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Feeding of Pacific Salmon During Anadromous Migrations in the Kamchatkan Waters

by

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Abstract

This report is devoted to the analysis of feeding of five species Pacific salmon - pink, chum, sockeye, chinook and coho salmon - during anadromous migrations in summer 1995-1996 in the waters of the Pacific Ocean and of the west part of the Bering Sea. The studies were undertaken to describe currently basis of feeding of adult salmons and to estimate changes which could take place in pre-spawning feeding period of salmons at the East Kamchatka for recent 30 years.

The main pink and sockeye salmon food in the Pacific Ocean waters adjacent to Kamchatka consisted of euphasiids, copepods, juvenile squids and myctophids. In 1995 dominate food species among euphausiids was Thysanoessa longipes, in 1996 - Th. inermis. Calanus cristatus and Eucalanus bungii were found as mass food species for pink and sockeye salmons among copepods. Pteropoda, Limacina helicina and Clione limacina, dominated in the food of chum salmon. Juvenile squids was general food object for coho and chinook salmons in this area. Food similarity was maximum between pink and sockeye salmon. In 1995 it reached 70.4 %, in 1996 - 47.6 %.

In the west part of the Bering Sea in summer 1996 the basis of food for pink salmon consisted of euphausiids, it being Th. longipes dominate. Chum salmon mostly fed on Pteropoda and myctophids. Sockeye salmon food was the most variable; C. cristatus, juvenile squids, myctophids and L. helicina were dominate objects in the spectrum. Basis of food for chinook salmon consisted of juvenile squids. Food similarity was maximum between chum and sockeye salmons (34.2 %).

Introduction

The data concerned the feeding of Pacific salmon over marine period of their life, actually, were absent until 50s. First information on food composition to juvenile and adult salmons in the waters adjacent to Kamchatka were published in 1951 (Sinkova 1951). Since 1954 until 1962 in KamchatNIRO (personally by L.D. Andrievskaya) there were carried out detail investigations feeding of adult fishes throughout their migration course since wintering until the time to enter the rivers. Materials for analysis we
re collected from the catches of driftnets preferably from the north-west part of the Pacific Ocean (Andrievskaya and Mednikov 1956; Andrievskaya 1958, 1966). From the results of the analysis there were revealed areas of feeding, food composition and the features of food relationships between pink, chum and sockeye salmon.

Some later, until second part 80s, studies of that kind were not carried out in our country, literature data for that period concerned the only characteristics of feeding of juvenile salmons over spring-summer and fall periods of life (Karpenko 1979; Karpenko and Piskunova 1989).

The period since late 80s to early 90s was characterized by intensification of salmon driftern fishery within Russian economic zone, also there was an opportunity used to get new information on salmon feeding during of anadromous migration again. Studies were undertaken to describe current state of feeding basis for adult salmons at the East Kamchatka and to estimate changes which could take place there for recent 30 years. Materials collected from the catches of driftnets were less representative if to compare them to ones collected from trawl surveys. Nevertheless, on our view, the materials should be more comparable to ones published either in Russia and abroad in 50-80s.

The work was written on the basis of materials collected and analyzed during voyages of Russian fishery fleet worked on scientific program of short-time forecast of salmon prespawning run to the

offshore of Kamchatka in summer 1995-1996. All materials for 1995 and partially for 1996 were collected in the area of general fishery activity - in the waters of Pacific Ocean adjacent Kamchatka. In 1996, moreover, there was some material collected in the open sea of the north-west and central parts of the Pacific Ocean southward from the Commander Islands, in the west and central parts of the Bering Sea. 617 stomachs were examined totally:170 stomachs of pink, 191 - of chum, 200 - of sockeye, 30 - of coho and 26 - of chinook salmon. The stomachs were processed and analyzed in the respect to the methods generally accepted (Handbook on..., 1974, part 1). The work at the start was focused on ascertaining the composition of food. We used some standart indexes. Stomach fullness (%oo) = food weight (g)/fish weight(g) x 10,000. Food composition (%) = individual prey species weight (g)/food weight (g) x 100. Food similarity (%) was calculated by summing the minimum food composition for those prey common to the groups being compared.

