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MOULTING AND GROWTH OF THE PACIFIC EDIBLE CRAB

by

Donald C.G. MacKay

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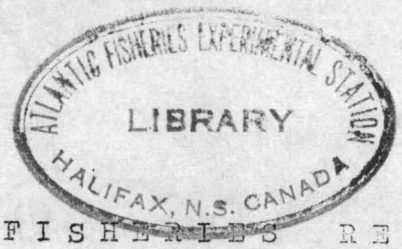

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INTRODUCTION:

Moulting in the Edible Crab is an event in the life history which is of the greatest scientific and economic interest. Scientifically it is of paramount importance because of the physiological and growth changes which accompany ecdysis. Economically we may regard the event as a most important one both because of its close temporal relationship with mating, a process necessary for the continuance of the industry, but also because it is at this time that crabs are most helpless and hence most susceptible to wholesale slaughter.

More than a year ago it was decided that one of the most important pieces of information yet to be gathered for the study of the growth and life history of the Edible Crab would be a large number of accurate measurements of the sizes of crabs both before and after moulting. However, necessary and important though this was seen to be, it seemed almost impossible to realize. Practically nothing was known of the moulting habits of the species and nothing was, so far as the writer was able to ascertain, to be found in the literature. To have depended upon the catches of the commercial fishermen would have been to have confined ones efforts to large crabs since the construction of the traps is not, for obvious reasons, such as to retain the small individuals. It was also realized from numerous trips with the fishermen that this would have been a very slow and difficult procedure. The ultimate success of the present attempt, which was realized in a different manner, came about through an interesting and somewhat unexpected discovery. From April 6, 1932 onward,

cast-off Edible Crab exoskeletons had been found along the shores of Boundary Bay in small numbers and had been eagerly sought for the data which they supplied.

On May 11, while making a search for either exoskeletons or young crabs, the writer happened to lift a sheet of rusty corrugated metal which was lying on the sand at low-tide level beneath an old disused lumbed pier at Whiterock B.C. Ordinarily, if any crabs are to Be found in such places they are the common so-called "shore-crabs" Hemigrapsus oregonensis and Hemigrapsus nudus. Finding nothing on the surface of the sand beneath the metal but happening to observe what resembled a part of an exoskeleton slightly projecting from the sand, the writer bwgan to dig. The result was the discovery of twelve crabs forming a close aggregation in the sand beneath the place where the metal had rested. This represented an area of approximately three square feet (three feet long by one foot wide). No crabs were found outside the borders of the metal though an effort was made to find them. It was as though shelter had been sought first beneath the metal and later the crabs had dug themselves into the sand beneath. More interesting still, in this connection, was the fact that almost all these crabs showed evidence of having just moulted or else of being on the point of moulting. The latter condition could be judged by the colour of the membranes at the various leg joints (there is a double membrane at this time and the colour is often dark-brown or greenish rather than white) or by the appearance of a slight opening along the line of separation of the exoskeleton in ecdysis.

In the days which followed this discovery other crabs in similar physiological condition were found to exist in considerable numbers under water-logged boards and metal and around the bases of the dock-piles. On a

few occasions they were found beneath the docks but without any wooden or metal objects on the sand above. They were also reported on May 19 from the Oyster beds of the Crescent Oyster Co., where during low-tide oyster-raking, they were frequently pulled to the surface of the sand and were often injured in the process. Many visits to the oyster beds revealed the presence of a small number of large crabs and a very large number of small ones. As at Whiterock most of these buried crabs had either recently moulted as judged by the hardness of their exoskeletons or else they were on the point of so-doing. The presence of such large numbers of crabs of the same species was thought to be related to the appearance at the same time on the oyster beds of larval oysters which would constitute excellent food for small crabs of one and two years of age but which would be almost certainly too small to attract the larger crabs. That crabs do sometimes eat oysters has been pointed out by the writer in a short paper entitled "The Edible Crab of the Pacific Coast" which appeared in Progress Reports of the Biological Board of Canada, No. 11, 1932. During the summer of 1932, on several occasions, crabs were found on the oyster beds in the act of eating oysters.

Coincident with the discovery of crabs buried in the sand and ready to moult it was decided to prepare to retain and study as many crabs in this condition as conveniently possible. In the ensuing section attention will be given to the method, conditions, and the success of the experiment.

