

Morphometric variations of three species of harvested cephalopods found in northern sea of Aceh Province, Indonesia

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ABSTRACT

Muchlisin ZA, Zulkarnaini B, Purnawan S, Muhadjier A, Fadli N, Cheng SH. 2014. Morphometric variations of three species of harvested cephalopods found in northern sea of Aceh Province, Indonesia. *Biodiversitas* 15: 142-146. The purpose of the present study was to evaluate the morphometrics of three harvested cephalopods, *Sepioteuthis lessoniana*, *Sepia officinalis* and *Uroteuthis* sp. found in northern sea of Aceh Province, Indonesia. Sampling was conducted for six months from July to December 2012 in one week interval. A total of 318 cephalopods; 139 *Sepioteuthis lessoniana*, 139 *Uroteuthis* sp. and 40 *Sepia officinalis* were analyzed for morphometric study and 13 anatomical characters were measured to the nearest 0.01 mm using a digital caliper. Morphometric measurements were significantly different between the different species of cephalopods (ANOVA, $p < 0.05$). *S. officinalis* differed in six morphological characters (head length, head width, tentacles length, gladius width, rancis width and length) from the squid species. Fin width and length were significantly greater in *S. lessoniana* than in *S. officinalis* and *Uroteuthis* sp. On the other hand, *Uroteuthis* sp. had significantly greater mantle lengths, standard lengths and gladius lengths than the other two cephalopod species (Duncan Test, $p < 0.05$). However, fin width was similar between *S. lessoniana* and *Uroteuthis* sp., while eye diameter was similar between *S. officinalis* and *Uroteuthis* sp. A Discriminant Function Analysis scatter plot successfully discriminated the three species indicating significant differences in morphological variation. This analysis also indicates that morphometrically, *S. lessoniana* and *S. officinalis* are more similar to each other despite being in different orders.

Key words: Morphology, Malacca strait, *Sepioteuthis lessoniana*, *Sepia officinalis*, *Uroteuthis*.

INTRODUCTION

There are at least 100 species Decapodiform cephalopods (cuttlefish and squids) occurring in Indonesia waters, of which 24 are economically valuable (Djajasasmita et al. 1993) including *Sepioteuthis lessoniana*, *Sepia officinalis*, *Uroteuthis chinensis*, *Uroteuthis duvauceli*, *Uroteuthis edulis*, *Uroteuthis singhalensis*, *Uroteuthis bartschi*, *Pterygioteuthis giardi* and *Symplectoteuthis oualaniensis* (Ismawan 2006). The cephalopods are economically very valuable aquatic organisms and they play an important role especially in the food web in marine ecosystem (Okutani et al. 1993). These species are traded in both fresh and processed forms, as well used as live bait for the tuna capture industry.

Aceh Province is situated at the northern tip of Sumatra in Indonesia. It occupies two Indonesia Regional Fisheries Management Units, locally known as *Wilayah Pengelolaan Perikanan* (WPP), the Malacca Strait (WPP 571) and Indian Ocean (WPP 572). While Decapodiformes in these regions are heavily harvested, little is known concerning their biology and ecology. According to the Department of Marine and Fisheries Affairs of Indonesia (DKP 2011), the estimated maximum sustainable yields (MSY) per year are

1,900 MT and 1,700 MT in WPP 572 and WPP 572, respectively. Unfortunately, total exploitation in both regions is in excess of this estimate at an average of 3,000 MT per year (DKP 2011) indicating an overfishing in these regions.

Our field observation at the local market, there are three species of squids were frequently caught by Acehese fishermen i.e. *Uroteuthis* sp., *S. lessoniana* and *S. officinalis*. To date, study on the morphometric of cephalopods found in Aceh waters especially at WPP 571 and WPP 572 have not been evaluated. On the other hand, information on morphometric variation is needed to provide comprehensive understanding on the biology of this aquatic animal to plan a better management and conservation strategies. The quantitative morphology of cephalopods can be studied through morphometrics, a numerical techniques used in the process of scientific description of fishes and cephalopods as well (Barriga-Sosa et al. 2004; Pinheiro et al. 2005). The morphometric is concerned with methods for the description and statistical analysis of shape variation within and among samples of organisms (Boletzky and Nege 1997). The study on the cephalopods has been increasing during the last three decades due to increasing of exploitation and overfishing

(Caddy 1995). Study on the genetic of the big-fin reef squid, *Sepioteuthis lessoniana* from this region has been reported by Cheng et al. (2014), and the incubation period and hatching rate of big-fin squid eggs under various salinity levels has been reported by Andy-Omar et al. (2001); However, information on biological aspects of other cephalopods from Indonesian in general and Aceh waters is still in infancy. Hence, the objective of the present study was to evaluate the morphometric variations of three species of cephalopods, *Sepioteuthis lessoniana*, *Uroteuthis* sp. and *Sepia officinalis* harvested from northern sea of Aceh, Indonesia.

