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RESULTS OF 2001 SALMON RESEARCH CRUISE OF THE *RTM "DALOKEAN"*

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Abstract

The cruise of RTM "Dalokean-2" was conducted in June-August, 2001, to study distribution, time of anadromous migration, biological structure of stocks and relative abundance of some salmonid species in marine pre-spawning aggregations. The research was conducted in four fishing areas: 1 – Northern Okhotsk Sea Area (61.05.1); 2 – Petropavlovsk-Komandor Area (61.02.2); 3 – North Kurils Area (61.03.1); 4 – South Kurils Area (61.04.1). The research included temperature conditions control of 10-meter surface layer, daily biological analysis of salmon, collection of mass samples of chum salmon otoliths, evaluation of stomach content and anomalies in development of gonads. Salmon were caught by drift gillnets. 55 stations of gillnets were set in total, 5070 salmon were caught, including 2214 chum, 1050 sockeye, 1034 pink, 548 coho, 183 chinook and 41 masu salmon.

Introduction

MagadanNIRO and VNIRO conducted collaborative research cruise to evaluate distribution, time of migration, biological structure and relative abundance of salmon recruits during pre-spawning migrations from the northwest part of the Pacific Ocean to the Sea of Okhotsk. Essential tasks of the research included the following: 1 – collection of materials characterizing abundance, species composition, feeding and biological structure; 2 – collection of data to be used as biological markers for identification of regions of salmon origin and evaluation of anatomic and physiological condition of gonads (samples of scales and otoliths, phenodeviants of gonads structure).

Research Area and Period

Driftnet salmon survey was conducted in the Pacific Ocean and the Sea of Okhotsk from 06/04 until 08/06/2002. The work sequence was as follows: Northern Okhotsk Sea Sub-zone (06/04-23) 51°06' – 55°02' N and 152°05' – 153°26' E; Petropavlovsk-Komandor Area (06/27-07/02) 52°01' – 52°27' N and 161°15' – 163°38' E; North Kurils Area (07/04 – 07/16) 49°43' – 50°47' N and 158°10' – 158°40' E; Northern Okhotsk Sea Sub-zone (07/20 – 08/01) and South Kurils Area (08/03 – 08/06) 44°35' – 46°34' N and 152°50' – 154°40' E (Fig. 1, Table 1).

Methods

The research included temperature conditions control of 10-meter surface layer, daily biological analysis of all trapped salmon, collection of mass samples of chum salmon otoliths to determine percentage of marked fishes, evaluation of stomach content and gonads condition. Salmon were caught by drift gillnets. 55 stations of gillnets were set in total, 5070 salmon were caught, including 2214 chum, 1050 sockeye, 1034 pink, 548 coho, 183 chinook and 41 masu salmon. All caught salmon were subjected to biological analysis. Samples of scales were taken from all salmon. Otoliths were collected from 1200 chum salmon. Except for masu, all analyzed salmonid fishes were checked for anomalies in gonads development. Otoliths were treated by conventional method (Nelson, Geen, 1981).

Results and Discussions

1. Salmon Catches

Chum salmon. Chum occurred in catches during the whole period of survey. In June (06/04-20), catches in the Northern Okhotsk Sea Sub-zone were represented mainly by chum salmon. In June, catches per effort varied from 0.6 (06/04) to 19.5 (06/09) ind./net, in July – from 3.9 (07/26) to 8.1 (07/25) ind./net. In the Northern Okhotsk Sea Sub-zone, aggregate portion of chum in catches reached 32.3%.

In late June – early July, catches of chum in the Petropavlovsk-Komandor Sub-Zone made up more than a half of all caught fish – 50.9%. Net catches varied from 4.1 (06/28) to 9.4 (06/27) ind./net.

In July, portion of chum in catches in the North Kurils Area amounted to 62.4%, catches per effort – from 4.5 (07/04) to 7.4 (07/10) ind./net. In the South Kurils Area portion of chum in early July made 38.7%, catches – 2.8 (08/04) – 5.3 (08/06) ind./net.

In the Northern Okhotsk Sea Sub-zone catches of chum were gradually reducing by late June, thus indicating the ending of pre-spawning migration of early form. High level of catches in June, as against that in July, was caused

by higher abundance of early form of chum. This fact was later confirmed by the data on spawning runs of both early and late forms of chum.

High abundance of chum in the Petropavlovsk-Komandor Sub-zone and the South Kurils Zone in July indicates the beginning of late chum migration.

Generally, chum was dominant background species in driftnet salmon catches during the entire period of survey.

Sockeye salmon. Sockeye occurred in catches from July 7 until August 1. Highest catches were registered in the Petropavlovsk-Komandor Area – from 3.1 (06/27) to 7.5 (07/02) ind./net and the North-Kurils Area – from 0.5 (07/04) to 10.0 (07/08) ind./net. In these areas portion of sockeye amounted to 35.0% and 19.5% of total catch respectively. In the southwestern part of the Northern Okhotsk Sea Sub-Zone, sockeye began to sporadically occur in early June – 0.1 ind./net. Portion of sockeye in catches in this area reached 22.6%. Maximum catches, up to 8.5 ind./net, were recorded in July 21-23. Considering time of migration and abundance of sockeye spawning stocks in the basin of the Okhotsk Sea, it can obviously be concluded that inconsiderable in number sockeye populations of the northern coast of the Okhotsk Sea and northwestern Kamchatka spawn in June. In July, biggest part of sockeye in the Okhotsk Sea was presumably represented by population of Ozernovskaya River. No sockeye were observed in South-Kurils Zone.

Pink salmon. Pink salmon occurred in catches from June 12 until the end of the research work. Catches per effort in the Northern Okhotsk Sea Sub-zone varied from 0.2 (08/01) to 1.5 (06/15) ind./net. In the Petropavlovsk-Komandor and the North Kurils sub-zones pink salmon catches were approximately the same and varied from 0.1 (07/01) to 1.7 (07/08) ind./net. Highest catches were registered in the South Kurils Zone: from 0.3 (08/04) to 2.3 (08/06) ind./net. Portion of pink salmon in catches amounted to 9.7% – 35.0% of the total catch in different areas.

Coho salmon. Coho began to occur in catches in the North Kurils Sub-zone. Catches varied from 0.1 (07/12) to 0.6 (07/15) ind./net. Higher level of driftnet catches was observed in the Northern Okhotsk Sea Sub-zone – from 0.7 (07/24) to 2.1 (07/28) ind./net. Portion of coho in catches in the North Kurils Sub-zone made up 5.3%, in the Northern Okhotsk Sea Sub-zone – 12.9%, in the South Kurils Sub-zone – 26.3%.

Chinook salmon. Chinook sporadically occurred in catches in all the sub-zones. Minimum [0.01 ind./net (06/05)] and maximum [0.3 ind./net (06/09)] catches were registered in the Northern Okhotsk Sea Sub-zone. On the average, catches in all sub-zones fluctuated from 0.04 (North Kurils) to 0.05 (Northern Okhotsk Sea Sub-zone) ind./net. Portion of chinook in catches did not exceed 5.3%.

