Songklanakarin J. Sci. Technol.
37 (1), 15-20, Jan. - Feb. 2015

http://www.sjst.psu.ac.th

Original Article

Morphometric variation among three local mangrove clam species of Corbiculidae

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Received: 12 March 2014; Accepted: 8 December 2014

Abstract

Three common species of Corbiculidae (*Polymesda erosa*, *P. bengalensis* and *P. expansa*) can be found inhabiting the mangrove areas in Southeast Asia. The morphometric variations of three species were examined based on 15 morphometric characters. A total of 16 populations from six localities were analyzed in the present study. Analysis of variance had revealed significant differences ($P<0.05$) for LCT/SL and VPM/SL for proportion ratio on morphometric variables among species. Cluster analysis for these populations formed two groups at 70% of similarity. Morphometric characteristics, such as LCT and VPM, of Corbiculidae are proposed to differentiate these three species.

Keywords: Corbiculidae, morphometric analysis, mangrove clam, Sarawak, wetland

1. Introduction

Corbiculidae is grouped under bivalvia class, heterodonta subclass (Okutani, 2000). One of the important characters that are used to differentiate them with other bivalve family is the present of heterodon type of tooth at the hinge of the shell. There are four common species in Southeast Asia, *Polymesoda erosa, Polymesoda expansa, Polymesoda bengalensis* and *Batissa violacea* (Morton, 1984). Few studies on Corbiculidae such as food effect to *Polymesoda erosa* were conducted on Corbiculidae at the Southeast Asia region (Supriyantini *et al.*, 2007), isolation of *Vibrio* sp. gene from *Corbicula moltkiana* (Marlina *et al.*, 2007), and a review of *Polymesoda* (Morton, 1984) have indicated the importance of this family in a malacology study.

Those four species distribute in the Indo-West Pacific from India to Vanuatu, north to southern island of Japan, south to Queensland and New Caledonia (Poutiers, 1998). Corbiculidae can be found in the mangrove area because it is a suitable place to support many types of organisms and a source of plenty of nutrients (Macintosh *et al.*, 2002). Malaysia has several places with mangrove such as Sarawak mangrove forest which covers 173,792 ha from the total of land (Paul, 2011). It was reported that Corbiculidae was found at Sabah (Hashim, 1993; Supian and Ikhwanudin, 2002) and at the west coast of Peninsular Malaysia (Abu Hena *et al.*, 2004).

Morton (1984) proposed that these four species can be differentiated based on the hinge structure. Identifying species based on morphology character is easier, cheaper, and faster compared to genetic identification. Many other studies were conducted based on shell characters and size for species identification. However, both characters are not enough to differentiate Corbiculidae species because of the environmental variables effect (Fuiman *et al.*, 1999; Akester and Martel, 2000). Morphometric characteristics can be used to differentiate two different species of Pinnidae as described by Idris et al. (2009). The morphometric method can be used with other methods such as, to identify relationship between morphometric measurement with anatomical character for

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Corbicula taxonomic clarification and distribution (Araujo *et al.*, 1993). Other methods involve morphological techniques supported with molecular genetics in order to assess mussel populations (Mass *et al.*, 1999). The combination with other method is to specify the identified species. However there is no study on Corbiculidae family particularly on the morphology and morphometric characters from Sarawak region. Thus, the present study aimed to fill the information gap on this family by determining the morphometric differences between Corbiculidae species that exist in the mangrove areas of this region.

2. Materials and Methods

2.1 Locality

The study was carried out in seven localities (Figure 1) in Sarawak: Kuching (N 01°33.094' E 110°20.256'), Sibu (N 02°17.335' E 111°49.756'), Mukah (N 02°58.837' E 112°05.751'), Bintulu (N 03°10.250' E. 113°02.393'), Miri (N 03°23.526' E 113°59.142'), Limbang (N 04°46.864' E 115°02.539'), and Lawas (N 04°54.902' E 115°13.506') between July 2010 and January 2012. Study sites at the Kuching, Sibu, Mukah and Bintulu localities are located at the south of Sarawak area with pH range between 7.36-7.49, 6.46-6.67, 7.83-7.84, and 7.52-7.90, respectively. The North of Sarawak sites are represented by Miri, Limbang, and Lawas localities with pH range between 6.03-6.07, 6.53-6.59, and 6.93-6.99, respectively. These localities are mangrove forest covered with brackish water during high tide.

