REPORT OF

Crab Mortality on Chesapeake Bay Shedding Floats

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CHESAPEAKE BIOLOGICAL LABORATORY

Solomons Island, Maryland

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CRAB MORTALITY ON CHESAPEAKE BAY SHEDDING FLOATS 1938-1939

G. F. BEAVEN[1] and R. V. TRUITT[2]

Reports of high mortality resulting from the impoundment of crabs (*Callinectes sapidus*) during the preshedding period, to produce soft crabs, have been current in Maryland and Virginia for many years. The death rate of crabs on floats has been estimated by certain of the operators to run as high as 86% at Cape Charles, and to figures nearly as high at Crisfield and elsewhere during one season of the year. Such a high death rate during a period of three weeks or a month, midseason, of a fishing period of barely five months' duration, seemed to affect adversely the problem of conservation of the species involved and to contribute, in part, directly to the decline experienced in the crab industry of the Chesapeake Bay. A study of this mortality and the factors influencing it have been in progress at the Chesapeake Biological Laboratory for two seasons.

Moulting Stage:

Immediately upon shedding, the size of a crab large enough to meet the legal requirement, three-and-a-half inches, increases in all dimensions—length, width, and thickness—approximately thirty-three and one-third per cent. The number of times a crab moults or sheds has not been determined definitely, although Mr. Roy Robertson,[3] of the Laboratory, has been able to culture the same crab through eighteen successive moultings to reach the size of two and seven-sixteenths inches in width, at which time it was estimated that at least three more instars were necessary for maturity. The shedding operation of a crab is a tedious, slow process of twisting, writhing, twitching, contracting, and expanding, as a result of which all of its hard parts, exoskeletal in nature, are cast off.

The immediate process of sloughing the shell varies in crabs according to environmental factors, especially temperature, and according to the vigor of the different individuals involved. In typical cases, at summer water temperatures (78°F.+), between two and three

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hours time is required for casting off the shell after it has begun to separate, about fifteen minutes of which time is required for the actual withdrawl. At this time the crab is known as a "peeler." When the shell cracks beneath the lateral spine and begins to open along the posterior edge of the top shell, carapace, through which opening the crab extricates itself, the stage is known as "buster." "Rank peelers" and "rank busters" are terms common to the industry. Expansion during the soft stage largely takes place while sloughing is in progress and very shortly thereafter, at which time the crab, though very soft, is able to move from place to place either by walking or by swimming. However, it normally remains in seclusion until the hardening process has started.

The soft crab becomes hard within a period of three days, during which time, through continued deposition and hardening of chitin and lime, it is known as a "paper shell." Because of the great expansion and the secession of feeding during the soft period, the new hard crab, known as a "buckram," is exceedingly poor. However, by this time feeding actively has begun, and the crab again becomes "fat" and acceptable to the crab-meat producers. As the shell becomes more and more compacted with tissue, through growth, a series of markings, indicating the approach of another shedding stage, develops on the crab's anatomy. While there are several criteria by which the crabbers recognize the degree of instar maturity, from the "green crab" to the soft one, those most generally used by dealer and crabber alike are based upon color change on the margins of the last two segments of the fins or swimming legs. These margins definitely develop a white rim, pink rim, and red sign, successively, before the buster stage is reached. The value of the individuals in soft-crab production on floats is determined, in part, by these markings, since they denote the interval to the actual sloughing of the shell. However, in both Maryland and Virginia it has been a common practice in the industry to accept late green-stage crabs, just before the white rim has appeared, to be placed in the floats.

Under natural conditions, mortality during the moulting process is exceedingly low. On the shedding floats, as previously indicated, records show that as many as 86% of the crabs purchased by one dealer, during a single day of August, 1936, died within fifteen days. This case, it should be indicated, was an exceptional one, although in the course of these observations several records were made in which the death rate of impounded crabs exceeded 60% of those placed in the floats.