Masu salmon. Masu occurred only in southwestern part of the Northern Okhotsk Sea Sub-zone, as their main spawning grounds are located in the rivers of southwestern Kamchatka. Masu was sporadic in catches. All caught individuals were represented by adult mature fishes. Portion of masu in catches amounted to 1.8%.

2. Biological Data

Chum salmon. Early form of chum salmon occurred in catches in southeastern part of the Northern Okhotsk Sea Sub-zone in June. This is proved by typically small size and weight values – 59.4 cm and 2.69 kg as an average. Recruits of bigger late form averaged 60.7 cm and 3.15 kg and made up most of the catches in the Northern Okhotsk Sea Sub-zone and other sub-zones in July-August (Table 6). Portion of female chum in this sub-zone increased in June from 39.5% to 56.0%, in July – from 36.0% to 60.1%. Size and weight characteristics of chum in the Petropavlovsk-Komandor and the North Kurils sub-zones - 60.3 cm and 3.01 kg (Tables 7-8), indicate that chum were represented by both early and late forms. Portion of females in these areas amounted to 57.4% and 55.2% respectively. In the South-Kurils Sub-zone, prevailed late (fall) chum with typical appearance and bigger size and weight – 62.9 cm and 3.26 kg (Table 9). Portion of females made up 52.6%.

Among sampled chum of both seasonal races of the Northern Okhotsk Sea, Petropavlovsk-Komandor and North Kurils sub-zones dominating were fifth-year fishes (4+) – 55.4-61.0%. Chum of the South Kurils zone were an exception with prevailing fourth-year fishes – (3+) – up to 76.3%.

Highest abundance of immature fishes (gonad maturation stage II) was observed in the Northern Okhotsk Sea Sub-zone in June – up to 43%, in July their portion reduced to 4%, and no fish of this category occurred in catches in August. In the Petropavlovsk-Komandor Sub-zone portion of immature fishes amounted to 43%, North Kurils Sub-zone – 24%, South Kurils Sub-zone – 8% (Table 6-9).

Dominating in all explored areas were fishes with gonads at III (25.6 – 44.7%) and III-IV (37.7-50%) maturation stages. From the beginning to the end of migration, gonadosomatic index (GSI) of males in the Northern Okhotsk Sea Sub-zone varied from 2.03 – 2.17 in early June up to 4.45 – 5.04 in late July; GSI of females within the same

time period – from 5.65-5.68 to 8.66-10.58. GSI of chum in the Petropavlovsk-Komandor and North Kurils sub-zones were quite the same: males – 2.98-3.63, females – 6.44-7.89. In the South Kurils Sub-zone variations of GSI for the males were 3.41-3.52, females – 6.43 – 6.78.

Hyperiidae, euphausiidae, pteropods, squid fry, fishes, crab larvae, tunicates and shrimps (Tables 10-13) were observed in chum stomachs. Feeding intensity in all areas was not high – 1-1.5 (Tables 14-17).

Sockeye salmon. Sockeye occurred in catches in all explored sub-zone, except for the South Kurils Sub-zone. Relatively small sockeye were migrating in the Northern Okhotsk Sea Sub-zone in June – 57.9 cm and 2.63 kg, in July their size and weight values increased to 59.2 cm and 2.97 kg (Table 18). In other sub-zones sockeye size and weight were represented by intermediate values (Table 19-20). In the Northern Okhotsk Sea Sub-zone portion of females had been increasing from 40.4 to 51.8% from the first decade of June till late July. Being typical for the first half of the pre-spawning migration, portion of females in the Petropavlovsk-Komandor Sub-zone was 41.7%, in the North Kurils Sub-zone – 48.2%. Sockeye catches were represented by 9 age groups. Dominant were individuals with three years of sea life at the age of 1.3 and 2.3. Their portion in catches varied from 81.2 (North Kurils Sub-zone) to 91.6% (Northern Okhotsk Sea Sub-zone). Portion of immature fishes in the Northern Okhotsk Sea Sub-zone was only 3%. In the Petropavlovsk-Komandor Sub-zone immature sockeye made 28% of catches, in North Kurils Sub-zone – up to 9%. Biggest part of sockeye had gonads at III maturation stage in June – 71.3% in the Petropavlovsk-Komandor and 76.2% in the North Kurils sub-zones. In July, portion of such fishes reduced to 51.1%, however, portion of sockeye with gonads at the IV maturation stage increased to 46.4%. From the beginning until the end of migration GSI of males in the Northern Okhotsk Sea Sub-zone had been changing from 1.25-1.75 to 2.06-2.93, GSI of females – from 3.42-3.77 to 5.88-6.84 (Table 18). In the Petropavlovsk-Komandor and North Kurils sub-zones GSI values appeared to be relatively the same and were 1.14-1.50 for males and 4.63-6.43 for females (Tables 19-20). Feeding spectrum of sockeye was quite wide: stomachs were filled with hyperiidae, euphausiidae, crab larvae, fishes (Tables 21-23). Index of fullness was not high – 1.0-1.7 (Tables 24-26).

Pink salmon. In the Northern Okhotsk Sea Sub-zone the length of pink salmon averaged 47.4 cm, weight 1.48 kg. In the Petropavlovsk-Komandor and North Kurils sub-zones pink salmon had similar body length – 48.5 cm and 47.7 cm with an average weight of 1.61 kg and 1.49 kg respectively. Largest were pink salmon of the South Kurils Sub-zone – 50.4 cm and 1.77 kg. All pink salmon individuals had gonads of III, III-IV maturation stages. From early June till late July, GSI of males in Northern Okhotsk Sea Sub-zone was changing from 2.39-2.51 to 5.34-6.16, GSI of females – from 4.59-6.90 to 8.19-10.40. In the Petropavlovsk-Komandor Sub-zone GSI of pink salmon was higher than that of pink salmon in the South Kurils Sub-zone, probably due to shorter migration route of examined group to the coast of Eastern Kamchatka. GSI of males was 5.13 and 1.56, females – 10.75 and 6.43 respectively. GSI of pink salmon in the South Kurils Sub-zone was 3.52 for males and 7.30 for females. Pink salmon recruits preferred to feed on plankton organisms, basically hyperiidae and euphausiidae. Occasionally, crab larvae and squid fry were found in stomachs. Average stomach fullness varied from 1.0 to 2.3.

Coho salmon. In the Northern Okhotsk Sea Sub-zone and other sub-zones prevailing were coho of relatively small size and weight – 59-61 cm and 2.9-3.3 kg. Such size and weight values are typical for coho of Kamchatka populations. Coho of the northern Okhotsk Sea populations are usually larger. Portion of females in the North Kurils Sub-zone amounted to 47.1%, in the South Kurils Sub-zone – 51.7%, in the Northern Okhotsk Sea Sub-zone – 53.0%.

Age composition of coho was represented by three age groups – 1.1, 2.1 and 3.1. Dominating were fishes at the age of 1.1 and 2.1 – from 51.6% to 70.0%. Immature coho were observed only in the North Kurils and the South Kurils sub-zones – 1.5% and 1.7% respectively. In all examined areas dominating were fishes at III and III-IV gonad maturation stages – 81%-92%. In the North Kurils Sub-zone GSI of males amounted to 2.46, that of females – 4.06; in the South Kurils Sub-zone – 4.06 and 5.41 respectively. During July, GSI of males in the Northern Okhotsk Sea Sub-zone had been increasing from 2.46 to 4.19, GSI of females – from 4.07 to 6.16. Coho stomachs were found to be filled with fish (char, herring, greenlings), crustaceans, and squid fry. Feeding intensity varied from 1.2 to 2.5.

