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Molting season and growth at molt of lobsters in the Bideford River estuary, Prince Edward Island

by

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ABSTRACT :

Two molting seasons for sublegal and commercial size lobsters are identified in the Bideford River estuary, Malpeque Bay, Prince Edward Island; one in the spring and the other in the fall. Molting activity of lobsters is higher in the spring than in the fall for both sexes. The comparison of regressions for post molt size vs. initial size shows a slight but significant difference of the elevations of regression lines for males. The comparison of the same regressions for claw regenerating individuals and morphologically normal ones also reveals significant differences for either sex.

RESUME :

Dans l'estuaire de la rivière Bideford, Baie Malpeque, Ile-du-Prince-Edouard, il existe deux saisons de mue pour les homards de taille sublégale et de taille commerciale des deux sexes. Une saison de mue au printemps et l'autre en automne. La comparaison des droites de régression pour les tailles de postmue en fonction des taille de prémue indique une différence légère mais significative entre les pentes établies pour les deux saisons, ceci aussi bien chez les mâles que chez les femelles. Le même type de régression permet de déceler des différences significative entre individus régénérant leurs pinces et individus morphologiquement normaux.

INTRODUCTION :

Conan (1978), comparing previous estimates of growth at molt of the American lobster from different geographic locations, reported that on the basis of the available tag return data, the differences were slight or nonexistant. More recently, Conan et al. (1982), using a new set of data based on more precise measurements, reported that significant difference of growth at molt of lobster existed between two locations in the Northumberland Strait (Egmont Bay and Beach Point). These differences could be related to the existence of two molting seasons per year in Egmont Bay. Two molting seasons have also been reported for commercial size lobster by Templeman (1936) in Magdalen Island, eastern part of the Northumberland Strait and Malpeque Bay, Wilder (1956) in Egmont Bay, and Munro and Therriault (1983) in Magdalen Island. Little information is available on the biological characteristics of these lobster populations with two molting seasons. In the present work the existence of each molting season is reported in the area of Bideford River estuary (Malpeque Bay). The growth at molt relative to each molting season is compared. A comparison is also made between growth at molt of lobsters with two normal claws and with regenerating claws.

MATERIAL AND METHODS :

Experimental lobster trap fishing was carried out in the Bideford River estuary, Malpeque Bay, P.E.I. (Figure 1), during May to December 1983 from the research vessel of the Invertebrates Research Section. All lobsters caught were brought to the laboratory and the following data recorded : carapace length, body weight, sex, shell rigidity (Aiken, 1980), proecdysis stages (Aiken, 1973), missing claw and / or regenerating process.

During this experiment, a total number of 4,704 lobsters (3,450 males and 1,254 females), with carapace length ranging from 26.5 mm to 99.5 mm for male and 30.4 mm to 81.4 mm for female were examined. Pre-molt individuals (proecdysis stages D_2' - E) were kept in the laboratory and fed with blue mussels (*Mytilus edulis*) or rock crab (*Cancer irroratus*) until stages C_2 - C_3 at which carapace length and body weight were recorded as post-molt measurement.

A set of claw regenerating individuals (15 males and 15 females) and a set of morphologically normal ones (76 males and 43 females) were separated for further analysis. A predictive linear regression was fitted by least squares to each set of data of post-molt vs. pre-molt carapace length. Fitted linear regressions were compared by ANOVA (Snedecor and Cochran, 1980).

RESULTS :

Percentage of frequency of molt averaged on a period of ten days : percentage of active molt stages (D_2' - E, and wholly or partly soft shell individuals, A - C_2, vs. total sample number) are shown in Figure 2. In the Bideford River estuary, two molting seasons are identified ; late May to mid- July and late August to late September. Molt frequency is higher in the first season (45 - 50 %) than that in the second season (14 - 19 %) for both sexes.

The overall carapace length distribution, the carapace length distribution of animals in active molting stages over the first and second molting season and the frequency of molt per size class are presented in Figures 3 and 4. The size composition of the samples and the molting frequencies per size class show no marked difference between the two molting seasons. The proportion of individuals in active molting stages is higher in sublegal size lobster but the existence of two molting seasons is shown for sublegal and legal size lobsters of both sexes.

Monthly average water temperatures between May and December are shown in Figure 2. During our experiment, the monthly average water temperature varied from 1.4 °C to 21 °C showing a peak in July.

Data for post-molt carapace length vs. pre-molt carapace length with fitted linear regression lines for lobsters molting during July (first molting season) and between late August and September (second molting season) are compared in Figure 5. Regression equations for these two sets and for sexes are presented in Table 1. Results of comparisons made between regression lines are presented in Table 2. The residual variances are homogeneous for sets of data relevant to first and second molt for both sexes ($\alpha > 0.50$). The slopes do not differ significantly ($\alpha > 0.25$). The elevations do not differ significantly for females ($\alpha > 0.50$) but differ significantly for males ($\alpha < 0.01$).