The Industry:

The soft-crab industry is centered largely at Crisfield, Maryland, within forty miles distance from which point the main shedding grounds for legal size crabs are located. Peeler crabs are captured most typically by means of sailboat-drawn scrapes, although a large portion of the entire supply comes from trotlines. A small part of the Crisfield supply is taken by means of dip nets. The term "run crabs," as used in the industry, covers those purchased at distant points and transported over long periods of time with consequent

A Crab Pound—Crab floats are tied to stakes in the sheltering pound. When algae-covered or partially water-logged they are removed to dry, as may be observed in front of the shanty.

exposure. Crabbing is done early in the morning and by mid-afternoon the crabs have been purchased by shedders and placed in the floats. A group of floats constitutes a crab pound, and in cases there may be as many as one hundred floats employed in a single pound. These floats are of wooden construction, being made of tightly fitted pine board bottoms, with laths on the sides and ends so as to assure the circulation of water over the crabs. The size of floats in general use at Crisfield is twelve feet long and three and one-third feet wide with a depth of one and one-half feet. Water in the float is usually about nine inches deep. A wing or flange of six-inch pine boards is attached all the way around the outside of the float at the points to which the water level is desired. Because of

fouling it is essential that these floats be removed from the water at intervals to be cleaned and dried out. An enclosed shed usually is built over or near the site of the floats for purposes of handling the crabs brought to the pound and those taken from the floats preparatory to shipping. These houses are known as crab shanties.

The work here reported has to do with factors contributing to the high death rate among crabs confined on shedding floats, a study that was initiated in the summer of 1938 and continued during the summer of 1939. All observations and experiments were conducted on the floats of representative shedders in Crisfield, the principal center of the soft-crab industry, in order that data might be obtained under typical working conditions. The owners of crab pounds and men in charge of floats who were asked to co-operate in the problem offered much assistance through supplying information and workers, and by permitting the use of crabs and floats for experimental purposes. Crabs typical of the catches in the industry were carried on commercial floats in order to have them subjected to prevailing conditions of water circulation, handling, and other factors met with under commercial practices. In certain cases groups of crabs were segregated on sections of floats, but always under conditions normal in the industry.

The complexity and variability of environmental conditions to which a crab is subjected from the time of its capture until its preparation for shipment make it difficult to completely evaluate the effects of isolated causative agents affecting mortality. No satisfactory records were available from which the exact periodic losses of operating shanties could be obtained, since it is a common practice in the industry to keep temporary tallies on blackboards and erase them when the crabbers are paid on Saturday. Approximate losses, ranging from 10% to 75%, were estimated by Crisfield shedders, almost all of whom were interviewed. It is a matter of common knowledge among all Crisfield shedders that the death rate varies during the season and that it differs according to the type of crab bought, as well as according to the care taken before and after crabs are placed in the floats.

Prior to August 1, 1939, purchasers of crabs separated them into five floats according to whether they were busters, red-sign, pink-rim, white-rim, or green crabs showing no coloration in the margin of the back fin. Soft crabs purchased for further development in the water, usually those not sufficiently hard to stand the rigors of shipping, are confined with the busters, and like the latter are kept

in the floats for only a short time before being prepared for the market. The rate of mortality on such floats is very low and, in practically every case, the death of the crab is traceable to poor handling on the part of the crabber.

INVESTIGATIONAL PROCEDURE

Experimental peeler groups, isolated according to the various signs indicating the degree of instar maturity, were held until final disposition was made of the crabs by virtue of shedding or through the removal of those that died. These crabs included an even distribution from the sources of capture such as the scrapes, the trotline, and dip nets, and they were confined in pounds where physical, biological, and chemical conditions were known to be good. Results of the observations are shown in the following table.

TABLE No. I

Shedding—Mortality—Time Relationships

Stage of Crab	% Shedding	% Loss	Average Time to Shed
Red Sign	91.2	8.8	2 (1– 3) days
Pink Rim	83.5	16.5	3 (2– 5) days
White Rim	59.2	40.8	5 (3–10) days
Green	47.5	52.5	9 (5–25) days

The data in Table No. 1 indicate that, under comparatively good conditions in the industry during midsummer, crab mortality on floats may run from 9.8% in the red-sign crab to 52.5% in green crabs. During the past decade and especially during the four years preceding this investigation, there had been an increasing tendency in the industry to use more and more white-rim and green crabs until their numbers marketed during 1938 extended into the millions. In this connection it should be pointed out that with the use of greener crabs the tendency grew to accept freely, crabs captured from trotlines and termed peelers whether they actually were peelers or not. Trotlines are the source of the major part of the green crabs that die on floats.