MATERIALS AND METHODS

Sampling

The squid samples were obtained from local fishermen from July to December 2012. The fishing ground is located at northern sea of Aceh Province, Indonesia (Figure 1). The sampling frequency was one week interval and the cephalopods were obtained from the same fishermen at fishing port of Lampulo, Banda Aceh, Indonesia. Collected samples were preserved in crush ice and transported to the laboratory at Syiah Kuala University, Banda Aceh, Indonesia for further analysis.

Morphometric characters measurement

A total of 318 cephalopods (139 *Sepioteuthis lessoniana*, 139 *Uroteuthis* sp. and 40 *Sepia officinalis*) were analyzed for traditional morphometric study and 13 anatomical characters were measured to the nearest 0.01 mm using a digital calipers. All measurements were

conducted on the left side of specimen (Figure 2). The description of each character is shown in Table 1. The data were standardized by transforming the measurements to size-independent shape variables based on Schindler and Schmidt (2006) as follows:

$$M_{\text{trans}} = M \times 100/\text{TL}$$

Where, M is the original measurement, M_{trans} is transformed measurement, and TL is total length.

Data analysis

Univariate analysis

The data of morphometrics were analyzed by one-way Analysis of Variance (One-way ANOVA) to test differences among species for each character and followed by a Duncan multiple range tests to investigate sources of variance if data had significant difference (Dytham 2003).

Multivariate analysis

Discriminant Function Analysis (DFA) was utilized in this study. The eigenvalues, cumulative percentage, percentage of total variance, and canonical correlation were generated in this analysis. Functions are considered useful for explaining the data if the eigenvalues are higher than 1 (Kaiser 1960). A structure matrix was also performed and the largest absolute correlation between each character and any discriminant function was utilized to explain the data. The Mahalanobis squared distance was used in a stepwise method to calculate overlap between each group. The group separation was shown in a scatter plot of function 1 versus function 2. All statistical analyses were performed using SPSS software v14 (SPSS Inc., Chicago, IL, USA).

