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Patterns of Reproduction and Spawning of the *Scomberomorus commerson* in the Coastal Waters of Iran

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Abstract: Patterns of reproduction and spawning were studied for the king fish (*Scomberomorus commerson*) in the Persian Gulf (Hormozgan province). During one year of sampling, 599 fish were collected from different landing sites along the Persian Gulf. Analysis of the reproductive stages and gonadosomatic index revealed a single yearly reproductive cycle beginning in March and ending with a single spawning period in August-September. The mean length at first maturity (Lm 50%) for females was 75 cm. The sex ratio was M/F = 0.97 in the samples.

Key words: King fish, Persian Gulf, gonado somatic index, sex ratio, Lm 50%

INTRODUCTION

The king fish, *Scomberomorus commerson*, is an epipelagic species throughout the coastal tropical waters of the Indo- pacific (Claereboudt *et al*., 2005). This species belongs to family Scombridae that has 15 genus and 51 species (Collette and Nauen, 2001).

The king fish is considered the most important commercial pelagic species. A few studies have applied to *Scomberomorus commerson* by Al-Hosni and Siddeek (1999) in Indian Ocean (Kedidi *et al*., 1993), Bertignac and Yesaki (1993) and Govender (1993) in Saudi Arabia, Oman and South Africa coastal waters. Few studies carried out in the coastal waters of Iran by Hosseini *et al*. (2003), Ghodrati *et al*. (2007) and Taghavi *et al*. (2008) in coastal waters of Iran. Little information about *Scomberomorus commerson* is present in the coastal waters of Iran. This project was conducted to determine biology reproduction in *Scomberomorus commerson*.

The aim of this study was included determination of period and peak of spawning, the first length of maturation Lm 50, GSI in *Scomberomorus commerson*. The specimens were collected from different landing sites in the Persian Gulf (Hormozgan province).

MATERIALS AND METHODS

The size frequency data were collected from commercial catches by gill net of *Scomberomorus commerson* made off the coast of the Persian Gulf between October 2006 and September 2007 (Fig. 1).

Fish were selected at random from landings; Lengths were taken using a measuring board and recorded to the nearest 1 cm Fork Length (FL). The monthly target sample size was 50 fish.

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Fig. 1: Study area reproduction biology of Scomberomorus commerson in the Coastal Waters of the Hormozgan province (Persian Gulf)

Biological data were collected during the first week of each month. Whole wet weight was taken with an electronic balance and recorded to the nearest 100 g.

Fish were sexed by macroscopic examination of the gonad which was dissected out and subsequently weighted to 0.1 g using an electronic balance,

The sexes were differentiated and length-weight relationship were studied by sex.

The parameters a and b of the L-W relationship of the form:

$$W = aL^b \text{ (Biswas, 1993)}$$

Where:

W = Weight (g)
FL = Fork Length (cm)
a,b = Factors

were estimated through logarithmic transformation (Biswas, 1993)

$$LnW = Ln\ a + b\ Ln\ FL$$

If the calculated number for b does not have a significant difference with 3, the species has isometric growth. To test this difference, we used the below equation (Pauly, 1984):

$$t = [(s.dx)/(s.dy)]*[(|b-3|)/(v(1-r^2))]*[v(n-2)]$$

Where:

s.dx = Std.LnFork length
s.dy = Std.Ln weight
r^2 = Identify factor
n = Sample No.

Table 1: Maturity stage classification for female *Scomberomorus commerson*

Development	Category	Description
1	Immature	Gonad about one- third length of the abdominal cavity. Ovaries thin, pinkish, ribbon like and invisible to the naked eye
2	Maturing	Gonads occupy about half of the abdominal cavity. Ovary pinkish, translucent; eggs visible under magnifying glass
3	Ripening	Gonads about two- thirds length of body cavity. eggs large and readily seen with the naked eye. Ovary pinkish- yellow with granular appearance
4	Ripe	Gonad occupy about full length of the body cavity. Ovaries distended and containing large translucent eggs
5	Spent	Gonads shrank having loose walls. Ovary may contain few ripe darkened or translucent eggs

The maturity development stage was assessed according to the criteria given by Table 1 (Biswas, 1993).

