OBSERVATIONS ON THE FISHERY AND BIOLOGY OF *MEGALASPIS CORDYLA* (LINNAEUS) AT VIZHINJAM

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ABSTRACT

The fishery for *Megalaspis cordyla* (locally called *Vangoda*) formed on an average 6.63% of the total marine fish landings at Vizhinjam. An increasing trend in the fishery was noticed from 1969 to 1973. Hooks and lines and drift nets contributed to about 95.8% of the catch. Post-monsoon period was the best season for the landings of *M. cordyla*.

Maturity studies indicated that the fish spawned only once a year and the spawning period was of prolonged nature, from December to July with intensive spawning during monsoon season. Spawning takes place beyond 5Km fishing belt of Vizhinjam and the probable time of spawning being during night. Both the females and males mature at the minimum size of 250 mm and the size at first maturity being 270 mm. Females were generally found more in the catches.

The fish grows to 250 mm in the first year and to 290 mm in second year, 320 mm in the third year and to 330 mm by 40 months. The fishery was composed of 0-year and one-year old fishes, both of them accounting to 90% of the catches, and generally the former being the dominant.

INTRODUCTION

Megalaspis cordyla (Linnaeus), locally known as "Vangada" (Malayalam), forms on an average about 40% of the carangid catch at Vizhinjam. A study of this important fishery at Vizhinjam was initiated, since no information was available regarding its fishery potential and biology except for the breif remarks of Radhakrishnan (1973) and the study on the food habits by Sreenivasan (1975). The present paper embodies the results of the work on age and growth, maturity, catch and disposal, undertaken during the period from July 1970 to December 1973.

MATERIAL AND METHODS

The catch data presented in this account related to a period of five years from 1969 to 1973 and samples for biological studies were collected from the commercial catches at Vizhinjam for a period of 40 months from August 1970 to November 1973. Random samples were taken twice a week for biological

studies and catch analysis. Usually 10 to 50% of the total number of units of each type operated were sampled. The catch of *M. cordyla* on the day of observation (Yd), monthly catch (Y) and catch per unit of effort (Catch per unit of gear per day (Y/g) were estimated by the method employed by Sekharan (1965).

Length in the text refers to the fork length measured from tip of snout to the tip of the smallest caudal ray. For general classification of maturity stages, the I.C.E.S. system was followed.

Since there were no external characters by which sex could be distinguished abdominal incision was made to determine the sex. After noting the stage of maturity and colour, the gonads were preserved in 5% formalin. For measuring the ova, the method developed by Clark (1934) and adopted by Antony Raja (1967) was followed. One microdivision of the micrometer used equalled 0.0196 mm and the magnification used was 5 x 10. Ova samples were taken from preserved ovaries. To find out differential distribution of ova within the ovary, samples of ova from six regions, anterior, middle and posterior regions of right and left lobes of a ripe ovary (Stage VI) were taken. 300 ova from each sample were measured and the percentage occurrence of these ova showed no marked difference. Therefore, measurements of ova were taken from a single samples from the middle portion of the left lobe of each ovary. In immature and in spent recovering ovaries, all the available sizes of ova were measured, while from ovaries in other stages of maturity, ova above 6 m.d. only were measured.

EXPLOITATION

Catch

The annual landings of *M. cordyla* at Vizhinjam was 223, 288, 316, 338 and 372 tonnes respectively during the years 1969, '70, '71, '72 and '73 showing a steady increase and the catch in 1973 was 1.66 times that of 1969. The details of *M. cordyla* landings with its percentage composition in the total marine sh production and among the carangid catch at Vizhinjam are presented in Table 1.

Fishing crafts and gears

Among the various crafts and gears employed at Vizhinjam (Nayar 1958), four types namely, *'Thattu madi'* (boat seines), *'Kara madi'* or *'Kamba vala'* (Shore seines), *'Choonda'* (hooks and lines) and *'Pattu vala'* (drift nets) land *M. cordyla*. These are operated from two types of crafts, *'Vallom'* (dug-out or plank built canoes) and *'Maram'* (raft catamarans). Drift nets are operated at night and hooks and lines and shore seines during day, whereas boat seines are operated during both night and day. The period of operation of these gear is also restricted to certain months, and this is particularly true of the drift nets,

TABLE 1. *Annual landings of* M. cordyla *and its percentage in the carangid catch and total fish production at Vizhinjam.*

Year	Catch of *M.cordyla* in Kg.	Percentage in carangid catch	Perecntage in total fish catch
1969	223484	36.05	8.69
1970	287513	36.87	6.33
1971	315752	34.85	6.00
1972	338291	44.22	5.81
1973	371693	42.23	6.32

which are employed from September to middle of May (during monsoon season they were not operated) while boat seine operation also is limited to about nine months a year (March to November).

