

## 論文内容の要旨

農学国際専攻

平成 17 年度博士課程入学

氏 名 Md. Sherazul Islam

(モハマド シェラズル イスラム)

指導教員名 黒 倉 壽

論文題目 Study on the fisheries biology of mud crab (*Scylla* spp.) in Pak  
Phanang mangrove swamps, Thailand, with emphasis on age estimation

(タイ国パックパナン湾のマングローブ域におけるノコギリガザミ属 (*Scylla* spp.)  
の漁業生物学的研究：カニ類の年齢推定)

### Abstract

Mud crabs of the genus *Scylla* are commercially important and conspicuous crustaceans, being traditionally exploited by artisanal fishermen, provide basic source of income for coastal fishing communities throughout the Indo-Pacific region including Thailand. Although, globally the mud crab production increased by approximately 10% per year, in specific region or country productions have decreased particularly in Asian countries. In Thailand, yield of mud crab catch started to fall down from 1994 and have fallen dramatically since 2000. On the other hand, the exploitation of mud crab fishery is an unregulated fishery throughout the Indo-Pacific region. In most Southeast Asian

countries, there is no existence of regulation and varying levels of over-fishing have been reported with resulting decreases in both size and abundance of mud crabs in many fisheries.

Thus management of mud crab fishery in Asian countries is becoming the key issue. For the management of mud crab fishery or any other such open water common access resources, the information on resources such as species composition, production etc., fishery biology such as maturation, breeding, recruitments, age-structure etc., and life history such as life span and age at maturity are fundamental. In case of mud crab fishery in Asian region including Thailand, despite their abundance and economic importance, all above mentioned information are lacking particularly on age-structure. Thus in accordance with the above concepts, the present study was conducted to provide basic information on production and biological traits of mud crab (*Scylla* spp.) at Pak Phanang mangrove swamps in Thailand, by examining the reproduction, age and seasonality to establish effective management of these valuable resources.

Pak Phanang Bay is located in Nakhon Si Thammarat province in the southeastern part of Thailand covering an area of 126,000 ha. The eastern side of the bay is largely occupied by mangrove forest (approximately 9,000 ha) and an extensive mudflat (1-3 km wide) emerges at low tide. The present study was conducted in the eastern mangroves covering 7,000 ha, 82% of the total Pak Phanang district mangroves. There are three distinct seasons: hot-dry season (February-May), rainy season (June-September) and the highest rainfall period of monsoon season (October-January) with water temperature

ranging 25-36° C. Average rainfall ranged about 2000-3000 mm and salinity highly fluctuated between 1-25 ppt due to the freshwater flushing from Pak Phanang river.

Crab fishing is conducted throughout the year in mangrove channels as well as associated channels connected to the Bay. In the present study, survey was focused on two trifling communities within the mangrove. Mud crab samples were taken seven times during June 2006 to January 2008 from middle traders in the locality. At the same time of crab collection, a semi-closed questionnaire survey was done in three levels; crab fishers in the fishing ground, fishers in household and local leaders. Several group discussions were also arranged among the fishers as well as local leaders to gather more accurate data on the mud crab fisheries and life cycle of the species.

At the beginning, the research was concentrated on the mud crab fishing activities, species composition, seasonal availability, distributions and importance of mud crab fishery at Pak Phanang mangroves swamps. Mud crab fishery had significant impacts on livelihoods of local communities. There were 95% villagers engaged in fishing and more than 70% of them were crab fishers generating about 70% of household income in both communities. Although 100% crab fishers used crab traps, only 20% were exclusively limited with crab traps while others were involved with other fishing activities.

Among the three mud crab species reported in Thailand, *Scylla olivacea* and *S.*

*paramamosain* are believed to be the most common and commercially important species. In the present study, *Scylla olivacea*, *S. paramamosain* and *S. serrata* were recorded composing 49%, 38% and 13% of specimens, respectively. Samples ranged 50-130 mm in internal carapace width (ICW) and 25-490 g in body weight. However, the highest mode composed by the size class of 70-80 mm ICW whereas it was at the size class of 90-100 mm ICW during 1991. This signifies the lower population size in the present study and hence over exploitation of mud crab resource. *Scylla olivacea* were abundant in monsoon season and associated mostly with mangroves while *S. paramamosain* were abundant during dry season and distributed mostly in inter-tidal or bay area. Size-frequency distribution showed that recruitment of both species occurred throughout the sampling period with peak during monsoon season. The third and minor species, *S. serrata* was found in each sampling time in low percentage. The estimated total annual catch and value ranges of mud crabs were 94-156 tons and US\$ 281,000-468,000 respectively with productivity of 13-22 kg/ha of mangroves. This contributed about 42% of total fisheries catch in Pak Phanang mangroves.