2.2 Morphometric and morphology characteristics

A total of 436 individuals of matured *Polymesoda erosa*, *P. expansa* and *P. bengalensis* were collected from the natural habitats. Samples preserved under freeze point before identification based on Morton (1984), Poutiers (1998), and Hamli *et al.* (2012). A total of 14 characters were used to study morphometric characteristics, which are ratio to standard length (SL) based on Scheltema (1983) and Idris *et al.* (2008). Five general characters: shell height (SH), shell width (SW), umbo length (UL), anterior length (AL), and posterior length (PL) (Mass *et al.*, 1999) were examined. Moreover nine additional characters: ligament length (LL), cardinal tooth length (LCT), anterior adductor muscle scar width (AW), posterior adductor muscle scar width (PW), length from anterior adductor muscle scar to posterior adductor muscle scar (LPAS), length from anterior adductor muscle scar to anterior margin (AAAM), length from posterior adductor muscle scar to posterior margin (PAPM), length from ventral margin to pallial line (PVM), and ventral posterior margin length (VPM) were also included in the analysis (Figure 2). In the addition shape of each shell were observed and recorded qualitatively.

2.3 Statistical analysis

The ratio of morphometric variables were tested with one way analysis of variance (ANOVA) with general linear model (GLM) by using statistical analysis computer software (SAS) version 9.1 (SAS Institute, 2004). Tukey mean comparison was used to determine which of the characters were significantly different from others. Clustering by Bray-Curtis similarity distance at 70% analysis was carried out based on Nurul Amin *et al.* (2010) by using computer program PRIMER version 5 (Plymouth Routines In Multivariate Ecological Research) (Clarke and Gorley, 2001).

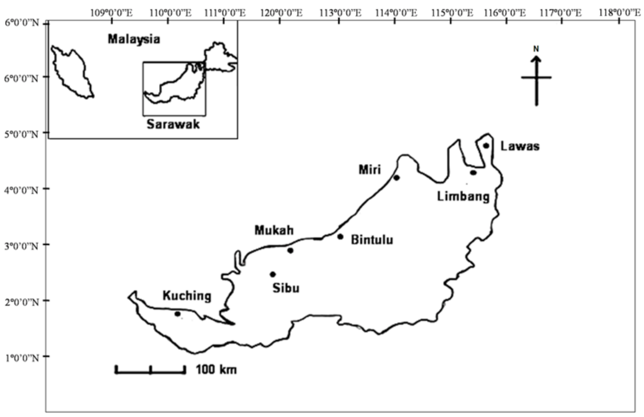

Figure 1. Seven different localities of three *Polymesoda* species.

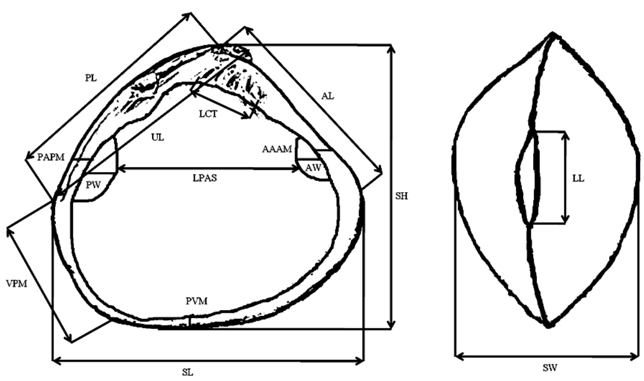

Figure 2. Diagram of morphometric characteristic measurement of *Polymesoda* shell (SL) standard length ; (SH) shell height; (SW) shell width; (UL) umbo length; (AL) anterior length ;(PL) posterior length ; (LL) ligament length; (LCT) cardinal tooth length; (AW) anterior adductor muscle scar width; (PW) posterior adductor muscle scar width; (LPAS) length from anterior adductor muscle scar to posterior adductor muscle scar; (AAAM) length from anterior adductor muscle scar to anterior margin; (PAPM) length from posterior adductor muscle scar to posterior margin; (PVM) length from ventral margin to pallial line; (VPM) ventral posterior margin length.

