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PURSE SEINE FISHERY FOR OIL SARDINE OFF COCHIN DURING THE YEARS 1980-'85

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ABSTRACT

Observations on the purse-seine fishery for oil sardine at Cochin indicated that the fishery fluctuated widely during 1980-'85. The best catch was in 1984 (17,665.90 t) and the poorest in 1985 (5,470.27 t). The highest monthly catch rate (1,181.0 kg) was in December, 1984 while the lowest (295.4 kg) in November, 1982. Range of total instantaneous mortality 'Z' was from 1.59 to 2.88, the average being 2.15. The natural mortality 'M' worked out to 0.75. The instantaneous fishing mortality 'F' has been estimated to be 1.4. The annual rate of exploitation 'a* has been estimated to be 0.5743. Average annual purse-seine catch (A1) of oil sardine during these six years was 10,3361. The standing stock at Cochin for 1980-'85 has been calculated at 7,383 t. The average annual stock of oil sardine at Cochin has been estimated at 17,998 t. Average annual catch of oil sardine in Kerala during the 6-year period was 1,23,519 t; the standing stock has been estimated at 88,228 t and the average annual stock has been calculated as 2,15,077 t. For Cochin, the MSY has been estimated to be about 12,500 t; and for Kerala the value has worked out to about 1,50,0001. The Beverton and Holt yield per recruit analysis revealed that any further increase in the rate of exploitation (i.e. 0.65) by purse seiners would not result in significant increase in the yield; but by increasing the length at first capture from 125 to 145 mm, might yield higher catches. The 15-40 m depth area was found to be the most productive. Preponderance of 0-year recruits was observed during 1980-'85 (except in 1983) whereas the 1 + year group had only a secondary dominance. The study revealed that the success of the sardine fishery in any year was mainly dependent on the abundance of the 0-year recruits.

Though a small-scale spawning was noticeable by the end of May, the peak spawning was during June to August off Cochin. Application of Chi-square test on sex composition indicated predominance of females during 1980-'84 in purse-seine catches.

INTRODUCTION

Wide fluctuations have been an inherent characteristic of the oil sardine fishery (Balan, 1966,1971,1973,1984 and 1986; Balan *et al*, 1979; Jacob *et al*, 1982). In the present study observations were made on the biology of oil sardine landed by the purse seiners operated from Cochin during the years 1980 to 1985 in order to find out changes if any in the fishery characteristics, abundance of the resource and the catch levels at the Cochin region, and the results are presented in this paper.

FISHERY

The oil sardine catches landed by purse seiners at the Fisheries Harbour, Cochin, during the years 1980-'85 are presented in Fig. 1. The catches during 1980 were fairly good, and, compared to this, the catches during 1981 was even better. The magnitude of the fishery during 1982 and 1983 was low but in 1984, however, the best catches (17,665.9 t) were obtained, surpassing the figures of the other five years, only to lead to a conspicuous decline in landings (5,470.271) during 1985.

The monthly landings of oil sardine by the purse seiners and the details regarding

