



**Establishment and Operation of a Regional System of  
Fisheries *Refugia* in the South China Sea and Gulf of Thailand**

**REPORT**

**THE STUDY CASE OF SHORT MACKEREL (*Rastrelliger Brachysoma*)'S GONAD AND  
SPERM DEVELOPMENT IN KOH KONG PROVINCE, CAMBODIA**

**KOH KONG, CAMBODIA  
FEBRUARY 2019-MARCH 2020**

Prepared by  
**FISHERIES ADMINISTRATION, CAMBODIA**

---

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER  
TRAINING DEPARTMENT



First published in Phrasamutchedi, Samut Prakan, Thailand in June 2020 by the SEAFDEC-UNEP-GEF Fisheries Refugia Project, Training Department of the Southeast Asian Fisheries Development Center

Copyright © 2020, SEAFDEC-UNEP-GEF Fisheries *Refugia* Project

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder provided acknowledgement of the source is made. The SEAFDEC-UNEP-GEF Fisheries *Refugia* Project would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or for any other commercial purpose without prior permission in writing from the SEAFDEC Secretary-General at.

Southeast Asian Fisheries Development Center  
Training Department  
P.O.Box 97, Phrasamutchedi, Samut Prakan, Thailand  
Tel: (66) 2 425 6100  
Fax: (66) 2 425 6110  
<https://fisheries-refugia.org> and  
<https://seafdec.or.th>

**DISCLAIMER:**

The contents of this report do not necessarily reflect the views and policies of the Southeast Asian Fisheries Development Center, the United Nations Environment Programme, and the Global Environment Facility.

For citation purposes this document may be cited as:

FIA/Cambodia. 2020. Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand, Report of The Study Case of Short Mackerel (*Rastrelliger Brachysoma*)'s Gonad and Sperm Development in Koh Kong Province, Cambodia. Southeast Asian Fisheries Development Center, Training Department, Samut Prakan, Thailand; FR/REP/CAM67, 11 p.

## 1. INTRODUCTION

Short mackerel (*Rastrelliger brachysoma*, Bleeker, 1851) is the specie of small pelagic fish distributing in Southeast Asian countries, supporting food security, and contributing about 38% of total fish production to the region (SEAFDEC/Sweden Project, 2019). The commercial pelagic fish is preferential species at high level among consumers due to its low price and providing cheap protein source (*Forcep R. et al. 2015*). The research studies concerning to gonad or sperm development stage, and spawning season are the most important to assess fisheries resource, however the biological studies and information of short mackerel are limited in Cambodia.

Thus, SEAFDEC/UNEP/GEF Project on Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand supported funds to conduct the research studies of short mackerel related to its biological studies starting from February 2019 to March 2020 in Koh Kong province to find and provide scientific data to support the establishment and management of mackerel fisheries *refugia* in Koh Kong province.

Therefore, the proclamation on the establishment of management area of mackerel refugia at Peam Krasob, Koh Kong province is approved officially by the Minister of the Ministry of Agriculture, Forestry, and Fisheries on 16 September 2019.

## 2. METHODOLOGY

### 2.1 Research Study Area

The study area is located in Koh Kong province, where is in the South West of Cambodia with distance of 290km from Phnom Penh, bordering the East part close to Preah Sihanouk and Kampong Speu province, the North part close to Pursat province, and the South-West part close to Gulf of Thailand (Koh Kong, 2019: 5 year-Development Plan from 2020-2024).

The Koh Kong is a province, which is rich of short mackerel and also spawning ground. Moreover the province is closed to Trat province, Thailand. Therefore the study is intended to express trans-boundary specie between its population in Koh Kong province, Cambodia and Trat province, Thailand as well (Figure1).

