combinations could form the best figure of score plot compared to the others and there was no overlapping distribution among the genus.

Table 5. Score and Variability Proportion of Five Principal Components

Morphometric Characters	***Principal Component***				
	PC1	**PC2**	**PC3**	**PC4**	**PC5**
TL	-0,292	0,235	**0,480**	-0,132	-0,179
HL	**0,379**	**-0,357**	0,071	-0,185	-0,016
PPL	0,073	**-0,334**	**0,450**	**0,567**	**-0,407**
PAL	0,010	**-0,411**	**0,393**	**-0,378**	**0,544**
PFL	**0,427**	0,168	0,287	-0,077	0,265
AFL	**0,428**	0,216	0,223	0,096	0,185
STH	**0,414**	-0,149	-0,081	**0,525**	**0,544**
TSL	**0,306**	0,211	**0,484**	-0,130	-0,119
DW	**0,340**	**-0,383**	0,134	0,216	0,013
DL	0,140	**-0,499**	-0,130	**-0,360**	**-0,301**

Note: TL: Total length; AFL: Abdominal fin length; HL: Head length; STH: Stem tail height; PPL: Pra pectoral length; TSL: Tail sahft length; PAL: Pra abdominal length; DW: Disc wide; PFL: Pectoral fin length; DL: Disc length;

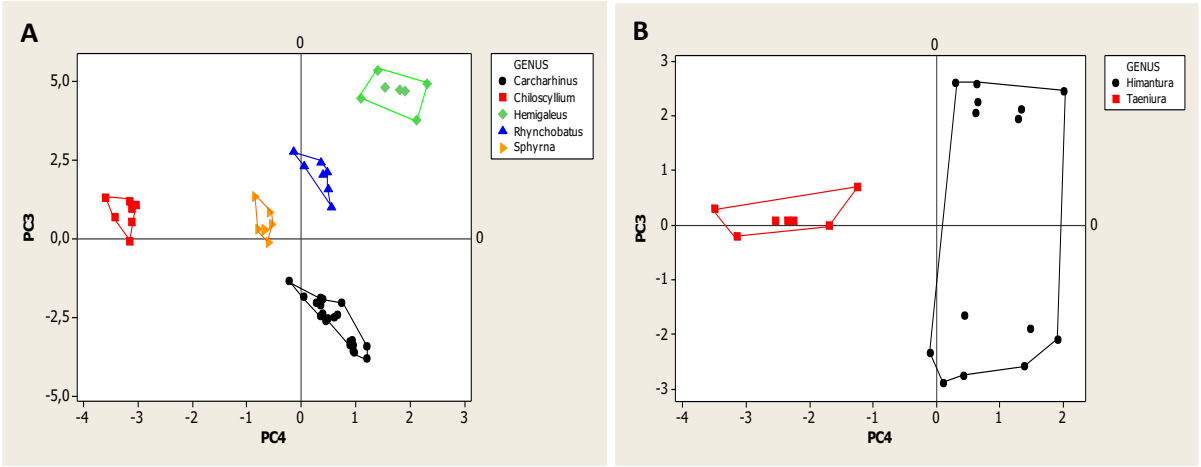

Figure 2. Scoring plot graphic separating among: A. genus of Shark; B. genus of Pari based on the combinaiton of pricipal component PC3 and PC4.

3.4. Morphometric Characters of Shark Differentiating Shark Type within the same Genera Using Scatterplot.

The combination of morphometric characters that separated species within *Carcharhinus* genus were pradorsal length (PL), head length (HL), dorsal fin height (DFH), and head height (HH).

In the Figure 3A, the characters combination of DFH and HL can be used to cluster the sample into each species. Based on the DFH character, *Carcharinus amblyrhynchos* have the smallest value (0.08 to 0.09 mm), followed by *Carcharinus brevipinna* (0.11 to 0.14 mm), and *Carcharinus melanopterus* (0.09 to 0.10 mm). While from the HL characters, the smallest value possessed by *Carcharinus melanopterus* (0.16 to 0.21 mm) followed by *Carcharinus amblyrhynchos* (0.23 to 0.25 mm), and *Carcharinus brevipinna* (0.26 to 0.29 mm)

The character combination of HL and HH (Figure 3B) clustering the sample into species. As mentioned above, species that have the smallest to largest head length are *Carcharinus melanopterus*, *Carcharinus amblyrhynchos*, and *Carcharinus brevipinna*. While from the characters HH, smallest to largest in sequence *Carcharinus amblyrhynchos* (0.06 to 0.08 mm), *Carcharinus melanopterus* (0.10 to 0.11 mm), and *Carcharinus* (0.12 to 0.14 mm).

3.5. Morphometric Character of Stingrays Differentiating Between Type within the Same Genus Using Scatterplot

The combination of morphometric characters that separated species within *Himantura* genus were total length (TL), head length (HL), pectoral fin length (PFL), abdominal fin length (AFL), tail shaft length (TSL), and disc length (DL).

From Figure 4A, the combination of characters TL and HL is able to separate the sample into species. Based on TL characters, *Himantura warnak* (2.50 to 2.75 mm) is smaller than *Himantura gerrardi* (2.75 to 4.00 mm). Likewise, on HL characters, *Himantura warnak* has a smaller range size (0.28 to 0.39 mm) than *Himantura gerrardi* (0.44 to 0.59 mm).