TABLE No. II

Distribution of Peelers According to Gears and Maturity, 1938

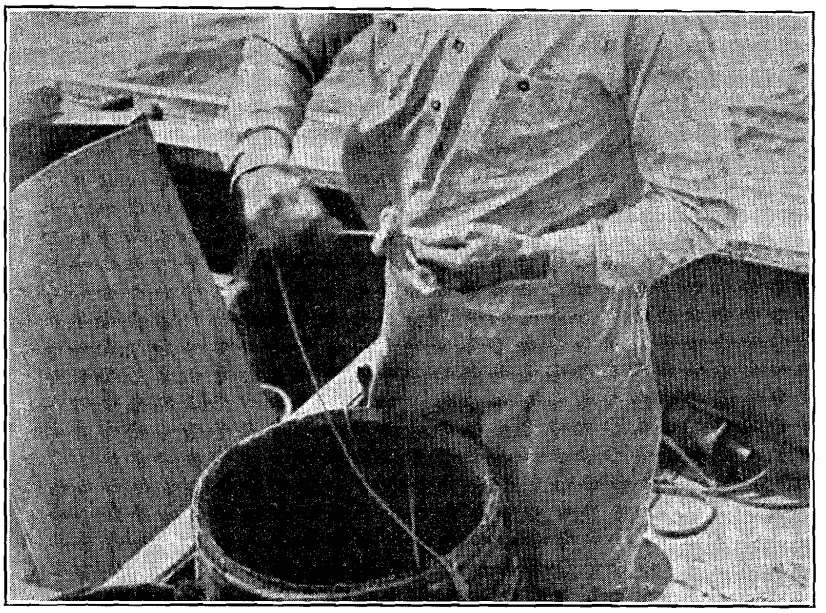
Source	No. of Crabs	% Soft	% Buster	% Red Rim	% Pink Rim	% White Rim	% Green
Trotline	3358	.06	2.2	6	4.8	24.6	62.3
Scrape	6568	12.2	6.4	10.7	13.8	27.1	29.8
Netted	221	14.9	7.2	11.8	4.1	20.4	41.6

TABLE No. III

Distribution of Peelers According to Gears and Maturity, 1939

Source	No. of Crabs	% Soft	% Buster	% Red Rim	% Pink Rim	% White Rim	% Green
Trotline.....	4129	.02	.5	2.1	2.9	23.3	71.1
Scrape.....	4401	17.3	6.7	13.	9.5	27.9	25.5
Run.....	4980	.0	1.6	5.9	5.8	41.2	45.4
Netted.....	1759	16.8	3.4	15.2	8.5	31.3	24.9

Data in Tables II and III indicate that scrape and netted crabs contain the smaller numbers of green crabs and, conversely, that



Baiting a Trotline—Trotlines are a half mile long. Salted eel and tripe are preferred types of bait used on local waters.

the greater numbers of green crabs are taken by means of trotline and from run crabs. Records from shanties handling trotline and run-boat crabs show higher losses than those shanties that use only scraped and netted crabs. Comparison was made in the various stages of maturity—green, white, pink, red—between scraped and those captured by a trotliner who exercised precaution in caring for his catches, and only an insignificant difference in the rate of mortality was found. Many peelers are taken by trotline at remote points and delivered to the shanties by run boats. Trotline peelers run some-

what larger than those caught by scrape and are more desired by certain buyers who sell most of their supply as "shedder" to be used as bait by sport fishermen. For the most part, even those trotliners who have a local and ready market for their peeler crabs do not give their catches the attention necessary to keep them in good condition for transportation and recovery on the floats, since their major interest is in the capture of hard crabs.

Another cause of losses on the floats not immediately obvious to the operator is found in the long period of time required for green crabs to shed after being impounded. These crabs are not fed and frequently die before or during the event of shedding, or if shedding actually takes place they are weak and do not stand up well under holding and shipping conditions. Such crabs are usually recognized in the soft state by their weak coloration and watery appearance. With a rapidly expanding market for peeler crabs to be used for fish bait it is possible for the shedder to dispose of many of these crabs before their death, and thus to reduce the rate of mortality on the floats.

Further evidence of the loss of green crabs was obtained during the 1939 season by counting the crabs as the floats were filled at various pounds and recording the dead crabs each day thereafter until the floats were culled. From these records floats contained an average of four hundred and thirty-one crabs, and of that number 23.7% died up to the time of culling, which usually took place on the fifth day. Continued observations gave indication that the general mortality is upward of 50% of all green crabs used on the floats.

