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BREEDING BIOLOGY OF RAINBOW SARDINE, *DUSSUMIERIA ACUTA* FROM MANGALURU REGION

K. Halesha, H. N. Anjanayappa, Mansing Naik, Jaya Naik , D. P. Rajesh and P. Nayana

Karnataka Veterinary, Animal and Fisheries Science University, College of Fisheries,
Department of Fisheries Resources and Management, Mangaluru - 575 002, India.
e-mail : manya4018@gmail.com

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ABSTRACT : The present study is based on the reproductive biology of Rainbow sardine, *Dussumieria acuta* from Mangaluru waters from August 2015 to April 2016. Studies on spawning periodicity indicated that this species spawned only once in a year over a prolonged period extending from January to April with a peak during March to April. Analysis of size at first maturity of *D. acuta* using cumulative frequency method showed that male and female attained first maturity between 16-18cm in total length. Male always recorded lower gonado-somatic index (GSI) values than female due to higher ovary weight compared to testis. The GSI values of female were high during January to April with peaks in March and April. The fecundity of fish ranged from 12,642 to 34,782 eggs with an average of 21796 eggs. Log linear relationship was established between fecundity and gonad weight. The sex ratio of male to female was 1:0.74. There was an overall male predominance in the population.

Key words : *Dussumieria acuta*, breeding biology, Mangaluru.

INTRODUCTION

The rainbow sardine, *Dussumieria acuta* belongs to family Dussumieridae are small pelagic fishes, forming fairly good and not abundant fishery. Distributed all along tropical and temperate countries in the Indo-Pacific region. In India it is common all along the coast mainly Gulf of Mannar, Palk Bay, Mandapam areas on the south east coast.

The biological factor connected with the reproduction of *D. acuta*, recognizing the significance of such knowledge in successful management of its biology investigated. This includes descriptions on the structure of gonads and the classification of their maturity stages. Based on the ova diameter studies and the seasonal variation in the maturity stages, the spawning season and the frequency of spawning were assessed. The state of maturity was also determined by estimating the gonado-somatic index of the fish. The size at first maturity was determined to assess the size at first maturity. Based on the counts of maturing and mature ova, these destined to be spawned in the current spawning season. The fecundity of fish was estimated on its relation with factor such has length of fish, weight of fish and weight of the ovary studied in detail (Radhakrishnan, 1982).

MATERIALS AND METHODS

The present study is based on the observation of a total of 724 *D. acuta* individuals ranging in size from 12 to 24 cm total length (TL) comprising 417 males and 307 females. Fortnightly sample were collected from fish landing center, Mangaluru during the period between August 2015 to April 2016. The length, weight, sex and stage of maturity of individual fish in each sample were noted. The ovaries were removed and preserved in 5% formalin for further studies.

Maturity stages of female were classified based on macroscopic appearance of the ovary and microscopic characteristics of ova. In the male, stages were classified based on the macroscopic appearance of testis. The macroscopic observation were based on fresh material, whereas, microscopic observation were 5% formalin preserved material. For ova diameter studies of intra ovarian eggs, small pieces of ovaries from the anterior, middle and posterior region were cut and ova teased out on to a glass slide. Diameter of intra- ovarian eggs was measured by means of an ocular micrometer with a magnification of 0.01mm to each ocular micrometer division (O.M.D.) using compound microscope for the purpose of studying the process of growth of ova from the one stage of maturity to another. For ova diameter measurements a total of 300 to 400 ova were measured from each individual. These were grouped in to four ocular micrometer division and frequency polygons were drawn of all stages of maturity.

The spawning season was determined on the basis of availability of mature gonads in commercial catches. The gonado somatic index (GSI) and relative condition

factor (K_n) were also considered for assessing the spawning seasons. The size at first maturity was determined (a) using mean relative condition factor with respect to size of fish (b) using length weight relationship for male and female fishes (c) plotting cumulative percentage of mature fish IV, V and VI, stages in case of male and female against size.