The mean size at first maturity (Lm) was estimated for female sex by fitting the logistic function to the proportion of mature fish in 20 cm (LF) size categories and determined as the size at which 50% of individuals were mature.

Mean Monthly Gonadosomatic Index (GSI) were calculated for each sex by expression the gonad weight as a proportion of the total body weight. GSI was calculated using the following formula (Claereboudt *et al*., 2005):

$$GSI = \frac{\text{Mass of Gonad (g)}}{\text{Gutted Fish mass (kg)}}$$

The timing and frequency of spawning were established by plotting of fish by maturity stage and gonado- somatic index against the sample period.

The population sexual structure was examined using χ^2 goodness of fit tests. Independent tests were conducted to determine whether sex ratio differed significantly from unity for the whole sample. The probability level was set at 0.05.

RESULTS

A total of 599 biological samples were collected, ranging in size from 35 to 121 cm FL (Males) and 29-128 cm FL (Females) (Fig. 2).

The b parameter value in the length- weight relationship model, $W = 0.0194\ L^{2.89}$, $R^2 = 0.987$ for female and $W = 0.0187\ L^{2.91}$, $R^2 = 0.986$ for male that are closed to 3 for males and females, indicating isometric growth (Fig. 3, 4, Table 2). The t-test was used for b parameter correctness evaluation with comparing to table value.

In total 296 males and 303 females were included in the analysis. The sex ratio in the samples M/F = 0.97 was not significantly different ($p<0.05$) in the overall male to female sex ratio 1:1(χ^2 test) (Fig. 5).

Length at first maturity of *Scomberomorus commerson measured* for females. The mean size at first sexual maturity (Lm 50%) was 75 cm (Fig. 6) .The smallest mature female and largest immature female were respectively 52 and 100 cm.

The gonadosomatic index for both males and females increased rapidly between May and June with spawning occurring between June-September (Fig. 7, 8).

The following results are based on macroscopically determined different stages in females. Frequently of immature fish (stage 1) shows an annual cycle with and almost complete absence during June-August.

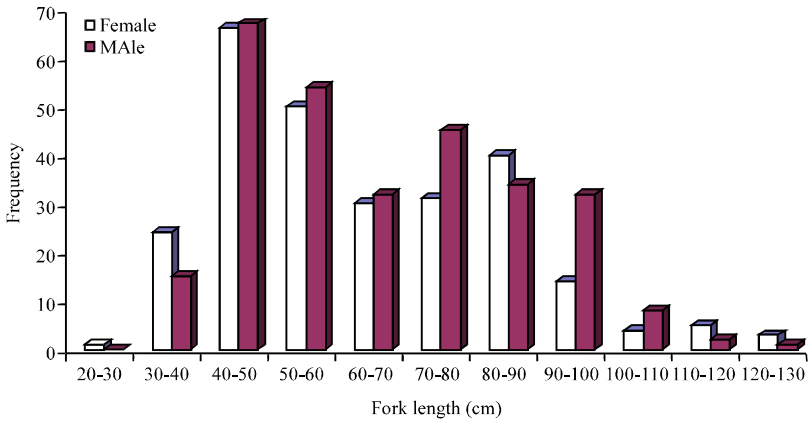

Fig. 2: Fork length frequency distribution of male and female *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

