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Relative growth and sexual maturity in the marine crabs, *Portunus (Portunus) sanguinolentus* (Herbst) and *Portunus (Portunus) pelagicus* (Linnaeus) along the southwest coast of India

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ABSTRACT

The relative growth of the secondary sexual characters like chela in male and abdomen in female of *Portunus (Portunus) sanguinolentus* and *P.(P.) pelagicus* was studied and the results presented. Morphological analysis revealed that transitions in the cheliped dimensions and abdominal widths of these crabs are related to prepubertal and postpubertal changes associated with gonadal development and onset of sexual maturity. The study indicated that the pubertal moult occurred in *P. (P.) sanguinolentus* and *P. (P.) pelagicus* at a carapace width of 85-90 mm in males and 80-90 mm in females as evident from sudden increase in morphological characterisitics. The allometric relations between the set of characters studied suggested that the relationships were positive and significant.

Introduction

Among brachyura, morphometric analysis has been used to study attainment of sexual maturity (Sieple and Salmon, 1987; Atrill and Hartnoll, 1991; Lovrich and Vinuesa, 1993; Gurriran and Freire, 1994). Within Portunidae, relative growth has been studied by Newcombe *et al.* (1949), Ryan (1967), Lewis (1977), Prasad and Neelakantan (1988), Sumpton (1990), Haefner (1990), Jacob *et al.* (1990) and Reeby *et al.* (1990). In the present study, an attempt has been made to analyse the morphometric data to define growth patterns of male and female of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* and to show changes in form with the onset of maturity.

Materials and methods

The morphometric characters studied in males were carapace width, carapace length, chelar propodus length and chelar propodus depth. To study their interrelations carapace length was regressed on chelar propodus length and chelar propodus depth; carapace width was regressed on chelar propodus length and chelar propodus depth and chelar propodus length was regressed on chelar propodus depth. The characters studied in females were carapace width and abdomen width, carapace

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width and abdomen length, carapace length and abdomen width, carapace length and abdomen length and abdomen width and abdomen length. For this purpose, carapace width, carapace length, chelar propodus depth, chelar propodus length in males, and abdominal length and width of fourth abdominal segment of females were measured to the nearest 0.1 mm with vernier calipers as indicated below and in Fig.1. Carapace width (CW) was measured between the tips of the largest spines (tips of epibranchial spines). Carapace length (CL) was measured along the middle line between the frontal notch and posterior margin of carapace. Right chelar propodus length (Ch L) was measured from the tip of the propodus fixed finger to the base of the propodus.

Right chelar propodus depth (Ch D) was measured across the widest region of the cheliped palm. Abdomen width

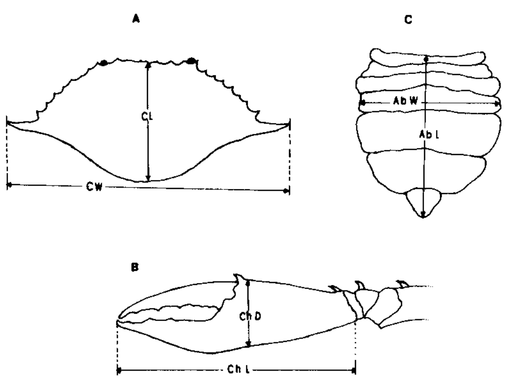

Fig.1. The measurements made for morphometric studies in *P. (P.) sanguinolentus* and *P. (P.) pelagicus.* A – carapace dorsal view; B - chela; C - abdomen; CW - carapace width; CL - carapace length; Ch L - chelar propodus length; Ch D - chelar propodus depth; Ab W - width of fourth abdominal segment; Ab L - length of abdomen.

(Ab W) was measured across midline of the fourth segment. Abdomen length (Ab L) was measured along the midline from the frontal margin of the first segment to the posterior margin of the last segment of abdomen.