For calculating the gonado -somatic index, the weight of the individual fish was noted and the gonads were removed carefully and weighed in an electronic balance after removing the excess moisture using blotting paper. Gonado-somatic index was calculated using the formula, gonad weight x 100/fish weight (James, 1967; Baragi, 1977) the average GSI value plotted against months. Fecundity was estimated gravimetrically using formalin preserved ovaries. The excess moisture was drained out and their ovaries were weighed to the nearest milligram. Ovaries of the IV and V Stages were used for fecundity estimation. Sample from each ovary was removed and weighed. The number of mature ova in the weighed sample was counted. From the number of mature ova for each individual, fecundity was calculated y using following formula

$$\text{Fecundity} = \frac{\text{Number of mature ova in the sub sample} \times \text{Total weight of ovary (g)}}{\text{Weight of sub sample (g)}}$$

The relationship between fecundity and length of fish/ / weight of fish/ ovary weight were calculated using appropriate statistical method. In addition gonad index of body weight, relative fecundity on body weight and ovary weight are also calculated. Sex -ratio was studied with respect to months and size groups of fish. Data on sex ratio were analyzed by χ^2 (Chi-square) test to find out whether there was any dominance of either sex.

RESULTS AND DISCUSSION

Development of ova to maturity

The ovaries of *D. acuta* belonging to seven stages of maturity described above were selected and the ova diameter frequency polygons of these ovaries were drawn. The data are presented in Fig. 1. In stage I, the size of ova ranged from 0.12mm to 0.19mm majority of them ranging in size from 0.12 mm to 0.16 mm. In stage II, a batch of mature in eggs withdrawn from the general egg stock, the maturing group has model value at 0.16mm while the largest ova measure at 0.50mm.In stage III, this progress to 0.41mm to 0.66mm. Advance group of ova have a mode at 0.56mm. In IV stage the maximum size of ova observed 0.78mm and the lowest group of 0.56mm, most advance group present 0.72mm in size. In stage V the maximum diameter observed 1.03mm, and the lowest size range starts from 0.82mm, in stage VI the maximum size observed in 1.12 and minimum in the range of 0.94mm in size. In stage VII the maximum size range is 0.81 and minimum size range of 0.69mm.

Spawning habits

Dussumieria acuta may be considered as spawning once in a season for a prolonged period as evidence from the ova diameter studies.

Spawning season

In case of male, stage I, II, III and IV were recorded in the month of August and III stage was dominant, in the month of September I, II and III were present and I stage was dominant (Fig. 2). In October, November and December months Stage I, II and III were present stage II was dominant. In January stage IV was dominant. In February and March stage I to stage IV were seen and stage IV was recorded dominant, in the month of April stage I to stage VII were recorded except II stage, highest percentages were found in stage V.

The result of gonadal maturity of female during August to September showed only, I II, III, IV and V stages Fig 3. II and V were predominant. In the month of October, stage I and II were dominant. In the month November II stage was dominant, in December stage II and III were predominant. In January stage II and IV were dominant and lowest percentage occurred in stage V. In the month of February and March III and IV were present in the highest percentage was found in III stage. In the month of April stage V was dominant and the lowest percentage was found in VI and VII stages.

Relation between the size of fish and maturity

The size at first maturity was also estimated using distribution of cumulative percentage of IV, V and VI stages. For this purpose, cumulative percentage frequencies of fishes plotted against size group. The size at 50% cumulative percentage frequency was considered to indicate the overall reproductive maturity of the population as a whole (Fig. 4). The size at first maturity of male and female mature at 16.3cm.

