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MATURITY AND SPAWNING IN *DECAPTERUS DAYI* WAKIYA

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ABSTRACT

Decapterus dayi Wakiya spawns over a prolonged period from February to November with intense spawning during February to April. Intraovarian eggs in the spawning stock range in size from 0.73 to 1.06 mm and only a single oil globule is present. The fish spawns during night in the inshore waters. K_n values oscilate between 0.92 and 1.00.

Both male and female mature at a size of 130-139 mm. Generally males were dominant in the fishery. Fecundity estimates varied from 16,388 to 1,07,640 in various size groups. Relationship between fecundity and length and ovary weight and weight in logarithmic values was observed to be linear.

INTRODUCTION

A STUDY on the cyclical changes in the maturation of gonad is aimed at understanding and predicting the changes which the population undergoes annually. Together with fecundity estimates, this information is useful in understanding the size of its stock and reproductive potential. A knowledge of the size at first maturity is of use in assessing the potential spawners lost from the stock by fishing while that of sex composition of catches is of help in understanding whether any differential fishing exists, its possible bearing on the fishery and whether sexual congregation takes place during spawning which can be effectively utilised for fishing.

Decapterus dayi Wakiya is one of the important fishes constituting the carangid catches of Vizhinjam, southwest coast of India (Sreenivasan, 1978 a). Since no knowledge on its maturity and spawning is available, the results of the detailed investigation undertaken during 1971-1974 are presented in this account.

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MATERIAL AND METHODS

Material for the present study was obtained twice a week from the Vizhinjam fish landing centre. A total of 4556 fish were examined over a period of four years. The extension of the gonad in the body cavity and the general appearence were used in noting down the stages of maturity. I. C. E. S. scale of maturity (Lovern and Wood, 1937) was followed with some modification as stated below.

Maturation of ova was studied by the method adopted by Clark (1934). For this study as well as for the fecundity estimates, the ova were drawn from the ovaries preserved in 5% formalin. Ova were measured with a microscope using an ocularmicrometer (1 micro-division = 0.0196 mm) at 5 x 10 magnification. In the preliminary examinations, it was observed that there were no marked variations in the number and size of ova between the anterior, middle and posterior portions of right and left lobes of the ovary. Therefore samples were drawn only from the left lobe later on. 300 ova were measured from each ovary and 15 ovaries were examined in each stage of maturity. In gonads of the stages I and II,

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eggs of all sizes were measured, while in other stages eggs above 6 md only were measured.

For the purpose of finding out the K_n values, the equation

$$K_n = \frac{W}{W^{\wedge}}$$

was employed (Le Cren, 1951) where W represents the observed weight of the fish and $W^{\wedge}$ the calculated weight. Only adult fish of both sexes were considered for the study. Since the length-weight relationship for both male and female of *D. dayi* did not differ significantly (Sreenivasan, 1981), combined regression equation was utilised for calculating the $W^{\wedge}$ values.

For estimating the fecundity, the method followed by Burd and Howlett (1974) was employed and for this only ovaries in Stage V were used.

Maturity Stages

Stage I : Immature (Virgin)

Ovary: Thin, small and pink coloured. Small transparent ova measuring 0.0196 mm or less; visible under higher magnification only.

Testis: Thin, pale pinkish in colour.

Stage II : Immature (Virgin)

Ovary: Small, tubular; fills ¼ of the body cavity; pinkish in colour. Ova range in size from 0.0196 to 0.1764 mm. Transparent eggs with clearly visible nucleus present.

Testis: Pale pinkish; slightly flattened; occupies 1/3 of the body cavity.

Stage III : Maturing

Ovary: Large tube like occupying ½ of the body cavity; ovarian wall thick and the eggs not visible through it; dusky yellow in colour; eggs range in size from 0.0196 to 0.4704 mm; two sets of ova are seen, one set with clearly visible nucleus and the other with opaque and yolked ova.

Testis: Pale whitish in colour occupying ½ of the body cavity.

Stage IV : Mature

Ovary: Bright yellow in colour occupying ¾ of the body cavity; ovary wall thin and yellow yolked ova are seen through it; both transparent and yolked ova are present; their sizes range from 0.0196 to 0.6468 mm.