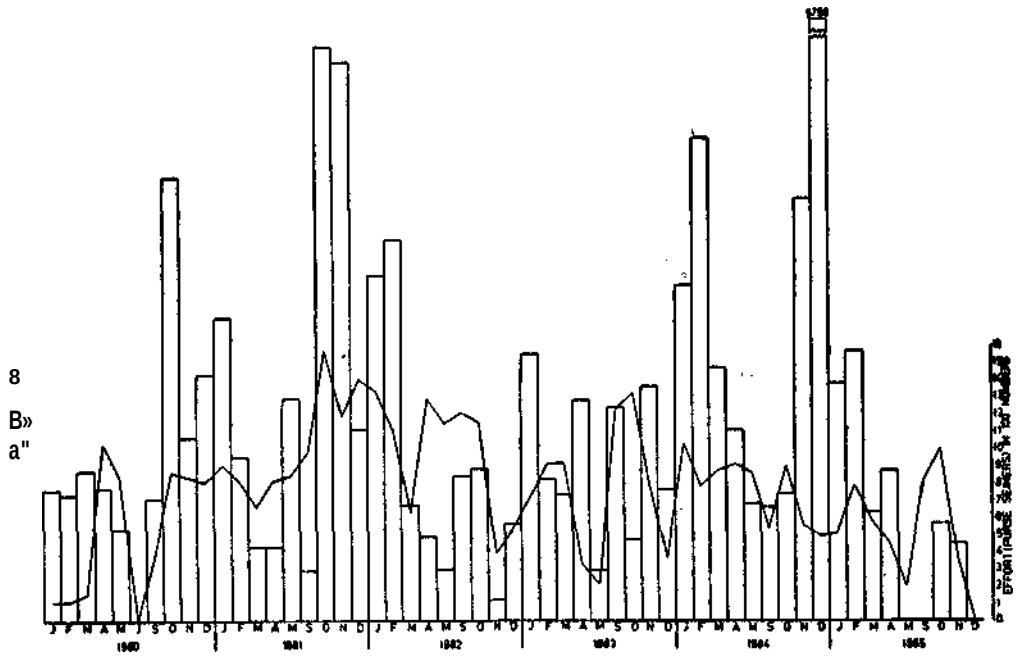

Fig. 1. Oil sardine catches and the number of purse seiners landed at Fisheries Harbour, Cochin, during the years 1980-'85.

fishing effort and catch per unit effort of the purse seiners operated from Cochin harbour during 1980-'85 are presented in Fig. 2. Remarkably heavy catches were landed on 24-12-1980, 9-11-1981, 13-9-1982, 28-12-1983, 27-2-1984 and 7-1-1985 which were estimated to be 234.02 t, 359.67 t, 409.06 t, 303.01 t, 348.45 t and 238.50 t respectively.

In 1980, the catch per purse seiner was maximum in February. In 1981, the maximum was in November with small peaks in January and October. In 1982, again the highest value recorded was in February. In 1983, though the catch was unusually high in April, there were minor spurts in January and December. In 1984, December recorded the highest (bumper one among the six years) monthly catch per purse seiner (11.81), with lesser peaks in November and February. In 1985, the highest catch was recorded in January. Hence it is obvious from the foregoing account that both the purse seine landings and the catch rates fluctuated widely during the years 1980 to 1985.

Consequent on large-scale northward migration of sardine shoals, the purse seine fishery at Cochin suffered a near collapse during the last quarter of 1985 when 1,361 unit operations landed only 1,023 t of oil sardine. Synchronous with this decline in fishing effort and catch at Cochin, heavy oil sardine landings by purse seiners were reported from Mangalore and Karwar regions. At Mangalore, 7,504 unit operations landed 10,009 t and at Karwar, 2,596 units landed 1,8881 during the quarter.

Mortality Rates

Based on the length frequency data of oil sardine in purse seine catches at Cochin during the years 1980-'85, the estimates of 'Z' and 'M' have been made. On the basis of earlier estimates (Balan, 1986) the growth co-efficient 'k' was found to be 0.75 and the asymptotic length (L_∞) 225 mm. The mortality rate has been estimated by using Beverton and Holt (1957) method. Utilizing these values, the total instantaneous

mortality 'Z' has been estimated which ranged from 1.59 to 2.88, the average being 2.15. The natural mortality 'M' worked out to 0.75 based on the assumption that -|t = 1. The instantaneous fishing mortality 'F'has been estimated as 1.4, using the formula: F = Z - M, i.e., 2.15-0.75.

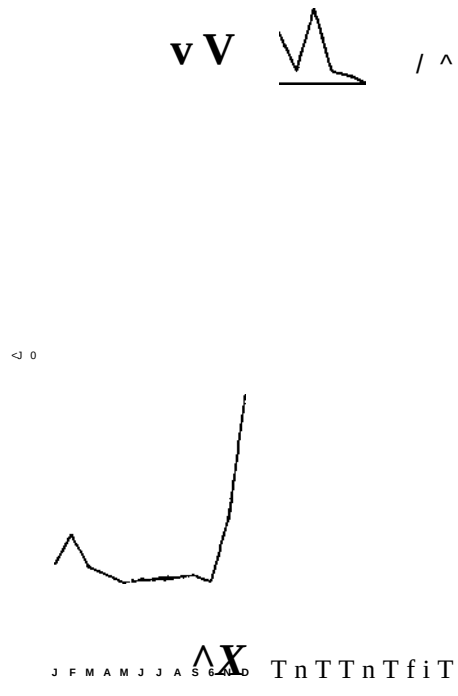

Fig. 2. Catch per unit effort (CPUE) of oil sardine in purse seine catches at Fisheries Harbour, Cochin, during 1980-'85.