Chinook salmon. Length and weight of chinook in the Northern Okhotsk Sea Sub-zone in June averaged 68.5 cm and 3.93 kg. In July, these values averaged 66.5 cm and 4.27 kg. Length of chinook in the Petropavlovsk-Komandor Sub-zone in late June – early July averaged 74.9 cm, weight – 6.62 kg. For the North Kurils Sub-zone these values were 64.7 cm and 3.81 kg.

Chinook were represented by four age categories. Prevailing in all areas were individuals at the age of 1.2 and 1.3 – 75-95%.

In June, mature chinook mainly occurred in the Northern Okhotsk Sea Sub-zone, immature individuals made up 4.0%. In July, majority of chinook (94.9%) was represented by immature fishes. Biggest portion of immature chinook in examined regions of the Pacific Ocean was observed in the North Kurils Sub-zone – 87.2%, their portion

in the Petropavlovsk-Komandor Sub-zone made 10%. In early June, GSI of chinook males in the Northern Okhotsk Sea Sub-zone was 1.83-2.76, that of females – 8.78-10.47, in July – 4.61-5.05 and 8.40-11.12 respectively. GSI for the Petropavlovsk-Komandor and the North Kurils sub-zones corresponded to GSI values recorded in July for the Northern Okhotsk Sea Sub-zone.

Chinook fed on crustaceans (hyperiidae and euphausiidae) and fish (char, herring, capelin) and squid fry. Average stomach fullness varied from 1.3 to 3.5.

Masu salmon. Masu salmon were characterized by small size and weight values – 45-50 cm and 1.5-2.0 kg. Average size of masu made 48.5 cm, weight – 1.80 kg. Males prevailed in catches – 78.0%. Age structure of masu was represented by three classes: 1.1, 2.1 and 2.2. Individuals with two freshwater and one saltwater years of life were dominant (2.1) – 58.5%. Masu was found to be feeding on euphausiids and fish. Feeding intensity averaged 1.0.

Temperature of 10-meter surface layer in surveyed regions fluctuated within the following limits: Northern Okhotsk Sea Sub-zone – from 2.0 (06/04) to 11.4 (08/01); Petropavlovsk-Komandor Sub-zone – from 4.5 (06/27) to 5.0 (07/02); North Kurils Sub-zone – from 5.6 (07/04) to 7.4 (07/15); South Kurils Sub-zone – from 9.4 (08/03) to 10.5 (08/05).

3. Anomalies and Abnormalities in Development of Gonads

Numerous analyses were conducted in all examined regions in order to evaluate anatomic abnormalities in development of gonads of all salmon species, excluding masu. All main identified phenodeviants can be referred to anomalies that reduce reproductive potential: folds, overlaps, twisted ejaculatory ducts, constrictions, fragmentary segmentation into lobes, juvenility of one of the gonads, etc. (Fig. 2-7). All aforementioned changes are typical mainly for males. Occurrence of females with similar abnormalities is rather insignificant (Table 27).

In the Petropavlovsk-Komandor Sub-zone portion of males with gonad anomalies, without regard for species, made up 52.1%, females – 1.6%. Same with regard for species: sockeye – males 47.1%, females 4.3%; chum – males 52.3%, females 0.6%; pink salmon – males 53.4%, females 0.0%; chinook – males 75.0%, females 0.0%. Biggest portion of males with anomalies in development of gonads falls at the mass age groups: for instance, 1.3 and 2.3 for sockeye and 3+ and 4+ for chum.

Portion of males with phenodeviants of testes in the North Kurils Sub-zone was also high: 55.8% for sockeye, 67.6% for chum, 37.6% for pink and 50.0% for coho. No females with phenodeviants of ovaries were observed.

Portion of fishes with abnormal gonads in the Northern Okhotsk Sea Sub-zone was high: sockeye – males 60.9%, females 0.7%; chum – males 65.8%, females 1.1%; pink – males 59.7%, females 0.0%; coho – males 80.9%, females 0.0%.

Portion of all salmonid species males with abnormal testes in the South Kurils Sub-zone was higher than that in the northern regions of the Pacific Ocean and the Okhotsk Sea: 92.1% for coho, 84.8% for chum, 65.8% for pink (Table 27).

Phenodeviants of testes are typical for males of all species of the Pacific salmon occurring in the Russian area: rivers of Sakhalin, coast of the northern part of the Okhotsk Sea, Primorie, western coast of Kamchatka Peninsula, East Sakhalin Sub-zone of the Okhotsk Sea (Mikodina, Pukova, Klovach, 1999; Mikodina, Kovalenko, Demyanov, 2000; Mikodina et al., 2000; Mikodina et al., 2001; Gritsenko et al., 2001; Pukova, 2002). Sporadic anomalies of chum and sockey testes and ovaries structure were registered in the northwest Pacific (Shershneva, Vvedenskaya, 2001).

It should also be noted that the number of gonads greatly reduces (two or three times) by the end of pre-spawning migration (Mikodina, Kim, 2000) and in the rivers (Pukova, 2002). Presumably, numerous anomalies in development of testes are caused by allometry of growing gonads, which obviously get leveled in the process of growth and maturation. However, different adverse impacts, such as anthropogenic pollution of water and artificial reproduction should also be taken into account.

4. Results of Analysis of Chum Salmon Otoliths Structure

Out of 1200 examined chum otoliths 7 were identified to be marked at salmon hatcheries of the Magadan Region. One otolith belonged to chum released from the Yana hatchery at the age of 5+ (Fig. 8). Other six otoliths were marked at the Ola Pilot Acclimatization and Production Station (Fig. 9). Otoliths were labeled by thermal marking – reduction of water temperature by 2.5°C in the first case and increasing water temperature by 3.5°C in the second case.

Mark of chum from the Yana hatchery consisted of 6 rings (Rbr 1:[1.6]).
Mark of the Ola hatchery chum consisted of 3 rings (Rbr 1:[1.3] and 2:[1.3]) with one interval between the rings slightly wider than the others. Marking was conducted stepwise at the embryonic and larval stages of development. 11.5 million fry bearing such mark (Fig. 9) were released. Part of fry were released to the base hatchery river, another part was released to the coastal zone of Ghertnera Bay after being raised in marine nursery ponds. Over a period of years it was noted that high rate of return was peculiar to fishes raised in marine enclosures. This fact was confirmed by our results.

In our opinion, the occurrence of such number of marked individuals from relatively small release at open sea, indicates good survivability of this chum generation (1996). At the same time, the return of adult fish to origin rivers is not very high and does not exceed 10%.

Low occurrence of fish released from hatcheries of the Magadan Region is due to insignificant quantity of released marked fry and the large number of unmarked fish constituting other far-eastern stocks in mixed spawning aggregations of chum.

