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GROWTH OF THE KING SEERFISH (Scomberomorus commerson) FROM THE SOUTH EAST COAST OF INDIA

by

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ABSTRACT

Length frequency data of Scomberomorus commerson collected from April 1984 to March 1987 from artisanal fisheries using three types of gill nets, hook and line, shore seine and shrimp trawls are analysed. Assuming that the length frequencies of combined gears will give distributions unaffected by selectivity data were pooled and analysed by the Bhattacharya method. However, only the length frequencies obtained from the less selective gears could be used to obtain estimates of L_∞ = 177.5 cm (FL) and K = 0.38 per year. These values mean that S. commerson would reach a fork length of 154 cm and a weight of 21.3 kg in 5 years, and they would indicate a faster growth than what had been assumed by other authors. The results are so far apart that obviously further research is needed.

1 INTRODUCTION

Seerfishes (king fishes or Spanish mackerels) are highly esteemed table-fishes. The species exploited in the coastal waters of India are Scomberomorus commerson, S. guttatus, S. lineolatus and Acanthocybium solandri of which the first is the most important. They are exploited by different types of traditional gears, as well as trawls. In some countries the seerfishes have been overfished e.g. near Mauritius (Baissac, 1964). In Palk Bay the fishery for spotted seerfish (S. guttatus) declined due to overfishing (Devaraj, 1977). In this paper only the species Scomberomorus commerson (Lacépède) (king seerfish or barred Spanish mackerel) is considered. It is distributed widely in the Indo-Pacific. In India it is caught along all shores, including the Andaman and Lakshadweep islands. Compared to other commercial species the numbers landed are very low, which makes it difficult to collect sufficient material for biological studies and especially for growth estimation. Information has been accumulated on various biological aspects of S. commerson by Williams (1964) and Devaraj (1977, 1981 and 1983). This study mainly deals with growth of this species, based on data on length, catch and effort obtained from fisheries with different gears in the Gulf of Mannar, Palk Bay and the Bay of Bengal during 1984-1987.

S. commerson landing statistics for India are given in Table 1. Detailed information for the two areas under study, Mandapam and Madras (Fig. 1) is given in Table 2.

Table 1 Landings of king seerfish (Scomberomorus commerson) in India, (by state, quarter and average for 1981-84 (in tonnes)

State	Quarter I	II	III	IV	Average yearly total 1981-84
West Bengal	119	7	49	414	589
Orissa	171	20	4	99	294
Andra Pradesh	1256	275	262	356	2151
Tamil Nadu	1284	776	1531	1187	4778
Kerala	618	215	701	1675	3209
Karnataka	459	98	890	1959	3406
Goa	51	2	67	97	217
Maharashtra	484	211	168	1182	2045
Gujarat	367	-	-	36	403
Total	4809	1604	3672	7005	17090

Source: CMFRI Special Publications No. 31 to 38 (1987)

