

INTRODUCTION INTO AYSEN, CHILE OF PACIFIC SALMON

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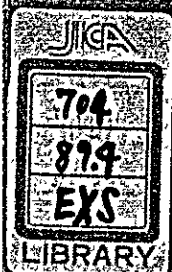
**Feeding Trials with Chum Salmon Fry (*Oncorhynchus keta*)
in Aysen, Chile, 1977 - 1979**

by
Akiyuki Nagasawa, E.
and
Hector Novoa, S.

1980

**SERVICIO NACIONAL DE PESCA
MINISTERIO DE ECONOMIA, FOMENTO Y RECONSTRUCCION
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Dedicated to my wife, my sons, my friends and Republic of Chile.

Dedicado a mi esposa, mis hijos, mis amigos y Republica de Chile.

Authors

Aliaky Nagasawa E. was assigned as expert from April 1977 to February 1980 to the Servicio Nacional de Pesca, Ministerio de Economía Fomento y Reconstrucción, Chile, by the JICA in the National Hokkaido Salmon Hatchery Service, Ministry of Agriculture and Fisheries, Sapporo, JAPAN.

Hector Novoa S. is a hatchery technologist in the Servicio Nacional de Pesca, XI Region, Coyhaique, Chile.

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Teatinos 120, 8-piso, Santiago de Chile

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1. SUMMARY

Three feeding trials were conducted with chum salmon (*Oncorhynchus keta*) in fresh water ponds in the winters of 1977 and 1979, 1978 in the summers at the Coyhaique Hatchery, Aysen, Chile. These eggs originated from the fall spawning run in the Hokkaido, Japan.

The purpose of the fry feeding experiments were to determine and evaluate the fish growth and survival in the winter season at the hatchery for the forthcoming comprehensive scheme which was launched in 1980.

The first feeding trial in 1977 was a test with 64,000 fry from 15 June to the end of September, the winter season in Chile. Average weight of the fry increased from 0.32 g to 1.74 g and length from 36 mm to 59 mm. A condition factor of 8.86 was shown. During period the cumulative temperature was about 666°C U.T. Feed conversion efficiency was 1.46. The fingerlings were liberated in the Simpson and El Salto rivers (Table 22) after the trial was finished, it was spring when in Aysen.

The second feeding trial in 1978 was almost fullscale, covering 1,641,000 fry from the sac-fry stage to swim-up, the incubator channels were used for a total 34 days in the summer, 20 January to 24 February. The cumulated temperature in this priod was 490° U.T. The average weight increased from 0.30 g to 1.24 g and length from 35 mm to 54 mm. Condition factor was 7.45. Mortalities were 8.6% during this period. Feed conversion efficiency was 1.02. These fish were liberated in the Simpson river on 24 February, near the end of the summer season in Aysen.

In the third feeding trial, ponds were used, facilities completed in 1976, for 173 days, 26 April to 15 October. The cumulative temperatures reached 915°C U.T. in this period. Average weight of the fry increased from 0.40 g to 3.60 g and length from 35 mm to 77 mm. Final condition factor was 9.96. Two types of feed were used, made in Japan and Chile, the efficiency was 1.22 and 2.17 respectively on the average each month, but the Chilean diet induced dropsy disease. Pond mortalities during this period were about 4.0%. The fingerlings were liberated in the spring in the Simpson river and Pajarrones stream connected with Ensenada Baja in Fjord Aysen near Puerto Chacabuco (Fig. 20).

Growth of chum salmon fry was excellent during prolonged rearing in fresh water and ensured successful production of fingerlings for release in the spring. Survival also was excellent.

Summer rearing showed rapid and excellent growth in a short time. Mortalities in summer feeding were higher than in winter feeding. Both are significantly influenced by the high level of temperature.

2. INTRODUCTION

Since 1974, chum salmon eggs from Japan were incubated in the Coyhaique Hatchery and the fry released in Simpson river. Each year-breed has a code name, as shown in Table 1. There were no returns from the first group of fry, released in 1974, also did not return although the fish released in 1975 and 1976 year. Some were said to have been seen on the coast of Aysen by fisherman, but this was not conformed.

The reasons for the failure to return may be excessive loss due to predation and fish size and release time were not optimum. The fry may have been too small, both summer and winter groups; some of the winter fish stayed in the river until October when spring had arrived (A. Nagasawa & G. Araya, 1979).

The improvements for these problem might have attempted with feeding at the hatchery before liberation. In general, research has suggested that large fish survive at higher rates than smaller fish, as indicated by returns to the home river. However, during 1974–1976 there were no facilities for maintaining the fry at the hatchery. In 1977, the first feeding trial experiment was begun and fullscale experiments feeding fry were attempted in 1978 to 1979.

The long feeding period with chum salmon seems to be unnatural. They are inclined soon as the yolk-sac is absorbed to move down to the sea, at least in the Northern hemisphere. However, at Aysen, the seasons are upside down, so it may be that the tendency. Besides water temperatures along the coast were not over 20°C the year round indicating it may be possible to pen rear them in the Fjord. Data on the North-hemisphere shown young salmon disappear with a coast temperatures condition in 17–18°C they move out to off shore.

These data suggest that the main problem is to determine a controlling release timing and fish size for the seaward migration. This should enhance the possibility of realizing substantial returns of the fish in future operations.

The feeding experiments were conducted in 1977, 1978 and 1979. The first time chum salmon were fed in the history of Chilean fish culture. And the size of fish at time of release will be anticipated to effect survival of adult fish appeared in the coast or river in Chile. These feeding programs had to be considered and correlated with the comprehensive scheme which began in 1980 under an agreement signed at Santiago in September 1979 by the Servicio Nacional de Pesca, Chile and Japan International Cooperation Agency.

Table 1. Codes for the transplanted stocks and shipment program

No.	Code	Parent year & egg collection	Shipment		Number of received eggs.	Anticipated return	Remarks
			Number of egg.	Date			
1.	KJ-73-B	1973 December	1,000,000	Mar. 1974	1,000,000	1977-1979	Experimental
2.	KJ-74-A	1974 October	1,000,000	Nov. 1974	1,000,000	1978-1980	Pilot culture
3.	KJ-74-B	1974 December	1,000,000	Mar. 1975	950,000	1978-1980	Pilot culture
4.	KJ-75-A	1975 October	1,000,000	Nov. 1975	1,000,000	1979-1981	Pilot culture
5.	KJ-75-B	1975 December	1,000,000	Mar. 1976	1,000,000	1979-1981	Pilot culture
6.	KJ-76-A	1976 October	1,000,000	Nov. 1976	1,000,000	1980-1982	Pilot culture
7.	KJ-76-B	1976 December	2,000,000	Mar. 1977	2,000,000	1980-1982	Pilot culture
8.	KJ-77-A	1977 October	2,000,000	Nov. 1977	2,000,000	1981-1983	Pilot culture
9.	KJ-77-B	1977 December	1,000,000	Mar. 1978	-	-	Dead in arrive
10.	KJ-78	1978 December	1,000,000	Mar. 1979	1,000,000	1982-1984	Replace for KJ-77-B
Total			12,000,000		10,950,000		

Code: K = *Oncorhynchus keta*
 J = Japan as original source
 Number (as 73) = Parent year as 1973
 A = Early season in egg collection such as October
 B = Late season in egg collection such as December

3. LOCATION

These feeding trials were conducted during three years from 1977–1979 at Coyhaique Hatchery. This hatchery facilities were installed in 1976 as complete for production fed fry. Coyhaique Hatchery is located on the border of Coyhaique, Region XI Aysen, Chile, at latitude South $45^{\circ}35'$ and longitude West $72^{\circ}07'$. The city of Coyhaique is capital of province where is approximately 1,600 km from Santiago de Chile, but without road connection. Map of the Hatchery showing location of Coyhaique is in *Figure 1 and 2*.

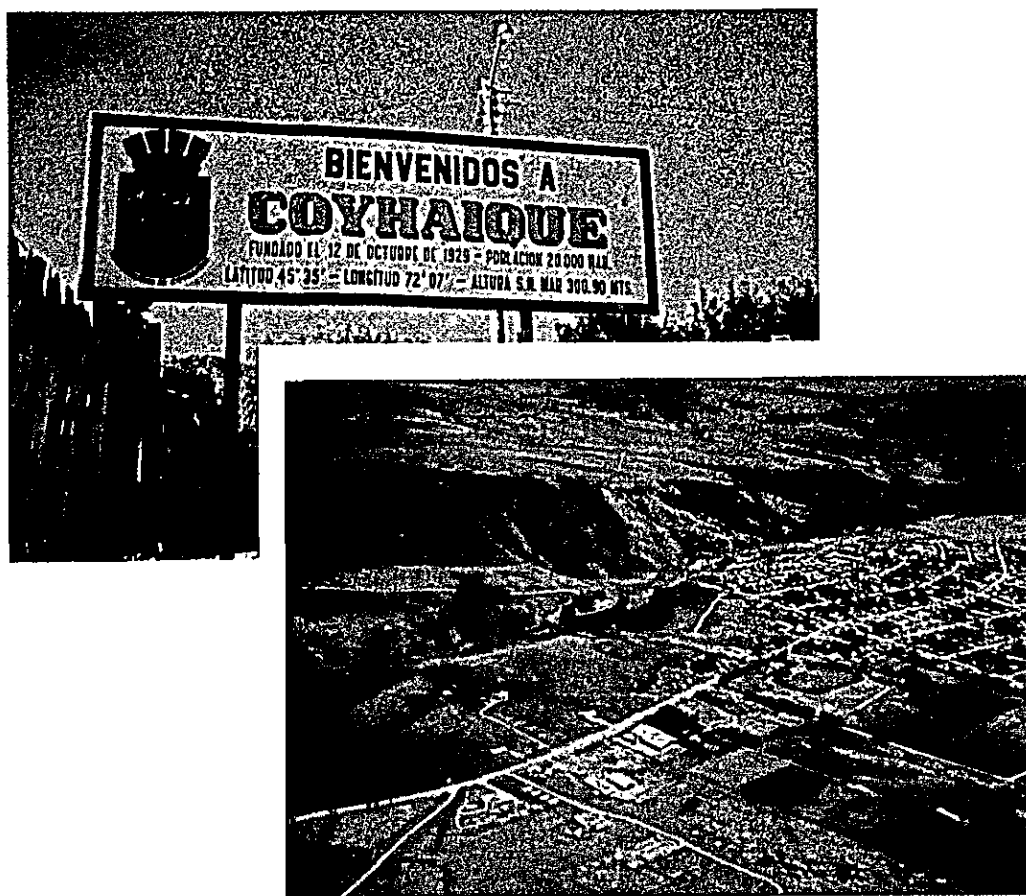


Fig. 1. Entrance sign board of Coyhaique and aerial view of Hatchery site.

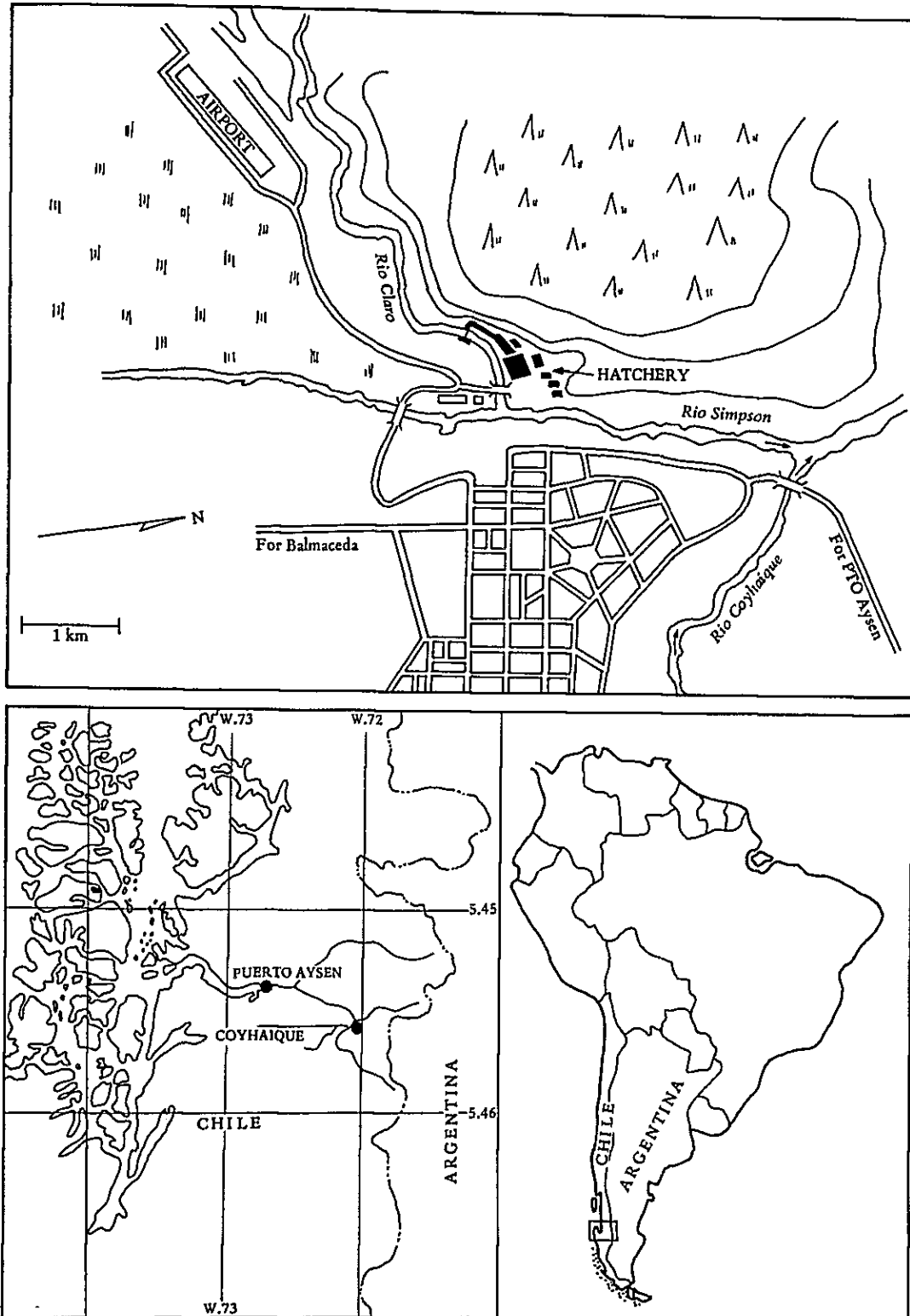


Fig. 2. Map showing location of Coyhaique and salmon hatchery.

4. FEEDING TRIAL WITH WINTERED FRY IN 1977

(1) Egg and Fry

This group, code KJ-76-B, was produced by two million eyed eggs which arrived in Coyhaique Hatchery 4 and 11 March 1977. They were taken from Shibetsu River, Hokkaido, Japan, on 20 and 24 December 1976. Total produced fry were 1,661,000, at the end of May, transplanted at 402–405°C U.T. eyed-egg stage to the Coyhaique Hatchery. The majority were liberated into Simpson River unfed. The fry produced from the eggs were identical to those described in detail by Nagasawa & Araya (1979).

About 200,000 fry were used in the feeding trial. The fish averaged 0.33 g in weight and 36 mm in size.

Produced progress of the experimental fish (KJ-76-B)

Date of stripped eggs:	20–24 November 1976
River name:	Shibetsu River, Hokkaido, Japan
Number of egg transplanted:	2,000,000 yed eggs
Date of accepted eggs:	06 and 12 March 1977
Egg mortality:	39,000 (02%)
Number of hatched-out fry:	1,961,000 (98%)
Sac-fry mortality:	300,000 (15%)
Produced swim-up fry:	1,661,000 (83%)
Released fry (unfed):	1,461,000 (73%)
Feeding (experimental):	200,000 (10%)
Size of fry:	0.33 g and 36 mm in average

(2) Feeding period and water temperature

The feeding experiment with swim-up fry commenced June 1st until 30 September, onset of spring, 1977, a total of 122 days. This was the first time the feeding of Chum salmon was undertaken in Chilean fish culture. In the North Hemisphere Chum salmon fry usually migrate seaward immediately after they absorb the yolk-sac, always in Spring season; they have no chance of wintering there.

