Species Identification of Commercially Important Cephalopods of Thailand

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Identification of commonly important species of cephalopods could be a gigantic task. However, a system to identify common species of cephalopods has been developed by turning to the morphological characteristics of their paralarvae. Paralarva is the stage after hatching or small size of aquatic species that usually looks similar with that of their parents. However, in some species of cephalopods the paralarvae could look differently from their parents, making it difficult to identify some species even at the genus or species level. It is in this regard that a study was conducted at Kasetsart University in Thailand with the objective of establishing the morphological characteristics of the paralarvae of cephalopods commonly found in the waters of Thailand as means of facilitating species identification at the paralarval stages of the species.

Cephalopods belong to Phylum Mollusca and are evolutionary in nature with long history of existence. Cephalopods are believed to have evolved from the earliest coleoids with internal shells to the Cambrian period when most had reduced or lost their shells up to the Jurassic period when modern species of coleoids (Subclass: Coleoidea; Class: Cephalopoda) had much reduced shells or completely lost their shells (Boyle and Rodhouse, 2005). Cephalopods usually lay eggs after fertilization of about one week or more.

Nabhitabhata (2009) reported that many cephalopods are abundant in the waters of Thailand with high biodiversity, and are reported to belong to 23 families, 43 genera and 80 species, which had been identified and classified from adult specimens. Based on Collins *et al*. (2002), the external morphology of paralarvae could be used in determining the distribution and abundance of cephalopod species noting also that knowledge of the morphology of paralarvae is important to fully understand the cephalopod's life cycle. It has therefore become necessary to compile information on the external morphological characteristics of the paralarvae of some species of cephalopods to better understand their life cycles, especially those commonly found in the waters of Thailand.

In Thailand, many cephalopods are commercially important and in the 2012 fishery statistical records, these species comprised about 8% of the country's total production from marine capture fisheries in terms of volume and about 19% in terms of value (SEAFDEC, 2014). In the Gulf of Thailand, it was reported that the Indian squid (*Photololigo duvaucelli*), mitre squid (*Photololigo chinensis*), bigfin reef squid (*Sepioteuthis lessoniana*), and cuttlefish (*Sepia* spp.) appeared dominant in the catch from squid jigging experiments conducted in 2013 (SEAFDEC/Training Department, 2013).

In the national and regional fishery statistical reports, cephalopods are classified as cuttlefish, bobtail squids *nei*, common squids *nei*, various squids *nei*, octopuses *nei*, and bigfin reef squid, implying that there are still considerable number of cephalopods that have not been identified at species level, and as a result, their production has been recorded only as *nei* (not elsewhere included). Considering the significant production volume reported under these categories, *e.g.* production of common squids *nei* reported by Thailand in 2012 was 74,282 metric tons, therefore it is necessary that the species level of such cephalopods should be identified in the future for the purpose of establishing the status and trend of their production and utilization at the regional level. An analysis of the case study carried out by the authors from Kasetsart University in Thailand indicated that identification of commonly important cephalopods could be facilitated through the morphological characteristics of their paralarvae, and suggested that this system could be useful as reference in similar endeavors.

The Case Study

In the case study, broodstocks of five species of commercially important cephalopods collected from the coastal waters of

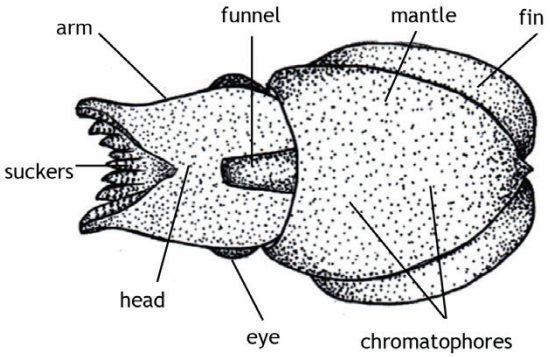

Fig. 1. External parts of paralarvae of cephalopods used for species identification

the Gulf of Thailand and Andaman Sea were reared and made to spawn at the laboratories of the Department of Marine Science, Faculty of Fisheries of Kasetsart University in Bangkok, Thailand. These are the bigfin reef squid (*Sepioteuthis lessoniana*), needle cuttlefish (*Sepia aculeata*), spineless cuttlefish (*Sepiella inermis*), Pharaoh cuttlefish (*Sepia pharaonis*), and marble octopus (*Amphioctopus aegina*).

After the paralarvae of the commercially important species had been collected from the spawned broodstocks, these were preserved in 10% formalin and put in 70% alcohol for observation. The external morphological characteristics of the paralarvae were then observed under stereo microscope and measured for their mantle length (ML) and head length (HL), while their arm pattern and characteristics of the suckers in each arms as well as the chromatophores (**Fig. 1**) were noted. Moreover, other distinguishing characteristics were also recorded and finally, the paralarvae were weighed accordingly. Furthermore, the morphological characteristics of the corresponding adult stages of the species were also observed as these could be used for verifying the species identified (**Fig. 2-6**).