CONDITIONS OF THE EXPERIMENT -

For the purpose of retaining the crabs obtained from various sources, but mainly from the vicinity of the old lumber pier at Whiterock, a number of compartment-boxes were constructed. One of these (see Fig. 2) was divided into two decks separated by galvanized metal screening and was composed of 140

separate compartments, each 3 x 3 x 4 inches. Small crabs were placed one in each section, or occasionally two (one of each sex so that should both moult simultaneously no confusion would result in identifying the exoskeletons).

Another box of similar over-all dimensions (3 x 4 feet by about 9 inches in thickness) was constructed with larger compartments which varied in size. This box had 54 separate compartments and was used to house somewhat larger crabs than the box previously described.

In addition to these two large compartment-boxes several other wire and wooden cages were employed and proved useful though not as efficient as the two just mentioned.

In all about 311 crabs moulted in captivity and about 300 could be accommodated at one time. The compartments were nearly always all occupied so that the 311 do not necessarily represent 300 of the original 300 plus 11 others. Some did not seem so likely to moult as soon as did others and in all cases preference was given to those judged most likely to moult in the immediate future. Also some crabs died in captivity, though not many, and had to be replaced by others as occasion permitted.

The following is a table with dates to show chronologically the distribution of moulting in this experiment. No particular importance is attached to days in which many crabs moulted in view of several conditions - (e.g. there were not always the same number in captivity and the boxes were not always examined daily at the same time). Had financial conditions permitted the continuance of the crab investigation until somewhat later in the season the writer feels assured that moulting would have been found to continue, though less generally.

TABLE NO. 1

TO SHOW THE DISTRIBUTION OF MOULTING

Date	males	females	undetermined	total
May 27	-	1	-	1
30	-	1	-	1
June 1	1	1	-	2
2	3	1	-	4
3	-	1	-	1
4	3	1	-	4
5	-	1	-	1
6	1	3	-	4
7	-	-	-	1
8	2	-	-	2
9	2	2	-	4
10	3	1	-	4
11	1	1	-	2
13	1	3	-	4
14	3	-	-	3
15	5	10	-	15
16	4	1	-	5
18	4	2	-	6
22	7	-	-	7
23	2	2	-	4
24	1	2	1	4
25	4	1	-	5
26	1	-	-	1
27	8	11	-	19
28	3	4	-	7
29	4	-	-	4
30	8	3	-	11
July 1	-	1	-	1
4	13	14	-	27
5	4	4	-	8
6	1	-	-	1
8	7	3	1	11
11	16	16	1	33
13	1	-	-	1
15	2	-	-	2
16	3	4	-	7
22	4	6	-	10
23	7	2	-	9
25	2	1	-	3
26	3	5	-	8
29	4	6	-	10
30	-	-	1	1
Aug. 1	1	2	-	3
5	5	3	-	8
10	6	6	-	12
17	1	1	-	2
23	13	7	-	20
Uncertain	3	5	-	8
TOTALS	168	139	4	311

EXPLANATORY NOTE

The charts later presented in this paper are based on 224 individuals, 120 males and 104 females. The reason for the fact that 87 were not used for the later statistical considerations was that not all moultings were successful. Some individuals, for example, did not harden sufficiently for accurate measurements. Others were deformed after moulting and could not well be used. In a few cases there is some question as to the accuracy of the recorded results. All records about which there is any doubt or which are not normal are eliminated in the later part of this paper but are included here to show the distribution of the moulting in time.

OBSERVATIONS ON THE MOULTING OF A CRAB

During the afternoon of June 5, 1932, three crabs found by the conditions of their exoskeletons to be on the verge of moulting were placed in a large vessel of water for observation. The essential details concerning these three crabs were as follows:-

(1) A large female found at noon the same day in the mating-embrace with a large male. The carapace indicated that moulting was imminent. Called "A". Died about 5 A.M. the next morning when in the early stages of moulting.

(2) A medium-sized male estimated to have been about two years of age. On the point of moulting. Called "B". Moulted at about 4 A.M. the following morning.

(3) A small female crab, roughly one year old. Greatest carapace width 5.11 cn. before moulting and 6.11 cn. after moulting or an increase of 25.4. Greatest length of carapace before moulting 3.38 and 4.05 afterwards. No external parasites found. Hereafter spoken of as "C".

The following is a brief description of the moulting of "C". When taken into the laboratory at Crescent, B.C. and placed in the aquarium at about 5 P.M. a very slight gape had become noticeable where separation occurs in ecdysis. Judging from the examination of many crabs it would appear that the opening was of very recent origin - probably having started about noon the same day.