Growth at molt of claw regenerating lobsters of both sexes during the second molting season is presented in Table 3 and Figure 6. Results of comparison of regression lines between claw regenerating lobsters and morphologically normal ones are presented in Table 4. The residual variances are homogeneous for both sexes ($\alpha > 0.25$). The slopes differ significantly for females ($\alpha < 0.01$) and the elevation are significantly different for males ($\alpha < 0.01$).

DISCUSSION :

In the Bideford River estuary, sublegal and commercial size lobsters experience two periods of molt per year, one in the spring, the other in the fall. This confirms Templeman's (1936) observations in Malpeque Bay.

Aiken (1980) reported that elevated temperatures accelerate the metabolic processes and have a direct effect on molt frequency of homarid lobsters within the range of approximatively 8 °C - 25 °C. Monthly average water temperature in the Bideford River estuary varied from 1.4 °C to 21 °C showing a peak in July. This peak in July does not correspond to any of the peak of molting activity. The peaks of frequency of molt occur during the seasons when the water temperature starts to increase or decrease. Temperature variations could be an important factor as a triggering mechanism for molting rather than a stable high temperature. This matter will need further investigation. Other factors such as photoperiod and density of lobster will have to be considered.

Munro and Therriault (1983) reported that commercial size lobsters molt twice a year in the lagoons of Magdalen Island, in the spring and in the fall. At this point, data are not available to draw conclusions for lobsters in the Bideford River estuary. Further investigations will be required in order to determine whether lobsters molt twice a year and if so what proportion in each size class and sex molts once and twice.

Comparison of the regression equations for growth at molt reveals that a slight but significant difference exists between the two molting seasons for males. The increase in size at molt in the fall is greater than in the spring. But this is, so far not statistically verified for females. Many biological and non-biological factors may affect size increase at molt such as nutrition, density of lobsters, maturity, water temperature and light. Aiken (1980) reported that nutrition may affect size increase at molt. Higher growth observed for males in the fall compared to the spring may be partly explained by higher food intake activity during the summer season. For lobsters in captivity, many biological and non-biological factors may also affect growth at molt, such as density, nutrition, habitat type and space . Templeman (1936) pointed out that lobsters kept in lobster ponds for a number of weeks grew considerably less than those molting within a few days after being taken from the fishing grounds. The data collected for growth at molt are derived from individual molting in the laboratory, although it is unlikely that short period maintenance (one week before and about two weeks after molt) should affect size increase at molt. Further investigations will be needed to explain why size increase at molt in the spring and fall differs and why this difference is significant only for males. The females may use more energy than the males in gonad growth over the summer, therefore the observation of growth at molt in relation to gonad maturation stages would be useful.

During experimental fishing, a high percentage of lobsters missing claws (13 - 47 %) were found (unpublished data), a similar phenomenon (4 - 19 %) has been reported by Scarratt (1973) on the Gulf side of Prince Edward Island. Growth at molt of claw regenerating lobsters and morphologically normal ones differed significantly for both sexes. These results support Emmel's (1906) finding that regeneration of Homarus reduce size increment at molt.

Aiken (1980) reported that while some researchers have expressed the opinion that bilateral removal of the first cheliped greatly accelerates molt frequency in Homarus, he rejected this conclusion. If claw regeneration accelerates molt frequency, a very high percentage in number of lobsters missing claws and regenerating in the area of the Bideford River estuary could be one of the causes for the existence of two molting seasons.

ACKNOWLEDGEMENTS :

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Table 1.

Regression equations of post-molt (Y) vs. pre-molt (X) carapace length (in mm) for lobsters caught in the Bideford River estuary Malpeque Bay, P.E.I.

	MALE I	MALE II	FEMALE I	FEMALE II
a	2.6052	1.2537	1.2063	1.1507
b	1.0386	1.0822	1.0710	1.0697
R	0.9909	0.9954	0.9973	0.9956
N	25	51	16	27
ΣX	1322.20	2618.50	757.80	1457.50
ΣX^2	71263.76	139189.93	3792.84	80338.53
$\Sigma X \cdot Y$	77460.92	153915.25	40857.17	87617.66
ΣY^2	84226.82	170252.85	44770.96	95574.04
ΣY	1438.40	2897.70	832.00	1592.20

I : 1st. molting season (May to mid-July)

II : 2nd. molting season (mid-August to September)

Table 2.
Comparison between regression equations of post-molt vs. pre-molt carapace length in 1st. and 2nd. molting season in the Bideford River estuary, Malpeque Bay, P.E.I.