Testis: Whitish occupying ¾ of the body cavity.

Stage V : Ripe

Ovary: Bright yellow in colour, occupies the whole of the body cavity; eggs measuring from 0.0196 to 0.8232 mm.; some eggs with oil globule are also present.

Testis: Fill the entire body cavity; whitish in colour.

Stage VI : Running

Ovary: Body cavity is wholly filled with the ovarian lobes; pale yellowish in colour; ovary wall thin; eggs extrude under slight pressure; large translucent ova with single oil-globule (size ranging from 0.137 to 0.176 mm), opaque, yellow ova and also small transparent ova are present; size of eggs range from 0.0196 to 1.0584 mm.

Testis: Running testes were not available for examination.

Stage VII : Spent

Ovary: Blood stained and flacid ovaries were assigned to this stage. Some ovaries occupy 3/4 of the body cavity; eggs in them range in size from 0.0196 to 0.8232 mm; three types of ova are met with *viz.*, transparent

small ova, yolked opaque ova and few eggs with oil globule (VII a); most of the large eggs are under condition of disintegration with broken egg membrane and yolk oozing out. In some other ovaries, only transparent and opaque eggs were present (VII b) and (VII c), while in others only transparent eggs were seen (VII d). The first two types of ovaries occupy less than ½ of the body cavity while the third occupies only ¼ of it.

Testis: Blood shot and shrunken occupying ¾ of the body cavity in some fish while in others much smaller.

Stage II^R : Recovered spetn

Ovary: Small tubular; pale reddish or pinkish; eggs range in size from 0.0196 to 0.1764 mm.

Testis: Pale reddish occupying less than 1/3 of the body cavity.

OBSERVATIONS

Maturation of ova

Ova diameter frequency of *D. dayi* in different stages of maturity is given in Fig. 1. In Stage I and II, only transparent ova with clearly visible nucleus was observed. This stock ranging in size from 1 md to 9 md were present in all stages of maturity and can be named as general egg stock. In Stage III, some of the eggs drawn from the general Tock were under the process of maturation. sthese eggs were deposited with yolk and become opaque. They increase in size further in next stage (IV) and form a separate stock with mode at 25–27 md. In stage V, the above group increases in size with a mode at 28–30 md, while another batch of eggs assort themselves into a separate group with a mode at 16–18 md and starts to undergo the process of maturation. In Stage VI, the first batch swells enormously to become large hyaline eggs with a mode at 46–48 md and this batch represents the eggs to be spawned immediately. At the same time the second batch of eggs were also present with mode at 22–24 md. It is significant to note that the size of the pelagic eggs observed by Delsman (1926) for *Decapterus* spp. was 0.84 mm to 1.04 mm which is more or less equivalent to the size of the spawning eggs in the ovaries.

TABLE 1. K_n *values* of D. dayi *in different months during* 1971 – 1974

Month	1971	1972	1973	1974
January	—	0.95	—	0.95
February	0.95	—	—	0.96
March	0.97	—	—	0.96
April	0.95	0.95	0.96	0.97
May	0.97	0.94	0.95	0.98
June	1.00	0.95	0.95	0.99
July	0.97	0.96	0.96	0.97
August	0.98	—	0.97	0.98
September	0.92	0.96	0.97	—
October	0.95	0.96	0.97	0.97
November	0.98	—	0.97	0.98
December	0.93	—	—	1.00

In stage VII a, the first batch were lost, while the second batch of eggs remain with very little representation. In Stage VII b, the maximum size of the eggs drop further to 33 md. In Stage VII c and VII d, the second batch was not represented altogether and in II^R only the general egg stock was observed.

The above observation leads to the conclusion that the second batch of mature stock was not spawned but reabsorbed within the ovaries. Such cases of reabsorbtion of eggs were earlier observed among the carangids by Macer (1974) and Sreenivasan (1978 b).