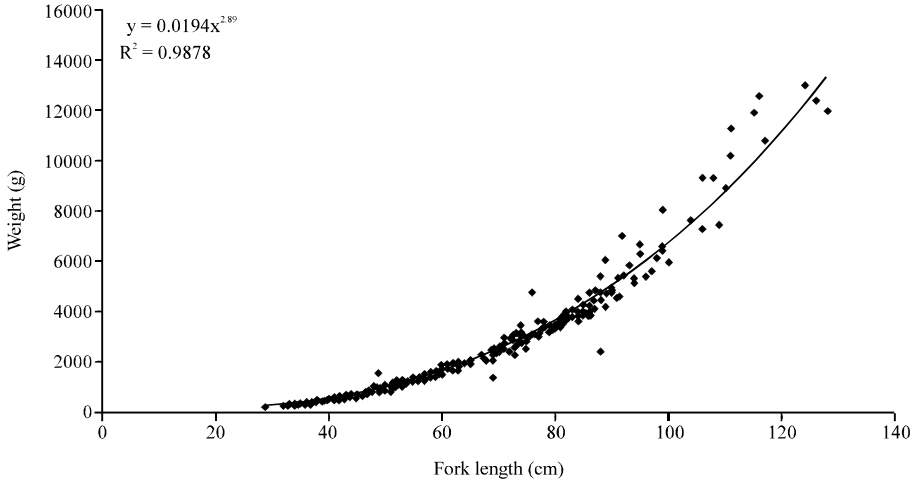

Fig. 3: The length-weight relationship curve for female of *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

Table 2: Relation between fork length and total weight *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

	Fork length (cm)		Total weight (g)					
Sex	Maximum	Minimum	Maximum	Minimum	No.	a	b	R^2
Female	128	29	15350	235	303	0.019	2.89	0.987
Male	121	35	13050	320	296	0.018	2.91	0.986
Total	128	29	13050	235	599	0.019	2.86	0.988

Pattern in the proportion of fish by maturity development stages also suggested that the peak of spawning took place After June with fish in spawning condition being observed during this period (Fig. 9).

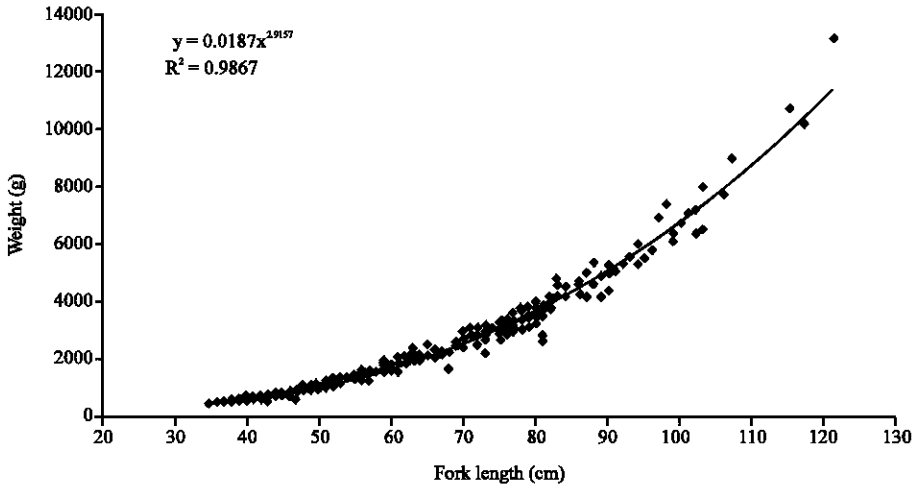

Fig. 4: The length- weight relationship curve for male of *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

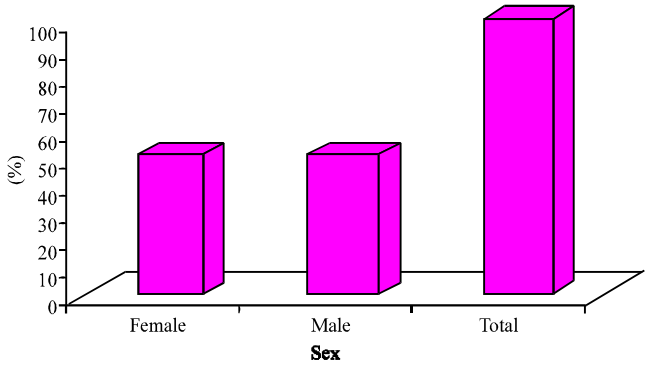

Fig. 5: Sex ratio percentage *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

