

Maturation and spawning of *Decapterus russelli* (Ruppell, 1830) along the Malabar Coast

P.P. MANOJKUMAR

Calicut Research Centre of Central Marine Fisheries Research Institute
West Hill, Calicut - 673005

ABSTRACT

The spawning period of the Indian scad *Decapterus russelli*, as indicated by ova diameter frequencies is prolonged, extending from March to December with peak in April-May and September. Fishes with mature, ripe and spent gonads were noticed from March to December. The relative condition factor (Kn) and gonadosomatic index (GSI) values ranged between 0.93-0.98 and 0.75-3.85 respectively, with peaks in March-May. The size at first maturity of male and female is 143 mm and 155 mm respectively. The fecundity varied from 33,159 to 1,96,392 and the number of ova per gram ovary varied from 8,270 to 28,300, increasing with increase in length of the fish. The females dominated over males in the population.

Introduction

Study on maturation and spawning of fish are aimed at understanding and predicting the changes in composition of the population, which are expected to undergo fluctuations from time to time. Further, such studies are also useful for the judicial management of the fishery. Very few work has been done on the maturation and spawning of *Decapterus russelli* in Indian waters. Sreenivasan (1982, 1983, 1984 and 1987) studied length-weight relationship, age and growth, feeding, maturity and spawning of *D. russelli*. Shameen (1988) made biometric studies on this species. Murty (1991) worked on some aspects of biology and population dynamics in the trawling grounds of Kakinada. Reuben *et al.*, (1992) studied the fishery, biology and stock assessment of carangids including *D. russelli* from Indian seas.

Balasubramanian and Natarajan (1999 and 2000) reported the resource characteristics and biology of scads from Vizhinjam.

D. russelli is one of the important species constituting the carangid fishery of Malabar region along the southwest coast of India. The present study was undertaken during 2000-'02 and the results are presented.

Materials and methods

Material for the present study was collected once a week from Puthiappa and Beypore fish landing centres. A total of 4160 specimens were examined during the period from September, 2000 to August, 2002. The maturity stages of gonads were determined on the basis of physical appearance and by observing under microscope, following the standards laid down by I.C.E.S (Lovern

and Wood, 1937). The spawning periodicity was determined by ova diameter study following Clark (1934) taking homogeneous samples from 25 ovaries each in different stages of maturity. The spawning season was determined on the basis of distribution of different maturity stages during different months. Gonadosomatic Index was studied based on ovaries of 628 fishes at different stages of maturity following Qasim (1973). Relative condition factor (Kn) values were estimated following Le Cren (1951) and only adult fishes of both sexes were considered for this study. Fecundity was studied by examining 50 female specimens in the penultimate stage of maturity by the formula $F = \frac{W}{W_1} \times \text{No. of ova in the sample}$, where F is fecundity and W and W_1 are total weight and sample weight of the ovary, respectively. The relationship of fecundity with total length and weight of fish was determined by the least square method. The size at which 50 % of the fish were mature (stage IV and above) was considered as the size at first maturity. The monthly Male: Female ratio was estimated and the values were tested for significance using chi-square values.

Results

Development of ova to maturity

Ova diameter frequency of *D. russelli* in different stages of maturity is given in Fig. 1. Immature eggs measuring less than 0.06 mm were present in all the stages of maturity and can be considered as general stock. In immature stage I, transparent ova with clearly visible nucleus were observed. In stage II, the ova diameter was slightly more than the stage I. In the stage III, some of the eggs drawn from the immature general stock were under the process of maturation. These eggs were

deposited with yolk and become opaque. The maximum size of the eggs in this stage was 0.45 mm. They increase in size further in next stage (IV) and form a separate group with mode at 0.46-0.51mm. The largest egg measured 0.62 mm. In stage V, the above group increased in size with a mode at 0.57-0.61 mm and the size of the eggs reached up to 0.79 mm. In stage VI, the yolk laden mature eggs increased very much in size. The first batch swelled enormously to become large hyaline eggs with mode at 0.91-0.95 mm and this batch represented the eggs to be spawned immediately. A single oil globule was clearly seen in the transparent eggs. The maximum size of the eggs noticed was 1.02 mm. At this stage, a second batch of eggs were present with mode at 0.17-0.22 mm. In stage VII, the first batch eggs were spawned, while the second batch remained with very little representation. In II R, only the immature general stock was observed.