3. Results

3.1 Morphometric and morphology

Results on shell measurement and their ratios was significantly different (P<0.05) between *P. erosa*, *P. expansa,* and *P. bengalensis* (Table 1). The ratio on cardinal tooth length to standard length (LCT/SL) showed significant differences on the mean value. Other morphometric characteristics were indicated non-significant differences among three species. Mean value of LCT/SL for *P. bengalensis* was higher than *P. expansa* and *P. erosa* with 0.17±0.00 mm, 0.14±0.00 mm, and 0.16±0.00 mm respectively (Figure 3). *Polymesoda bengalensis* is the only species that presents VPM characters and that therefore was available for VPM/SL (Figure 4). In terms of morphology, *P. erosa* has subrhomboidal-ovate shell shape which is very different compared to *P. expansa* that has shell expand posteriorly and *P. bengalensis* with subtrigonal shell shape.

3.2 Cluster analysis

A total of 16 populations of *P. erosa*, *P. bengalensis* and *P. expansa* were tested for cluster analysis. Two groups of clusters have been formed through similarity based on LCT and VPM morphometric characteristics (Figure 5). Group 1 comprised of *P. bengalensis* from Kuching, Bintulu, Miri, Lawas, Limbang, and Sibu locality. Group 2 comprised of *P. expansa* (Miri, Bintulu, Lawas and Limbang) and *P. erosa* (Limbang, Lawas, Miri, Sibu, Mukah and Bintulu).

3.3 Dichotomus key for *polymesoda* spp.

Polymesoda genus from Sarawak was categorized into three species, *P. erosa, P. expansa,* and *P. bengalensis* based on morphology and morphometric characteristics. The particular identification key of mangrove clam as listed below:

1. Shell peculiarly presence of ventral posterior margin *Polymesoda bengalensis*
2. Shell absence of ventral posterior margin (Refer to number 3)
3. Shell expanded posteriorly in outline *P. expansa*
4. Shell subrhomboidal-ovate in outline *P. erosa*

4. Discussion

The propotion of LCT/SL is significantly diverse between *P. bengalensis* (0.17±0.00 mm) and *P. expansa* (0.14±0.00 mm) (Table 1). However, the proportion of VPM/SL is applicable only to *P. bengalensis*. Both of these charac-

Table 1. Analysis of one way ANOVA with general linear model (GLM) for 14 morphometric characteristic proportion with standard length of three *Polymesoda* species.

Morphometric characteristic	*Polymesoda erosa* N=194 (mm)	*Polymesoda expansa* N=139 (mm)	*Polymesoda bengalensis* N=103 (mm)	F value	P
SH/SL	$0.89±0.21^{a}$	$0.89±0.01^{a}$	$0.93±0.01^{a}$	0.39	0.678^{ns}
SW/SL	$0.53±0.03^{a}$	$0.54±0.01^{a}$	$0.55±0.01^{a}$	0.11	0.895^{ns}
UL/SL	$0.75±0.04^{a}$	$0.78±0.01^{a}$	$0.80±0.00^{a}$	0.58	0.564^{ns}
LL/SL	$0.32±0.02^{a}$	$0.31±0.00^{a}$	$0.34±0.01^{a}$	0.91	0.409^{ns}
AL/SL	$0.56±0.03^{a}$	$0.58±0.01^{a}$	$0.60±0.01^{a}$	0.66	0.523^{ns}
PL/SL	$0.72±0.04^{a}$	$0.75±0.01^{a}$	$0.60±0.01^{a}$	0.48	0.625^{ns}
PAPM/SL	$0.05±0.00^{a}$	$0.05±0.00^{a}$	$0.05±0.00^{a}$	1.99	0.149^{ns}
AAAM/SL	$0.05±0.00^{a}$	$0.05±0.00^{a}$	$0.05±0.00^{a}$	1.22	0.305^{ns}
PVM/SL	$0.10±0.01^{a}$	$0.10±0.00^{a}$	$0.09±0.00^{a}$	1.39	0.261^{ns}
LPAS/SL	$0.60±0.03^{a}$	$0.63±0.00^{a}$	$0.63±0.00^{a}$	0.68	0.535^{ns}
AW/SL	$0.12±0.01^{a}$	$0.12±0.00^{a}$	$0.13±0.00^{a}$	1.78	0.180^{ns}
PW/SL	$0.17±0.01^{a}$	$0.15±0.00^{a}$	$0.17±0.00^{a}$	1.91	0.160^{ns}
LCT/SL	$0.16±0.01^{ab}$	$0.14±0.00^{a}$	$0.17±0.00^{b}$	4.45	0.017
VPM/SL	NA	NA	$0.36±0.00^{a}$	8550.24	<.0001