The gear-wise landings of *M. cordyla* indicated that hooks and lines and drift nets fetch together on an average of 95.8% of the catch, while boat seines and shore seines land the rest. Moreover, the data on catch per unit of effort in respect of each type of gear and in different months presented in Table 2, further indicate that drift nets and hooks and lines are more successful than the seine nets in catching this species. Their success can be attributed to two reasons: (1) both of them are operated away from the near shore region, where probably good concentrations of the fish were found and (2) operation of drift nets in surface layers during night and the hooks and lines in slightly deeper waters during day may suitably utilise the vertical migratory habits of the fish.

Among the four gears, the boat seines landed only individuals less than 200 mm, the hooks and lines and drift nets caught fish above 200 mm and the shore seines netted all size groups. However, on any single day, the modal values of the size groups of fish caught in different gears were generally observed to be the same.

Seasonal abundance

The fishery of *M. cordyla* at Vizhinjam extends for a period of 10 to 11 months in a year with two peak seasons, viz., the pre-monsoon peak, from March to May and the post-monsoon peak from September to December (Fig. 1) the latter being the more important. The post-monsoon fishery was composed mainly of spent-recovering fishes and this period was observed to be the active feeding season for *M. cordyla* (Srenivasan 1975) and it may therefore, be inferred that fish move to inshore waters, where good concentration of food of the fish is available.

TABLE 2. *Catch per unit of effort* (in kg) *of different gears for* M. cordyla *during* 1969-73.

Year	Gear	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average for the year
1969	Hooks and line	1.32	—	5.85	7.07	—	—	—	—	8.83	8.01	17.13	7.54	5.81
	Boat seine	—	—	—	—	—	—	—	—	—	—	—	—	—
	Shore seine	—	—	1.50	1.67	—	—	—	—	—	—	4.38	—	0.80
	Drift net	1.06	—	4.36	2.12	—	—	—	—	—	1.31	20.60	4.54	4.04
1970	Hooks and line	0.80	3.61	7.76	4.44	6.32	—	—	—	—	—	11.51	1.95	3.82
	Boat seine	—	—	3.41	1.00	0.85	—	—	0.41	1.23	—	—	—	0.04
	Shore seine	—	—	3.61	—	—	—	—	—	2.62	3.50	—	—	0.61
	Drift net	1.07	—	7.65	3.48	4.28	—	—	—	—	6.30	4.80	0.88	3.82
1971	Hooks and line	1.40	—	2.11	2.74	2.70	—	0.48	—	1.10	—	11.89	4.77	2.85
	Boat seine	—	—	—	—	—	—	0.28	0.05	3.92	—	—	—	0.83
	Shore seine	9.10	—	0.43	—	—	—	—	—	1.96	—	—	—	0.61
	Drift net	1.30	1.38	1.70	—	—	—	—	—	11.00	16.95	14.20	7.03	7.30
1972	Hooks and line	1.56	1.59	1.33	3.23	2.74	0.87	12.29	—	0.98	4.75	5.49	1.28	3.02
	Boat seine	—	—	—	—	—	—	—	—	—	1.50	—	—	0.13
	Shore seine	—	—	—	—	—	—	—	—	—	—	4.39	—	0.16
	Drift net	4.04	4.37	2.20	4.78	1.94	—	—	—	—	11.84	13.80	8.45	5.32
1973	Hooks and line	—	—	2.99	3.13	2.47	0.28	0.66	—	—	2.16	3.62	—	1.65
	Boat seine	—	—	—	—	—	0.24	0.16	0.43	—	—	—	—	0.12
	Shore seine	—	—	—	—	—	—	—	—	—	10.95	—	—	1.57
	Drift net	—	—	1.60	2.86	0.62	—	—	—	5.17	50.91	5.10	3.12	12.77

Catch disposal

The catch of *M. cordyla* at Vizhinjam is disposed off in fresh condition at nearby places like the Trivandrum city and the markets of suburban areas like Balaramapuram, Neyyattinkara, Kattakkada and Nedumangad, where it finds a ready market. The price of the fish varies from day to day depending on the availability of *M. cordyla*, as well as other fishes and the rate per Kg. of fish varied from Rs. 2.50 to 3.00. During glut seasons the fish are iced and sent to interior markets like Kottayam in lorries. Sun-drying or other methods of preservations of *M. cordyla* are rarely used at Vizhinjam.

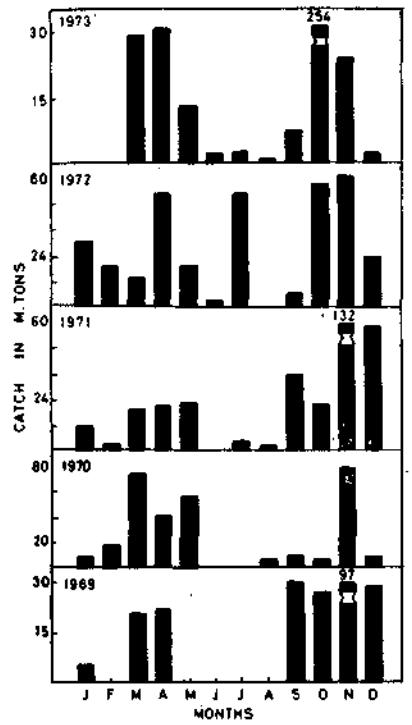

FIG. 1. Seasonal abundance of *M. cordyla* during 1969-1973.

