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MATURATION AND BREEDING SEASON OF THE RED SEA BREAM[1]

CHUNG-CHIA HUANG[2], KUN-HSIUNG CHANG[1],
HOCK-ANN NG[1] AND I-NUOH SHAW[1]

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ABSTRACT

C. C. Huang, K. H. Chang, H. A. Ng and I-N. Shaw (1975). *Maturation and breeding season of the red sea bream.* Bull. Inst. Zool., Academia Sinica, **14**(1): 47-53. Analyses of the annual change of the gonadosomatic index (one hundred times the ratio of the gonad weight to the gross body weight) were performed on 577 red sea breams, *Chrysophrys major* Temminck & Schlegel (Perciformis, Sparidae), collected in Northern Taiwan. The hermaphrodite appears not to involve in reproduction. Male and female red sea breams reach their sexual maturity at 4- and 5-year old, respectively. The breeding season falls in February to late March. The distinctions on the maturation age and breeding season with other samples were discussed.

The biology of the red sea bream, *Chrysophrys major*, has been studied since 1970 in the Laboratory of Fisheries Biology, Institute of Zoology, Academia Sinica. By scale reading, determination of the fork length and body weight of the individual fish, the growth of the red sea bream was formulated[(1)]. Ovotestes were observed in the red sea bream from two to six years old; no male was found at the age below three. It was postulated that the red sea bream undergoes sex reversal and is protogynous[(2)]. The present communication provides further suggestions on maturation and breeding season of the red sea bream through analyses of seasonal changes of the gonadosomatic index.

MATERIALS AND METHODS

The red sea bream, *Chrysophrys major* Temminck & Schlegel (Perciformis, Sparidae) was sampled monthly, from April 1972 through April 1974, from the fishing boats stationed in Keelung. The local fishermen make their catches with hand liners in small motor boats, in the areas of the Vase Islets and the Cotton Islet which are 38 Km and 54 Km from the port, respectively[(3)].

Twenty-three samples consisting of 577 fish were collected for this study. The gross body weight and the gonad weight of each individual were measured in grams and one hundredth of of a gram, respectively. Ctenoid scales posterior to the pectoral fins were used for age determination[(1)]. The gonadosomatic index (GI) of the fish is expressed in one hundred times ratio of the gonad weight (G. Wt.) to the gross body weight (B. Wt.), i.e., (G. Wt./B. Wt.) $\times 100$.

The gonads were fixed in Bouin's or Carnoy's

1. Paper No. 94 of the Journal series of the Institute of Zoology, Academia Sinica, Taipei, Taiwan 115, Republic of China.
2. Department of Zoology, National Taiwan University, Taipei, Taiwan 107, Republic of China.

fixatives. Paraffin sections of 5 to 7 μ were stained with Delafield's hematoxylin and eosin Y. Histological observations were made with bright field compound microscope, and the sex was then determined[2].

RESULTS

The Gonadosomatic Index (GI) of the Hermaphrodite

There were 163 hermaphrodites; their GIs ranged from 0.01 to 0.13. The frequency distribution of the GI in different age groups is given in Table 1. Hermaphrodites were found in the fish between 2 to 6 years old, but not in the fish less than two and above six years old.

The mean of the GI and the standard deviation of the mean for 2-, 3-, 4-, and 5-year old hermaphrodites are 0.03 ± 0.02, 0.04 ± 0.02, 0.04 ± 0.02 and 0.05 ± 0.03, respectively. The GI of 2-year old hermaphrodites is significantly different from that of the 3-, 4-, and 5-year old groups at 5% level (t-test), while the differences among 3-, 4-, and 5-year old hermaphrodites are not significant. Therefore, the GIs of 3-, 4-, 5-. and 6-year old hermaphrodites were combined in the study of the seasonal changes. Monthly distribution of the GI of 3-year old and older hermaphrodites in shown in Fig. 1. The seasonal change of the GI is apparent.