4.30 P.M. Somewhat inactive; otherwise normal in behaviour.

11.30 P.M. No change

12.00 (midnight) Attempts to provoke "C" into using her chelipeds all failed - such behaviour is unusual for a crab!

12.40 A.M. Motionless.

1.00 A.M. Motionless.

2.30 A.M. Motionless.

5.45 A.M. The separation of the two parts of the exoskeleton has progressed a little further and the new one can be seen beneath the old one. Not much of it is visible as yet, however. The new exoskeleton is beginning to swell ever so slightly. She is more active than before and goes about the aquarium with her back to the wall.

6.00 A.M. By her actions the observer believes moulting to be getting close at hand. She can still walk about and move her claws readily.

6.10 A.M. Mouth parts in almost constant motion despite the fact that there is no food present in the aquarium. Chelipeds moving up and down as in eating. Back to the wall. A slight rocking motion occurs at this time. Her body is on a distinct incline due to the position of her feet. The anterior end of the body is the higher.

6.30 A.M. The motion of the chelipeds and legs and mouth parts continues every two or three minutes. The exoskeleton opening increases slightly allowing a little more of the new one beneath to become visible.

7.25 A.M. The old exoskeleton has separated to the large mid-lateral spines.

7.45 A.M. "C" now faces the wall and displays very considerable activity. (This is coincident with noises in the building but is not thought to be due to stimulation from this source). Slightly more of the inner carapace is to be seen now. The large mid-lateral spines, which until now were folded over, are beginning to straighten out. Considerable activity of the legs

and claws is evident. The critical time seems to have arrived.

7.50 A.M. "C" is rapidly emerging now. Almost constant sideway and backward motions of the legs and abdomen seem to be leading to further extrusion of the posterior portion of the animal. The hinder legs are now more or less straightened out thus facilitating the pulling out of these legs from the old exoskeleton. The posterior region is in almost continual motion and is being rapidly"extracted". The animal would be a helpless victim if attacked now. It cannot walk, cannot use its chelae, and probably cannot see.

7.55 A.M. For the first time the new exoskeleton can be seen to move independantly of the old one. It is, however, still mostly inside the latter. Within one minute "C" is entirely out, having backed away from her former outer body-covering and drawn her legs and chelae after her. The latter apparently came out last.

7.56 A.M. "C" has a shining new exoskeleton. The body has been swelling out (due to an intake of water), and already closely approximates the new dimensions. The large mid-lateral spines are now straightened out. The general appearance is that of a crab much larger than that represented by the now motionless former exoskeleton.

8.00 A.M. "C" can now dash away rapidly from a moving object. She is very active and seems to depend mostly upon speed rather than on her armour and chelae which as yet are very soft. Judging from numerous other crabs her claws will probably be of some use by tomorrow but will not reach their full hardness for perhaps two weeks. As is usual the new carapace is much darker than the old one and is darkest about the antero-dorsal margins. Underneath the colour is a watery transparent white which will later become a more distinct and opaque white.

Such was the procedure in the moulting of crab "C". It will have been noted that a long preparatory period preceded the actual sloughing of the old body-covering. During this period the animal enjoys the protection of its exoskeleton and presumably is able to look after itself. Only during the short period of perhaps ten minutes (in the foregoing case) when the animal is actually moulting would it be almost entirely helpless. During this period it would be particularly susceptible to attack from the rear. Immediately following this sloughing the animal, though now unprotected by a hard body-covering or by useful chelae, is so active as to successfully evade any ordinary attacker.

The following quotation from notes written on July 8, 1932 while watching a small crab moult should be of interest in the present discussion.

> "The abdomen and hind legs started to be pulled out first. The abdomen was first to get clear and it was followed by the legs, first the hind ones and lastly the front ones - with the exception that on the side under observation the chela came before the leg next to it. Vertical movements in the abdomen and legs were very evident. This seems to be necessary to the extraction of the legs and chelae but such convulsive movements were not taking place in all legs simultaneously, or so it appeared".

The following table gives the measurements of "C" both before and after moulting together with the percentage increase in each case. Somewhat similar information but based on a large number of crabs follows in a later section of this paper. (Table II).

ABSOLUTE GROWTH AT MOULTING

For the purpose of studying size increase, both absolute and percent, at moulting, accurate carapace measurements were taken wherever possible. As explained on page 5 not all measurements were sufficiently reliable for one reason or another to be used.