MATURITY AND SPAWNING

A total of 2458 specimens of *M. cordyla* were examined of which 582 were indeterminates. The following characters distinguish the different stages of maturity of female and male gonads.

Stage I Immature (Virgin)

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

Testes: Thin, pale pinkish in colour.

Stage II Immature (Virgin)

Ovaries: Translucent, occupying 1/4 to 1/3 of the body cavity. Pinkish in colour. Ova size range from 0.0196 mm to 0.118 mm. Eggs transparent with visible nucleus and cytoplasmic layer but without yolk deposition, oval in shape and not seen with naked eye.

Testes: Pinkish in colour occupying about 1/3 of the body cavity.

Stage III (Maturing)

Ovaries: Yellow in colour and occupying half of the body cavity. Walls thick, so eggs not visible through the walls. Transparent eggs as well as yellow, spherical, opaque eggs with yolk present. Size of eggs ranges from 0.0196 mm to 0.431 mm.

Testes: Pinkish in colour occupying about 1/3 of the body cavity.

Stage IV (Mature)

Ovaries: Bright yellow in colour occupying 3/4 of the body cavity. Tunica at this stage thin and large eggs seen through the walls with naked eye. Transparent and opaque eggs present. Size range of eggs is from 0.0196 mm to 0.510 mm.

Testes: Whitish in colour and extend to 3/4 of the body cavity.

Stage V (Ripe)

Ovaries: Bright yellow in colour occupying the entire body cavity. Eggs measuring from 0.0196 mm to 0.627 mm present. A few large eggs with oil-globules also observed.

Testes: Whitish in colour, and fill the entire body cavity.

Stage VI (Running)

Ovaries: Occupying fully the body cavity, pushing aside the digestive organs. Large translucent ova with single oil-globule (Size range from 0.137 mm to 0.176 mm). Opaque, yolked ova and small transparent ova also present. The maximum size of the eggs recorded are 0.882 mm and the total size ranged from 0.0196 mm to 0.882 mm. Ovaries pale reddish yellow in colour giving "plum pudding" appearance, because of the visibility of both translucent and opaque eggs through thin tunica.

Testes: Testes at this stage were not available during the period of observation.

Stage VII (Spent)

Ovaries of this stage were not recorded.

Testes of this stage also could not be collected.

Stage II^{R} (Recovered spent)

Ovaries: Pink coloured, shrunk and loosely packed occupying 1/3 of the body cavity. Eggs range in size from 0.0198 mm to 0.118 mm.

Testes: Flesh coloured occupying 1/3 of the body cavity.

Maturation of ova

Representative samples of ovaries in different stages of maturity were selected, and 300 ova measured from each of these ovaries were assorted into 2 m.d. groups and the percentage occurrence of each group was calculated and average values were found. The ova diameter frequency in each stage of maturity is given in Fig 2.

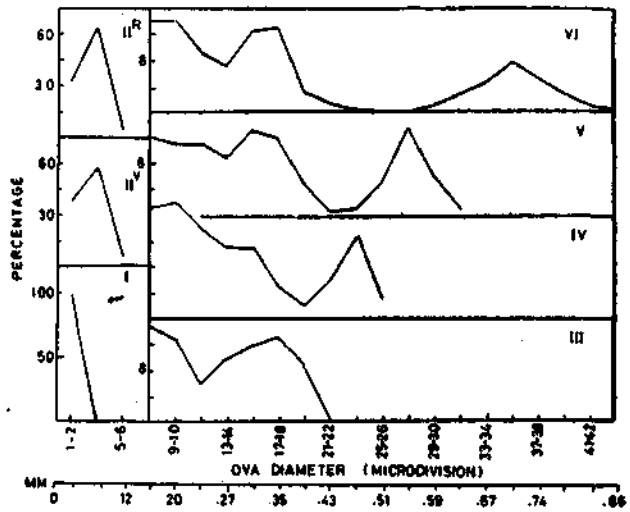

FIG 2. Ova diameter frequency in *M. cordyla* in differennt stages of maturity.

The immature ova with mode at 1-2 m.d. of Stage I, and at 3-4 m.d. of Stage II, which can be termed as general egg stock, are present in all stages of maturity. In Stage III, a batch of ova drawn from the general egg stock, begins to undergo the process of maturation. The mode of this batch at this stage is at 17-18 m.d. and in the next stage (IV) at 23-24 m.d. At Stage V, the same batch of matured eggs increases in diameter to 27-28 m.d. while one more mode at 15-16 m.d. is also noticed. At the next stage (VI), while the first batch of

eggs increases in size rapidly and reaches a modal value of 35-36 m.d. and gets itself isolated from the rest of egg stock ready to be extruded, the maturing second batch of ova moves only to 17-18 m.d. At Stage II^R both the batches of ova are lost and only the general egg stock is present.