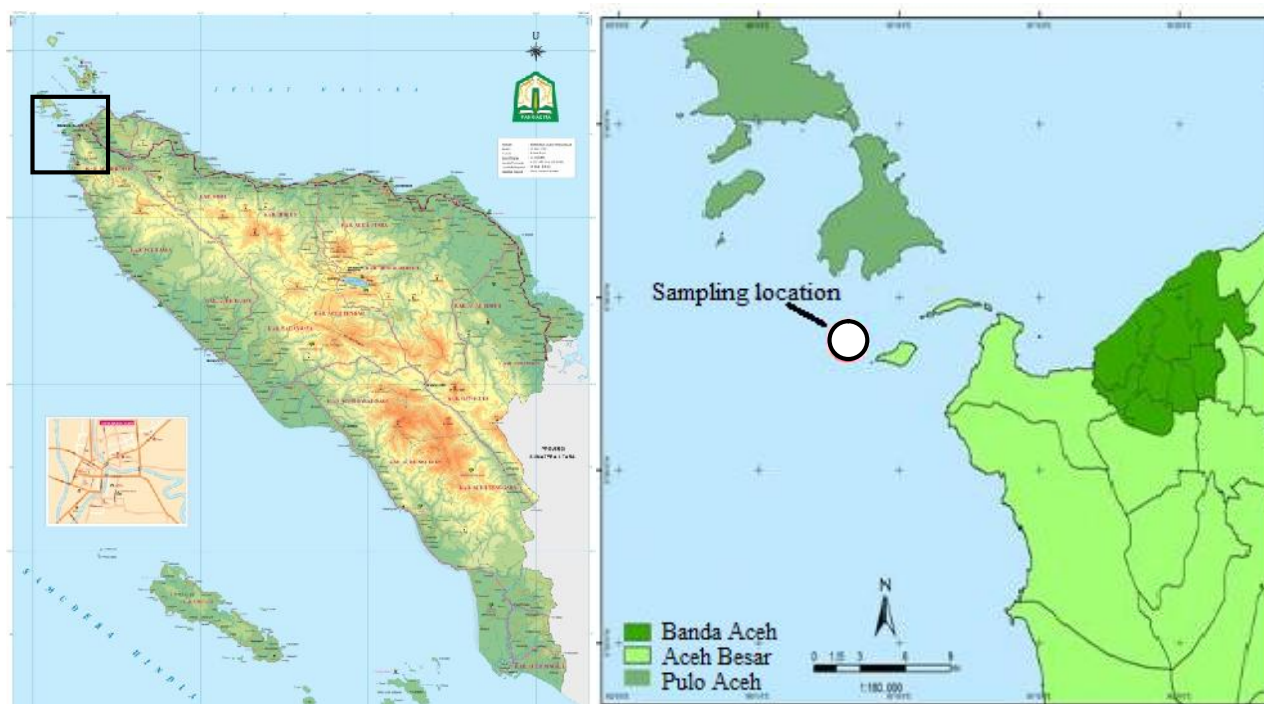


Figure 1. The map of northern sea of Aceh, Indonesia showing fishing ground of Cephalopods (circle of left map).

RESULTS AND DISCUSSION

The ANOVA test showed that species were significantly different on morphometric measurements of squids ($p < 0.05$), and Duncan multiple range tests revealed that *S. officinalis* had significantly higher values for head length, head width, tentacular length, gladius width, length and width of rancis, than the other two species. *S. lessoniana* had higher value on two characters namely

width and length of fins, these values were significantly different from those of *S. officinalis* and *Uroteuthis* sp. While, *Uroteuthis* sp. had higher value on three characters of mantle length, standard length and gladius length. However, the higher similarity of fins width was detected between *S. lessoniana* with *Uroteuthis* sp. and eye diameter between *S. officinalis* with *Uroteuthis* sp. (Table 2). Hence, the three species of tested squids had higher morphological variation.

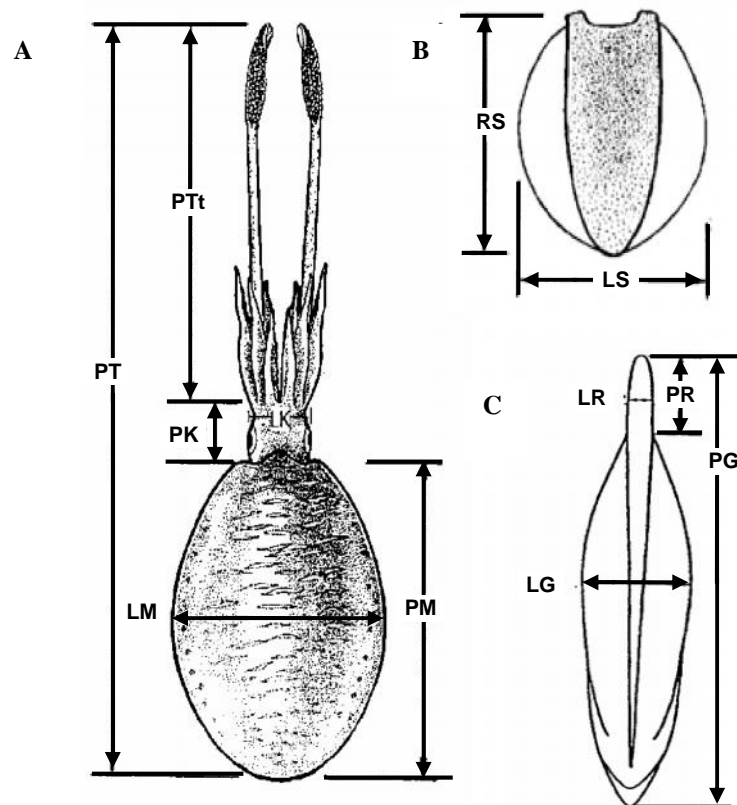


Figure 2. The morphometric characters of cephalopods measured in the study (modified from Andy-Omar 1999). A. Dorsal body view; PK= head length, PM= mantle length, LM= mantle width, PTt = tentacle length, PT= total length, B. Mantle and fins view; PS= fin length, LM= mantle width, LS= fins width, C. Gladius ventral view; PG= gladius length, PR= Rancis length, LR= Rancis width.