SL=Standard length, SH=Shell height , SW=Shell width, UL=Umbo length, LL=Ligament length, AL=Anterior length, PL=Posterior length, PAPM=Posterior adductor scar to posterior margin, AAAM=Anterior adductor scar to anterior margin, PVM=Pallial line to ventral margin, LPAS=Length of posterior adductor scar to anterior adductor scar, AW= Anterior adductor scar width, PW=Posterior adductor scar width, LCT=Cardinal tooth lenght, VPM=Ventral posterior margin length, NA=Not available.

Note: difference superscripts indicate a significantly different at level P<0.05 using Tukey mean comparison, ns: no significantly different.

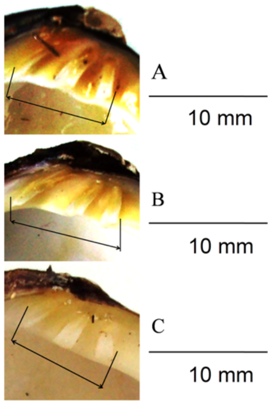

Figure 3. Photo on Cardinal tooth lenght (A) *P. bengalensis*, (B) *P. erosa*, (C) *P. expansa.*

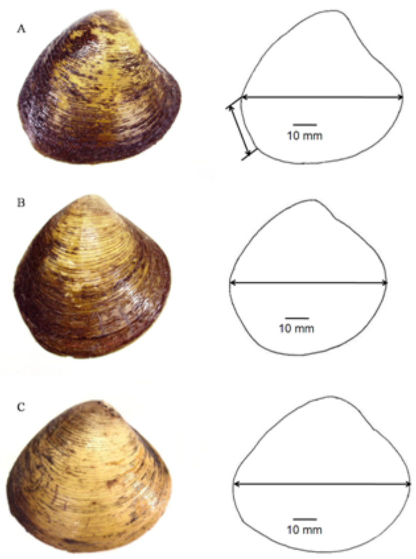

Figure 4. Photo sketch of morphometric ratio on ventral posterior margin (VPM/SL). (A) *P. bengalensis*, (B) *P. erosa* and (C) *P. expansa.*

ters (LCT and VPM) are unable to differentiate between *P. erosa* and *P. expansa*. Idris *et al.* (2009) reported that the ratio on width and total length was able to differentiate *Pinna bicolor* and *P. deltodes* which is contradictory to the present study. This suggests LCT can be used to differentiate between *P. bengalensis* and *P. expansa.* Meanwhile the VPM character is unique for *P. bengalensis* so that it can be used to differentiate *P. erosa* and *P. expansa.* Similar morphometric characteristics between *P. erosa* and *P. expansa* might be caused by the abiotic factor such as shallow habitat which is reported by Lajtner *et al.* (2004). Shallower habitat can produce a higher ratio of shell length and shell width compared to deeper habitat (Lajtner *et al.*, 2004). Hamli *et al.* (2012) reported that *P. bengalensis, P. erosa,* and *P. expansa* were found to inhabit similar localities which may cause the shell character during growth to be comparable. The only character to differentiate between *P. erosa* and *P. expansa* are by morphological observation based on Poutiers (1998). *Polymesoda erosa* has subrhomboidal-ovate shape compared to *P. expansa* that has expanded posteriorly (Figure 2). *Polymesoda bengalensis* has a shell with subtrigonal shape compared to *P. erosa* and *P. expansa*. Mangrove clam also were potentially rendering to desiccation and variable range of salinities which might be able alter the shell outline (Gimin, 2004).