A rapid increase in the size of ovum is noticed from Stage V to VI when the intra-ovarian eggs reach the maximum size measuring 0.882 mm. This Phenomenon of sudden increase in the ova diameter prior to extrusion may be due to the uptake of fluid by fully ripe ova which results in their swelling and becoming hyaline (Fulton 1898). The size of the largest intra-ovarian egg recorded in the present observations is close to those of the planktonic eggs of *M. cordyla* reported by Kuthalingam (1959) from Madras waters, the size of which were about 0.9 mm.

Qasim (1973), reviewing the works on maturation and spawning in marine teleosts from Indian waters, stated that different batches of eggs are likely to be spawned during different seasons of the year. Antony Raja (1967) and Mecer ,1974) are, however, of the opinion that the first batch of ripe eggs alone are spawned while the secondary batch generally gets disintegrated and resorbed soon after spawning. The present observations also show that only the first batch of ova are developing actively for spawning while the second batch of ova showed no advancement in growth suggesting that this batch of eggs may not be extruded but probably be resorbed.

Spawning

From the percentage occurrence of different stages of maturity of females and males presented in Table 3 and 4 respectively, it could be inferred that the spawning in *M. cordyla* was of prolonged nature commencing from December and extending to July. However, occurrence of fish with gonads in Stage IV to VI in comparatively higher percentages during May-July indicate that intensive spawning occurred during this period.

The absence of planktonic eggs, larvae, postlarvae and also the dearth of adult individuals in Stages IV-VI suggest that *M. cordyla* spawn far away from the 5 km fishing zone of Vizhinjam. The presence of fish with running ovaries in drift net catches which were operated during night, indicates that spawning may probably take place during night hours.

Size at first maturity

To determine the minimum size of fish at first maturity, a total of 1098 specimens of females and 772 males were grouped sex-wise into 20 mm groups and the percentage occurrence of fish of various maturing stages in each group was worked out.

TABLE 3. *Monthly percentage occurrence of females of* M. Cordyla *in different stages of maturity.*

Month	No. of Specimens Examined	I	II	III	IV	V	VI	VII	IIR
1970									
Aug.*	—	—	—	—	—	—	—	—	—
Sep.	2	—	—	—	—	—	—	—	100.00
Oct.	16	50.00	6.25	—	—	—	—	—	43.75
Nov.	104	1.92	16.35	15.38	—	—	—	—	66.35
Dec.	95	—	3.15	29.47	2.11	1.05	—	—	64.21
1971									
Jan.	87	2.30	32.18	37.93	—	—	—	—	27.59
Feb.	33	—	—	75.76	3.03	—	—	—	21.22
Mar.	77	—	10.39	66.23	1.30	—	—	—	22.08
Apr.	57	—	—	92.98	3.51	—	—	—	3.51
May	54	—	—	98.15	1.85	—	—	—	—
Jun.	—	—	—	—	—	—	—	—	—
Jul.	17	—	—	100.00	—	—	—	—	—
Aug.*	—	—	—	—	—	—	—	—	—
Sep.	17	—	—	17.65	—	—	—	—	82.35
Oct.	15	26.67	—	—	—	—	—	—	73.33
Nov.	52	7.69	13.46	3.85	—	—	—	—	75.00
Dec.	33	—	33.33	27.27	—	—	—	—	39.40
1972									
Jan.	—	—	—	—	—	—	—	—	—
Feb.	27	—	44.44	—	—	—	—	—	55.56
Mar.	21	—	66.67	—	—	—	—	—	33.33
Apr.	27	3.70	62.96	7.41	—	—	—	—	25.93
May	27	—	25.93	11.11	3.70	—	—	—	59.26
Jun.	17	11.76	64.71	17.65	—	—	—	—	5.88
Jul.	27	—	—	96.30	—	3.70	—	—	—
Aug.	—	—	—	—	—	—	—	—	—
Sep.	13	—	—	—	—	—	—	—	100.00
Oct.	14	—	—	—	—	—	—	—	100.00
Nov.	50	20.00	24.00	4.00	—	—	—	—	52.00
Dec.	47	2.13	23.00	—	—	—	—	—	74.47
1973									
Jan.	—	—	—	—	—	—	—	—	—
Feb.	—	—	—	—	—	—	—	—	—
Mar.	40	—	7.50	42.50	2.50	—	—	—	47.50
Apr.	38	—	78.95	15.79	2.63	2.63	—	—	—
May	11	—	27.27	36.37	9.10	9.10	18.18	—	—
Jun.	4	—	100.00	—	—	—	—	—	—
Jul.	1	—	—	100.00	—	—	—	—	—
Aug.*	—	—	—	—	—	—	—	—	—
Sep.	15	—	—	26.67	—	—	—	—	73.33
Oct.	30	3.33	—	16.67	—	—	—	—	80.00
Nov.	33	—	12.12	6.06	—	—	—	—	81.82

* All specimens examined were sexually indeterminates.