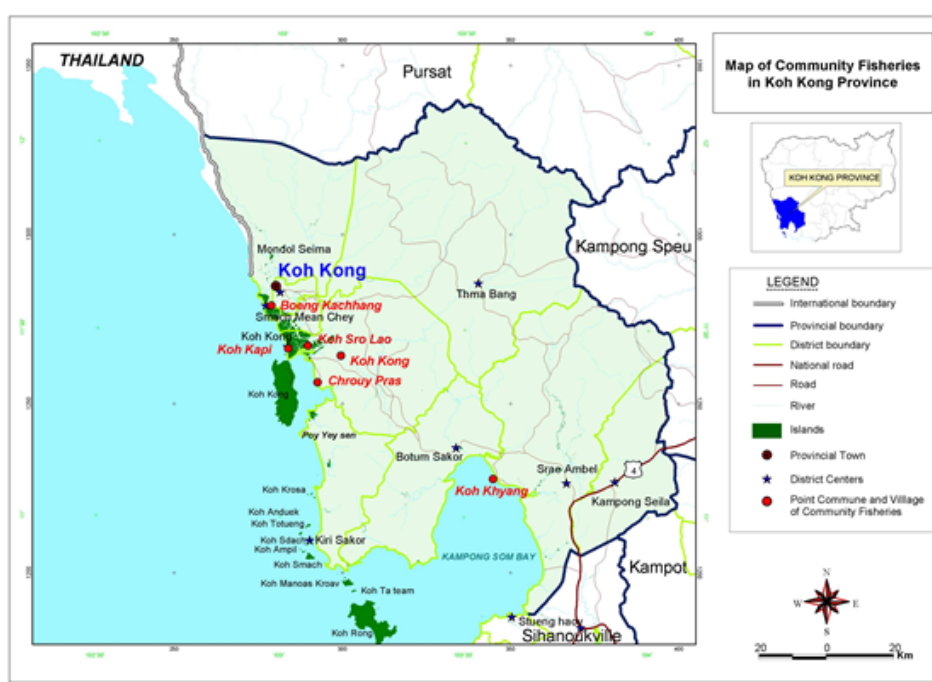


Figure 1: Map of Koh Kong province

## 2.2 Materials for Research Studies

Materials are used for processing of the research study as following:

- Tweezers, dissection scissors, and scalpels,
- Weighing balance for measuring of fish body weight at 0.1 g level,
- Data Sheet, Tray, Glove, Plastic bottles,
- Calipers, and Ethanol at 99.9%, and fish



## 2.3 Sample Size Collection

The monthly sample size collection of short mackerel is conducted at local market (i.e. Village 4 and Dornng Tung markets in Sangkhat Dornng Tung) and landing site (i.e. Ly Yungphat landing site in Bak Khlorng commune) in Koh Kong province. All fish harvested by fishermen in Koh Kong province are always transported to sell at those markets and landing site.

According to Table1, at least 100 individual of fish is collected from those market every month from February 2019 to March 2020. But the sample size collection of fish from the landing site, it is practiced once in May due to difficulty in buying fish there (it is private company). However, it is not available of the sample of fish during the month of June and July due to no short mackerel to sell at the local markets because fishermen cannot catch short mackerel in those months.

**Table1: Number of Sample Size of Mackerel Collected at Local Market and Landing Site in Koh Kong province**

No.	Month/Year	No. of Sample Size						Total (N=)
		Short mackerel (N=)			Long mackerel (N=)			
		Dang Tung market	Village 4 market	Ly Yungpat landing site	Dang Tung market	Village 4 market	Ly Yungpat landing site	
1	Feb-19	28	54	0	4	17	0	103
2	Mar-19	49	38	0	0	0	0	87
3	Apr-19	52	35	0	8	6	0	101
4	May-19	39	0	23	0	7	3	72
5	Aug-19	81	0	0	19	0	0	100
6	Sep-19	42	31	0	3	5	0	81
7	Oct-19	46	47	0	4	3	0	100
8	Nov-19	49	40	0	11	1	0	101
9	Dec-19	49	43	0	1	7	0	100
10	Jan-20	48	48	0	2	2	0	100

11	Feb-20	50	49	0	0	1	0	100
12	Mar-20	50	50	0	0	0	0	100
<b>Total</b>		<b>583</b>	<b>435</b>	<b>23</b>	<b>52</b>	<b>49</b>	<b>3</b>	<b>1145</b>

Moreover, the sample of fish collected is not all short mackerel and it is always mixed with Indian mackerel. Thus, the Indian mackerel is deleted from the table sheet because it is concentrated on the short mackerel in the case of study.



#### 2.4 Fish operation to check gonad and sperm development

All sample size of fish collected from the local markets and landing site are kept in plastic bag container and transported to a place near Peam Kramsob commune for the fish operation. During the fish operation, it is worked with the measurement of its total length, fork length, and body deep, and checking body weight, sex, gonad and sperm weight.