Stock Assessment

Applying the formula: -£(l-e''^z^),the annual rate of exploitation 'a' has been estimated as 0.5743. The average annual catch of oil sardine in purse seine Al at Cochin has been found to be 10,336 t during l980-'85. Applying the formula A1, the standing stock at Cochin for these six years has been calculated as 7,383 t. Using the expression ^, the average annual stock of oil sardine at Cochin is estimated as 17,998 t. From the average annual stock value and using the 'F' value (1.4), the Maximum Sustainable Yield (MSY) for Cochin has been estimated as about 12,500 t.

Fig. 3. Age composition of oil sardine in purse seine catches at Cochin, during 1980-'85.

The all-Kerala oil sardine stock has also been assessed from the total oil sardine catches landed by different gears during the same period of study (1980-'85). The average annual catch (A2) of oil sardine in Kerala during this period has been found out as 1,23,519 t. Applying the 'F' value of 1.4 in the expression -~, the standing stock of oil sardine for Kerala has been estimated as 88,228 t. Applying the annual rate of exploitation value a : 0.5743 in the expression the ~, average annual stock of oil sardine in Kerala has been calculated as 2,15,077 t. Balan *et al.* (1979) had estimated the average annual stock of oil sardine in Kerala at above 2 lakh tonnes based on 1969-'78 data. This closely agrees with the present estimate for Kerala. The MSY works out to about 1,50,000 t for Kerala.

Fig. 4. Monthly length distributions and length modes of oil sardine in purse seine catches at Cochin, during 1980-'85.

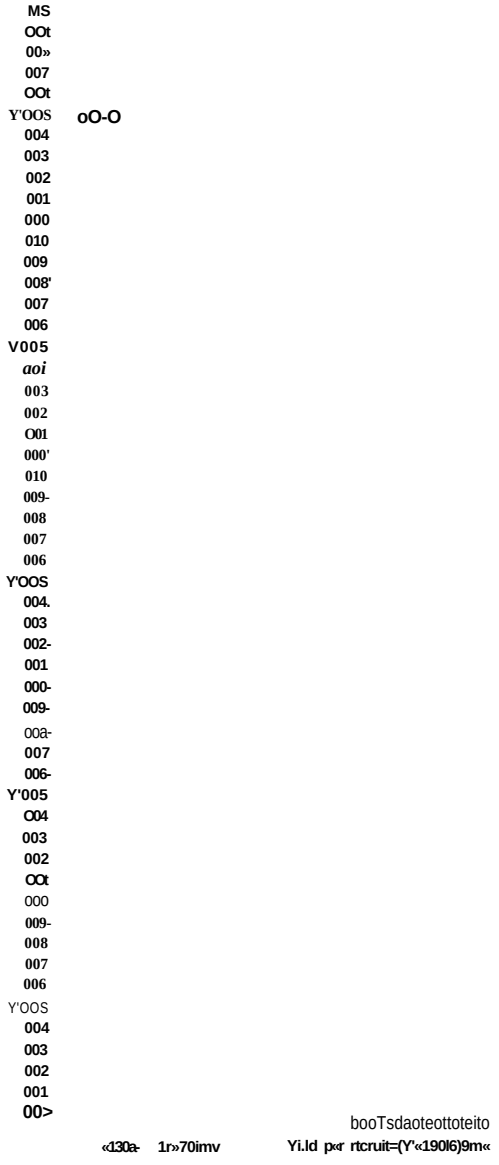

Fig. 5. Oil sardine yield per recruit at Cochin (Purse seine), during 1980-*85.

To study the effect of exploitation and the length at first capture on the stock, Beverton and Holt yield per recruit analysis was carried out. The results are presented in Fig. 5. During the period of observation the rate of exploitation of oil sardine by purse seiners off Cochin was 0.65, the length at first capture 1_0 =125 mm and using the expression $\frac{l_n}{Loo}$ the 'c' value was calculated as 0.56.