Size at first maturity

The percentage occurrence of males in different stages of maturity for the year 2000-01 and 2001-02 are pooled and presented in Fig. 2. It would appear that males up to 90-99 mm were all immature. Maturing males appear in the fishery when they grow beyond 100 mm and attain maturity at 120-129 mm size. However, 50 % of the fishes were mature at 143 mm. Therefore, it can be concluded that the size at first maturity of males of *D. russelli* is 143 mm.

The percentage occurrence of females of *D. russelli* for 2000-01 and 2001-02 were pooled and presented in figure 2 for assessing the size at first maturity of females. Females up to 119 mm were all immature. The maturing females started to appear in the fishery

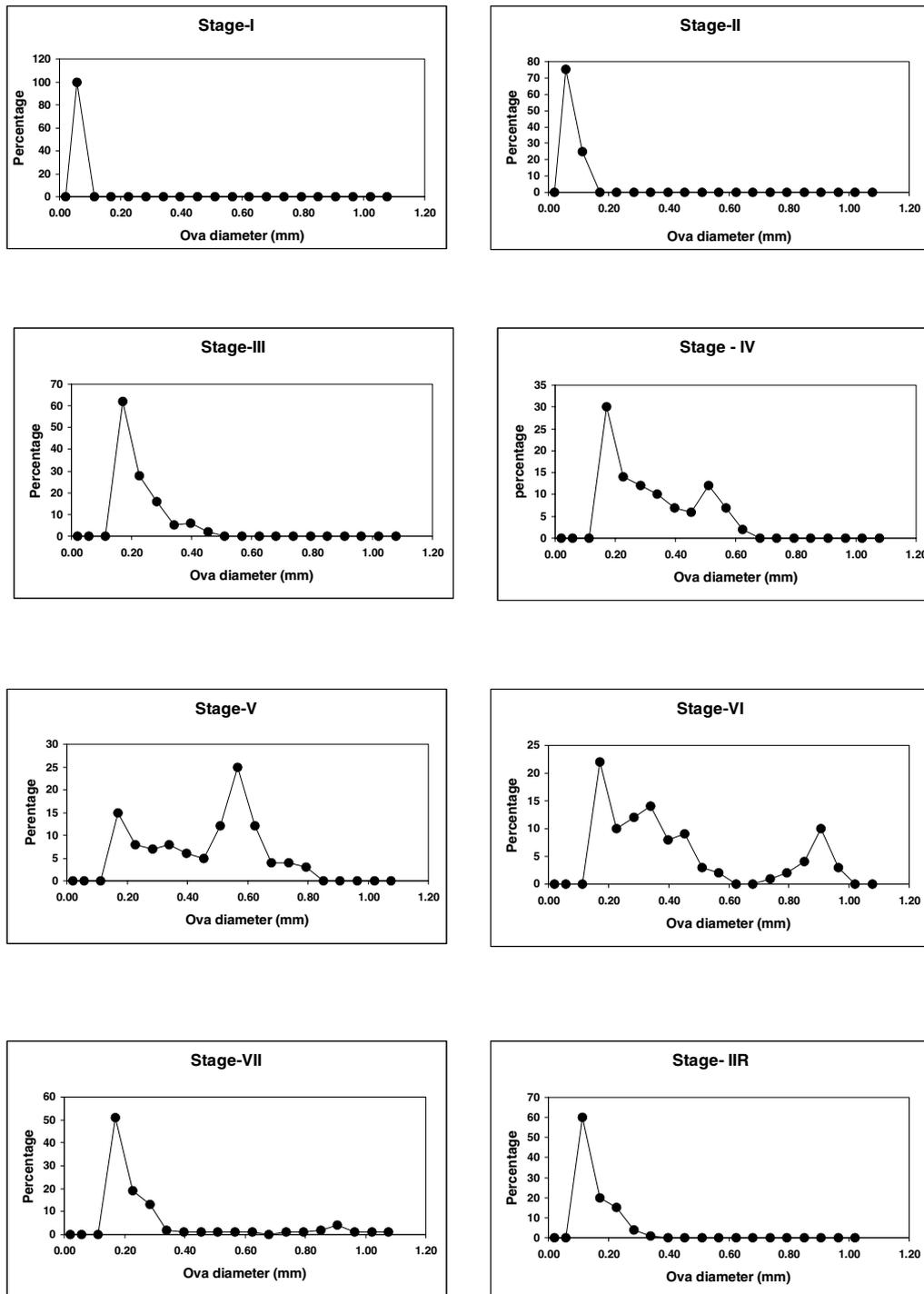


Fig 1. Ova-diameter frequency in *D. russelli* in different stages of maturity

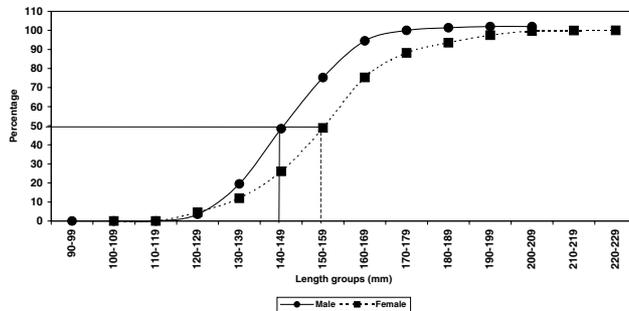


Fig 2. Size at first maturity of male and female *D. russelli*

from 120-129 mm size group onwards and 50 % of them were mature at 155 mm size which is the size at first maturity of females of *D. russelli* along the Malabar Coast.

Spawning season

For determination of spawning season of *D. russelli*, females above size at first maturity only were considered. An arbitrary classification of gonads into five stages namely immature (I), maturing (II and III), mature (IV & V), ripe (VI) and spent (VII) was made. In the preliminary examination, it was seen that there was apparently not much