#### 2.5 Data Entry and Analysis

Excel program is practiced to analyze data. Table sheet is designed and prepared to entry data from the fish operation. Data analysis is used with Excel program to calculate an average of total length, fork length, and body deep, body weight, and gonad and sperm weight and count the number of male and female. In other hand, Gonadosomatic Index (GSI) was calculated in the study case by following formula (Amtyaz Safti et al. 2014):

$$\text{GSI} = \text{Gonad or Sperm Weight} * 100 / \text{Body Weight}$$

### 3. RESULTS

### 3.1 Sex

The sample of 1028 individual of short mackerel were collected from local markets and landing site in Koh Kong province starting since February 2019 to March 2020, including 50.68% of female (521 individual) and 49.32% of male (507 individual) based on Table1. Moreover, Table 2 showed that the female was caught mostly in February and April in 2019 that account for 74.39% and 85.21%, respectively. In contrast, the male was harvested massively in December 2019 and March in 2019 and 2020 that account for 65.93%, 67.44%, and 73%, respectively.

**Table2: Distribution of Short Mackerel by Sex in Different Month of the Year**

No.	Month/year	Female		Male		Total	
		N=	%	N=	%	N=	%
1	Feb-19	61	74.39	21	25.61	82	100
2	Mar-19	28	32.56	58	67.44	86	100
3	Apr-19	75	86.21	12	13.79	87	100
4	May-19	40	64.52	22	35.48	62	100
5	Aug-19	42	56.00	33	44.00	75	100
6	Sep-19	34	47.89	37	52.11	71	100
7	Oct-19	47	51.09	45	48.91	92	100
8	Nov-19	46	52.27	42	47.73	88	100
9	Dec-19	31	34.07	60	65.93	91	100
10	Jan-20	39	40.63	57	59.38	96	100
11	Feb-20	51	52.04	47	47.96	98	100
12	Mar-20	27	27.00	73	73.00	100	100
<b>Total</b>		<b>521</b>	<b>50.68</b>	<b>507</b>	<b>49.32</b>	<b>1028</b>	<b>100</b>

### 3.2 Relationship of Short Mackerel's Total Length, Fork Length, and Body Weight in Average by Sex in Different Month of the Year

According to Table 3, the total length, fork length, and body weight of fish varied from month to month. In August, the total length, fork length, and body weight of fish is 16.33cm, 14.55cm, and 44.92g for female and the male is 15.77cm, 14.10cm, and 41.15g. In September, the total length, fork length, and body weight of fish is 16.26cm, 14.46cm, 44.77g for female and the male is 16.84cm.

Table 3 showed that the total length, fork length, and body weight for female started to increase from 17.16cm to 18.22cm, 15.29cm to 16.31cm, and 58.13g to 74.73g, respectively meanwhile the male also increased from 16.83 to 17.82cm for the total length, from 15.02cm to 15.89cm for the fork length, and 55.05g to 67.02g for body weight, starting from the month of October to December 2019 and January to March 2020.

As the result, the short mackerel started the first maturity in August and September with the total length from 16.26 -16.33cm and the fork length from 14.46 -14.55cm for female, and from 15.77cm -16.84cm for the total length and 14.10cm - 14.87cm for the fork length for male.

**Table 3: Distribution of Short Mackerel's Total Length, Fork Length, and Body Weight in Average by Sex in Different Month of the Year**

No.	Month/year	Female			Male		
		Total length (cm)	Fork length (cm)	Body weight (g)	Total length (cm)	Fork length (cm)	Body weight (g)
1	Feb-19	17.70	15.87	67.89	17.09	15.23	58.15
2	Mar-19	17.03	15.25	58.70	16.69	14.90	53.87
3	Apr-19	16.25	14.64	52.24	16.09	14.51	49.94
4	May-19	17.61	15.74	58.10	16.64	14.94	50.54
5	Aug-19	16.33	14.55	44.92	15.77	14.10	41.15
6	Sep-19	16.26	14.46	44.77	16.84	14.87	49.94
7	Oct-19	17.16	15.29	58.13	16.83	15.02	55.05
8	Nov-19	17.50	15.59	60.73	16.92	15.11	53.67
9	Dec-19	17.32	15.51	61.96	16.84	15.04	57.18
10	Jan-20	17.55	15.72	66.77	17.15	15.35	61.65
11	Feb-20	18.41	16.41	75.64	18.08	16.09	69.27
12	Mar-20	18.22	16.31	74.73	17.82	15.89	67.20

### 3.3 Percentage of Short Mackerel's Gonad or Sperm Development Stage by Sex

Short mackerel's gonad or sperm development stage was divided into 5 stages based on the Leaflet of SEAFDEC/UNEP/GEF/PCU, 2019 on *Five-point Maturity Scale for Partial Spawners*. The development stage of fish was detailed as follow:

1. Ovary and testis about 1/3 length of body cavity. Ovaries pinkish, translucent; testis whitish. Ova not visible to naked eye.
2. Ovary and testis about 1/2 length of body cavity. Ovary pinkish, translucent; testis whitish, more or less symmetrical, and Ova not visible to naked eye.
3. Ovary and testis is about 2/3 length of body cavity. Ovary pinkish-yellow color with granular appearance, testis whitish to creamy and No transparent or translucent ova visible.
4. Ovary and testis from 2/3 to full length of body cavity. Ovary orange-pink in color with conspicuous superficial blood vessels, Large transparent, ripe ova visible, and Testis whitish-creamy soft.
5. Ovary and testis shrunken to about 1/2 length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe ova, darkened or translucent, and Testis blood shot and flabby.

According to Table 4, the gonad or sperm development stage of fish was found mostly in the stage 3 and 4 that account for 23.25% (239 individual) and 36.58% (376 individual), respectively, following the stage 5 accounted for 21.11% (217 individual). The minor percentage is in the stage 1 and 2 that accounted for 11.48% (118 individual) and 7.59% (78 individual).

**Table 4: Percentage of Short Mackerel's Gonad or Sperm Development Stage by Sex**

No.	Development Stage	Female		Male		Total	
		N=521	%	N=507	%	N=1028	%
1	Stage 1 (Immature)	63	12.09	55	10.85	118	11.48
2	Stage 2 (Maturing)	44	8.45	34	6.71	78	7.59

3	Stage 3 (Ripening)	122	23.42	117	23.08	239	23.25
4	Stage 4 (Ripe)	213	40.88	163	32.15	376	36.58
5	Stage 5 (Spent)	79	15.16	138	27.22	217	21.11
<b>Total</b>		<b>521</b>	<b>100.00</b>	<b>507</b>	<b>100.00</b>	<b>1028</b>	<b>100.00</b>

### 3.4 Relationship of Short Mackerel's Gonad or Sperm Development Stage and GIS Value by Sex

Figure 2 showed the relation of the gonad or sperm development stage of fish and GSI value. GSI value plays a main role in setting the maturity of fish. GSI value is higher than in stage 4 (3.92 for female and 3.75 for male) while GSI value is lower than in stage 1 (0.48 for female and 0.68 for male). Following, GSI value in stage 3 is 2.64 for female and 2.63 for male while GSI value in stage 2 is 1.26 for female and 1.09 for male. The GSI value in stage 5 is 1.49 for female and 1.96 for male.

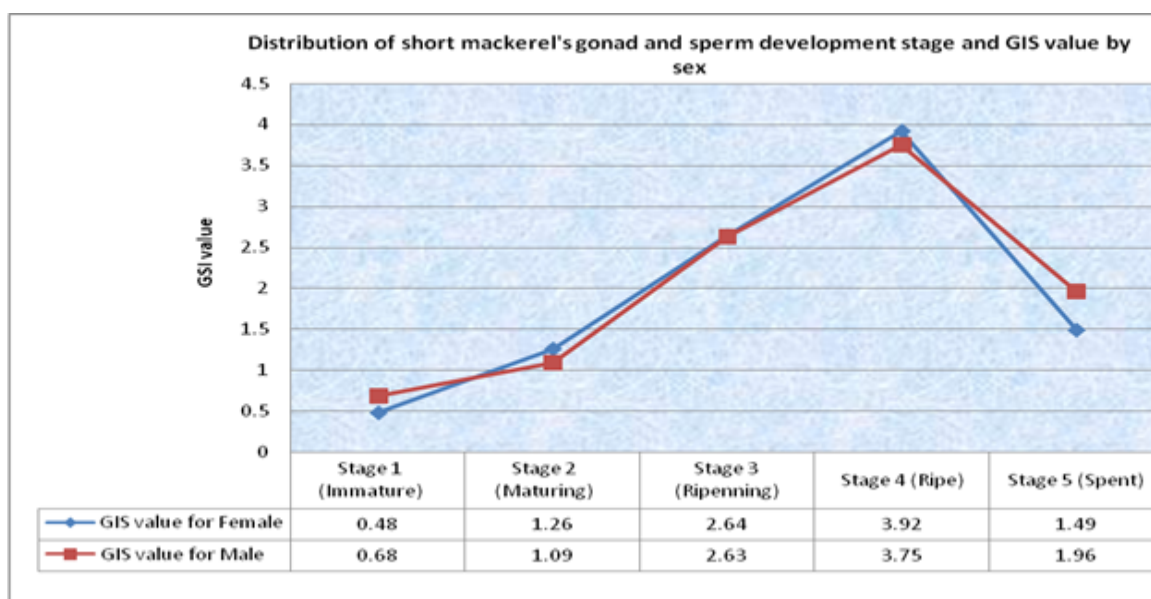


Figure2: Distribution of Short Mackerel Gonad or Sperm Development Stage and GSI Value by Sex