ANOVA	MALE	FEMALE
Residual variance :		
Two tailed F	1.0049	1.1921
Degrees of freedom	23 / 57	14 / 25
α	0.9714	0.7495
Significance	N.S.	N.S.
Slopes :		
One tailed F	0.8128	1.9360E-03
Degrees of freedom	1 / 80	1 / 39
α	0.3700	0.9651
Significance	N.S.	N.S.
Elevations :		
One tailed F	10.9653	1.9360E-03
Degrees of freedom	1 / 81	1 / 40
α	1.3883E-03	0.6522
Significance	**	N.S.

N.S. : not significant ** : significant

Table 3.

Regression equations (Y = a + bX) of post-molt (Y) vs. pre-molt carapace length (X) in 2nd. molting season for claw regenerating lobsters caught in the Bideford River estuary, Malpeque Bay, P.E.I.

	MALE	FEMALE
a	-2.7321	-0.0018
b	1.1240	1.0612
R	0.9922	0.9992
N	15	15
ΣX	836.00	838.70
ΣX^2	47638.78	48313.45
$\Sigma X \cdot Y$	51262.95	51268.64
ΣY^2	55186.11	54407.12
ΣY	898.70	890.00

Table 4.
Comparison between regression equations of post-molt vs. pre-molt carapace length of claw regenerating individuals and morphologically normal individuals in 2nd. molting season in the Bideford River estuary, Malpeque Bay, P.E.I.

ANOVA	MALE	FEMALE
Residual variance :		
Two tailed F	1.5176	1.0709
Degrees of freedom	13 / 49	25 / 13
α	0.2897	0.9300
Significance	N.S.	N.S.
Slopes :		
One tailed F	1.2807	96.8041
Degrees of freedom	1 / 62	1 / 38
α	0.2621	1.3412E-12
Significance	N.S.	**
Elevations :		
One tailed F	27.0807	
Degrees of freedom	1 / 63	X
α	2.2672E-06	
Significance	**	

N.S. : not significant, ** : significant, X : elevation cannot be compared.