Morphological characteristics of cephalopods that are of commercial importance in Thailand

The compiled information on the morphological characteristics of the paralarvae of common cephalopods shown in **Tables 1-5** would serve as useful reference for the identification of commercially exploited cephalopods, especially at species level. From the results of the analysis conducted on these common cephalopods, their morphological characteristics are summarized below which could be used in identifying the species of cephalopods at species level even at their paralarval stages.

Bigfin reef squid (*Sepioteuthis lessoniana*)

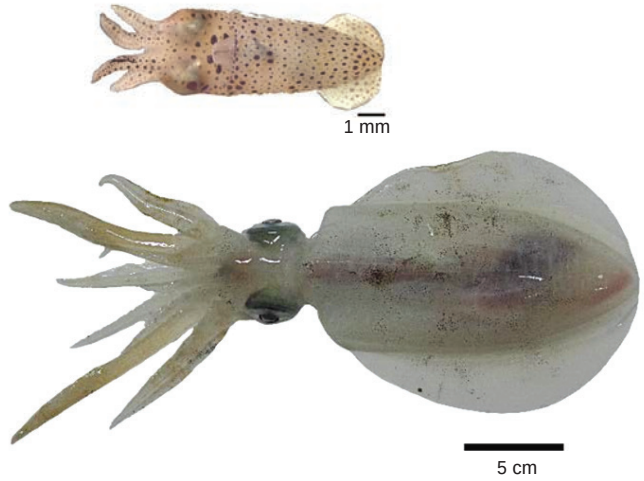

Fig. 2. Paralarva *(top)* and adult *(below)* of the bigfin reef squid

Table 1. Morphological characteristics of paralarva and adult of the bigfin reef squid

Bigfin reef squid (*Sepioteuthis lessoniana*)	Morphological Characteristics	
	Paralarva	Adult
Mantle	long and sharp at posterior, ave length of mantle (ML) = 6 mm	long and robust
Fins	semicircle in shape and medium in size, length = 40% of ML and width = 16% of ML	very large and with length over 90% of ML
Head	large, length (HL) = 43% of ML	large, narrower than the width of anterior part of mantle
Eyes	big, length= 60% of HL	large, more than 80% of HL
Funnel	short, length = 26% of ML	large, thick, length more than 90% of ML
Arms	formula is III>II>IV>I, length ranging from 17 to 42% of ML	formula is III>IV>II>I
Suckers	short-stalked and two rows in each arm	a largest sucker is present, almost one quarter of arm length from proximal end
Tentacular club	slightly expanded with four rows of suckers	slightly expanded with four rows of suckers
Chromatophores	spread throughout the body, head, fin and arm; pattern in each arm is straight line and at ventral side of head, pattern appears triangle in shape	spread throughout the body, head, fins and arms
Weight/ML	Weight: 0.0258 ± 0.0027 g	Max ML: 422 mm.

Needle cuttlefish (*Sepia aculeata*)

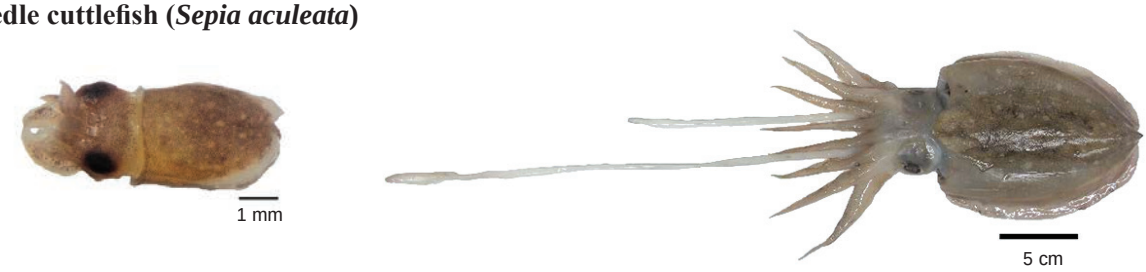

Fig. 3. Paralarva *(left)* and adult *(right)* of the needle cuttlefish

Table 2. Morphological characteristics of paralarva and adult of the needle cuttlefish