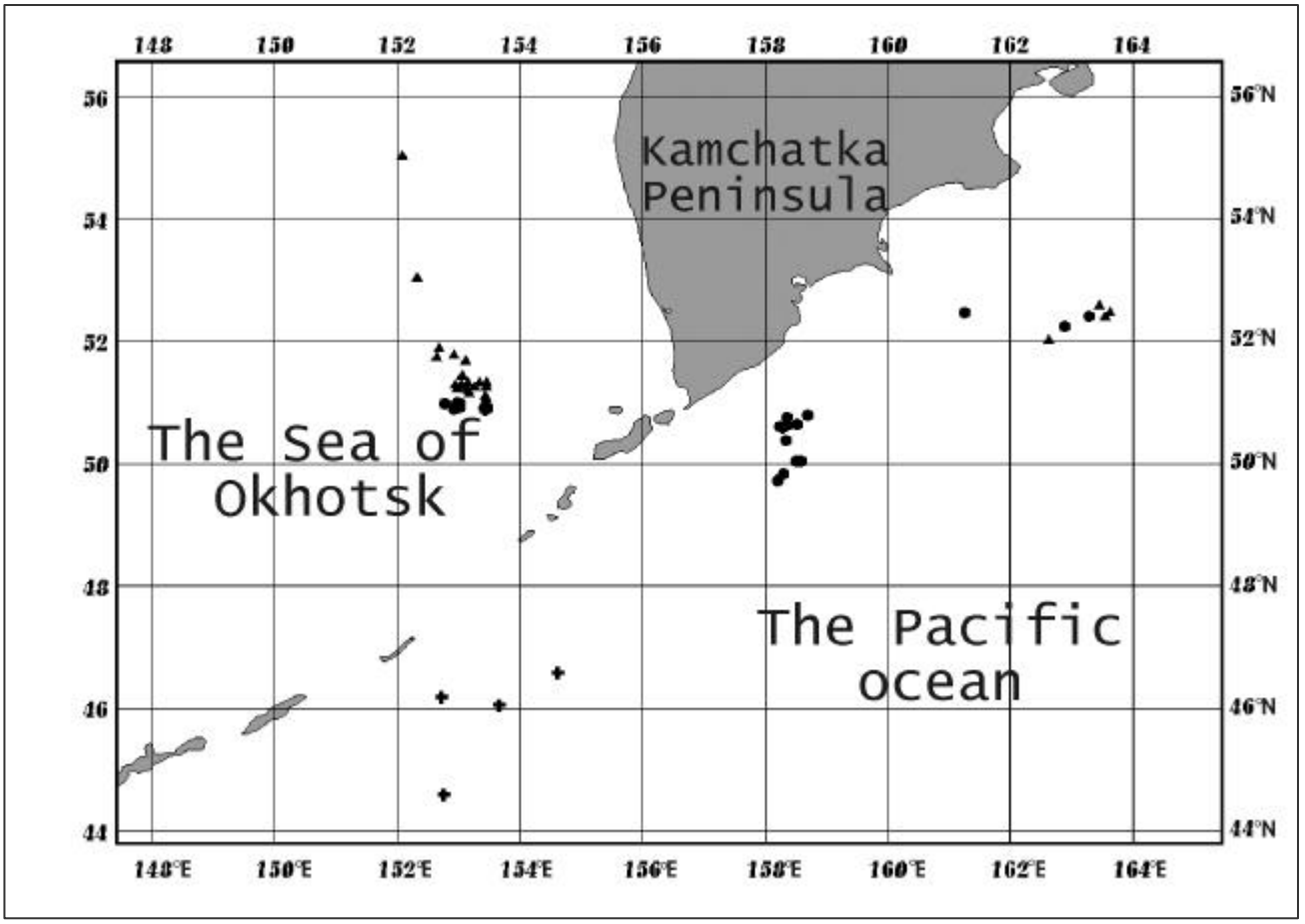

Fig. 1. Map of area surveyed in 2001

▲ - Drifts in June; ● - Drifts in July; ✚ Drifts in August

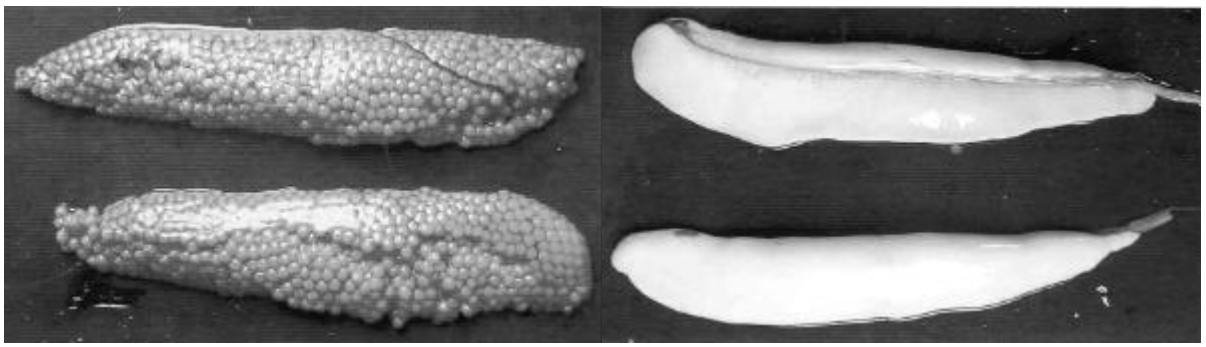

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Fig. 2. Normal gonads morphology of the Pacific salmon
A – females, B – males

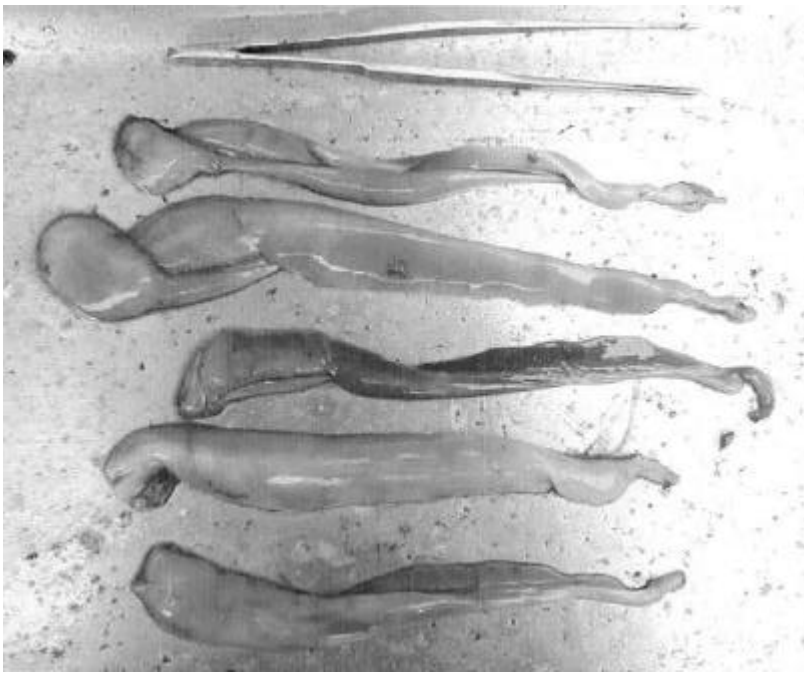

Fig. 3. Folds and twists in the forepart and backend of salmon testes

Fig. 4. "Wrinkled" surface of chum testes induced by multiple minor scars caused by small superficial focal points of resorption of generative tissue

