STOMACH CONTENTS OF THE BERING SEA KING CRAB

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SPECIAL NOTE

The North Pacific Fisheries Commission, established in 1953 by the International Convention for the High Seas Fisheries of the North Pacific Ocean, coordinates the research of the member nations: Japan, Canada, and the United States. The resulting investigations provide data to the Commission for use in carrying out its duties in connection with fishery conservation problems in the North Pacific Ocean. Publication of this scientific report has been approved by the United States Section of the Commission.

United States Department of the Interior, Fred A. Seaton, Secretary
Fish and Wildlife Service, Arnie J. Suomela, Commissioner

STOMACH CONTENTS OF THE BERING SEA KING CRAB

by

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Contribution No. 6 to research conducted with the approval of the United States Section of the International North Pacific Fisheries Commission.

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ABSTRACT

This preliminary study of the stomach contents of Bering Sea king crabs indicates that the major food items of these crabs are molluscs and echinoderms. The frequent occurrence of echinoderms in the stomachs in large amounts is in contrast to the findings of Russian workers who feel that echinoderms play only a very minor dietary role in the king crabs of the Kamchatka region. Differences in food preferences apparently do not exist between the sexes.

This report is the result of the analysis of king crab stomachs collected during the summer of 1957 in southeastern Bering Sea by biologists of the King Crab Investigation of the U. S. Fish and Wildlife Service. A study of the food habits of the crab is of considerable importance because food availability and utilization may play important roles in the distribution, migration, and molting patterns of the crabs.

Very few reports on the food habits of the King crab, *Paralithodes camtschatica* (Tilesius), are found in the literature. Among the available papers, the work of C. F. Feniuk (1945) is the most recent and perhaps the most complete. For the most part, his methods were used in this analysis. Quantitative studies on the species of food of the crab are made exceedingly difficult because, in contrast to fish which for the most part swallow food whole, the crab breaks up his food with the chelae before ingesting it; hence reconstruction of individual organisms is usually impossible. Methods which are used in quantitative food studies of vertebrates which masticate their food are not adaptable to the food studies of crabs, since the quantity of crab stomach contents is usually small. As yet, no suitable method of quantitative analysis of these stomach contents has been devised.

Because of this lack of an applicable method, the smallness of samples from any one area, and the limited scope of available related data, this report intends primarily to indicate the types of organisms which contribute to the diet of the crabs, however it will show quantitatively the fullness of the stomachs examined. More intensive studies designed to compensate for the inadequacies noted here will be pursued in 1958.

The crabs from which stomach samples were taken were from catches made by the chartered trawler *Mitkof* during the months of June and July 1957 (fig. 1). Of the 329 stomachs obtained, the sexes were almost

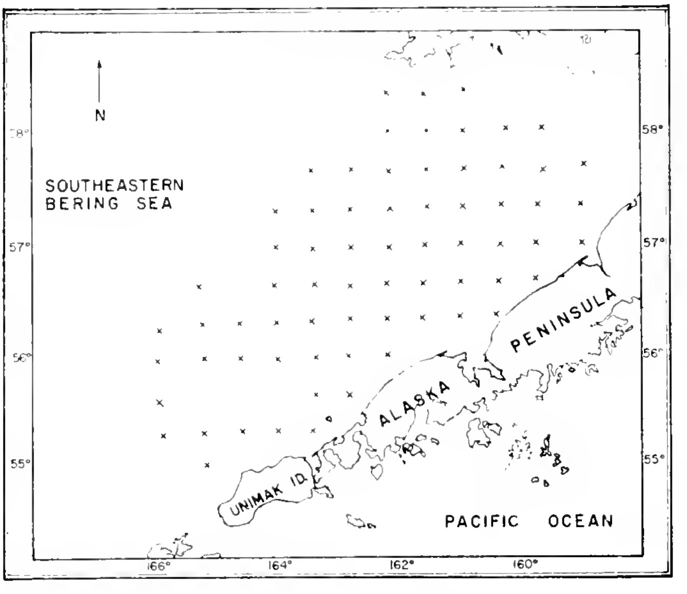

Figure 1.--Stations at which stomach samples were taken during 1957.

equally represented--160 females and 169 males. Sizes ranged from 63 mm. to 193 mm. in carapace length. All types of presently recognized shell conditions were also represented, as the samples varied from newly molted, soft-shelled crabs to those having barnacle-encrusted very old shells. The majority of the crabs, however, possessed hard new shells indicating a molt within the season.

