



# Studies on Gonadosomatic index (GSI) & sex ratio of Sind sardine fish, *Sardinella sindensis* (day, 1878) (family: Clupeidae) of Karachi coast, Pakistan

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## Abstract

The sex ratio & Gonadosomatic index of sind sardine, *Sardinella sindensis* (Day, 1878) of Karachi coast, Pakistan were investigated. *Sardinella sindensis* had sex ratio of 1: 1.25 (male to female). The difference in sex ratio was not significantly different ( $p > 0.05$ ) from the expected theoretically 1: 1 distribution except April 2002.

The highest Gonadosomatic index value in males during June – August were 3.813 to 4.078, while in females the high values during June – August were found to be 3.157 to 5.616, which suggested the spawning period. The highest GSI value in males were 2.548 to 2.711 in size groups of 170 – 199Mm and the lowest GSI value were 0.627 – 0.746 recorded in 110 – 129Mm, while in females at high values were 3.769 to 4.550 in 180 – 209 Mm Size groups and the lowest GSI values were 0.686 to 1.064 in 100 – 139 Mm size groups. The results will increase our knowledge of reproductive biology of *Sardinella sindensis* which is relevant for fisheries and aquaculture management as well as breeding programmes.

**Keywords:** Sex ratio, gonadosomatic index, *sardinella sindensis*.

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## 1 Introduction

Commercial quantities of large numbers of finfish and shellfish are present in the Pakistani coastal waters [1]. The Striped piggy grunt, *Sardinella sindensis* is among the fish species of great economic importance in the Pakistani coastal waters. It belongs to the family Clupeidae and can be found in pelagic-neritic; depth range 0 - 50 m of Western Indian Ocean: Arabian Sea, from Gulf of Aden to the Persian Gulf and Bombay (Fig. 05). Gonadosomatic index which is an index of gonad size relative to fish size is a good indicator of gonadal development in fish [2]. The percentage of body weight of fish that is used for production of eggs is determined by the gonadosomatic index. The percentage of body weight of fish that is used for production of eggs is determined by the gonadosomatic index. Sex ratio studies provide information on the representation of male and female fish present in a population. It states the proportion of male to female fish in a population and indicates the dominance of sex of fish species in a given population. Sex ratio also constitutes basic information necessary for the assessment of the potential of fish reproduction and stock size estimation in fish population [3]. In estimating the reproductive potential of fish, information on sex ratio of fish can be included to determine female spawning biomass.

Information on the reproductive biology of some other economically important fishes of the Indo-Pak and Arabian Gulf coasts has been reported by some authors ([4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14]). There is paucity of information on the study of reproductive biology of the Sind Sardine, *Sardinella sindensis* in the Karachi coast. However some works are available on reproductive biology, fecundity, maturation, spawning and sex ratio of some other important Sardine species ([15], [16], [17], [18], [19], [20], [21], and [22]). The reproductive biology of *Sardinella sindensis* has not been widely reported in literature. The aim of this study was to investigate the gonadosomatic index and sex ratio, which are some aspects of the reproductive biology of *Sardinella sindensis* of the Karachi coast, Pakistan. It is hoped that the information obtained from this study will contribute to our knowledge of the reproductive biology of *Sardinella sindensis* and will be useful for fisheries and aquaculture production.

## 2 Materials and methods

### 2.1 Study area

The Karachi coast was the study area for this research. The Karachi coastline is between latitude 24°53'N and longitude 67°00'E and lies in the Northern boundary of Arabian Sea.

### 2.2 Collection of specimens and sampling

Samples of *Sardinella sindensis* were collected fortnightly (A total of 32 collections) from fish harbors of West Wharf and Korangi Creek of Karachi coast. The specimens were collected during January 2001 – April 2002. The fish was identified by using [23] (FAO fish identification manuals). Simple random sampling technique was used [24]. A total of 419 samples collected during the study period. The samples were transported to the laboratory and preserved in a deep freezer at -20°C until examination and analysis.

### 2.3 Body measurements

The specimens were brought out of the deep freezer and allowed to thaw and the body length and weight were measured. Total and standard lengths were measured using a one-meter measuring board graduated in cm. The fish was wiped with a dry napkin before weighing and body weight and ovary weight were measured using a weighing balance (Sartorius model).