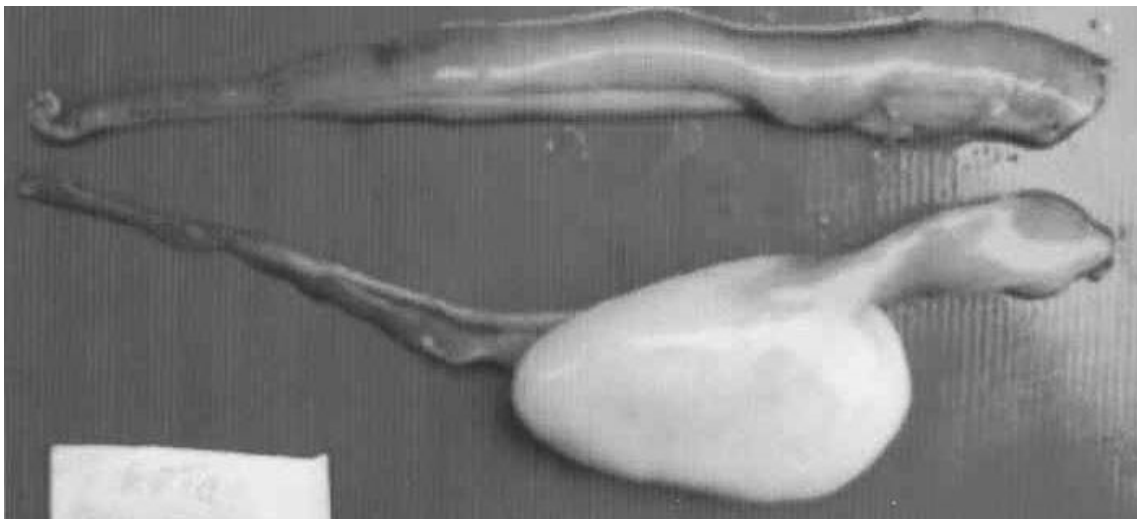

Fig. 5. Tumor of the right testis of chum with degenerated caudal part

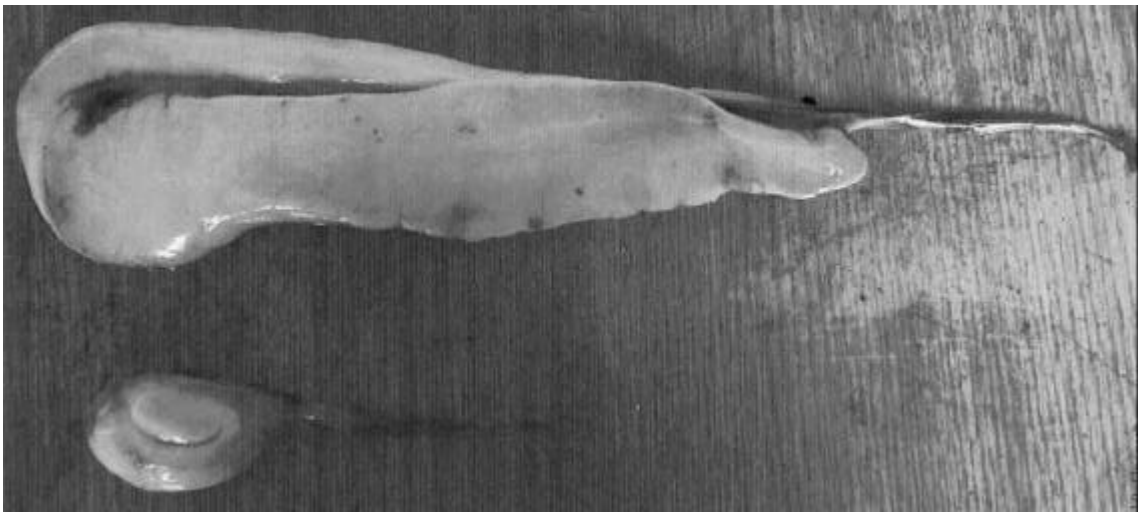

Fig. 6. Left testis of coho in a form of an egg-shaped formation with superficial lobe. Right testis folded, forepart twisted.