There were meiotic divisions of the spermatocytes in the ovotestis; the microscopic study clearly revealed the presence of the mature sperms in the gonad. The oocytes were invariably immature. Vitellogenesis, which leads to the enormous increase of the egg diameter and to the deposition of large quantity of the yolk globules in the ooplasm, had not been observed in the ovotestis of the hermaphrodite. Furthermore, those with numerous spermatozoa in the ovotestis also showed a greater GI.

The Gonadosomatic Index (GI) of the Male

One hundred and twenty males were identified in the samples and their GIs varied greatly among the fish of the same age as well as of

TABLE 1

The frequency distribution of the Gonad Index of the hermaphrodite

GI	Age, years.					Number of fish
	2	3	4	5	6	
0.01	12	1	1			14
0.02	10	5	6			21
0.03	10	10	9	3	1	33
0.04	12	13	19	4	1	49
0.05	3	8	7	3		21
0.06	3	5	3	2		13
0.07	1		1	1		3
0.08		1				1
0.09	1		2			3
0.10		1				1
0.11		1				1
0.12	1	1				2
0.13				1		1
Number of fish	53	46	48	14	2	163 Total

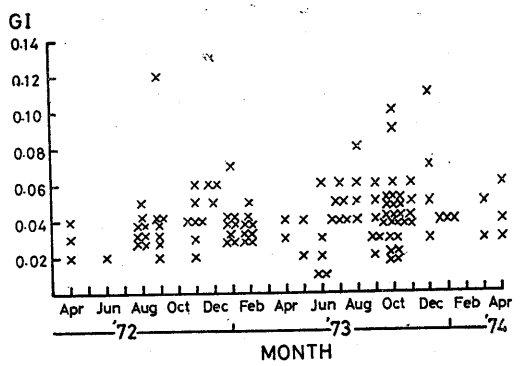

Fig. 1. Monthly distribution of the Gonadosomatic index of 3-year and older hermaphrodites.

the different ages. The distribution of the GI of the male fish is depicted in Fig. 2. It appears that the GI distributions of 4-, 5-, 6-, 7-, and 9-year old fish are bimodel. However, the GI distribution of 3-year old males is unimodel. The data for 8- and 10-year old fish are insufficient to justify the model of distribution. The GIs of 3- and 8-year old fish are 0.05 ± 0.02 and 0.16 ± 0.09, respectively, which are statistically different ($t = 3.627$, $p < 0.005$).

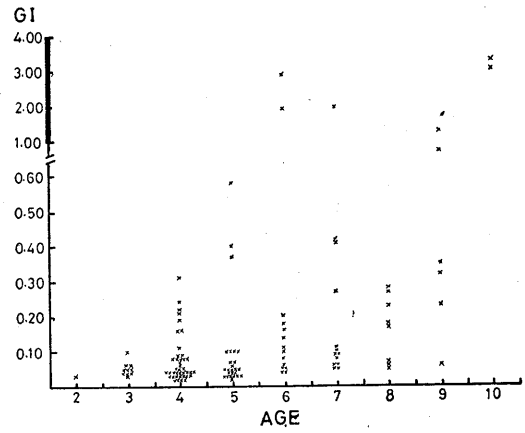

Fig. 2. Distribution of the Gonadosomatic Index of different ages of males. Age in years.

Monthly distribution of the GI of the males is shown in Fig. 3. Seasonal fluctuation of the GI is apparent in 4-year old and older fish. The amplitude of the cyclic change is more