### 2.3 Sex ratio

Each specimen was dissected and the gonads were removed. The sex of each specimen was identified by examination of the gonads. The proportion of the two sexes relative to one another was used to calculate the sex ratio.

### 2.4 Gonad somatic index

The Gonad somatic index was calculated according to Strum [25] as follows:

$$\text{GSI} = \frac{\text{Weight of gonad} \times 100}{\text{Weight of fish}}$$

## 3 Results

A total of 199 males and 220 females were observed out of 419 samples examined. The sex ratio was 1:1.25 (male to female). The difference in sex ratio was not significant ( $p > 0.05$ ) (Tab. 01 & 02; Fig. 01 & 02).

The GSI values in males during August – November were 3.109 to 5.630 after which the values decreased slowly reaching to minimum in July (1.072), while in females the high values during August – December were found to be 3.542 to 6.679. This suggests that male and female gonads mature during August – December, the peak value being in October (Table 02 & 03) & (Fig. 03).

The highest Gonad somatic index value in males during June – August were 3.813 to 4.078, while in females the high values during June – August were found to be 3.157 to 5.616, which suggested the spawning period. The highest GSI value in males were 2.548 to 2.711 in size groups of 170 – 199Mm and the lowest GSI value were 0.627 – 0.746 recorded in 110 – 129Mm, while in females at high values were 3.769 to 4.550 in 180 – 209 Mm Size groups and the lowest GSI values were 0.686 to 1.064 in 100 – 139 Mm size groups (Table 05 & 06) & (Fig. 04).

The GSI value in males during June – August were highest, after which the values decreased slowly reaching to minimum in February (0.609) and March (0.602), while in females the high values during June – August. After which the values decreased slowly reaching to minimum in February (1.350) & March (0.840). This suggests that male and female gonads mature during June – August and these are the peak seasons for spawning (Table 03 & 04) & (Figure 03).

The highest gonad somatic index value in males were 2.711 (190-199 Mm of size group) and the lowest GSI value 0.627 (120-129 Mm of size group) were recorded, while in females the high value was 4.550 (190-199 Mm of size group) and the lowest GSI value were 0.686 (120-129 Mm of size group) (Table 05 & 06) & (Figure 03 & 04).

Table 1: Sex ratio (male: female) of *s. sindensis* in different months.

Month	Ratio M : F	Proportion of Male	X <sup>2</sup>
Jan. 2001	10 : 09	52.631578	6.24
Feb	12 : 11	52.17391	0.36
Mar	05 : 07	41.66666	0.08
Apr	09 : 08	52.94117	3.56
May	10 : 09	52.63157	3.83
June	11 : 09	55.00	0.18
July	20 : 20	50.00	0.0
Aug	09 : 14	39.13043	1.17
Sep	13 : 14	48.14814	19.91
Oct	16 : 23	41.02564	1.17
Nov	28 : 11	71.79487	0.86
Dec	16 : 28	36.36363	19.38
Jan. 2002	05 : 07	41.66666	0.59
Feb	09 : 14	39.13043	5.54
Mar	20 : 18	52.63157	3.58
Apr	06 : 18	25.000	0.01

Table 2: Sex ratio (male: female) of *s. sindensis* in different size group.

Size group (mm)	Ratio M : F	Proportion of Male	X <sup>2</sup>
100-109	02 : 02	50.00	0.00
110-119	17 : 14	54.8387	0.19
120-129	10 : 06	62.5	0.03
130-139	11 : 09	55.00	0.05
140-149	29 : 14	67.44186	0.29
150-159	19 : 21	47.5	0.27
160-169	23 : 28	45.09803	0.20
170-179	45 : 25	66.17647	0.64
180-189	32 : 69	31.68316	0.26
190-199	09 : 24	17.24137	0.08
200-209	00 : 08	00.00	8.00