Regression equations were calculated assuming an allomertic growth equation, Y = a + bx, where, x = carapace width/ length, and Y = abdomen width or length / propodus length or propodus depth as the case may be. In order to determine the constant of allometry 'b' all data were transformed to logarithms and a log-log regression was performed (Simpson *et al.*, 1960). The correlation coefficients (r) were employed to know the relationship between abdomen/propodus and carapace dimensions.

Results and discussion

Morphological analysis revealed transitions in the cheliped dimensions and abdominal widths of *P. (P.) sanguinolentus and P. (P.) pelagicus* (Figs. 2-6). It is often inferred that such transitions are related to prepubertal and post–pubertal changes associated with gonadal development and the onset of sexual maturity (Hartnoll, 1982). The present study presents evidence that support such inference.

The chelar propodus length of males *P.(P.) sanguinolentus* and *P. (P.) pelagicus* exhibited positive allometry in both immature and mature crabs and mature crabs showed slightly higher levels of allometry as compared to immature ones. The present study indicated that males of *P. (P.) sanguinolentus* and *P. (P.) pelagicus* may undergo pubertal moult at a carapace width ranging between 80-85 mm as evident from the sudden increase in morphometric characteristics (Figs 2-3, 6A and B).

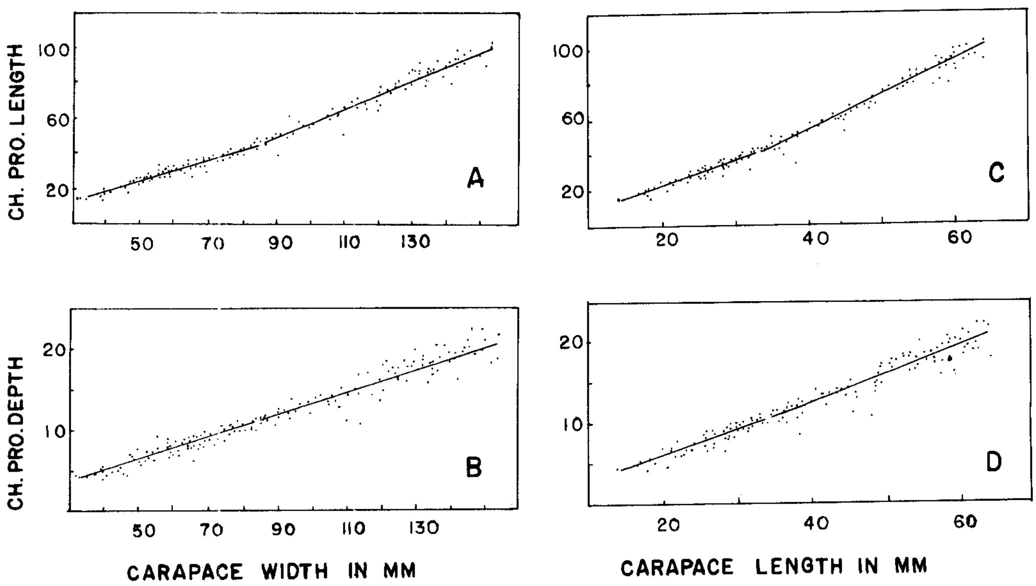

Fig.2. *P. (P.) sanguinolentus* males. Growth pattern of chelar propodus length in relation to carapace width (A); chelar propodus depth in relation to carapace width (B); chelar propodus length in relation to carapace length (C) and chelar propodus depth in relation to carapace length (D).