Anatomically, the stomach of the king crab is divided into two sections, referred to as the cardiac and pyloric sections. (Marukawa 1933). This conventional nomenclature will be used in this report. However, as pointed out by Pearson (1908), these terms may technically be misnomers when applied to the Malacostraca since the cardiac section of the stomach is farthest from the heart, and lies under the region of the carapace defined as the gastric region (fig. 2) by Marukawa. Figure 3 shows the position of the stomach, with relation to the carapace and the rest of the body.

The cardiac section of the stomach was dissected out of each crab and preserved

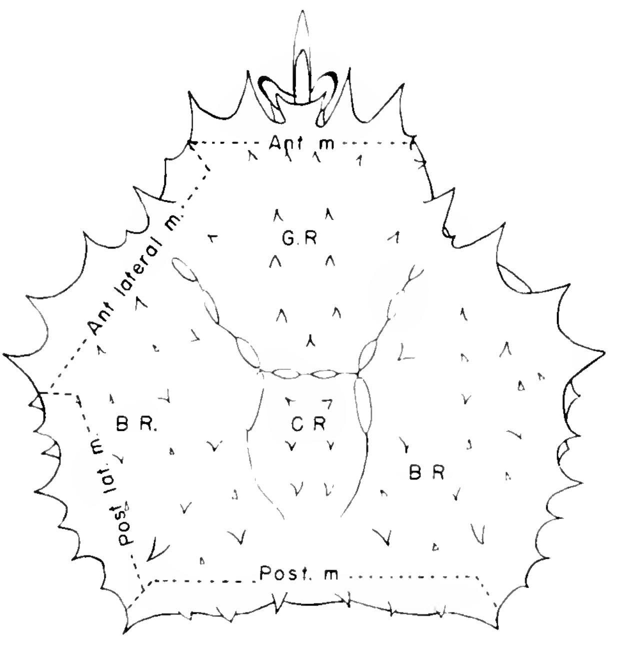

Figure 2.--Carapace of king crab (after Marukawa) G.R., Gastric region; C.R., Cardiac region; B.R., Bramchail region.

in 4 percent formalin in an individual cloth bag. The pyloric section and the intestine were not used in this study. Anatomically the cardiac section of the stomach is divided into two parts. The anterior part, which comprises the largest area of the entire stomach, is guarded at its entrance by a hairy filter and at its exit by the teeth of the gastric mill. The smaller part of the cardiac stomach lies between the teeth of the gastric mill and the pyloric valve which is the entrance to the pyloric section of the stomach. When the stomach is filled to maximum capacity in both sections, the ratio of the amount of food in each of the three parts is 6:2:1 respectively (Feniuk 1945). Each percentage of fullness was assigned a coded index (table 1). Each part was considered individually and the fullness estimated visually:

Table 1.--Code for relative fullness of stomachs.

Percentage of fullness	Index (k_x)
Empty	0
Trace of food	1
1 - 20	2
21 - 40	3
41 - 60	4
61 - 80	5
81 -100	6

In order to eliminate variations due to the different sizes of the parts of the stomach, a common index of K_x was obtained for each part by multiplying its index of fullness (k_x) by its factor taken from the ratio of the parts to the whole. The total K factor represents the sum of the K_x factors, i.e., $K = 6k_1 + 2k_2$ (+ $1k_3$ not used in these samples). With the entire cardiac stomach filled to maximum capacity, the maximum K obtainable in our samples if 48 units. The percentage of fullness of the stomach, both parts considered, is thus calculated from this K factor. The quantity of food present in the stomachs varied considerably; however, only 7.6 percent of the stomachs were found to be completely empty. Table 2 shows the distribution of stomach fullness.