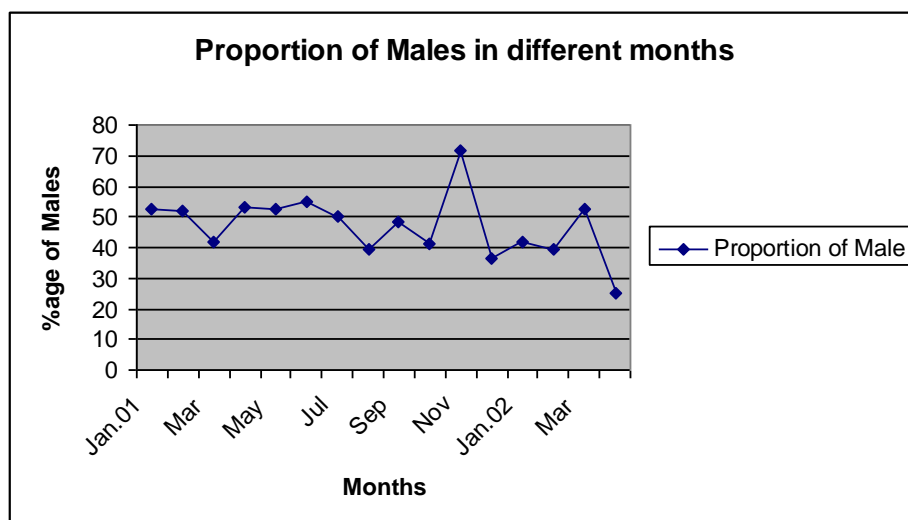


Fig. 1: Proportion of Males in different months.

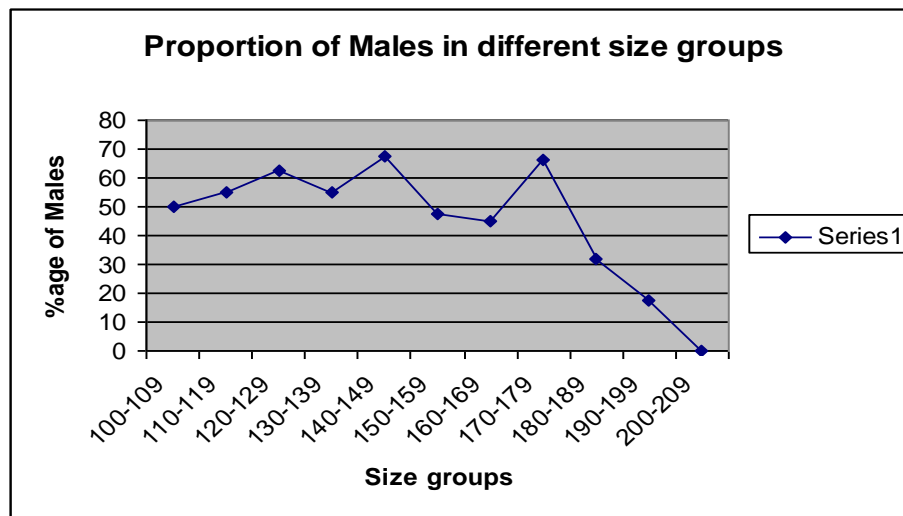


Fig. 2: Proportion of males in different size groups.

Table 3: Mean G.S.I of male *S. sindensis* in different months.

Month	N	X	S.E	C.L Min.-Max.
Jan. 2001	11	1.2520109	0.294193543	0.768062521 1.735959278
Feb	11	0.79528	0.18140331	0.496871555 1.093688445
Mar	05	1.486646	0.388053437	0.848298096 2.124993904
Apr	09	1.4590088	0.445718075	0.725802566 2.192215033
May	10	1.17975	0.24488235	0.776918534 1.582581466
June	11	3.9798972	0.596789817	2.998177951 4.961616449
July	20	3.813038	0.287438497	3.340201672 4.285874328
Aug	09	4.07778333	0.286129163	3.607100827 4.548465773
Sep	13	1.9989976	0.5486240	1.0346328 2.90148408
Oct	16	0.8244504	0.168075596	0.547966044 1.100934755
Nov	28	2.61614107	0.198559667	2.134770048 2.788031352
Dec	16	0.9132275	0.200849545	0.582829998 1.243625002
Jan. 2002	05	0.6454116	0.332519402	0.107121583 1.201110416
Feb	09	0.6090077	0.2182903	0.249920156 0.968095243
Mar	18	0.6015588	0.036798171	0.541025808 0.662091791
Apr	06	1.39494	0.432804268	0.682976979 2.106903021

Table 4: Mean G.S.I of female *S. sindensis* in different months.

