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EXPERIMENTS ON THE SIMULTANEOUS REGENERATION OF CLAWS IN THE AGED MALE STONE CRAB, *MENIPPE MERCENARIA* (SAY), WITH SPECIAL REFERENCE TO THE TERMINAL MOLT*

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ABSTRACT

T. S. Cheung (1973) *Experiments on the simultaneous regeneration of claws in the aged male stone orab,* Menippe mercenaria *(Say), with special reference to the terminal molt.* Bull. Inst. Zool., Academia Sinica **12(1)**: 1–11. The possibility of harvesting regenerated claws in adult male stone crabs, *Menippe mercenaria* (Say) was studied. This idea was found to be impractical, since the crab would have already reached the terminal molt (TA) before its claws could have time to regenerate back to their normal size. Removal of claws from intermolt crabs, other than at TA was found to promote ecdysis. The double operation of destalking plus declawing in the same crab was found to accelerate molting to a greater extent than the operation of declawing alone, but not destalking alone. At TA, declawing was found to induce no ecdysis. At the early stage of TA, however, destalking plus declawing were found to induce an ecdysis with the regeneration of claws much smaller than the normal size. At late TA, the same operations produced no effect. Instances of degrowth occurred in claw buds of adult crabs before TA in about 1 of every 21 recordings. At TA, degrowth occurred once in every 4. Most of the degrowths occurred during the TA stage, which is the non-growth stage of the crab, between R values of 4 and 6, and possibly up to 13, the slow growth period during bud regeneration, and also during winter, the slowest growing season. It is suggested that degrowth reflects the slow activity of the Y-organs, which is well-known to produce crustecdysone (the molting hormone). The effect of aging on the crab is discussed.

Most of the recent works on crustacean limb regeneration were performed on relatively young animals[1,2,7,8,9,10,11,12,16,18], comparable information on older ones is essentially lacking, while works on claw regeneration are rare.

The stone crab, *Menippe mercenaria*, an economically important marine species in Florida,

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is valuable only for its claws, well-known as an expensive food item in the local markets. Traditionally, many American fishermen believe that removing the claws without killing the crab is a profitable practice, as the same crab will then produce claws once more. The present work was carried out in order to test the economic feasibility of this hypothesis; at the same time it also brought to light certain biological aspects in the control of regeneration and the effect of aging.

The study was facilitated by the continuous supply of sea water in the culture laboratory, making it easy to crary out long-term observations of older crabs. These animals are of greatest economic value, yet their regeneration is slow.

MATERIALS AND METHODS

This work was performed exclusively with male crabs large enough to be of any commercial value, i. e. above 60 mm in carapace width (CW). From unpublished results this size has been found to be much above the average on first maturation and is about 3 ecdysis before the terminal molt (TA). Further, the total number of ecdysis from the first crab stage to TA is about 24. Because of these, and the frequent occurrence of degrowth (see below), the experimental crabs are defined as "aged" crabs. They were collected with baited traps from Biscayne Bay, within approximately one mile of the Institute of Marine Science, University of Miami. They were maintained in wooden tanks with compartments measuring 2 sq. ft. and circulating sea water. Each compartment contained one crab in order to avoid cannibalism. All the crabs were fed daily with an excessive amount of shrimp meat, and the compartments were cleaned regularly. The experiments were planned for the study of the simultaneous regeneration of the 2 claws, which were unequal in size. The right claw was usually larger. In order to make the results comparable, only intermolt crabs of comparable size were used in each experiment (Table 1). Autotomy of the claws was induced by poking a needle through the arthrodial membrane into the muscles between the ischium and merus. After some practice, this proved to be a very convenient method of autotomizing the claws. Both claws were removed on the same day. Eyestalks were removed after burning them at the base with an electric solder and thus severing the exoskeleton and nervous tissue. A few days later, the damaged eyestalks would detach automatically. This method of destalking was found to be better than all other methods tried, since blood loss and wound closure were practically avoided in a one step operation. Whenever destalking and declawing had to be performed in the same crab, the crab was declawed first, because destalked crabs invariably failed to autotomize their claws by the above method. The size of each crab was determined by its carapace width (CW). Claw size was determined by the longest dimention (PL) of its propodus. The above measurements were recorded in millimeters. The limb bud of each regenerating claw was examined daily, and its length was measured once a week, with the use of calipers reading to 0.1 mm. The measurements were then converted into R values, defined as $\frac{\text{"length of bud} \times 100\text{"}}{\text{CW}}$ after Bliss[2]. The advantage of the R value is that it converts all limb bud measurements of different crabs into a comparable scale.