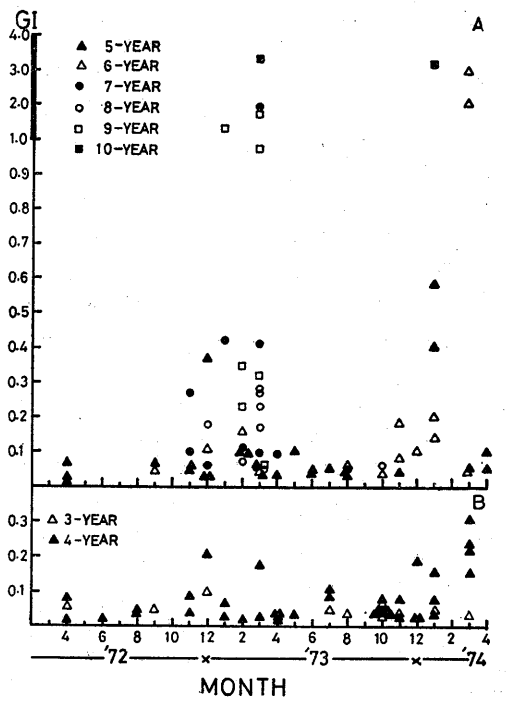

Fig. 3. Monthly distribution of the Gonadosomatic Index of males: (A) 3- and 4-year old fish; (B) 5- to 10-year old fish.

pronounced in the aged males. The number of 3 years old males are scant, thus analysis of their seasonal change of the GI would not be meaningful. Also there were none or very few spermatozoa in the collecting tubules of the 3-year old male testis and the meiotic activity was far from vigorous. The GI levels below 0.1 from April through October in all age groups. The GI of the aged males (4 and above) increases in November and reaches its maximum in the following March.

Some testicular sections prepared from samples of February and March gave spongy appearance. The epithelial lining of the seminiferous tubules was incomplete, and the tubule appeared more or less empty with sperms. These were possibly discharged testes. Mitotic and meiotic activities in samples of April to early October were few or none in the testes of all ages. However, from November through the

early months of the succeeding year, the seminiferous tubules of the mature males are lined with numerous clusters of spermatocytes which are in the process of maturation divisions. Collecting tubules and vas deferns are filled with spermatozoa. In the gravid testis the seminiferous tubules are more or less depleted of their lining epithelium and the lumen is full of sperms.

The Gonadosomatic Index (GI) of the Female

There were 294 females at the age ranging from one to 14 years old. Their GIs ranged from 0.01 to 4.47. The frequency distribution of the GI of the fish in different age groups and in different ranges are summerized in Table 2.

It is evident that the older the fish is the greater the range of the GI distributes. There are indications of the bimodel distribution of the GI in 6-year and older fish. The distributions of the GIs of 2 to 5 years old fish are unimodel and skew with various degrees toward the left. The last column of this table provides the mean of the GI and standard deviation for different age groups. Since the standard deviations of 7- and 8-year old females exceeded their means, these two values were excluded from significance test. The mean GIs of different age groups are statistically (t-test at 5% level) different from each other, except two sets of comparision: these are 4/5 and 5/6 years old fish. It is apparent that the means of the GI increase almost linearly in the first four years of the life span and reach the plateau for the 5 year old fish.

Vitellogenisis of the oocyte had been observed in the 5-year old fish and occurred more often in the older fish. However, mature ova had only been identified in 7- and 8-year old females.

Available data indicated that the monthly GI of the two consecutive years (April, 1972 to April, 1974) were homogeneous among the fish of the same age. Therefore, the sample of these two years were combined for the study of the annual changes of the GI of the female.

TABLE 2

Frequency distribution of the age and Gonadosomatic Index of the female red sea bream

Age, years	GI														Number of fish	GI Mean±S.D.
	0.01–0.05	0.06–0.10	0.11–0.15	0.16–0.20	0.21–0.25	0.26–0.30	0.31–0.35	0.36–0.40	0.41–0.60	0.61–0.80	0.81–1.00	1.01–3.00	3.01–5.00			
14											1				1	(0.92)
10							2						1		3	(0.34, 0.35, 3.33)
9				1	1				3	3	2				10	0.56±0.23
8		1		1		1			4	1	1	1	1		11	0.96±(1.28)
7			2	1	2		1		4		1		1		12	0.61±(0.88)
6	1		2	5	5		1	1	4	1					20	0.28±0.16
5	1		9	12	4	5	3	3	2						39	0.23±0.10
4	4	2	14	20	16	10	5	2	4						77	0.22±0.09
3	3	14	16	9	13	6			2						63	0.17±0.09
2	18	12	17	3	2	3									55	0.10±0.07
1	3														3	(0.01, 0.02, 0.03)