Gonado Somatic index

In this study, both male and female were taken in to consideration separately. The Gonado somatic index was calculated for individual fish and was averaged for each month (Fig. 5). The GSI value ranged between 1.966 to 2.876 in male during August 2015 to April 2016. The lowest GSI value was recorded in December (1.966), while, the highest was in the month of April (2.875). In case of female, the GSI value fluctuated between 2.676

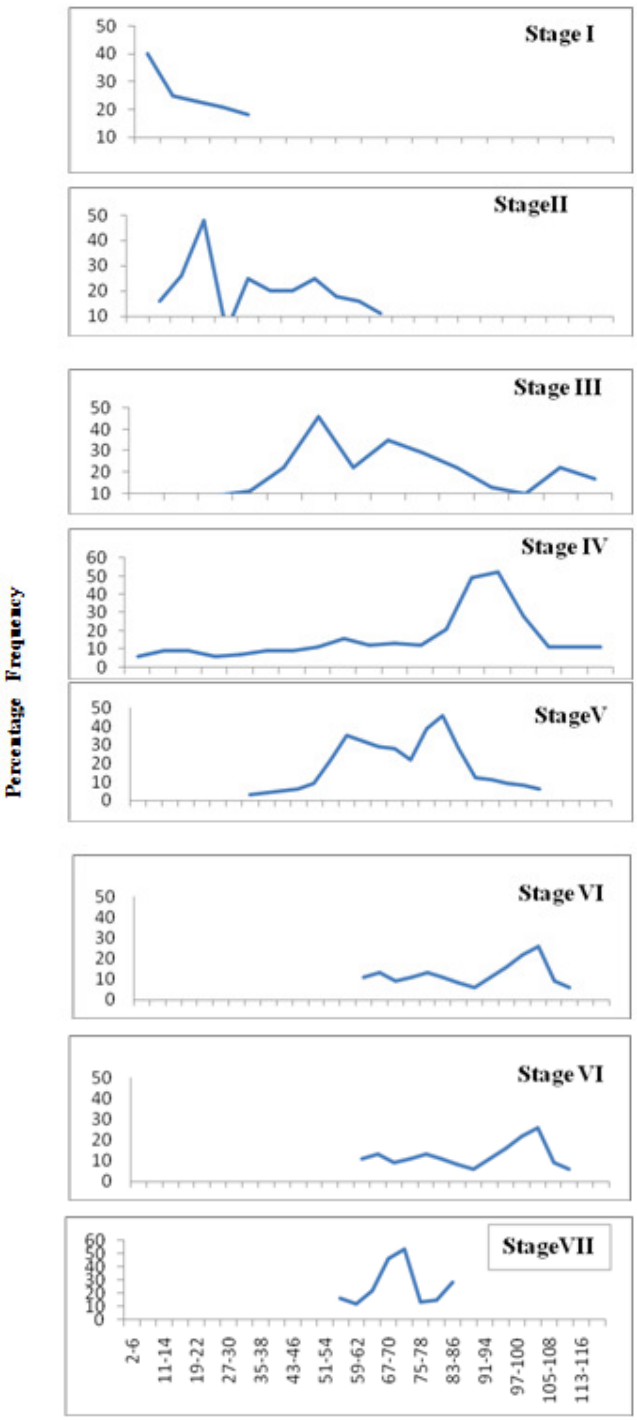

Fig. 1 : Frequancy polygon of ova diameter of *Dussumieria acuta* in various stages.

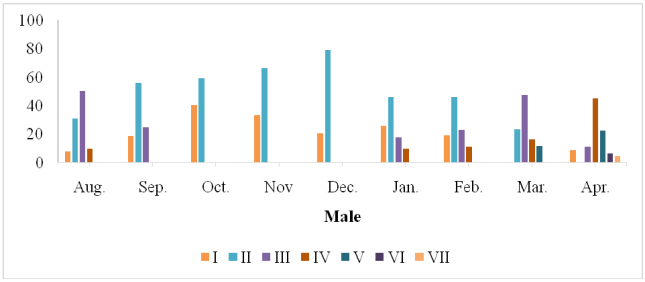

Fig. 2 : Month-wise percentage occurrence of gonads in different stages of maturity of *D. acuta* -Male

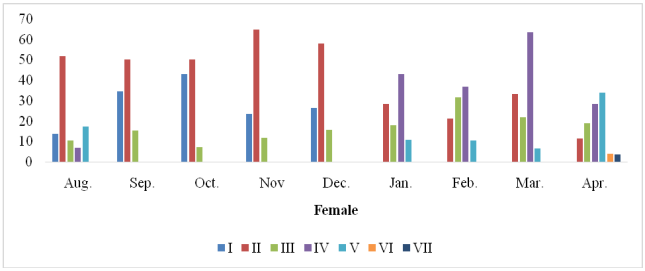

Fig. 3 : Month-wise percentage occurrence of gonads in different stages of maturity of *D. acuta* - Female.