Since growth had been found to be inhibited by ovarian development in the adult female stone crabs[6], males were used in all the experiments. Further, at the termination of the experiments all crabs were dissected and examined for any internal parasites that could have influenced limb bud growth.

RESULTS AND DISCUSSION

From 16 regeneration curves of claws (unpublished), the following sequence was shown. (a) After autotomy, there was a resting period of 2 to 3 weeks. (b) The bud then entered a basal growth period that lasted until the R value reached about 2. (c) Then it entered into a slow growth period until the R value reached about

13. (d) R values of 13 to 24 marked the premolt fast growing period. (e) Molting usually took place around an R value of 24, at which time the new claw emerged from the bud. The length of time for each of these phases may vary according to season and age of the crabs etc., but the range of R values for each phase remains quite constant and thus comparable in different crabs.

The effect of removing claws and eyestalks (Table 1, Groups I–VII)

Experiment (a). Period covered: from April 22nd.—September 15th. The crabs were divided into 3 groups. Group I was declawed, Group II declawed and destalked, while Group III was kept intact for controls. The majority of the crabs in Group I molted before the middle of September, and had regenerated their claws.

TABLE 1

A summary of destalked and declawed experiments

Expts.	Groups	Total numbers	Average CW (mm)	Destalked	Declawed	Numbers molted	Mean number of days to molt
(a)	I	14	89.4*	—	14	8	105.5 ± 8.9
	II	8	89.3	8	8	6	55.0 ± 5.6
	III	10	90.0	—	—	2	110.5 ±15.5
(b)	IV	4	62.5	—	4	4	122.5 ±15.2
	V	4	62.5	—	—	0	—
(c)	VI	8	78.1	8	—	4	40.75± 3.4
	VII	9	74.7	9	9	3	47.0 ± 5.7
Early TA	VIII	11	115.1	11	11	9	98.2 ± 6.9
Late TA	IX	9	116.1	—	9	0	—

Expts.	Numbers not mlted	Dead without molting	Numbers at TA	Experimental period	Remarks
(a)	6	3	3	4/22/66–9/15/66	2 dead with premolt limb buds
	2	2	0	—	1 molted twice, the 2 dead had premolt limb buds
	8	0	1	—	—
(b)	0	0	0	11/4/66–4/9/67	—
	4	0	0	—	—
(c)	4	4	0	10/5/67–12/4/68	—
	6	6	0	—	—
Early TA	2	2	11	All year round	operated within 3 months after reaching TA
Late TA	9	9	9	—	operated 1 year after reaching TA

* This average excludes the largest three, which were at the TA size range.

Three crabs, 2 of which had already developed premolt limb buds, died before molting. The only 3 crabs that did not molt, were the largest in the group (CW 112-114 mm). Further, their limb buds never grew beyond a certain size (see terminal molt below).

In Group II, 6 crabs molted. The last ecdysis in this group occurred about the same time as the first molt in group I. Two crabs died, one in May and one in June respectively, both of which had premolt limb buds. In group III, the control group, only 2 crabs out of 10 molted during the whole period of observation.

This experiment showed that (i) removal of the claws promoted molting, (ii) that removal of both claws and eyestalks accelerated and promoted molting to a greater extent, but (iii) that removal of claws from the largest crabs (CW. 112-114 mm) failed to effect molting.