Month	N	X	S.E	C.L Min. - Max.
Jan. 2001	09	1.106823	0.287360154	0.627974846 1.573389753
Feb	11	1.2609651	0.66622012	0.165033002 2.356897197
Mar	07	1.2511125	0.244359085	0.849141805 1.653083195
Apr	08	1.7411462	0.288174174	1.267699684 2.215792716
May	09	1.614769	0.49700171	0.797201187 2.432331813
June	09	3.157425	0.238536502	2.765032454 3.549817546
July	20	4.540871	0.411923079	3.86327535 5.218484465
Aug	14	5.6158437	0.52842369	4.74658673 6.48510067
Sep	14	2.90768	0.627642281	1.875208448 3.940151552
Oct	23	1.307217	0.31378687	0.761022298 1.823381101
Nov	11	3.5331363	0.456703689	2.781858732 4.284413868
Dec	28	1.4361185	0.220844797	1.072828809 1.799408191
Jan. 2002	07	2.6832585	0.818911239	1.336149512 4.030367488
Feb	14	1.3500447	0.222186374	0.984548114 1.715541285
Mar	18	0.8405813	0.140224042	0.60991275 1.071249849
Apr	18	2.2621518	0.979197046	0.651372659 3.872930941

Table 5: mean G.S.I of males *s. sindensis* in different size groups

Size group(mm)	N	X	S.E	C.L Min - Max.	
100-109	02	1.01175	0.4088	0.9445024	1.0789976
110-119	17	0.7462215	0.052444299	0.659950620	0.83249237
120-129	10	0.626837	0.018182836	0.596926234	0.65674776
130-139	11	1.3144054	0.907316357	0.178130007	2.806940807
140-149	29	2.0465934	0.218036186	1.68792387	2.40526292
150-159	19	1.1018517	0.20299738	0.767921009	1.43578239
160-169	23	1.6493191	0.427005424	0.946895177	2.351743022
170-179	45	2.5481178	0.24757007	2.140865035	2.955370565
180-189	32	2.5740809	0.345525857	2.005690865	3.142470935
190-199	09	2.710506	0.84172282	1.3525774146	4.095237854

Table 6: Mean G.S.I of females *s. sindensis* in different size groups

Size group(mm)	N	X	S.E	C.L Min. - Max.	
100-109	02	0.918689	0.05162	0.8287651	0.9985949
110-119	14	1.063909	0.0513285	0.979473617	1.148344383
120-129	06	0.6862538	0.09534739	0.529403479	0.84310412
130-139	09	0.7305816	0.109775651	0.550000654	0.911162545
140-149	14	2.3794366	0.4292335909	1.67317903	3.08569417
150-159	21	2.075804	0.397034466	1.422682303	2.72892569
160-169	28	2.1533809	0.400452653	1.49463628	2.812125516
170-179	25	1.6240298	0.382548609	0.994737338	2.253322262
180-189	69	4.2213809	0.20264652	3.88802737	4.554734425
190-199	24	4.549554	0.522374753	3.69024753	5.408060469
200-209	08	3.7692254	0.676884968	2.655749628	4.882701172

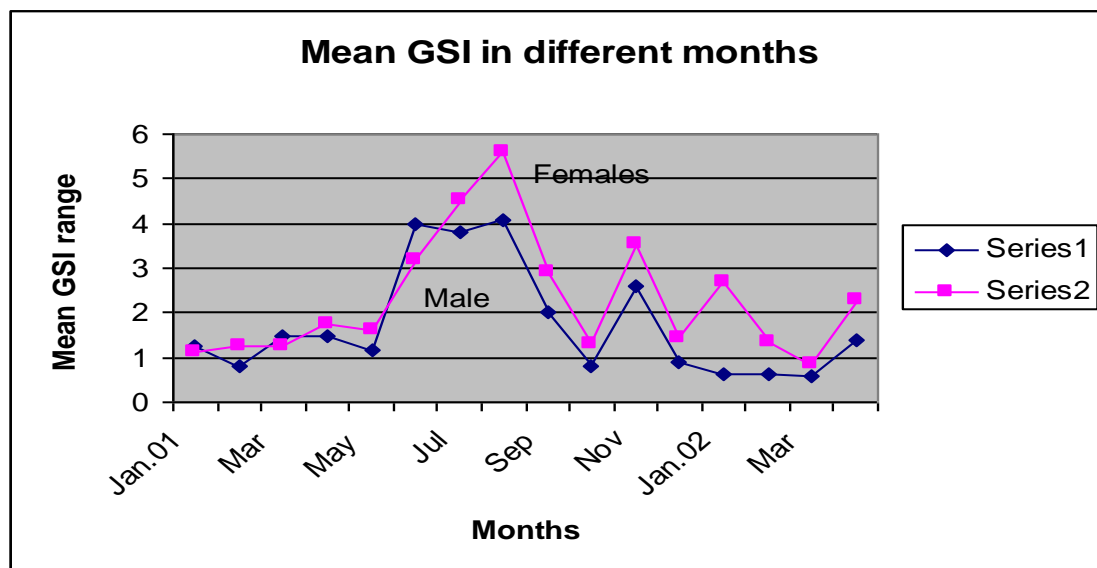


Fig. 3: Mean GSI of male &amp; female in different Months.