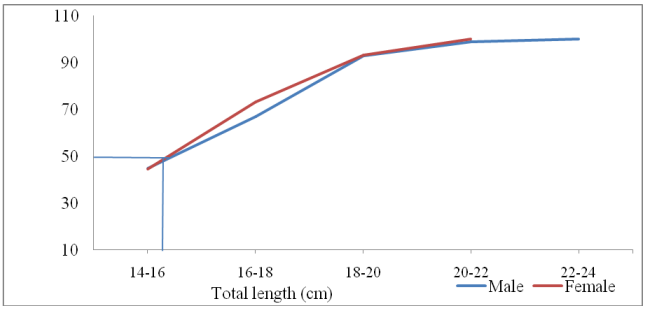

Fig. 4 : Size at first maturity of *D. acuta*.

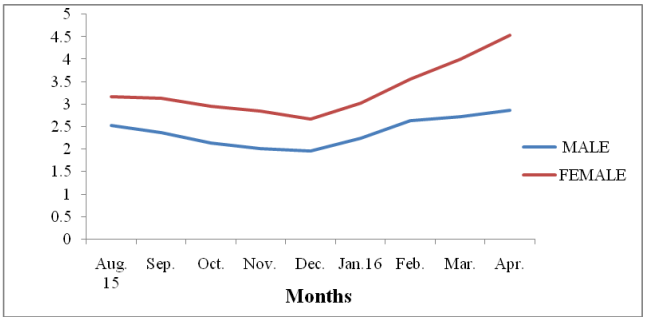

Fig. 5 : Monthly variations in Gonado-somatic index of *D. acuta*.

and 4.530.The GSI value decreased in the month of December and gradually increased from March to April. Maximum value of GSI was in 3.995 and 4.530 indicated that the appearance of maximum number of mature fish.

Fecundity

Only the mature ova were considered for the estimation of fecundity, a clear demarcation of mature and immature ova were noticed from stage IV onwards Table 1. Hence, for fecundity studies, fishes of stage IV, V and were taken into consideration. The fecundity of *D. acuta* ranged from 12,642 to 34,782 with an average of 21,796 eggs. The minimum weight of the mature fish was 35.2 g and the maximum weight was 77.56g with length varied between 14.6cm to 20.9cm TL. The number of ova increased generally with increase in length and weight of fish.

Table 1 : Number of mature ova in individuals of *D. acuta*.

S. no.	Total length (cm)	Body weight	Gonad weight (g)	Fecundity	Stages of maturity
1	16.3	44.2	2.28	21923	V
2	16.3	42.69	2	18552	IV
3	16.4	43.55	2.2	18590	IV
4	16.5	46.32	2.87	23916	VI
5	15.6	36.46	1.96	20696	V
6	15.6	35.2	1.25	12642	IV
7	16.3	42.69	2	18552	IV
8	16.2	39.37	1.92	16824	IV
9	14.6	35.2	1.25	12642	IV
10	16	32.62	1.55	18484	IV
11	16.5	36.33	1.58	18483	IV
12	15.2	36.66	2.45	21719	V
13	15.1	32.3	1.86	21191	IV
14	16	48.56	2.96	22431	V
15	16.5	51.28	2.85	20452	IV
16	13.4	43.85	2.56	28314	VI
17	18.4	63.55	3.85	25141	V
18	17.4	55.28	3.22	19338	IV
19	14.6	38.5	2.23	23863	IV
20	18.6	47.21	2.85	20223	V
21	17.6	36.44	2.96	21688	V
22	18.7	41.25	1.89	20205	V
23	21.2	72.35	3.22	19004	IV
24	20.9	77.56	4.95	34782	VI
25	19.5	60.2	2.85	19031	IV