Experiment (b). Period covered: November 4th-April 9th. In order to verify the first point in the above' this experiment was performed with 2 groups of 4 crabs each. Group IV was declawed while V was used as controls. Within the observed period, all Group IV crabs molted, but none of the controls did. This confirmed conclusion (i), irrespective of the difference in seasons.

Experiment (c). Period covered: October 5th—December 4th. Since experiment (a) indicated that removal of both claws and eyestalks accelerated molting to a greater extent than removing only the claws, it was decided to test whether removal of both claws and eyestalks would accelerate molting to a greater extent than removing the eyestalks only. Two groups of crabs were employed. Group VI was destalked while VII was both destalked and declawed. Because of the high mortality in VII, conclusions were difficult to draw. However, results from the survivors indicated in VII that there was no greater acceleration of molting than VI, or rather contrary, Group VII took considerably more days than VI to molt. It is possible that acceleration of molting due to the loss of 2 claws is mediated through the eyestalks. The loss of the eyestalks permits maximum acceleration, so that losing the claws in addition could have no further effect. Also, an explanation for the slowing down of molting in Group VII could possibly lie in the effect of greater injuries resulted from the double operation.

The Terminal molt (TA)

The TA after which no further ecdysis would occur, (nor any physiological signs of entering a new premolt stage) has so far been demonstrated only in a few brachyurans. It has not yet been recorded in any known macrurans, which are believed to grow until death. It may either occur at first maturation as species in *Callinectes*[17] or several ecdyses after this as in the present species[6]. In the former species, a full development of secondary sexual characters can be conveniently used for the identification of the TA. In the latter species, the identification may require dissecting the crab for determining the absence of the developing new shell for an on-coming ecdysis, or simply rely on its large size. The best method appears to be the regenerating limb bud method, viz., by observing whether the limb bud would grow or not. Hartnoll[18] noted in the spider crab, *Microphryo* that, at the TA stage, no limb bud would develop after a limb was removed. Carlisle[5] showed that at this stage (named terminal anecdysis), removal of the eyestalks, which contained the X-organ sinus gland complex, induced one further ecdysis in *Carcinus* but not in *Mija*. However, if an extract of the Y-organs is injected into crabs of the latter species, the crabs respond by increasing the calcium level of the blood, a physiological event that occurs prior to molting. Thus, at TA, a large production of molt-inhibiting hormone (MIH) from the X-organs stopped molting in *Carcinus*. This inhibition would therefore be removed by destalking. In *Maja*, the degeneration of the Y-organs which normally produced crustecdysone caused cessation of molting at TA. This explained the ineffectiveness of destalking and the fact that Y-organ extract induced symptoms of premolt.

In addition to the above works, only a few scattered reports commenting on the TA in certain other species are available (e.g.[19]). In spite of its great interest related to growth and aging, little of the biology of TA is known. The present study on *Menippe* has revealed some of its characters.

(a) *The approach to TA.* A number of male stone crabs had been reared in the laboratory through at least two ecdyses to TA. Since such work in the laboratory has not been done in the past, a summarized history of one is described in Table 2. This crab had an initial CW and propodi of the left and right claws measuring respectively 92.0 mm, 69.2 mm and 78.8 mm. Its claws were removed in Oct. 28th. 1965, after which regenerated buds developed. The crab molted at March 29th. 1966. The new CW and propodi of the left and right regenerated claws were respectively measuring 103.0 mm, 57.4 mm and 58.3 mm. A second ecdysis took place in August 18th. 1966, with the above three dimensions increased to 118 mm, 84.1 mm and 89.3 mm respectively. As the size of the CW had reached the suggested range of TA (below), the crab was again declawed on November 1st. 1966 for observation when its shell was fully hardened, i. e. when it had reached the intermolt stage. Small regeneration buds were then observed to develop and their sizes appeared to fluctuate. At this stage, the crab had never molted again, in spite of the fact that it was destalked in August 23rd. 1967, as an attempt to induce a further ecdysis by the removal of its MIH, which is well-known to be present in the eyestalks. The crab finally died in October 22nd. 1967.