A change in the policy of law enforcement, by which the use of green crabs was not permitted after August 1, 1939, reduced the crab mortality on shedding floats greatly. From the pound of a very reliable and cooperative shedder, August, 1939, records disclosed that 81.5% of the combined red-sign, pink-rim, and white-rim crabs successfully passed through the shedding process. This record is especially significant since these observations were carried on during the hottest part of the year and at a time when even the loss among the red-sign peelers was at its height. The records from the several cooperating shedders were markedly similar in that the red-sign crabs shed to the extent of about 85%, the pink crabs about 80%, and the white-rim crabs to about 55%. Considering the numerical distribution in the three types of crabs, the average total loss during the month was barely in excess of 20%. A slight dis-

crepancy may be found in the records given in that the unreported crabs not found dead on the floats were assumed to have died and to have been eaten by remaining crabs.

The placing of green crabs on shedding floats has been shown to be the cause of a marked increase in the death rate of impounded crabs. Of the more mature crabs, late in the instar, confined on floats, the death rate would seem to be unnecessarily high in that among the crabs with colored rings the loss in the industry usually

Hauling Crab Scrape Aboard—Crab scrapes are made of ridged frames with rope-constructed bunts. A flat bar at the bottom moves over the grassy surface and gathers peeler crabs.

is about 20%. Effort has been made to establish the factors which determine this mortality, such as the biological relationships of closely confined crabs, the problems of sunshine, temperature changes, and, possibly, chemical relations of the water.

Nicking:

Hard crabs readily feed on soft ones, especially when confined and without food. Under such conditions hard crabs destroy each other. Various methods are employed by the crabber in breaking the claws

of peelers in order to render them harmless. This practice, known in the industry as "nicking," consists of pushing in the free or movable segment of the biting claw until it snaps and becomes nonfunctional. Frequently bleeding results from nicking. Also, in many cases there follows a marked proliferation of the cells to form a swelling at the point where breaking takes place. When such crabs are put on the float and shedding takes place they are unable to extricate their claws, since the swelling is too large to be squeezed or pulled through the joints in the leg. When the crab has partly sloughed the shell such legs prevent its further release and the rank buster dies.

In an effort to determine the effect of nicking on peelers, records were kept for three groups of white-rim crabs taken from a single catch and handled under identical conditions until they were placed on a float partitioned into three separate compartments. The claws (*chelae*) of the crabs in the first compartment were left unbroken and free to function. The claws of the crabs in the second float were unbroken but bound together with rubber bands so that they could not function. The crabs in the third float were nicked in as careful a manner as possible. As may be seen from Table No. IV, the death rate varied in the several groups, being lowest, 18%, among those crabs unnicked but with sealed biting claws.

TABLE No. IV

Claw-Injury Effects on Peeler Crab Mortality, 1939

Type	No. Crabs	Treatment	Mortality
White line	500	claws whole	26%
White line	500	claws nicked	24%
White line	500	claws bound	18%

The nicked crabs died to the extent of 24%, while the crabs with undisturbed claws had the highest mortality, 26%. Observations on the three types of crabs indicated that those with free claws had attacked each other with considerable injury, resulting in the highest death rate, while those crabs with the bound claws showed the lowest death rate. At present there is no practical method of binding the unbroken claws of crabs for shedding purposes; thus nicking offers the best results. However, it should be emphasized that careless nicking is in part the cause of the high death rate of crabs on floats, not only because of the swelling that follows the injury but because of the loss of blood and consequent lessening of energy for successful moulting.

Sunshine:

The effect of direct summer sunshine on impounded peeler crabs was investigated. Commercial floats were used in which each float was partitioned in the middle in order to assure like conditions on the test groups. Unbleached muslin was used as the shading agent in which one end of a float was covered one day and the cover placed on the other end the second day in order to dertermine the immediate sun effects. Eleven tests were made altogether, and approximately two thousand two hundred crabs were shaded in the different tests. During the study the days were clear and the sun showed brightly for approximately twelve-hour periods in air temperatures ranging upward of 80° F. As far as possible, under the working conditions that obtained, crabs were chosen from the same source and from groups similarly exposed during capture and transportation. These crabs were estimated rather than actually counted in order to determine their numbers, thereby avoiding further handling and consequent injury. During the period of experimentation there was an average difference of only two crabs in the death rate, which constituted one-tenth of one per cent of the total. This slightly higher death rate was observed on the unshaded crabs. Sunlight, as a factor, did not seem to contribute greatly to the problems of mortality on shedding floats.

