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Age and growth in two marine portunid crabs, *Portunus (Portunus) sanguinolentus* (Herbst) and *Portunus (Portunus) pelagicus* (Linnaeus) along the southwest coast of India

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ABSTRACT

Age and growth of two marine protunid crabs, *Portunus (Portunus) sanguinolentus* and *P. (P.) pelagicus* was investigated based on the data collected from the commercial catches landed at Mangalore, Malpe and Karwar, three major fish landing centres in Karnataka state, along the southwest coast of India during 1992-'94. The size frequency analysis indicated that the growth rate was high and more or less uniform in juveniles, while the adults showed relatively low rate of growth and marked variation in males and females. In *P. (P.) sanguinolentus*, the mean monthly growth rates were 10.3 m and 8.8 mm and attained a carapace width of 124.1 and 112.5 mm by males and females respectively on completion of one year. In *P. (P.) pelagicus*, the average growth rates were 11.0 and 9.6 mm and attained a size of 145.2 and 132.5 mm by males and females respectively, at the end of one year. The von Bertalanffy's growth parameters, L_∞, K and t_o were 195 mm, 0.99 yr^{1} and -0.0132 yr for males and 188 mm, 0.82 yr^{1} and -0.0975 yr for females. In *P. (P.) pelagicus*, the growth parameters were 211 mm,. 1.14 yr^{1} and -0.0194 yr for males and 204 mm, 0.97 yr^{1} and -0.0691 yr for females.

Introduction

With an annual average of 23,137 tonnes (1983-'93), crabs form an important constituent in the marine fish landings in India (Sukumaran, 1995). *Portunus (Portunus) sanguinolentus* and *P. (P.) pelagicus* support good fishery all along the Indian coasts and together contribute upto 90 % of the marine crab landings in the country. In the context of increased importance given to crab resources and interest evinced in its culture, there is an urgent need to study the biology and ascertain the present status of the crab stocks for their rational exploitation and to augment production through culture. The present study is, therefore, directed to understand the age and growth of *P.(P.) sanguinolentus* and *P. (P.) pelagicus* from the southwest coast of India. No detailed studies are made on these

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aspects other than a few brief accounts based on tagging/rearing experiments (Prasad andTampi, 1953; Hamsa, 1982; Smith, 1982; Potter *et al.*, 1983) and by modal progression analysis (Thomas, 1984; Sumpton *et al,* 1994).

Material and methods

The material for the study included: (1) samples taken once a week on a random basis from the commercial trawl landings at Mangalore and Malpe during September 1992 through September 1994, (2) monthly samples from the commercial trawl and shore-seine landings at Karwar during September 1992 through September 1994, (3) occasional samples taken during 1993 and 1994 from the mini trawl catches landed from the Netravati-Gurupur estuary (Mangalore) and (4) occasional samples during 1993 and 1994 from the indigenous gears (mini trawl, gill net) catch at Panambu (near Mangalore) and Malpe during monsoon months (June-September).

For growth studies, carapace width measurments of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* including lateral spine were taken using a graduated measuring board. These measurements were classified into size groups with a class interval of 5 mm and pooled monthwise. The monthly size-frequency were plotted sexwise for *P. (P.) sanguinolentus* and *P. (P.) pelagicus* and growth patterns were determined *by* graphical analysis of the progression of modes in successive size-frequency distribution.

The scatter diagram for modes against months was drawn and trend lines tracing the growth of successive broods by means of modal progression through time were fitted by free hand as adopted by Devaraj (1983). These lines were extrapolated to intersect the time axis in order to resolve the periodicity and frequency of brood production during each spawning season and also the growth of each brood through successive months. The grand mean for the growth at age in months for the population was derived from the growth of individual broods.

To determine the parameters of the von Bertalanffy's growth model such as L_M, K and t_o, the carapace widths at age in months in the monthly modal distribution for the main broods were tabulated and the mean size at age was determined.

Using this length at age data as the input, the growth parameters, L_M and K were estimated using the Ford-Walford plot (Ford, 1933; Walford, 1946) and the Gulland and Holt plot (1959) and K and $t_o$were estimated from age/length data employing von Bertalanffy (1934) growth plot. The growth parameters were also determined by following the method of ELEFAN I (Pauly and David, 1981).

The expected lengths of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* at different ages (months) were determined by employing the von Bertalanffy's equation.

Results

The monthwise size frequency distribution of males and females of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* for Mangalore, Malpe and Karwar is presented in Figs. 1-6. The progression of modes through the successive size frequency distribution indicating the initial mode, the month of appearance, the final mode, the month upto which the mode could be traced, the growth increment, the duration and the average

growth of males and females of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* for Managalore, Malpe and Karwar are given in Tables 1-4.

A close look at the size frequency distribution of males and females of *P. (P.) sanguinolentus* given in Figs. 1-3 indicates that the fishery in January and February is often supported by two major size classes, one large size class (size range 90-160 mm) with a mode at 120-140 mm and another smaller size class of juveniles with a modal size at 40-60 mm (size range 20-70 mm). These

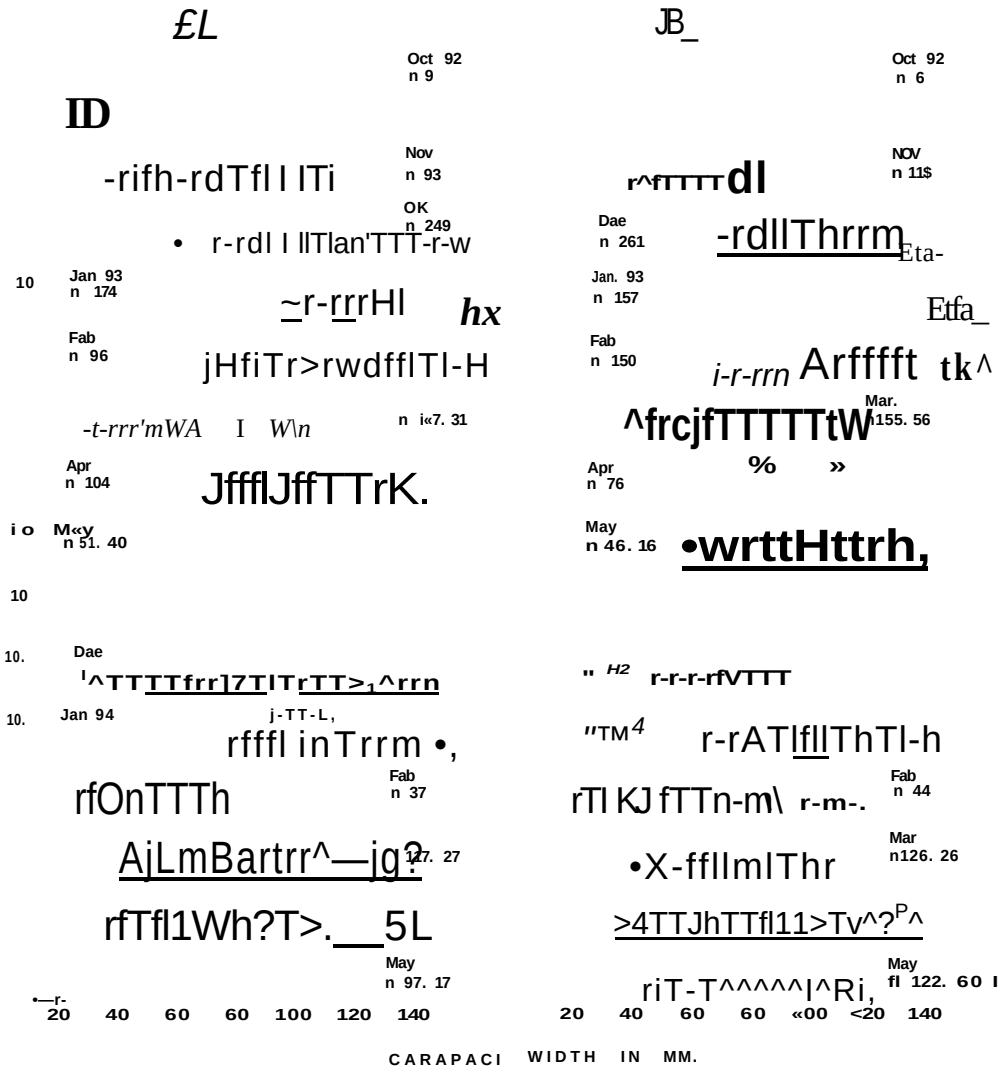

Fig. 1. *P. (P.) sanguinolentus.* Size-frequency histograms of males (A) and females (B) at Mangalore during 1992-'94 (hollow bars = trawl data; filled bars = indigenous gear data; n = number of crabs analysed).