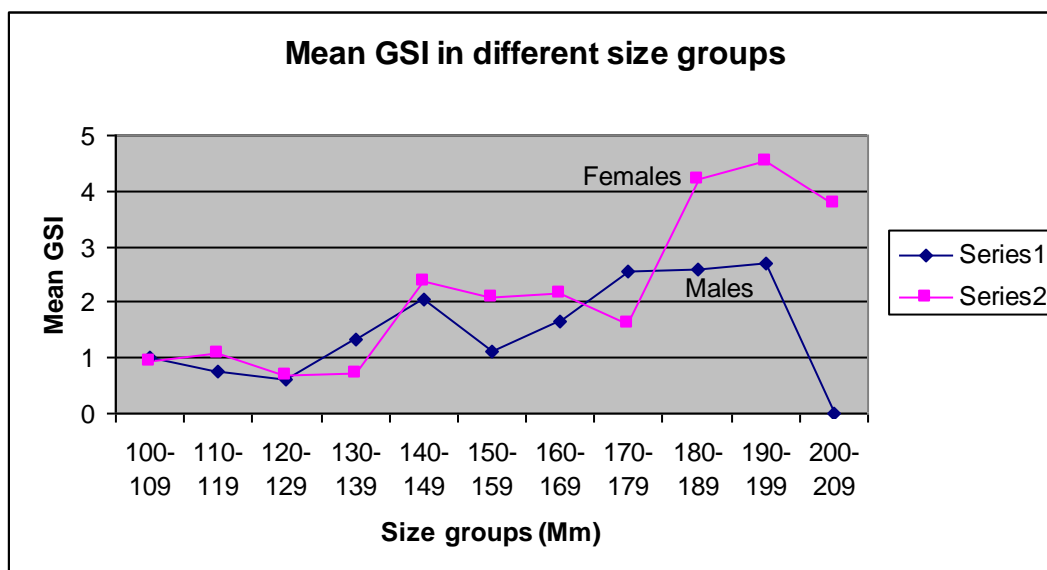


Fig. 4: Mean GSI of male & female in different size groups (Mm).



Fig. 5: Native range of *sardinella sardinella* (courtesy by waekipedia.com)

## 4 Discussion

The females were more than the males. However, the difference in sex ratio was not significantly different ( $P > 0.05$ ) from the expected 1: 1 distribution. Deshmukh (2010) reported the sex ratio of *Sardinella longiceps* off Ratnagiri coast of Maharashtra, India, which was in favour to the result obtained in this study; the females were more than the males. This is also similar to the sex ratio of *Sardinella aurita* recorded by Tsikliras in North-eastern Mediterranean Sea. A sex ratio of 1: 1.10 (Males to Females) was reported by Saud for the *Sardinella longiceps* In the Al-Seeb area of Oman, There were more females than male fish in the population, which was similar to the sex ratio of *Sardinella sardinella* observed in this study from Karachi coast, Pakistan.

High gonadosomatic indices were recorded for both male and female *Sardinella sardinella* in this study from June - August, which suggested that the spawning period of *Sardinella sardinella* was June to August, the peak value being in July. The gonadosomatic index of *Sardinella longiceps* was high in Feb - August (Saud., 2010). This was about similar to the results of the gonadosomatic index of *Sardinella sardinella* observed in this study. High gonadosomatic indices were recorded for *Sardinella longiceps* in March, april and August (Mussalam). According to [26] high GSI were recorded for Japanese sardine, *Sardinops melanostictus* from January to March. This was in contrast to the results obtained in this study.

This study will contribute valuable knowledge needed for fisheries management and aquaculture of *Sardinella sardinella* by increasing the knowledge of reproductive biology of *Sardinella sardinella*

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