The calipers used were newly purchased ones which were calibrated to measure to one one-hundredth of a centimeter. With this instrument a large number of measurements were obtained and 224 (120 male and 104 female) which have been judged complete and accurate are herein considered.

TABLE II

MOULTING MEASUREMENTS FOR CRAB "C"

Measurement	Before	After	Absolute Increase	Per Cent Increase
Carapace Width	5.11	6.41	1.30	25.4
Carapace Length	3.38	4.05	.67	19.8
2nd last abdomenal segment width	.80	1.10	.30	37.5
Width of same	.54	.69	.15	27.4

Chart No. 1 indicates that the absolute width increase does not become greater or even maintain itself in the larger crabs but becomes less and less in both males and females. For example a 5.00-2.99 cn. female crab increases about the same absolute degree as does one twice as large but a crab midway between in original size may increase one and one half times as much.

This would seem to indicate that growth is greatly slowed in the larger (and hence older) crabs - provided, of course, that moulting is no more frequent in the older crabs than in the younger ones. The evidence from other species, notably the English crab Cancer pagurus indicates that this is not apt to be so. The evidence in the case of Cancer pagurus leads to the conclusion that the much barnacled crabs which they call "Grannies" probably are quite old crabs which moult only about once every two years rather than yearly or oftener as with younger crabs of the same species. One return from the writers crab tagging experiments, if accurate, would indicate that the species under present consideration does not necessarily moult yearly in old age.*

It will also be noted that the absolute increase in male size does not fall so rapidly as does the female size in the same chart. This is probably to be expected since, as pointed out at greater length in the following section, the males ordinarily attain a larger ultimate size than do the females.

*Contrary to his usual custom the writer liberated a much-barnacled crab at Prince Rupert, British Columbia on July 28, 1930. This crab had been caught and tagged on July 21 and had been retained in a live-well of the Kaien Shellfish Co. at Seal Cove, near Prince Rupert, until liberated near the mouth of the Skeena River on the afternoon of July 28.

On July 21, 1931 this crab was reported recovered from near the point of liberation.

The crab was a female 17.0 cn. in width having barnacles, a few parasites and a few unhatched eggs when found in 1930.

The presence of barnacles of considerable size in 1930 would indicate that moulting had not occurred for some considerable period.

PERCENTAGE WIDTH INCREASE IN MOULTING

The percentage growth increase is concisely given in Chart No. 2. A constant falling off in percentage increase will be noted for both males and females. The latter fall from a high of 21-22% at 3.00 - 6.00 cn. width to about 8-9% when they reach 12.00 cn. in width. The males seem to decrease somewhat less rapidly which again seems to help to account for their larger ultimate size. Very few females ever reach commercial size, which in British Columbia is 6 1/2 inches in greatest carapace width. The writer in 1930 reported from a study of 793 crabs caught in the commercial traps at Prince Rupert that only 11% of the females were of legal size*; whereas 73% of the males had attained at least the minimum legal size.

A study of 1035 post-larval crabs carried out during 1932 at Stanford University on material collected in the Crescent region indicated that even larger percentage increases occur in the smaller crabs. The following conclusions were reached in that report:-

Increase from 1st# to 2nd post-larval stage	38.9%
Increase from 2nd to 3rd post-larval stage	31.1%
Increase from 3rd to 4th post-larval stage	39.2%

This would seem to indicate, among other things, that for both males and females there is a fairly steady "decrease in percentage increase" at moulting throughout most of the life history of Cancer magister.

* Egg-bearing crabs are not legally taken whatever their size. The fishermen take "egg-bearing" to include all crabs potentially capable of bearing eggs rather than those doing so when caught and hence they throw back into the sea ALL FEMALE CRABS.

\# The first post-larval stage represents a crab about 52 mm. in maximum width.