differences in the month wise occurrence of different stages of maturity between the years 2000-01 and 2001-02, hence, the data for the two years were pooled and presented in Table 1. It may be seen that immature gonads were present from July to February. Females in the maturing stages were present from June to February. Mature females were present throughout the year. Fishes with ripe ovary were present for 10 months from March to December. The spent fishes were also present during the same period and absent during January to February. The presence of mature, ripe and spent gonads from March to December indicates the prolonged spawning season. Occurrence of limited number of spawners in the fishery during spawning season also indicates that fish may be spawning away from the traditional fishing ground. Fishes with spent gonads started appearing in March and were present till December.

TABLE 1. Average percentage occurrence of *D. russelli* with gonads in different stages of maturity during 2000-'01 and 2001-'02

Month	No. of specimens examined	Stages of maturity				
		Immature	Maturing	Mature	Ripe	Spent
Sep.	182	9.29	28.63	37.565	13.215	11.3
Oct.	145	37.55	21.145	15.34	22.075	3.89
Nov.	209	29.725	38.725	21.175	6.375	4
Dec.	198	40.405	37.12	14.21	5.175	3.09
Jan.	254	2.845	10.015	87.14	-	-
Feb.	169	8.12	12.54	79.34	-	-
Mar.	235	-	-	40.63	30.14	29.23
Apr.	145	-	-	17.12	22.425	60.455
May.	269	-	-	41.775	25.18	33.045
Jun.	154	-	24.82	32.785	13.21	29.185
Jul.	106	13.325	11.95	33.835	34.13	6.76
Aug.	91	17.63	14.635	36.33	20.625	10.78