TABLE 2

A summarized history of an adult male crab declawed twice, the second time at TA

Event & date	CW (mm)	Left claw: propodus (mm)	Right claw: propodus (mm)
Original	92	69.2	78.8
Declawed 10/28/65	↓		
No degrowth in bud	↓		
Molted with claws regenerated 3/29/66	103	57.4	58.3
Molted to TA 8/18/66	118	84.1	89.3
Declawed 11/1/66		↓	↓
Degrowth occurred frequently in buds		bud forming	bud forming
Destalked 8/23/67		↓	↓
Dead 10/22/67		bud degrown	bud degrown

(b) *The effect of declawing at TA.* From Group I in Table 1 the only 3 crabs that did not molt after declawing were the largest in the group (CW 112–114 mm). This suggested that their sizes were within the range of TA (see also the following paragraph). Eleven male crabs, all above 112 mm in CW, were then declawed and observed for at least 18 months in the laboratory. None of them molted. These results agree with those in Group I that declawing had no effect on molting at TA.

(c) *The effect of destalking and declawing on TA (Table 3).* Observations were made on 20 crabs of non–TA adult sizes that subsequently molted into the suggested TA size range. Of these crabs, 11 were declawed and destalked not later than 3 months after molting into TA. Eventually 9 of them again molted. The remaining 9 crabs were similarly operated about 1 year after reaching TA. None of them was found to go through another ecdysis until death. The last one died 6 months after the operations. Further, their regenerated buds fluctuated in size (as those given in Table 6) and had never reached the premolt size (R–value above 13, p. 3 above).

(d) *Degrowth of claw buds.* Since there was a possibility of misidentifying degrowth when actually accidental damage followed by regrowth had happened between the period of 2 consecutive weekly measurements, the claw buds

TABLE 3

The effect of destalking and declawing on early and late TA crabs

No.		CW (mm)	Molted to TA at	CW at TA	Declawed at	Destalked at	Molted at	Died at
Gp. VIII	X2	100	10/25/65	115	12/26/65	12/27/65	3/ 7/66 (71 days)	
	X3	96	11/ 2/65	113	1/ 3/66	1/ 4/66	5/15/66 (132 days)	
	X5	95	11/ 8/65	114	1/ 3/66	1/ 4/66	4/20/66 (107 days)	
	X6	95	11/15/65	112	1/19/66	1/20/66	5/ 1/66 (102 days)	
	X9	102	11/29/65	118	1/19/66	1/20/66	5/19/66 (120 days)	
	X11	101	3/ 3/66	115	5/14/66	5/15/66		2/10/67
	X12	95	4/ 2/66	113	5/31/66	6/ 1/66	9/10/66 (103 days)	
	X14	97	10/ 1/66	113	12/19/66	12/20/66	3/ 4/67 (75 days)	
	X18	103	5/14/67	118	7/19/67	7/20/67		4/ 8/68
	X19	98	10/19/67	116	12/19/67	12/20/67	3/ 8/67 (79 days)	
	X20	104	10/25/67	119	1/ 6/67	1/ 7/67	4/11/67 (95 days)	
Gp. IX	X1	99	9/18/65	115	9/30/66	10/ 1/66		4/ 2/67
	X4	102	11/ 7/65	118	12/ 3/66	12/ 4/66		3/ 7/67
	X7	105	11/21/65	120	11/ 1/66	11/ 2/66		7/ 7/67
	X8	97	11/25/65	114	10/17/66	10/18/66		5/ 4/67
	X10	95	12/ 4/65	112	11/13/66	11/14/66		5/ 8/67
	X13	99	4/ 4/66	119	3/26/67	3/27/67		12/ 4/67
	X15	100	10/24/66	115	11/ 6/67	11/ 7/67		5/30/68
	X16	97	11/16/66	116	11/15/67	11/16/67		6/16/68
	X17	101	11/20/66	115	11/23/67	11/24/67		9/12/68

