

Biology of Indian squid, *Loligo duvauceli* in Thailand\*ชีววิทยาของหมึกกล้วย *Loligo duvauceli* ในประเทศไทย

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## Abstract

In Thailand, one of the commercial marine animals is Indian squid, *Loligo duvauceli*. The objective of this report is to review a recent knowledge for commercial mariculture of Indian squid. Generally, this squid is widespread in the Gulf of Thailand, and is able to spawn annually. The average size of mantle length (ML) of spawners ranges from 4.3 to 10.0 cm, and external sex characteristic of squid can be observed on hectocotylyzed arm in male. In nature, sex ratio of male to female is 1:2. The fertilized female has average fecundity about 2,000 to 10,000 eggs. After fertilization female will deposit numerous egg capsules on suitable substrates in 5 to 7 days. For life span, the squid could persistently exist about one year with average growth rate about 0.4 mm ML per day and maximum ML was recorded approximately 400 mm ML. Regarding the feeding behavior, the squid is considered as carnivorous and selective feeder. In commercial culture aspect, the appropriate food for squid should be zoea stage of blue swimming crab, *Portunus pelagicus* and post larva of penaeid shrimps such as *Penaeus vannamei*.

**Key words:** biology, Indian Squid, *Loligo duvauceli*, Gulf of Thailand

## บทคัดย่อ

ในประเทศไทยหมึกกล้วย *Loligo duvauceli* เป็นสัตว์ทะเลที่มีความสำคัญทางเศรษฐกิจ ซึ่งวัตถุประสงค์ของบทความนี้เพื่อรวบรวมองค์ความรู้ในปัจจุบันที่เกี่ยวข้องกับการเพาะเลี้ยงหมึกกล้วยเชิงพาณิชย์ โดยทั่วไปหมึกกล้วยมีการกระจายกว้างในแหล่งอาศัยของพื้นที่อ่าวไทย และสามารถสืบพันธุ์ได้ตลอดทั้งปี ในด้านสัณฐานวิทยาขนาดเฉลี่ยของความยาวแมนเทิล (ML) ของพ่อแม่พันธุ์จะมีค่าอยู่ระหว่าง 4.3 ถึง 10.0 เซนติเมตร และลักษณะภายนอกที่บ่งบอกเพศสามารถสังเกตได้จากแขนพิเศษ (hectocotylyzed arm) ซึ่งพบเฉพาะเพศผู้เท่านั้น ในธรรมชาติอัตราส่วนเพศของหมึกกล้วยเพศผู้และเพศเมียเท่ากับ 1:2 หมึกกล้วยเพศเมียที่ได้รับการปฏิสนธิแล้วจะมีความตกไข่เฉลี่ย 2,000 ถึง 10,000 ฟอง หมึกกล้วยวางไข่โดยการติดฟองไข่ (egg capsules) บนพื้นผิวของวัสดุใต้น้ำหลังจากปฏิสนธิประมาณ 5 - 7 วัน หมึกกล้วยมีช่วงชีวิต (life span)

\* This paper is reviewing some biological support data for culture of Indian squid in Thailand

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ประมาณ 1 ปี และมีค่าเฉลี่ยอัตราการเติบโตอยู่ที่ 0.4 มม. ของความยาวแมนเทิลต่อวัน และหมึกกล้วยขนาดใหญ่ที่สุดที่มีบันทึกไว้คือประมาณ 400 มม. ของความยาวแมนเทิล พฤติกรรมการกินอาหารของหมึกกล้วยพิจารณาได้ว่าเป็นพวกกินเนื้อเป็นอาหารหลัก (carnivorous) และเป็นพวกกินอาหารที่เฉพาะเจาะจง (selective feeder) ในเชิงพาณิชย์อาหารที่ประสบความสำเร็จในการเพาะเลี้ยงหมึกกล้วยเชิงพาณิชย์คือ ตัวอ่อนของปูม้า (*Portunus pelagicus*) ในระยะ zoea และตัวอ่อนระยะ post larva ของกุ้งทะเลในกลุ่ม penaeid shrimp เช่น กุ้งขาว (*Penaeus vannamei*) เป็นต้น