Spawning

To determine the period of spawning of *D. dayi*, the percentage composition of female

TABLE 2. *Percentage occurrence of males of* D. dayi *in different stages of maturity in different length groups*

Length group (in mm)	Number of fish examined	Stages of maturity I	II	III	IV	V	VI	VII	II^R
70– 79	1	100.00	—	—	—	—	—	—	—
80– 89	1	100.00	—	—	—	—	—	—	—
90– 99	8	62.50	25.00	12.50	—	—	—	—	—
100–109	33	69.70	30.30	—	—	—	—	—	—
110–119	41	53.40	36.60	7.30	2.40	—	—	—	—
120–129	118	13.60	38.10	28.80	3.40	2.50	—	13.60	—
130–139	239	1.20	10.50	27.70	10.90	5.10	—	33.20	11.30
140–149	305	—	4.60	24.90	21.30	5.60	—	35.10	7.50
150–159	216	—	—	26.90	32.40	2.30	—	31.50	6.90
160–169	248	—	—	26.60	27.00	9.30	—	30.00	6.20
170–179	279	—	—	18.60	30.80	10.40	—	18.60	16.60
180–189	191	—	—	13.10	28.30	13.10	—	41.30	4.20
190–199	50	—	—	2.00	38.00	24.00	—	32.00	4.00
200–209	3	—	—	—	33.30	33.40	—	—	23.30

TABLE 3. *Percentage occurrence of females of D. dayi in different stages of maturity in different length groups*

Length group (in mm)	Number of fish examined	Stages of maturity I	II	III	IV	V	VI	VII	II^R
90–99	4	50.00	50.00	—	—	—	—	—	—
100–109	12	75.00	25.00	—	—	—	—	—	—
110–119	30	63.30	36.70	—	—	—	—	—	—
120–129	69	11.60	49.30	11.60	2.90	5.80	—	18.80	—
130–139	121	2.10	14.10	13.10	17.80	18.30	—	33.50	1.10
140–149	205	—	2.40	9.30	17.70	16.10	2.40	49.70	2.40
150–159	265	—	1.10	5.70	18.90	7.20	3.80	61.00	2.30
160–169	267	—	—	12.40	34.10	5.20	0.80	45.00	2.60
170–179	332	—	—	10.80	30.00	7.80	—	49.60	1.8
180–189	181	—	—	10.50	34.80	8.80	—	49.20	1.70
190–199	30	—	—	3.30	30.00	13.40	—	50.00	3.30
200–209	4	—	—	—	75.00	—	—	25.00	—

and male in different stages of maturity in different months was analysed (Fig. 2 and 3 respectively). Mature, ripe and spent gonads were observed from February to November of broods in various months from June to November which confirms the theory of prolonged spawning in *D. dayi*. Delsman (1926), Tiews (1958) and Tiews *et al.* (1975)