Table 1. Description of morphometric characters of cephalopods examined in the study

Character	Descriptions
Total length (PT)	Distance from the left foremost tip of the mantle to the end of tentacle.
Eye diameter (DM)	Distance between anterior and posterior edge of the eye ball.
Head length (PK)	Distance between the origin of mantle to origin of tentacle
Head depth (LK)	Orbital between right eye and left eye
Tentacle length (PTt)	Distance between origin of the tentacle to end of longer tentacle
Mantle length (PM)	The distance between the ventral lateral protruding to the posterior
Mantle width (LM)	The larger part of mantle on the ventrolateral
Fins width (LS)	The distance between the end tip of right fin to the the end tip of left fin at dorsal part
Fins length (PS)	The fin length between the anterior lobe and the posterior
Gladius length (PG)	The total length of the dorsal gladius.
Gladius width (LG)	The larger width between the anterior and posterior parts.
Rancis length (PR)	The length of gladius tip at posterior part
Rancis width (LR)	The width of gladius at posterior part

Table 2. The mean (\pm SD) of measured character of cephalopods. The mean value the same row followed by a different superscript are significant different ($P < 0.05$).

Characters	<i>Sepioteuthis lessoniana</i> n = 139	<i>Sepia officinalis</i> n = 40	<i>Uroteuthis</i> sp. n = 139
Eye diameter	2.47 \pm 0.38 ^b	1.25 \pm 0.22 ^a	1.25 \pm 0.47 ^a
Head length	9.04 \pm 1.24 ^b	10.20 \pm 1.17 ^c	7.59 \pm 1.15 ^a
Head depth	7.07 \pm 1.12 ^b	9.63 \pm 3.44 ^c	5.12 \pm 1.06 ^a
Mantle length	36.00 \pm 3.20 ^b	32.99 \pm 2.65 ^a	41.06 \pm 3.83 ^c
Mantle length	27.36 \pm 3.75 ^c	26.16 \pm 3.19 ^b	11.39 \pm 2.35 ^a
Fins length	32.07 \pm 2.91 ^c	29.47 \pm 2.79 ^b	13.17 \pm 4.75 ^a
Fins width	6.36 \pm 1.06 ^b	4.25 \pm 0.48 ^a	5.95 \pm 1.65 ^b
Tentacle length	56.49 \pm 5.53 ^b	60.28 \pm 2.69 ^c	52.64 \pm 5.42 ^a
Total length	44.04 \pm 4.95 ^b	40.72 \pm 3.10 ^a	48.17 \pm 4.42 ^c
Gladius length	35.00 \pm 3.23 ^b	32.69 \pm 2.30 ^a	40.28 \pm 3.83 ^c
Gladius width	6.15 \pm 0.91 ^b	11.18 \pm 0.87 ^c	5.09 \pm 0.82 ^a
Rancis length	8.24 \pm 1.10 ^b	8.97 \pm 0.71 ^c	6.79 \pm 2.03 ^a
Rancis width	2.07 \pm 0.59 ^b	7.69 \pm 0.69 ^c	1.80 \pm 0.55 ^a

Discriminant Function Analysis (DFA) resulted in two functions and both had eigenvalues of more than 1. Function 1 had eigenvalues of 28.33 explaining 62.6% of total variance, and this function had high loadings for eleven characters i.e. mantle width, mantle length, fins length, fins width, gladius width, gladius length, head length, head width, standard length, rancis length and tentacle length. While function 2 had eigenvalues of 16.94, explaining 37.4% of total variance and had high loadings for eye diameter and rancis width (Table 3). The scatter plot of Function 2 against Function 1 showed that individuals of the three cephalopods groups were divided into three clusters where *S. lessoniana* and *Uroteuthis* sp. were closely related while *S. officinalis* was clustered separately (Figure 3).