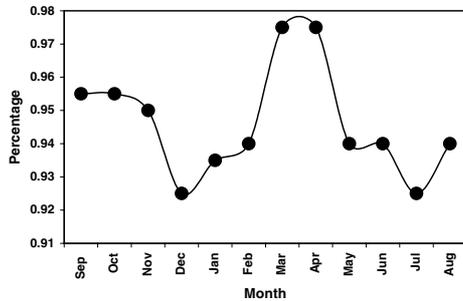


Fig 3. Average Kn values of female *D. russelli* during different months

These values of relative condition factor (Kn) are mostly high during March-April and September and vary within a narrow range of 0.92 to 0.98 strengthening the earlier conclusion that this species has prolonged spawning season.

Fishes having a total length of 20 cm and above only were considered for the study. The gonadosomatic index of male showed maximum value in April and in the subsequent months the values showed a downward trend except for a slight increase in July and reached the lowest value in December. In the case of females the index showed a bimodal nature indicating two peak spawning

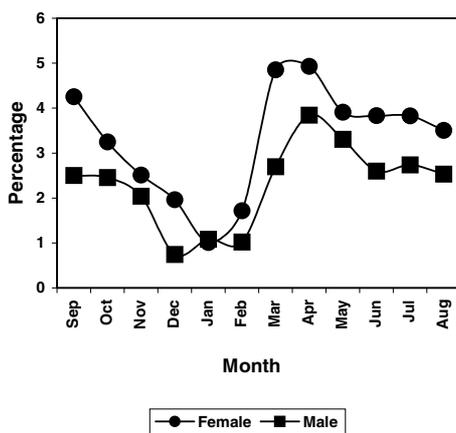


Fig 4. Monthly average gonadosomatic index of *D. russelli* during different months

periods. From March to December the gonadosomatic index remained high representing the spawning season. The observations on the occurrence of spawning individuals in the fishery for a long period stood as the confirmatory evidence to the present results on the spawning season of *D. russelli*. Based on the gonadosomatic index values and on the incidence of spawning and spent fishes in the commercial catches it is evident that the spawning season of *D. russelli* is prolonged and falls between March and December.

Sex ratio

Females dominated over males during seven months. The annual average for the whole period shows M: F ratio as 1: 1.07, indicating marginal domination of female population which was proved as insignificant at 5 % level when the sex ratio was subjected to chi-square test.

Fecundity

A curvilinear relationship exists between fecundity and length of fish and also fecundity and weight of ovary and fecundity.

The fecundity of *D. russelli* was found to vary from 33,159 to 1,96,392 ova. The number of ova per gram ovary weight varied from 8,270 to 28,300 (average 19,460). The parabolic equation between fecundity and fish length was estimated to be:

$$F = 0.0060534 L^{5.5952} \quad (r = 0.9891)$$

The graphic expression of the equation is curvilinear indicating that fecundity increases at more rapid rate in relation to length (Fig 5).

The relationship between fecundity and fish weight was found to be

$$F = 0.0076913 W^{3.7672}$$

TABLE 2. Average sex ratio between male and female of *D. russelli* during 2000-2001 and 2001- 2002

Months	No. of males	No. of females	Sex ratio M:F
September	163	182	1.12
October	141	145	1.03
November	154	209	1.36
December	166	198	1.19
January	178	254	1.43
February	156	169	1.08
March	178	235	1.32
April	200	145	0.73
May	235	269	1.14
June	187	154	0.82
July	130	106	0.81
August	115	91	0.79
Annual	2003	2156	1.07