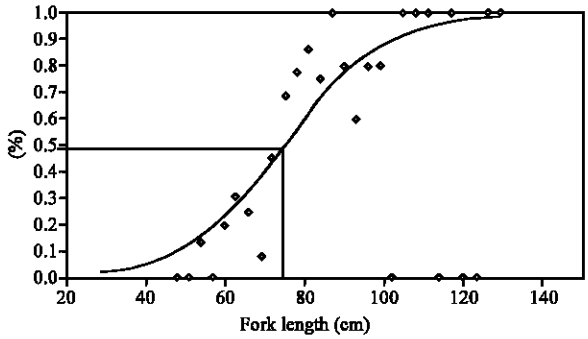

Fig. 6: Cumulative relative frequency of the length at first maturity for female *Scomberomorus commerson* in the Persian Gulf (Oct. 2006- Sep. 2007), the 50% maturity is marked by a thin horizontal line

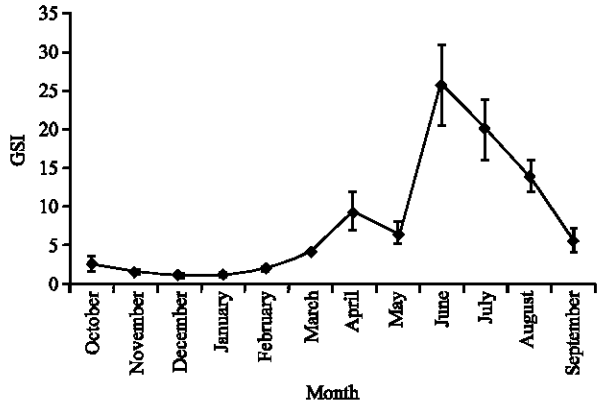

Fig. 7: Mean monthly gonadosomatic index for female (7.16±0.68) *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

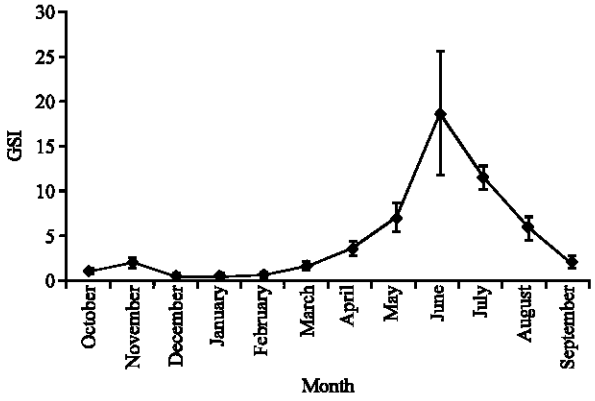

Fig. 8: Mean monthly gonadosomatic index for male (5.18±0.89) *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

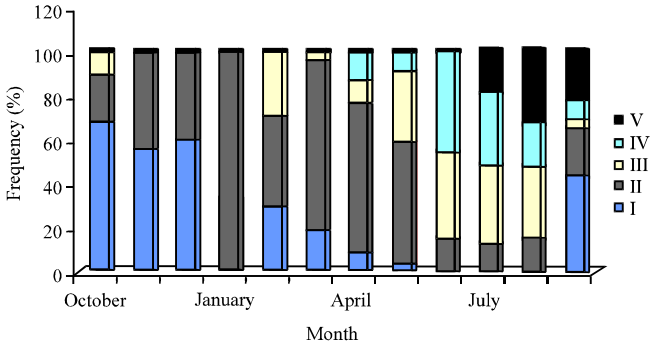

Fig. 9: Reproductive stages percent in female *Scomberomorus commerson* in the Persian Gulf (Oct. 2006-Sep. 2007)

DISCUSSION

As a result of the importance of *Scomberomorus commerson* to fisheries, there have been a number of studies relating to the reproduction, age and growth of this species.