TABLE 4. *Monthly percentage occurrence of males of* M. cordyla *in different stages of maturity.*

Month	No. of specimens Examined	I	II	III	IV	V	VI	VII	IIR
1970									
Aug.*	—	—	—	—	—	—	—	—	—
Sep.	6	—	—	16.67	50.00	—	—	—	33.33
Oct.	13	15.38	—	—	—	—	—	—	84.62
Nov.	82	—	13.42	18.29	—	—	—	—	68.29
Dec.	67	7.46	20.90	—	—	—	—	—	71.64
1971									
Jan.	69	11.59	28.99	33.33	5.80	—	—	—	20.29
Feb.	21	—	—	76.19	14.29	—	—	—	9.52
Mar.	55	—	5.45	76.37	5.45	—	—	—	12.73
Apr.	38	—	—	86.84	10.53	—	—	—	2.63
May	21	—	—	38.10	42.86	19.04	—	—	—
Jun.	—	—	—	—	—	—	—	—	—
Jul.	8	—	—	75.00	25.00	—	—	—	—
Aug.*	—	—	—	—	—	—	—	—	—
Sep.	10	—	—	10.00	—	—	—	—	90.00
Oct.	24	16.67	8.33	—	—	—	—	—	75.00
Nov.	33	6.06	36.36	3.03	—	—	—	—	54.55
Dec.	29	6.90	37.93	13.79	—	—	—	—	41.38
1972									
Jan.	—	—	—	—	—	—	—	—	—
Feb.	18	11.11	27.78	5.56	—	—	—	—	55.55
Mar.	19	36.84	31.58	—	5.26	—	—	—	26.32
Apr.	18	11.11	55.55	11.11	5.56	—	—	—	16.67
May	13	—	30.77	30.77	7.70	15.38	—	—	15.38
Jun.	7	—	—	85.72	—	—	—	—	14.28
Jul.	17	—	17.65	47.06	29.41	5.88	—	—	—
Aug.	—	—	—	—	—	—	—	—	—
Sep.	7	—	14.28	14.28	—	—	—	—	71.44
Oct.	3	—	—	—	—	—	—	—	100.00
Nov.	29	10.34	10.34	24.14	—	—	—	—	55.18
Dec.	18	—	44.44	—	—	—	—	—	55.56
1973									
Jan.	—	—					—	—	—
Feb.	—	—					—	—	—
Mar.	37	—	—	37.84	—	—	—	—	62.16
Apr.	29	17.24	65.52	17.24	—	—	—	—	—
May	15	—	66.67	33.33	—	—	—	—	—
Jun.	2	50.00	50.00	—	—	—	—	—	—
Jul.*	—	—	—	—	—	—	—	—	—
Aug.*	—	—	—	—	—	—	—	—	—
Sep.	20	—	—	10.00	—	—	—	—	90.00
Oct.	30	3.33	3.33	20.00	—	—	—	—	73.34
Nov.	17	—	—	5.88	—	—	—	—	94.12

* Samples examined, but males did not occur.

Fish upto 159 mm were totally indeterminates and the percentage composition of such individuals decreased to 84.44% in 160-179 mm; 69.41% in 180-199 mm; 52.05% in 200-219 mm and to 10.76% in 220-239 mm groups.

The percentage occurrence of different stages of females (Table 5), showed that fish upto 239 mm were mainly virgin immatures, but from 240-259, stage III-VI and recovered spents occurred in high percentages. It is, therefore evident that the minimum size at maturity is 240-259 and 50% or more of fish either mature or spent recovered at the size of 260-179 mm.

TABLE 5. *Percentage composition of different stages of maturity of females of* M. cordyla *in relation to length.*

Length Group	No. of Specimens examined	I	II	III	IV	V	VI	VII	IIR
160-179	11	81.81	18.19	——	——	——	——	——	——
180-199	23	47.83	47.83	4.34	——	——	——	——	——
200-219	29	24.13	75.87	——	——	——	——	——	——
220-239	85	3.53	90.58	5.89	——	——	——	——	——
240-259	104	4.81	60.58	23.08	1.92	1.92	1.92	——	5.77
260-279	149	——	19.46	39.60	0.67	0.67	——	——	39.60
280-299	371	——	——	43.55	0.27	——	——	——	56.18
300-319	255	—	——	41.96	2.35	0.39	——	——	55.30
320-339	48	——	——	14.58	——	——	——	——	85.42
340-359	12	——	——	8.33	——	——	——	——	91.67
360-379	11	——	——	——	——	——	——	——	100.00

In the case of males (Table 6), the maturing, mature, ripe and recovered spents increased in their percentage composition from 240-259 mm onwards suggesting the minimum size of first maturity is at 240-250 mm and 50% and more individuals either mature or spent recovered at the length group of 250-279 mm as in the case of females.

