REPRODUCTIVE BIOLOGY OF FEMALE INDO- PACIFIC KING MACKEREL, *SCOMBEROMORUS GUTTATUS* (BLOCH& SCHNEIDER, 1801) FROM KYAUKPHYU ENVIRONS, RAKHINE STATE

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Abstract

In this study, a total of 240 samples were collected and dissected, from Kyaukphyu Market during the study period from February 2016 to January 2017. Identification was followed after Fisher and Whitehead (1974) and FAO (1984).The gonads were extracted from the specimens. Total body length, standard length, body weight and gonad weight were recorded and preserved in neutral buffer for further histological examination and to analyze the Gonosomatic indices (GSI).The GSI value of female is the highest (4.23± 3.12) in August and the lowest is (1.16 ± 0.06) in June. According to GSI value and based on its histological characteristics, four stages of cyclical changes i.e. maturity in March and July, spawning in April and August, , post spawning in May, September and October, resting in November, December, January, February and June were found in studied species. The breeding season of Spanish mackerel were two peaks in a year such as pre-monsoon and post-monsoon.

Keywords: Gonosomatic indices (GSI), histological examination, breeding

Introduction

Indo – Pacific king mackerel, it is also known as seer fish. *Scromberomorus guttatus* was one of the number of different species of pelagic fish. It belongs to the family Scrombridae. These fishes are found in both temperate and tropical sea, mostly inhabiting along the coast or offshore in the oceanic environment. Its sides are silvery white with several longitudinal rows of round dark brownish spots scattered in about 3 irregular

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rows along lateral line. There are over 30 different species of mackerel, of these, 21 species were Spanish mackerel in the world. (FAO, 2003). Seer fishes are considered as one of the high value resources due to high economic return and export markets (Muthiah,2002). Among the five species of seer fishes the king seer fish, *Scomberomorus commerson* and Spotted seer fish, *Scromberomorus guttatus* are commonly caught in the Myanmar coasts.

Myanmar has three coastal regions with a long coastline of nearly 3,000 km. It possesses a considerable diversity of coastal habitats (FAO, 2003). In addition, fisheries in Myanmar plays an important role in the development of a nation of considerable economic value, especially in the coastal fisheries (FAO, 2003). The mackerel species are found in the marine water. Those species are economically important in Rakhine State studied. Mackerel inhabit marine, mostly living along the coast or offshore in the oceanic environment. Knowledge on reproductive biology is essential not only for the benefit in life history and stock management but also for evaluating the potential in successful culture (Rahman *et al*, 2006). Spawning periods differ with different species of fish and environmental conditions (Thant Zin, 1988).

The reproductive cycle must ensure a sufficient quantity of mature egg cells, which is possible only within the regular process of the oogenesis. The oogenesis is a very dynamic process in the ovaries, in which the oocyte passes through various phases of development that are very similar in different fish species. The fish oocyte development can be divided into oocyte growth and oocyte maturation. Vitellogenesis plays an important role in the oocyte growth. (Nagahama *et al*., 1983, Yueh and Chang 2000).

This study was thus undertaken with the following objectives:

(1) To determine the annual reproductive cycle of Gonosomatic Index (GSI) and maturity stages of *S. guttatus*

(2) To find out the morphological and histological development of ovaries of *S. guttatus*

Materials and Methods

Study area and study periods

The study area was coastal area of Kyaukphyu environs, Rakhine State between 18° 30'- 20° 35' N and 93° 20' - 94° 22' E was selected as study site and the study periods lasted from February 2016 to Feb 2017(Fig., 1)

Collection of specimen and data

The specimens were collected monthly from the catches from Kyaukphyu Market. These were measured Total length (TL), standard length (SL), body weight (BW) and gonad weight (GW) and liver weight (LW) to the nearest millimeter. The photograph of mackerels were taken. The specimens were dissected and the gonads are extracted. And then gonads were blotted dry, weighed and preserved in neutral buffered formalin, for further histological examination (Fig 2)

Identification and classification

These species were identified based on Fischer and Whitehead (1974), and FAO (1984).

Analysis of Gonosomatic Index (GSI) Agarwal (1996)

Conditions of ovaries were checked monthly and recorded. This process was conducted in order to estimate the peak periods and decline of the breeding conditions.