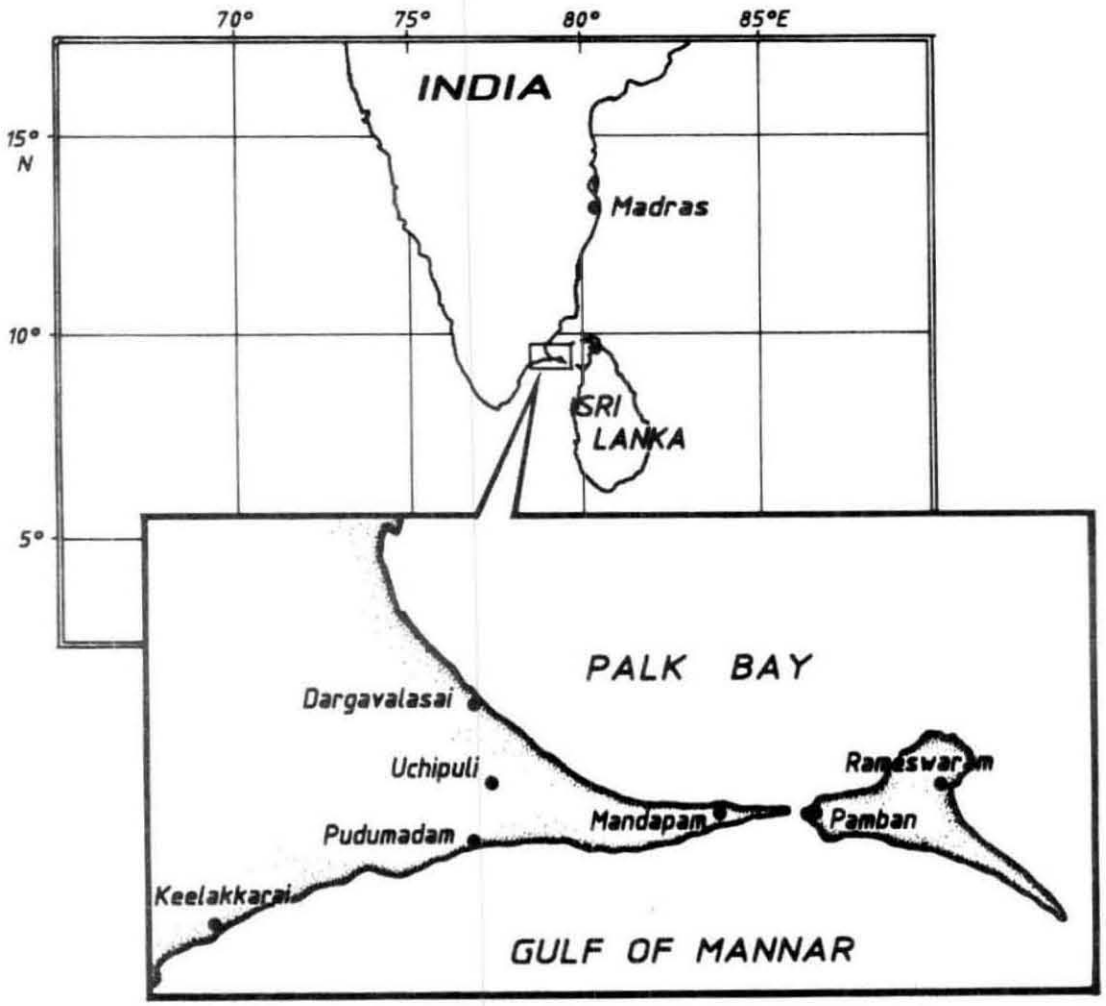

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Fig. 1 Map of the sampling area

Table 2 Summary of fishing gears sampled in Mandapam area and Madras, 1984-87

Locations (see Fig. 1)	Gear type (Tamil name)	Mesh size cm	Seer fish catch t/year, %		Sizes caught cm (FL)	Modes in length freq.	Catch rates kg/unit	Other species caught Notes
Palk Bay Gulf of Mannar Mandapam	shore seine (karai valai)	2.5-3.0	92	19%	5-135	30, 40, 55, 95	2-11	sardines, anchovies, silverbellies, Table 4a
Mandapam	hook and line (oodu thundi)	-	130	27%	30-150	45, 60, 85	14-17	perches. Combined with drift gill net fishery, except from Nov. to Jan. then exclusively hook and line. Table 4b
Mandapam	drift gill-nets: maya valai	6.0	17	3%	5-75	20, 30, 50	2-5	mackerel, hilsa, Chirocentrus, sciaenids, sharks. Table 4c
	valai valai	7.6	173	36%	30-125	40, 75, 100	5-22	Up to 50 km offshore, Chorinemus, tunas, sharks, Lethrinus, Caranx. Table 4d
	para valai	14.0	73	15%	25-150	95	2-28	Table 4e
Total catch			485	100%				
Madras	mechanised drift gill-net	6.0-12.0	128		10-125	45, 70, 110	69	little tuna, carangids Table 4f
Madras	shrimp trawl	2.0	137		5-65 (100-115)	15, 35	3	shrimp and usual fish by-catch, juvenile seer fish Table 4g

Table 3 Catch (in kg) and CPUE (kg/unit) of Scomberomorus commerson of different gears at Mandapam area on a quarterly basis during the years 1984-87 (CPUE in parantheses)

Year	Quarter	Shore seine	Hook & line	Drift gill nets (mesh in cm) 6	7.6	14
1984	II	15244 (3.2)	15842	3155 (2.2)	53573 (14.3)	2004 (24.4)
	III	16098 (3.7)	15624	2868 (2.4)	54936 (11.8)	11237 (27.7)
	IV	41558 (11.0)	45801	3395 (4.9)	34980 (14.9)	10258 (16.5)
1985	I	18851 (5.8)	50317	2376 (1.7)	32240 (22.2)	17005 (10.2)
	II	11476 (3.1)	8945	3624 (2.7)	39934 (13.1)	13066 (26.2)
	III	8374 (3.0)	12376	3726 (2.6)	11992 (4.8)	41546 (23.9)
	IV	30746 (10.4)	48746	5340 (4.6)	15934 (5.1)	20187 (15.1)
1986	I	21175 (3.8)	48006	3623 (2.7)	3290 (9.0)	4247 (2.0)
	II	15137 (2.2)	22601	1440 (2.5)	28749 (8.0)	26609 (10.8)
	III	29387 (5.4)	31455	2316 (2.5)	63538 (17.9)	27240 (15.6)
	IV	36836 (9.6)	47240	3300 (4.4)	57004 (17.0)	22550 (14.3)
1987	I	31553 (9.4)	44620	3280 (2.2)	34540 (7.3)	21570 (8.6)

2 BIOLOGY

S. commerson is found in coastal regions where it feeds mostly on sardines and anchovies. The reported length at first maturity differs considerably from place to place viz. south east coast of India (Palk Bay and Gulf of Mannar) 75 cm (Devaraj, 1983). East African waters 55 and 64 cm (Williams, 1964). Papua New Guinea 65 cm (Lewis et al., 1974) and Red Sea 85 cm (Bouhlel, 1985).