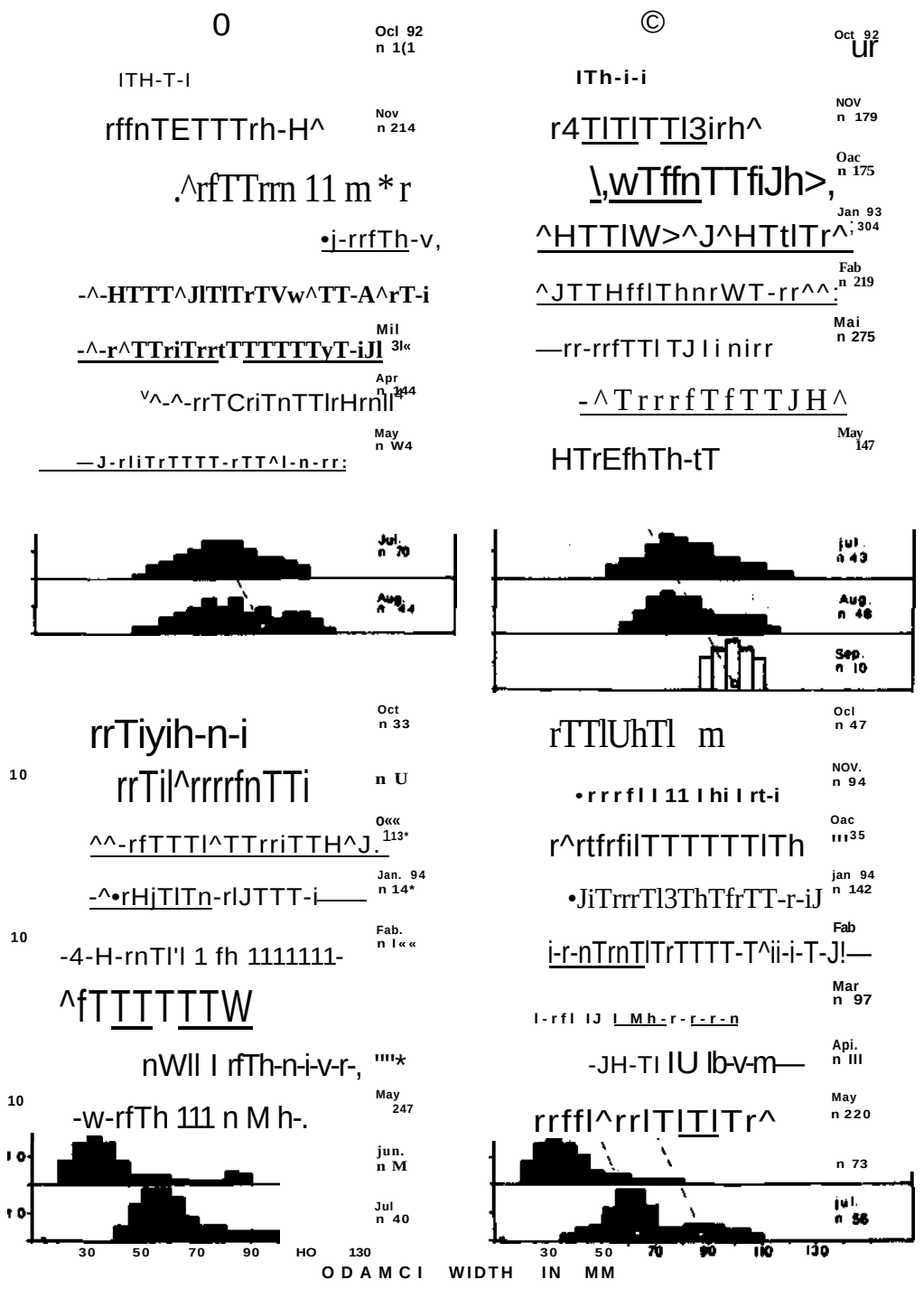

Fig. 2. *P. (P.) sanguinolentus.* Size-frequency histograms of males (A) and females (B) at Malpe 1992-'94 (hollow bars = trawl data; filled bars = indigenous gear data; n = number of crabs analysed).

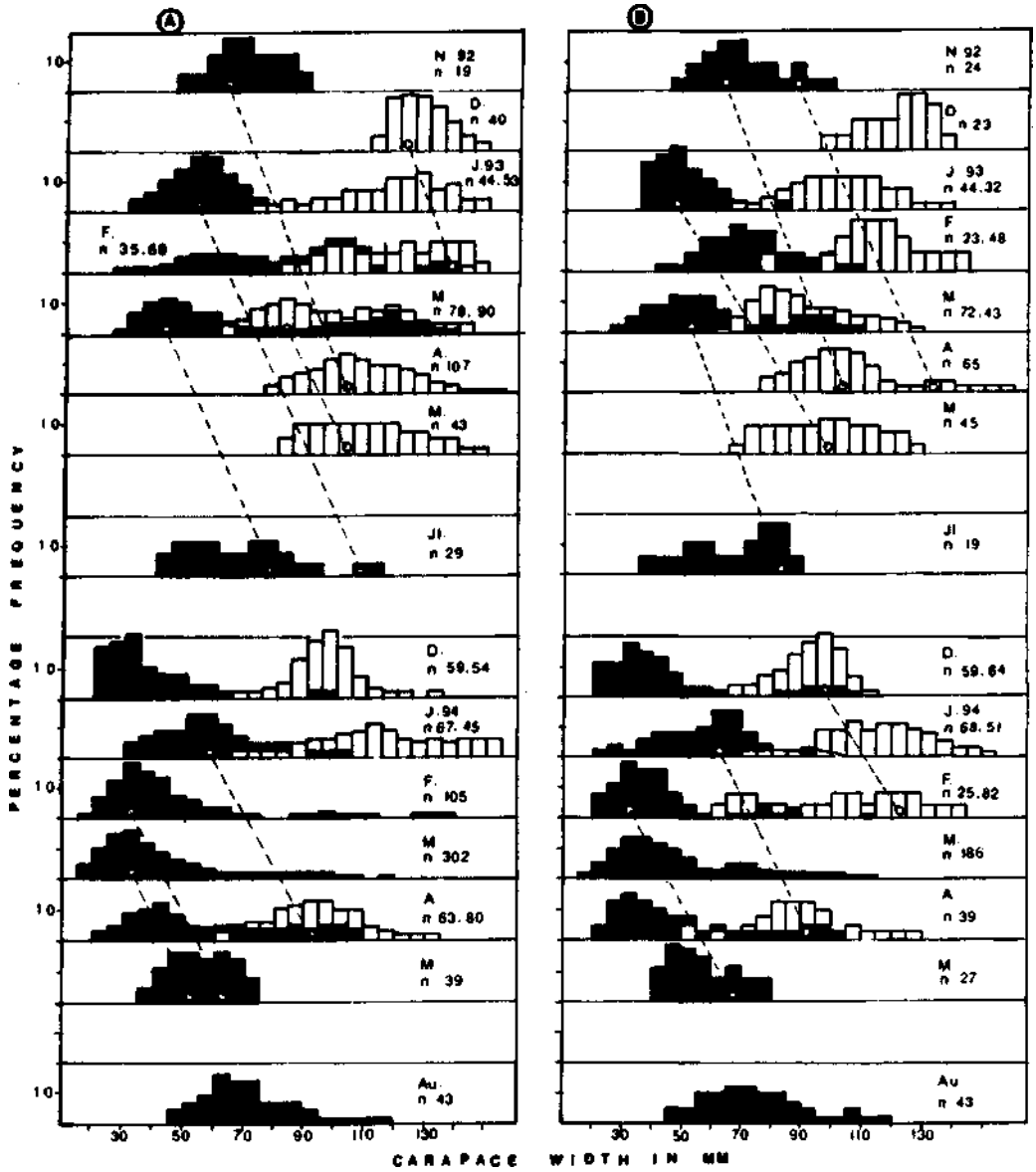

Fig. 3. *P. (P.) sanguinolentus.* Size-frequency histograms of males (A) and females (B) at Karwar 1992-'94 (hollow bars = trawl data; filled bars = indigenous gear data; n = number of crabs analysed).