The Gonosomatic Index is an indicator of the breeding pattern of fish and Gonosomatic Index (GSI) was calculated as follow:

$$GSI = \frac{\text{Gonad weight}}{\text{Whole body weight}} \text{ x } 100\%$$

Histological study of gonads

Monthly histological examinations of gonads (ovaries) were taken into consideration to determine the spawning season. The gonads (ovaries) were preserved in neutral buffered formalin for further histological examination. Gonads samples (ovaries) were taken from anterior, middle and posterior region for further sectioning and staining. Double staining method was used according to Harris's Haematoxylin and eosin methods (1977). The stages of oocyte were identified according to Agarwal (1996), Htun Han (1978) and Kitsawat, Chinabut and Limsuwan (1991).

The sectioned ovaries were observed under the image analyzer microscope. Six stages of oogenesis were defined as oogonia (stage I), primary oocyte (stage II), secondary oocyte (stage III), primary vitellogenesis (stage IV), secondary vitellogenesis (stage V), tertiary vitellogenesis (stage VI) were recorded by utilizing image analyzer microscope to the nearest micro millimeter (μmm). Reproductive cyclical changes of species were recorded based on the cell morphology and histological examination.

Figure 1. Map of the study site

Results

Systematic position

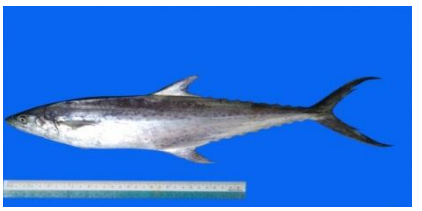
Kingdom - Animalia
Phylum - Chordata
Subphylum - Vertebrata
Class - Actinopterygii
Order - Perciformes
Suborder - Scombroidei
Family - Scombridae
Genus - *Scomberomorus*
Species -*S. guttatus*
Common name- Indo-Pacific king mackeral or Indo-Pacific Spanish mackerel
Local name - Nga – Kun- Shut

External features of *Scromberomorus guttatus*

Mackerels **a**re swift-moving, streamlined body and sport fishes mostly found in temperate and tropical seas around the world, allied to tunas in the family Scombridae (order Perciformes). Mackerels are rounded and torpedo-shaped, with a slender, keeled tail base, a forked tail, and a row of small finlets behind the dorsal and anal fins. They are carnivorous fishes and feed on crustaceans, mollusks, fish eggs, and small fish. They congregate in schools and swim actively in the upper 25–30 fathoms of the water in the warmer months and then descend to as deep as 100 fathoms during the winter. They spawn during the spring and early summer along coastlines.

Morphological characters of ovaries of *Scromberomorus guttatus*

The ovaries of *S. guttatus* were paired and not too elongated. The ovaries are generally equal in length but sometimes one may be longer than the other. The weight, length, width and color of the ovaries vary greatly with the stages of their maturity. In early stage, they were opaque giving pale pink to yellowish coloration. The colour of the ovaries changed brightly yellowish when they reached the maturing stage. During breeding season, the ovaries were much larger and almost occupying the major portion of the body cavity and changed the pale yellowish color.



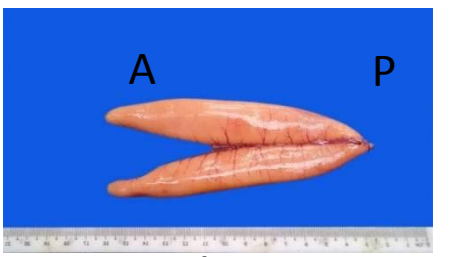
External feature of *S. guttatus*

Weighing of ovaries

Variations sizes of *S. guttatus of the samples*

Plate 1. External feature, weight of ovary and different sizes of *Scromberomorus guttatus*

A. Size of Immature ovaries



B. Size of Mature ovaries

C. Size of Ripe ovaries

D. Size of Spent ovaries

Plate 2. Macroscopic developmental stages of female reproductive organ of *Scomberomorus guttatus*
A = Anterior part, P = Posterior part

Histological study

Oogonesis of *Scromberomorus guttatus*

There were six stages of oogenesis in female *Scromberomorus guttatus*

Oogonia (Stage 1)

Perinucleolar oocytes dominant. Yolk nucleus in cytoplasm, nucleolus was found in the periphery of nuclear membrane. The oogonia of *Scromberomorus guttatus* were rectangular shape.