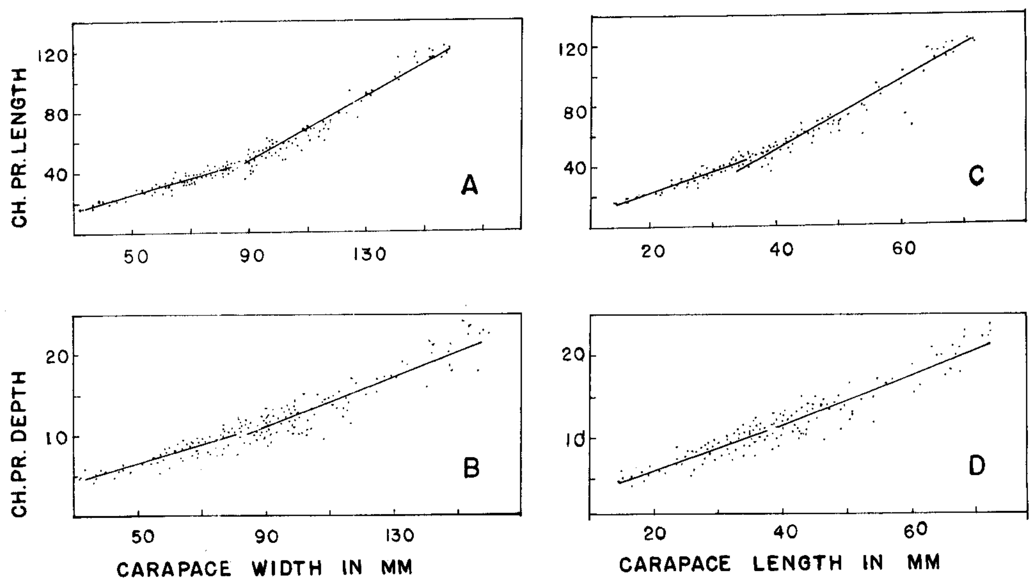

Fig.3. *P. (P.) pelagicus* males. Growth pattern of chelar propodus length in relation to carapace width (A); chelar propodus depth in relation to carapace width (B); chelar propodus length in relation to carapace length (C) and chelar propodus depth in relation to carapace length (D).

Females of *P. (P.) sanguinolentus* and *P. (P.) pelagicus*, on the other hand, exhibited positive allometry of abdomen width and length against carapace width and length in immature and mature crabs with a marked increase in size of abdomen at a mean size of 80-90 mm CW (Figs. 4-5, 6C and D).

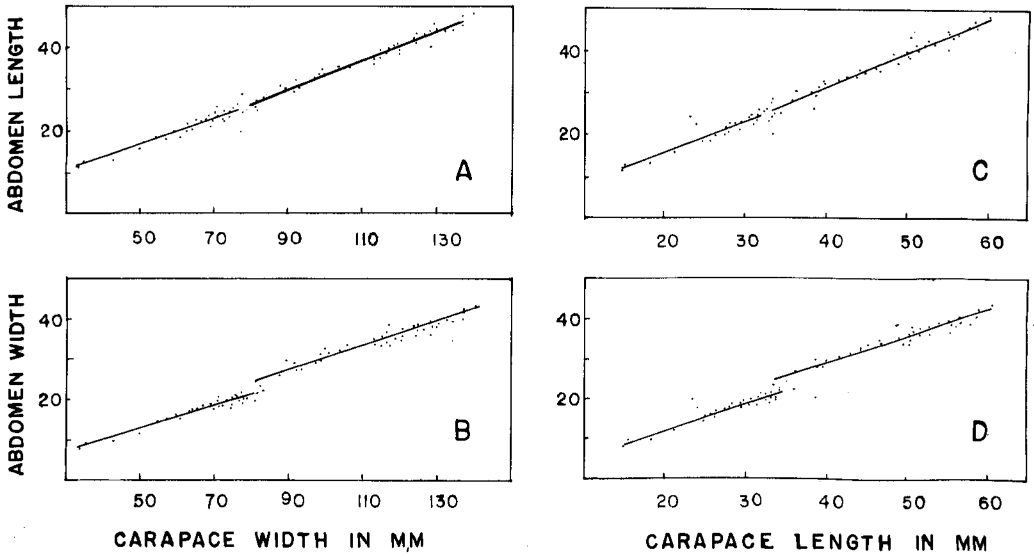

Fig. 4. *P. (P.) sanguinolentus* females. Growth pattern of abdomen length in relation to carapace width (A); abdomen width in relation to carapace width (B); abdomen length in relation to carapace length (C) and abdomen width in relation to carapace length (D).