Group VIII consisted of crabs operated within 3 months after reaching TA.
Group IX consisted of crabs operated within 1 year after reaching TA.

were examined for damage once daily. Degrowth has been recorded in other animals[14] but observations of this in crustacean limb buds are probably original. I have noted that a limb bud which has undergone degrowth to be morphologically indistinguishable from one which has grown to the same size. Also, a limb bud which has degrown may grow or degrow subsequently. For these reasons, the changes are not similar to pure regression. Table 4 is a record of weekly measurements of claw buds in one crab at TA over a period of 8 months. The figures indicate a frequent fluctuation in their linear sizes.

(e) *R value of claw buds at degrowth.* Data from weekly measurements of limb buds on 18 non-TA sized male crabs were grouped in Table 5 according to their R values. The period ran from declawing to the subsequent ecdysis. Instances of growths and degrowths occurring within similar R values were given in a separate column. The total number of degrowths were 12 in 254 measurements, or about 1 in 21. All degrowth instances occurred within an R value range between 2 and 13, the slow growth period (p. 2 above). Similar recordiugs were given in Table 6 for 15 TA crabs. The Table shows

TABLE 4

Record on size changes of the claw buds in a TA crab. CW=113 mm.

Date	Left claw	Right claw
10/31/66	propodus length: 93.9	propodus length: 57.4
11/ 1	(declawed)	(declawed)
11/ 7	budding	no bud
11/12	budding	no bud
11/19	budding	no bud
11/29	budding	no bud
12/ 6	budding	budding
12/12	bud: 1.2 mm	budding
12/19	1.4	buddirg
12/27	1.3	bud: 1.0 mm
1/ 3/67	1.6	1.0
1/10	1.5	1.7
1/17	1.9	1.1
1/25	1.7	1.9
2/ 1	1.1	2.4
2/ 3	1.2	2.6
2/16	1.9	2.9
2/23	2.3	2.8
3/ 2	2.6	2.4
3/ 9	2.7	2.5
3/17	2.2	2.6
3/25	1.9	2.7
3/31	2.9	3.0
4/10	2.5	2.8
4/14	2.2	2.9
4/24	2.9	3.3
4/28	2.4	2.6
5/12	1.9	2.5
5/19	2.0	2.9
5/26	2.0	3.4
6/ 2	2.6	3.4
6/10	2.0	3.0
7/17	(crab died)	

Note that its size fluctuated without being able to grow straight into premolt stage, and that the relative dimension of the 2 buds changes as they grow.

TABLE 5

Distribution of R values in the claw buds of 18 adult male crabs declawed before the terminal molt

R value	Frequency of occurrence of growth	Occurrence of degrowth
0	14	
1+	2	
2+	19	1
3+	22	2
4+	19	
5+	17	3
6+	8	
7+	13	2
8+	17	1
9+	12	1
10+	16	
11+	11	1
12+	11	1
13+	9	
14+	4	
15+	8	
16+	8	
17+	5	
18+	2	
19+	4	
20+	9	
21+	5	
22+	4	
23+	2	
24+	1	
25+	1	
26+	0	
Total	242	12

that there were 170 degrowth instances in 657 measurements, or approximately 1 in 4. Throughout the observation periods, the R value fluctuated in size, mostly under 13. In only 6 single instances the crabs had R values greater than 13; however, none of the crabs molted. On examining the ratio degrowth/growth instances, the Table indicates that it was 9/165 and 16/63 at R values of O+ and 1+ respectively, which fell on the basal growth period (p. 2 above). The ratio then increased significantly at R values of 2+ to 6+, being 43/104, 44/59, 52/72, 5/11 and 1/0 respectively. These fell in the slow plateau growth period (above). As the limb buds at TA seldom grew above an R value of 6, there was not sufficient data on R values higher than this. Nevertheless, the above results showed that degrowth occurred much more often at TA than during the earlier ecdyses. In both TA and the earlier ecdyses, it occurred largely at the slow-