Temperature:

Temperature records of the water were made throughout this study, both inside of the floats and outside of them. The maximum temperature recorded was 86.5° F. while the lowest temperature during the period of study was 72° F. Practically no difference was found in the temperature of the water of any given crab pound, whether inside or outside of a float. Higher water temperature, in general, was accompanied by a higher death rate among the crabs under observation, a condition that prevails in the industry and one that is generally recognized by the shedders. Overcrowded peeler crabs, those ranging from five hundred to eight hundred or more to a float, suffered a marked increase in mortality at high temperatures as compared with the crabs in smaller numbers on floats.

Float Construction:

The commercial crab float, as indicated previously, is of wooden construction with a solid bottom and regularly spaced laths on the side to permit a free flow of water over the crabs. Tests were set

up in which peeler crabs were placed in a type of float in which regularly spaced laths instead of solid board bottoms were used. To protect the crab from predatory animals abundantly found in the pounds, such as eels, the open spaces were protected by fine wire. Still other tests were made on standard-built floats with crab concentrations varying from two hundred to six hundred crabs. In addition, experimental floats were placed where currents were strong in order to compare the mortality of peeler crabs on them with the death rate of those on floats held in the pounds where, typically, the water is more sluggish. Insurmountable difficulty was experienced in securing enough crabs of comparable origin, that is, in the same instar development and captured and transported under like conditions, with which to carry this work to a successful conclusion, although indicative data were secured. The commercial pounds located in coves of a type that largely eliminate tidal action and are greatly agitated only by wind, show a higher death rate among peeler crabs than those located more favorably with reference to tide. In certain pounds it was observed that during prolonged windy spells large quantities of sediment were stirred up by wave action on the shoals with a consequent increase in the death rate of impounded crabs. Further observations are planned in connection with the efficiency of the floats now in commercial use as to water circulation, crab-carrying capacity, and the effects of tidal circulation on the pound sites.

CONCLUSION

A number of factors operate in the handling of peeler crabs to affect adversely the soft-crab industry. Frequently crabbers, more especially trotliners, do not give the necessary care to their catches of peelers to eliminate injuries from drying, direct sunlight, too much heat, and motor fumes—disturbances readily eliminated by such equipment as liveboxes and covered boxes in which wet eelgrass (*Zostra*) is used. In certain cases where pounds are located on unfavorable sites, peeler death rate, especially during the height of summer, is greatly increased because of poor tidal oscillations and the exposure to wind effects with resulting intense sedimentation.

Crabs injure each other when confined in small quarters, thereby necessitating the breaking of the tip of the biting claw to prevent injury. The loss of a considerable portion of crabs in the pink-rim and red-sign stages that die on floats is directly traceable to careless nicking, which results in the loss of blood and in the enlargement of

the claw at the point where broken. This swelling, in turn, makes it impossible for the crab to withdraw its claw at the time of shedding and results in death, especially to those crabs in the weakened condition.

The greatest single factor contributing to the high mortality of shedder crabs in the Chesapeake Bay industry is found in the practice of using green crabs as shedders. The source of these crabs in a large degree is from trotline fishing where, in general, the crabbers' major interest is in hard crabs. This results in comparatively poor care of the catch. These crabs are further from actual shedding than any of the other peeler types used; thus it is necessary to carry them on floats for long periods of time. In addition to their being more greatly exposed in the capture and transportation, the unnatural conditions on the floats constitute added hazards resulting in the very high death rate observed.

The use of green crabs is a direct, immediate, and unnecessary big factor in the high mortality of peeler crabs experienced in the commercial pounds. It is estimated that in 1938 some seven million crabs died in transit or on floats in the Chesapeake territory, of which nearly five million were lost in Maryland. This loss of about five hundred and eighty-four thousand dozen (the commercial unit) of crabs constitutes a factor that not only adversely affects the general crab supply and increases the problem of conservation, but is a loss outright of thousands of dollars to the industry. This loss is, of course, eventually passed on to the consumer and, in turn, adversely affects the market. The losses of shedding crabs during future years should be reduced at least 80%, by the simple expedient of eliminating illegal green, nonpeeler crabs from the floats. The millions of crabs destroyed, if allowed to escape, would increase the general yield as well as contribute to a higher level of brood stock. The recent practices in the industry are definitely injurious.