Table 3. Eigenvalues, percentage of variance and DFA loading of morphometric characters. High loading characters indicated in bold types

Function	1	2
Eigenvalue	28.33	16.94
% of Variance	62.6	37.4
Cumulative %	62.6	100
Canonical correlation	0.983	0.972
Mantle width (LM)	0.436(*)	0.228
Fins length (PS)	0.412(*)	0.239
Gladius width (LG)	0.315(*)	0.299
Gladius length (PG)	0.179(*)	0.040
Mantle length (PM)	0.161(*)	0.006
Head length (PK)	0.141(*)	0.010
Fins length (PS)	0.118(*)	0.087
Rancis length (PR)	0.099(*)	0.009
Tentacle length (PTt)	0.091(*)	0.014
Head depth (LK)	0.084(*)	0.003
Fins width (LS)	0.061(*)	0.031
Rancis width (LR)	0.382	0.555(*)
Eye diameter (DM)	0.153	0.293(*)

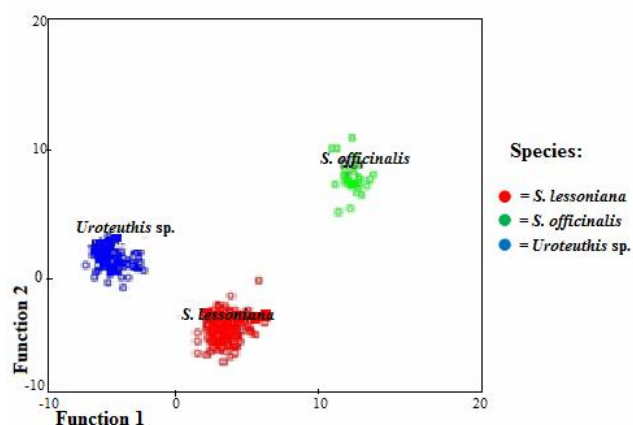


Figure 3. The Canonical Discriminant Function scatter plot: function 1 versus function 2 of morphometric characters of cephalopods

Generally the three examined squids displayed higher morphological differences among groups, indicating valid taxonomic status of these species. Morphometric characters have been widely utilized in fisheries biology to assess differentiation and relationships among various taxonomic categories and also for stock identification (Turan 1999). Based on the morphological data the squids samples have been discriminated into three separate groups indicating the different taxonomic status. However, for validation of the taxonomic status of these species, genetic analysis data are needed. Presently the genetic data of *S. lessoniana* has been reported by Cheng et al. (2014), but no information on the rest species was available. According to Prioli et al. (2002) genetic data have been recognized as useful information in species identification. In addition, within the same species, size can vary with the age and affected by environmental factors (Armstrong and Cadrin 2001), therefore genetic data are useful in overcoming this problem. Therefore, studies on the genetic variations of *Sepioteuthis lessoniana*, *Sepia officinalis* and *Uroteuthis* sp. are crucially needed. According to Dewanto (2001) morphological variations are affected by environmental factors i.e. water temperature, current and salinity, and by genetic factor. Moreover, Matthews (1998) stated that aquatic organisms have morphological adaptation to their environment.

In general, the similarities in morphometric measurements indicate similar responses in growth to similar environmental conditions, or similar life histories. It is significant that systematically, *Uroteuthis* sp. and *Sepioteuthis* are more closely related (both being in the same family Loliginidae and same order Teuthidae) while *S. officinalis* is in an entirely different order (Sepiidae). Phylogenetically, this is a different story since the deeper phylogenetic relationships between families and orders of Decapodiformes is quite complex and not well resolved (Anderson 2000; Lindgren et al. 2010). It is significant that *Sepia* and *Sepioteuthis* share similar habitat characteristics and life histories and home ranges and are shown here to be

more morphometrically similar than *Uroteuthis* which is much more associated with open waters and less with strictly coastal environments. This is in agreement with Tehranifard and Dastan (2011) who studied one species of *Sepia* (*S. pharaonis*) where the species is a neritic demersal species which occurs down to 130 m. Thus despite being divergent systematically, *Sepia* and *Sepioteuthis* are similar morphometrically. This has major implications for management and conservation. Strategies to conserve *Sepia* may benefit *Sepioteuthis*, however, in no way does it seem that practices benefiting *Uroteuthis* will benefit either of those. This is highly contradictory to how catch is reported and monitored for *Sepioteuthis* in particular, because it is usually lumped in with other *Uroteuthis* species when in fact, morphometrically, and ecologically, they are more similar to *Sepia*.

CONCLUSIONS

Most of the morphometric characters of cephalopods were highly different among the three species were observed. However, the fin width *S. lessoniana* and *Uroteuthis* sp. were relatively similar and the eye diameter of *Uroteuthis* sp and *S. officinalis* were relatively similar. There was higher similarity in body shape between *S. lessoniana* and *S. officinalis*.

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