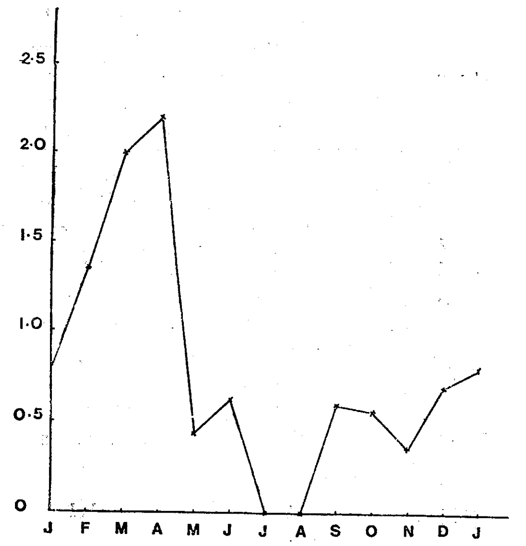
TABLE 6

Distribution of R values of 15 crabs declawed at terminal molt (TA)

R value	Frequency of occurrence of growth	Occurrence of degrowth
0+	165	9
1+	63	16
2+	104	43
3+	59	44
4+	72	52
5+	11	5
6+	0	1
7+	0	
8+	2	
9+	2	
10+	1	
11+	0	
12+	2	
13+	2	
14+	0	
15+	2	
16+	1	
17+	1	
Total	487	170

growth period. Once the crab reached the premolt fast growing period (R value 13 and above) to which buds of the TA crabs seldom could, any degrowth would be over-compensated by growth and thus could not be shown (see below).

(f) *Monthly distribution of degrowth in TA crabs.* In order to study the nature of degrowth related to seasonal changes, the ratio: degrowth/growth instances in 11 TA male crabs declawed and destalked at various times of the year, were totalled in each month, although the number of TA crabs available for experiment were not the same in all the months. The results over 12 months are represented in the Figure, which shows that the ratio increased to a peak from November to April, then dropped back, until July



Monthly distribution of degrowth/growth in TA crabs. The curve is constructed based on the total recordings of the measurements of regenerated claw buds from 11 TA crabs in different months of the year. Horizontal axis gives time in months starting from January. Vertical axis gives the ratio: number of degrowth/number of growth instances.

and August when no degrowth occurred. The curve bears strong correlation to the slow and fast growing seasons described by Cheung[6] (see Table 2 and Fig. 2 of this reference). Degrowth was absent in summer, apparently the optimal season for growth. In winter, the slow growth season, degrowth occurred most commonly.

The results in (e) and (f) suggest that both growth and degrowth occurred at all times, but degrowth could be detected by measurement only if its rate exceeded that of growth. Thus, analogous to the continuous processes of anabolism and catabolism in any living system, formation and destruction of cells occurred at all times in the regenerating buds. Since degrowth disappeared in the months of optimal growth, the results agree with Cheung's view[6] that both growth and spawning of this species, or both gonadal and somatic growth had the same temperature optimum.

CONCLUSION

Autotomy of limbs or claws had been found to induce ecdysis in *Gecarcinus lateralis*[4,16], although the exact reasons are still unknown. With the loss of a considerable part of the body, it is easy to imagine that the same amount of circulating crustecdysone produced by the Y-organs would become more concentrated, and therefore it would be easier to reach the necessary titer for effecting premolt. However, a corresponding increase in concentration would be found in the circulating MIH produced by the X-organs, which is known to inhibit the activities of the Y-organs. It seems more likely that autotomy would somehow bring about a change in the normal balance of hormonal activities between the X-and Y-organs at the intermolt stage, so that precocious molting is induced. A substance like "wound factor" postulated by Needham[14] (p. 299) would well contribute to this function (but see Bliss[3], (p. 576). Such a substance might either act in stimulating the Y-organs or inhibiting the X-organs or both. Skinner and Graham[16] showed that injection of arthropod ecdysones did not accelerate molting of autotomized *Gecarcinus* beyond the effect of autotomy, which the authors had already found to accelerate molting. The present work on *Menippe* showed that destalking could produce a greater molt-accelerating effect than that due to autotomy (p. 4 above). It is more likely that the "wound factor" would act directly on the X-organs by inhibiting them rather than by stimulating the Y-organs. Apparently, the X-organs are the direct regulators of this morphogentic process, having to receive all the stimuli (probably both internal and external) before finally effecting their control by regulating the amount of MIH released.