Results

Pink salmon

Pacific Ocean waters adjacent to Kamchatka. Food spectrum of pink salmon in 1995 consisted of 34 components which among adult euphausiids (Thysanoessa longipes - 29.0 % of the total food weight), juvenile squids (16.4 %), Calanus cristatus (14.8 %), mollusc Limacina helicina (12.1 %) and myctophids (11.1 %) were dominant (Table 1). Other forage animals were met much more rarely. Fullness of stomach, in average throughout over the area in summer 1995, reached to 47.9 %oo, index of food variability was equal to 2.7 bit.

In 1996 food spectrum of pink salmon included of 26 components, food basis consisted of C. cristatus (22.0 %), myctophids (20.4 %), Th. inermis (15.3 %) and juvenile squids (12.3 %). Food component of juvenile fish was relatively large - of 8 %. The component of Pteropoda, that was significant in summer 1995, had been reduced more than in 6 times in 1996. The fullness of fish in the year was poor 15.6 %oo, the index of food variability was equal to 2.3.

West part of the Bering Sea. Food spectrum of pink salmon in June 1996 included only 13 components, general components were euphausiids (67.4 %), it being Th. longipes amounted 43.8 % of the amount (Table 2). Among other crustaceans C. cristatus (9.8 % of food weight, at 100 % frequency of occurrence) was the most important. Juvenile hyperiids, Parathemisto japonica, was actually met in all stomachs, also it's amount was small - 1.0 %. Other hyperiids were met as single samples. Molluscs played insufficient role in feeding of pink salmon in the area. Fish component of food was represented by the only myctophids (12.3 %). The fullness of stomach was high - 146.2 %oo, the index of food variability was equal to 2.3. There were no met fishes with empty stomachs.

Chum salmon

Pacific Ocean waters adjacent to Kamchatka. Food spectrum of chum salmon in 1995 included 35 components, general components were molluscs, L. helicina (55.2 %) and Clione limacina (10.9 %) (Table 3). Among crustaceans included in the food of chum salmon the euphausiids (17.6 %), mainly Th. longipes (11.9 %) dominated; among other animals that were myctophids (6.5 %) and Oikopleura sp.(3.9 %). The rest components of food totally hardly amounted over 6%. The fullness of stomach, in average throughout over the area, was 48.4 %oo; index of food variability was equal to 2.3.

Food ration of chum salmon in 1996 consisted of 36 components, when dominating molluscs L. helicina (39.9 %) and Cl. limacina (29.2 %). Other food components took significant part among food

components were myctophids (11.8 %) and juvenile fish (9.2 %). The fullness of stomach in 1996 was lower, compared to that in 1995 - 32,8 %oo, the index of food variability was equal to 2.4.

West part of the Bering Sea. Food spectrum of chum salmon in June 1996 consisted of 24 components, molluscs L. helicina and Cl. limacina took 40% of the total food weight (30.2 % and 12.8 %, respectively) (Table 2). The amount of other animals in stomachs of chum salmon was poor. Average in the area fullness of stomach took 69.5 %oo; the index of food variability was equal to 2.5.

Sockeye salmon

Pacific Ocean waters adjacent to Kamchatka. Food spectrum of sockeye salmon in 1995 consisted of 31 components, also crustaceans took 71.2 % of the total food weight (Table 1). Adult euphausiids of 1.5-2.0 cm by length dominated (54.6 %), Th. longipes amounted 45.8 %. The rate of Copepoda was significant too; large C. cristatus (6.8 %) individuals (up to 9mm), E. bungii (7.1 %)and juvenile squids (13.9 %) formed general weight of food. Abundance of other animals found to be objects of feeding of sockeye salmon over the period, was poor. The fullness of stomach over the period amounted 40.6 %oo; the index of food variability was equal to 2.5.

In 1996 there were 18 food components revealed in food spectrum of sockeye salmon; the euphausiids dominated (43.2 %), the rate of Th. inermis consisted 40.1 % (Table 1). The rate of squids and myctophids were significant too - 35.5 and 12.1 %, respectively. Other fishes were met rarely. High frequency of occurrence of the hyperiids could be noted, although the amount of hyperiids in food weight was less than 2 %. The fullness of stomach in sockeye salmon reached 20.6 %oo; the index of food variability was equal to 2.4.