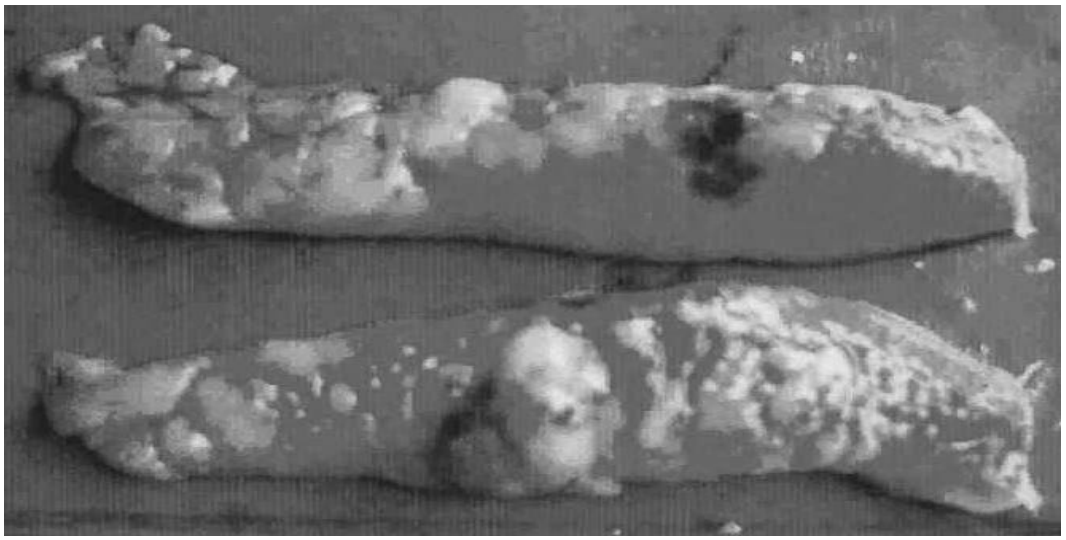

Fig. 7. Testes with lipomata and haematoma

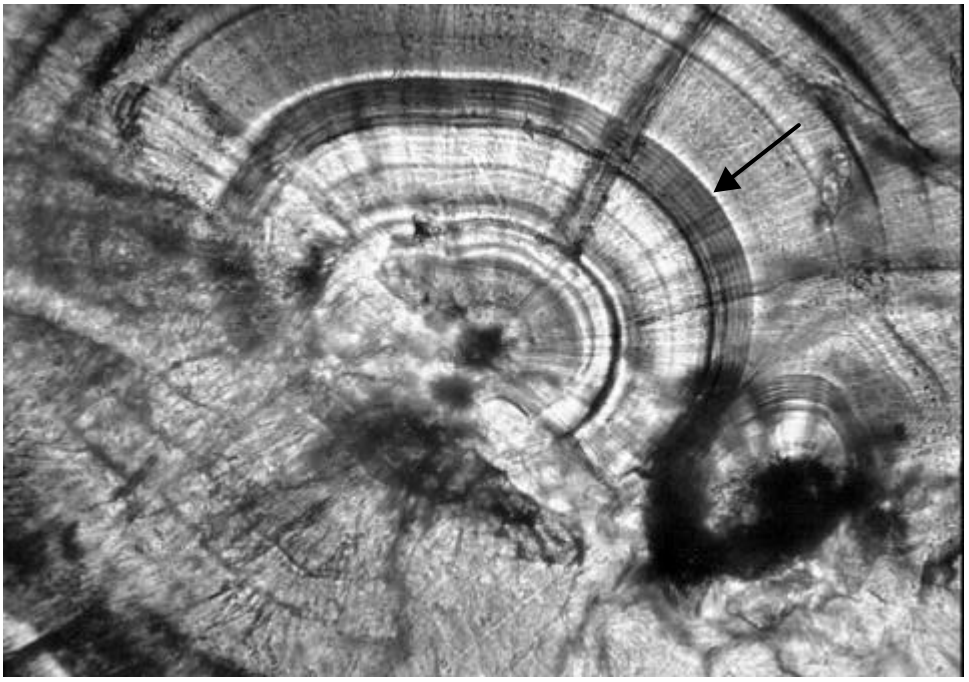

Fig. 8. Sample of mark on the otolith of chum made at the Yana hatchery

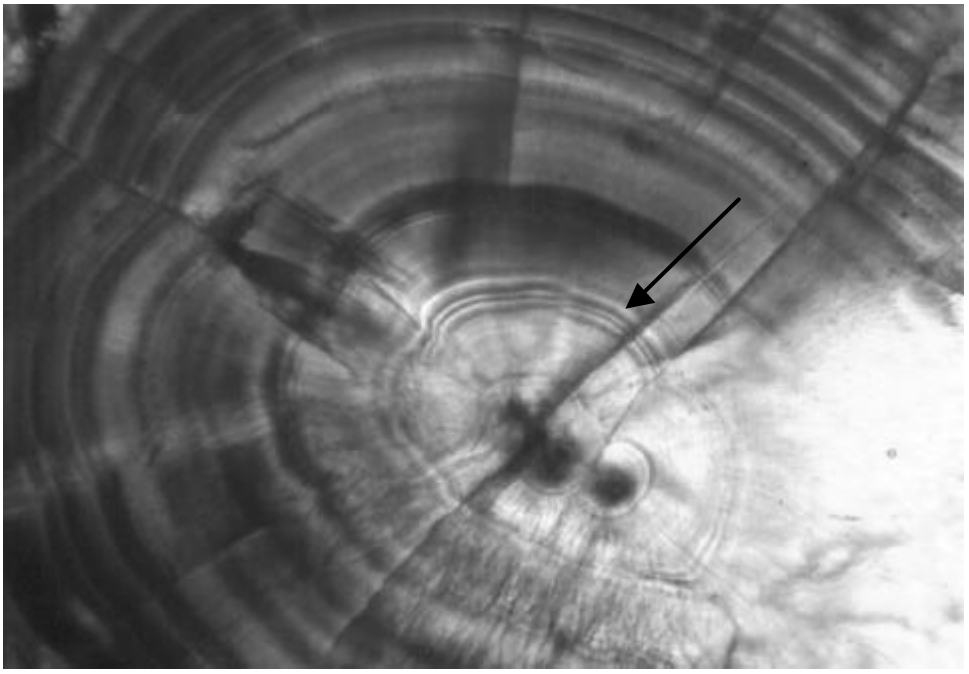

Fig. 9. Sample of mark on the otolith of chum made at the Ola hatchery

Table 1

Coordinates of driftnets

Station	Date	N	?	Course (?)	t°C
1	4.06	55º02'	152º05?	270	2,0
2	5.06.	53º02?	152º20?	90	2,9
3	6.06	51º53?	152º41?	90	3,6
4	7.06	51º41?	153º07?	270	5,4
5	8.06	51º17?	152º57?	90	5,4
6	9.06	51º16?	153º02?	90	5,6
7	10.06	51º17?	153º15?	90	5,5
8	11.06	51º20?	153º09?	90	5,3
9	12.06	51º26?	153º03?	90	5,0
10	13.06	51º13?	152º59?	90	4,6
11	14.06	51º12?	153º09?	90	3,3
12	15.06	51º09?	153º10?	90	4,1
13	16.06	51º15?	153º16?	90	4,8
14	17.06	51º19?	153º20?	270	5,7
15	18.06	51º44?	152º39?	270	6,3
16	19.06	51º47?	152º55?	90	5,4
17	20.06	51º20?	153º27?	270	5,4
18	21.06	51º15?	153º19?	270	5,6
19	22.06	51º03?	153º27?	270	5,7
20	23.06	51º06?	153º26?	270	5,0
21	27.06	52º01?	162º37?	30	4,5
22	28.06	52º28?	163º38?	220	4,6
23	29.06	52º24?	163º33?	220	4,8
24	30.06	52º35?	163º27?	220	5,0
25	01.07	52º24?	163º17?	210	5,0
26	02.07	52º14?	162º53?	30	5,0
27	04.07	52º27?	161º15?	20	7,4
28	05.07	50º44?	158º21?	210	5,6
29	06.07	49º50?	158º18?	210	6,0
30	07.07	50º36?	158º21?	30	7,6
31	08.07	50º47?	158º41?	210	6,8
32	09.07	50º37?	158º31?	40	6,4
33	10.07	50º34?	158º17?	20	5,2
34	11.07	50º35?	158º14?	20	5,2
35	12.07	50º22?	158º20?	210	5,4
36	13.07	49º43?	158º12?	30	5,8
37	14.07	50º02?	158º30?	20	6,0
38	15.07	50º02?	158º33?	20	6,8
39	16.07	50º02?	158º35?	20	7,4
40	20.07	50º54?	153º01?	90	8,5
41	21.07	50º56?	153º00?	90	8,4
42	22.07	50º59?	152º59?	90	8,4
43	23.07	50º58?	152º59?	90	8,4
44	24.07	50º58?	153º01?	90	8,6
45	25.07	50º58?	152º47?	90	8,8
46	26.07	50º54?	152º57?	90	9,6
47	28.07	50º53?	153º28?	270	9,6
48	29.07	50º55?	153º01?	90	9,6
49	30.07	50º53?	153º25?	270	10,4
50	31.07	50º52?	152º55?	90	11,2
51	01.08	50º52?	153º27?	270	11,4
52	03.08	46º34?	154º38?	220	9,4
53	04.08	46º03?	153º41?	230	10,0
54	05.08	46º11?	153º01?	30	10,5
55	06.08	46º02?	152º44?	40	10,2

Table 2

Materials collected in the Northern Okhotsk Sea Sub-zone
(July 4 – 23, July 20 – August 1, 2001)

Species	Number of individuals	Number of food analyses	Stomachs examined	Phenodeviants of gonads
Chum	750	6	150	300
Sockeye	525	9	275	274
Pink	580	12	228	228
Coho	300	12	300	300
Chinook	123	4	59	-
Masu	41	2	12	-