Needle cuttlefish (*Sepia aculeata*)	Morphological Characteristics	
	Paralarva	**Adult**
Mantle	broad and sac-like in shape, ave length = 3.69 mm	elongated-oval
Fins	narrow and long but less than mantle length, while posterior fin lobes are free and not connected at posterior end, length = 74% of ML and width = 17% of ML	thin and narrow, marginal and bordering the mantle, widest near posterior part
Head	large, length = 49% of ML	large, broader than length
Eyes	big, length = 58% of HL	moderately large
Funnel	long, length = 40% of ML	stout, conical, tapered at anterior
Arms	formula is I>IV>III>II, length = 22-43% of ML	formula is IV>III>II>I
Suckers	sub-equal in size, 2-3 rows on arm I-III and 4 rows on arm IV	large proximally and diminishing into smaller size at distal end
Tentacular club	small and short	with minute club suckers, sub-equal and arranged in about 10-14 longitudinal rows
Chromatophores	spread throughout body, head and arms but not on fins; more on dorsal side than on ventral side but size on latter is smaller, pale spots spread on dorsal side but not on ventral side	spread throughout the body, head, fins and arms
Weight/ML	Weight: 0.0205 ± 0.0013 g	Max. weight: 1.3 kg; Max. ML: 230 mm

Pharaoh cuttlefish (*Sepia pharaonis*)

Fig. 4. Paralarva *(left)* and adult *(right)* of the Pharaoh cuttlefish

Table 3. Morphological characteristics of paralarva and adult of the Pharaoh cuttlefish

Pharaoh cuttlefish (*Sepia pharaonis*)	Morphological Characteristics	
	Paralarva	**Adult**
Mantle	broad and sac-like in shape, ave. length = 7.1 mm	broadly elongated-oval, slightly pointed at posterior
Fins	narrow, long but less than length of mantle, posterior fin lobes are free and not connected at posterior end, length = is 71.42% of ML and width = 15.45% of ML	large, length is about 90% of ML
Head	large, length = 41% of ML; spine present at posterior end	large, slightly narrower than mantle opening

Table 3. Morphological characteristics of paralarva and adult of the Pharaoh cuttlefish (Cont'd)

Pharaoh cuttlefish (*Sepia pharaonis*)	Morphological Characteristics	
	Paralarva	**Adult**
Eyes	medium in size, length = 32% of HL	large
Funnel	medium in size, length = 30.72% of ML	large, stout and extends to interbranchial area of arm IV
Arms	formula is IV >I>III>II, length ranges from 18 to 47% of ML	formula is IV>III>II>I
Suckers	sub-equal in size, on arm I- IV arranged in 4 rows	equal in size
Tentacular club	broad	moderate in size, club suckers arranged in 6-8 transverse rows and 2 median rows, 5-6 of which are greatly enlarged
Chromatophores	spread throughout body, head and arms but not on fins, white spots present on ventral side along the mantle margin	spread throughout the body, head, fins and arms
Weight/ML	Weight: 0.0350 ± 0.0060 g	Max. weight: 5 kg; Max. ML: 420 mm

Spineless cuttlefish (*Sepiella inermis*)

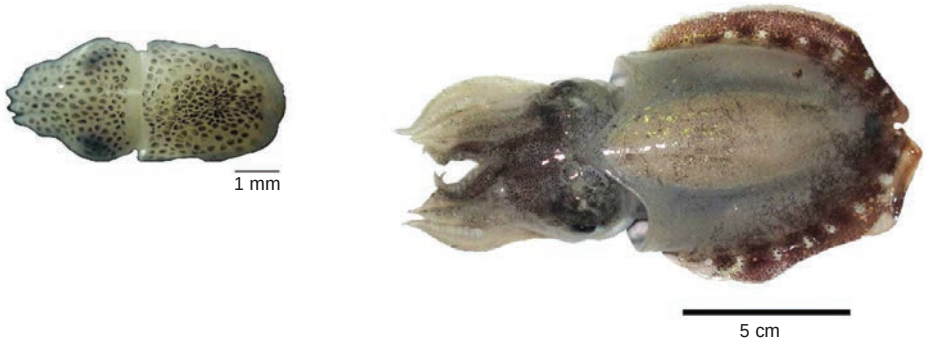

Fig. 5. Paralarva *(left)* and adult *(right)* of the spineless cuttlefish

Table 4. Morphological characteristics of paralarva and adult of the spineless cuttlefish

Spineless cuttlefish (*Sepiella inermis*)	Morphological Characteristics	
	Paralarva	**Adult**
Mantle	broad and sac-like in shape, ave length= 3.2 mm	elongated-oval, with pigment gland and pore present at posterior tip on ventral side
Fins	narrow, long but less than mantle length, posterior fin lobes are free, not connected at posterior end, length = 67.8% of ML, width = 20.6% of ML	narrow at anterior and slightly broader at posterior, length of which is about 90% of ML
Head	large, length = 69% of ML	moderately broad, slightly narrower than mantle opening
Eyes	medium in size, length = 42% of HL	large
Funnel	medium, length = 34% ML	short, conical, tapering at anterior, free in anterior half
Arms	formula is IV>I>II>III, length = 20.0-52.5% of ML	formula is IV>III>II>I
Suckers	sub-equal in size, 2 rows on arms I-IV and 3 rows on tentacular club	equal in size
Tentacular club	small and short	long, with minute club suckers and sub-equal in size
Chromatophores	spread throughout body, head and arms but not on fins, those on dorsal side are more than on ventral side but size on the latter is smaller, none on ventral side near posterior end	spread throughout the body, head, fins and arms
Weight/ML	Weight: 0.0119 ± 0.0010 g	Max. ML: 125 mm.