Since degrowth occurred largely in (a) the slow growth seasons, (b) slow growth period during bud regeneration as well as (c) the non-growing TA stage of the crab, it may be used as an indication of the inactivity of the Y-organs. Thus, the activity of the Y-organs, apart from being regulated by the X-organs, is here shown to depend on seasons as well as the age of the crab. Before reaching TA, the adult Y-organs occasionally showed signs of slow activity by the occurrence of degrowth. At early TA, the Y-organs were still active enough to effect molting if the eyestalk inhibition was removed. At late TA, when removal of the same inhibition was practically ineffective, the function of the Y-organs must have further decreased due to aging. No attempt had been made on the *Menippe* to determine whether there could be an overactivity of the X-organs at any time during TA as Carlisle[5] stated for *Carcinus*, but the gradual decrease in function of the Y-organs alone during the course of aging appeared sufficient to account for the present results.

Finally, this work indicated that claws cannot be profitably harvested more than once. Claws of younger crabs below the marketable size (CW 60 mm) have no value. The effect of aging become more pronounced as the animal grows. This was shown by an increase in the occurrence of degrowth and the abnormally small regenerated claws. At TA, the most valuable size, claw regeneration has been found impossible (p. 5). However, the practice of induced molting to effect limb regeneration may still deserve investigation, particularly in macrurans, which are known to have no TA. But as the Y-organs cannot apparently remain functional for all ages, such a practice must have a limitation.

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老雄性石蟹 (*Menippe mercenaria*) 之螯的再生與末蛻的關係

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美國佛州名產石蟹，美國人只食其螯，故漁民亦只折螯營售， 而蟹則放回海中， 蓋認爲蟹能再生新螯，重捕之，又可獲利也。

本研究之動機，乃欲確定該見解之正誤， 從而探討此法之經濟價值， 及蟹螯再生之基本生理問題，與蟹齡之衰老影響。

去螯後釋放之石蟹能再生蟹螯之見解，殊非正確， 並無實施之經濟價值。 蓋再生之螯未及長成，而蟹齡已抵末蛻期，無可更長也。 至於屬長尾亞目之甲殼動物，因無末蛻限制， 此法值得繼續研究。

實驗顯示：(一)成長雄蟹： 如於蛻殼間期脫其螯則有促進自然蛻殼之效；如同時脫其螯及眼莖， 則此效略大；如只脫眼莖，則此效至大。每次蛻殼後能再生新螯。(二)在末蛻之雄蟹（甲幅 112 mm 以上）：脫螯則無促進自然蛻殼之效，但於末蛻初期，同時脫螯及眼莖， 仍可導致蛻殼一次； 如於末蛻後期行之，則此法失效。

凡螯脫後再生之芽體， 其生長可分三段過程：(一)基本生長期，R 值由零至二（R 值定義，請參文內），(二)生長遲滯期，R 值由二至十三，(三)蛻殼前之快速生長期， R 值由十三至廿四。 蟹蛻殼時，發生於 R 值廿四。

凡成長之蟹，脫螯後其再生之芽體，有時發生萎縮現象，其發生機會， 約爲廿一份之一， 末蛻之蟹其機會增至四份之一。又芽體萎縮之現象，多發生在：(一)生長遲滯期；(二) 末蛻時期；(三) 生長遲緩之冬季。作者統認爲芽體萎縮之現象，乃因產生蛻殼荷爾蒙之「Y」腺體機能遲緩所致。