Table 3

Materials collected in the Petropavlovsk-Komandor Sub-zone
(June 27 – July 2, 2001)

Species	Number of individuals	Number of food analyses	Stomachs examined	Phenodeviants of gonads	Otoliths
Chum	400	7	400	297	400
Sockeye	275	7	274	155	-
Pink	91	5	90	90	-
Chinook	20	5	19	19	-

Table 4

Materials collected in the North Kurils Sub-zone
(July 4-15, 2001)

Species	Number of individuals	Number of food analyses	Stomachs examined	Phenodeviants of gonads	Otoliths
Chum	800	6	400	799	800
Sockeye	250	10	250	250	-
Pink	124	9	124	124	-
Coho	68	3	68	68	-
Chinook	40	7	38	-	-

Table 6

Materials collected in the South Kurils Sub-zone
(August 3-6, 2001)

Species	Number of individuals	Number of food analyses	Stomachs examined	Phenodeviants of gonads
Chum	264	3	76	264
Pink	239	3	61	239
Coho	180	3	60	180

Table 6

Dynamics of biological characteristics of chum, Northern Okhotsk Sea Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								average	empty, %
4-10.06.01	males	81	54	31	60.5	2.77	2.03	1.1	81.5
	females	69	46	10	59.2	2.59	5.65	1.0	81.2
11-15.06.01	males	48	63	29	59.3	2.75	2.17	1.6	54.2
	females	28	37	14	58.4	2.59	5.68	1.2	39.3
16-20.06.01	males	62	50	23	59.0	2.75	2.21	1.1	88.7
	females	61	50	7	58.1	2.56	5.83	1.2	90.2
21-25.06.01	males	26	52	23	60.3	2.91	2.29	1.0	96.2
	females	24	48	8	59.3	2.74	6.88	1.0	83.3
20.07.01	males	16	64	0	61.6	3.34	4.45	1.7	81.3
	females	9	36	0	60.6	3.09	8.69	1.3	66.7
21-25.07.01	males	46	37	13	61.3	3.17	3.34	1.9	80.4
	females	79	63	0	60.8	3.14	6.32	1.6	77.2
26-31.07.01	males	50	40	4	60.9	3.25	5.07	1.3	86.0
	females	75	60	0	60.1	3.05	8.66	1.4	74.7
01.08.01	males	8	32	0	63.9	3.69	3.84	-	100.0
	females	17	68	0	59.5	3.03	10.58	1.0	94.1

Table 7

Dynamics of biological characteristics of chum, Petropavlovsk-Komandor Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								average	empty, %
26-30.06.01	males	95	48	36	61.0	3.14	3.43	1.2	44.2
	females	104	52	7	59.2	2.76	6.44	1.2	35.3
1-05.07.01	males	28	33	11	60.9	3.11	3.15	1.3	63.0
	females	58	67	0	59.4	2.74	6.55	1.2	52.6

Table 8

Dynamics of biological characteristics of chum, North Kurils Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								average	empty, %
1-05.07.01	males	54	54	15	60.0	3.05	2.98	1.1	44.4
	females	46	46	9	59.1	2.85	6.45	1.2	32.6
6-10.07.01	males	79	40	17	60.5	3.08	3.63	1.0	74.7
	females	120	60	3	60.2	3.00	7.89	1.0	76.7
11-15.07.01	males	225	45	17	60.6	3.09	3.43	1.2	85.9
	females	275	55	0	60.2	2.98	6.75	1.1	81.2

Table 9

Dynamics of biological characteristics of chum, South Kurils Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								average	empty, %
1-05.08.01	males	24	47	0	63.3	3.28	3.41	1.0	75.0
	females	27	53	4	62.3	3.14	6.43	1.1	59.3
6-10.08.01	males	12	48	0	64.4	3.58	3.52	1.0	83.3
	females	13	52	8	62.4	3.24	6.78	1.0	92.3

Table 10

Frequency of occurrence of food components in chum stomachs, Northern Okhotsk Sea Sub-zone

Food components	June		July		August	
	Specimens	%.	%	%	Specimens	%
Cephalopods	7	6.4	-	-	-	-
Appendiculariae	27	24.6	-	-	-	-
Gammariidae	4	3.6	-	-	-	-
Crustaceans	11	10.3	37	64.9	1	100.0
Euphausiidae	44	40.0	7	12.3	-	-
Fish	2	1.8	1	1.8	-	-
Hyperiidae	4	3.6	-	-	-	-
Unidentified	11	10.0	12	12.1	-	-

Table 11

Frequency of occurrence of food components in chum stomachs, Petropavlovsk-Komandor Sub-zone

Food components	June		July	
	Specimens	%	Specimens	%
Cephalopods	3	3.0	1	2.1
Gammariidae	-	-	1	2.1
Crustaceans	41	41.4	11	23.4
Euphausiidae	3	3.0	1	2.1
Hyperiidae	-	-	2	4.3
Plankton	13	13.1	24	51.1
Unidentified	39	39.4	7	14.9

Table 12

Frequency of occurrence of food components in chum stomachs, South Kurils Sub-zone

Food components	July	
	Specimens	%
Cephalopods	2	1.0
Gammariidae	2	1.0
Crustaceans	38	19.8
Jellyfish	1	0.5
Pteropods	21	10.9
Plankton	47	24.5
Polychaete	1	0.5
Unidentified	80	41.7

Table 13

Frequency of occurrence of food components in chum stomachs, South Kurils Sub-zone

Specimens	August	
	Specimens	%
Crustaceans	2	10.5
Euphausiidae	1	5.3
Plankton	12	63.2
Unidentified	4	21.1

Table 14

Intensity of chum feeding, Northern Okhotsk Sea Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimens
	0	1	2	3	4		
1-05.06.01	68.0	28.0	4.0	0.0	0.0	1.1	50
6-10.06.01	81.3	18.0	0.7	0.0	0.0	1.0	150
11-15.06.01	48.6	32.9	13.2	5.3	0.0	1.5	76
16-20.06.01	89.5	8.9	1.6	0.0	0.0	1.2	123
21-25.06.01	90.0	10.0	0.0	0.0	0.0	1.0	50
16-20.07.01	76.0	16.0	4.0	4.0	0.0	1.5	25
21-25.07.01	78.4	11.2	7.2	2.4	0.8	1.7	125
26-31.07.01	79.2	13.6	7.2	0.0	0.0	1.4	125
1-05.08.01	96.0	4.0	0.0	0.0	0.0	1.0	25

Table 15

Intensity of chum feeding, Petropavlovsk-Komandor Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimens
	0	1	2	3	4		
26-30.06.01	39.6	50.3	9.6	0.5	0.0	1.2	197
1-05.07.01	56.0	34.5	8.3	1.2	0.0	1.2	84
16-20.07.01	80.0	16.0	3.0	1.0	0.0	1.3	100

Table 16

Intensity of chum feeding, North Kurils Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimen
	0	1	2	3	4		
1-05.07.01	39.0	54.0	7.0	0.0	0.0	1.1	100
6-10.07.01	75.9	23.6	0.5	0.0	0.0	1.0	199
11-15.07.01	83.4	14.0	2.6	0.0	0.0	1.2	420