two broods might represent the progeny of two peak spawning seasons. Hence, the large size class of 120-140 mm, in both sexes, is one year olds, a product of peak spawning during January-February of the previous season/year, while the smaller brood of 40-60 mm might be the product of peak spawning during September-October and may be 3-4 months old. This brood first appeared in

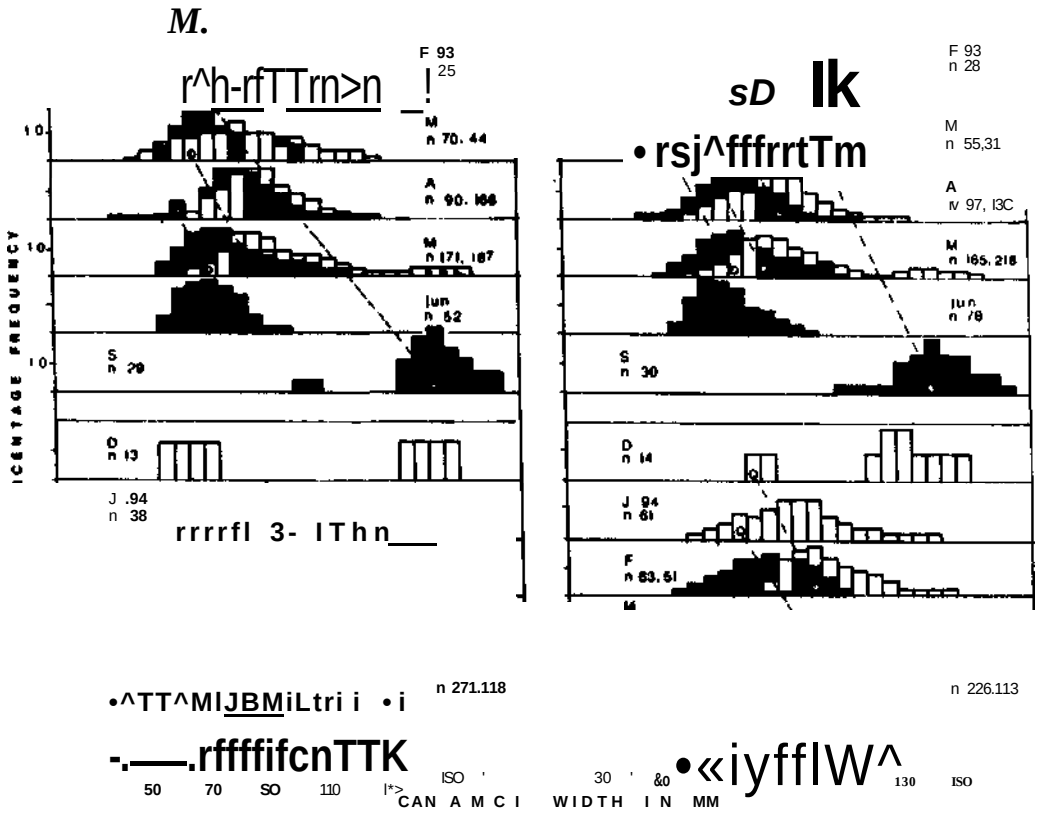

Fig. 4. *P. (P.) pelagicus.* Size-frequency histograms of males (A) and females (B) at Mangalore during 1992-'94 (hollow bars = trawl data; filled bars = indigenous gear data; n = number of crabs analysed).

the fishery in October at 32.5 mm and be traced upto May. By that time it attained a size of 100-110 mm thereby registering 70-80 mm growth in 7 months.

In the case of *P. (P.) pelagicus,* the fishery was supported by one size class with size ranging between 35 and 85 mm (mode at 62.5 mm in males and 57.5 mm in females) in January 1993 at Malpe (Fig. 5). This brood might be the progeny of peak spawning in September-October 1992 and hence 3-4 months old. This size class was grown to a size of 147.5 and 132.5 mm in males and females respectively by September 1993 when they complete one year.

It is seen that the larger size classes of these crabs are removed by the intensive trawl fishery during January-May and occur only in fewer numbers in the following months. During monsoon months (June-August) since the salinity is low in the coastal waters, these larger crabs probably migrate to more saline deeper waters and seldom return to the fishery before late December or early January.

Growth rate

The size frequency analysis indi-

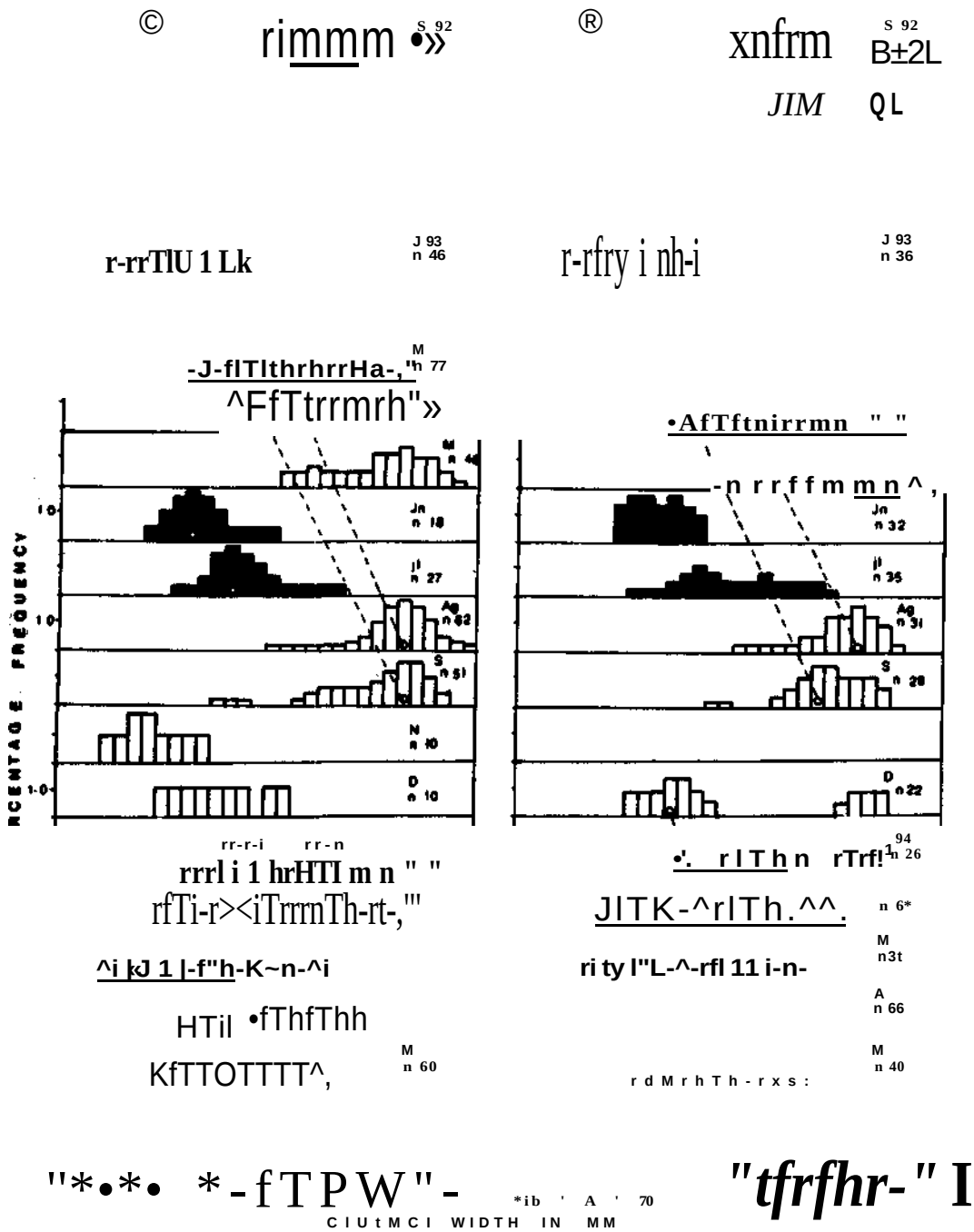

Fig. 5. P. (PJ *pelagicus.* Size-frequency histograms of males (A) and females (B) at Malpe 1992-'94 (hollow bars = trawl data; filled bars = indigenous gear data; n = number of crabs analysed).

cated that the growth rate is fast and more or less similar in juveniles, while the adults showed marked variation in their growth. It is found that the growth rate is high in juveniles, whereas, the adults registered low rate of growth in both these species.