Chi-square value = 5.62*

* Not significant at 5 % level

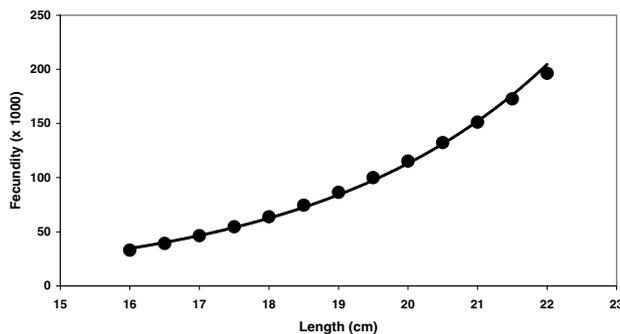


Fig 5. Relationship between length and fecundity of *D. russelli*

Discussion

Sreenivasan (1981) indicated prolonged spawning behaviour of *D. russelli* from Vizhinjam area, extending from February to November with peak during February and March. However, in the present study, *D. russelli* was observed as a continuous breeder with spent fishes appearing during March - December. Moreover, the increasing trend in the appearance of juveniles from April with an increase in the spent ones during the same period clearly suggests

that the peak spawning period is April- May. Delsman (1926), Tiews (1958) and Tiews *et al.*, (1975) also observed prolonged spawning period for *Decapterus* spp. from Java Sea and Manila Bay. Delsman (1926) reported that the spawning in *Decapterus* spp. takes place during night.

The size at first maturity is 143 mm for males and 155 mm for females. *D. russelli* in Vizhinjam area attains maturity at a fork length of 130 mm in the first year of life (Sreenivasan, 1982). Slightly different values regarding the size at maturity of *D. russelli* were observed by Premalatha (1993) as 140 mm; Murty (1991) as 150 mm and Reuben *et al.*, (1992) as 137 mm. Brinca *et al.*, (1983) reported that in Mozambique, male *D. russelli* matured at a size between 12 and 13 cm, while it was between 13 and 14 cm for females. Chullasorn and Yusukswad (1978) reported a wide range of 16.1 to 23.0 cm

size at first maturity in the study made in the Gulf of Thailand. The present observations are very close to the observations made by Sreenivasan (1982), Rueben *et al.*, (1992) and Premalatha (1993).

Sreenivasan (1981) reported that males were generally dominant in the fishery. Premalatha (1993) also observed similar dominance of males in Cochin area. Quite in contrast to the above findings, Balasubramanian *et al.*, (2000) reported marginal dominance of females over males. He further concluded that though females dominated over males, almost a 1: 1 ratio is satisfied. The present study also shows a marginal domination of females over the males substantiating the findings of Balasubramanian *et al.*, (2000).

Tiews *et al.*, (1975) reported a fecundity of 28,700 to 48,700 for *D. russelli*. Sreenivasan (1981) found a linear relationship between the length of the fish and fecundity, ovary weight and fecundity and there is a direct proportional increase in fecundity with increase in length and weight in *D. russelli*. In the present study also the fecundity of *D. russelli* is found to increase with increase in length of the fish thus supporting the earlier report by Tiews *et al.*, (1975) and Sreenivasan (1981).

Acknowledgements

I am grateful to Dr. V.J.Zacharias, former Head of Department of Zoology, St. Joseph's College, Devagiri, Calicut for the guidance and help; Prof (Dr.) Mohan Joseph Modayil, Director, CMFRI and Dr. (Mrs.) S. Sivakami, Scientist in charge, Demersal Fisheries Division, CMFRI, Cochin for their encouragement; Dr. P.N Radhakrishnan Nair, Principal Scientist, Calicut Research Centre of

CMFRI, for suggestions in the manuscript.