Primary oocyte (Stage II)

Cortical alveoli stage oocyte appeared containing cortical alveoli and yolk granules in cytoplasm. The number of nucleoli increased and was visible on the surface of the nucleus. The size of nucleus and cytoplasm were bigger than stage I.

Secondary oocyte (Stage III)

Large vitellogenic oocyte dominant containing well developed zona radiata and yolk globule. The size of nucleus and cytoplasm were increased.

Primary vitellogenesis (Stage IV)

The production and accumulation of the yolk began. This process was known as vitellogenesis. Mature follicles showing germinal vesicle migration and yolk granules in cytoplasm were found. At this stage, the nucleus enlarges and the nuclear membrane become irregular. During this stage the nucleus and cytoplasm continued to grow in these species.

Secondary vitellogenesis (Stage V)

The size and number of vacuoles were gradually increased in the peripheral and central zone of the oocyte. The whole cytoplasm was densely filled with vacuoles. In this stage, the nuclear membrane disintegrated.

Tertiary vitellogenesis (Stage VI)

Final stage of vitellogenesis, yolk vesicles were initially accumulated in the periphery of the oocyte. During this stage, the chorion started to form

around the oocyte (vitelline membrane and follicular cells). Both the oocytes and follicular cells had microvilli in their apical surfaces. The chronics materials were deposited around these microvilli and became perforated by pore channels. The size of the cells was largest.

Seasonal cyclicity

Monthly variation of Gonadosomatic index of female *S. guttatus* was recorded as shown in Table 1 (below). Based on the data recorded from GSI, four stages of cyclical changes (maturing in March and July) spawning in (April and August), postspawning in (May, September and October), resting in (November to February and June) were found in *Scromberomorus guttatus* (Table 2).

Table 1. Monthly variation of Gonadosomatic index of female *S. guttatus*

Months	GSI%
February	1.17± 0.03
March	1.23± 0.12
April	3.58 ± 2.10
May	2.21 ± 0.08
June	1.16 ± 0.06
July	1.56± 0.91
August	4.23± 3.12
September	2.47± 0.64
October	1.31± 0.33
November	1.21± 0.11
December	1.22± 0.06
January	1.23± 0.04

Gonadosomatic index(GSI) female

The GSI value of female was the highest (4.23± 3.12) in August and second highest (3.58± 2.10) in April and the lowest GSI value was recorded (1.16 ± 0.06) in June.

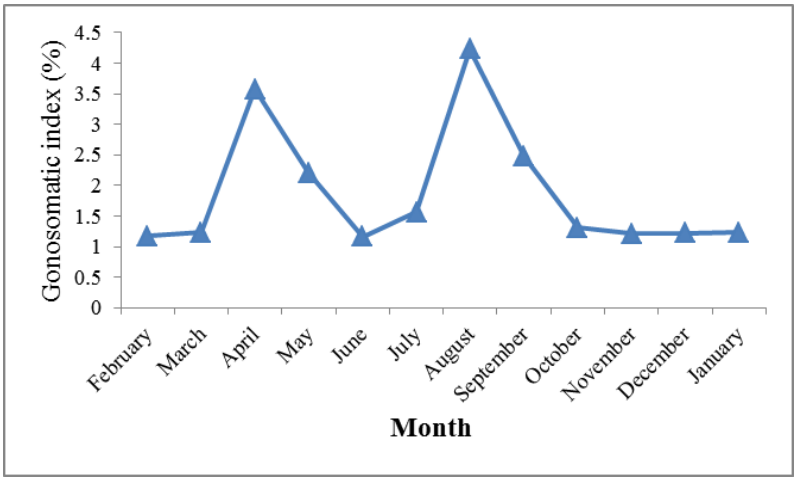
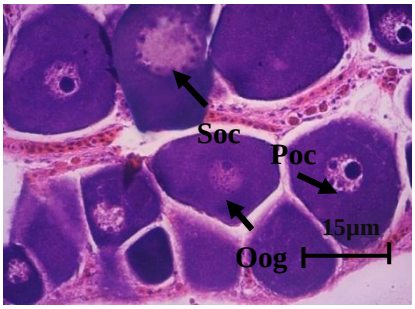