The mean monthly growth rate was found to be 10.3 mm in males and 8.8 mm in females of P. *(P.) sanguinolentus* (Tables 1-2). This species attained a mean carapace width of 124.1 mm in males and 112.5 mm in females on completion of one year.

In the case of *P. (P.) pelagicus,* the overall growth rate was 11.0 and 9.6 mm in males and females respectively (Tables 3-4). This species attained a carapace width of 145.2 mm in males and 132.5 mm in females at the end of first year.

Modal progression analysis

The scatter diagram for modes against months was drawn and trend lines tracing the growth of the successive broods by means of modal progres-

TABLE 1. *Progression of size modes and rate of growth in* P. (P.) sanguinolentus *males during 1992-V4*

Centre	Initial mode (mm)	Month	Final mode (mm)	Month	Growth increment (mm)	Duration in months	Average growth/ month (mm)
Malpe							
	67.5	Nov. '92	132.5	May '93	65	6	10.8
	32.5	Oct. '92	102.5	May '93	70	7	10.0
	52.5	Jan. '93	82.5	Apr. '93	30	3	10.0
	42.5	Mar. '93	92.5	Aug. '93	50	5	10.0
	52.5	Oct. '93	92.5	Jan. '94	40	3	13.3
	52.5	Jan. '94	92.5	May '94	40	4	10.0
						Average	**10.5**
	112.5	Dec. '92	137.5	Feb. '93	25	2	12.5
	32.5	Oct. '92	107.5	May '93	75	7	10.7
	72.5	Mar. '93	92.5	May '94	20	2	10.0
	77.5	Mar. '94	102.5	May '94	25	2	12.5
	37.5	Feb. '94	77.5	May '94	40	3	13.3
						Average	**11.6**
	122.5	Dec. '92	137.5	Feb. '93	15	2	7.5
	62.5	Nov. '92	102.5	Apr. '93	40	5	8.0
	82.5	Mar. '93	102.5	May '93	20	2	10.0
	52.5	Jan. '93	107.5	Jul. '93	55	6	9.2
	42.5	Mar. '93	77.5	Jul. '93	35	4	8.8
	57.5	Jan. '94	92.5	Apr. '94	35	3	11.7
	32.5	Feb. '94	62.5	May '94	30	3	10.0
	32.5	Mar. '94	52.5	Apr. '94	20	2	10.0
						Average	9.3
					All centres combined average		**10.3**

TABLE 2. *Progression of size modes and rate of growth* ii*n* P. (P.) sanguinolentus *femal es during 1992-•'94*

Centre	Initial mode (mm)	Month	Final mode (mm)	Month	Growth increment (mm)	Duration in months	Average growth/ month (mm)
Malpe	112.5	Dec. '92	122.5	Jan. '93	10	1	10.0
	77.5	Nov. '92	122.5	May '93	45	6	7.5
	32.5	Oct. '92	97.5	May '93	65	7	9.3
	52.5	May '93	97.5	Sep. '93	40	4	10.0
	92.5	Nov. '93	117.5	Feb. '94	25	3	8.3
	52.5	Oct. '93	77.5	Jan. '94	25	3	8.3
	52.5	Dec. '93	82.5	Apr. '94	30	4	7.5
	47.5	Mar. '94	87.5	Jul. '94	40	4	10.0
	47.5	May 94	62.5	Jul. '94	15	2	7.5
						Average	8.7
Mangalore	122.5	Jan. '92	132.5	Feb. *93	10	1	10.0
	87.5	Dec. '92	117.5	May '93	30	5	6.0
	32.5	Oct. '93	92.5	May '94	60	7	8.6
	72.5	Dec. '93	102.5	May '94	30	5	6.0
	37.5	Feb. '94	57.5	Apr. '94	20	2	10.0
						Average	7.5
Karwar	87.5	Nov. '92	132.5	Apr. '93	45	5	9.0
	62.5	Nov. '92	102.5	Apr. '93	40	5	8.0
	47.5	Jan. '93	97.5	May '93	50	4	12.5
	52.5	Mar. '93	82.5	Jul. '93	30	4	7.5
	97.5	Dec. '93	122.5	Feb. '94	25	2	12.5
	62.5	Jan. '94	92.5	Apr. '94	30	3	10.0
	32.5	Feb. '94	67.5	Mar. '94	35	3	11.7
						Average	9.8
					All centres combined average		8.8

sion through time was fitted free hand in respect of P. *(P.) sanguinolentus* and *P. (P.) pelagicus* (Figs. 7-8). The grand mean for the growth at age in months of the population of these crabs was derived from the monthly modal distribution for the main broods.

The maximum sizes recorded in males and females were 169 and 166 mm for *P. (P.) sanguinolentus* and 174 and 171 mm for P. *(P.) pelagicus* respectively. It is seen that the maximum age upto which a brood could be traced was 17 months in the former species when it attained a mean size of 147.5 mm in males and 132.5 mm in females. In the case of the latter species, the maximum age upto which the brood could be traced was 15 months in males (152.5 mm) and 17 months in females (152.5 mm). It is possible that crabs may live a few more months. It is therefore, reasonable to surmise that the life span of these crabs may be around 2.5 years although most of them are fished out by the intensive trawl fishery in the early part of their life leaving only a few to attain their maximum age.

Table 3. *Progression, of size modes and rate of growth in* P. (P.) pelagicus *males during 1992-94*

Centre	Initial mode (mm)	Month	Final mode (mm)	Month	Growth increment (mm)	Duration in months	Average growth/ month (mm)
Malpe	132.5	Feb. '93	142.5	Mar. '93	10	1	10.0
	92.5	Feb. '93	147.5	Aug. '93	55	6	9.2
	62.5	Jan. '93	147.5	Sep.'93	85	8	10.6
	67.5	Jun. '93	82.5	Jul. '93	15	1	15.0
	52.5	Mar. '94	82.5	May '94	30	2	15.0
						Average	**10.8**
Mangalore	72.5	Feb. '93	147.5	Sep. '93	75	7	10.7
	67.5	Mar. '93	87.5	May '93	20	2	10.0
	62.5	Apr. '93	72.5	May '93	10	1	10.0
	92.5	Jan. '94	107.5	Feb. '94	15	1	15.0
	72.5	Mar. '94	92.5	May '94	20	2	10.0
						Average	**10.8**
Karwar	87.5	Dec. '92	152.5	May '93	65	5	13.0
	52.5	Nov. '92	122.5	May. '93	70	6	11.7
	42.5	Dec. '92	87.5	Apr. '93	45	4	11.2
	67.5	Dec. '93	107.5	Apr. '94	40	4	10.0
	72.5	Mar. '94	82.5	Apr. '94	10	1	10.0
						Average	**11.5**
						All centres combined average	**11.0**

TAIILE 4. *Pragression of size modes and. rate of growth in* P. (P.) pelagicus *females di•/.ring 1992-94*