### 3.5 Relationship of Short Mackerel's Body Weight, Gonad or Sperm Weight, and GSI Value in Average by Sex in Different Month of the Year

Table 5 showed the relation of short mackerel's body weight and gonad or sperm weight and GSI value in average by sex in the different month of the year starting from February 2019 to March 2020.

The body weight of female started increasing from 44.92g in August 2019 to 74.73g in March 2020, but it started decreasing gradually from 67.89g to 58.10g in February to May 2019. At the same time for the male, it started increasing 41.15g in August 2019 to 69.27 in February 2020, but it started declining gradually from 67.20g in March 2020 to 50.54g in May 2019.

The gonad weight for female began increasing from 0.54g in August 2019 to 3.01g in February 2020, but it started decreasing gradually from 2.77g in March 2020 to 0.7g in April 2019. In contrast, it started increasing in May 2019 (2.97g). As for the male, its sperm weight started increasing 0.39g in August 2019 to 2.35g in February 2020, but it started declining gradually from 2.07g in March 2020 to 0.3g in April 2019. In contrast, it started increasing in May 2019 (2.38g).



**Table 5: Distribution of Short Mackerel's Body Weight, Gonad or Sperm Weight, and GSI Value in Average by Sex in Different Month of the Year**

No.	Month/year	Female			Male		
		Body weight (g)	Gonad weight (g)	GSI value	Body weight (g)	Sperm weight (g)	GSI value
1	Feb-19	67.89	1.66	2.42	58.15	0.95	1.57
2	Mar-19	58.70	1.49	2.25	53.87	0.99	1.76
3	Apr-19	52.24	0.7	1.3	49.94	0.3	0.61
4	May-19	58.10	2.97	5.01	50.54	2.38	4.59
5	Aug-19	44.92	0.54	1.17	41.15	0.39	0.92
6	Sep-19	44.77	0.66	1.29	49.94	0.46	0.86
7	Oct-19	58.13	1.85	3.17	55.05	1.36	2.43
8	Nov-19	60.73	2.11	3.44	53.67	1.92	3.49
9	Dec-19	61.96	1.45	2.32	57.18	1.33	2.31
10	Jan-20	66.77	2.45	3.61	61.65	2.33	3.69
11	Feb-20	75.64	3.01	3.94	69.27	2.35	3.36
12	Mar-20	74.73	2.77	3.57	67.20	2.07	3.04

According to Figure 2, GSI value of fish varied 1.3 in April 2019 to 5.01 in May 2019 for female and 0.61 in April to 4.59 in May 2019 for male. Figure 2 showed that GSI value 1.17 for female and 0.92 for male in August, and 1.29 for female and 0.86 for male in September, it means that fish started the first maturity during the month of August and September based on Figure 1.

GSI value started increasing from 3.17 to 3.44 for female and 2.43 to 3.49 for male in October to November; it means that fish started to develop its ovaries or sperm from stage 2 to stage 4 during the month of October to November based on Figure 1.

In contrast, GSI value started decreasing by 2.32 for female and 2.31 for male in December, it means that fish started to release egg or sperm in stage 5 during the month of December.

However GSI value started increasing in January to March 2020 with the value of 3.61, 3.94, and 3.57, respectively for female, and 3.69, 3.36, and 3.04, respectively for male. It means that fish started to develop its ovaries in stage 4 during the month of January to March according to Figure 1.

Then, GSI value started declining deeply by 1.3 for female and 0.61 for male in April 2019, it means that fish started to drop its egg or sperm in stage 5 (spent) during the month of April based on Figure 1.

In contrast, GSI value started increasing sharply with the value of 5.01 for female and 4.59 for male in May, it means that fish started to develop its ovaries or sperm in stage 4 during the month of May based on Figure 1.