References

- Balasubramanian, N. K. and P. Natarajan 1999. Resource characteristics of the scads, *Decapterus russelli* and *D. macrosoma* of the Vizhinjam area, southwest coast of India. *Indian J. Fish.*, **46**(2) : 111-122.
- Balasubramanian, N. K. and P. Natarajan 2000. Studies on the biology of the scads, *Decapterus russelli* and *Decapterus macrosoma*, at Vizhinjam, southwest coast of India. *Indian J. Fish.*, **47** (4) : 291-300.
- Brinca, L., J. D. A. Silva, L. Sousa, I. M. Sousa and R. Saetre 1983. A survey of the fish resources at Sofala Bank, Mozambique, September 1982. Institute of Marine Research. Rep. Surv. R/V Dr. F. Nansen, *Inst. De Inv. Pesq.*, 85 pp.
- Clark, F. N. 1934. Maturity of the California sardine (*Sardina caerulea*) determined by ova diameter measurements. *California Fish and game Fish Bull.*, **42** : 7-49
- Chullasorn, S. and S. Yusukswad 1978. Preliminary report on the fisheries biology of the round scad (*Decapterus* spp.) in the Gulf of Thailand. *FAO/SCSP workshop on the biology and resources of mackerels and round scads*, Penang, 7-11, Nov. 1977 (Mimeo).
- Delsman, H. C. 1926. Fish eggs and larvae from the Java Sea. 5. *Caranx kurra*, *Decapterus macrosoma* and *Selar crumenophthalmus*. *Treubia*, **8** (3-4): 199-211.
- Le Cren, E. D. 1951. Length-weight relationship and seasonal cycle in gonad weight and condition of the perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20** : 201-219.
- Lovern, J. A and H. Wood 1937. Variations in the chemical composition of herring. *J. Mar. Biol. Ass., U. K.*, **22** : 281-

- 293.
- Murty, V. S. R. 1991. Observations on some aspects of biology and population dynamics of the scad, *Decapterus russelli* (Ruppell) (Carangidae), in the trawling grounds off Kakinada. *J. mar. biol. Ass. India.*, **33**(1 & 2) : 396-408
- Premalatha, P. 1993. Observations on the carangid resources of the southwest coast of India. *J. mar. biol. Ass. India.*, **35**(1 & 2) : 157-166.
- Qasim, S. Z. 1973. An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters. *Indian J. Fish.*, **20** : 166-181.
- Reuben, S., H. M. Kasim, S. Sivakami, P. N. R. Nair, K. N. Kurup, M. Sivadas, A. Noble, K. V. S. Nair and S. G. Raje 1992. Fishery, biology and stock assessment of carangid resources from the Indian seas. *Indian J. Fish.*, **39** (3 & 4) : 195-234.
- Shameen, A. 1988. A preliminary study on the biometric comparison of certain meristic characters of *Decapterus russelli* (Ruppell) and *Carangoides malabaricus* (Bloch and Schneider) from two localities along Andhra coast. *J. mar. biol. Ass. India.*, **28**(1 & 2) : 218-221.
- Sreenivasan, P. V. 1981. Maturity and spawning in *Decapterus dayi* (Wakiya). *J. mar. biol. Ass. India.*, **23**(1 & 2) : 19-28.
- Sreenivasan, P. V. 1982. Length weight relationship of the scad *Decapterus dayi* (Wakiya). *Indian J. Fish.*, **28**: 283-286.
- Sreenivasan, P. V. 1983. Age and growth of the scad *Decapterus dayi* (Wakiya). *Indian J. Fish.*, **29**(1 & 2) : 144-152.
- Sreenivasan, P. V. 1984. Feeding biology of the scad *Decapterus dayi* (Wakiya). *J. mar. biol. Ass. India.*, **21** : 97-102.
- Sreenivasan, P. V. 1987. Maturity and spawning in *Decapterus dayi* (Wakiya). *J. mar. biol. Ass. India.*, **23** (1&2).
- Tiews, K. 1958. Report to the Government of Philippines on marine fishery resources. *Phil. J. Fish.*, **6** (2): 134-138.
- Tiews, K., I. A. Ronquillo and P. Caces-Borja 1975. On the biology of round scads (*Decapterus bleeker*) in Philippines waters. *Phil. J. Fish.*, **(9)**: 45-71.

Date of Receipt : 16-08-2004

Date of Acceptance : 25-10-2004