According to Devaraj (1983) there are three batches of eggs in the ripe ovaries and spawning takes place in successive batches at an interval of a month or even less from January to September. The spawning grounds are located in protected inshore areas in Palk Bay and the Gulf of Mannar. The number of eggs spawned by a single fish in one season varies from 0.5 to 6 million depending on the length and weight of the fish.

Devaraj (1981) analysed the length frequency distribution of drift gill-nets catches and found that S. commerson attains a total length of 40.2 cm at 1 year and 118.6 cm at 4 years of age. He estimated an L_∞ of 208 cm TL and a K of 0.18 (per year).

Bouhlel (1985) found the VBG parameters, L_∞ = 151 cm (TL) and K = 0.21, by using the Bhattacharya method on pooled length frequency distributions from hook and line catches in the Red Sea. Cheunpan (1988) found an L_∞ of 110 cm from gillnet catches and a K = 0.1 from pair trawl catches in the Gulf of Thailand.

3 MATERIAL AND METHODS

Length frequency, catch and effort data for S. commerson were collected during the period April 1984 to March 1987 from different types of gears around Mandapam on Palk Bay and Gulf of Mannar sides (Table 3). Fork length measurements were taken for all fishes and weights of individual fishes were also recorded wherever possible. The length measurements were taken at landing centres, fish markets, and packing centres mostly of

Table 4a Size composition of S. commerson, shore seine fishery, Mandapam, 1984-87 *)

Table 4a Size composition of S. commerson, shore seine fishery, Mandapam, 1984-87 *)

Year	1984	1984	1984	1985	1985	1985	1985	1986	1986	1986	1986	1987
month	5	8	11	2	5	8	11	2	5	8	11	2
5-		390										
10-	416	312					260		636			
15-	728	468					0		954	531		
20-	7488	5304	264			210	1040		10494	5310		
25-	4368	5928	858			420	260		6042	21240	864	
30-	2704	9360	2310	31		840	520	764	3816	22302	2376	
35-	728	3744	2706	0		210	520	0	954	7434	2808	
40-	832	3666	8184	31		0	260	0	1272	11151	8856	
45-	312	2496	4224	62	217	0	260	764	636	4779	4536	
50-	520	234	2310	620	217	0	2860	3820	636	531	1728	810
55-	520	0	1584	2480	1736	0	2340	1528	477	0	1080	4212
60-	832	0	594	1364	1302	0	0	1528	318	0	648	2268
65-	1456	156	396	558	868	0	0	2292	1590	0	432	810
70-	728	1014	462	279	651	0	260	0	636	1593	432	486
75-	208	468	924	372	0	0	1300	0	318	1062	648	648
80-	208	156	660	93	0	420	260	0	0		648	162
85-	104	156	924	93	0	420	520	0	318		864	162
90-	208	390	1254	62	434	420	260	0	0		1296	0
95-	208	156	528	124	217	210	520	1528	318		432	216
100-	312	78	330	372		210	520				216	648
105-	104	78	132	186			520				0	324
110-			66	186			260				0	324
115-			66	93			260				0	162
120-			198	93							216	162
125-			66	31								0
130-				62								108
135-				31								
Total	22984	34554	29040	7223	5642	3360	13000	12224	29415	75933	28080	11502
Sample No.	221	443	440	233	26	16	50	16	185	429	390	213

*) Fork length, sample size raised to total catch

Keelakkarai, Uchipuli, Pamban and Rameswaram (see Fig. 1). Catch and effort data were collected during the statistical observation days (two days in a month for each centre) and were also taken from the regular fishery statistics survey. The total catch by gear in the Mandapam area was computed from these data.

The length frequency data were pooled into 5 cm groups on a quarterly basis for each gear separately and then raised to total catch. These length distributions are given in Table 4.

The length-weight relationship was calculated from data on 460 fish, measuring 10 to 120 cm collected during the sampling period 1984-1987 at Mandapam. Subsequently the weight of the sampled fishes for each quarter was computed using this relationship.