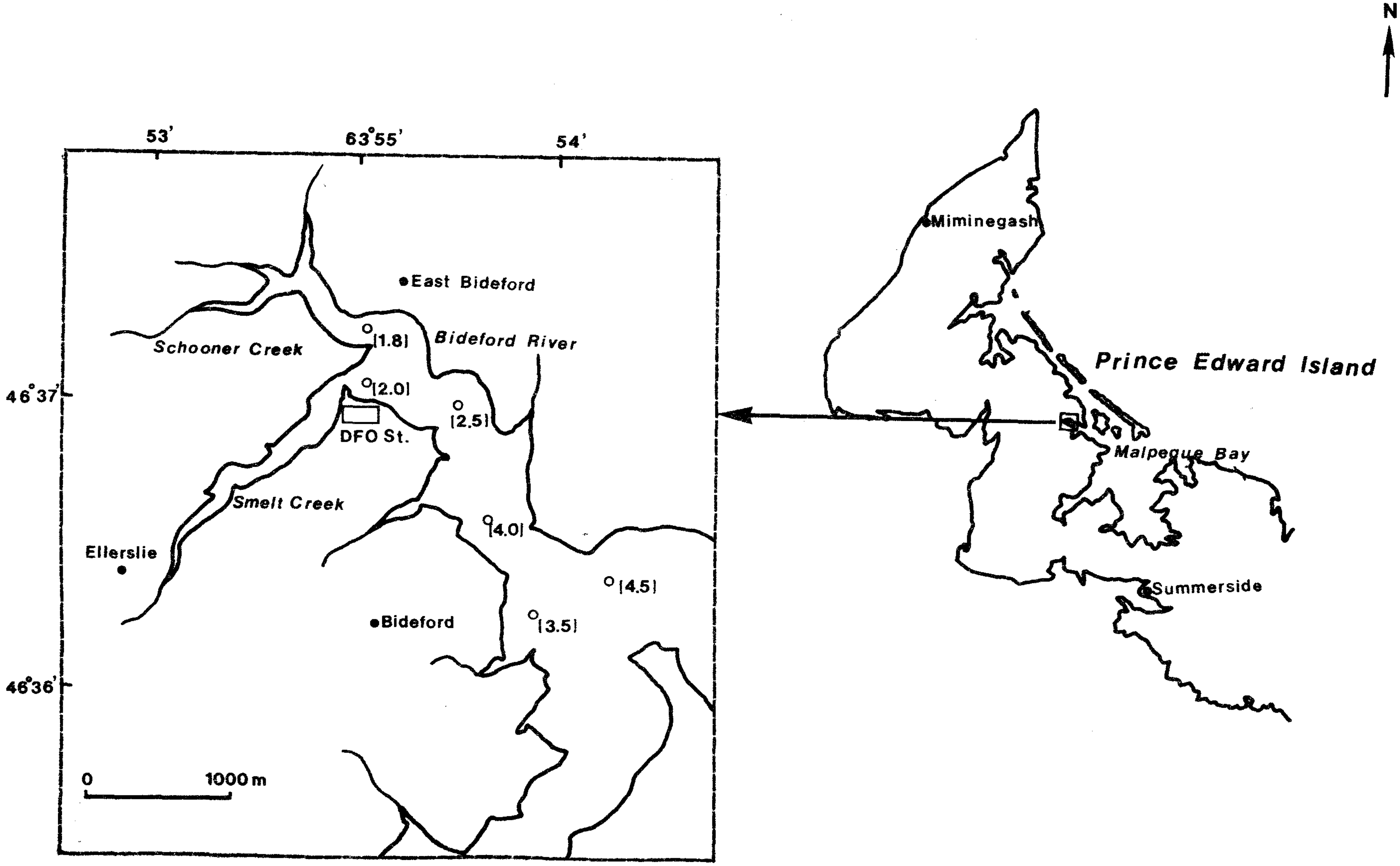


Figure 1.
Geographical location of sampling sites in the Bideford River estuary, Malpeque Bay, P.E.I.
o : location of experimetal lobster traps with depth [ ] in meters.

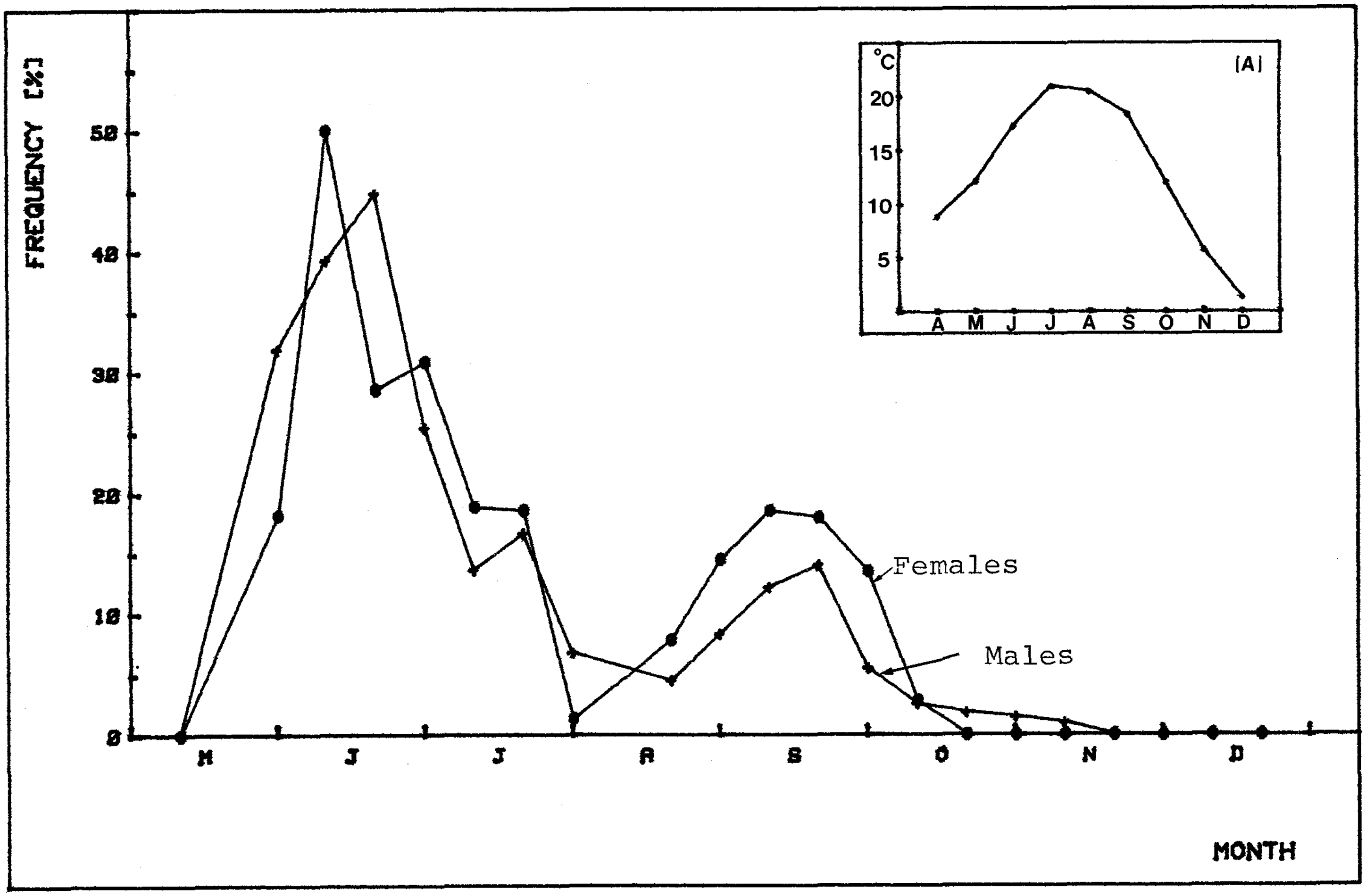


Figure 2.
Molting frequencies (% in number of individual in intermolt stages A – C_2 and D'_2– E in total sample) and monthly averaged water temperatures (A) in the Bideford River estuary, Malpeque Bay, P.E.I.