However, this experiment was beset with difficulties, unfortunately, the hatchery facilities were inundated by the heaviest rain in 11 years in the Simpson river catchments on 11 to 13 June 1977. Much sand, dead leaves, waste and dust flowed into the rearing ponds. This rubbish made it impossible for the ponds outlet screen to hold back fish, additionally, rats and weasels seeking safety from inundation entered the hatchery room and attacked fish in the indoor rearing pond. After the inundation, the river returned to a normal level. Only 64,000

fish remained in the ponds on June 15, then the feeding trial was resumed and continued until the fish released in October.

During this feeding period, cumulative temperatures of rearing water were 666°C U.T. as shown Table 2 with ten-day frequency shown in Fig. 3.

Table 2. Temperatures of feeding period in 1977.

Month	Water temperature			Day	Unit temperature	Remarks
	Min.	Max.	Average			
June						
Early	3.6	7.6	5.76	10	57.6	Start on 1/June
Middle	1.0	8.2	4.42	10	44.2	
Late	0.4	6.6	4.96	10	49.6	
					(151.4)	
July						
Early	3.6	6.8	5.24	10	52.4	
Middle	0.9	6.2	3.97	10	39.7	
Late	2.8	6.2	4.52	11	49.7	
					(141.8)	
August						
Early	1.8	6.0	4.22	10	42.2	
Middle	3.1	10.2	6.40	10	64.0	
Late	2.5	7.8	5.61	11	61.7	
					(167.9)	
September						
Early	4.0	10.5	6.65	10	66.5	
Middle	3.0	9.3	6.15	10	61.5	
Late	3.5	10.8	6.68	10	66.8	End on 30/Sept.
					(194.8)	
Total				122	665.9	

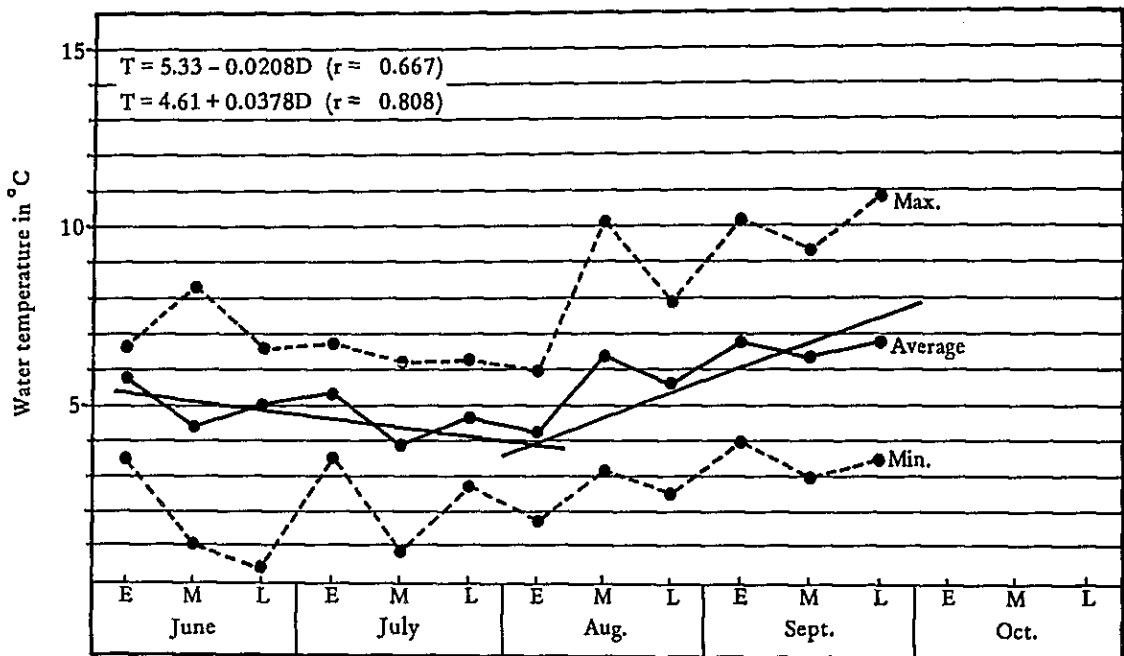


Fig. 3. Ten-day average of water temperature of the feeding period for KJ-76-B, 1977.

(3) Rearing pond and water

In this feeding experiment a small indoor concrete pond was used in hatchery room consisting of six ponds each 4 m long, 1 m wide, 0.5 m deep as Fig. 4. These ponds were made for incubating egg, holding sac-fry, rearing fish and some experiments with fishes.

They were completed in 1975 with dam, canals, and a filter pond as the first phase of hatchery facilities. At that time the ponds were used for incubating eggs, because the hatchery was partially completed without egg incubator piping, so that eggs were in these ponds in stacks of trays, as described in the previous report (A. Nagasawa & P. Aguilera 1976).

The 200,000 fish were distributed equally in the six ponds about 11 kg and 8,300 fish/m². Water depth in the pond is 0.25 m at starting trial. These fish needed about 25 Lt/min. minimum water a standard of safety shown in Tables 3 and 4 for Chum salmon fry up to one gram in size. Dissolved oxygen of inflowing water was 11.4 ppm (equal to 7.97 cc) in early May.

Water quality of 25 Lt/min. is sufficient to refresh water in the pond every hour. Rate of replacement of water under time trial conditions was 1.5 per hour according to the formula below used in calculation.

$$\text{Rate of replacement of water} = \frac{\text{inflowing water in 1 hour}}{\text{water quantity in pond}} = 1.0$$

$$\text{Where} = \frac{25 \text{ Lt/min.} \times 60 \text{ min.}}{4 \text{ m} \times 1 \text{ m} \times 0.25 \text{ m}} = 1.5$$

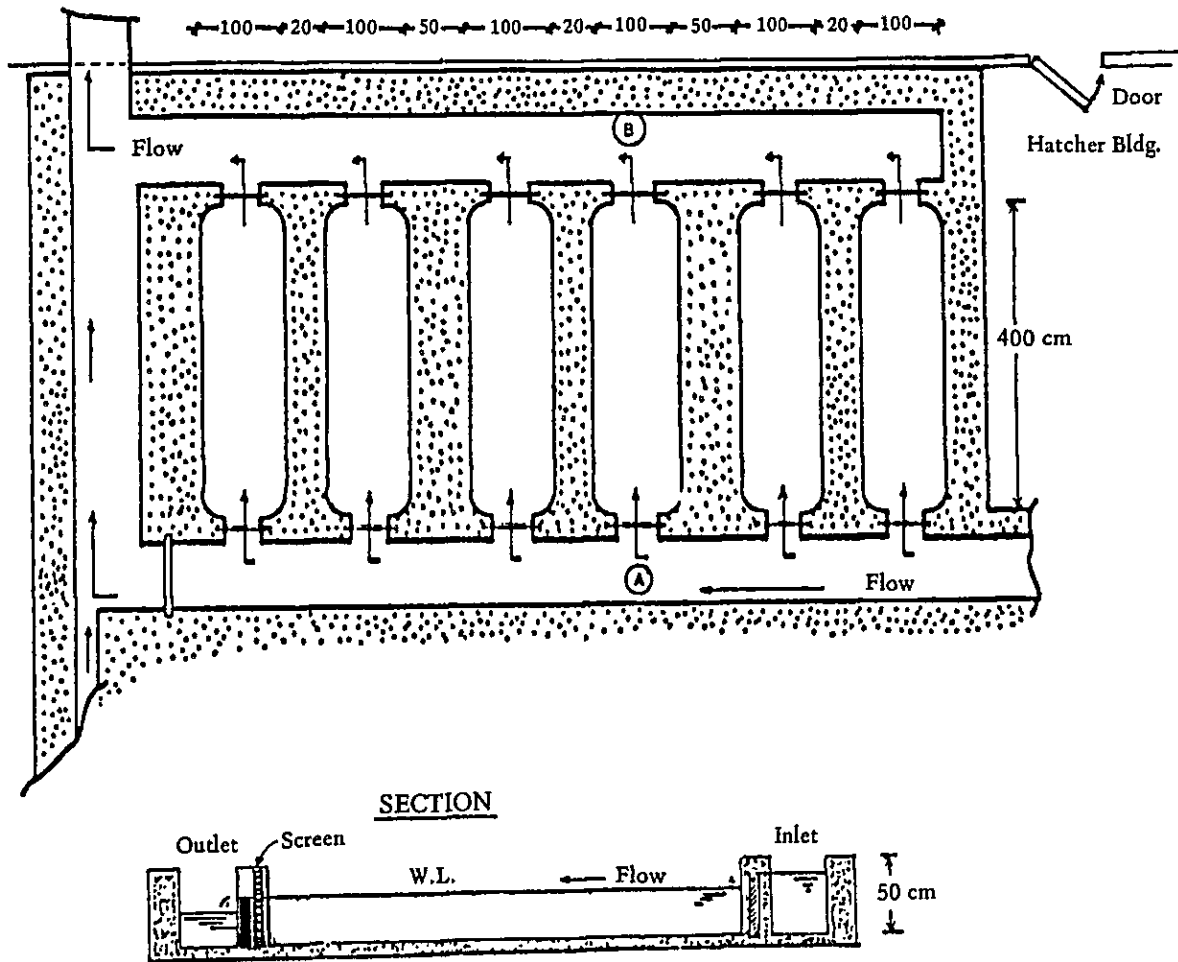


Fig. 4. Experimental feeding pond in 1977

Table 3. Water supply by oxygen requirement for one million fry of chum salmon rearing in different temperatures and sizes.

Use for		10,000 fry per m ² , Up to 1 million fry maximum.													
W.T. °C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight (g)	m ³ /min														
0.3	0.137	0.141	0.144	0.148	0.152	0.156	0.160	0.164	0.168	0.172	0.176	0.180	0.183	0.188	0.191
0.4	0.172	0.177	0.182	0.187	0.192	0.196	0.201	0.207	0.212	0.216	0.221	0.227	0.230	0.237	0.240
0.5	0.356	0.366	0.376	0.386	0.396	0.406	0.415	0.428	0.438	0.447	0.456	0.468	0.476	0.489	0.497
0.6	0.539	0.555	0.570	0.585	0.601	0.616	0.630	0.648	0.664	0.678	0.692	0.710	0.722	0.741	0.754
0.7	0.722	0.743	0.768	0.785	0.805	0.825	0.845	0.869	0.891	0.909	0.927	0.952	0.967	0.994	1.012
0.8	0.907	0.932	0.958	0.984	1.011	1.035	1.059	1.090	1.117	1.139	1.163	1.194	1.213	1.246	1.267
0.9	1.089	1.121	1.152	1.183	1.214	1.244	1.273	1.311	1.343	1.370	1.398	1.435	1.459	1.499	1.524
1.0	1.268	1.305	1.342	1.379	1.416	1.441	1.488	1.539	1.569	1.601	1.634	1.677	1.705	1.751	1.781

Source: Handbook of Salmon Hatchery, 1975, National Hokkaido Salmon Hatchery Service.

Table 4. O₂ requirement (cc/kg/min., in 8°C) of chum salmon

Development in °C U.T.	472	504	552	656	768	800	880	960	1,064
O ₂ requirement (cc/kg/min.)	0.26-0.31	0.5-1.0	0.9-1.1	1.4-1.8	2.1-2.9	2.3-2.8	4.0-3.8	4.3-5.8	2.56-4.57
Stages	Eye-egg	Hatch-out	Yolk sac fry				Swim-up fry		

Source: Annual Report 1969. National Hokkaido Salmon Hatchery Service.

(4) Diet

The fry were fed a commercial diet made by Nichiro Fisheries Co. in Japan, consisting of dried mixed pellets throughout the experiment. This food was also used in the 1978 and 1979 experiments. The ingredients are shown in Table 5.

The fish were hand fed six to eight times daily in the initial two weeks with starter size pellets permitting them to take all they could eat, after that four times daily at three hour intervals, 09:00, 12:00, 15:00 and 18:00. The amount of daily food consumed was about 2% constantly of the fishes weight when water temperatures were under 5°C in the winter.

(5) Growth

Growth in the period of feeding was determined at the end of each month. The sample used were 150 fish measured for body weight and total length. Results of the feeding trial are summarized in Table 8, the growth up to end of September averaged 1.74 g in weight and 58.9 mm in length during winter, shown in Table 7.

Condition factor at the end of each month is shown in Table 6. These was a general increasing trend with some fluctuations during the feeding period. In September, condition factor was down suggesting the need for more feed, otherwise the food efficiency was high, up to 1.05.

The rate of food fed per day should have been up to 2.5 or 3.0 percent of body weight. Starting value of condition factor was 6.86 at swim-up stage, but by June 15 when the experiment was resumed it was down to 5.78 due to the inundation when food that could not be given for about five days.

Table 5. Composition of dry diet

Type	Dried mixed feed (made in Japan)
Pellet size	Starter 0.5 mm – 1.0 mm (for 0.3 g – 0.5 g fish) Grower 1.0 mm – 1.5 mm (for 0.5 g – 1.0 g fish)
Composition	Crude Protein 48.0 – 54.0% Crude Lipid 4.0 – 7.0% Crude Fiber 0.2 – 1.5% Crude Ash 10.0 – 13.0% Moisture 7.0 – 10.0%
Material	White fish meal Liver powder Blood powder Yeast Defatted milk (powder) Wheat flour Starch Mixed mineral Mixed vitamin Trace elements (Fe, P, Ca)
Vitamin content (per kg)	A 4,400 IU B ₁ (Thiamine) 30 mg B ₂ (Riboflavin) 90 mg B ₆ (Pyridoxine) 30 mg B ₁₂ (Thianocobalamin) 0.05 mg C (Ascorbic acid) 1,000 mg D (Cholecalciferol) 1,000 IU E (Tocopherol) 180 mg H (Biotin) 2.5 mg K ₃ (Menadion) 20 mg Niacin 450 mg Pantothenic acid 200 mg Para-amino benzoic acid 200 mg Choline 4,000 mg Inositol 600 mg Folic acid 10 mg

Source: Nichiro Fisheries Co., Ltd.

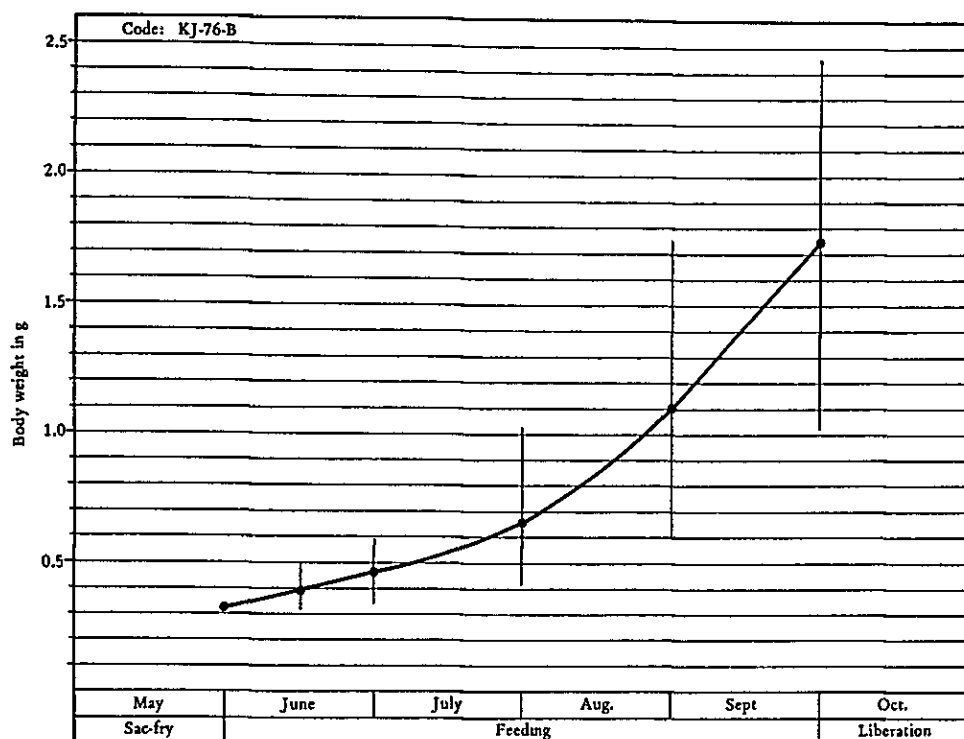


Fig. 5. Growth of chum salmon fry by artificial feeding in winter season, Coyhaique Hatchery, Chile, 1977

Table 7 and Fig. 7 shown the final fish size and frequencies of feeding in the hatchery feeding by size of group in weight and length. They grew slowly in June to July, and quicker from August on ward due to increased temperature which increased there appetites. They gained an average of 1.42 grams per individual from June 1st to September 30th. Samples taken from ponds indicated weights and lengths relationship as shown in Fig. 8.