**คำสำคัญ:** ชีววิทยา หมึกกล้วย *Loligo duvauceli* อ่าวไทย

## Introduction

Indian squid, *Loligo duvauceli*, is one of a high value marine fishery resource of the world. Cephalopod catches of all country from 1990 – 1999 was averaged 2,200,000 ton (Karnik et al., 2003). In Thailand, Indian squid is a commercial important resource and export goods to worldwide (Roongratri, 1989; Supongpan and Natsukari, 1996; Karnik and Chakraborty, 2001; Sukramongkol et al., 2006). This squid is distributed in Indo-Pacific Region and in Thailand this squid is found in both the Gulf of Thailand and Andaman Sea (Supongpan and Sinoda, 1995; Sukramongkol et al., 2006). The demand of Indian squid for food consumptions are large so that it is brought to the squid aquaculture. Biological data of squid such as life history, feeding habit and reproductive biology, are necessary for a commercial culture. The purpose of this report is reviewing some biological data for culture of Indian squid in Thailand.

## Life history

Growth parameter calculated by using the von Bertalanffy growth model, the differences in squid size between two populations is:

$$L_t - (L_{t-\Delta t}) = L_\infty \exp(-K(t + t_0)) (\exp(K \Delta t) - 1)$$

$L_t$  and  $L_{t-\Delta t}$  are the squid lengths of two groups,  $\Delta t$  is the time interval of interspawning,  $K$  and  $t_0$  are the constants of the von Bertalanffy growth equation, and  $L_\infty$  is the maximum attainable size. Supongpan and Sinoda (1995) reported that the time from birth to maturation was 4 months, the growth parameters  $K$  were estimated at 0.083 per month for male and 0.095 per month for female in the population of the Gulf of Thailand. The life span of squid could persistently exist about one year with average growth rate about 0.4 mm ML per day and the largest size was recorded about 400 mm ML.

An alternative method for age and growth determination is using statolith increments showed that  $ML_t = 1.56e^{1.64t^{0.180}}$  in male and  $ML_t = 1.56e^{1.35t^{0.209}}$  in female ( $ML_t$  is a mantle length in mm and  $t$  is a number of growth increments defined as age in day). The relationship between  $ML_t$  and  $t$  varies between male and female. Growth rate of male is higher than

female. Life span after post hatch is about 1 year or less and growth function of this species is double exponential. The growth of the squid is fast in early life but slower in later stage (Supongpan and Natsukari, 1996).

In india water, Karnik et al. (2003) reported that the maximum ML of Indian squid from Mumbai was about 323 mm, growth coefficient is 0.449 per year. Whereas the specimens from Mangalore had a maximum ML of approximately 343 mm and growth coefficient of 1.43 per year. The female squid grows at a faster rate than male but the size of male is larger than female.

The length-weight relationship of the squid calculated from the population data in the Gulf of Thailand is expressed as  $w = 0.005L^{1.902}$  for male and  $w = 0.0007L^{2.369}$  for female (Roongratri, 1989). In accordance with the data from Mumbai, west cost of India, the length-weight relationship of female squid is  $w = 0.001L^{2.2819}$  and male squid is  $w = 0.002L^{2.1617}$  (Karnik and Chakraborty, 2001) while the data from southern coast of Karnataka, India, the length-weight relationship of male and female squid are  $w = 0.005L^{1.942}$  and  $w = 0.001L^{2.242}$  respectively (Abdurahiman et al., 2004). The growth pattern of this squid supports the theory that the growth is allometric (Karnik and Chakraborty, 2001).

The body weight and ML relationships of this squid are calculated from the population of the Andaman Sea, Thailand. The result shows that  $BW = 0.008ML^{1.79}$  ( $n = 204$ , 41–224 mm in ML) for male and  $BW = 0.0007ML^{2.39}$  ( $n = 166$ , 42–186 mm in ML) for female. Age determination of this squid estimates from counting the statolith increments. The relationship between ML and age ( $t$ , day) is expressed as  $ML = 39.5e^{0.0113t}$  ( $n = 186$ ) for male and  $ML = 36.1e^{0.0111t}$  ( $n = 143$ ) for female. The population of the Andaman Sea, the young squids aged 40 – 60 days are mainly found in August. While the large female squid aged 160–170 days are found mainly in April (Sukramongkol et al., 2006).