The analysis revealed that any further increase in the rate of exploitation 'a' may not result in significant increase in the yield bat by increasing the size at first capture from 125 to 145 mm it may yield higher catches.

DEPTH-WISE EXPLOITATION OF SARDINE CATCHES

The data on the depth of operations of purse seiners off Cochin indicated that the highest sardine yield, in general, during the years 1980-'85, was from the 15-40 m depth area except during 1984 when the catch was the highest synchronising with a heavy shoreward (i.e. 6-16 m depth zone) thrust of the shoals. Depth-wise abundance of oil sardine during the years under consideration is given below:

In 1980, the purse seiners operated at the 22-40 m depth zone, produced appreciably good sardine catches. In 1981, though the boats had operated at zones of 12-20 m, 22-40 m and 42-60 m depths, the operations at the 22-40 m zone were the most productive. As in the previous year, the heaviest catch was made in October. In 1982, though the zone which yielded the best catches was the 22-40 m, the 12-20 m, 42-60 m and 60-80 m were also exploited with advantage during different months. The best catch was obtained from 22-40 m depth during February. In 1983, the 25-30 m depth region yielded the highest catch though the fishing ranged between zones 22 to 55 m depth. The heaviest catch was recorded in January. In 1984, though the depth range of fishing was from 6 to 40 m, the 15-16 m depth region contributed the best catch. December withnessed the highest landing. In 1985, a good yield was obtained from the 25-30 m depth zone, eventhough a wide range (12 to 50 m) was covered. The highest catch was made in February.

TABLE 1. *Effort and catch per unit effort for oil sardine landed at Fisheries Harbour, Cochin by purse seines during* 1980-'85

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual values
1980													
No. of units	109	105	153	1032	834	5	No operation		390	861	829	796	5114
CPUE of fish in nos.	150776	36954	219241	36824	25132	0	—	—	35309	104759	61103	104170	68578
1981													
No. of units	901	810	659	810	844		No operation		983	1566	1193	1396	9162
CPUE of fish in nos.	99426	66406	42208	26699	78345	—	—	—	19036	76729	97764	94506	70549
1982													
No. of units	1332	1108	625	1291	1145		No operation		1212	1149	392	525	8779
CPUE of fish in nos.	110736	106691	38984	22349	15609	—	—	—	18003	22249	22800	31636	46672
1983													
No. of units	709	909	908	327	210		No operation		1225	1323	790	368	6769
CPUE of fish in nos.	55108	22871	31329	140680	—	—	—	—	41216	—	40550	60373	35316
1984													
No. of units	1031	778	866	911	861		No operation		544	900	559	488	6938
CPUE of fish in nos.	84089	139499	72234	52777	25040	—	—	—	21752	131638	98314	242663	90964
1985													
No. of units	513	785	579	454	195		No operation		808	999	362	0	4695
CPUE of fish in nos.	67234	74909	74115	44436	0	—	—	—	0	17820	—	0	37090

BIOLOGY

The month-wise data on the biological characteristics of the sardine viz., the total-length range, dominant length modes and the percentage age-distributions, maturation stages and sex composition in purse seine catches are given in Tables 2 and 4.

Modal Length Distribution

During the period 1980-'85, the total length ranged from 65 mm to 220 mm. The maximum frequency (f) of occurrence of the oil sardine in a particular length group (L') was found to determine the major modes. During 1980 and 1981 the mode remained at 120 mm length group, representing 15.46 and 14.81%, respectively, in numbers of the total. In 1982, there was a shifting of mode to 125 mm which represented 20.45% of the year's total. All these modes during 1980—'83 belonged to the 0-year class. In the entire period under study only in 1983 the major mode was at 160 mm, representing 13.27% in numbers. The 160 mm mode belonged to the 1 + year age group. In 1984 and 1985, the mode was at 135 mm, representing 11.47% and at 130 mm representing 10.32% respectively of the sardine landings of these two years. Compared to the first half of the period under study i.e. 1980-'82, the second half showed

TABLE 2. *Monthly percentages of sex composition of oil sardine in purse seine catches at Cochin, Fisheries Harbour, during* 1980-'85