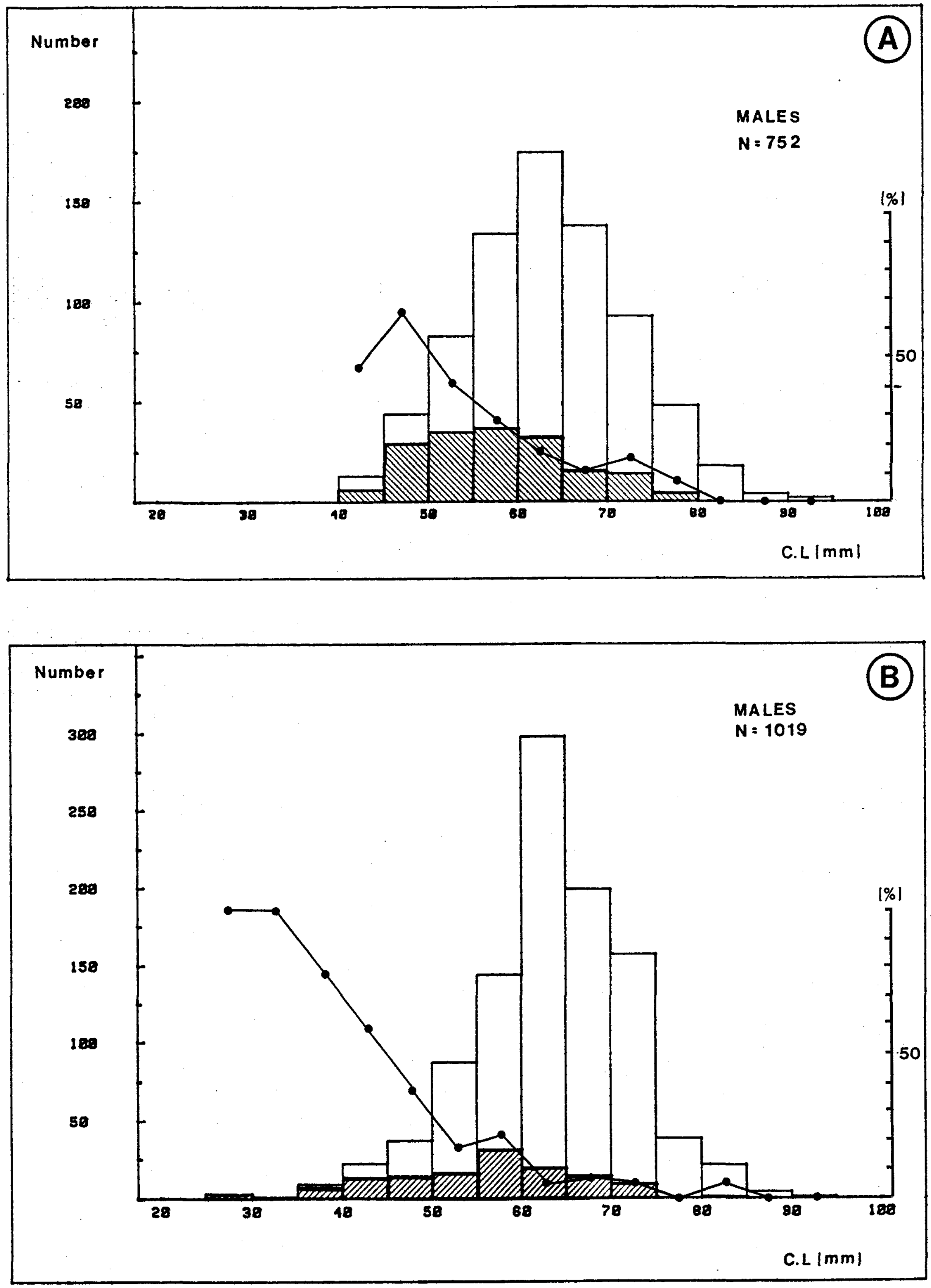


Figure 3.
Carapace length distribution for all males combined (□) and for males in a molting stage (▨). The curve represents the percentage of individuals in a molting stage per 5 mm size interval. A : first molting season, B : second molting season.