Centre	Initial mode (mm)	Month	Final mode (mm)	Month	Growth increment (mm)	Duration in months	Average growth/ month (mm)
Malpe	102.5	Feb. '93	132.5	May '93	30		10.0
	57.5	jan. '93	132.5	Sep. '93	75		9.4
	97.5	Mar. '93	147.5	Aug. '93	50		10.0
	77.5	Dec. '93	97.5	Mar. '94	20	**3**	6.7
	62.5	Feb. '93	82.5	Apr. '94	20	**2**	10.0
	57.5	Mar. '94	82.5	May '94	25	**2**	12.5
						Average	9.6
Mangalore	97.5	Feb. '93	142.5	Sep. '93	45	7	6.4
	82.5	Mar. '93	92.5	Apr. '93	10	1	10.0
	67.5	Mar. '93	87.5	May '93	20	2	10.0
	57.5	Mar. '93	77.5	May '93	20	2	10.0
	82.5	Dec. '94	102.5	Feb. '94	20	2	10.0
	77.5	Jan. '94	102.5	Mar. '94	25	2	12.5
	77.5	Mar. '94	102.5	May '94	25	2	12.5
						Average	9.2
Karwar	67.5	Nov. '92	102.5	Mar. '93	35	4	8.8
	87.5	Dec. '92	137.5	May '94	50	5	10.0
	47.5	Nov. '92	97.5	Apr. '93	50	5	10.0
	32.5	Dec. '92	57.5	Feb. '94	25	2	12.5
	107.5	Jan. '94	127.5	Mar. '94	20	2	10.0
	67.5	Dec. '93	102.5	Apr. '94	35	4	8.8
	57.5	Feb. '94	82.5	Apr. '94	25	2	12.5
						Average	**10.0**
						All centres combined average	9.6

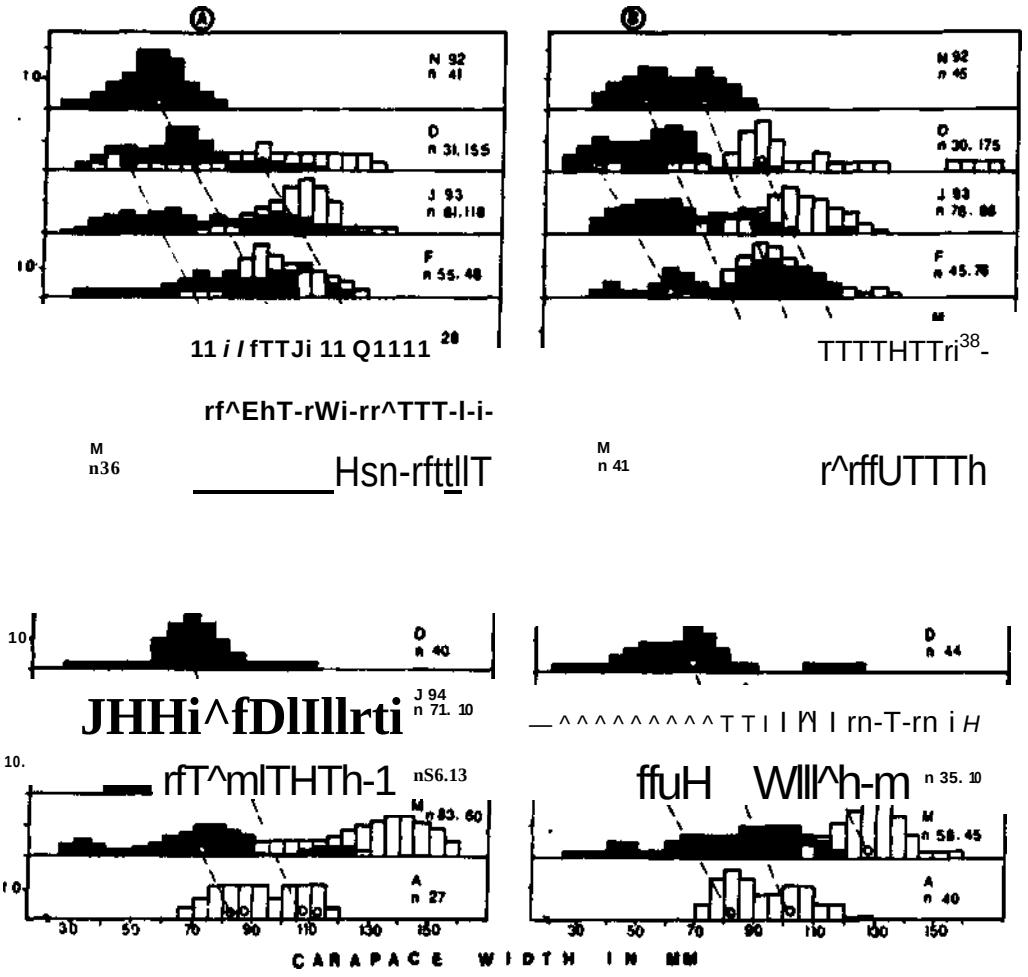

Fig. 6. *P. (P.) Spelagicus.* Size-frequency histograms of males (A) and females (B) at Karwar 1992-'94 (hollow bars = trawl data; filled bars = indigenous gear data; n = number of crabs analysed).

von Bertalanffy's growth parameters

The input data for estimating the growth parameters, L_m and K in *P. (P.) sanguinolentus* and *P.(P.) pelagicus* by the Ford-Walford plot and the GuUand and Holt plot given in Table 5 are based on the grand mean size for the growth at age in months tabulated from the monthly modal size distribution given in Figs. 7-8. The growth parameters estimated by the above methods and by following the method of ELEFAN I in respect of males and females of the two species are presented in Table 6. It is seen that the values of the growth parameters, L_M, and K estimated by the Ford-Walford plot and the Gulland and Holt plot were very close to each other in these crabs. These parameters

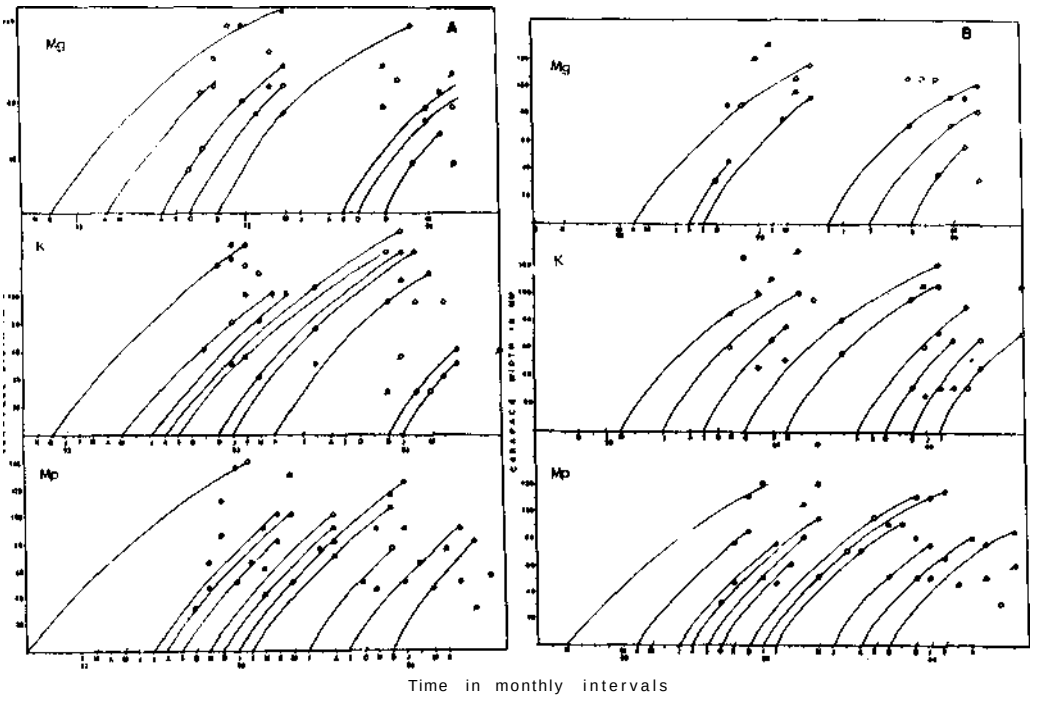

Fig. 7. *P. (P.) sanguinolentus.* Scatter diagram for modal lengths (CW) - month at Mangalore (Mg), Malpe (Mp) and Karwar (K) during 1992-'94. A - males; B - females

obtained by ELEFAN I method were 172.0 mm, 0.54 yr^{1} in males and 175.0 mm, 0.57VT^{1} in females for P. *(P.) sanguinolentus* and 188.0 mm, 0.72 $yr"^{1}$ in males and 181.0 mm, 0.59 yr^{1} in females for *P.(P.) pelagicus* respectively.

The $L_{\_}$ values obtained by graphical methods were 195 mm in males and 187 mm in females by the Ford-Waflford plot and 195 and 188 mm by the Gulland and Holt plot in P. *(P.) sanguinolentus* (Figs. 9-10). In P. *(P.) pelagicus*, the L_M, values obtained were 210 and 202 mm in males and females by the former method and 211 and 205 mm by the latter method (Fig. 10).