TABLE 3

The monthly change of the mean and standard deviation of the Gonadosomatic Index of the female red sea bream

Month	Age, years					
	1	2	3	4	5	6-14
Jan.			0.19±0.08(9)	0.30±0.11(11)	0.34±0.03(2)	0.99±1.16(6)
Feb.				0.19±0.09(4)	0.18±0.02(4)	0.34±0.17(3)
Mar.		0.28 (1)	0.30±0.17(4)	0.24±0.07(10)	0.31±0.10(6)	0.75±1.14(19)
Apr.	0.02±0.01(2)	0.18±0.12(4)	0.15±0.08(6)	0.17±0.08(10)	0.16±0.05(12)	0.32±0.30(6)
May						0.20±0.01(2)
Jun.		0.04±0.02(19)	0.05±0.04(3)	0.16±0.04(4)	0.15±0.04(3)	
Jul.		0.12 (1)	0.20±0.03(4)	0.22±0.07(6)		
Aug.		0.12±0.05(20)	0.13±0.05(8)	0.19±0.03(5)	0.20±0.03(2)	0.20±0.04(2)
Sept.	0.02 (1)	0.10±0.03(5)	0.09±0.03(9)	0.19±0.08(4)	0.20±0.03(3)	
Oct.		0.13±0.01(2)	0.20±0.09(14)	0.31±0.12(7)	0.22 (1)	0.32±0.11(2)
Nov.		0.06 (1)	0.22±0.09(3)	0.14±0.07(9)	0.27±0.12(3)	0.41±0.31(6)
Dec.		0.18±0.01(2)	0.17±0.04(3)	0.21±0.07(7)	0.38±0.16(3)	0.65±0.53(11)

Note: Sample size in parentheses.
Underlines indicating *t*-test, not significant at 5% level.

Since the sample size of the mature females was small in number, the 6 years old and older females were also pooled together for the study of the seasonal change of the GI. The results are tabulated in Table 3 and shown in Fig. 4.

Seasonal changes are apparent, however, the fluctuation of the GI is minimum from April through October. A gradual increase in the GI starts from November and reaches its peak in the early months of the next year. A steady decline of the GI is observed between March and April, and comes to its minimum in June. It is worth noting that: (1) the fluctuation in the curve of 4-year old females is minimal, and (2) there is a sharp dip in February for curves of 5-year old and older females.

DISCUSSION

Sexual Maturation in the Red Sea Bream

There were mature spermatozoa in the ovotestis of the hermaphrodite, the oocyte was always quiescent at the chromatin nucleolus stage or, at most, in the early perinucleous stage[2]. More than 85% of the ovotestis weighed less than 300 mg, and none exceeded 800 mg in weight. This indicates that most of the ovotestes probably could not release substantial volumes of semen with physiologically potent concentration of the sperms which are essential to ensure the success of fertilization. From the analysis of the gonadosomatic index and the observation of the histological sections of the ovotestis, it is suggested that the hermaphrodite is in a transitional stage in sex reversal, and would not involve in reproduction.

As shown in Fig. 3, seasonal fluctuation of the GI is apparent in 4-year old and older males, but not in 3-year old fishes. This implies that the 3-year old males may not participate in breeding of the red sea bream. The male red sea bream possibly reaches its sexual maturity in the fourth year of its life.

Seasonal changes of the GI are apparent in female red sea breams. These changes are more