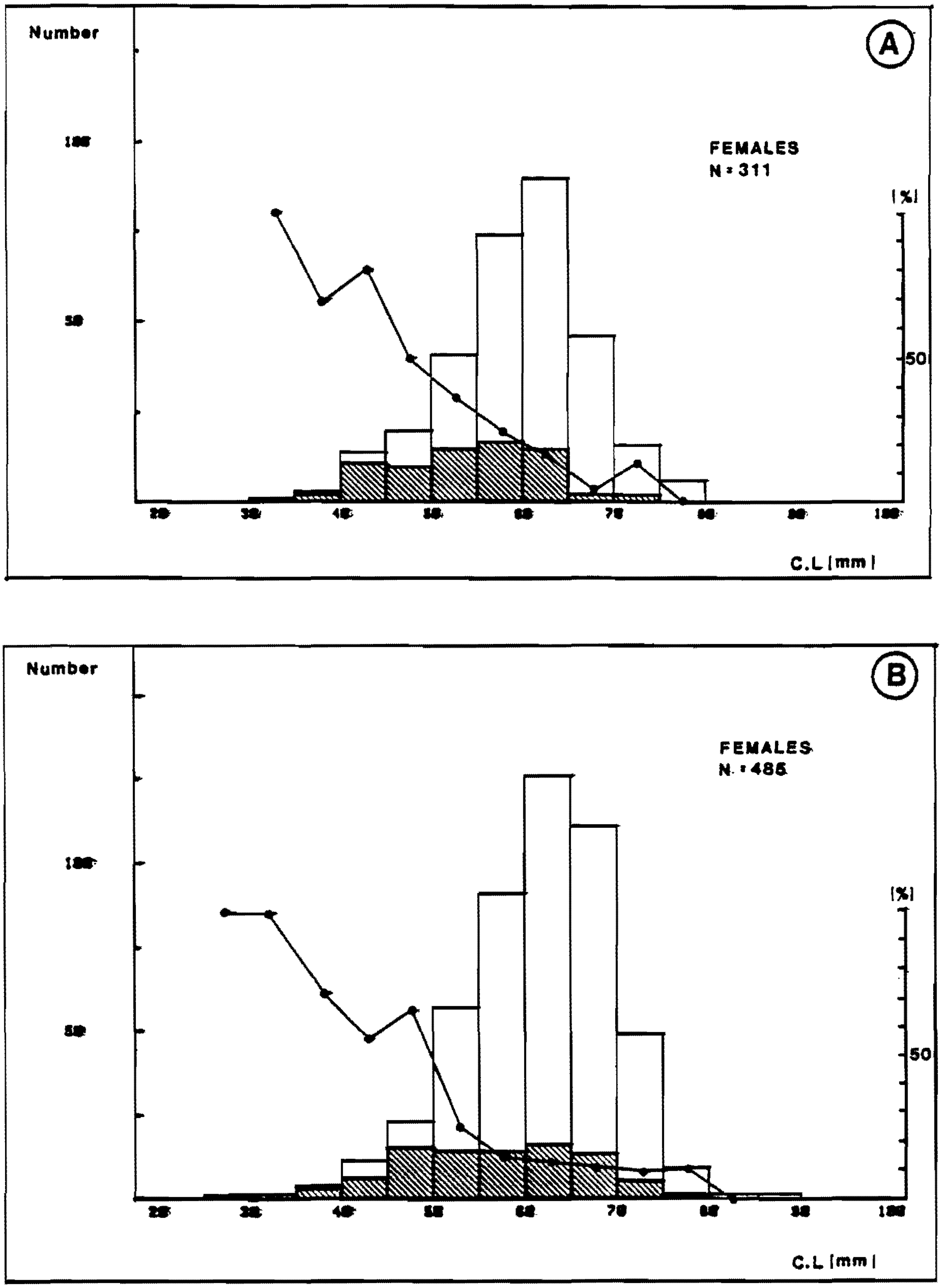
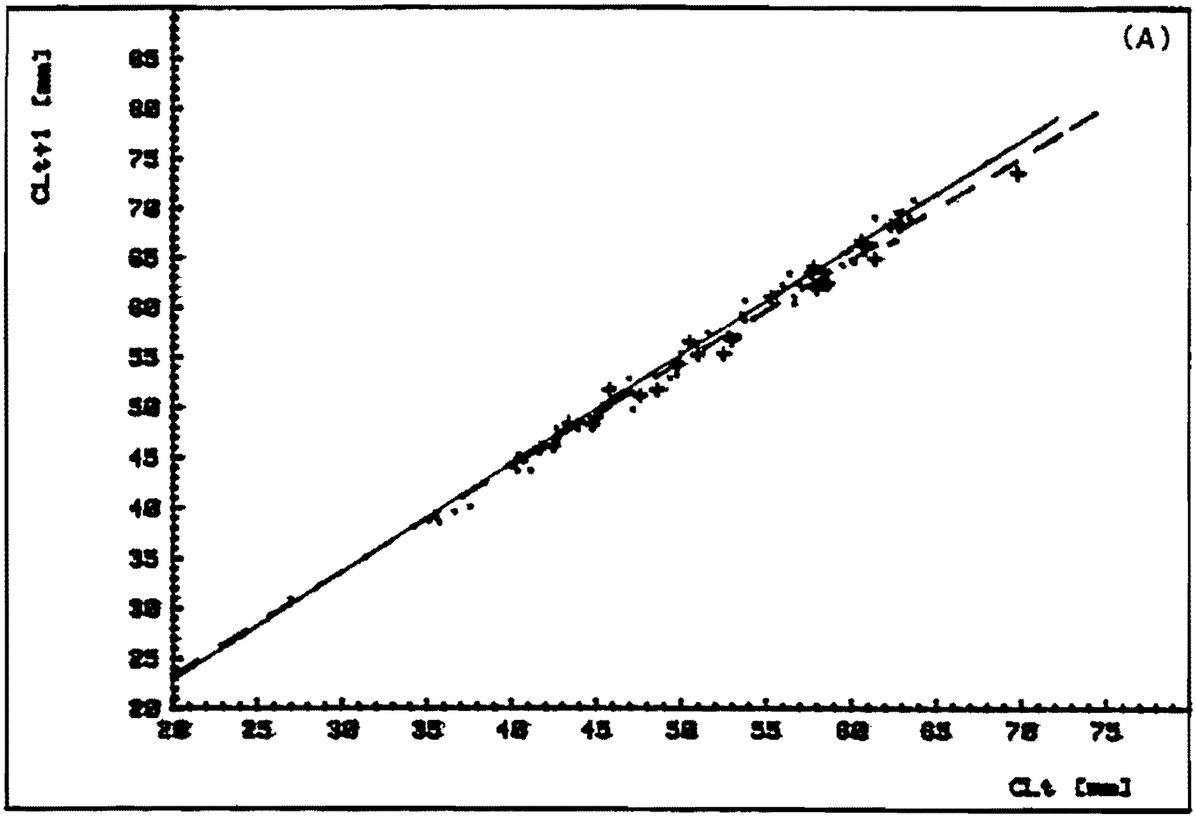