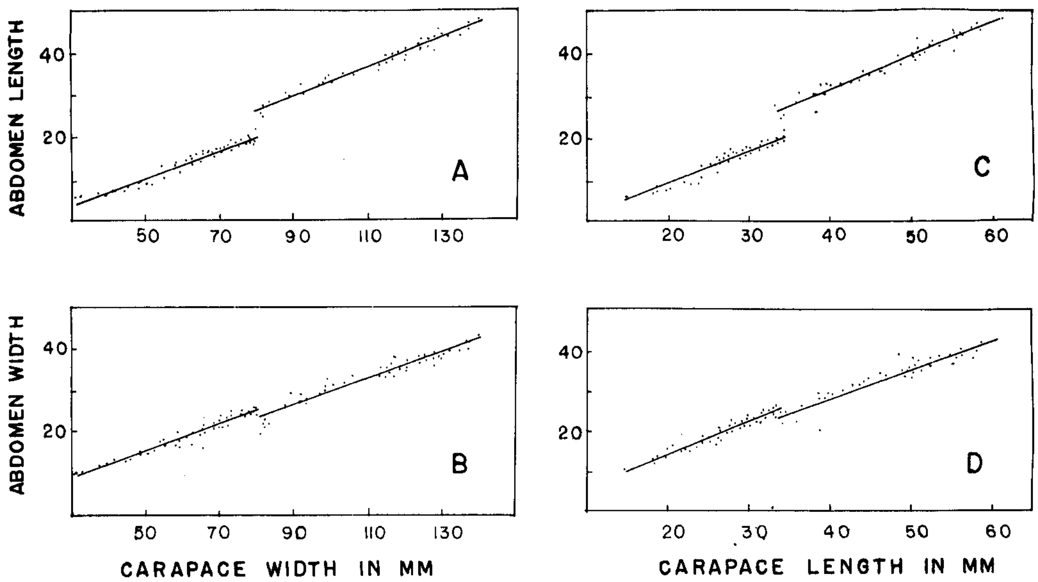

Fig. 5. *P. (P.) pelagicus* females. Growth pattern of abdomen length in relation to carapace width (A); abdomen width in relation to carapace width (B); abdomen length in relation to carapace length (C) and abdomen width in relation to carapace length (D).