Table 2 : Sex–ratio in different size groups of *D. acuta.*

Size groups	Total no. of fishes	Males		Female		Chi-square values	Male:Female
		n	%	n	%		
12-14	56	15	26.785	41	73.214	6.0354*	1:2.73
14-16	270	174	64.044	96	35.955	10.533*	1:0.56
16-18	179	91	50.837	88	49.162	0.067	1:0.49
18-20	169	108	63.905	61	36.094	13.07*	1:0.56
20-22	45	24	53.333	21	46.666	0.30	1:0.46
22-24	5	5	100	-	-	-	-
Pooled data	724	417	57.596	307	42.403	16.712*	1:0.74

Relation between fecundity and length of fish

The logarithm values of fecundity Y were plotted again logarithemic values of length X, it showed a linear relationship between the two variables. The relationship of fecundity was found to be Y=-3.881 +0.364 X where, Y=Log. Fecundity and X=Log. Length of fish. The correlation co-efficient r value of two variables was found to be 0.501.

Relationship between fecundity and weight of fish

The linear form of regression between weight of fish and fecundity was calculated as Y= 3.778 + 0.330 X where, Y=Log. F and X=log W.

The correlation coefficient r between fecundity and weight of fish was found to be 0.226.

Relationship between fecundity and gonad weight

The logarithmic values of fecundity (Y) when plotted against logarithemic gonad weight (X) of the fish indicated a linear regression equation of the form Y=A+BX. The calculated regression equation was Y=4.179 + 0.385 X where, Y=Log.F and X=Log.G. The correlation coefficient r between fecundity and weight of ovary 0.371.

Sex-ratio

For the study of sex ratio a total of 724 specimen were examined, similarly, the male and female sampled

in different size groups are presented in Table 2 represents data on sex ratio of *D. acuta* predominance of male were noticed throughout period except in the months of August, September, November, January and March. At 0.05 probability level, Chi-square value indicated no significance difference in the number of male and female in most of the months except August, September, November, January and March. The data were also analyzed by chi-square test to test the number of male and female in various size groups. It is clear from Table 2 that size group 12-14, 14-16, 18-20 cm. TL indicated significant difference in Chi-square value in the number of male and female.

The reproductive aspects of oil sardine were examined by (Antony, 1972). The stages were Immature (I), Developing virgin (IIa), Spent resting (IIb), Maturing (III & IV), Mature (V), Running (VI), Partially spent (VIIa) and Spent (VIIb). Number of mature eggs in the ovaries of the gravid females with the total weight of fish ranging from 50-60 g varied from 45,000-75,000 eggs. The size at first maturity was estimated at 158 mm. Average GSI values of females were 1.4998 with maximum GSI value 5.4962 in the month of September and minimum in the month of October (0.4299). In case of males the maximum GSI value 4.4962 was observed in the month of September and minimum was 0.2992 were observed in the month of October. Spawning season of Omani sardine, the length at 50% maturity for combined sex, female and male sardines was 16.35-16.46 and 16.28 cm, respectively. He also noticed that the spawning season in October, June, and July, September, June, and January and September during the years 2004, 2005, 2006, 2007 and 2008 respectively. An overall mean sex ratio of 0.68 ± 0.02 proved to be significantly different from the χ expected theoretical sex ratio of 1: 0.5 (Al-Jufaili, 2011).

The number of eggs which were found in *S. fimbriata* was ranged from 14513 to 25490 and estimated fecundity varied from 14508 to 25485. On an average the estimated fecundity was 19671 whereas, the observed fecundity was 19675. Study on the reproductive aspects such as fecundity and ova diameter studies can help in the fisheries forecast for its successful management (Kudale and Rathod, 2014).

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