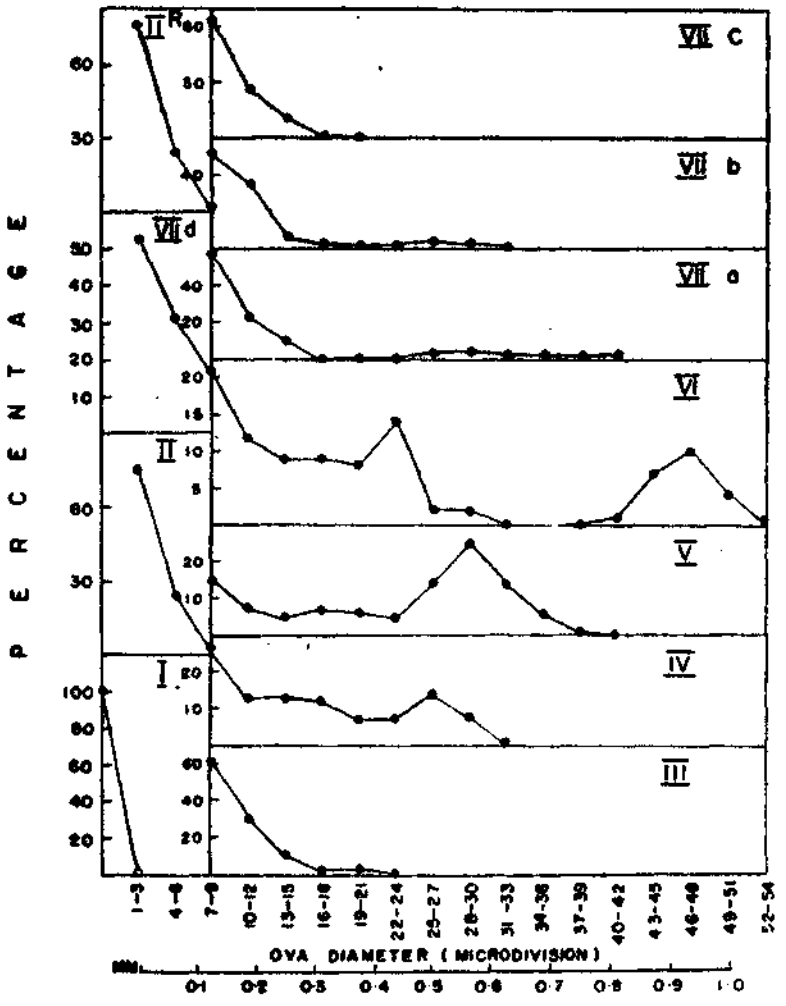

Fig. 1. Ova diameter frequency in *D. dayi* in different stages of maturity.

indicating the prolonged spawning season for this fish. Running ovaries were collected in April 1971, February and March 1974 indicating the period of active spawning. Sreenivasan (1982) recorded the appearence also observed prolonged spawning of *Decapterus* spp. from Java Sea and Manila Bay.

Extended period of spawning was also observed by Mc Kenny *et al.* (1958) *Caranx crysos*, Tandon (1962) in *Selaroides leptolepis*

Kagwade (1971) in *Caranx kalla* and Chabanne (1972) in *Caranx* spp.

Time of spawning appears to be during night and early morning since the specimens in spawning condition were collected from night and early morning catches. Delsman (1926) also observes that spawning in *Decapterus* spp. takes place during night.

Though neither planktonic eggs nor larval stages of *D. dayi* could be collected during the period of observation, from the occurrence of ripe and spawning individuals in the commercial catches and from the occurrence of juveniles measuring from 20 mm onwards it can be said that the fish spawn in the inshore waters only.

Relative condition factor

Relative condition factor (K_n) values obtained during different months of the years 1971-1974 are given in Table 1. These values are mostly high and vary within a narrow range of 0.92 to 1.00 strengthening the earlier conclusion that this species has prolonged spawning season.

Size at first maturity

The length of *D. dayi* at which it attains maturity was determined by analysing the percentage composition of various stages of maturity in different length groups. The length-maturity data of 1734 male specimens ranging in size from 70 to 219 mm (Table 2) and 1590 females ranging from 90 to 209 mm (Table 3) were analysed for the purpose. From the Tables it can be seen that fish below 109 mm were mainly immature. Mature specimens (Stage IV onwards) were recorded from 110 mm in case of male and from 120 mm in the case of female. However, 50% of fish were either mature, ripe or spent from 130 mm only in both the sexes. Therefore it can be concluded that the fish attain the maturity at this size which was attained by the fish at its 10th month of life. So, *D. dayi* attains maturity and spawns in the first year of life itself. Tiews *et. al.* (1975) state that *D. russelli* mature at the size of 180-200 mm total length (160–180 mm fork length) at the age of third year. They also state that the fish spawns only once in its life time.

Sex ratio

Sex ratios in the population *D. dayi* in different months are given in Fig. 4. Males appear to dominate during April, May, November and December. The percentage occurrence of males and females in different size groups (Fig. 5) shows that males dominate markedly till the fish attains 100–109 mm. The ratio of female progressively increases till the fish grows to 170–179 mm. Thus, there appears to be a congregation of both sexes as the fish attain first maturity and occur more or less in equal numbers till they grow to 180–189 mm.