Table 4b Size composition of S. commerson, hook an line fishery, Mandapam, 1984-87 *)

Table 4b Size composition of S. commerson, hook and line fishery, Mandapam, 1984-87 *)

Year	1984	1984	1984	1985	1985	1985	1985	1986	1986	1986	1986	1987
month	5	8	11	2	5	8	11	2	5	8	11	2
30-			63									
35-			126				195			83	1413	
40-		112	189			108	0			249	2826	
45-	89	784	126			756	195			1743	16328	
50-	356	1456	693	114	226	864	975		516	1992	5652	
55-	534	448	945	456	339	432	975		774	996	471	82
60-	1958	336	252	513	1243	324	390	524	2838	747	471	492
65-	1246	112	756	342	791	108	1170	393	1806	249	471	369
70-	89	56	252	228	0	0	390	262	344	83	0	246
75-	89	448	252	114	0	432	390	0	86	996	0	41
80-	178	224	378	171	0	216	585	131	0	498	0	123
85-	178	672	1701	798	0	648	2535	917	86	1494	471	820
90-	356	280	1512	1197	226	108	2340	1310	516	249	942	1230
95-	623	224	756	1482	339	216	1170	1572	774	498	942	1517
100-	178	392	252	1938	113	324	390	1834	258	747	1413	1845
105-	89	112	126	342	113	108	195	393	258	249	471	369
110-		112	315	114		108	390	131	86	249		123
115-			126	342			0	393		83		369
120-			315	114			195	131				123
125-			441	114				131				164
130-			252	285				0				41
135-			63	114				0				
140-				57				0				
145-								0				
150-								131				
Total	5963	5768	9891	8835	3390	4752	12480	8253	8342	11205	31871	7954
Sample	67	103	157	145	30	44	64	63	97	135	203	194

*) Fork length, sample size raised to total catch

Table 4c Size composition of S. commerson, drift gillnet (60 mm) fishery, Mandapam, 1984-87 *)

Table 4c Size composition of S. commerson, drift gillnet (60 mm) fishery Mandapam, 1984-87 *)

Year	1984	1984	1984	1985	1985	1985	1985	1986	1986	1986	1986	1987
month	5	8	11	2	5	8	11	2	5	8	11	2
5-	354					776						
10-	1416	60			158	0						
15-	2478	540			1106	3104	1560			450		
20-	6372	2160	90		158	0	1716	74	2286	1800	90	
25-	2124	2970	126	48	0	1552	156	296	508	2475	120	28
30-	1770	4110	324	48	0	776	624	74	508	3435	300	84
35-	1770	1530	414	192	158	3880	156	222	0	1275	380	224
40-	1416	750	540	192	316	3104	312	222	0	630	490	259
45-	354	150	1152	192	632		2808	222	0	135	1030	301
50-		120	1494	576	1422		1560	444	0	105	1430	819
55-			396	720	948		468	740	0		370	966
60-			36	288	158		312	518	0		40	448
65-			18	48				296	508		60	49
70-								148				28
75-												21
Total	18054	12390	4590	2304	5056	13192	9672	3256	3810	10305	4310	3227
Sample	51	413	255	48	32	17	62	44	30	687	431	461

*) Fork length, sample size raised to total catch

Table 4d Size composition of S. commerson, drift gillnet (76 mm) fishery, Mandapam, 1984-87 *)

Table 4d Size composition of S. commerson, drift gillnet (76 mm) fishery, Mandapam, 1984-87 *)

Year	1984	1984	1984	1985	1985	1985	1985	1986	1986	1986	1986	1987
month	5	8	11	2	5	8	11	2	5	8	11	2
30-		218	110							330		99
35-		2507	2915		366			162	58	3630	3496	198
40-	179	28122	3795		366			162	116	40590	4508	0
45-	179	16895	7920	930	2928	142		162	522	24420	9476	990
50-	895	2943	11055	1860	2928	284	1300	324	754	4290	13156	792
55-	895	218	2860	4805	2196	284	2080	702	754	330	3404	2376
60-	716	981	330	6045	3660	213	195	648	580	1320	368	2970
65-	1253	436	330	4960	1830	284	260	108	696	660	368	1287
70-	1790	218	825	1860	366	497	130	162	638	330	966	495
75-	3043	1417	1265	930	732	1065	455	432	1102	1980	1518	792
80-	1790	218	1210	1395	1830	142	65	216	928	330	1426	990
85-	1969	436	825	3100	1464	497	455	270	870	660	966	693
90-	716	218	1155	3565	366	71	65	162	464	330	1334	792
95-	358	109	220	620	366	142	260	162	174	330	276	891
100-	358		165	1860		213	325	810	174		230	891
105-	1074			155		71	195	1458	348			198
110-	179			155		71	130	1026	58			0
115-	179						61	270	58			99
120-								108				
125-								54				
Total	15573	54936	34980	32240	19398	3976	5976	7398	8294	79530	41492	14553
Sample	87	504	636	208	53	56	92	137	143	723	938	441

*) Fork length, sample size raised to total catch

Table 4e Size composition of S. commerson, drift gillnet (140 mm) fishery, Mandapam, 1984-87 *)