Sex ratio

It is seen from the monthly percentage composition of females and males presented in Table 7, that females dominated the catch in almost all the months. It is also observed from Table 8 that the females occur in maximum numbers in all the size groups except in the 240-259 mm groups where more or less equal proportion of both sexes are observed.

The dominance of a particular sex in the catches was variously interpreted, by Kesevan (1942), Alm (1959), and Qasim (1966). In the present

TABLE 6. *Percentage composition of different stages of maturity of males of* M. cordyla *in relation to length.*

Length Group	No. of Specimens examined	I	II	III	IV	V	VI	VII	IIR
160-179	4	100.00	—	—	—	—	—	—	—
180-199	4	50.00	50.00	—	—	—	—	—	—
200-219	6	50.00	50.00	—	—	—	—	—	—
220-239	81	28.40	61.73	9.87	—	—	—	—	—
240-259	96	7.29	65.63	22.92	2.08	—	—	—	2.08
260-279	129	—	13.95	33.33	5.43	0.78	—	—	46.51
280-299	270	—	—	34.81	5.56	1.48	—	—	58.15
300-319	134	—	—	34.33	4.48	1.49	—	—	59.70
320-339	37	—	—	27.03	10.81	—	—	—	62.16
340-359	10	—	—	20.00	20.00	—	—	—	60.00
360-379	1	—	—	—	—	—	—	—	100.00

findings, the occurrence of equal number of females and males in the length group 240-259, which is also the minimum size of first maturity suggests the congregation of both the sexes for spawning as was inferred by Kagwade (1971) in the case of *Caranx kalla.*

AGE AND GROWTH

For the study of age and growth, a total number of 5044 fish were measured from different gears, the data were pooled and the size groups were assorted into 20 mm groups (eg. 40-59 with mid point at 50 mm). The monthly size range and modal values are given in Fig. 3.

In the 1970-71 season, from July to June, three modal groups were found namely A, B and C. Of these, C represented the juveniles, B the spent recovering individuals and so also A, which was not of much significance after September. Group B which at 270 mm in August progressed into 310 mm by next November. Group C representing the new broods entered into the fishery at 110 mm in August progressed to 270 mm by next July and 310 mm by November, 1972. Of the two sub-groups recruited in 1971 (D), first one, representing the larger specimens, appeared with a modal size of 130 mm in July whereas the second group starting at 110 mm in August (as in the case of C), registering a very rapid growth caught up with the first group by December at the size of 230 mm. In next July this group progressed to 270 mm and by November 1973 to 310 mm. Group E, recruited at a comparatively larger size of 190 mm in November, 1972, progressed to 270 mm by next September and

TABLE 7. *Sex ratio (in percentage)* of M. cordyla *in different months*

Month	No. of Specimens examined	Female	Male
1970			
August*	—	—	—
September	8	25.00	75.00
October	29	55.17	44.83
November	186	55.91	440.9
December	162	58.64	41.36
1971			
January	156	55.77	44.23
February	44	61.11	38.89
March	132	58.33	41.67
April	95	60.00	40.00
May	75	72.00	28.00
June	—	—	—
July	25	68.00	32.00
August *	—	—	—
September	27	62.96	37.04
October	39	38.46	61.54
November	62	53.23	46.77
1972			
January	—	—	—
February	45	60.00	40.00
March	40	52.50	47.50
April	45	60.00	40.00
May	40	67.50	32.50
June	24	70.83	29.71
July	44	61.36	58.64
August	—	—	—
September	20	65.00	35.00
October	17	82.35	17.55
November	79	63.29	36.71
December	65	69.23	30.77
1973			
January	—	—	—
February	—	—	—
March	77	51.95	48.05
April	67	56.72	43.28
May	26	42.31	57.69
June	6	66.67	33.33
July	1	100.00	
August *	—	—	—
September	35	42.86	57.14
October	60	50.00	50.00
November	50	66.00	34.00

* All the specimens examined were indeterminates.

TABLE 8. *Sex ratio (in percentage) of* M. cordyla *in relation to length*

Length group	No. of species examined	Female	Male
160-169	15	73.33	26.67
180-189	27	85.19	14.81
200-219	35	82.86	17.14
220-239	166	51.21	48.79
240-259	200	52.00	48.00
260-279	276	53.26	46.74
280-299	641	57.88	42.12
300-319	389	65.55	34.45
320-339	85	56.48	43.52
340-359	22	54.55	45.45
360-379	12	91.67	8.33

to 290 mm by November, 1973. Group F was formed by three sub-groups at 170 mm and 90 mm recruited in June 1973 and at 90 mm in August; however, differential growth was observed among these groups by which they show a tendency to mix together to form a uniform group with single modal value.