Table 6. Condition factor at the end of each month during feeding trial.

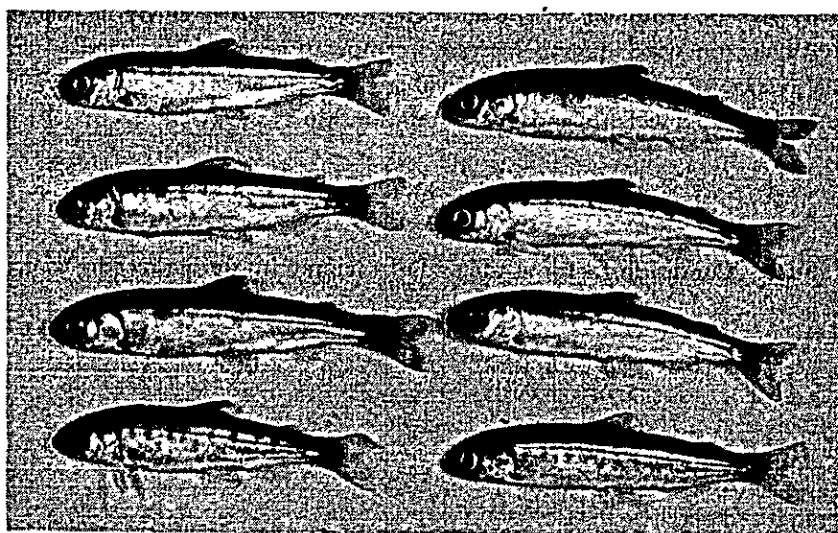
	Starting value	Month ending			
		June	July	August	September
Condition factor (K)	6.86	5.78	7.13	9.94	8.86

The condition factor for each month was calculated using the formula: $k = W \times 10^3 / L^3$

Table 7. Final fish size of 4-month (June-Sept.) winter feeding of chum salmon at Coyhaique Hatchery, Aysen, Chile, 1977.

(Code: KJ-76-B, Fed fry)

Size, group in g	Sample size	Percent	Average	
			Weight (g)	Length (mm)
Less than 1.00	0	—	—	—
1.00 — 1.09	3	2.00	1.06	50.0
1.10 — 1.09	3	2.00	1.15	54.6
1.20 — 1.29	9	6.00	1.25	53.8
1.30 — 1.39	6	4.00	1.35	54.0
1.40 — 1.49	17	11.33	1.45	55.5
1.50 — 1.59	15	10.00	1.54	57.3
1.60 — 1.69	17	11.33	1.64	56.9
1.70 — 1.79	14	9.33	1.73	58.6
1.80 — 1.89	13	8.66	1.82	59.6
1.90 — 1.99	12	8.00	1.93	60.7
2.00 — 2.09	13	8.66	2.04	62.9
2.10 — 2.19	18	12.00	2.13	63.7
2.20 — 2.29	4	2.66	2.23	64.0
2.30 — 2.39	3	2.00	2.35	64.6
2.40 — 2.49	3	2.00	2.45	67.6
More than 2.50	0	—	—	—
Total	150	100.00		
Mean (\bar{x})			1.74	58.9
Standard Deviation (SD)			0.442	4.949



Fish size of chum salmon fry (KJ-76-B) after 4 months artificial rearing period June-Sept. 1977, Coyhaique Hatchery, Chile

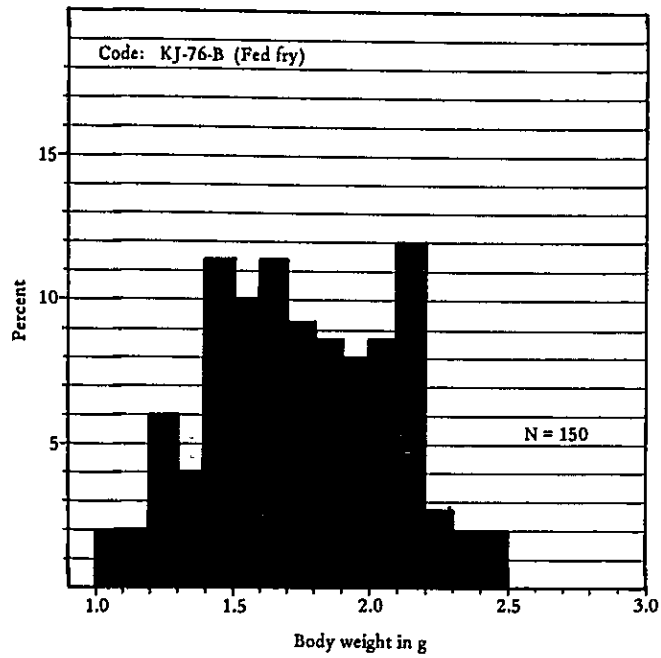


Fig. 7. Frequency-distribution of body weight at final samples during feeding period, Coyhaique Hatchery, Chile, 1977

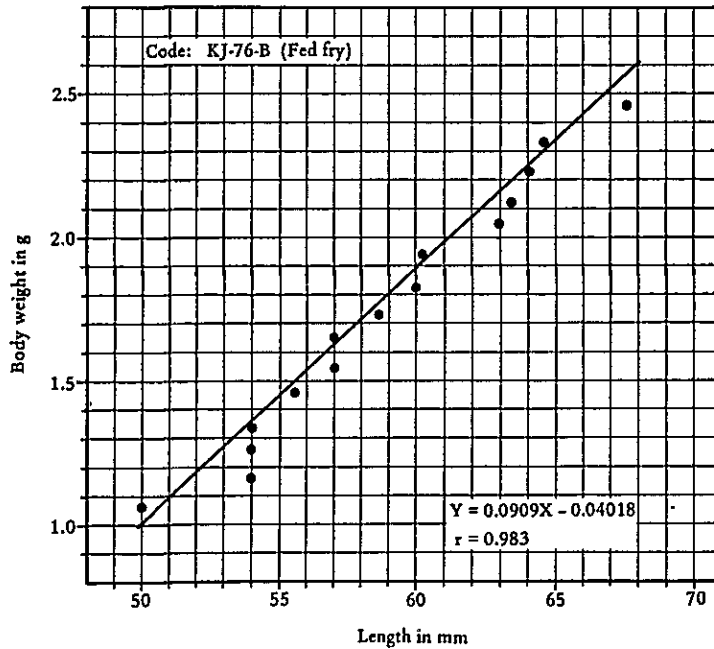


Fig. 8. Weight-length relationship of chum salmon fry reared at winter season (June-September), Coyhaique, Chile, 1977

(6) Survival

Survival was excellent (89%), except during the flood in June when many fish escaped through the screen. Five to fifteen fish were lost daily during the feeding period.

In the end of September, 1,300 fish were lost by driving net and dipper to obtain total weight in the pond for final results of the trial and release number.

Table 8. Summarized results of chum salmon fry feeding trial in winter, Coyhaique Hatchery, Chile, 1977

	June		July	August	September	Total/Average		Remarks
	1-10	15-30				15/Jan.-30/Sep.		
Size of fish at start (W')	0.32g-36.2mm	0.39g-39.0mm	0.46g-43.2mm	0.65g-45.0mm	1.10g-48.0mm	0.39g-39.0mm		
Size of fish at end (W'')	--	0.46g-43.2mm	0.65g-45.0mm	1.10g-48.0mm	1.74g-58.9mm	1.74g-58.9mm		
Number of fish (N') & weight at start (W')	200,000-64kg	64,000-25kg	63,400-29kg	63,000-41kg	62,800-69kg	64,000-25kg		
Number of fish (N'') & weight at end (W'')	--	63,400-29kg	63,000-41kg	62,800-69kg	61,500-107kg	61,500-107kg		
Survival (N''/N' x 100)	32% (escape)	99.0%	99.4%	99.0%	97.9%	98.7%		
Total food given (F)	15 kg	8 kg	18 kg	26 kg	45 kg	97 kg		
Food given per day	1.5 kg	0.5 kg	0.6 kg	0.85 kg	1.5 kg			
Total weight gain (W = W'' - W')	--	4 kg	12 kg	19 kg	38 kg	82 kg	1.42 g (from 1 Jun.)	
Individual gain (w = w'' - w')	--	0.07 g	0.19 g	0.27 g	0.64 g	1.35 g		
Growth rate (g = w''/w')	--	1.18	1.41	1.70	1.58	4.48	5.43 (from 1 Jun.)	
Feed efficiency (f = F/W)	--	1.8	1.5	1.37	1.18	1.46		
Water temperature (°C)								
Average (T)	5.0°C		4.6°C	5.4°C	6.5°C	5.4°C		
Range (max.-min.)	8.2-0.4		6.8-0.9	10.2-1.8	10.8-3.0	10.8-0.4		
Unit temperature (U.T. = T x D)	151.4°C U.T.		141.8°C U.T.	167.9°C U.T.	194.8°C U.T.	656°C U.T.		
Footnote: * by inundation								
Initial 10 days culled off to totaling for the result.								

5. FEEDING TRIAL WITH SUMMERED FRY IN 1978

(1) Egg and Fry

The eggs in this group, Code KJ-77-A, came from Chitose River, Hokkaido, Japan. They taken on 19 and 27 October 1977 and arrived in Coyhaique Hatchery on 4 and 10 December 1977 in the stage of 352°C U.T. eyed egg. They totalled two million. The swim-up fry produced were 1,879,000, averaging 0.30 g and 35 mm. 238,000 unfed fry was released into El Salto River on 27 January 1978, as described by Aliaky Nagasawa and Gustavo Araya (1979).

Experimental fish produced (KJ-77-A)

Date of striped egg:	19 and 27 October 1977
River name:	Chitose River, Hokkaido, Japan
Number of egg transplant:	2,000,000 eyed eggs
Date of accepted egg:	4 and 10 December 1977
Egg mortality:	61,000 (3.0%)
Number of hatched-out fry:	1,939,000 (97.5%)
Sac-fry mortality:	60,000 (3.0%)
Number of produced fry:	1,879,000 (95.5%) January 1980
Released un-fed fry:	238,000 (12.7%) El Salto River
Feeding experimental:	1,641,000 (87.3%)
Size of fry at start of feeding:	0.31 g – 35 mm

(2) Feeding period and water temperature

This time feeding was made on 20 January to 23 February 1980, during 34 days, onset high summer season in the Patagonia district. The weather and the air temperature of this period was shown whereas the appendix tables in this report series No. 3 (A. Nagasawa & G. Araya 1979).

Release program of this group fish, code KJ-77-B, was made within summer season as possible as big size in grower than swim-up stage, because if they were liberated in Autumn they will wintered in the river. So that this time feeding trial was conducted only one month for they can reach into the coast before the winter, besides the ceiling of diet stock undertaken 1,500 kg.

Water temperature of during this feeding period shown in Fig. 9. Seasonal trend of the temperature in the summer was increase as a regressions line formula $T = 12.15 + 0.201D$ ($r = 0.8$).

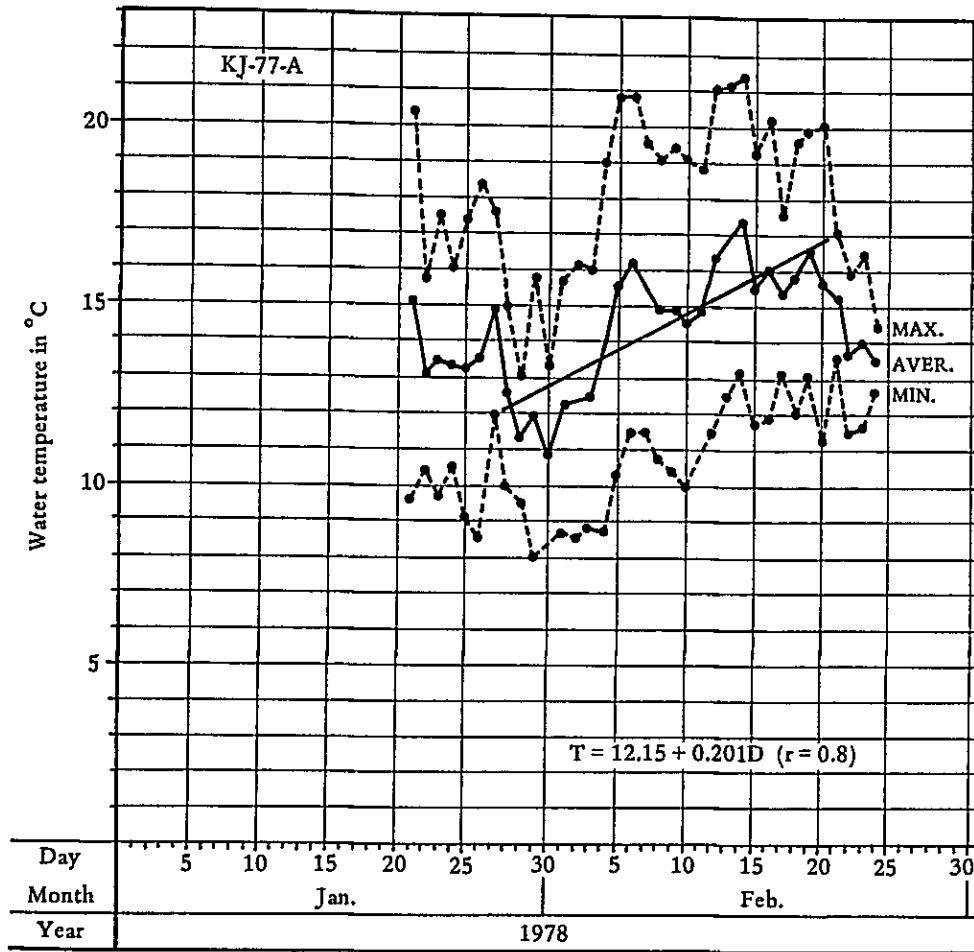


Fig. 9. Daily water temperature of the feeding period for chum salmon fry, Coyhaique Hatchery, Chile, 1978

Water temperature in summer (February) reached or exceeded 20°C. This seems to be the upper lethal temperature for chum salmon fry. During the feeding experiment cumulative temperature was 490°C U.T.

(3) Rearing pond and water

The pond chosen for the feeding trial consists of incubator channels used to produce swim-up fry. It consists of six parallel channels 40 m long by 1 m wide separated by a 0.5 m wall with gravel bottom, as shown in Fig. 10.

The channel works provide independent hydraulic control at inlet canal from main canal; each channel flow is controlled by drop structure boards at inflow and outflow. Any portion of the channel flow can be diverted into the rearing pool or riffle up to its depth.