Figure 4.
Carapace length distribution for all females combined (□) and for females in a molting stage (▧). The curve represents the percentage of individuals in a molting stage per 5 mm size interval. A : first molting season, B : second molting season.



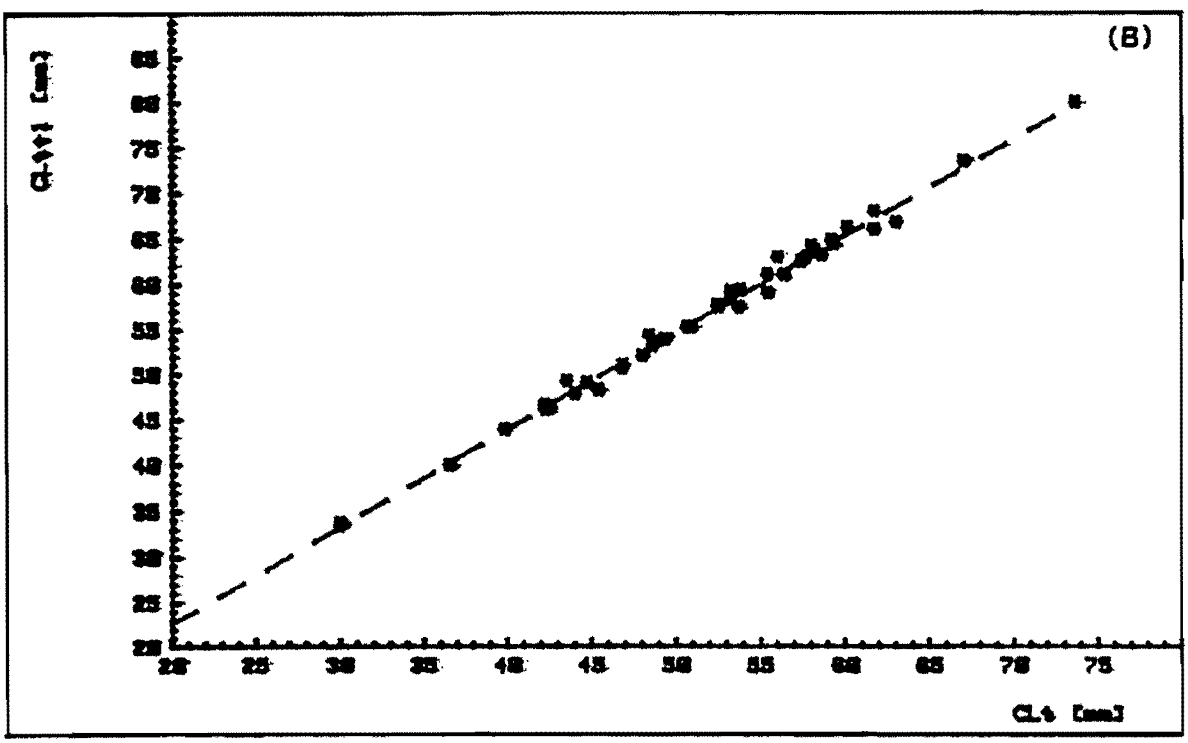


Figure 5. Relationship between post-molt vs. pre-molt carapace length (mm)