Month	M/F	1980	1981	1982	1983	1984	1985
Jan.	M		41.72	52.90	49.90	45.78	58.82
	F	—	58.28	47.10	50.10	54.22	41.18
Feb.	M	60.00	54.50	32.80	52.30	47.86	55.86
	F	40.00	45.50	67.20	47.70	52.14	44.14
Mar.	M	48.80	39.20	54.50	50.10	53.15	42.62
	F	51.20	60.80	45.50	49.90	46.85	57.38
Apr.	M	36.09	52.60	45.50	38.18	44.23	45.65
	F	63.91	44.70	54.50	61.82	55.77	54.35
May	M	37.29	51.10	37.30	—	42.22	.—
	F	62.71	48.90	62.70	—	57.78	—
Jun.	M	—	—	No	operation	—	—
	F	99	>>	99	99		99
Jul.	M	5)	99				99
	F	99	99	J»	99	99	9)
Aug.	M	99	99	99	99	99	99
	F	99	,,	99	9J	99	39
Sep.	M	38.10	61.90	53.10	53.33	50.94	28.00
	F	61.90	38.10	46.90	46.67	49.06	72.00
Oct.	M	44.39	39.60	45.40	—	41.36	50.50
	F	55.61	60.40	54.60	—	58.64	49.50
Nov.	M	45.86	52.90	52.20	46.02	48.62	—
	F	54.14	47.10	47.80	53.98	51.38	—
Dec.	M	35.89	49.30	42.60	44.00	51.20	—
	F	64.11	50.70	57.40	56.00	48.80	—
Jan.	M	41.78	49.77	45.38	48.47	47.66	50.00
Dec.	F	58.22	50.23	54.62	51.53	52.34	50.00

TABLE 3. *Maturation stages of oil sardine (both sexes combined) in purse seine catches during* 1980-'85 *at Cochin Fisheries Harbour.*

Year	Stages of maturation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
	I	—	—	126	53	34	—	—	—	—	98	239	290	840
	II	_	_	10	60	65	—	—	—	—	—	18	—	153
	III	_	_	15	-	242	—	—	—	—	—	—	—	257
	IV	—	—	*2*	—	2	—	—	-	—	—	-	—	4
1980	V		_	_	_	_	_	_	_	_	_	_	_	_
	VI	—	—	—	—		_	_	—	_	_	_	_	_
	P S		_	_	_	_	_	_	_	4	i	5	_	_	4 6
	S	-	30	44	11	—	—	—	—	45	146	113	36	425
	SR	—	—	12	9	19	—	—	—	87	134	101	—	362
	Total	~	~^	30	209	~~133	362	—	—	—	173	383	471	326	2,087
	I	60	8	11	65	5	—	—	—	—	—	4	12	165
	II	—	25	17	40	51	—	—	—	—	—	4	—	137
	III	—	25	—	3	32	—	—	—	26	2	—	—	88
	IV	—	8	—	—	16	—	—	—	5	1	—	—	30
1981	V		_	_	_	_	2	4	—	—	—	—	—	—	—	24
	V I		_	_	_	_	_	_	_	_	_	_	_	_	_	_
	PS		_	2	—	—	10	—	—	—	—	—	2	—	—	14
	S	91	_	93	2	1	1	—	—	—	—	27	41	76	332
	SR	_	63	44	62	80	—	—	—	32	69	108	50	508
Total		151	224	74	171	219	—	—	—	63	101	157	138	1,298
	I	4	123	23	9	—	—	—	—	14	69	—	52	294
	I I	_	_	4	5	5	_	_	_	2	—	—	2	18
	III	_	_	_	_	40	—	—	—	—	—	—	_	40
	IV	_	_	_	_	6	—	—	—	—	—	—	—	6
1982	V		_	_	_	_	_	_	_	_	_	_	_	_	_
	V I		_	_	_	_	_	_	_	_	_	_	_	_	_
	P S		_	_	_	_	_	_	_	1	9	_	_	_	1 9
	S	36	28	—	10	—	—	—	—	71	92	7	20	264
	SR	30	78	230	31	—	—	—	—	37	57	39	276	778
Total		70	229	257	55	51	—	—	—	143	218	46	350	1,419
	I	11	5	67	38	—	—	—	—	72	—	84	27	304
	II	1	—	83	19	—	—	—	—	1	—	—	—	104
	Hi		_	_	2	—	—	—	—	—	—	—	—	—	2
	I V														
1983	V		_	_	_	_	_	_	_	_	_	_	_	_	_
	V I		_	_	_	_	_	_	_	_	_	_	_	_	_
	P S		_	_	_	_	_	_	_	_	_	_	_	_	_
	S	22	19	9	—	—	—	—	—	10	—	—	—	60
	SR	295	129	272	108	—	—	—	—	67	—	142	23	1,036
Total		329	153	433	165	—	—	—	—	150	—	226	50	1,506