Table 4e Size composition of S. commerson, drift gillnet (140 mm) fishery, Mandapam, 1984-87 *)

Year	1984	1984	1984	1985	1985	1985	1985	1986	1986	1986	1986	1987
month	5	8	11	2	5	8	11	2	5	8	11	2
25-									264			
30-									0			
35-									264			
40-									528			
45-			24						1320			
50-	40	76	24			1320			792			21
55-	40	304	96		119	990			924			126
60-	64	228	216	50	952	330		56	1056			84
65-	128	76	144	75	714	0		42	2640			63
70-	160	304	168	225	476	1320	243	28	1584			21
75-	64	418	336	300	357	660	567	0	0	783		21
80-	32	190	360	100	119	2640	1134	14	0	522	132	210
85-	24	494	336	250	119	990	1134	98	0	348	198	315
90-	56	266	456	300	476	1320	567	140	264	348	264	378
95-	32	190	192	425	476	1320	324	196	924	1044	594	546
100-	32	266	120	750	119	660	243	182	528	522	660	777
105-	16	76	48	225	119	330	324	42	264	522	594	210
110-		76	48	175			81	14		261	198	168
115-			48	150			162	42		261	0	147
120-			72	100				14		0	396	84
125-			24	50				14		174	0	42
130-				100				0			0	42
135-				50				14			0	
140-				25							0	
145-											0	
150-											396	
Total	688	2964	2712	3350	4046	11880	4779	896	11352	4785	3432	3255
Sample	86	78	113	134	34	36	59	54	86	55	52	155

*) Fork length, sample size raised to total catch

Table 4f Size composition of S. commerson, mechanized gillnet fishery, Madras, 1987 *)

Table 4f Size composition of S. commerson, mechanized gillnet fishery, Madras 1987 *)

Year	1987	1987	1987	1987	1987	1987
month	4	5	6	7	8	9
10-		145				
15-	90	878				
20-	120	0				
25-	30	0				638
30-	0	0				1264
35-	30	0	53			3165
40-	60	73	0			1902
45-	30	73	0	80		3165
50-	90	370	53	0	660	638
55-	90	370	53	323	330	0
60-	60	290	53	243	660	0
65-	120	515	110	80	660	1264
70-	60	290	661	403	660	1264
75-	180	733	768	403	0	
80-	240	1175	331	833	330	
85-	180	805	163	80		
90-	120	587	384	80		
95-	60	218	163			
100-	30	73	53			
105-	30		163			
110-			604			
115-			110			
120-			53			
Total	1620	6595	3775	2525	3300	13300
Sample	54	90	69	31	10	21
Catch (t)	4.2	17.6	17.6	7.0	6.3	11.3
CPUE (kg)	23.5	73.1	86.4	74.7	59.5	102.8

*) Fork length, sample size raised to total catch

Table 4g Size composition of S. commerson, trawl fishery, Madras, 1987 *)

Table 4g Size composition of S. commerson, trawl fishery, Madras, 1987 *)

Year	1987	1987	1987	1987	1987	1987
month	4	5	6	7	8	9
5-		40541				
10-		0				9695
15-	622	1665	246			86820
20-	0	0	12095	442		19245
25-	0	0	7093	4906	346	14470
30-	0	0	5248	15647	1373	2460
35-	0	0	4715	9370	4118	7335
40-	1557	4163	3936	7691	2746	4775
45-	935	2442	1066	4464	1027	
50-	622	1665	1558	1768		
55-	0	0	1312			
60-	935	2442	779			
65-	935	2442	246			
70-			0			
75-			0			
80-			0			
85-			0			
90-			0			
95-			0			
100-			246			
105-			779			
110-			1066			
115-			246			
Total	5606	55360	40631	44288	9610	144700
Sample	18	67	156	99	28	60
Catch (t)	5.6	14.8	13.1	17.4	4.2	13.6
CPUE (kg)	1.4	2.4	2.6	8.2	1.7	3.9

*) Fork length, sample size raised to total catch

4 RESULTS

4.1 Length-weight relationship

The relationship between fork length (cm) and total weight (g) based on the data recorded during the sampling period (1984-1987) at Mandapam was found to be:

$$W = 0.0138\ L^{2.8296}$$

The correlation coefficient (r) was 0.99 and the 95% confidence interval of the slope was 2.8218 to 2.8374. The exponent was found to be significantly different from the cubic one.

4.2 Gillnet selectivity

Three years of length frequency data collected from two different drift gillnet fisheries with 6 and 7.6 cm stretched mesh size from the Mandapam area were used for estimating the gillnet selectivity. The selection factor was worked out by comparing the number caught per 100 units in 5 cm length groups for the pooled 3 years data, as suggested by Holt (1963). In Table 5 the number caught per 100 units of drift gillnets of 6 and 7.6 cm by length groups are given. Only the length groups where the frequencies overlap (here 32 to 62 cm) were used for regression analysis. The selection factor was found to be 6.53 and the optimum lengths for 6 and 7.6 cm mesh were found to be 39.2 and 49.6 cm respectively. The selectivity for each length group and each of the two gillnets is given in Table 5. The inverse of the selectivity is used in growth studies to obtain the modal sizes in the stock.