Of the six channels, four channels were used with separated 20 m long by a screen used for rearing fish, two channels were used for the by-pass exceeded water. Each channel initially held approximately 410,000 fry, weighing 123 kg, the four channels held 1,641,000 fry totalling 492 kg at the beginning of the feeding experiment.

Water level was 30 cm deep and inflowing water was controlled at about 75 litres per minute for each pond, according the standard of safety, as shown in Table 3.

(4) Diet

The food was the same as in the 1977 experiment for KJ-76-B (Table 5). It was fed daily according to levels suggested by Table 9 (see reference to Leitritz chart for the trout and salmon culture).

The fish were fed eight times per day in the starter period, six times in middle period and four times in last period of the 34 day program. Total consumed was 1,500 kg (Table 10). Daily intake of food was about 4.0–6.5% of the weight of the fish with each ten-day adjustment. Food efficiency was indicated as 1.02 in this feeding trial.

(5) Growth

The growth to the end of the feeding period on 23 February at incubator channel was determined for a sample of 150 fish calculated at an average of 1.2 g in weight and 54.7 mm length (Table 11).

The growth rate is close to the rate of previous experimental feeding in winter, from June to September 1977. The influence of temperature on metabolism and growth of fry has received much attention in summer feeding. Unit temperature of this feeding period (34 days) was approximately 490°C U.T. Condition factor was 7.45.

At the end of the feeding, 150 fingerlings were measured. Weight frequency distribution and body form are shown in Table 12 and Fig. 12 and 13.

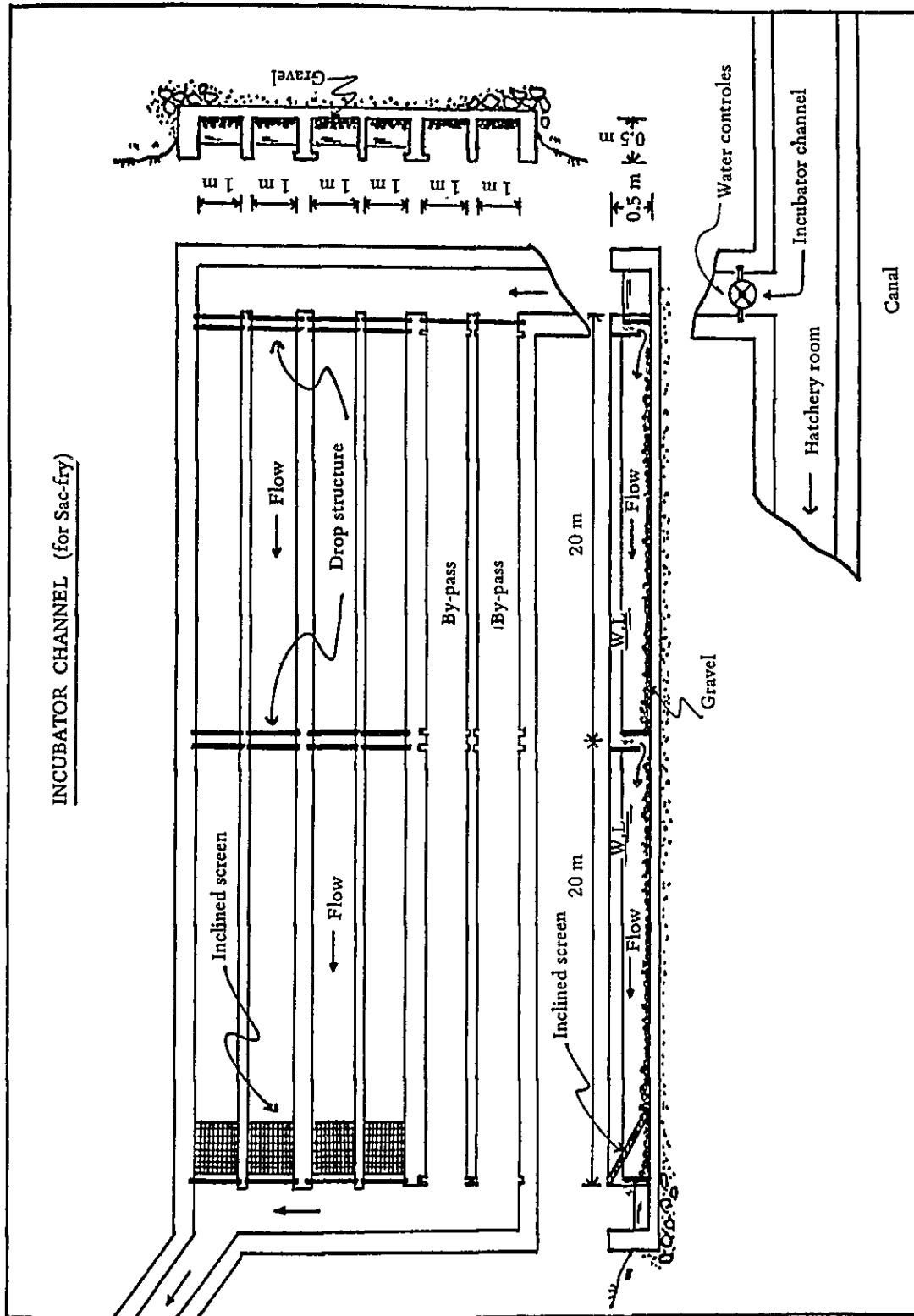


Fig. 10. Experimental feeding pond in 1978, Coyhaique Hatchery

Table 9. Amount of dry food per day in percentage of 0.18–1.5 g size fry in varying water temperature

Water temperature in °C	3	4	5	6	7	8	9	10	11
Dry food per day in percent for total weight	2.3	2.5	2.7	3.0	3.2	3.5	3.8	4.2	4.5
°C	12	13	14	15	16	17	18	19	20
%	4.8	5.2	5.6	6.0	6.4	6.8	7.3	7.9	8.2

From "Trout and Salmon Culture" by Earl Leitritz

Table 10. Food consumed in summer feeding experiment of chum salmon fry, Coyhaique Hatchery, Chile, 1978

Period	Days	Fish size at start	Holding fish in approx.	Water T. at start	Food for fish weight	Food per day	Total food requirement
		g	kg	°C	%	kg	kg
20–31 Jun.	11	0.3	500	23.0	4.0	20	220
01–10 Feb.	10	0.4	650	13.0	5.0	33	330
11–23 Feb.	13	0.7	1,120	15.0	6.5	73	950
	34						1,500

Table 11. Results of chum salmon fry feeding trial in summer, Coyhaique Hatchery, Chile, 1978

Size of fish at start (W')	0.30 g – 35.0 mm
Size of fish at end (W'')	1.24 g – 54.7 mm
Condition factor at start ($W' \times 10^3/L^3$ cm)	7.00
Condition factor at end ($W'' \times 10^3/L^3$ cm)	7.45
Number of fish & weight at start (W')	1,641,000 – 492 kg
Number of fish & weight at end (W'')	1,500,000 – 1,860 kg
Survival	91.4%
Total food given (F)	1,400 kg
Food given per day	4.0 – 6.5% for W'
Total weight gain ($W = W'' - W'$)	1,368 kg
Individual gain ($w = w'' - w'$)	0.94
Growth rate ($g = w''/w'$)	4.13
Feed efficiency ($f = F/W$)	1.02
Temperature:	
Average	14.4°C
Range (max.-min.)	21.4 – 8.0°C
Unit temperature (U.T.)	490°C U.T.

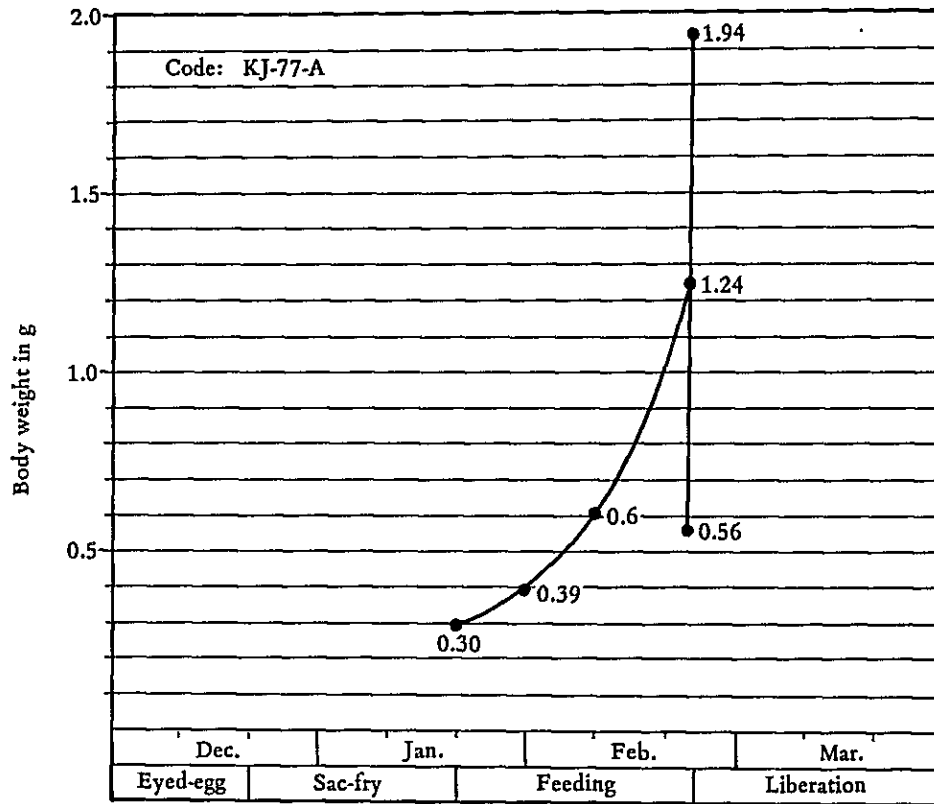


Fig. 11. Growth of chum salmon fry by artificial feeding in summer season, Coyhaique Hatchery, Chile, 1978

Table 12. Weight and length of sampled 1-month (20/Jan.—23/Feb.) feeding
in summer of chum salmon at Coyhaique Hatchery, Chile, 1978

(Code: KJ-77-A, Fed fry)

Size, group in g	Sample size	Percent	Average	
			Weight (g)	Length (mm)
Less than 0.40	0	—	—	—
0.40 — 0.49	0	—	—	—
0.50 — 0.59	1	0.66	0.53	42.6
0.60 — 0.69	3	2.00	0.62	45.0
0.70 — 0.79	5	3.33	0.72	47.3
0.80 — 0.89	7	4.66	0.85	48.4
0.90 — 0.99	16	10.66	0.93	50.1
1.00 — 1.09	21	14.00	1.04	51.9
1.10 — 1.19	15	10.00	1.15	53.5
1.20 — 1.29	20	13.33	1.28	55.6
1.30 — 1.39	19	12.66	1.26	56.3
1.40 — 1.49	15	10.00	1.46	59.5
1.50 — 1.59	14	9.33	1.54	58.4
1.60 — 1.69	8	5.33	1.66	61.5
1.70 — 1.79	3	2.00	1.77	61.5
1.80 — 1.89	2	1.33	1.89	62.0
1.90 — 1.99	1	0.66	1.94	62.4
More than 2.00	0	—	—	—
Total	150	100.00		
Mean (\bar{x})			1.24	54.4
Standard deviation (SD)			0.460	6.596

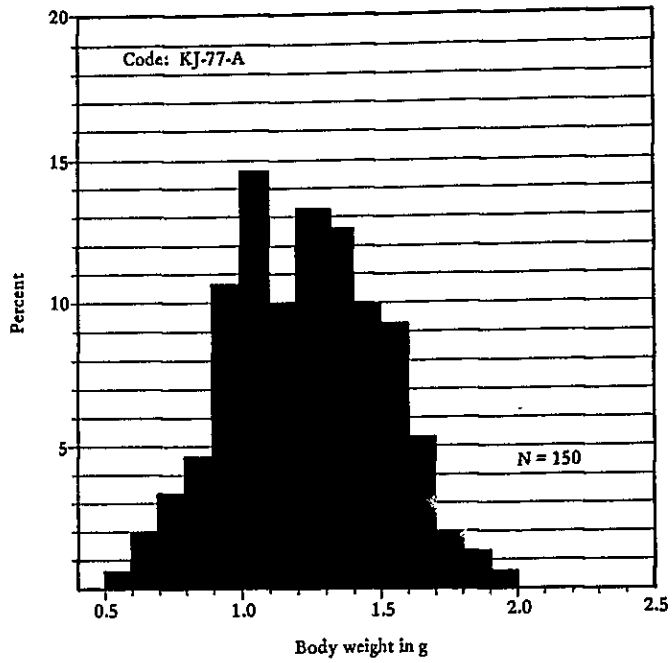


Fig. 12. Frequency-distribution of body weight of samples during feeding period, Coyhaique Hatchery, Chile, 1978

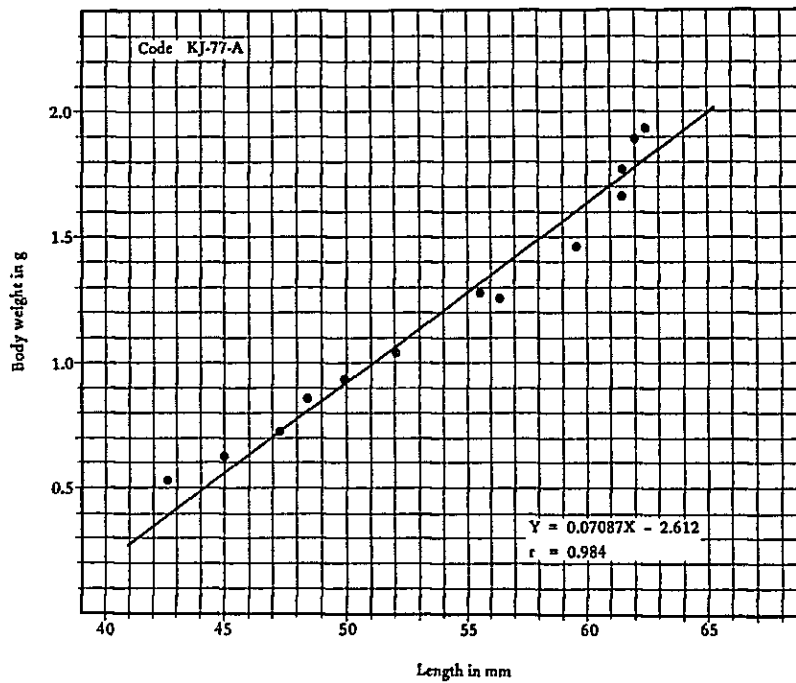


Fig. 13. Weight-length relationship of chum salmon fry reared in summer (February), Coyhaique Hatchery, Chile, 1978

(6) **Survival**

Mortality was approximately 141,000 fry or 8.6% in feeding period daily hand counted. These dead fish comprised two groups; weak fish who could not eat the food and died in the early stages of the operation, and the other were average size fish who could not survive temperatures up to 20°C during the late period many died in an attempt to move down to colder waters.