In the next step, the reproductive traits and size at sexual maturity of the male and female of two abundant mud crabs, *Scylla olivacea* and *S. paramamosain*, were investigated. Sex ratio of *S. olivacea* and *S. paramamosain* were 1: 0.94 and 1: 0.77, respectively. For male, gonad development was determined based on histological appearance that was classified into three stages: 1) Immature (Spermatogonia), 2) Maturing (Spermatocytes), and 3) Mature (Spermatids & Spermatozoa). In female,

ovarian development was determined based on both morphological and histological appearance that were classified into five stages: proliferation (immature), previtellogenesis (developing), primary vitellogenesis (early maturation), secondary vitellogenesis (late-maturing) and maturation. Among the male sample population, the highest 49% and 78% were under gonad development stage I, whereas mature stage III were only 25% and 12% in *S. olivacea* and *S. paramamosain* respectively. Among the female sample population, the highest 60% was under stage I in both species and lowest (3%) was in stage III for *S. olivacea* and in stage IV for *S. paramamosain*.

The sexual maturity in both sexes was estimated by morphological and histological observation to reveal the size at first maturity and the size at which 50% individuals attain maturity. In male crabs, the proportional secondary sexual allometric increments and in female, abdominal characteristics were further incorporated in maturity estimation. The mean size at first sexual maturity and 50% maturation were 87 mm and 103 mm ICW for male *S. olivacea* whereas 96 mm and 109 mm ICW for *S. paramamosain*. In case of female, these values were 88 and 104 mm ICW and 95 and 110 mm ICW in *S. olivacea* and *S. paramamosain* respectively. The mean maturity size revealed that 75% of *S. olivacea* and 88% of *S. paramamosain* male individuals were immature. On the other hand, in female, it was observed that about 80% individuals were immature in both species. The histological observations exposed that gonad development patterns and maturity stages were essentially similar between two species. First sexual maturity and the size at 50% maturation revealed that in both sexes *S. paramamosain*

attain a larger mean size at maturity than *S. olivacea* by as much as 6 to 10 mm ICW.

Regarding the breeding pattern, histological examination showed that in males mature gonad of *S. olivacea* and *S. paramamosain* and their testes were functional in breeding in every month of sampling. These results demonstrate that males in two species, breeding occurred continuously throughout the year, though there were inconspicuous peak observed in May for the species of *S. olivacea*. The existence of vitellogenesis ovary development stage and gonadosomatic index in all sampling months suggested that female of both species are also continuous breeder with peak in rainy season for *S. olivacea* and dry season for *S. paramamosain*.

The information on wild mud crab age-structure is very rare due to difficulties in age determination in crustaceans because of high variability in growth rates and molting frequencies. It is also impossible to use permanent hard body parts as growth indicator, which is frequently used in other animals, because of the crustacean's molting properties. Recently scientists introduced a new technology "histological lipofuscin quantification" for the age determination of crustacean and have found promising results. This method is depending on the hypothesis that the concentration of lipofuscin in the nerve cell mass in crustacean brain increase with the life-span of that individuals. For the first time, with the concept of above method, the age structure of wild mud crab (*Scylla olivacea* and *S. paramamosain*) was explored using autofluorescent age pigment, "lipofuscin". From the collected samples, sample in May, 2007 were further used for the

age estimation. The carapace width-frequency distribution did not show any distinct modes of the sample population in both species. Lipofuscin concentration in the olfactory lobe cell mass (OLCM) of the brain was measured using image analysis of fluorescent micrographs and its concentration showed positive correlation with carapace width in both species.

The lipofuscin concentration (% of area fraction) ranged from 0.06 to 0.28 with the formation of three modes in both species. The species *S. paramamosain* showed higher accumulation of lipofuscin in each mode rather than *S. olivacea*. Strong correlation was found between lipofuscin concentration and mode numbers observed in the lipofuscin concentration histogram ( $R^2 = 0.99$ ) and when modes were considered as distinct ages, the lipofuscin accumulation rate showed almost constant (0.07% in *S. olivacea* and 0.08% of area fraction in *S. paramamosain*) in each year. Although existence of wide size ranged population in a lipofuscin concentration mode, the analysis suggested that both species live in the mangrove ecosystem at best of 2<sup>+</sup> year class. In age estimation of maturity, male and females crabs showed different maturity age between two species. Most of the *S. olivacea* started maturity at the age group of 1<sup>+</sup> whereas at that period, *S. paramamosain* first started maturity but most individuals were matured at the age group of 2<sup>+</sup> year-classes. This result indicates that two species probably attain maturity at different ages.

In the last part, it is discussed the current status of mud crab fishery, associated

problems, and the findings in previous chapters for the development of better management strategy of mud crab fishery at Pak Phanang mangrove swamps. It was realized that the regulation of mud crab fishery should be species-specific as both species mature at different size and their availability also differed in different season. The regulation also should be area-specific as species composition and their maturity size differed in different places even within the same country. However, it is better to generalize management policy for both species as ease and affordable to fishermen who in fact can play a vital role for the management of mud crab resource. The limitation on two crab fishing gears (channel net and hand capture) are recommended as they are catching > 95% immature crab and limitation on close seasons between April-May and October-November are also recommended for sustainable management of the fishery.

Finally, it can be concluded that although crab catch and its size are decreasing, mud crab fishery is still the major source of livelihoods welfare to the poorest sections of the society. But unfortunately, the fishery is exploited in most unregulated ways and hence the future is questionable. To sustain the resources and the fishers itself in the study area, the proposed management strategies should be considered. In addition, fisher's awareness need to be raised as they are catching about 85% immature crabs which have no chance to enter in reproductive cycle, and this is alarming for the re-generation of these lucrative natural gifts.