Fecundity

The reproductive potential of a population has considerable bearing on the fecundity in the females. Fecundity estimates made for the present study were based on the eggs found in the advanced group ranging in size from 22 md to 42 md in Stage V of the maturity. Totally 43 ovaries were examined from the fish ranging in size from 125 to 248 mm. The number of eggs ranged from 16,388 to 1,07,640 in various groups. Tiews *et al.* (1975) report a fecundity of 28,700 to 48,700 for

D. russelli and 69,900 to 1,06,200 for *D. macrosoma/lajang*.

(Fig. 6) and there is a direct proportional increase in fecundity with increase in length

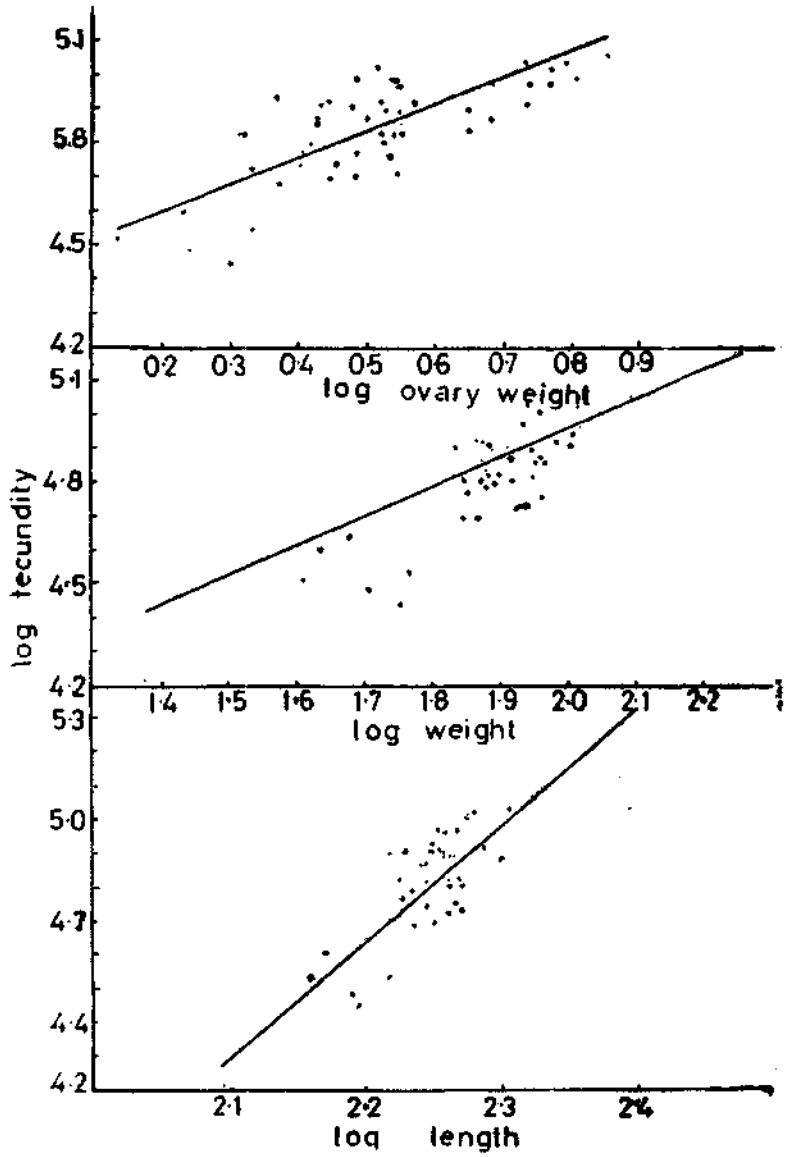

Fig. 6. Fecundity in relation to length, ovary weight and weight (Continuous line indicates the calculated values).

A linear relationship exists between the *log* values of length, ovary weight and fecundity and weight. The regression equation obtained by least square method for the relationships

between length, ovary weight and weight and fecundity are:

For length:

log fecundity = —3.2841 + 3.5976 *log L* (r = 0.9456, P > 0.01, significant at 5% level).

For *ovary weight:*

log fecundity = 4.4429 + 0.7836 *log* W (r = 0.8634, P > 0.01, significant at 5% level).

For weight:

log fecundity = 3.3716 + 0.7639 *log* W (r = 0.9499, P > 0.01 significant at 5% level).

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