West part of the Bering Sea. In summer of 1996 food spectrum of sockeye salmon consisted of 23 components. The rate of crustaceans took 50 % of food weight, C. cristatus was dominate component of the food (34.6 %) (Table 2). More or less significant percent in the food mass was formed by various species of hiperiids (9.2 %). The rate of fish component took more than 13 % of food weight, where myctophids took 10.7 %. Moreover, significant rate of food mass consisted of juvenile squid (16.5 %) and L. helicina (10.8 %). The fullness of stomach amounted 32.4 %oo; index of food variability was high - of 3.0.

Coho salmon

Pacific Ocean waters adjacent to Kamchatka. In 1995 food spectrum of coho salmon consisted of 13 components, where juvenile squids of 4.0-10.0cm in length dominated (93.2 %) (Table 1). Other animals were met rarely; low abundance of Th. longipes and 2.5-3.0 cm sculpin juveniles should be noted (3.4 % and 1.3 %, respectively). The fullness of coho salmon stomach in this period amounted 56.0 %oo; the index of food variability was equal to 0.5.

Chinook salmon

Pacific Ocean waters adjacent to Kamchatka. In May 1996 food spectrum of chinook salmon consisted of 7 components, the squids was dominating (88.9 %) (Table 1). There were juvenile individuals with length about 7.0 cm and residuals of large individuals with length of mantle up to 20 cm met. Among other components of food Th. rashii and fishes took low rates - 4.3 and 6.0 %, respectively, it being 2.3 % of fish rate consisted of myctophids. The fullness amounted 95.4 %oo; the index of food variability was equal to 0.7.

West part of the Bering Sea. Juvenile squids (93.6 % of the total food weight) and myctophids (6.4 %) were met in stomachs of chinook salmon in June-July 1996 (Table 2). Sculpin alevins of 3cm in length was met in the one fish stomach. Therefore the index of food variability was found as extremely low (0.01), although the fullness of stomach itself was high (178.9 ‰).

Food similarity of Pacific salmon

Pacific Ocean waters adjacent to Kamchatka. Food similarity (FS) between various salmon species in the area examined in 1995 was higher than in 1996. Food similarity found between pink and sockeye salmons (70.4 % in 1995 and 47.6 % in 1996) was higher than FS determined between pink and chum salmon (34.5 % in 1995 and 27.7 % in 1996) or chum and sockeye salmon (35.2 % and 22.8 %, respectively) (Table 3). Significant food similarity between pink and sockeye salmons could be explained at the expense of extent presence of euphausiids (Th. longipes) and copepods (C. cristatus) in food rations of both these species. Dominate food components in the food composition chum salmon in different years were Pteropoda, therefore FS either between chum and pink salmons also between chum and sockeye salmons was not high. It should be noted high level FS between sockeye and chinook salmons in 1996 (41.6 %) - result of high rate of squid found in stomachs of the species. Minimum food similarity was assessed in 1995 between chum and coho salmons (7.8 %).

West part of the Bering Sea. In summer of 1996 food similarity between various salmon species was relatively not high (Table 4). Maximum FS was found for sockeye and chum salmons (34.2 %), it was some lower for pink and sockeye salmons (33.9 %). Low food similarity was estimated for pink and chinook salmons (8.9 %).

Conclusion

In the Pacific ocean waters adjacent Kamchatka food similarity among Pacific salmon was the most high between pink and sockeye salmon. In 1995 it reached 70.4 %, in 1996 it was 47.6 %. The main pink and sockeye salmon food were euphausiids, copepods, juvenile squids and myctophids. Although in 1995 Th. longipes was dominate among euphausiids, in 1996 the dominate was Th. inermis. Mass species of copepods in pink and sockeye salmon food were C. cristatus and E. bungii. Pteropoda, L. helicina and C. limacina, dominated in the food of chum salmon, so food similarity between chum salmon and other salmon species was not significant and reached 34.5 % in 1995 and 35.2 % in 1996. The main coho and chinook salmon food in the Pacific Ocean waters adjacent Kamchatka consisted of juvenile squids.

In the west part of the Bering Sea in 1996 food similarity between various salmon species was low because the spectra of food of these species differed. Euphausiids dominated in the pink salmon food, it being general rate of the taxon represented by Th. longipes. Chum salmon food consisted, mainly, of myctophids and Pteropoda - L. helicina and C. limacina. The food of sockeye salmon mostly consisted of C. cristatus; the food of chinook salmon consisted of juvenile squids (90 %).

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