TABLE NO. III

MALE MOULTING DATA

IN A CONDENSED FORM AND

UPON WHICH THE CHARTS ARE BASED

&

Size Range	No. of Crabs	Average Size	Average Size Increase	Average % Increase
2.00 - 2.99	1	2.69	.69	25.6
3.00 - 3.99	12	3.46	.82	23.6
4.00 - 4.99	21	4.50	.91	20.2
5.00 - 5.99	9	5.49	1.17	21.1
6.00 - 6.99	10	6.52	1.23	18.9
7.00 - 7.99	19	7.67	1.31	17.1
8.00 - 8.99	8	8.44	1.71	20.3
9.00 - 9.99	15	9.57	1.74	18.2
10.00-10.99	12	10.60	1.81	17.1
11.00-11.99	5	11.51	1.89	16.4
12.00-12.99	6	12.43	1.82	14.6
13.00-13.99	1	13.57	2.13	15.6
15.00-15.99	1	15.82	1.23	12.5

TABLE NO. IV

FEMALE MOULTING DATA

Size Range	No. of Crabs	Average Size	Average Size Increase	Average % Increase
3.00 - 3.99	11	3.64	.77	21.2
4.00 - 4.99	33	4.46	.97	21.8
5.00 - 5.99	20	5.47	1.15	21.0
6.00 - 6.99	11	6.41	1.38	21.5
7.00 - 7.99	12	7.48	1.51	20.2
8.00 - 8.99	6	8.47	1.55	18.3
9.00 - 9.99	3	9.51	1.77	18.6
10.00-10.99	3	10.36	1.47	14.2
11.00-11.99	3	11.75	1.41	12.0
12.00-12.99	2	12.23	1.06	8.7

All measurements are widths before moulting.

Loss of Appendages With Moulting in Captivity

The following table briefly indicates the appendage loss with moulting in captivity as already described. The value of this information is admittedly doubtful since some of the experimental conditions were not as would be found in nature.

TABLE NO. V

APPENDAGE LOSS IN MOULTING

	MALES		FEMALES	
	Total	No. of crabs*	Total	No. of crabs
Legs missing before moulting	74	86	87	75
Legs " after "	173	102	105	85
Chelae " before "	8	86	7	75
Chelae " after "	21	102	7	87
Total appendages miss. after	194	102	112	87
Total " " before	82	86	94	75
Perfect before moulting #	45	86	35	75
Perfect " "	34	86	35	85
Perfect " and after	28	86	31	75

* This means the total number of crabs on which a particular part of this table is based. Unfortunately more records were available for some observations than for others.

\# This refers to a "perfect" condition with respect to appendages. A perfect crab here is one with all its ambulatory legs and chelae.

THE TIME OF MOULTING

Evidence that moulting occurs from the latter part of May and on into August has been given herein. Other evidence which bears this out is furnished by the fact that approximately 8000 case-off exoskeletons of this species were picked up on the shores of Boundary Bay between April and July. The abundance showed considerable variation. In April they were relatively scarce whereas in June they were very abundant. By July they seemed to be more scarce than previously so that the height of the moulting season was judged to have passed by that time. An indication of the sex of these cast-off exoskeletons is given in the following table.

TABLE VI

SEX PROPORTIONS IN CAST-OFF EXOSKELETONS

MONTH	MALES		FEMALES	
	No.	%	No.	%
April	80	45.5	96	54.5
May	549	47.3	602	52.3
June	903	49.2	934	50.8

OBSERVATIONS ON THE REGENERATION OF LOST APPENDAGES

The following are the regeneration observations made during this experiment. Since no attempt is being made to draw conclusions from this part of the material it is merely being given in as brief a form as possible.

(1) No. 122, Male, July 4**. A "bulb" of 1.13 cn. (2nd last right leg) became a leg of 5.20 cn.***. (The mate was 8.34 cn. before moulting and 7.49 cn. afterward.

(2) No. 122, Male, July 4. Two "bulbs" before moulting became walking legs of 6.11 cn. and 9.19 cn. Width of crab 7.70 (before) and 9.19 cn. (after).

(3) No. 65, male, width 10.72 and 12.65 cn. Two bulbs before moulting became legs of 7.75 and 6.82 cn. length.

(4) No. 32, July 14, Male, width 12.84 and 14.08. A bulb for the left chela became a claw of 5.7 cn. Another formed the second-last walking leg on the left side. The latter was 6.7 cn. in length. The chela bulb was 1.23 cn. long and the leg one 1.12 cn. Both regenerated appendages, as usual, were less robust than the normal unregenerated ones or the ones which, presumably, had moulted once more at least following the regeneration (partial) of the appendage.

(5) No. 43, June 18, width 12.98 and 15.02 cn. A bulb before moulting became a chela 7.8 cn. long.

(6) No.115, July 4, female, width 7.36 and 8.81. A bulb became a leg 5.76 cn. long.