The calculated number for b has not significant differences with 3. The b parameter value in the weight-length are closed to 3 for the *S. commerson* in our area study(Area 51), indicating isometric growth (King, 2007). The sex ratio *Scomberomorus commerson* in the Indian waters, eastern Arabian sea and Omani waters is approximately 1:1 (Bal and Rao, 1990; Anon, 2005), which supported present results in this study. Observations from Gulf of Oman (Claereboudt *et al*., 2005) revealed that males were almost always slightly more abundant than females in the catches, similar to the present data. Welsh *et al*. (2002) supported the migration and aggregation in larger numbers around several reefs just prior to spawning in the spring.

Devaraj (1983) estimated the size at first sexual maturity 75 cm FL in the northern Indian ocean, compare to the estimated size at spawning of 75-80 cm FL given for males and females combined off Oman. Claereboudt *et al*. (2004) estimated the size at first sexual maturity (also off Oman) at 80.4 cm FL for females. *Scomberomorus commerson* has been found to mature between 70-80 cm FL off Madagascar, Papua New Guinea, Fiji and north eastern Australia (Claereboudt *et al*., 2005).The mean size at first sexual maturity was also found in our study 75 cm FL for females which coincide well with the published values of size at first maturity for *Scomberomorus commerson.*

The period during which there was a decline in the gonado-somatic index and when fish in spawning condition were observed in our samples suggests a single spawning period from June to September. Although small short spawning took place during April to May. The results of Claereboudt *et al*. (2004) also revealed a single though earlier spawning season in May and June for king fish off Oman.

The reproductive activity of *Scomberomorus commerson* in waters off the east coast of Australia also peaked in the spring and summer months (Mackie, 2001) in contrast to the defined single seasonal spawning pattern for this species, Devaraj (1983) established three distinct spawning periods between January and September in the waters off the southern coast of India. whilst seasonal fishery closures have often been dismissed as a management tool for tropical species because of the assumption that spawning is protracted, the existing ban on the use of gillnet to target *Scomberomorus commerson* between the end of April and the beginning of October is appropriate in relation to the reproductive cycle of this species. Bouhlel (1985) determined a peak of spawning from March to June for stocks in Djibouti coastal waters. Kedidi and Abushusha (1987) stock reported a peak of spawning from March to June in Red sea and Persian Gulf. Nzioka (1991) reported reproductive activity during year with two peaks in May and October in coastal water in Kenya, according to this research, there is a direct relation between spawning peaks and monsoon intensity. Abdulqader *et al*. (2001) reported *Scomberomorus commerson* spawning cycle is in March to June in Saudi Arabian waters and is in March to July in Gulf of Oman. Siddeek (1995) reported *Scomberomorus commerson* in 51 FAO region has two spawning peaks, one power peak during spring and summer and another weak peak in autumn, also his hypothesis about long time reproductive cycle based on high production annual of plankton and small pelagic fish in region. Also two peaks for spawning (spring and autumn) was synchronous to the beginning monsoon, so larvae use of plankton and small pelagic fish in coastal waters after monsoon (Siddeek, 1995). Claereboudt *et al*. (2005) supported the idea of a migration (at least partial) out of Omani water during the reproductive season (April-May), moving north-wards (Iranian coasts) to spawn in the Persian Gulf.

Although the strong decrease in catches observed during the spawning season and the decrease in GSI in large individuals support the hypothesis of a reproductive migration, part of the populations from both areas Gulf of Oman and Arabian Sea were locally engaged in spawning activity. Fully mature

(stage III), spawning (stage IV) and spent (stage V) individuals have been found along both coasts in April-June and in June-September (Iranian coasts of Persian Gulf), supporting the existence of local spawning ground along three sides (Arabian Sea, Omani waters and Iranian waters).

As mitochondrial DNA studies indicated that these are one genetic stock in the Persian and Oman Gulf and the current data set only belongs to one year, therefore future joints studies and researches should address the issue of migration, particularly during the reproduction season between northern and southern coasts of the Persian Gulf (Hoolihan *et al*., 2006).

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