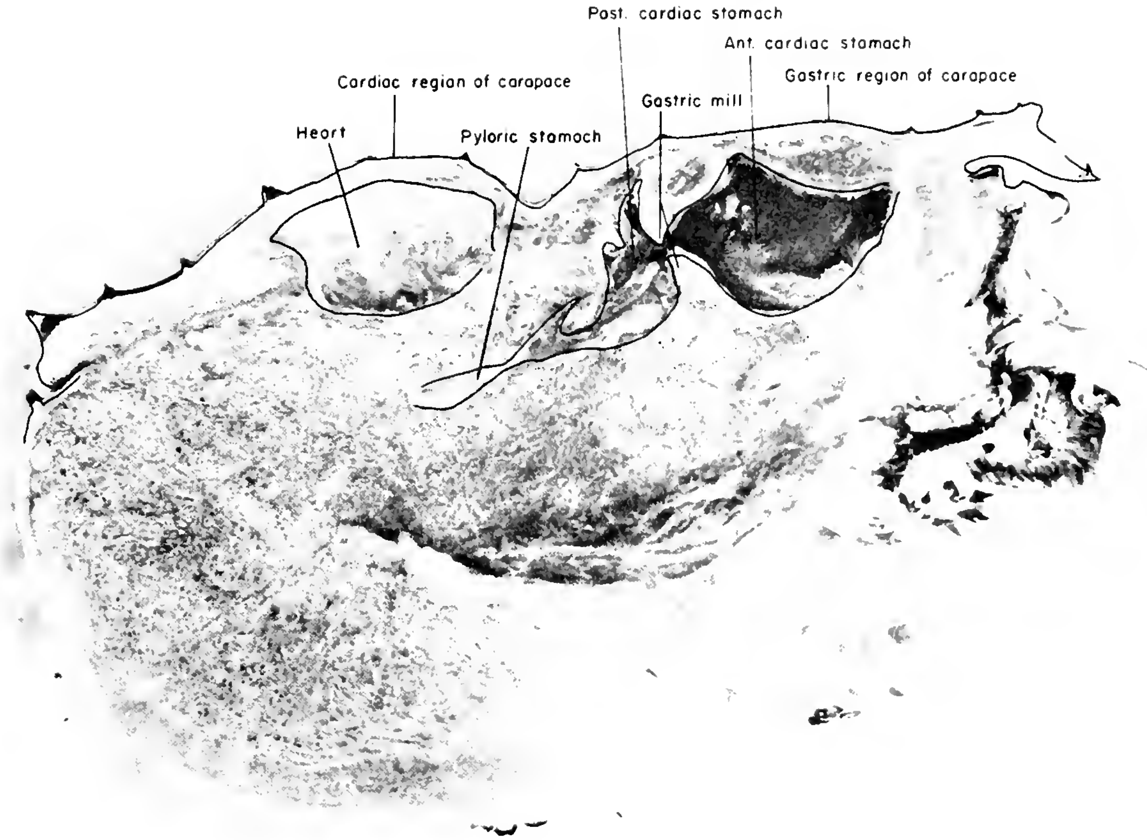

Figure 3.--Left side of sagittal section of a king crab.

Table 2.--Distribution of stomach fullness in 329 crabs.