Table 5 Estimation of gillnet selection of Scomberomorus commerson and the correction factor for length frequency data for drift gillnets

Mid length cm	Catch in numbers/100 units 6 cm mesh	7.6 cm mesh	Selection 6 cm mesh	7.6 cm mesh
7.5	6			
12.5	24		0.005	
17.5	50		0.029	
22.5	143		0.123	0.004
27.5	87		0.358	0.025
32.5	104	2	0.716	0.110
37.5	65	37	0.980	0.331
42.5	48	220	0.919	0.684
47.5	31	177	0.590	0.968
52.5	36	115	0.260	0.940
57.5	19	60	0.078	0.623
62.5	5	55	0.016	0.283
67.5		48	0.002	0.088
72.5		32		0.019
77.5		46		0.003
82.5		32		
87.5		43		
92.5		39		
97.5		9		
102.5		16		
107.5		8		
112.5		2		
117.5		1		

Regression analysis ln (C7.6/C6.0) = a + b * L
a = -7.0085 optimum length SF = 6.53
b = 0.15795 60 mm = 39.15 cm S = 8.130
76 mm = 49.63 cm

4.3 Growth

The estimation of age and growth of S. commerson based on the available length frequency data is very problematic, because of gear selectivity. In addition the long spawning period probably leads to multiple broods each year producing a rather unmarked structure in the length compositions.

The length frequencies of the respective gillnets were corrected for selectivity. The raised distributions were then separated into normal components with the Bhattacharya method. The extreme ends on both sides of the corrected gillnet length frequencies gave extraordinary figures and therefore the gillnet data were only used when the selectivity was above 0.1.

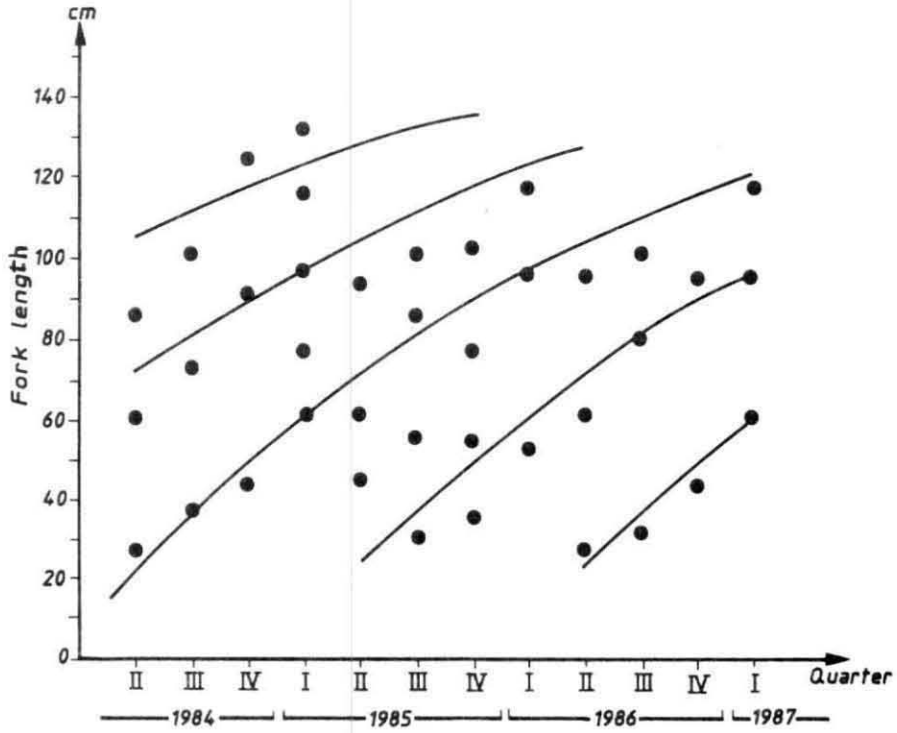
The gillnet length frequencies showed a rather irregular picture after correcting for selectivity. To overcome the problem of small sample sizes the corresponding quarters in each of the three sampling years were pooled. This yielded four samples which were separated into normal components using the Bhattacharya analysis (Sparre, 1985). The mean length of each mode is given in Table 6.