Table 17

Intensity of feeding, South Kurils Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimen
	0	1	2	3	4		
1-05.08.01	66.7	31.3	2.0	0.0	0.0	1.1	51
6-10.08.01	88.0	12.0	0.0	0.0	0.0	1.0	25

Table 18

Dynamics of biological characteristics of sockeye, Northern Okhotsk Sea Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								Average	Empty, %
4-10.06.01	males	13	59	0	60.9	2.94	1.25	1.0	92.3
	females	9	41	0	54.7	2.12	3.77	-	100.0
11-15.06.01	males	34	57	3	58.5	2.67	1.75	1.7	64.7
	females	26	43	0	56.5	2.51	3.42	1.4	42.3
16-20.06.01	males	68	58	0	59.0	2.8	1.85	1.0	88.2
	females	49	42	0	56.4	2.44	4.30	1.1	81.6
21-25.06.01	males	34	68	0	58.2	2.68	1.82	1.0	97.1
	females	16	32	0	57.1	2.52	6.84	-	100.0
20-25.07.01	males	71	57	0	61.1	3.27	2.93	1.2	83.1
	females	53	43	0	57.5	2.7	4.70	1.1	86.8
26-31.07.01	males	47	47	0	60.0	3.11	1.97	1.6	89.4
	females	53	53	0	57.6	2.71	4.88	1.3	86.8
1.08.01	males	6	24	0	60.5	3.28	2.06	1.0	83.3
	females	19	76	0	58.4	2.86	5.88	1.0	89.5

Table 19

Dynamics of biological characteristics of sockeye, Petropavlovsk-Komandor Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								Average	Empty, %
26-30.06.01	males	63	63	25	59.8	3.13	1.14	1.3	42.9
	females	37	37	3	57.7	2.77	4.63	1.1	40.5
1-05.07.01	males	21	44	5	59.1	2.97	2.08	1.4	61.9
	females	27	56	4	56.7	2.61	3.59	1.2	48.2
16-20.07.01	males	16	64	25	58.1	2.66	-	-	100.0
	females	9	36	0	57.6	2.52	-	1.3	66.7

Table 20

Dynamics of biological characteristics of sockeye, North Kurils Sub-zone

Date	Sex	Number of individuals	Sex ratio, %	Percentage of immature individuals, %	Fork length, cm	Body weight, kg	GSI	Fullness of stomach, points	
								Average	Empty, %
1-05.07.01	males	35	71	3	59.1	2.94	1.50	1.0	62.9
	females	14	29	0	58.5	2.75	6.43	1.0	57.1
6-10.07.01	males	35	47	6	58.6	2.91	1.56	1.1	77.1
	females	40	53	3	56.7	2.61	5.52	1.0	70.0
11-15.07.01	males	59	47	3	59.7	3.01	1.74	1.0	83.1
	females	66	53	0	57.6	2.64	4.86	1.0	89.4

Table 21

Frequency of occurrence of food components in sockeye stomachs, Northern Okhotsk Sea Sub-zone

Food components	June		July		August	
	Specimens	%	Specimens	%	Specimens	%
Crustaceans	2	4.3	22	57.9	-	-
Euphausiidae	41	87.2	4	10.5	-	-
Fish	3	6.4	-	-	-	-
Plankton	1	2.1	11	29.0	2	66.7
Unidentified	-	-	1	2.6	1	33.3

Table 22

Frequency of occurrence of food components in sockeye stomachs, Petropavlovsk-Komandor Sub-zone

Food components	June		July	
	Specimens	%	Specimens	%
Cephalopods	11	20.0	3	11.5
Gammariidae	2	3.64	3	11.5
Crustaceans	23	41.8	10	38.5
Euphausiidae	15	27.3	2	7.7
Hyperiidae	-	-	3	11.5
Plankton	2	3.6	3	11.5
Unidentified	2	3.6	2	7.7

Table 23

Frequency of occurrence of food components in sockeye stomachs, North Kurils Sub-zone

Food components	July	
	Specimens	%
Gammariidae	5	8.9
Crustaceans	16	28.6
Euphausiidae	2	3.6
Fish	6	10.7
Pteropods	3	5.4
Plankton	8	14.3
Unidentified	16	28.6

Table 24

Intensity of sockeye feeding, Northern Okhotsk Sea Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimens
	0	1	2	3	4		
4-10.06.01	95.5	4.5	0.0	0.0	0.0	1.0	22
11-15.06.01	55.0	31.7	5.0	6.7	1.6	1.5	60
16-20.06.01	85.4	13.7	0.9	0.0	0.0	1.1	117
21-25.06.01	98.0	2.0	0.0	0.0	0.0	1.0	50
16-20.07.01	72.0	20.0	8.0	0.0	0.0	1.3	25
21-25.07.01	84.7	12.9	2.4	0.0	0.0	1.2	124
26-31.07.01	88.0	7.0	5.0	0.0	0.0	1.4	100
1.08.01	88.0	12.0	0.0	0.0	0.0	1.0	25

Table 25

Intensity of sockeye feeding, Petropavlovsk-Komandor Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimens
	0	1	2	3	4		
26-30.06.01	42.0	44.0	13.0	1.0	0.0	1.3	100
1-05.07.01	54.2	35.4	8.3	2.1	0.0	1.3	48
16-20.07.01	88.0	8.0	4.0	0.0	0.0	1.3	25

Table 26

Intensity of sockeye feeding, North Kurils Sub-zone, %

Date	Fullness of stomach, points					Average	N, specimens
	0	1	2	3	4		
1-05.07.01	61.2	38.8	0.0	0.0	0.0	1.0	49
6-10.07.01	73.3	25.3	1.3	0.0	0.0	1.1	75
11-15.07.01	86.4	13.6	0.0	0.0	0.0	1.0	125

Table 27

Portion of salmon with abnormalities in gonads, %

Species	Zone, sub-zone	Males			Females		
		Fish, total	Abnormal		Fish, total	Abnormal	
			Quant.	%		Quant.	%
Chum	Petropavlovsk-Komandor Sub-zone	130	68	52.3	167	1	0.6
	North Kurils Sub-zone	358	242	67.6	441	0	0.0
	Northern Okhotsk Sea Sub-zone	120	79	65.8	180	2	1.1
	South Kurils Sub-zone	125	106	84.8	139	0	0.0
Sockeye	Petropavlovsk-Komandor Sub-zone	85	40	47.1	70	3	4.3
	North Kurils Sub-zone	129	72	55.8	121	0	0.0
	Northern Okhotsk Sea Sub-zone	136	82	60.9	138	1	0.7
Pink	Petropavlovsk-Komandor Sub-zone	88	47	53.4	2	0	0.0
	North Kurils Sub-zone	109	41	37.6	15	0	0.0
	Northern Okhotsk Sea Sub-zone	181	108	59.7	47	0	0.0
	South Kurils Sub-zone	152	100	65.8	87	0	0.0
Coho	North Kurils Sub-zone	36	18	50.0	32	0	0.0
	Northern Okhotsk Sea Sub-zone	141	114	80.9	159	0	0.0
	South Kurils Sub-zone	89	82	92.1	91	0	0.0
Chinook	Petropavlovsk-Komandor Sub-zone	12	9	75.0	7	0	0.0

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