### Reproductive biology

In nature, sex ratio of male to female for squid is 1:2. Spawning season of Indian squid in Thailand is found throughout the year. However, two peaks spawning occur in two ranges, March – May and August – October. For morphology, the average size of ML at first maturation is approximately 4.3 cm and 10.0 cm in spawner male and female respectively. The average fecundity of spawner female is about 2,000 (recorded from 9 cm female size) to 10,000 eggs (22 cm female size). The Indian squid is partial spawner because the ovary contains various development stage of eggs (Roongratri, 1989). Others *Loligo* may lay eggs about 4 times during spawning season (Giese and Pearse, 1977). Sex external characteristic of squid can be observed, from “hectocotyized arm”, a modified arm of the male squid

(Nabhitabhata, 1983). Two pairs sucking disc in 4th left arm are reduced and transformed to this organ. Hectocotylized arm is used to transfer spermatophore to sperm receptacle of female (Fields, 1965 followed Nabhitabhata, 1983). Once the female agrees to mate, color skin will change rapidly and the male will reply colorful later. The mating behavior begins when the male swims above his mate and it grasps her arms from above. Fertilization begins in a head-to-head position, after 2 – 5 seconds the pair is separated. Mating behavior occurs several time a day, but mostly at night under the moonlight (Nabhitabhata and Kbinrum, 1975; Nabhitabhata, 1983; Nabhitabhata, 1995). It takes only a week for squid to develop from fertilization to hatching. Before hatching, it examines various places for fastening the egg string (Nabhitabhata, 1995).

### Feeding habit

Similar to other cephalopods, Indian squid is a carnivore. It mainly feeds on some fish and marine invertebrates such as crustaceans, mysids, euphausiids, ostracods and squids. Crustaceans declined as the increase of the size of squid. Cannibalism is found in the squid larger than 80 mm (Kore and Joshi, 1975; Sottiyothin and Kulabtong, 2011; Preecha et al., 2011). In culture system, the squid paralarva feeds on living crustacean with an appropriate age. If the food is inappropriate for the paralarva, it might be starved and turned to cannibalism in some groups. In Thailand, brine shrimp (*Artemia* spp.) is the most popular live feed for nursing of economic marine culture, the multinutrition of squid paralarva leads to low survival and growth rate (Vorathep et al., 1993). Nabhitabhata (1978) reported that mysid shrimps, *Mesopodopsis* spp. were appropriate feed for small scale culture of squids. The main problem of rearing paralarva for commercial culture is the dietary. In commercial culture aspect, the appropriate food for squid should be addressed in order to the success in massive production. Zoea of the blue swimming crab, *Portunus pelagicus* and post larva of penaeid shrimps such as *Penaeus vannamei* were recommended as proper animal food (Nabhitabhata et al., 1992).

### Note on culture technique

The recommended size of the squid spawner tank is 8 ton. Sex ratio of male to female loading in the tank should be 1:2. In spawning season, mature female will deposit egg capsules on substrate at the bottom of the tank after fertilization 5 days. Each egg capsule contains about 250 eggs. After breeding the female squid lays the egg capsules which is transparent and soon die. Capsule size is 5 x 8 cm (the eggs size is 1.12 x 1.35 mm and is sphere). It hatches to paralarva in 8 – 10 day (Wudthisin and Singhagraiwan, 1988). Paralarva

feeds on larvae of penaeid shrimps such as *Penaeus monodon* or *P. vannamei*. Squid feeding is a key to the success of mass production of the squid paralarva. Fortunately squid food (*P. vannamei* postlarva) has a low unit cost. The adult squid can be trained to consume fish meat or trash fish (Nabhitabhata et al., 1992). The pellet feed is an inappropriate food for juvenile and adult because it leads to low survival rate (Sangpradub et al., 1984).

## Conclusion

Indian squid takes about 4 months from birth to maturation and Life span is about one year or less. Age and growth determination using statolith increments showed that  $ML_t = 1.56e^{1.64t^{0.180}}$  and  $ML_t = 1.56e^{1.35t^{0.209}}$  and the length weight relationship is  $w = 0.005L^{1.902}$  and  $w = 0.0007L^{2.369}$  in male and female respectively. Sex ratio of male to female is 1:2. Breeding season occurs two peaks per year (March – May and August – October). ML at first maturation is 4.3 cm and 10.0 cm in male and female respectively. Culture larvae of *Penaeus vannamei* as food of squid larvae is a key to success for mass production of squid paralarva and adult squid can be trained to consume trash fish.

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