For fitting the von Bertalanffy's growth equation, the average values of the growth parameters obtained by the Gulland and Holt plot and the Ford and Walford plot were used since these values were found to be more realistic.

The von Bertalanffy's growth equation in respect of males and females of P. *(P.) sanguinolentus* and *P.(P.) pelagicus* are as follows:

P. *(P.) sanguinolentus*

male $L_t = 195.0[1-e^{-0"(t+00132)}]$

female : $L_t = 188.0\ [1-e^{082\ (t+00975)}]$

P.(P.) pelagicus

male : L = 211.0 [l-e> ^TM»*]*

female : L = 204.0 $[1-e^{-0.97(t+0.0691)}$

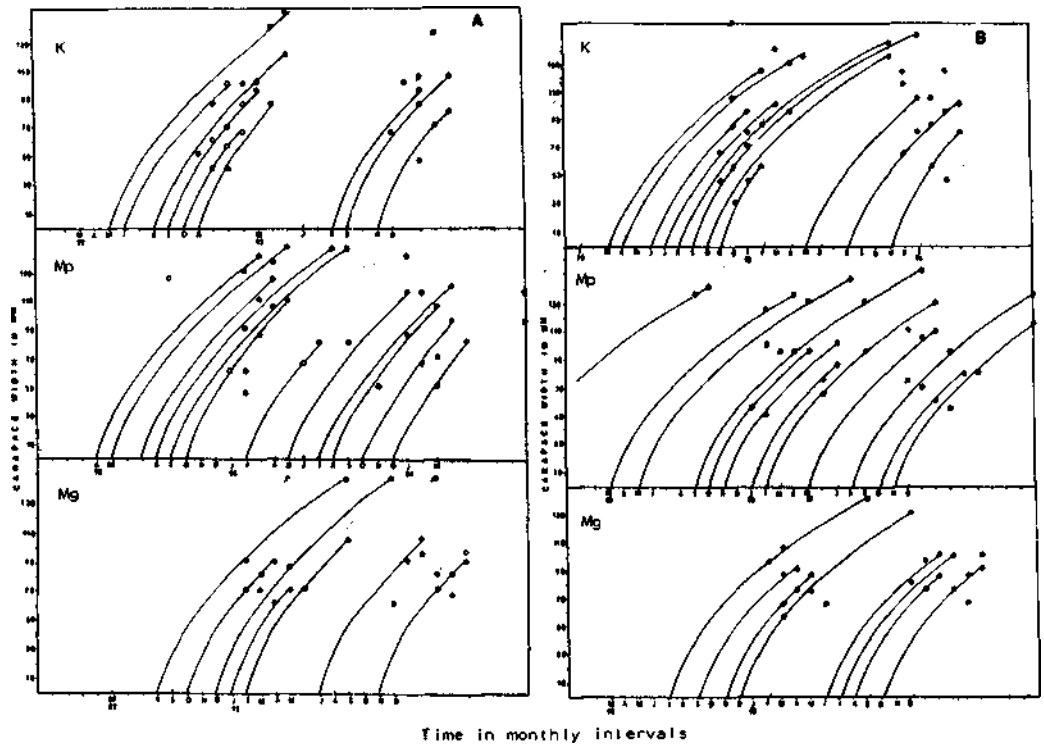

Fig. 8. *P. (P.) pelagicus.* **Scatter diagram for modal lengths (CW) - month at Mangalore (Mg), Malpe (Mp) and Karwar (K) during 1992-'94. A - males; B - females.**

TABLE 5. *Pairs of consecutive lengths (mm) with At = 0.25 year used as input data for determining growth parameters by Ford-Walford plot and Gulland and Holt plot*

Species	t	Ford-Walford plot x	Ford-Walford plot y	Gulland-Holt plot y	Gulland-Holt plot x
		L (t)	L (t x At)	A L/At (growth increment)	X/L (mean size)
P. (P.) sanguinolentus					
Male	1	45.0	78.0	33.0	61.5
	2	78.0	104.0	26.0	91.0
	3	104.0	124.0	20.0	114.0
Female	1	47.0	73.0	26.0	60.0
	2	73.0	95.0	22.0	84.0
	3	95.0	112.0	17.0	103.5
P. (P.) pelagicus					
Male	1	56.0	94.0	38.0	75.0
	2	94.0	124.0	30.0	109.0
	3	124.0	145.0	21.0	134.5
Female	1	55.0	86.0	31.0	70.5
	2	86.0	114.0	28.0	100.0
	3	114.0	132.0	18.0	123.0

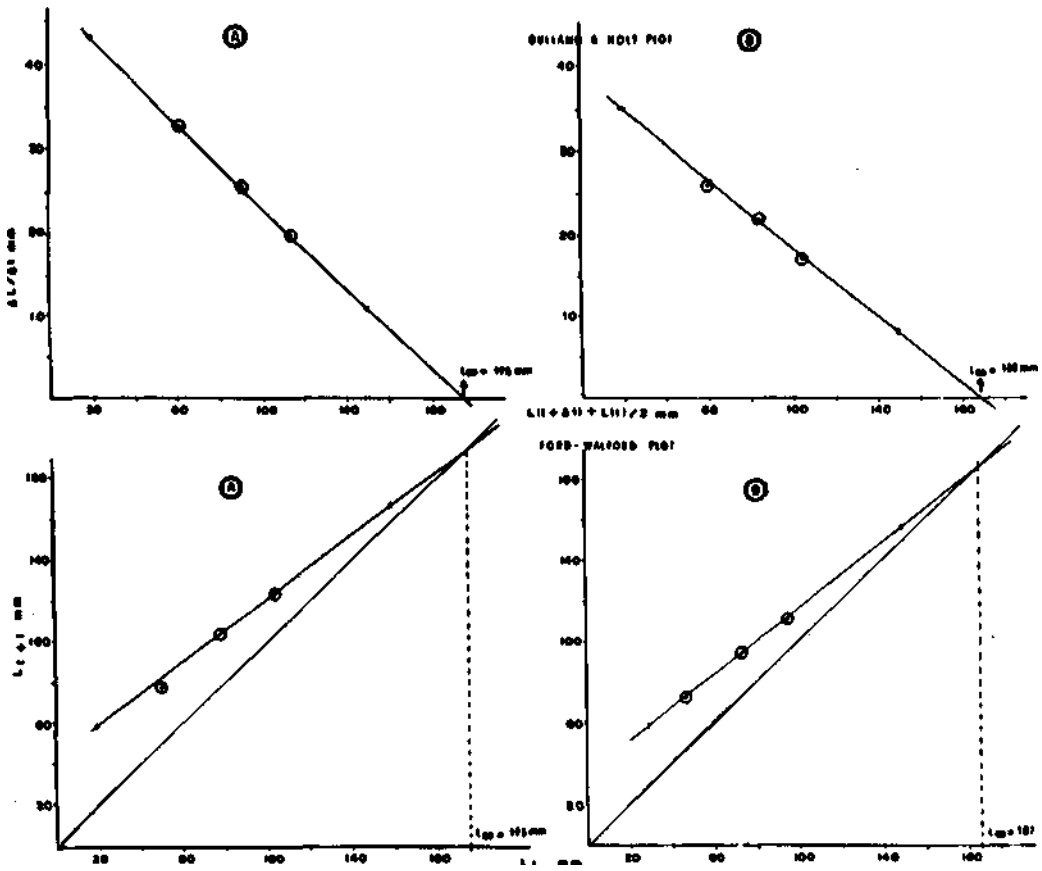

Fig. 9. Estimation of L for males (A) and females (B) by Gulland and Holt plot and Ford-Walford plot in *P. (P.) sanguinolentus.*

Employing these equations, size at different ages was determined for males and females of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* (Fig. 11 A, B). It is found that the estimated size at different ages was very close to the observed values (Fig. 11 C, D).