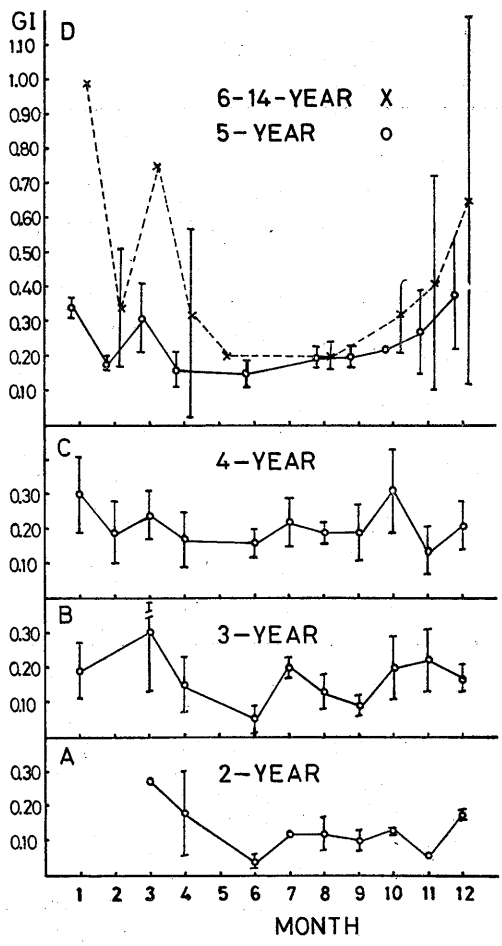

Fig. 4. Monthly change of th mean Gonadosomatic Index of females: (A) 2-year old fish; (B) 3-year old fish; (C) 4-year old fish; and (D) 5- and 6- to 14-year old fish.

or less parallel to the females of different ages. As indicated earlier, the monthly change of the GI of the 4-year old female is not as pronounced as that of the younger fish. It seems that the younger ones may involve more actively in the build-up of the immature oocyte in the ovary. This is substantiated by the steady increase of the mean GIs of the 2- and 3-years old females. Ling[4] reported a similar observation in the sea garfish, *Reporhamphus melanochir*, which has the cycle of growth and regression of ova in the immature fish mimicking the annual cycle of the ovary of the spawner.

Vitellogenesis, the prelude of the maturation of the ovum has been observed in 5-year old and older fish. Based on the histological sections, the female red sea bream probably could not reach their sexual maturity until the fifth year of their life. A single 3 years old female (GI 0.55) collected in March 1974 was found in the early process of vitellogenesis. Its GI was the highest in that age of females. However this growth could be abortive, because the spawning season was reaching its closing phase.

In Japan, the female sea bream, *Pagrus major*, was found to reach maturity in its fourth year. Few 3-year old females could also contribute in the reproductive pool. Furthermore, cultured sea bream could spawn as early as two years old[6]. The abundance of the food may exert a direct influence upon the time of maturation[7].

It has been suggested that *Pagrus major* and *Chrysophrys major* are of the same species morphologically[8]. This would imply that the specimens in the higher latitude (Japan) mature earlier than those in the lower latitude (Keelung). This is quite unusual for the red sea bream which distributes widely in the Western Pacific and Australian waters. Maturity normally sets in early at lower latitudes than at higher ones for fishes of widely distributed species. It has been observed that the roach (*Rutilus rutilus*) in Finland becomes mature at an age of 5-6 years, in central Europe at 4-5 years and in southern Europe at 3 years[7]. Taking this into account, it could imply that *P. major* and *C. major* would not be the same species but could be a pair of synmorphic species. This implication remains to be resolved.

The Spawning Season of the Red Sea Bream

Spent female and male red sea breams were recognized with the histological sections of specimens sampled on February to April. A

prominent dip in the gonad index of the sexually mature female is also observed in February. Thus, the spawning season for the red sea bream might start in February and last for two months.

Vigorous vitellogensis of the sea bream in Japan occurrs in March and breeds in late April to late May[6]. Egg maturation of the red sea bream in Keelung sets in January and spawns in February to late March. The differences in temperature and especially in the photoperiod could account for the distinction in reproductive ecology. Similar case has been reported for the yellow sea breams, *Dentex tumifrons*, the fish of the lower latitude breed in the early months of the year while those of the higher latitude spawn in the middle of the year[5].

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嘉鱲魚之成熟及生殖季節

黃仲嘉　張崑雄　黃福安　邵一諾

分析五七七尾臺灣北部近海產嘉鱲魚之生殖巢成熟度指數，生殖巢重量與體重之百分比，獲知雌雄同體魚不參與生殖；雄魚及雌魚之成熟魚齡分別爲四歲及五歲；生殖季節在二月至三月末。成熟魚齡及生殖季節之海域性差異曾予討論。