6. FEEDING TRIAL WITH WINTERED FRY IN 1979

(1) Eggs and Fry

A million eyed eggs were obtained from Hokkaido, Japan, by JICA to replenish specially the loss of an equal number in route to Chile of KJ-77-B (A. Nagasawa & G. Araya, 1979). The code name of this group was KJ-78. History of these eggs is as follows:

(Origin)

Date of striped egg:	21 December 1978
River name:	Abashiri River, Hokkaido, Japan
Hatchery:	Abashiri National Salmon Hatchery
Temperature & pH:	5.0–6.0 pH 7.0
Date of eyed:	06 February 1979
Date of shocking:	16 February 1979, also picking
Treatment:	Malachite green 1/400,000 30 min. 2-times in a week.
Egg mortality:	12.0% up to shocking
Egg quality:	Small size, 0.22 g per egg
Egg condition:	Good

(Shipment)

Date of shipment:	23 February 1979, Chitose Hatchery
Development:	39.5°C U.T. eyed egg stage
Number of eggs:	1,000,000 eggs, 220 kg, 20-boxes
Air route:	Chitose–Tokyo–Frankfurt–Rio de Janeiro –Buenos Aires–Santiago–Pto Montt–Coyhaique
Hours in transportation:	70 hours approximately
Date of arrival:	26 February 1979, Coyhaique Hatchery
Egg mortality on the trip:	6,000 eggs (0.6%)
Egg condition in arrival:	Good

(Fry)

Egg mortality at the incubator:	15,000 eggs (1.5%) hand-counted
Date of hatched-out:	5–20 March 1979
Percentage of hatched-out:	98.5% (979,000 sac-fry)
Sac-fry mortality at the fry- incubator channel:	5.0% (49,000 sac-fry) Random counted by 1 m ² square
Date of swim-up:	20–25 April 1979
Produced fry:	930,000 fry (372 kg)
Produced fry size:	0.40–3.14 cm in average

This group was used in connection with the second 5-year scheme 1980–1984 involving winter feeding, tracing down migration in the river, fingerling transport to the estuary, pen rearing in the fjord, measurement of hatchery facilities for fingerling release, etc.

(2) Feeding period and water temperature

This time trial were maintained for 173 days from 26 April 1979, during late autumn to early spring in October. During this period, feeding temperatures were as shown in Fig. 14. From April to the middle of June temperatures tended to decrease, reaching bottom in the middle of August at 5–6°C; after that temperatures began to increase such as in 1977, typical of this area in Chile. Unit temperature of this feeding period was 915°C U.T. as shown in Fig. 14 and Table 13.

Table 13. Unit temperature of feeding period in 1979, Coyhaique Hatchery

Month	Water temperature			Day	Unit temperature °C	Remarks
	Min.	Max.	Average			
April						
Early	—	—	—	—	—	
Middle	—	—	—	—	—	
Late	7.7	9.0	8.9	4	35.6 (35.6)	Start on 26/Apr.
May						
Early	5.0	7.3	6.15	10	61.5	
Middle	5.5	7.1	6.32	10	63.2	
Late	3.4	5.4	4.29	11	47.2 (171.9)	
June						
Early	3.6	5.2	4.44	10	44.4	
Middle	2.6	4.0	3.36	10	33.6	
Late	4.6	6.0	5.30	10	53.0 (131.0)	
July						
Early	3.1	5.1	4.19	10	41.9	
Middle	4.2	5.9	4.61	10	46.1	
Late	3.1	4.8	3.98	11	43.8 (131.8)	
August						
Early	3.6	6.3	4.90	10	49.0	
Middle	2.9	5.8	4.40	10	44.0	
Late	3.3	5.8	4.54	11	49.9 (142.9)	
September						
Early	3.8	8.3	6.07	10	60.7	
Middle	4.1	7.8	5.99	10	59.9	
Late	3.8	8.4	6.11	10	61.1 (181.7)	
October						
Early	4.4	10.6	7.51	10	75.1	
Middle	5.8	12.1	8.99	5	44.9	End on 15/Oct.
Late	—	—	—	—	— (120.0)	
Total				172	915.0	

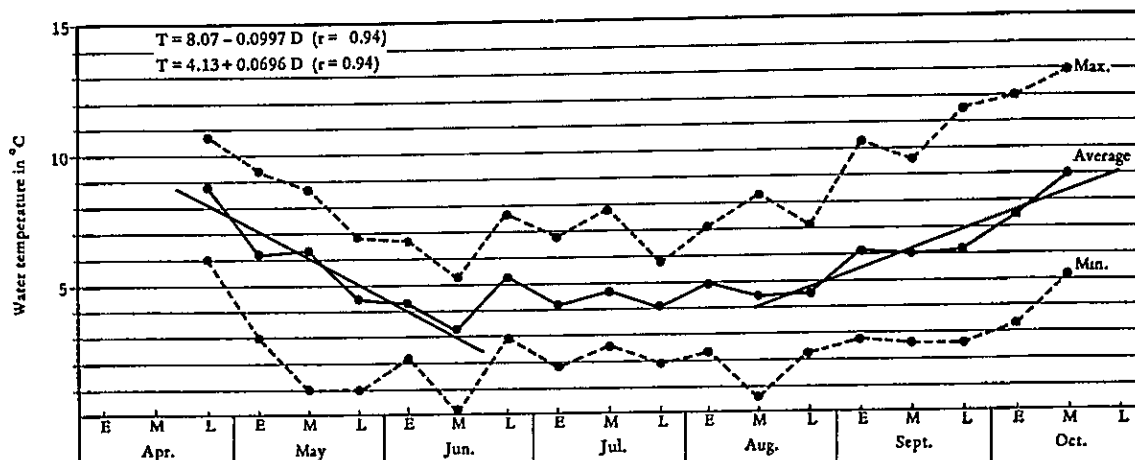


Fig. 14. Ten-day average of water temperature of the feeding period for KJ-78, Coyhaique Hatchery, Chile, 1979

(3) Rearing pond and water

In this year the rearing ponds were for the first time cemented completed concrete in 1976. The fish were started on crumble food for three weeks in the fry incubator channel, as in the 1978 summer trial. Size of each pond is 10 m long, 2 m wide and 0.6 m deep as shown in Fig. 15.

Water was kept about 33 cm deep in the initial period; that is, 6.6 m³ of water space, increased as the fish grew. The ponds were treated with 1/10,000 formalin solution, with brushing two days before fish moved in.

Fish in each pond totalled 15 kg/m³ at the beginning increasing to 25–30 kg per m³ in the later period with 10 tons of water in each pond, depth kept to 0.5 m. Water supply was about 400–600 Lt/min. per pond. The exchange rate was 3.6 time per hour.

In August, fish averaged 2.0 g, and each ponds load reached 285 kg about 30 kg/m³, almost the maximum limit of pond capacity, 282,000 fish (564 kg) were liberated into the Aysen river down stream of Simpson river.

(4) Diet

The majority of the fish were fed dried-mixed-pellets made in Japan as trial in the feedings in 1977 and 1978 (Table 5); in August the diet changed to dry-pellets made in Chile (Table 15), because it was difficult to procure supplies from Japan. This food induced disease because it was too high in oxides, and killed some fish. The pellets were compounded from meal, such as Jurel (*Trachurus murphyi*) and Sardina (*Sardinops sagax*). They were very hard and indigestible for some fish.

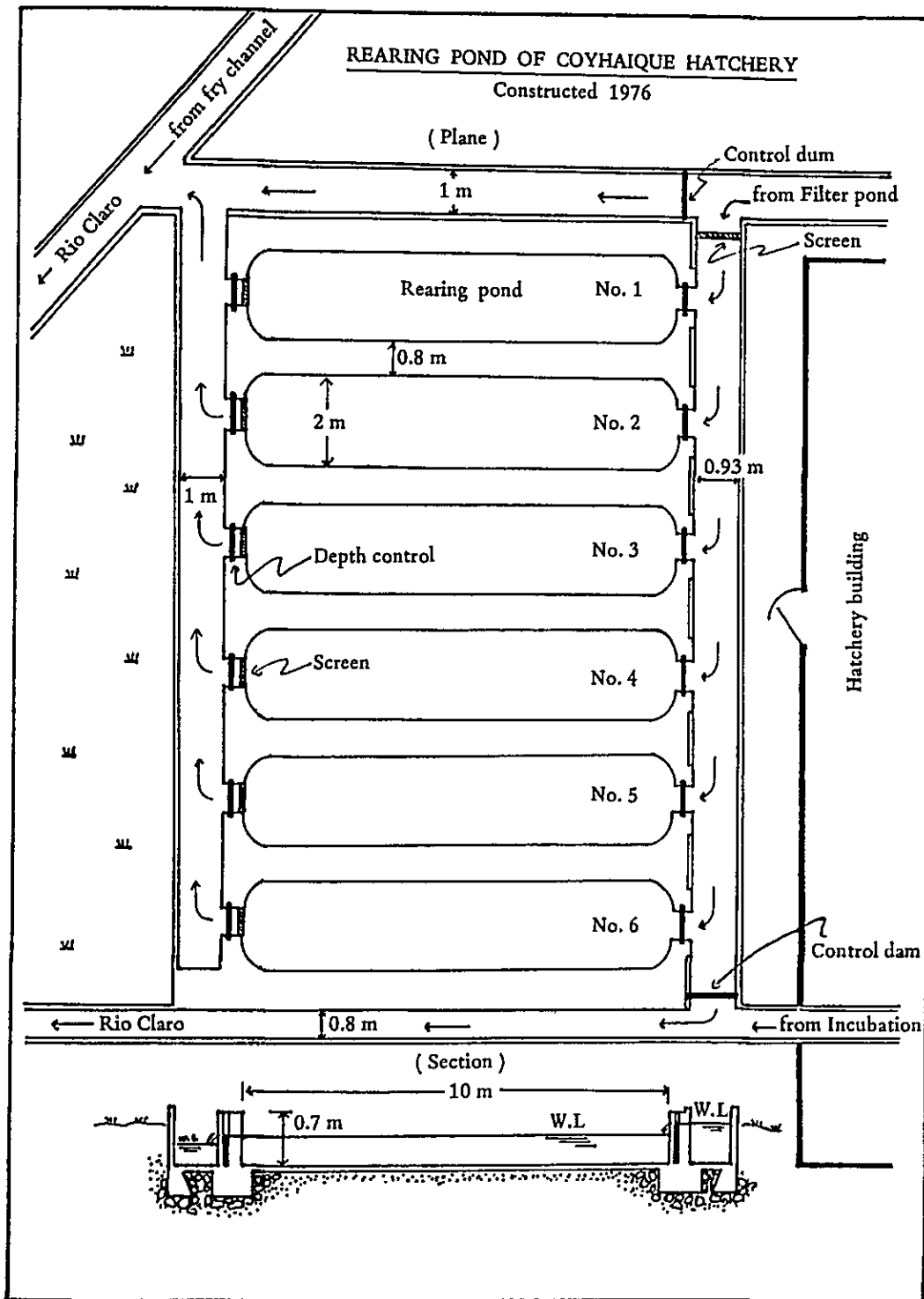


Fig. 15. Extent of the rearing ponds, Coyhaique Hatchery

Table 15. Composition of dry diet

<u>Food type;</u>	Dried mixed feed (made in Chile)
<u>Pellet size;</u>	Grower 2.0–2.5 mm (for 2.0–10 g fish)
<u>Composition;</u>	
Crude protein	46.0%
Crude lipid	3.5
Crude ash	10.0
Crude fiber	0.7
Moisture	10.0
<u>Material;</u>	
Fish meal (Jurel and Sardina)	55%
Wheat flour	20
Defatted milk (powder)	8
Yeast (Levadura)	5
Liver	5
Starch	3
Dry shrimp	2
Mixed vitamin	2
<u>Vitamin composition;</u> (per 1 kg mixed vitamin)	
Vitamin A	500,000 IU
Vitamin B ₁ (Thiamin)	1.0 g
Vitamin B ₂ (Riboflavin)	3.0 g
Vitamin B ₆ (Pyridoxine)	0.7 g
Vitamin B ₁₂ (Thianocobalamin)	1.5 mg
Vitamin C (Ascorbic acid)	40.0 g
Vitamin D (Cholec aliciferol)	1,000,000 IU
Vitamin E (Tocopherol)	8.0 g
Vitamin H (Biotin)	0.05 g
Vitamin K ₃ (Menadion)	0.8 g
Nicotinic acid	10.0 g
Polic acid	0.3 g
Pontothenic acid Ca	4.0 g
Choline	70.0 g
Inositol	10.0 g
P-Amino benzoic acid	7.0 mg

Boiled beef liver was used to supplement the food supply when there was a shortage of pellets. A total of 2,705 kg (Table 16) including beef liver converted to dry food was consumed by the fish. Food efficiency was 2.17 composed with 1.22 for the diet made in Japan.

(5) Growth

The fry were fed for 173 days in the winter, the fall and spring of 1979. In the first 21 days, they were fed in the fry-incubator channel. After this training, they were transferred to concrete rearing ponds supplied with fresh water during the 5-month experiment.

Each months measurements are presented in Appendix Table and growth in Fig. 16 and 17. Condition factor also worsened under the influence of food was changed and rate of food was down.

After 173 days of rearing, the average individual weight was 3.60 g and length 7.70 cm by random sample (Table 17). Condition factor was 9.96 (Table 18).

Growth range was spread out according to feeding period. A group of small fish always existed, and small percentage never grew up. This group would fade out by natural selection, a rule of all wildlife. It was about 3.4% of the population were under 1.5 g through the five months and 0.4% were under 1.0 g during 173 days. On the other hand 15% were over 5.0 g.

(6) Survival

The total mortality after five months feeding of chum salmon reared in fresh water in the pond was about 4% by daily hand count and monthly samples. This is not regarded as high mortality. Mortality during the initial training period was 1.6%, which is most usual in swim-up stage; this group would die anyway if they were liberated in the river.

After the fish moved to the rearing pond, 30–60 dead fish were counted daily, or 5–10 for each pond daily, which is normal. However, from middle August, when the diet was changed to pellets made in Chile, mortality rose to 800 fish daily, with maximum in September suffering from dropsy disease. Since the Chilean diet was not used in October mortality was lower. It was significant that the fish in one pond which was not Chilean diet this disease did not appear. If the food supply had arrived from Japan on time, survival would have been higher.

A total of 36,000 fish died, 60,000 escaped, 801,000 were released and 33,000 could not be accounted for Table 19.