A cluster analysis of 16 *Polymesoda* localities were separated into two groups which is a group of *P. bengalensis* and the other group comprise of *P. erosa* and *P. expansa*. *Polymesoda erosa* and *P. expansa* were grouped in the similar cluster due to similar characteristics of LCT and VPM. This is in agreement with Morton (1984) who states that the two species *Geloina erosa* and *G. expansa* were hard to differentiate. Similar abiotic properties in a habitat probably cause high similarities in morphometric characteristic between two *Polymesoda* species of different localities. Moreover the presence of salinity, total suspended solid, pH, ferrous, and ferric iron affected the abundance of bivalve at the particular habitat (Tanyaros and Tongnunui, 2011). The range of pH for every locality of *Polymesoda* mentioned at the locality

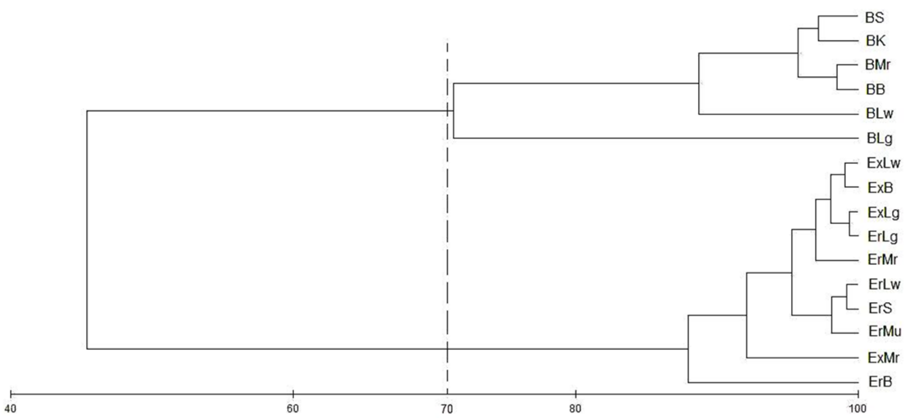

Figure 5. Cluster group of *Polymesoda* at seven localities of Sarawak based LCT and VPM morphometric characters. Species: (B) *P. bengalensis*, (Ex) *P. expansa*, (Er) *P. erosa*. Population: (B) Bintulu, (K) Kuching, (S) Sibu, (Mr) Miri, (Mu) Mukah, (Lg) Limbang, (Lw) Lawas.

section was slightly different probably affecting shell outline of *P. erosa* and *P. expansa*. Bivalve shells especially from mangrove area are vulnerable to erosive effects of the acid mangal soil (Morton, 1984). However, salinity condition does not affected to the *P. bengalensis* population, maybe due to its strong shell feature such as ventral posterior margin which is grouped *P. bengalensis* in the same clade. Hiebenthal *et al.* (2012) has reported that salinity less affect to the bivalve shell formation.

Present morphometric characteristics investigation can be used to differentiate different species that are known and same species from different populations. Through this morphometric analysis differences morphological characteristics between species have been revealed. The present study provides new taxonomic characters that can be applied in the key of these three species. It is important to apply these characters for species identification because it is a fast, cheap and efficient method. Furthermore, additional genetic identifications can help to reveal the species identity.

Acknowledgements

The authors would like to thank the Dean and staffs of the Department of Animal Science and Fishery, Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus, Malaysia for technical, logistic supports, and laboratory facilities provided. H.H would like to thank the Ministry of Education, for a research grant (5523703 FRGS and 9199876 RUGS).

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