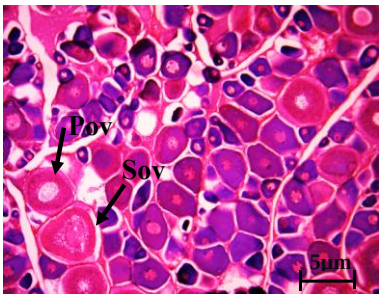
Figure 2. Monthly GSI of female *Scromberomorus guttatus*

Table 2. Annual reproduction cycle of *S.guttatus*

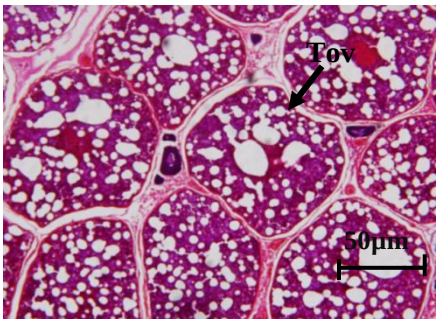
Months	**Stages**
February	Resting
March	Maturing
April	**Spawning**
May	Post spawning
June	Resting
July	Maturing
August	**Spawning**
September	Post spawning
October	Post spawning
November	Resting
December	Resting
Jan	Resting



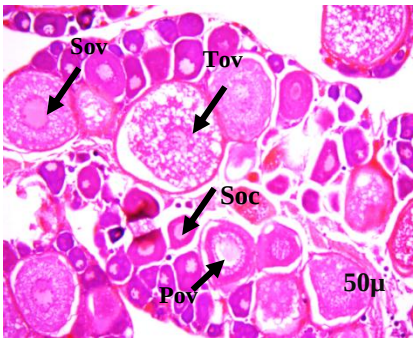
A. Immature stage



B. Mature stage

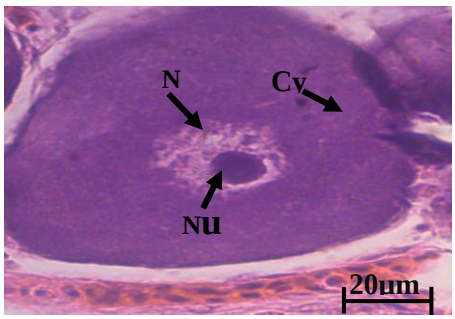


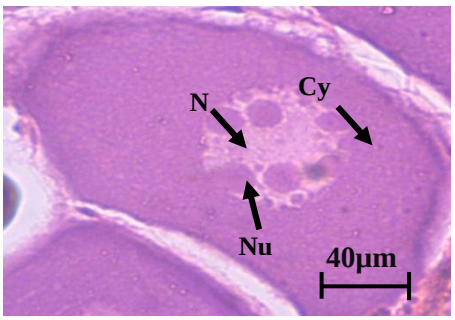
C. Ripe stage



D. Spent stage

Plate 3. Microscopic gonadal maturation stages in female *S.guttatus*; Oog(oogonia), Soc (secondary oocyte), Poc (primary oocyte), Pov (primary vitellogenesis), Sov (secondary vitellogenesis) and Tov (tertiary vitellogenesis)