Table 16. Amount and Type of Fish Food given in each period - 1979

Fish code: KJ - 78
 Rearing period: 26 April to 15 Oct., 1979
 Coyhaique Hatchery, Chile

Type	Fish Food		Training	May	June	July	Aug.	Sept.	Oct.	Total	Remarks
	Grade	Size (mm)									
Dry Mixed	Crumble Starter	0.1-1.0	80 kg	170 kg	-	-	-	-	-	250 kg	made in Japan
	Crumble Grower	1.0-1.5	-	-	500	-	-	-	-	860	made in Japan
	Pellet (Japanese)	2.0-2.5	-	-	-	120	150	150	150	420 (1,530)	
	Pellet (Chilean)	2.0-2.5	-	-	-	270	810	-	-	1,080	
	Total	-	80	170	360	500	390	960	150	2,610	
Wet	Beef liver (Boiled)	4.0 (minced)	-	-	-	(43)	(137)	-	-	(180)	contained water 48.3%
	convert into Dry		-	-	24	71	-	-	-	95	
Total in Dry Food			80	170	360	524	461	960	150	2,705	Wet Food convert into Dry
Ref.	Total Fish Weight (kg)		372	426	564	883	1,360	1,140	1,565	-	released 564 kg in end of Aug.
	Feed per day in % of fish weight		1.0	2.6	2.6	2.3	1.1	2.8	0.7	-	

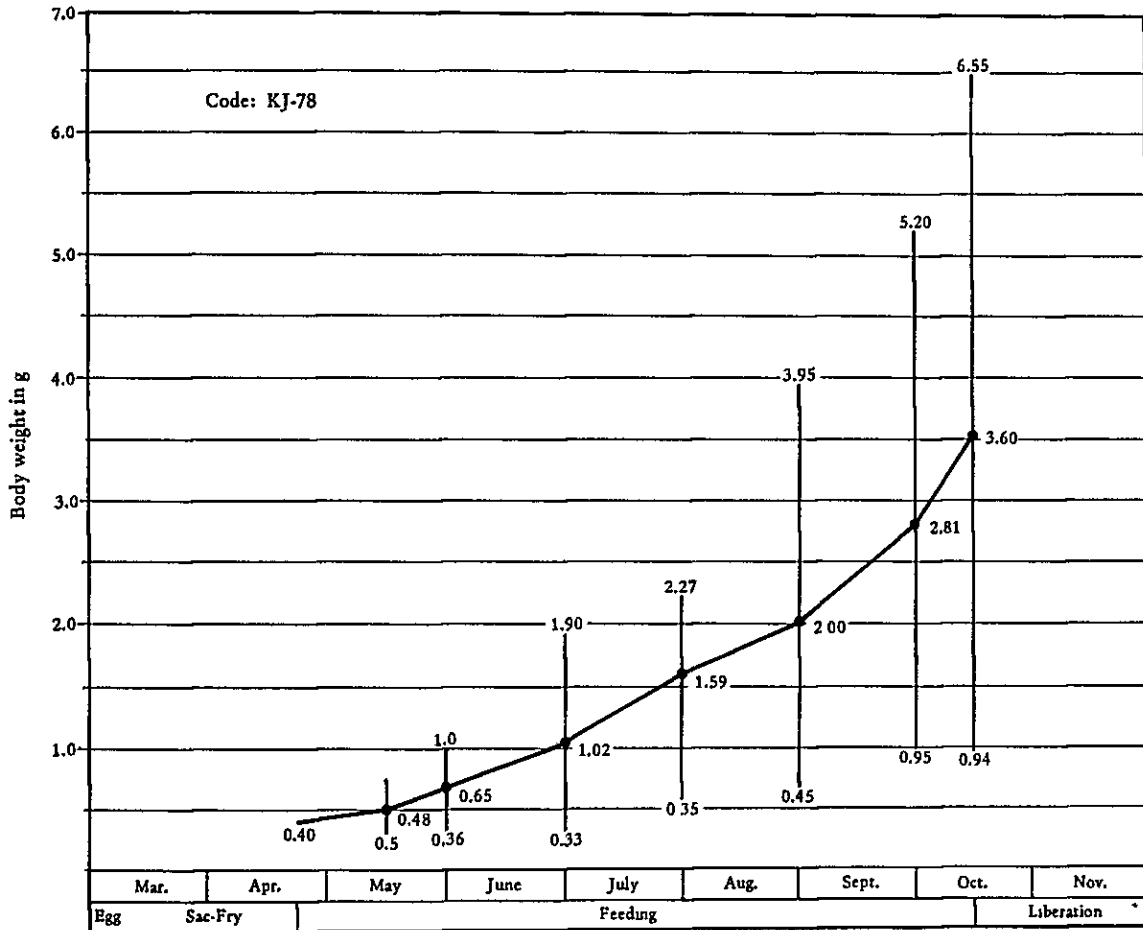


Fig. 16. Growth of chum salmon fry by artificial feeding in the winter season, Coyhaique Hatchery, Chile, 1979

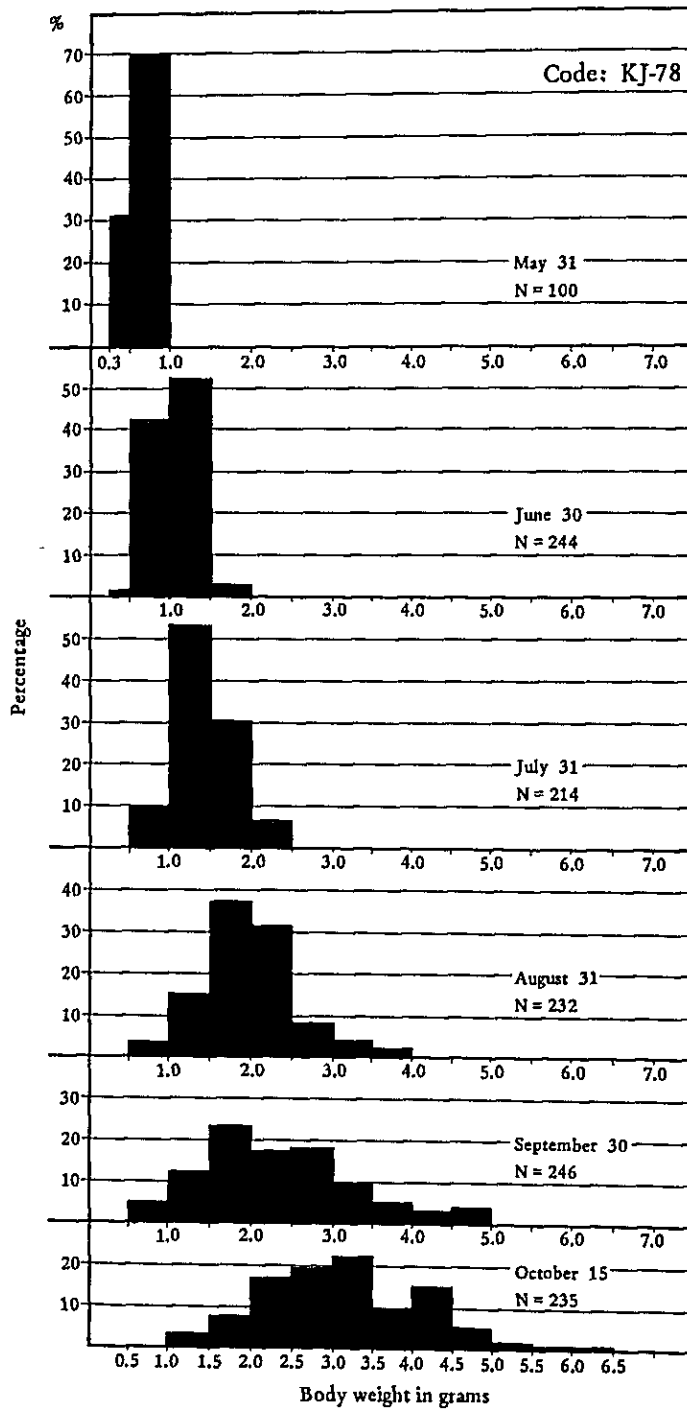


Fig. 17. Frequency-distribution of body weight in month end samples during feeding period, Coyhaique Hatchery, Chile, 1979

Table 17. Final fish size of sample 173 days (26/Apr.–15/Oct.) feeding in the winter season, chum salmon fry at Coyhaique Hatchery, Aysen, Chile, 1979

(Code: KJ-78, Fed fry)

Size group in g	Sample size (N)	Percent (%)	Average	
			Weight (g)	Length (mm)
Less than 0.99	1	0.4	0.94	53.0
1.00 – 1.49	7	3.0	1.31	58.5
1.50 – 1.99	19	8.0	1.75	65.8
2.00 – 2.49	40	17.0	2.41	69.1
2.50 – 2.99	45	19.1	2.74	75.4
3.00 – 2.49	52	22.1	3.27	79.8
3.50 – 3.99	21	9.0	3.73	81.3
4.00 – 4.49	36	15.3	4.42	85.3
4.50 – 4.99	11	4.6	4.95	85.5
5.00 – 5.49	2	0.8	5.34	88.9
5.50 – 5.99	1	0.4	5.80	91.0
More than 6.00	1	0.4	6.55	93.0
Total	235	100		
Mean (\bar{x})			3.60	77.0
Standard deviation (SD)			1.836	13.011

Table 18. Average monthly condition factor (K) for fed-fry of chum salmon, Coyhaique Hatchery, 1979

Code: KJ-78

Period	Sampled date	Condition factor (K)	Sample size (N)	Remarks
Free swimming stage	Apr. 25	9.34	100	Yolk-sac absorbed more than 90%
Feeding training	Apr. 26	(9.34)	(100)	Starting day on the feeding training
	May 16	8.94	100	
Rearing with wintering	May 17	(8.94)	(100)	Starting day on the regular feeding
	May 31	9.43	100	
	Jun. 30	9.82	241	
	Jul. 31	7.74	214	
	Aug. 31	6.95	222	
	Sep. 30	7.02	261	
	Oct. 15	9.96	235	

Note: $K = W / L^3 \times 1,000$

where, W = Weight in g, L = Length in cm

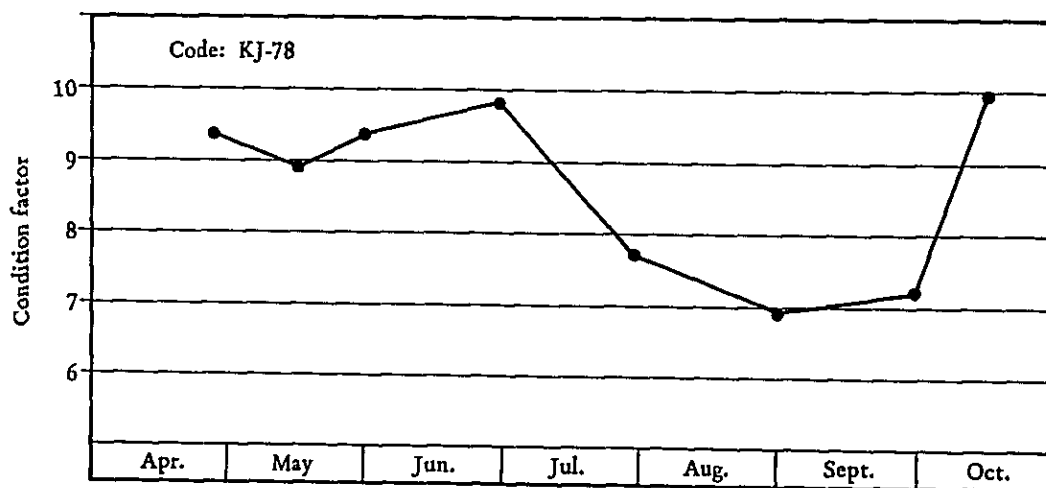


Fig. 18. Monthly average condition factor of chum salmon fed-fry, Coyhaique Hatchery, 1979

Table 19. Monthly Fish-holding Survival of Chum Salmon Fry in the Rearing Pond with Wintering at Coyhaique Hatchery, CHILE, 1979

Period	Date		Number of fish at starting	Out				Number of fish at ending	Remarks
	During	Days		Dead	Escap	Release	Unknown		
Pre-feeding	26 Apr - 16 May	21	930,000	15,000	45,000	-	-	870,000	Feeding at Incubator channel for training
Periodical rearing with wintering	17 May - 31 May	15	870,000	2,000	-	-	-	868,000	Fish move in Feeding pond
	01 Jun - 30 Jun	30	868,000	2,000	-	-	-	866,000	
	01 Jul - 31 Jul	31	866,000	1,000	10,000	-	-	855,000	
	01 Aug - 31 Aug	31	855,000	3,000	-	282,000	-	570,000	Release into Aysen River (Simpson R. system) by tank, 29-30 Aug.
Release	01 Sept. - 30 Sept.	30	570,000	8,000	5,000	-	-	557,000	
	01 Oct - 15 Oct	15	557,000	4,000	-	253,000	-	300,000	Release into Simpson River from Hatchery, 09-10 Oct.
	16 Oct - 19 Oct	(4)	300,000	1,000	-	266,000	33,000	000	Release into Ensenada Baja station by tank
Total	26 Apr - 15 Oct	173	930,000	36,000	60,000	801,000	33,000	000	
%		-	100.0	3.9	6.5	86.1	3.5	-	

Fish number exceeding 1,000 were inventoried.

Dead fish number were daily hand counted include monthly samples.

Escapment due to defective screen and over flows were estimated.

Unknown number is the accounts does not balance by predators, cannibalism, scaling error in all period.

7. RESULTS AND DISCUSSION

Feeding trials were conducted with chum salmon fry in the winter and summer of 1977, 1978 and 1979 at the hatchery of Coyhaique, Southern Chile. These fish originated from the spawning runs returning to Hokkaido, Japan, in the fall.

Chum salmon fry can tolerate salt water as soon as the yolk-sac is absorbed and migrate down the sea; this is a basic ecological character. However, in this project, introducing chum salmon into southern Chile, the eggs must originate from the fall spawning run in the Northern Hemisphere. The eggs were developed in Hokkaido to the eyed egg stage in late fall to winter. This corresponds with spring to summer on the southern hemisphere; the eyed eggs hatching out and reaching swim-up stage in the summer to autumn.

In 1977, 200,000 fish were stocked in ponds inside the hatchery building, but unfortunately many of fish were escaped during severe flooding. Mortality determined after the flood the trial was resumed resulting in 98.7% survival. Fish grew to an average of 1.7 g and 58.9 cm with 666°C U.T. cumulative temperature. Growth was most rapid in August and September when the temperature increased.

In 1979, a random sample of weight measurement of the entire population at time of release ranged from 0.9 g to 6.55 g, a 5.6 g variance. It is possible that the larger fish ate many of the smaller ones, because salmon can eat food three times the size of the diameter of its mouth.

The relation between cumulative gains and unit temperatures in the 1977 and 1979 trials in winter and summer in 1978 is shown in Fig. 19. Compared with coho salmon that is most rapid growth in the *Oncorhynchus* genus, six species (Table 21). The gains of these chum salmon fry feeding trials were very similar to the coho's growth curve in Fig. 19 coho are believed to make the most rapid growth during their freshwater and ocean life of all six species of Pacific salmon (*Oncorhynchus* species), Table 21.

Many reports suggest that the size of fish at time of release appeared to effect their survival in the ocean and return to the river to spawn. On this basis it is believed that the return of results from the 1979 releases, stock KJ-78, in 1982-3 will be considerable. This group of 253,000 fingerling was liberated October 16-19 1978, from Coyhaique Hatchery.

Their migration behavior based on down-stream observation will be made available in a later report.

The feeding trial indicate the weight of the fish released in the spring season should reach 2-3 g after the winter feeding at Coyhaique Hatchery. The hatchery has the capacity of producing about 2,000 kg fingerlings in the rearing ponds.

Table 20. Growth and cumulative temperatures of feeding trials, 1977, 1978 and 1979, chum salmon fry, Coyhaique Hatchery, Chile.

Sample No.	Unit temperature (°C)	Growth (g)	Code of fish group	Year/season of feeding
1	132	0.39	KJ-77-A	1978 Summer
2	141	0.49	KJ-78	1979 Winter
3	151	0.46	KJ-76-B	1977 Winter
4	208	0.65	KJ-78	1979 Winter
5	271	0.60	KJ-77-A	1978 Summer
6	293	0.65	KJ-76-B	1977 Winter
7	339	1.02	KJ-78	1979 Winter
8	461	1.10	KJ-76-B	1977 Winter
9	475	1.59	KJ-78	1979 Winter
10	490	1.24	KJ-77-A	1978 Summer
11	618	2.00	KJ-78	1979 Winter
12	656	1.74	KJ-76-B	1977 Winter
13	803	2.81	KJ-78	1979 Winter
14	932	3.60	KJ-78	1979 Winter

$$Y = 0.00321X - 0.0541 \quad (r = 0.965)$$

Table 21. Sea life age and average body weight of *Oncorhynchus* genus. Southern-west coast of the Peninsula Kamchatka, 1973.

Species (Salmon)	Average weight (kg) in sea life age				
	Age I	Age II	Age III	Age V	Age VI
Sockey	1.02	2.19	3.03	3.07	—
Chum	—	2.74	3.73	4.40	—
Pink	1.38	—	—	—	—
Coho	3.35	—	—	—	—
King	2.50	3.90	7.71	12.77	18.13

Presumed weight when they were into the sea: Pink & chum were 1 g, others were 20 g.

Source: Agriculture and fishery technical conference (1976)
Symposium of anadromous salmon culture.