The character combination of PFL and AFL (Figure 4B) can be used to clustering the stingray samples into species. *Himantura warnak* (0.9 to 0.10 mm) has a pectoral fin length longer than *Himantura gerrardi* (0.5 to 0.7 mm). *Himantura warnak* (0.5 to 0.7 mm) also has an abdominal fin length that is longer than *Himantura gerrardi* (about 0.2 mm).

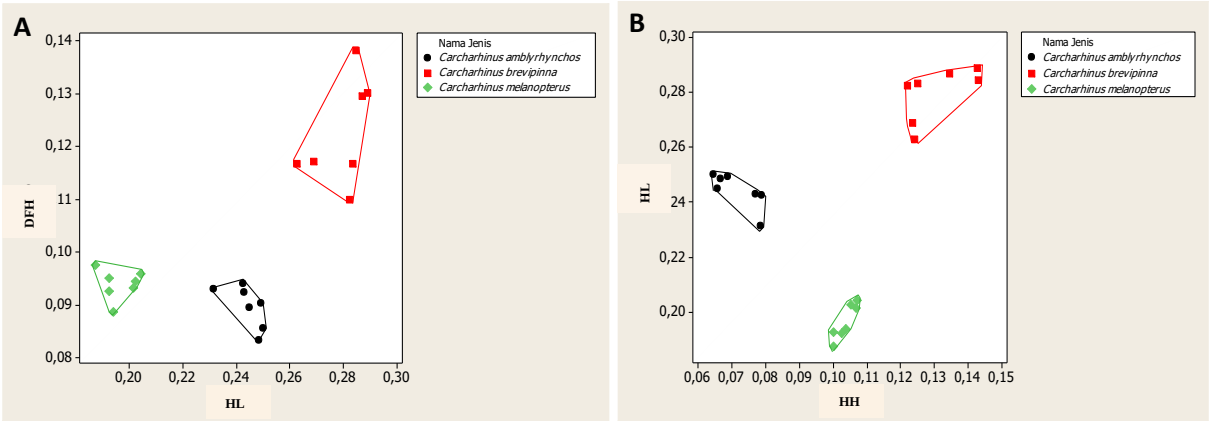

Figure 3. Scatterplot of character combination of: A. dorsal fin height (DFH) and head height (HL); B. head length (HL) and head height (HH) of shark type within the same genus

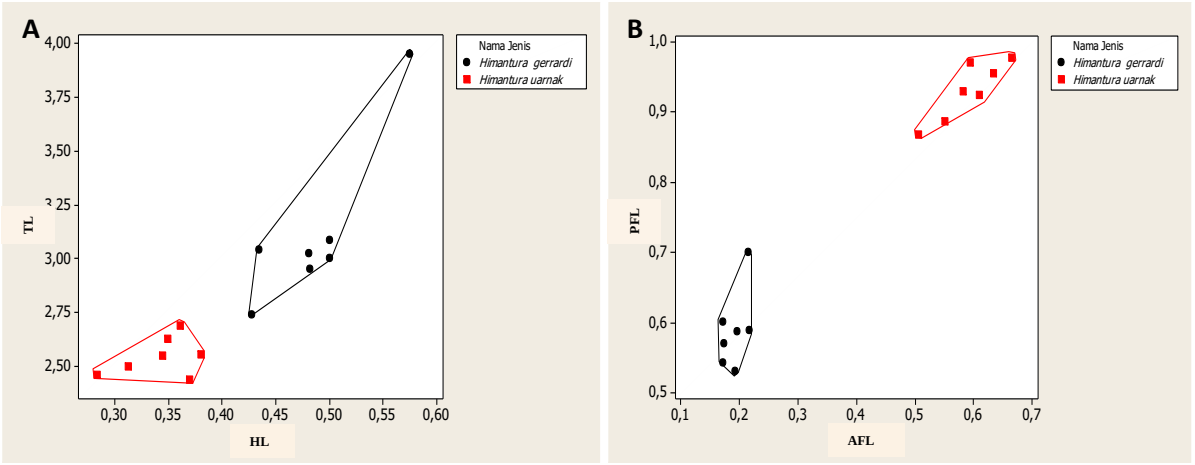

Figure 4. Scatter plot of the combination between: A. total length (TL) and head length (HH); B. pectoral fin length (PFL) and abdominal fin length (AFL) of stingrays within the same genus

4. CONCLUSION

From the results we found four orde of fishes, six families, seven genera and ten species, which included *Carcharhinus brevipinna*, *Carcharhinus melanopterus*, *Carcharhinus amblyrhynchos*, *Himantura uarnak*, *Himantura gerrardi*, *Taeniura lymma*, *Sphyrna lewini*, *Hemigaleus microstoma*, *Chiloscyllium punctatum*, and *Rhynchobatus australiae*. The best PC combination to separate genera of sharks and rays is the combination of PC3 and PC4. The best combination of characters that can separate shark species (genus Carcharhinus) is a combination of PL (pradorsal length) with HL (head length), DFH (dorsal fin height) with HL (head length), DFH (dorsal fin height) with HH (head height), and HL (head length) with HH (head height). The best combination of characters that can separate stingrays (genus Himantura) is the combination of TL (total length) with HL (head length), PFL (pectoral fin length) with AFL (abdominals fin length), and TSL (tail shaft length) with DL (disc length).

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