Assuming that the length frequencies of combined gears will give distributions more or less unaffected by selectivity the length frequencies of all gears were pooled and separated into normal components by the Bhattacharya method. The mean values for the cohorts were plotted. A multitude of lines could be drawn, following each other closely, but tracing a growth curve was difficult. Therefore length frequencies of the less selective gears alone (shore seines and hook and line) were merged and analysed as before. Fig. 2 shows the mean length of the modes into which these distributions were separated. The mean values of the modes were taken to estimate VBG parameters by the Ford-Walford plot (Fig. 3). The estimates of L_∞ and K thus obtained were 177.5 cm (FL) and 0.38/year. The peak spawning period in the Mandapam area is during March-April (Devaraj, 1983). From this peak spawning period the progressive modes were aged and applying a von Bertalanffy plot, the constant t_o was estimated to be -0.231 year.

The obtained values for L_∞ and K mean that S. commerson would reach a forklength of 154 cm and a weight of 21.3 kg in 5 years.

Table 6 Mean length of normal components obtained from a Bhattacharya analysis on length frequencies obtained from catches of S. commerson with gillnets of 60 and 76 mm meshsize, pooled and corrected for selectivity (cm, forklength)

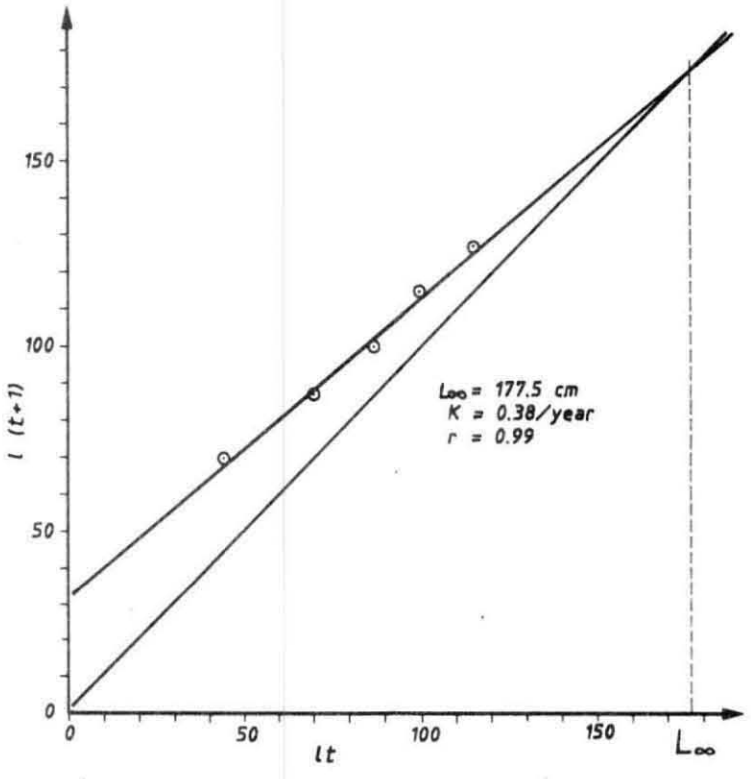
Quarter	$\bar{L}_1$	$\bar{L}_2$
I	34.4	58.1
II	-	52.2
III	44.0	-
IV	50.2	-



Thiagarajam fig 2

Fig. 2 Modal progression graph from Bhattacharya analysis of beach seine and hook and line samples combined.

The superimposed curve is the fitted growth curve
L_∞ = 177.5 (FL), K = 0.38/year



Thiagarajan: fig.3

Fig. 3 Ford-Walford plot for S. commerson

Table 7 Various estimates of growth parameters of Scomberomorus commerson (See also Fig. 4)

Area	L_∞ FL, cm	K per year	t_o year	Author
India Palk Bay	187	0.183	-	Devaraj (1983)
Gulf of Thailand	110	0.1	-	Cheunpan (1988)
Red Sea, Gulf of Aden	135.7	0.210	-	Bouhlel (1986)
Palk Bay Gulf of Mannar	177.5	0.38	0.231	This study