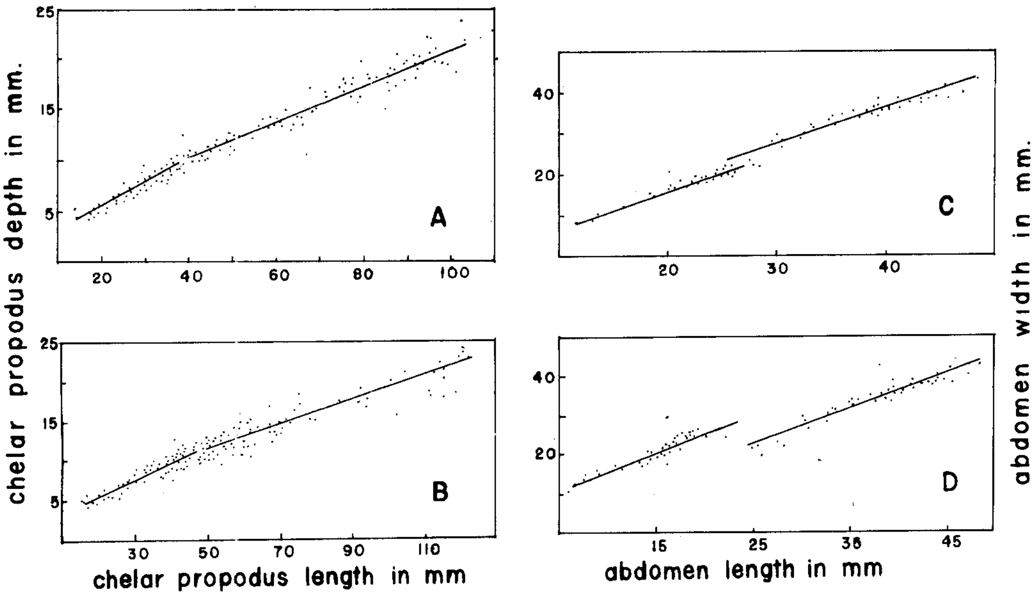

Fig. 6. Growth variation of chelar propodus depth in relation to chelar propodus length in *P. (P.) sanguinolentus* (A) and *P. (P.) pelagicus* (B). Growth variation of abdomen width in relation to abdomen length in *P. (P.) sanguinolentus* (C) and P. (P.) pelagicus (D).

The allometric equations in respect of immature and mature males and females of these two species are indicated in Tables 1-4. The allometric relation between the set of characters studied suggested that the relationships were positive and significant (highly significant in many set of characters studied).

Most brachyurans show sexual differences in the relative size of abdomen and chela. Relative growth studies in crabs provide possible indications of the size at sexual maturity for both males and females since maturity often coincide with critical moult (pubertal moult) at which there are changes in allometry and relative size (Hartnoll, 1969, 1974). In females, the abdomen, pleopods and thoracic sterna are greatly changed and in males, the shape and size of chela are often modified.

In males, the general criterion of maturity is the vasa deferentia which contain large number of spermatophores. In addition, external morphological changes effecting the chela in particular, coinciding with maturity, also occur at the puberty moult. In females, in contrast to males maturity cannot be determined from the condition of gonads as the ovary reverts back to immature stage after spawning. Fortunately, the moult of puberty is much more prominently developed in females than in males and can involve changes in features of the abdomen, pleopods and sternum.

Sulkin (1977), Berrill (1982) and Smith (1982) opined that the size at which portunid crabs reach maturity may vary according to their geographical location. Such variations in the size at maturity were observed in the same species caught from different locations in the present investigations as well as in the study made by several research-

TABLE 1. *Regression analysis of body dimensions in immature and mature males of* P. (P.) sanguinolentus. *Constant of allometry (b) based on log-log transformations provided for all relationships.*

Parameters			Allometric equations	n	'b'	'r'+
Immature males						
CW	x	Ch.D	Y = −0.0411 + 0.1320 x	92	0.9792	0.996
CW	x	Ch.L	Y = −3.9362 + 0.5696 x	92	1.1645*	0.998
CL	x	Ch.D	Y = −0.4538 + 0.3195 x	92	1.0479	0.992
CL	x	Ch.L	Y = −5.7314 + 1.3781 x	92	1.2214*	0.997
Ch.L	x	Ch.D	Y = 0.8762 + 0.2318 x	92	0.8573	0.995
Mature males						
CW	x	Ch.D	Y = 0.0417 + 0.1328 x	94	1.0677	0.924
CW	x	Ch.L	Y = −23.6330 + 0.8036 x	94	1.3491*	0.996
CL	x	Ch.D	Y = −1.6600 + 0.3509 x	94	1.1089	0.998
CL	x	Ch.L	Y = −27.6180 + 1.9943 x	94	1.4031*	0.997
Ch.L	x	Ch.D	Y = 3.2079 + 0.1758 x	94	0.7890	0.989

C W = carapace width; C L = carapace length; Ch.D = chelar propodus depth;
Ch.L = chelar propodus length. The asterisk indicates high positive allometry. + Significant at P = ≤ 0.001.

TABLE 2. *Regression analysis of body dimensions in immature and mature males of* P. (P.) pelagicus. *Constant of allometry (b) based on log-log transformations provided for all relationships*