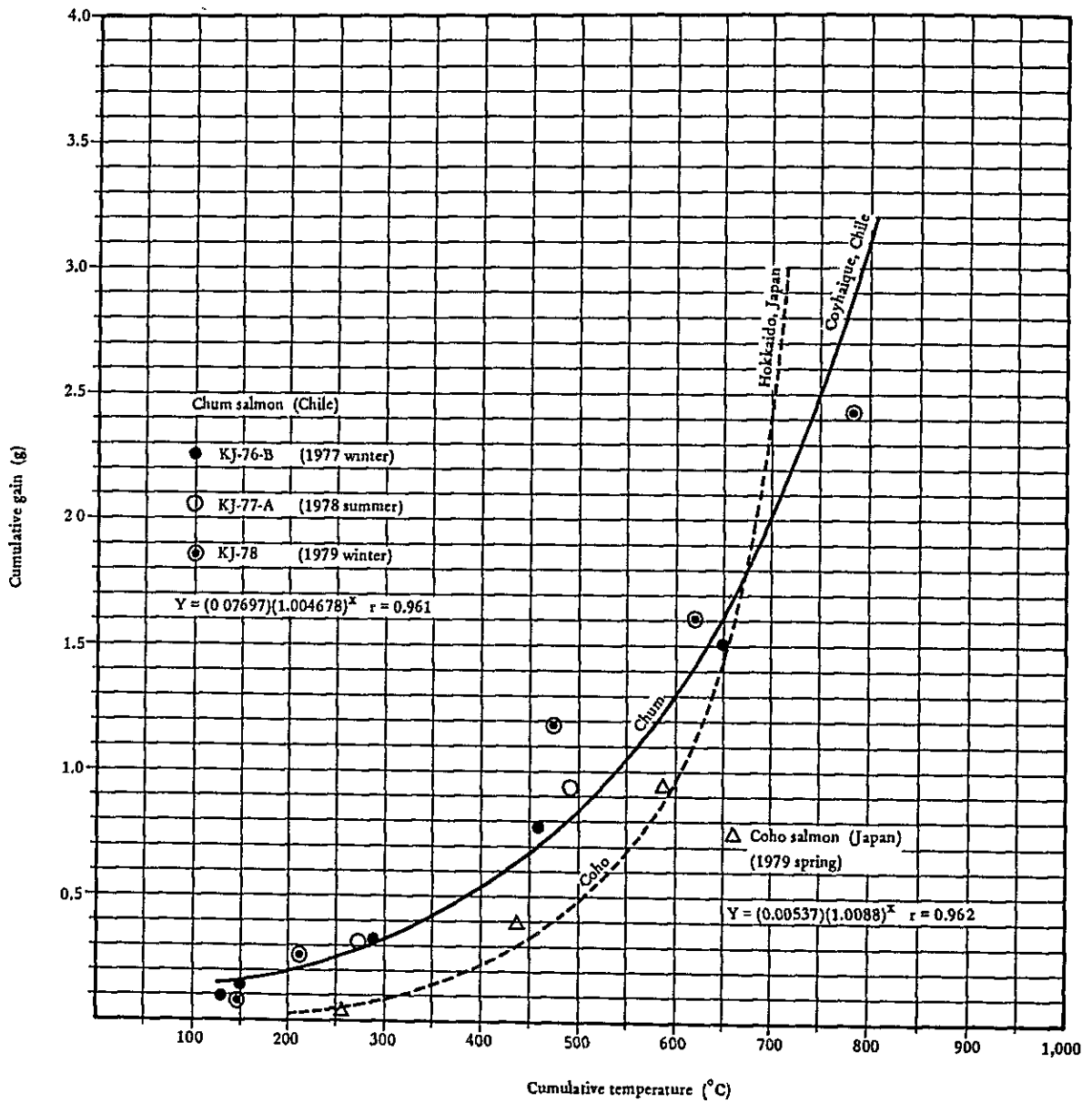


Fig. 19. Exponential curve with units temperature from start of feeding chum salmon fry at Coyhaique Hatchery, Chile.

Mortalities of fry and fingerlings during feeding periods were 1.3%, 8.6% and 4.0% respectively in each trial. Most of the mortality occurred in the first two weeks after swim-up stage at the start period of the training period. These fish would probably fade out normally in the process of natural selection.

Two type of experimental diets were used one made in Japan and the other in Chile. Food efficiency was an average of 1.22 and 2.17 respectively, on third trial. The Chilean diet produced poor growth and dropsy disease and many fish became emaciated. The pellet was very hard and some toxic properties may have been involved. The diet must be selected with care and the highest quality should be selected. In last trial, 1979, food efficiency was only 0.48 in October, suggesting that natural food, such as aquatic insects, appeared in the rearing ponds.

In 1979 trials, 226,000 fingerlings were moved to Ensenada Baja nearby PTO Chacabuco for the release after imprinting with Pajarones stream water (Fig. 20); some 40,000 remained for an experiment in pen feeding in the Fjord for about one month. The results of this experiment will be made available in a later report.

The third trial in 1979 was most useful, but the difficulty was that the same quality diet was not available through the long period of the trial. The Chilean diet should be tested intensively for its efforts on growth and survival of the fish.

The phase of the program, should involve studies of the physical and biological environment of the river where the fish are released, and how to acclimate liberated salmon into their new world.

8. LIBERATION FRY

In 1979, the ponds seemed to reach the maximum limit of loading, 28.5 kg/m³ of fish, so they were trucked 70 km and released into Aysen River estuary of Simpson River system.

After each feeding trial, the surviving chum salmon fry which grew to fingerling stage were liberated. The annual releases until 1978 were published in report No. 3; the 797,000 fingerlings produced by shown in Table 21 and Table 22 show the survivals in the incubator process and Table 23 the quantity, season, fish size and number of fry released to each river.

Table 21. Annual release of chum salmon fry in Aysen, Chile (1974–1979)

Year	Simpson River		El Salto River		Pajarones Stream		Total	Remarks
	Unfed-fry	Fed-fry	Unfed-fry	Fed-fry	Unfed-fry	Fed-dry		
1974	645,000	—	—	—	—	—	645,000	KJ-73-B
1975	1,700,000	—	—	—	—	—	1,700,000	KJ-74-A, B
1976	1,732,000	—	80,000	—	—	—	1,812,000	KJ-75-A, B
1977	2,281,000	50,000	—	10,000	—	—	2,341,000	KJ-76-A, B
1978	—	1,500,000	228,000	—	—	—	1,728,000	KJ-77-A
1979	—	535,000	—	—	—	262,000	797,000	KJ-78
Total	6,258,000	2,085,000	308,000	10,000	—	262,000	8,923,000	Unfed
	8,343,000		318,000		262,000			Fed
								73.5%
								26.4%

Table 22. Chum salmon survival in the incubator process,
Coyhaique Hatchery, Aysen, Chile, 1974–1979

Code	Breed Year	Number of Eyed eggs	Dead egg	Hatch-out Sac-fry	Dead fry	Swim-up fry	%	Remarks
KJ-73-B	1974	1,000,000	200,000	800,000	155,000	645,000	64.5	(a)
KJ-74-A	1975	1,000,000	20,000	980,000	80,000	900,000	90.0	
KJ-74-B	1975	950,000	10,000	940,000	140,000	800,000	84.2	(b)
KJ-75-A	1976	1,000,000	1,000	999,000	29,000	970,000	97.0	
KJ-75-B	1976	1,000,000	1,000	991,000	155,000	836,000	83.6	
KJ-76-A	1977	1,000,000	10,000	990,000	170,000	820,000	82.0	
KJ-76-B	1977	2,000,000	39,000	1,961,000	300,000	1,661,000	83.0	
KJ-77-A	1978	2,000,000	61,000	1,939,000	600,000	1,879,000	94.0	
KJ-77-B	1978	1,000,000	1,000,000	—	—	—	0.0	(c)
KJ-78	1979	1,000,000	21,000	979,000	49,000	930,000	93.0	(d)
		11,950,000						

Remarks: (a) Experimental
 (b) 50,000 eyed egg lost in transport
 (c) All eggs died in transport
 (d) Feeding trial

Note: Breed year in Chile

Table 23. Chum salmon fry release quantity, season, fish size and river (1974–1979)

Coyhaique Hatchery, Servicio Nacional de Pesca, Region XI Aysen, Chile

Stock code	Number of eyed eggs from Japan	Number of released fry	Fry liberation					River	Remarks
			Date			Fish size			
			Dry	Man.	Year	g	mm		
1. KJ-73-B	1,000,000	645,000	15-26	May	1974	0.33	32	Simpson	Experiment
Total	1,000,000	645,000							
2. KJ-74-A	1,000,000	900,000	07-10	Jan.	1975	0.44	35	Simpson	Pilot release
3. KJ-74-B	950,000	800,000	20-25	May	1975	0.35	33	Simpson	Pilot release
Total	1,950,000	1,700,000							
4. KJ-75-A	1,000,000	976,000	08-27	Jan.	1976	0.45	35	Simpson	Pilot release
5. KJ-75-B	1,000,000	756,000	26-30	May	1976	0.37	35	Simpson	Pilot release
		80,000	28	May	1976	0.35	35	El salto	Experiment
Total	2,000,000	1,812,000							
6. KJ-76-A	1,000,000	820,000	15-31	Jan.	1977	0.33	34	Simpson	Pilot release
7. KJ-76-B	2,000,000	1,461,000	15-30	May	1977	0.35	37	Simpson	Pilot release
		50,000	30	Sep.	1977	1.74	59	Simpson	Feeding trial
		10,000	03	Oct.	1977	1.74	59	El salto	Experiment
Total	3,000,000	2,341,000							
8. KJ-77-A	2,000,000	228,000	27	Jan.	1978	0.30	35	El salto	Experiment
		1,500,000	24-25	Feb.	1978	1.24	54	Simpson	Pilot release
9. KJ-77-B	1,000,000	-0	All eggs were dead in transport which egg condition very bad.						
Total	3,000,000	1,728,000							
10. KJ-78	1,000,000	282,000	29-31	Aug.	1979	2.00	66	Simpson	Experiment
		253,000	09-10	Oct.	1979	3.60	77	Simpson	Experiment
		262,000	16-19	Oct.	1979	3.60	77	Pajarones	Experiment
Total	1,000,000	797,000							
Grand total	11,095,000	8,923,000							

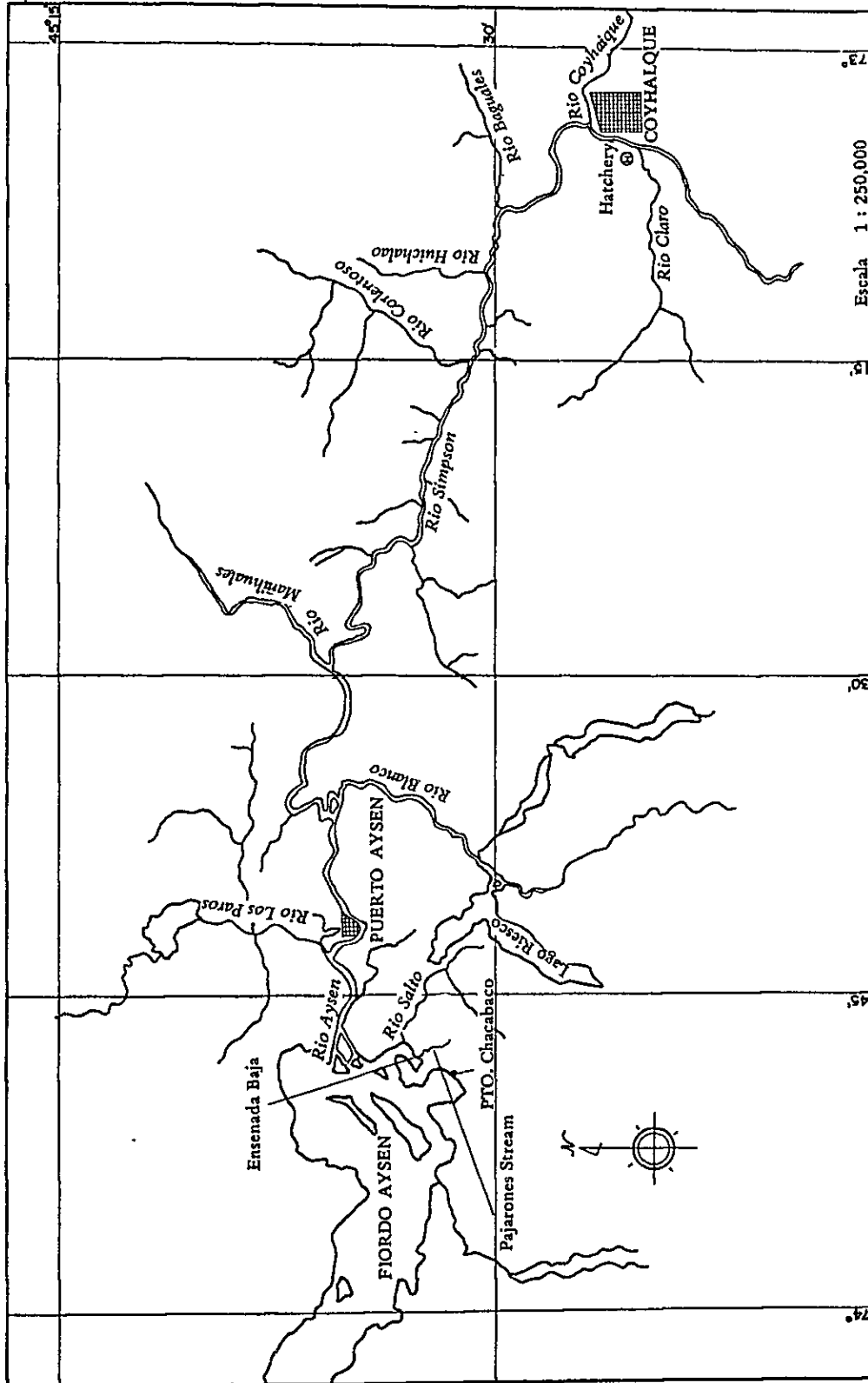


Fig. 20. Location of Pajarones Stream and Ensenada Bay

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Plate 1

Final measurement of wintered feeding trial in 1977.

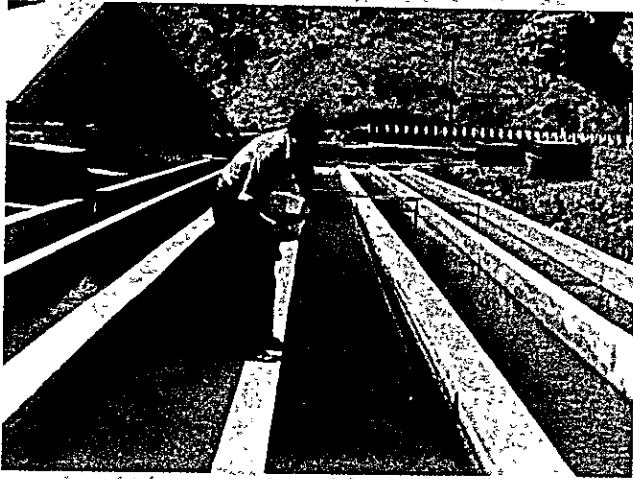


Plate 2

Hand-fed at the fry incubator channel for the summered feeding trial in 1978.

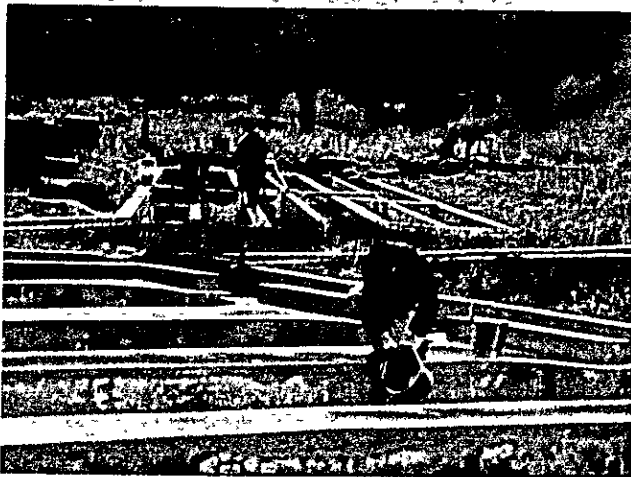


Plate 3

Ponding fry from the fry incubator channel for wintering trial in 1979.



Plate 4

Final measurement of wintered feeding trial in 1979.

Crowding fish.