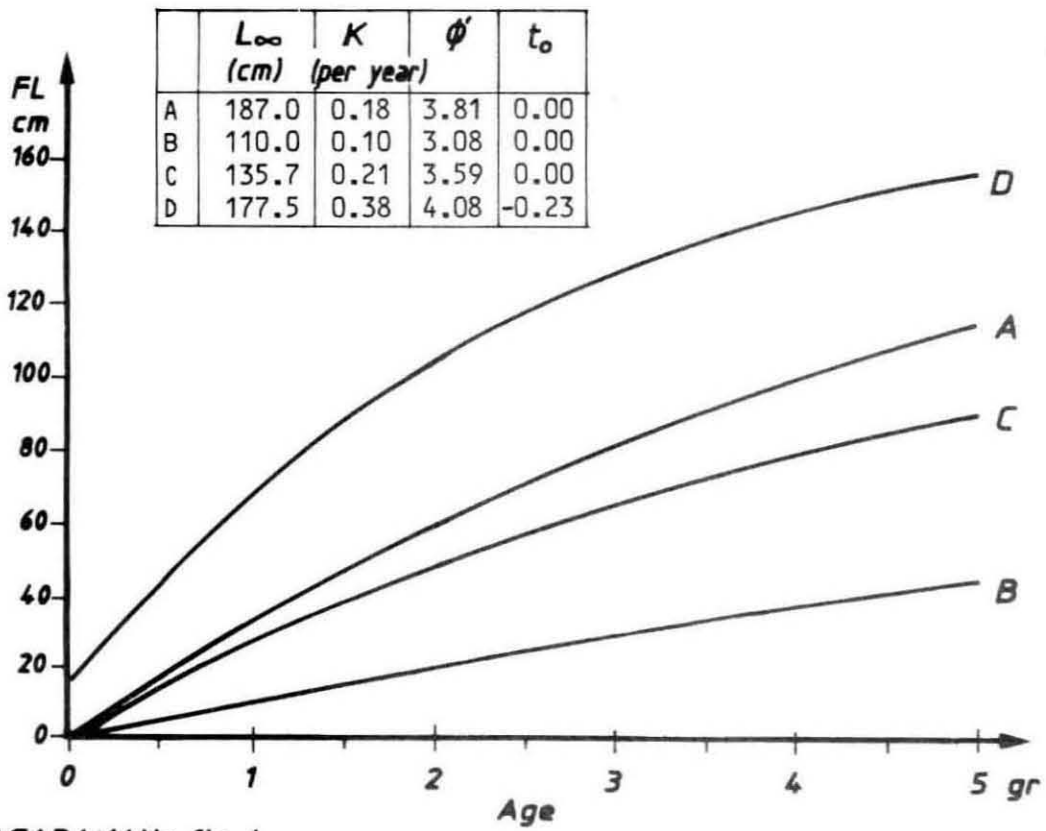


Fig. 4 Growth curve calculated from parameters found for Scomberomorus commerson: A by Devaraj (1983); B by Cheunpan (1988); C by Bouhlel (1985) and D this paper

5 DISCUSSION

Devaraj (1983) estimated L_∞ to 208.1 cm TL (= 187 cm FL). The present estimate of 177.5 cm FL from the same study area is lower. The curvature parameter K = 0.183 per year estimated from gillnet samples by Devaraj (1983) is much lower than the present estimate of 0.38 per year. In the Gulf of Thailand, Cheunpan (1988) estimated the growth parameters from this species as L_∞ = 110 cm (FL) and K = 0.1 per year, but she also stated that these are probably underestimated. Table 7 summarizes these estimates.

In Djibouti, Bouhlel (1985) estimated the VBG parameters as L_∞ = 151 cm TL (= 135.7 cm FL) and K = 0.2097 per year from hook and line samples, using pooled length frequency data and identification of cohorts based on normal distribution of successive cohorts. A similar type of analysis was done with the Mandapam data for all gears pooled during the peak spawning quarter (January to March) and the trawl and gillnet data from Madras during (April-September 1987). This resulted in L_∞ values of 212.4 and 189.4 cm and K values of 0.190 and 0.221 per year respectively. However, these results were rejected because the separation between possible broods was highly subjective and because the gillnet data introduced spurious modes in the distribution within each year.

The gillnet modes, Table 5, are not in agreement with the growth estimated from shore seine and hook and line length frequencies. The mean length calculated from the estimated growth curve is compared below with the gillnet modes.

Year	Quarter	Estimated	Observed
0	I	(not born)	34.4
	II	22.46	-
	III	36.51	44.0
	IV	50.2	49.3
1	I	60.9	58.1
	II	71.5	52.2

It is seen that the estimated growth curve is not in general agreement with all observations. An ELEFAN analysis (Pauly and David, 1981) of the pooled data all gears was made. This gave L_∞ = 162 cm and K = 0.4 per year. However, the fit was not very good, as could be expected from the scatter diagram in Fig. 2.

While in temperate waters a cohort usually represents a year class of fish, in the tropics a cohort may not be a year class, but one of a number of broods resulting from a long spawning period (Sparre, 1985). Several broods in one year could be interpreted as yearly cohorts and the K value thus obtained by modal progression analysis will then be much lower. This may be the case in Bouhlel's (1985) data analysis.

Table 6 summarises four growth parameter estimates made by various authors and these growth curves are shown on Fig. 4. It is seen that the growth curves differ dramatically, much more than what could be expected from differences in environmal conditions. This study presents a faster growth, K = 0.38 per year, than what previously has been assumed. A glance at the scatter diagram (Fig. 2) demonstrates however that several different linkages of the modes could easily be made. Hence it is a question of whether length frequency data may actually lead to a reliable growth estimate of such possibly slow growing species. This will require a detailed study of the structure of the length frequencies and our ability to find the modes. Such studies might be done through computer simulations.

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