Population age structure

The age composition of males and females of P. *(P.) sanguinolentus* and *P. (P.) pelagicus* in the samples analysed during the course of present study is summarised in Tables 7-8. It is possible to deduce from the Tables that in the former species, around 89.0 % of the population exploited by the fishery belongs to 0-year class, while the rest (11.0 %) to 1-year. In the indigenous gears, 0-year class contributed to the bulk of the fishery (99 %) (Table 7). In the case of *P. (P.) pelagicus* about 95 % of the population exploited by the trawl fishery was constituted by 0-year class, while the 1-year olds formed the rest (5 %). In the indigenous gears, 0-year

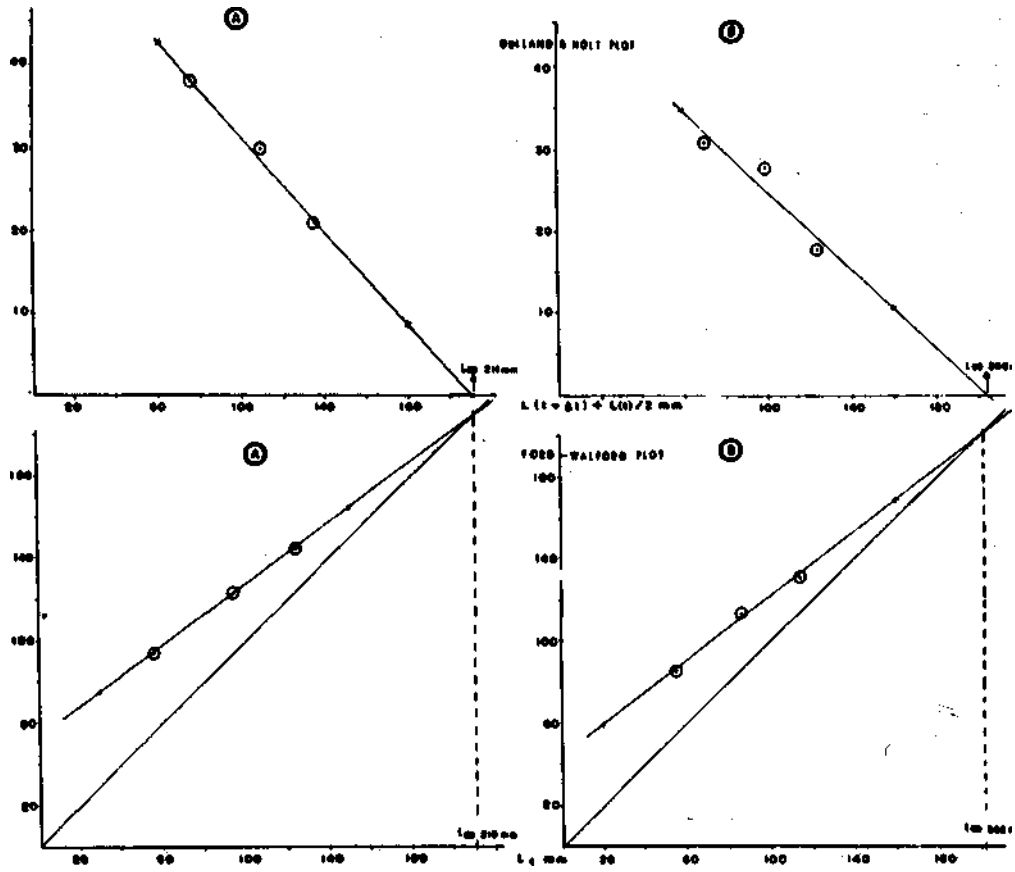

Fig. 10. Estimation of L for males (A) and females (B) by Gulland and Holt plot and Ford-Walford plot in *P. (P.) pelagicus.*

class contributed to 93 %, whereas 1-year olds formed the rest (7 %) (Table 8).

Discussion

The nature of crab growth by moulting has led to much difficulty in determining the true growth rate under natural conditions. Most of the earlier studies on the growth has been made on crabs kept in tanks and more recently by tagging.

The present investigation has indicated that although the growth studies by progression of modes of the size-frequency distribution is highly subjective, it gives certain amount of success in determining the growth rate and life span of the individual species.

In the present study, the growth is found to be rapid in these portunids and the adult size may be reached in less than a year after hatching. According to Smith (1982), the Australian population of *P. (P.) pelagicus* reaches a size of 150 mm in about 18 months, while

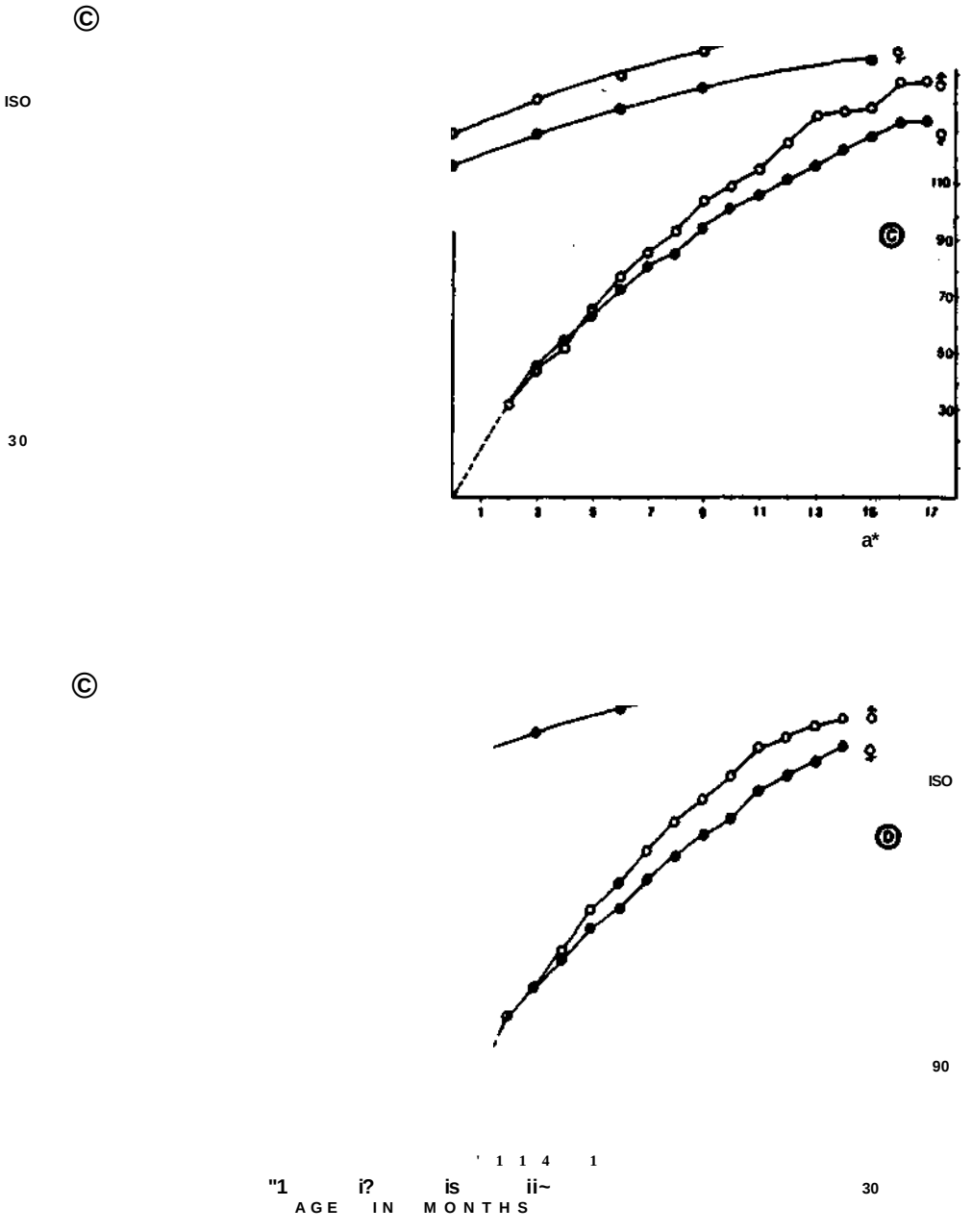

Fig. 11. von Bertalanffy growth curve for *P. (P.) sanguinolentus* (A) and *P. (P.) pelagicus* (B). C and D - observed values.