Marble octopus (*Amphioctopus aegina*)

Fig. 6. Paralarva *(left)* and adult *(right)* of the marble octopus

Table 5. Morphological characteristics of paralarva and adult of the marble octopus

Marble octopus (*Amphioctopus aegina*)	Morphological Characteristics	
	Paralarva	**Adult**
Mantle	short and oval in shape, ave length = 1.2 mm	elongated-oval to oblong
Head	medium, length = 56% of ML	small, slightly narrower than mantle
Eyes	very large, length = 95% of HL	moderate in size
Funnel	short, length = 33% of ML	long, tubular with slightly broad base
Arms	long and sub-equal in length, length = 66% of ML	moderately long about 2-3 times of ML, arm formula is III>IV>II>I
Suckers	sub-equal in size, only one row on each arm, each row contains 4 suckers, those close to buccal are smallest while those at middle arm are biggest	cup-like, typically biserial, normally large at the base
Chromatophores	spread throughout body, head and arms, number on dorsal side is same as on ventral side but are smaller on dorsal side than on the ventral side, appears triangle in shape in all arms and in zigzag pattern	spread throughout the body, head and arms
Weight/ML	Weight: 0.0030 ± 0.0005 g	Max. ML: 90 mm.

Discussion and Recommendations

Keys to the identification of cephalopods commonly found in the waters of Thailand based on their paralarvae are still not adequate (Jivaluk, 2001). Although in the past, many surveys and studies had been carried out, especially on the distribution and abundance of cephalopod paralarvae in Thai waters, many specimens could not be identified up to the species level. In 1995 and 1996, Jivaluk (2001) surveyed the Gulf of Thailand to determine the species, abundance and distribution of cephalopod paralarvae. Conducted in two periods, *i.e.* pre-monsoon in 1995 and post-monsoon of 1996, the survey collected samples using the oblique tow of bongo net. Specimens of the cephalopod paralarvae were identified to belong to 5 genera and 6 species, such as *Idiosepius* sp., *Sepiola trirostrata*, *Loligo* sp., *Abralia armata*, *Octopus* sp.1, and *Octopus* sp.2. Another survey on the distribution and abundance of cephalopod paralarvae in the Gulf of Thailand by Sukramongkol *et al*. (2013) from 14 March to 12 April 2013 using the M.V. SEAFDEC 2 collected samples that belong to only two families of cephalopods, *i.e.* Octopodidae and Enoploteuthidae. In addition, Thapthim (2002) reported that using the paralarvae of cephalopods collected from the South China Sea comprised 152 specimens classified into 20 species from 9 families. The most abundant were from the family Enoploteuthidae, Ommastrephidae, Octopodidae, Loliginidae, Cranchiidae, Sepiolidae, Octopodoteuthidae, Onychoteuthidae, and Gonatidae. Moreover, Sukramongkol *et al*. (2008) reported that cephalopod paralarvae were collected from the Bay of Bengal using the M.V. SEAFDEC from 6 November to 7 December 2008 using a pair of bongo net. The specimens were identified to belong to 13 families and 19 genera. Many of the specimens were found to belong to Family Ommastrephidae (41%) followed by Enoploteuthidae (14%) and Onychiteuthidae (6%).

Majority of individual species were identified as *Nototodarus hawiiensis* and *Abraliopsis* sp. Results from this case study could serve as reference in improving the means of identifying the species of cephalopods based on their paralarvae. Specifically, the chromatophores pattern, size and weight of hatching stage are the most important

characteristics that should be observed and recorded as these information could be used during species identification (Okutani, 1965: Kubodera, 1991). The findings of Watanabe *et al*. (1998) could also be referred to during species identification, especially during the hatching stage or paralarvae of the diamondback squid, where the dorsal mantle is 1.4-1.6 mm long and chromatophores are scattered over the body, numbering about 190-230 on the dorsal side and about 220-320 on the ventral side. Yamamoto (1988) also reported that during the hatching stage of the pygmy cuttlefish (*Idiosepius pygmaeus paradoxus* Ortmann), ML is 1.0 mm long and HL is also 1.0 mm. However, such measurements are almost the same as those of the sharp-tail pygmy squid (*Idiosepius pygmaeus*) paralarvae found in the waters of Thailand as recorded at the laboratory facilities of the Department of Marine Science of Kasetsart University. Therefore, more efforts should be made to compile other morphological characteristics in order that correct and effective identification of common cephalopod species could be carried out.

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