(7) No. 121, July 4, female, width 8.02 and 9.39. A bulb before moulting became a 4.48 cn. right chela.

(8) No. 42, June 18, female, width 11.78 and 13.00. A bulb before became a chela 6.76 cn. long.

(9) No. 30, July 13, width 10.22 and 11.30. A small bulb became a 5.66 cn. chela.

** Date of moulting. *** from base of coxa.

ABNORMALITIES IN MOULTING

(1) No. 189, July 11, male. The right third maxilliped hardened normally but the left one showed no sign of hardening up to the time of liberation several days after moulting.

(2) No. 127, male, July 4. The large mid-lateral spine after moulting as well as before moulting was very noticeably anterior to the one on the other side.

(3) No. 45, male, July 18. This crab had a punctured carapace before moulting which, though smaller, was present in the new one. The region about the opening was of a whitish colour.

(4) No. 1, May 27, female. This crab, which moulted on May 27, was very active following that event. By March 30 it was very considerably * hardened, and on June 9 it was hard above and only slightly soft beneath. By the latter date many small barnacles had already formed on the carapace.

(5) No. 206, female, June 15. The third maxillipeds hardened in bent form.

(6) No. 2, female, May 30. Reddish brown before moulting and a darker greenish-brown afterwards. A hole in the carapace before moulting was still present afterwards, though smaller.

(7) No. 89, male, width 10.51. The old exoskeleton was adorned with some large barnacles. The inside of the carapace was darkened beneath the barnacles and their exact position could be determined from within. The barnacle marks were visible on the exterior of the new exoskeleton.

(8) No. 25, male, June 10. This crab was badly deformed during moulting and did not survive.

(9) No. 60, male, June 24. This crab was considerably deformed during moulting but lived. It was liberated in this condition.

* This case is not, of course, an abnormal one. Included here by mistake.

SUMMARY AND CONCLUSIONS

(1) Moulting crabs were found buried in the sand at Whiterock, B.C. on May 6, 1932, and were thereafter secured in abundance.

(2) Three hundred and eleven crabs moulted in captivity and two hundred and twenty-four of these furnished accurate measurements for the study of growth.

(3) A long period of preparation precedes the actual emergence from the old exoskeleton. The period of actual helplessness and lack of adequate protection is very brief.

(4) Crabs are sluggish before moulting and active afterwards.

(5) Crabs do not necessarily float if removed from the water immediately following moulting. (No previous mention of this has been made in the paper. Prof. Spencer in his bulletin on the Commercial Crab, Cancer magister Dana, in Claquot Sound, Vancouver Island, says that they do float.

(6) The size increase which occurs at the time of moulting is a very rapid one and mainly takes place within a few minutes. Whether or not water is taken in to fill up the greater internal capacity of the new exoskeleton is not known to the writer but an experiment to find this out is planned for the coming season.

(7) Absolute width increase in crabs of this species becomes rapidly greater up to a certain point and then becomes just as rapidly less. In the case of the females this point is reached at nine to ten centimeters in width and with the males it is reached somewhat later. In addition to this it is possible that the older crabs do not necessarily moult yearly in which case growth must be very greatly reduced in the largest individuals. Very young crabs are known to moult several times per year so that the absolute growthe ~~at an~~ early ages may be even greater than the enclosed chart would seem to indicate.

(8) The percentage size increase at moulting shows a falling off throughout the known life-history but shows a less rapid decrease in the case of the males than with the females. This would seem to be in accord with the fact that the females of the species do not reach as great a size as do the males. Individuals of about 52 mm. width increase nearly 40% at a moulting (and there may be several moultings per year at such early stages) whereas female crabs of 12-13 cn. have been found to increase only about 9%.

(9) Crabs used in the present experiment were found to have fewer legs and chelae afterwards than they had before. This would seem to have been due to experimental conditions.

(10) Legs and chelae were found to become more than half regenerated at a single moult and were believed to have been completely regenerated with two moults.