(A) : male + ; molting in July

· ; molting in August - September

(B) : female ⋆ ; two seasons combined

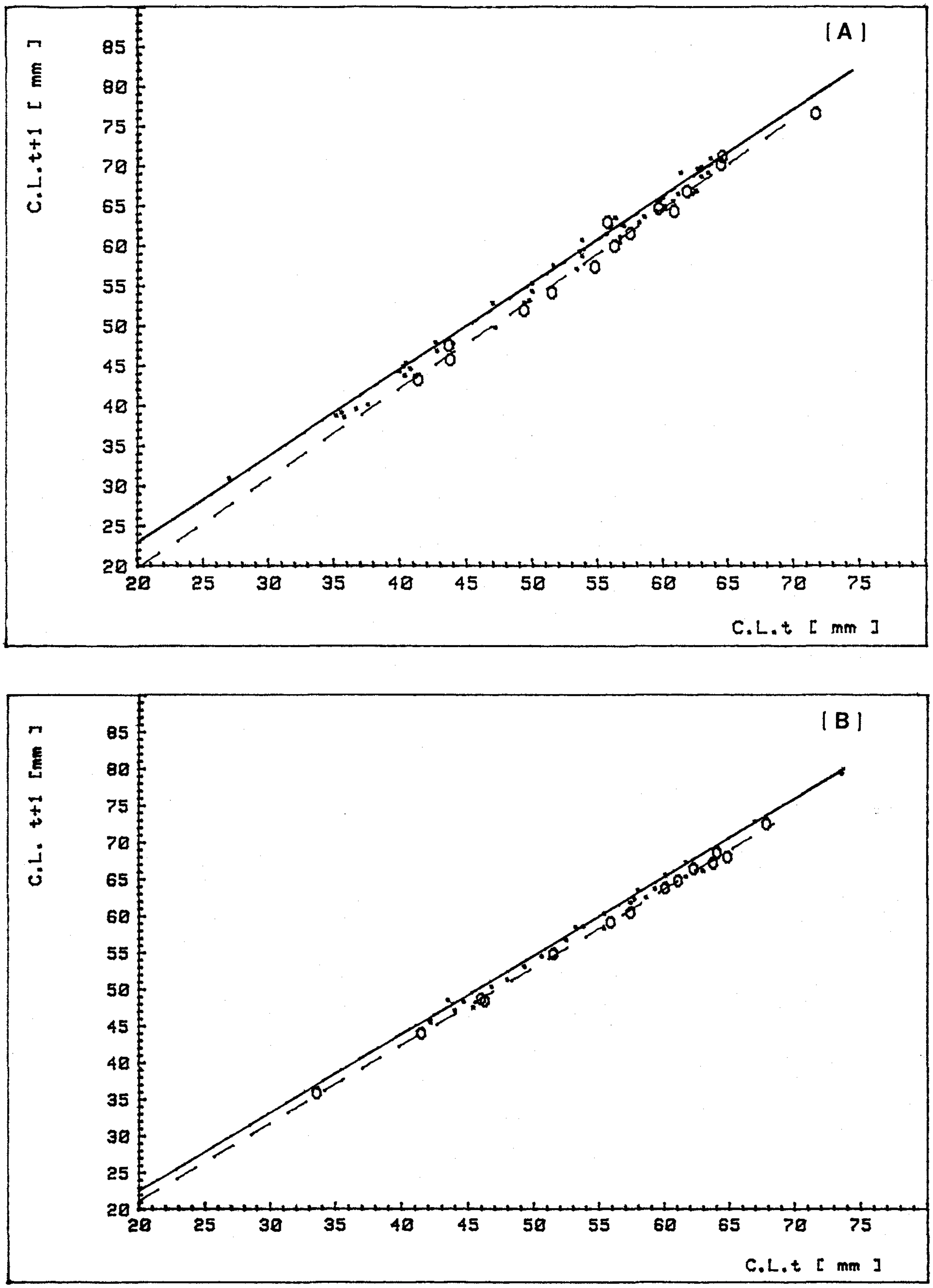


Figure 6. Relationship between post-molt vs. pre-molt carapace length for claw regenerating individuals (o) and morphologically normal ones (·). (A) : males, (B) : females