From the above account, it is evident that in a season, one or more than one sub-group, representing different broods were seen recruited into the fishery in the juvenile stage and the sizes and months of this incidence differring from year to year. Of these sub-groups, the earlier recruits at larger sizes showed a

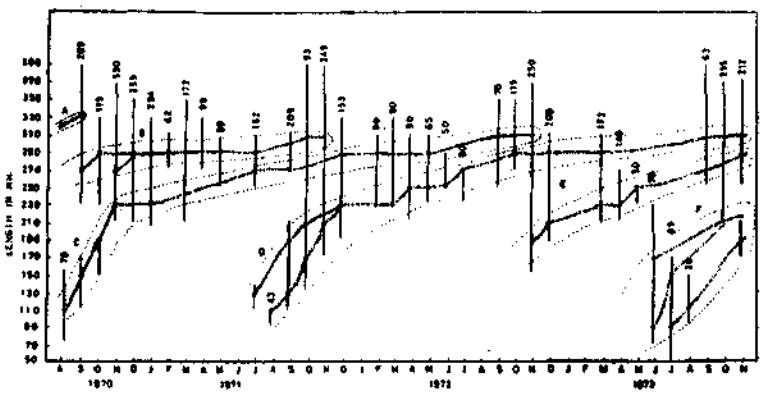

FIG 3. Length-frequency data of *M. cordyla* (pooled) for the years 1970-1973, at Vizhinjam. The straight line with black spots indicate the size range and modal values in that months. The numbers indicate the specimens measured during the month. Different groups, namely A, B, C, D, E and F are traced to show their monthly progression.

a slow growth rate, while late recruits grow rapidly to merge with the earlier one to form into single modal group and this was normally at 230 mm in the case of *M. cordyla* by which size all fish become sexually determined. With the growth of the sexual products, more energy was spent in this direction resulting in the slower growth of the body which is also evident in the case of *M. cordyla*.

For estimating the growth of fish in relation to the age, its probable period of birth is to be determined and for this purpose the rate of growth of juvenile fish has to be taken into consideration and this can be easily studied from Group C. This group from 110 mm in August progressed to 150 mm in September, 190 mm in October and 230 mm in November showing 40 mm growth in each month. In the case of D, the first sub-group appeared at 130 mm in July showed a growth of 60 mm in first two months and 20 mm in succeeding month while the second one from 110 mm in August attained 210 mm by November showing 100 mm growth in 3 months and all these facts indicate that a growth of 30 to 40 mm can be attained in a month by the fish of about 100 mm. Considering such faster growth, it can be inferred that 110 mm size of C would have been attained in about two months, pointing its probable month of birth to June, 1970. In the case of D, the first and second sub-groups were the products of the spawning of May and June 1971, E of June 1972, while first, second and third sub-groups of F were the products of March, May and June of 1973 spawning activity. The months of birth of different groups fall mostly to May to June which correspond to the active spawning season of *M. cordyla* as observed earlier.

Considering June 1970 as the month of birth, the group C attained 270 mm by next July, and 310 mm by November 1972, whereupon its identity was lost. In the case of D, from May-June 1971 it attains 250 mm by next June and 310 mm by November 1973. E too showed a similar trend by attaining 250 mm by next May and 290 mm by November 1973. When the modal values of different groups in the same months of different years are plotted as in Fig. 4, their progression of growth showed a similar trend. From the figure, the estimated rate of growth is 250 mm by first year, 290 mm in second year and 320 mm in third year and the maximum modal size recorded in the fishery, namely 330 mm of A, can be attained in about 40 months. Such fast growth was observed to be common in the carangids of tropical waters as recorded by Chabanne (1972) for *Caranx ignobilis, C. sexfasciatus* and *C. melampygus*. their first year growth being 500 to 600 mm.

Parameters of the Von Bertalanffy growth equation

Adopting Walford's (1946) method, the average lengths at each half year estimated from Fig. 4 were plotted against those of succeeding half year and was observed that all the points fall on a straight line (Fig. 5). The $L\infty$ value of 420 mm so obtained is close to the largest fish so far known for this

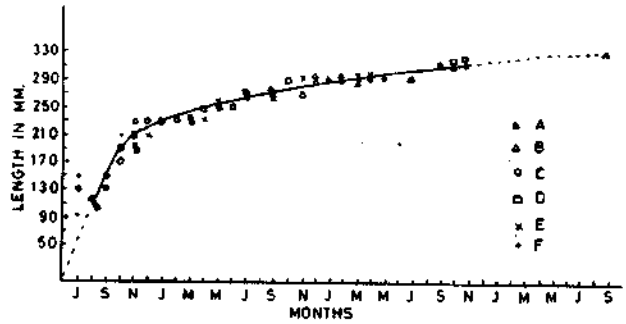

FIG 4. Growth curve of *M. cordyla*. Modal values of different groups in the same months of different years are plotted and their mean size connected.

species 455 mm measured at Vizhinjam and fish above 400 mm were very rare. The parameters, $L\infty$, K and to of the Von Bertlanfly growth equation on half basis were 419.09, 0.1312 and -5.0099 respectively.