TABLE 6. *Growth parameters estimated by various methods in males and females of P.(P.)* sanguinolentus and P. (P.) pelagicus

Species	Sex	Growth parameter	Methods				
			Ford-Walford plot	Gulland & Holt plot	von Bertalanffy plot	ELEFAN I method	L_{max}
P. (P.) sanguinolentus							
	Male	L_∞	195.3800	195.3900	195.0000	172.00	169.0
		K	0.9937	0.9886	0.9941	0.54	
		t_0	-	-	-0.0132		
	Female	L_∞	187.8500	188.0000	188.0000	175.00	166.0
		K	0.8256	0.8215	0.8265	0.57	
		t_0	-	-	-0.0975		
P. (P.) pelagicus							
	Male	L_∞	210.8200	211.0000	211.0000	188.00	174.0
		K	1.1416	1.1319	1.1431	0.72	
		t_0			-0.0194		
	Female	L_∞	202.6600	204.3900	204.0000	181.00	171.0
		K	0.9835	0.9772	0.9700		
i		t_0	-	-	-0.0691		

L in mm; K and t zero are annual values.

Potter *et al.* (1983) reported that the female of *P. (P.) pelagicus* attains a carapace width of 127 mm at the end of 1st year in the same area. Hamsa (1982) found that 11-25 mm cw crabs kept in tanks attained a size of 140-150 mm in 12 moults after a period of 14 months at Mandapam. The present result (attaining a carapace width of 132.5 mm in females on completion of one year in this species) is close to the results obtained by Potter *et al.* (1983) (127 mm on completion of one year in females) from Australia. Thomas (1984), while studying the growth of these portunids by size-frequency analysis from Cochin area reported that *P. (P.) pelagicus* attained a size of 90 mm at the end of one year which appears to be a very low estimate in view of the present studies as well as the observations made by Smith (1982) and Potter *et al.* (1983) from Australia.

Although crabs of the genus *Portunus* continue to moult throughout their life period, the intermoult period is larger and the length attained after each moult gets reduced as it grows older resulting in considerable overlap in the actual age of crabs in the larger size classes. This resulted in the larger size class making up a disproportionately larger share of the adult population during certain seasons.

Although *P. (P.) sanguinolentus* and *P. (P.) pelagicus* are having a possible life span of around 2.5 years, often they are taken at an age at which most of them might not have spawned once. The present study has indicated that the population of these crabs which was exploited by various types of gears comprised mainly of 0-year class,

Table 7. *Age composition of P.* (P.) sanguinolentus *at Mangalore, Malpe and Karwar during 1992-V4.*

Age groups	Male						Female					
	Mangalore (TN)		Malpe (TN)		Karwar (TN)		Mangalore (TN)		Malpe (TN)		Karwar (TN)	
	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94
<0.5	198	286	1,043	675	28	22	131	251	787	553	17	20
0.5 - 1.0	508	260	600	371	250	148	577	310	562	445	217	168
1.0 - 1.5	221	44	159	26	68	25	266	60	204	56	8	12
1.5 - 2.0	18	-	23	3	4	7	16	2	16	3	1	-
2.0 - 2.5	-	-	-	-	-	-	-	-	2	1	-	-
Sample size	945	590	1825	1075	350	202	990	623	1571	1058	243	200
Sum nos. x age	738.3	321.5	949.8	484.8	286.5	160.0	826.0	373.8	905.8	550.8	178.8	146.0
Mean age	0.78	0.54	0.52	0.45	0.82	0.79	83.0	0.60	0.58	0.52	0.74	0.73
Age groups	Mangalore (IG) (estuary)		Malpe (IG)		Karwar (IG)		Mangalore (IG) (estuary)		Malpe (IG)		Karwar (IG)	
	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94
<0.5	66	43	64	112	193	577	32	44	38	113	123	410
0.5 - 1.0	19	11	53	12	72	86	52	52	56	16	47	66
1.0 - 1.5	-	1	-	-	12	4	-	-	-	-	-	7
1.5 - 2.0	-	-	-	-	-	1	-	-	-	-	-	-
Sample size	85	55	117	124	277	668	84	96	94	129	170	483
Sum nos. x age	30.8	20.3	55.8	37.0	117.3	215.5	47.0	50.0	51.5	40.3	66.0	160.8
Mean age	0.36	0.37	0.48	0.30	0.42	0.32	0.56	0.52	0.55	0.31	0.39	0.34

TN = trawl net; IG - indigenous gear; Age in years.

TABLE 8. *Age composition of P.* (P.) pelagicus *at Mangalore, Malpe and Karwar during 1992-'94.*

Age groups	MALE						FEMALE					
	Mangalore (TN)		Malpe (TN)		Karwar (TN)		Mangalore (TN)		Malpe (TN)		Karwar (TN)	
	1992-'93	1993-'94	1992-':93	1993-'94	1992-'93	1993-'94	1992-*93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94
<0.5	212	388	130	146	95	57	144	249	94	131	89	50
0.5 - 1.0	130	234	194	166	133	160	181	324	263	160	234	198
1.0 - 1.5	13	3	56	32	39	20	18	8	4	-	9	6
1.5 - 2.0	-	-	-	-	-	-	1	-	-	-	-	-
2.0 - 2.5	-	-	-	-	-	-	-	-	-	-	-	-
Sample size	355	625	380	344	267	237	344	581	361	291	332	254
Sum nos. x *i*age	166.8	276.3	248.0	201.0	172.3	159.3	196.0	315.3	225.8	152.8	209.0	168.5
Mean age	0.47	0.44	0.65	0.58	0.65	0.67	0.57	*0.54*I	0.62	0.52	0.63	0.66

Age groups	Mangalore (IG)		Mangalore (IG) (estuary)		Malpe (IG)		Karwar (IG)		Mangalore (IG)		Mangalore (IG) (estuary)		Malpe (IG)		Karwar (IG)	
	1992-'93	:1993-'94	1992-"93	1993-'94	:1992-"93	1993-"94	1992-'93	1993-'94	1992-'93	1993-'94	1992-'93	1993-'94	:1992-'93	1993-'94	1992-'93	1993-'94
<0.5	-	-	305	261	44		321	108	-	-	368	232	46	-	308	85
0.5 - 1.0	8	11	47	40	23		52	23	2	6	94	108	30	-	26	36
1.0 - 1.5	4	18	-	-	21		-	2	16	20	-	-	10	-	2	16
1.5 - 2.0	-	-	-	-	-		-	-	1	4	-	-	-	-	1	2
Sample size	12	29	432	301	88		373	133	19	30	462	340	86	-	337	139
Sum nos. x age	11.0	30.8	111.5	95.3	54.5		119.3	46.8	23.3	36.5	162.5	139.0	46.5		100.8	71.8
Mean age	0.921	1.06	0.26	0.32	0.62	-	0.32	0.35	1.22	1.22	0.35	0.41	0.54		0.30	0.52

Age in years; TN trawl net; IG = indigenous gear.

whereas one year olds formed only 11.0 % in the former and 5.0 % in the latter species in trawls (Tables 7-8). In the indigenous gears, one year old groups contributed to only 1 and 2 % respectively in these species except in gill nets where the one year class of *P. (P.) pelagicus* formed upto 70 % during September-October. The large proportion of one year olds in gill nets may possibly be due to its large mesh size (6-65 mm) as well as the highly selective nature of the gear coupled with the short duration of the fishery at a time when the population was comprised of mostly larger crabs.

As such, there is no worthwhile study on the growth parameters of these portunids. Although Thomas (1984) determined the growth parameters of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* from Cochin area, the author arrived at some erroneous conclusions as the study was based on insufficient data. (L. of 318.63 and 394.68 mm against observed maximum size of 150 and 170 mm, and K of 0.1327 and 0.1231 for *P. (P.) sanguinolenus* and *P. (P.) pelagicus* respectively in contrast to their fast growth and short life span). In a recent study, the L_M and K determined by Sumpton *et al.* (1994) for *P. (P.) pelagicus* from Australia were 175 mm and 1.597 for males and 170 mm and 1.613 for females respectively, L_M and K were also estimated by the computerised ELEFAN I method, it is found that the K values were underestimated despite a reasonable estimate of Loo. However, the growth parameter complements (L^ and K) estimated by Gulland and Holt plot and Ford-Walford plot for *P. (P.) sanguinolentus* and *P. (P.) pelagicus* were found to be realistic and fairly accurate. The present study, hence, tends to suggest that the traditional methods were found to be more useful in determining the growth parameters in the brachyurans studied.

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