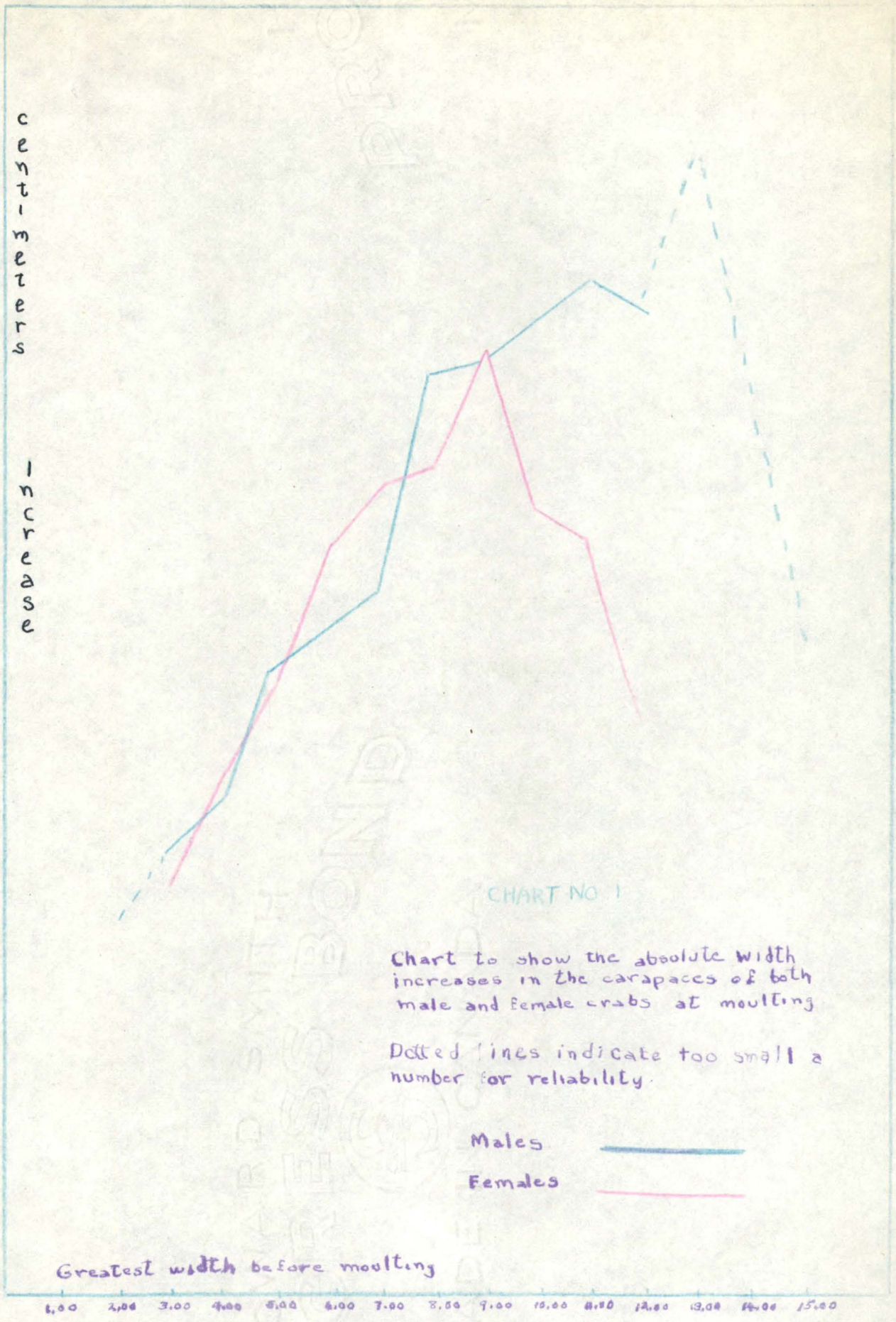
(11) The evidence definitely shows that moulting occurs at least from May until August and the peak would seem to be reached in the latter part of May or in early June.

(12) Sex proportions in the exoskeletons washed up on the shore was found to be almost fifty of one sex to fifty of the other. This closely approximates the proportions found in the live crabs procured during the summer with the exception of those counted in fishermen's traps. (The writer thinks that there may be a segregation of the sexes on the basis of water depth. This would not affect the proportions as washed up on the shore.)

(13) Several moulting abnormalities were noted. An opening in the exoskeleton sometimes was carried over with moulting, the animal being hardy enough to survive despite this disadvantage.

(14) Apparently an exoskeletons becomes hard in about two weeks. It is possible that this might be even more rapid in nature where food would be more

readily available. (Fishermen have admitted sometimes keeping crabs in the soft condition for sometime when they are scarce expecting to sell them when they get hard. Apparently they do not get hard before the fishermen lose patience! They apparently do not feed them. (It is not, of course, a general practice to keep soft-shelled crabs).