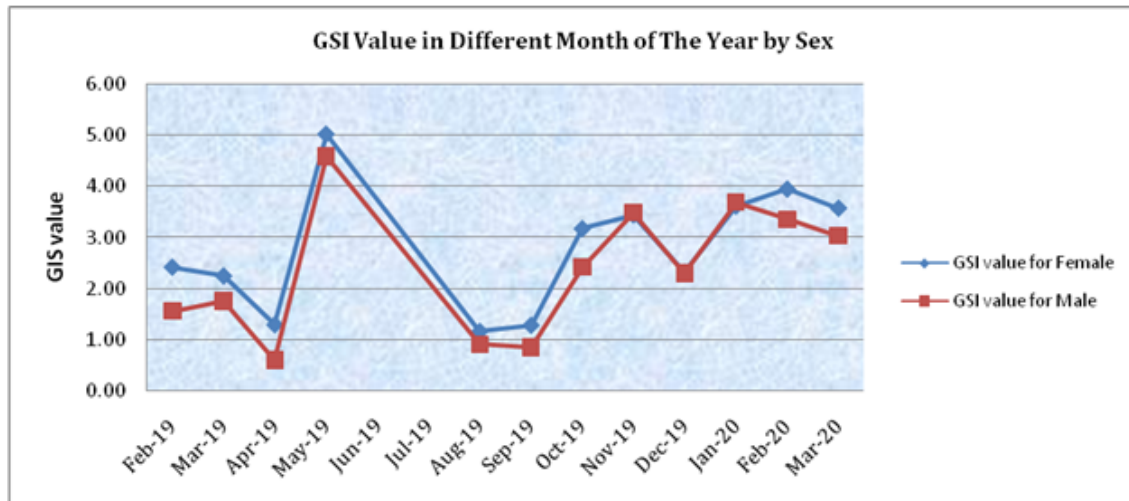


Figure 3: GSI Value in Different Month of the Year by Sex

#### 4. CONCLUSION

According to the research results, the sample of 1028 individual of short mackerel were collected from local markets and landing site in Koh Kong province, including 50.68% of female (521 individual) and 49.32% of male (507 individual).

The total length or fork length at the first maturity of fish is from 16.26 to 16.33 or 14.46 to 14.55 for female, and 15.77 to 16.84 or 14.10 to 14.87 for male in August and September.

The gonad or sperm development stage of fish was found mostly in the stage 3 and 4 that account for 23.25% (239 individual) and 36.58% (376 individual), respectively, following the stage 5 accounted for 21.11% (217 individual).

The GSI value is higher than in the stage 4 at the value of 3.92 for female and 3.75 for male while GSI value is lower than in the stage 1 at the value of 0.48 for female and 0.68 for male. In contrast, GSI value in stage 3 is 2.64 for female and 2.63 for male while GSI value in the stage 2 is 1.26 for female and 1.09 for male. The last GSI value in the stage 5 is 1.49 for female and 1.96 for male.

Short mackerel (*Rastrelliger brachisoma*) started to develop its ovaries or sperm in the stage 2 and 4 for three times, the first time in October to November, the second time in January to March, and third time in May, and it started to release its egg or sperm in the stage 5 for two times, the first time in December and the second time in April.

**REFERENCE**

*Amtiyaz Safit, Muhammad Usman Hashmi, and Zaheer MD Khan, 2014: The Sex Ratio, Gonadosomatic Index and Stage of Gonad Development of Saddle Grunt Fish, Pomadasys Maculatum(Bloch, 1793) of Karachi Coast.*

*Forcep R. Indaryanto, Hideyuki Imai, Yusli Wardiatno, 2015: Genetic variation of short body mackerel, Rastrelliger brachysoma of Jawa Island, Indonesia based on mt DNA control region sequences.*

*Koh Kong, 2019: Provincial Development Plan for 5 Year from 2020-2024.*

*SEAFDEC/UNEP/GEF/PCU, 2019: Leaflet of Five-point Maturity Scale for Partial Spawners during the Technical Training on Biological Studies of Short Mackerel (Rastrelliger brachysoma) for SEAFDEC/UNEP/GEF Project on Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand in Cambodia at Koh Kong, Cambodia on 12th –14th February 2019.*

*SEAFDEC/Sweden project, 2019: Technical Consultative Meeting on Drafting of the Regional Action Plan for Management of Transboundary Species, Rastrelliger brachysoma in the Gulf of Thailand Sub-region from 12-13 September 2019, Chonburi Province, Thailand.*