Parameters			Allometric equations	n	'b'	'r'+
Immature males						
CW	x	Ch.D	Y = 0.6915 + 0.1151x	79	0.8353	0.998
CW	x	Ch.L	Y = −2.4856 + 0.5462x	79	1.0683	0.992
CL	x	Ch.D	Y = 0.2164 + 0.2842x	79	0.9176	0.982
CL	x	Ch.L	Y = −4.9126 + 1.3554x	79	1.1689*	0.989
Ch.L	x	Ch.D	Y = 1.2773 + 0.2086x	79	0.8027	0.986
Mature males						
CW	x	Ch.D	Y = −2.6966 + 0.1532x	132	1.2807*	0.980
CW	x	Ch.L	Y = −49.3541 + 1.0697x	132	1.7037*	0.987
CL	x	Ch.D	Y = −0.7919 + 0.311 x	132	1.1678*	0.986
CL	x	Ch.L	Y = −35.3478 + 2.1559x	132	1.5549*	0.988
Ch.L	x	Ch.D	Y = 4.3431 + 0.1437x	132	0.7513	0.993

CW = carapace width; C L = carapace length; Ch.D = chelar propodus depth;
Ch.L. = chelar propodus length. Asterisk indicates high positive allometry. + Significant at P = ≤ 0.001.

TABLE 3. *Regression analysis of body dimensions in immature and mature females of* P. (P.) sanguinolentus. *Constant of allometry (b) based on log-log transformations provided for all relationships*

Parameters			Allometric equations	n	"b'	'r'+
Immature females						
CW	x	AW	Y = –0.6941 + 0.2728 x	40	1.0255	0.994
CW	x	AL	Y = 2.0707 + 0.2997 x	40	1.0155	0.995
CL	x	AW	Y = –1.6347 + 0.6684 x	40	1.1509*	0.992
CL	x	AL	Y = 1.0185 + 0.7350 x	40	1.1429*	0.994
AW	x	AL	Y = –2.5393 + 0.9083 x	40	0.9869	0.996
Mature females						
CW	x	AW	Y = –0.4864 + 0.3087 x	44	1.0527	0.983
CW	x	AL	Y = –1.4127 + 0.3479 x	44	1.0427	0.993
CL	x	AW	Y = 2.0989 + 0.6682 x	44	1.0401	0.952
CL	x	AL	Y = –1.0537 + 0.8063 x	44	1.0276	0.995
AW	x	AL	Y = 0.9257 + 0.8831 x	44	0.9012	0.985

CW = carapace width; CL = carapace length; A W abdomen width; AL = abdomen length.
Asterisk indicates high positive allometry. + Significant at P = ≤ 0.001.

TABLE 4. *Regression analysis of body dimensions in immature and mature females of* P. (P.) pelagicus. *Constant of allometry (b) based on log-log transformations provided for all relationships*

Parameters			Allometric equations	n	'b'	'r'+
Immature females						
CW	x	AW	Y = 1.0270 + 0.3334 x	63	1.4875*	0.992
CW	x	AL	Y = –6.2675 + 0.3319 x	63	0.9729	0.995
CL	x	AW	Y = –2.1650 + 0.8164 x	63	1.6806*	0.979
CL	x	AL	Y = –6.5474 + 0.7817 x	63	1.1014	0.978
AL	x	AW	Y = 5.7681 + 0.9708 x	63	1.5182*	0.995
Mature females						
CW	x	AW	Y = –1.8510 + 0.3178 x	128	1.4492*	0.996
CW	x	AL	Y = –1.2183 + 0.3467 x	128	1.1851*	0.999
CL	x	AW	Y = –0.9160 + 0.7237 x	128	1.3160*	0.998
CL	x	AL	Y = –0.4490 + 0.7949 x	128	1.0756	0.998
AL	x	AW	Y = –0.2580 + 0.9037 x	128	1.2221*	0.998

CW = carapace width; CL = carapace length; AW = abdomen width;
AL = abdomen length. Asterisk indicates high positive allometry. + Significant at P = ≤ 0.001.

ers from different regions (Prasad and Tampi, 1953; Pillay and Nair, 1971; Radhakrishnan, 1979; Thomas, 1984). Even in the same locality, the size at maturity of individual crabs of the same species may vary because the pubertal moult occurs over a wide range of size. It is observed that the pubertal moult may possibly be delayed for a considerable amount of time when the breeding activity is low resulting marked variation in the size at which both sexes mature.

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