Stomach fullness		
Upper limit of K	Equivalent percentage	Number of crabs (in percent)
0	Empty	7.6
8	Trace	14.4
16	1 - 20	42.7
24	21 - 40	18.6
32	41 - 60	10.0
40	61 - 80	4.9
48	81 -100	2.4

The contents of each stomach were examined microscopically. Although the components occasionally were completely unidentifiable masses of torn tissues, for the most part, relatively large pieces of recognizable materials were present in the anterior part of the cardiac stomach: for example, pelecypod shell fragments, legs and dactyls of crabs, gastropod shell fragments and opercula and legs of brittle stars. Occasionally, complete individuals were found--among these, small brittle stars and amphipods were the most common. Remains in the posterior part of the cardiac stomach were often still recognizable but were more finely broken from the action of the teeth of the gastric mill. Because no bottom fauna from the sampling area was collected or available for species identification and comparison with organisms present in the stomachs, these organisms in most cases were identified only to the class or order level. We express our appreciation to Dr. Paul Illg of the Department of Zoology of the University of Washington for his verifications of many of our identifications of the food organisms. Remains of organisms which apparently, because of decomposition rather than digestive action, had been dead prior to being ingested by the crabs, as well as the remains of animals which were alive prior to capture, were found in the stomachs.

In addition to the estimation of percentage of fullness, tabulations were made of the frequency of occurrence of the major food groups. In the determination of this frequency, each food group present in a stomach, even when represented by several organisms, was considered to have had an occurrence of one.

Among the food groups represented, molluscs, present in 69.0 percent of the stomachs examined, are the major food item--pelecypod remains dominating those of gastropods. Echinoderms rank second, appearing in 42.2 percent of the crabs. Representatives of the phylum include asteroids, ophiuroids, and echinoids of the sub-order Clypeastrina. In contrast to reports in the available literature, no regular echinoids (Hyman 1955) were present. This lack may be only coincidence, as regular echinoids are most commonly found in rocky areas, and the majority of our samples were not taken from these areas. The third most abundant food group is the decapod crustaceans, which were present in 22.8 percent of the stomachs, primarily represented by the sub-order Reptantia. Other groups in the order of their abundance include polychaete worms (17.5 percent), algae (14.3 percent, crustaceans, excluding decapods, (16.0 percent), and coelenterates (3.0 percent). Foraminifera, nematode worms, tunicates, echiuroids, fish and other groups were present occasionally but not often enough to be considered, on the basis of present information, foods of any relative importance. Possibly these organisms in some instances had been carried into the crab stomachs as food of other food organisms.

Contrary to the findings of Feniuk, we found relatively large amounts of algae present in many of the stomachs. At least with regard to king crabs of southeastern Bering Sea, this causes us to question his proposition that algae occur only as a food of other organisms. Sand, which appeared in practically all of his samples, was present only occasionally in our samples, thus leading us to believe that sand may not be a chosen item, but rather one of coincidence. Also, Feniuk's report indicates that the echinoderms play only a minor role in the diet of the king crab of the Kamchatka region, which is in contrast to our data on the southeastern Bering Sea crabs.

Our study, like Feniuk's, shows that the sexes exhibit no food preferences. Table 3 gives the percentages of frequency of occurrence of food groups for males and females.

Table 3.--Frequency of occurrence of food groups in 169 male and 160 female crabs.

Food group	Percentage of frequency of occurrence	
	Male	Female
Mollusca	76.9	60.6
Echinodermata	48.5	35.6
Decapod crustacea	26.0	19.4
Polychaeta	18.3	16.9
Algae	12.4	16.3
Other crustacea	11.8	15.6
Coelenterata	0.5	5.6

Chi-square tests show no statistically significant differences in the frequency of food group occurrence between the sexes with the exception of the Coelenterata, and this exception cannot be considered reliable because of the smallness of the sample. Limitations of this preliminary study prohibit further comparison of food preferences, if any, exhibited by newly molted crabs and crabs approaching the molt, or by various size groups of crabs.

SUMMARY

It appears that the major food items of the southeastern Bering Sea king crabs, of the sizes studied, are molluscs and echinoderms. On the basis of sex, these crabs do not seem to show a differential

preference for particular food items. This preliminary study indicates that a number of differences in feeding habits exist between the southeastern Bering Sea king crabs and those of the Kamchatka region. More complete studies are planned to answer the many remaining questions pertaining to the food habits and needs of the king crab.

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