2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
.90
.80
.70
centimeters
Increase
CHART NO. 1
Chart to show the absolute width increases in the carapaces of both male and female crabs at moulting
Dotted lines indicate too small a number for reliability.
Males
Females
Greatest width before moulting
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00

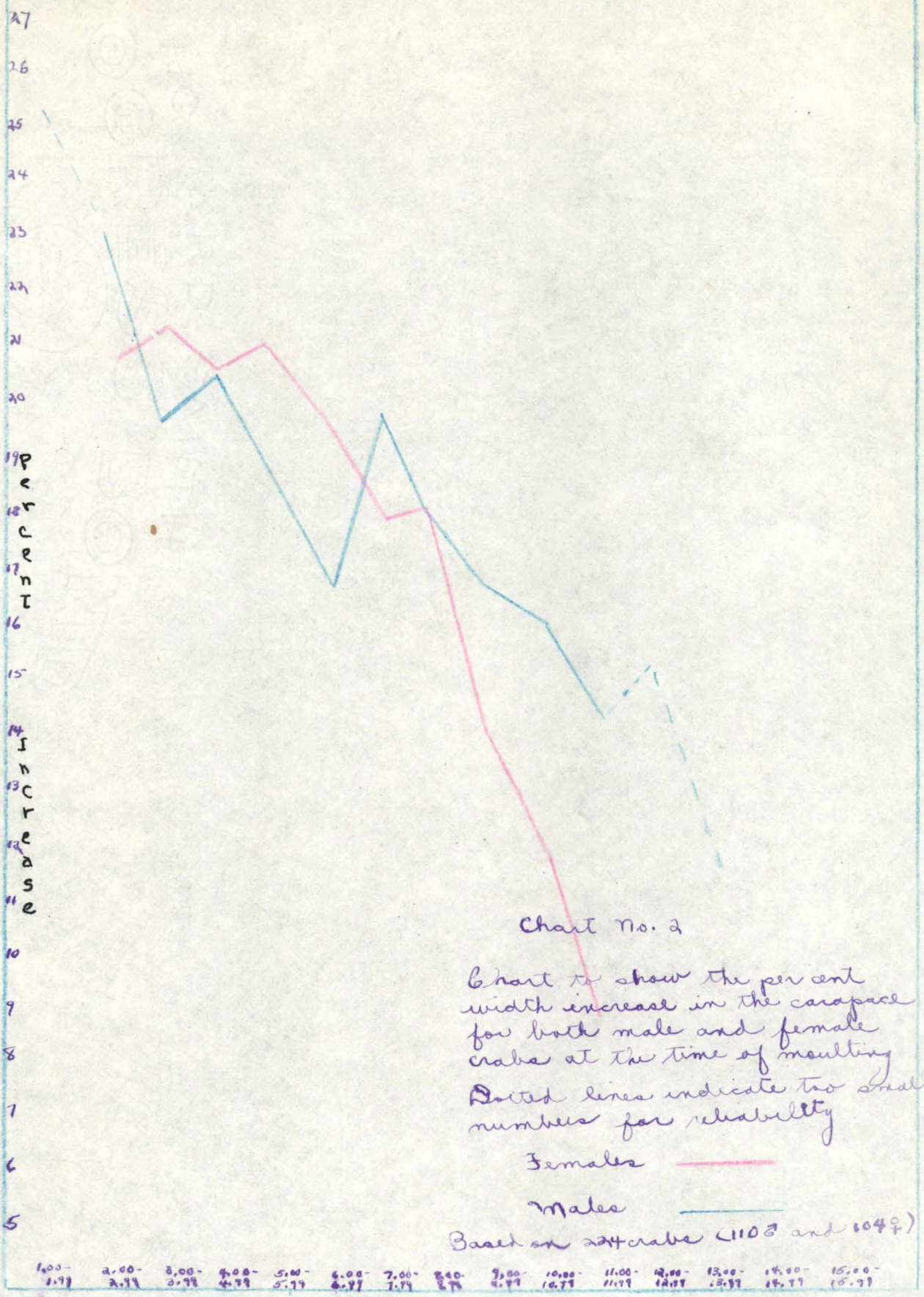


Chart No. 2

Chart to show the per cent width increase in the carapace for both male and female crabs at the time of moulting

Dotted lines indicate too small numbers for reliability

Females ——

Males ——

Based on 224 crabs (110 ♂ and 104 ♀)