Table 3 (Contd.)

Year	Stages of maturation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1984	I	86	184	149	2	35				–	78	104	66	704
	II	–	3	6	16	28					2	1	–	56
	III	–	–	–	–	24				–				24
	IV	–	–	–	–	6								6
	V	–	–	–	–	13								13
	VI	–	–	–	–	7						–	–	7
	PS	–	–	–	–	57				44	7			108
	S		21	13	1	3				4	2	–	–	44
	SR	163	72	118	85	7				5	73	185	143	851
Total		249	280	286	104	180	—	—	—	53	162	290	209	1,813
1985	I	22	79	31	10	—	—	—	—	—	23	—	—	165
	II	—	1	14	26	—	—	—	—	—	33	—	—	74
	III	—	—	—	25	—	—	—	—	—	11	—	—	36
	IV	—	—	—	15	—	—	—	—	—	10	—	—	25
	V													
	VI													
	PS	–	–	–	–	–	–	–	–	22	6	—	—	28
	S	—	7	—	3	—	—	—	—	—	93	—	—	103
	SR	29	58	16	13	—	—	—	—	3	24	—	—	143
Total		51	145	61	92		—	—	—	25	200	—		574

that the fishery was supported by comparatively bigger fish in appreciably good quantities. The higher percentage of the bigger oil sardine in 1984 can be one of the reasons for the maximum catch in weight of oil sardine, during the entire period of this investigation. The present study also revealed that the oil sardine fishery in any year is generally predominated by 0-year group.

MATURATION AND SPAWNING

During 1980, the fish in stage III dominated in May. Predominance of spent and spent-recovering ones was noticed from September to December. In 1981 and 1982 also, small quantities of fish in stages III-V were observed in May. During 1983, there was a dominance of spent-recovering ones during January-April. In 1984, small percentages of fish in III-VI stages were noticed in May. During 1985, meagre quantities of the fish in III-IV stages were observed in April.

Observations on the maturation stages based on the sardine catches landed by *Thangmala* units and trawlers during 1980—'84 period at Cochin indicated the occurrence of mature fish (IV-VI stages) during June-August. While the fish in stage V dominated in *Thanguvala* catches during July of 1980, both IV and V stages were dominant in trawl catches during June, 1981. During June, 1982, the sardines in stages IV and V were noticed in abundant numbers in trawl and *Thanguvala* catches; partly-spent fish dominated in July only. During July, 1983, substantial numbers of the fish in V, VI and 'partly-spent' stages were observed in both gears. However, in June of 1984, the *Thanguvala* catches were comprised solely of 'partly-spent' fish, thereby revealing recent spawning.

SEX COMPOSITION

The sex composition of the purse seine catches of oil sardine during 1980-'85 at Cochin was studied in detail. The male to female ratio was tested applying the formula: °X* e=^j- (§ap-np) where p is the proportion of males to the total for all the six years taken together, q is (1-p), 'a' is the individual number of males in each year, 'p' is the proportion of males to the total number in each year and 'n' is the total number of males examined during the 6 years. The $°X^2$ value was found to be 30.57 which is significant for 5 degrees of freedom, showing variations in the sex ratio during the six years. This study also revealed an overall preponderance of females and the ratio of males to females was 0.4 for 1980 and 0.5 from 1981—'85. Predominance of females in *Thanguvala* catches during 1959-'65 and in the same gear during 1978 at Cochin has been reported earlier (Balan, 1966 and 1979). The female predominance may be due to changes in schooling behaviour (Larraneta, 1960) or due to differential growth among the two sexes.

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