Plate 5

Wintered fingerlings.



Plate 6

Scaling and Liberation.

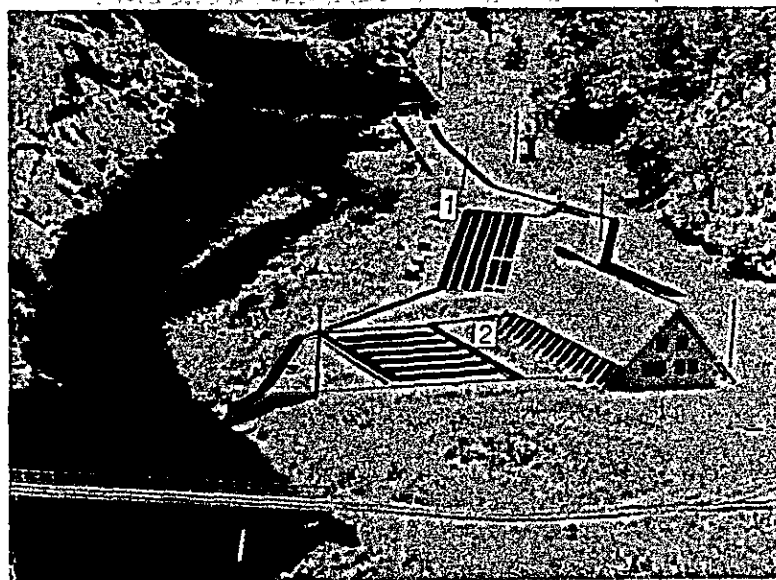


Plate 7

Birdview of the rearing ponds at Coyhaique National Hatchery, June 1979.

- (1) Fry incubator channel
- (2) Rearing pond



APPENDIX

Monthly Record of Chum Salmon Fry Feeding Trial in 1979.

(April - October)

Coyhaique National Hatchery, CHILE.



Appendix Table

CHUM ASLMON FRY FEEDING PROCESS IN COYHATQUE HATCHERY, 1979

Produced fry quantity;	930,000	(372 kg)
Date of start feeding;	26 April 1979	(Autumn)

Feeding beginning period

Period & days (D);	26 April-16 May 1979, 21 days	
Size of fish at start (W') ;	0.40 gr	3.51 cm
Size of fish at end (W'') ;	0.49 gr	3.82 cm
Number of fish (N') & weight at start (W') ;	930,000	372 kg
Number of Dead (Mn) & weight (Mw)	15,000	7.3 kg Mw = Mn.w''
Number of Escape (Xn) & weight (Xw)	45,000	22 kg Xw = Xn.w''
Number of Release (R)	---	
Number of fish (N'') & weight at end (W'');	870,000	426 kg N'' = N' - (Mn + Xn)
Survival (S) ;	93.55 %	S = (N''/N') 100
Total food given (F) ;	80 kg	
Food given per day ;	3.8 kg	1.0 % of W'
Food type;	Dried mixed feed	
Crumbele starter (Made in Japan)	80 kg	0.5 - 1.0 mm size
Crumble grower (Made in Japan)	-	
Pellet 2.5 mm (Made in Japan)	-	
Pellet 2.5 mm (Made in Japan)	-	
Boiled beef liver (Convert into Dry)	-	
Total weight of gain (W) ;	68 kg	W = (W''-W') + ½ (Mw + Xw)
Individual fish gain (w) ;	0.09 gr	w = w''- w'
Rate of growth (g) ;	1,23	g = w''/w'
Coefficient of food (f) ;	1.18	f = F/W
Water temperature (T) ;		
Average in this period	7.0° C	
Range (Minimum - Maximum)	3.0 - 10.8° C	

Unite temperature (U.T.) 137° C U.T. = T x D

Treatment;	None
Fruanace	-
Aivet	-
Daimeton	-
Chloromycetin	-

Note : Feeding at Incubator channel with 30 cm water depth

Number of dead – Daily hand counted include sample

Number of escape – Estimated

Number of fish – Round off

May

Period & days (D) ;	17 May-31 May 1979, 15 days	
Size of fish at start (w');	0.49 gr	3.82 cm
Size of fish at end (w'');	0.65 gr	4.11 cm
Number of fish (N') & weight at start (W') ;	870,000	426 kg
Number of Dead (Mn) & weight (Mw)	2,000	1.3 kg Mw = Mn.w''
Number of Escape (Xn) & weight (Xw)	---	
Number of Release (R)	---	
Number of fish (N'') & weight at end (W'') ;	868,000	564 kg N'' = N' - Mn W'' = N''.w''
Survival (S) ;	99.77 %	S = (N''/N') . 100
Total food given (F) ;	170 k	
Food given per day ;	11.3 kg	2.6 % of W'
Food type;	Dry curmble	
Crumble starter (Made in Japan)	170 kg	0.5 - 1.0 mm size
Crumble grower (Made in Japan)	-	
Pellet 2.5 mm (Made in Japan)	-	
Pellet 2.5 mm (Made in Chile)	-	
Boiled beef liver (Convert into Dry)	-	
Total weight of gain (W) ;	138 kg	W = W'' - W'
Insivdual fish gain (w) ;	0.16 gr	w = w'' - w'
Rate of growth (g) ;	1.32	g = w''/w'
Coefficient of food (f) ;	1.23	f = F/W
Water tempeeature (T) ;		
Average in this period	4.5° C	
Range (Minimum - Maximum)	1.0 - 7.5 ° C	
Unite temperature (U.T.)	67° C	U.T. = T x D
Treatment;	1 time in this period	
Fruanace	10 g/5000Lt, 15 min. Bathing	
Aivet	-	
Daimeton	-	
Chloromycetin	-	

Note: Fish move in feeding-pund from incubator channal on the day of 17-18 May after feeding trainning period was finished.

Number of dead -- Daily hand counted include ssmple

Number of fish -- Round off

Total gain (W) -- Does not provide for dead fish

June

Period & days (D) ;	01 June - 30 June 1979, 30 days	
Size of fish at atart (w') ;	0.65 gr	4.11 cm
Size of fish at end (w'') ;	1.02 gr	4.75 cm
Number of fish (N') & weight at start (W') ;	868,000	564 kg
Number of Dead (Mn) & weight (Mw)	2,000	2.0 kg $Mw = Mn.w''$
Number of Escape (Xn) & weight (Xw)	---	
Number of Release (R)	---	
Number of fish (N'') & weight at end (W'')	866,000	883 kg $N'' = N' - Mn$ $W'' = N''.w''$
Survival (S) ;	99.78 %	$S = (N''/N').100$
Total food given (F) ;	360 kg	
Food given per day ;	15 kg	2.6 % of W'
Food type;	Dry crumble	
Crumble starter (Made in Japan)	-	
Crumble grower (Made in Japan)	360 kg	1.0 - 1.5 mm size
Pellet 2.5 mm (Made in Japan)	-	
Pellet 2.5 mm (Made in Chile)	-	
Boiled beef liver (Convert into Dry)	-	
Total weight of gain (W) ;	319 kg	$W = W'' - W'$
Individual fish gain (w) ;	0.37 gr	$w = w'' - w'$
Rate of growth (g) ;	1.57	$g = W''/W'$
Coefficient of food (f) ;	1.13	$f = F/W$
Water temperature (T) ;		
Average in this period	4.4° C	
Range (minimum - Muximum)	- 0.5 ~ 7.7° C	
Unitetemperature (U.T.)	131° C	$U.T. = T \times D$
Treatmen;	2 time in this period	
Fruanace	10 g/500Lt, 15min. Bathing	
Aivet	10 g/500Lt, 15min. Bathing	
Daimeton	-	
Chloromycetin	-	

Note: Number of dead – Daily hand counted include sample
 Number of fish – Round off
 Total gain (W) – Does not provide for dead fish

July

Period & days (S);	01 July - 31 July 1979, 31 days	
Size of fish at start (w') ;	1.02 gr	4.11 cm
Size of fish at start (W") ;	1.59 gr	5.97 cm
Number of fish (N') & weight at start (W') ;	866,000	883 kg
Number of Dead (Mn) & weight (Mw)	1,000	1.6 kg Mw = Mn.w'
Number of Escape (Xn) & weight (Xw)	10,000	16 kg Xw = Xn.w''
Number of Release (E)	---	
Number of fish (N") & weight at end (W")	855,000	1,360 kg N" = n' - (M + X) W" = N".w''
Survival (S) ;	98.73 %	S = (N"/N') 100
Total food given (F) ;	624 kg	
Food given per day;	20 kg	2.3 % of W'
Food type:	Dry crumble & Boild beef liver	
Crumble starter (Made in Japan)	-	
Crumble grower (Made in Japan)	500 kg	1.0 ~ 1.5mm size
Pellet 2.5mm (Made in Japan)	-	
Pellet 2.5mm (Made in Chile)	-	
Boiled beef liver (Convert into Dry)	24 kg	Mixed with crumble
Total weight of gain (W) ;	488 kg	W = (W" - W') + ½ (Mw + Xw)
Individual fish gain (w) ;	0.57 gr	w = w" - w'
Rate of growth (g) ;	1.56	g = w"/w'
Coefficient of food (f) ;	1.27	f = F/W
Water temperature (T) ;		
Average in this period	4.4 C	
Range (Minimum ~ Maximum)	1.8 ~ 7.4 C	
Unite temperature (U.T.)	132 C	U.T. = T x D
Treatment;	2 time in this month	
Fruanice	10 g/500Lt, 15min.	Bathing
Aivet	10 g/500Lt, 15min.	Bathing
Daimeton	-	
Chloromycetin	-	

Note; Number of dead -- Daily hand counted include sample
 Number of fish -- Round off

Boiled beef liver 43 kg were given, contained water 48.3 %

August

Preiod & days (D) ;	01 Aug. - 31 Aug. 1979, 31 days	
Size of fish at start (w') ;	1.56 gr	5.97 cm
Size of fish at start (w'') ;	2.00 gr	6.59 cm
Number of fish (N') ; & weight at start (W') ;	855,000	1,360 kg
Number of Dead (Mn) & weight (Mw)	3,000	6 kg
Number of Escape (En) & weight (Ew)	---	
Number of Release (R) & weight (Rw)	282,000	564 kg
Number of fish (N'') & weight at end (W'') ;	570,000	1,140 kg
		$Rw = R \times w''$
		$N'' = (N' - Mn) - R$
		$W'' = N'' \times w''$
Survival (S);	99.65 %	$S = (N'' + R)/N'$
Total food given (F) ;	461 kg	
Food given per day ;	15 kg	1.1 % of W'
Food type ;	Dry pellet & Boiled beef liver	
Crumble starter (Made in Japan)	-	
Crumble grower (Made in Japan)	-	
Pellet 2.5 mm (Made in Japan)	120 kg	01-13 Aug. 13 days
Pellet 2.5 mm (Made in Chile)	270 kg	14-31 Aug. 18 days
Boiled beef liver (Convert into Dry)	71 kg	Mixed with pellet-J
Total weight of gain (W) ;	361 kg	$W = (W'' + R) - W' + (\frac{1}{2}Mw)$
Individual fish gain (w) ;	0.41 gr	$w = w'' - w'$
Rate of growth (g) ;	1.27	$g = W''/W'$
Coefficient of food (f) ;	1.28	$f = F/W$
Water temperature (T) ;		
Average in this period	4.6° C	
Range (Minimum ~ Maximum)	0.7 ~ 8.3° C	
Unite temperature (U.T.)	143° C	$U.T. = T \times D$
Treatment ;	1 time in this month	
Fruanace	10 g/500Lt, 15 min. Bathing	
Aivet	-	
Daimeton	-	
Chloromycetin	-	

Note : Number of dead – Daily hand counted include samlpe
 Number of fish – Round off

boiled beef liver 137 kg were given, contained water 48.3 %

Transport fish on the date of 29-30 Aug.

September

Period & days (D) ;	01 Sep.-30 Sep. 1979, 30 days		
Size of fish at start (w') ;	2,00 gr	6.59 cm	
Size of fish at end (w'') ;	2.81 gr	7.37 cm	
Number of fish (N') & weight at start (W') ;	570,000	1,140 kg	
Number of Dead (Mn) & weight (Mw)	8,000	22 kg	$Mw = Mn \times w''$
Number of Escape (En) & weight (Ew)	5,000	14 kg	$Ew = En \times w''$
Number of Release (R) & weight (Rw)	---	--	
Number of fish (N'') & weight at end (W'')	557,000	1,565 kg	$N'' = N' - (Dn + En)$ $W'' = N'' \times w''$
Survival (S) ;	97.72 %		$S = N''/N'$
Total food given (F) ;	960 kg		
Food given per day ;	32 kg	2.8 % of W'	
Food type ;	Dry pellet - J & C		
Crumble starter (Made in Japan)	-		
Crumble grower (Made in Japan)	-		
Pellet 2,5 mm (Made in Japan)	150 kg		
Pellet 2.5 mm (Make in Chile)	810 kg		
Boiled beef liver (Convert into Dry)	-		
Total weight of gain (W) ;	443 kg	$W = (W'' - W') + (1/2Mw)$	
Individual fish gain (w) ;	0.81 kr	$w = w'' - w'$	
Rote of growth (g) ;	1.40	$g = w''/w'$	
Coefficient of food (f) ;	2.17	$f = F/W$	
Water temperature (T) ;			
Average in this period	8.16° C		
Range (Minimum - Maximum)	3.3 12.6° C		
Unite temperature (U.T.)	182° C	$U.T. = T \times D$	
Teratment ;	None		
Fruanace	-		
Daimeton	-		
Chloromycetin	-		

Note: Number of dead -- Daily hund counted include sample
 Number of dish -- Round off

Dead fish -- About 75 % of then were death by some disease.
 It' views on the dropsy and liver impediment.
 It seem to come from Chilean pellet.

October

Peruid & Days (D) ;	01 Oct. - 15 Oct. 1979, 15 days	
Size of fish at start (w') ;	2.81 gr	7.37 cm
Size of fish at end (w'') ;	3,60 gr	7.70 cm
Number of fish (N') & weight (W') at start;	557,000	1.565 kg
Number of Dead (Mn) & weight (Mw)	5,000	18 kg
Number of Escape (En) & weight (Ew)	0	0 kg
Number of Release (Rn) & weight (Rw)	519,000	1.868 kg
Number of Unknown	33,000	-- since May
Number of fish (N'') & weight (W'') at end ;	---	--
Survival (S) ;	93,12 %	$S = Rn/N'$
Total food given (F) ;	150 kg	
Food given per day ;	10 kg	0,67 % of W'
Food type;	Dry Pellet	
Crumble starter (Made in Japan)	-	
Crumble grower (Made in Japan)	-	
Pellet 2.5 mm (Make in Japan)	150 kg	
Pellet 2.5 mm (Made in Chile)	No use	for preventive disease
Bioled beef liver (Convert into Dry)	-	
Total weight of gain (W) ;	312 kg	$W = (Rw - W') + \frac{1}{2} Mw$
Individual fish gain (w) ;	0.79 gr	$w = w'' - w'$
Rate of growth (g) ;	1.28	$g = w''/w'$
Coefficient of food (f);	0.48	$f = F/W$
Water temperature (T) ;		
Average in this period	7.5° C	
Range (Minimum ~ Maximum)	3.3 ~ 12.0° C	
Unite temperature (U.T.)	120° C	
Treatment ;	None	
Fruanace	-	
Aivet	-	
Daimeton	-	
Chloromycetin	-	

Note : Data and feeding closed on the day of 15 October.

Release -- 253,000 (850 kg) into Simpson River from Coyhaique hatchery in the date of 09 - 10 October.

266,000 (846 kg) transplant to Ensenada Baja Rearing station to the date of 16 - 19 October.

Survival -- Does not provide for Unknown fish which during all of feeding period since May.

Unknown -- Predatores, Cannibalis, etc. It eas 3.5% during 173 days.

E

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