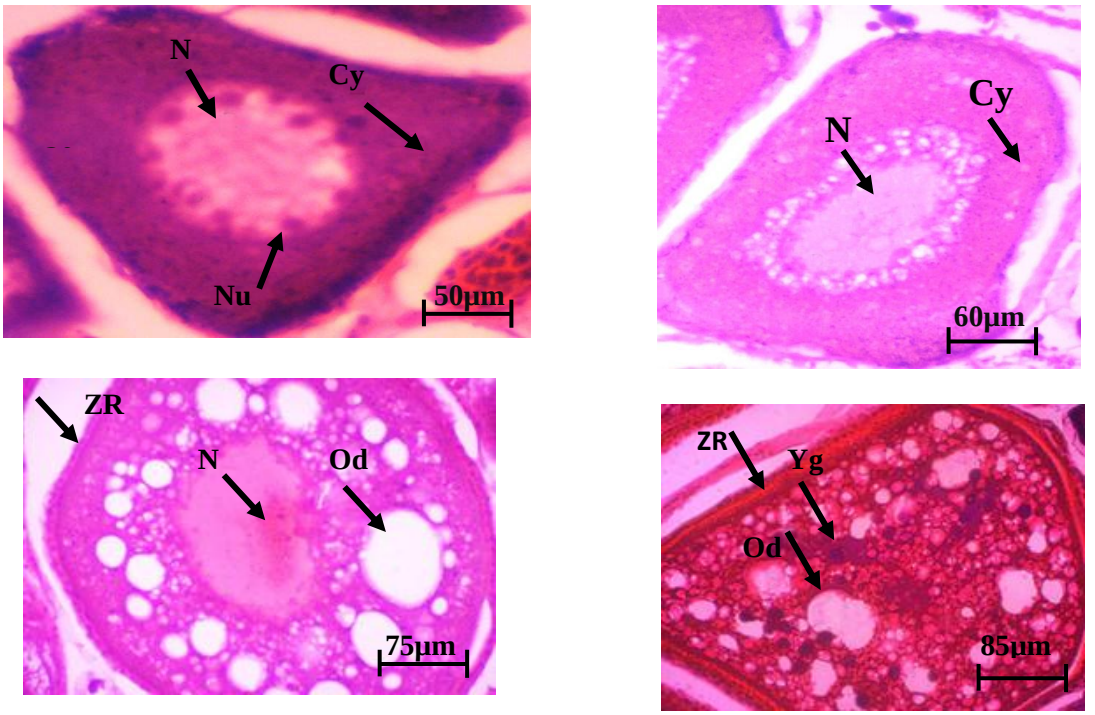


Plate 4. Microscopic gonadal maturation section, stages in female *S.guttatus*; transverse Cy (Cytoplasm), N (Nucleus), Nu (Nucleolus), Zr (Zona radia), Od (Oil droplets) and Yg (Yolk granule)

Discussion

In the present study, Reproductive biology of female Indo-Pacific king mackerel, *Scomberomorus guttatus* were undertaken in Kyaukphyu during the study period from Feb2016 to Jan 2017.The spawning season of *Scomberomorus guttatus* began April to May and June Krishnamoorthi. B. (1958).During nonbreeding season the gonads were small in size and hence a great difference in the ratio of gonad weight to body weight resulted in very low GSI value.

Ovarian development and spawning period of *S. brasiliensis* were investigated using both macroscopic and histological techniques. Mean monthly value of GSI and ovarian maturation indicated that the main spawning period occurs during the rainy season stated by Chellappa *et al.*, Reproductive peak of *Scomberomorus commerson* was occurred in October and November in QueeDBland east coast waters stated that G.R. McPHERSON (1993). Histological study of ovaries of *Alosa fallax fallax* was delineated a total of eight developmental stages recorded by Thresa pina,et.al. (2003). Oogenesis stages of *Rastrelliger brachysoma* was total of seven stages. In the present study, there were six stages of oogenesis was found and recorded.

Spanish mackerels were multiple spawners with asynchronous oocyte development and indeterminate fecundity. They spawn in the Chesapeake Bay area from June through August, June being the peak spawning month. (Cynthia L. Cooksey, 1996).She recorded that females spanish mackeral do not spawn after August, because all females were in either spent or resting stages in September, October and December. In this study, the GSI value showed highest in April and August Similar conditions were also reported by Kalayar Win Maung, 2007.She has recorded the peak of the spawning season for *Tenualosa ilisha* was May and Ocober, *Tenualosa toil* was recorded in April and October. It could be assumed that they breed twice a year in study areas. According to GSI values, breeding season of mackerel species showed two peaks in a year. During the study period, the months of November, December, January and February were found and recorded as the resting stages.

Acknowledgements

My great thankful goes to Dr. Thida Lay Thwe, Professor and Head of Zoology Department, University of Yangon, for her encouragement and permission to conduct this research.

Special thanks is expressed to, Professor Dr. Aye Mi San, Department of Zoology, University of Yangon, for her suggestion and valuable advice.

My sincerely gratitude is referred to Dr. Kalayar Win Maung, Lecturer, University of Yangon, who stood by my side and gave me full support and encouragement throughout my study periods.

Moreover, Co-supervisor Dr. Sandar Win, Associate professor, Zoology Department, University of Yangon, is the person who gets my heartfelt thank for her supervision, encouragement throughout the research work.

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