From the rate of growth estimated and the asymptotic length obtained, it can be seen that about 60% of the growth of whole life time was attained in the first year of life of fish and even in this 50% coming in the first six months. The fish attains the minimum size of first maturity and spawn in the first year while majority become mature and spawn in the second year. Sea-

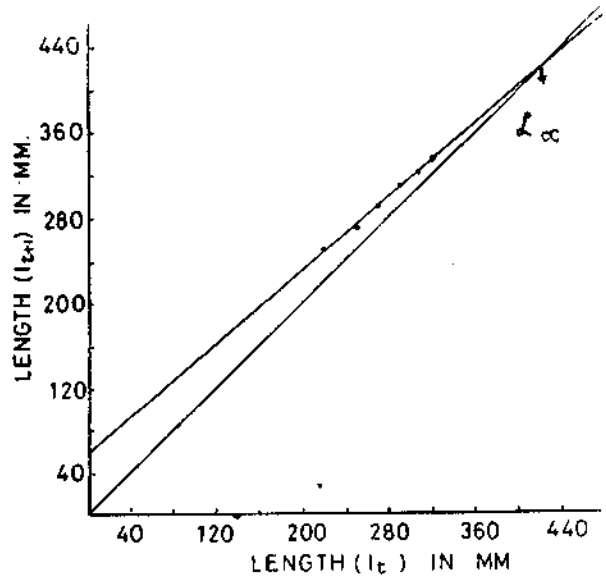

FIG 5. Walford's growth transformation for length of *M. cordyla*.

sonally speaking, active growth was observed from June to December, growth remains static from January to March and begins to rise from April onwards. It is significant here to note that active feeding during and post and pre-monsoon months was recorded in *M. cordyla* at Vizhinjam by Sreenivasan (1975) corresponding to the active growing season of the fish.

Age composition of the fishery

The total size range of *M. cordyla* recorded during the period was from 52 mm to 455 mm and fish above 390 mm, though occur, only in stray numbers and not to the extent of forming modal size group. Annual percentage composition of different length groups for 1970-71 (August-July), 1971-72 and 1972-73 given in Fig. 6 shows that the size group 280-299 mm were the dominant in all the three years. 0-year class supported the fishery to the magnitude of 30.9% in 1970-71, 64.3% in 1971-72 and 60.0% in 1972-73, while 57.8%, 30.3% and 29.1% was formed by one year old, and 8.4%, 4.1% and 7.8% by two year old in the respective seasons. The first and second year groups totallyforms about 90% of the total catches. Juveniles found to enter the fishery only once during the monsoon months of June-August in all the years except in 1972, in which year the recruitment had taken place late in November.

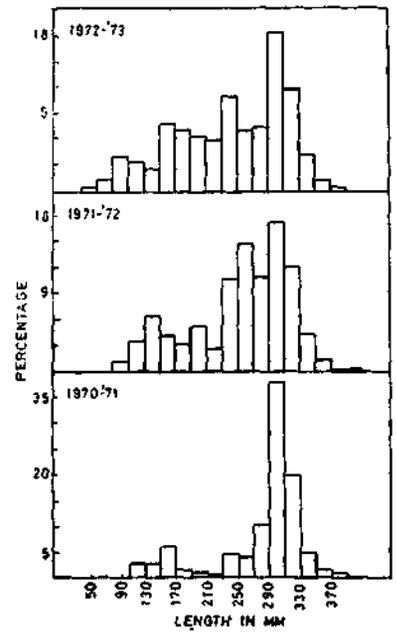

FIG 6. Percentage composition of different size groups in the fishery of *M. cordyla* during the years 1970 (August)-1971 (July), 1971-1972 and 1972-1973.

General remarks

Normally the fisheries composed mainly of 0-year class are subjected to wide fluctuations as in the case of oil sardine fishery of India, and such fluctuations are primarily due to the results of natural fluctuations in annual renewal of the 0-year class which are in turn determined by hydrological and biological factors prevailing during the spawning season. During 1969-73, the fishery of *M. cordyla* showed an increasing trend thus indicating the condition prevailed during this period were suitable for the renewal of the stock. Moreover the additional advantageous factors are the location of spawning ground which lies far away from the shore, thus, preventing the undersized juveniles being netted and also permitting the ripe fish to spawn.

Further expansion of the fishery by operating hooks and line during night hours was discussed by Sreenivasan (1975). Besides this method, extending fishery farther interior from the present fishing belt, introducing trolling and long lining may also be helpful in expanding this prosperous and untapped fishry resources to get maximum return.

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