

INTERNATIONAL PACIFIC SALMON  
FISHERIES COMMISSION

**PROGRESS REPORT**

No. 21

**EFFECT OF FEEDING BEFORE AND AFTER  
YOLK ABSORPTION ON THE  
GROWTH OF SOCKEYE SALMON**

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NEW WESTMINSTER, B. C.

CANADA

1969

INTERNATIONAL PACIFIC SALMON  
FISHERIES COMMISSION

Appointed under a Convention  
Between Canada and the United States for the  
Protection, Preservation and Extension of  
the Sockeye and Pink Salmon Fisheries  
in the Fraser River System

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1969

## ABSTRACT

The present study was carried out to determine how soon after hatching sockeye salmon (Oncorhynchus nerka) alevins would consume food and the effect of food consumption on subsequent growth. Six groups of alevins were reared under experimental conditions and the first food was introduced at different stages of development from just after hatching to beyond complete yolk absorption. Although alevins would eat very soon after hatching, food consumption prior to yolk absorption did not increase growth as compared with alevins held without feeding until yolk was completely used. However, when food was withheld until about a week after complete yolk absorption, subsequent growth was somewhat retarded. Alevins fed before yolk absorption appeared to consume larger quantities of food later in development than those denied food until yolk was absorbed. Also, if fry were denied food until well beyond yolk absorption, some refused to feed altogether. Thus although growth was not influenced by early feeding under these experimental circumstances, it is suggested that early association with food could influence feeding behavior through learning.

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EFFECT OF FEEDING BEFORE AND AFTER YOLK ABSORPTION  
ON THE GROWTH OF SOCKEYE SALMON

INTRODUCTION

Restoration and protection of sockeye salmon (Oncorhynchus nerka) populations of the Fraser River has involved the development of artificial aids to reproduction. As part of the development program, the Commission has sought to assess the effects of these artificial aids on the quality of fry produced. One area of considerable importance is the influence of these incubation environments on the feeding behavior of fry, especially with regard to initiation of feeding and availability of food.

Under normal hatchery conditions, food is generally introduced when fry reached the swim-up stage. However, in many hatcheries food is introduced too late, leading to large numbers of stunted or "pinhead" fry in the populations. Palmer et al. (1951) suggest that introduction of food should correspond to the critical time in development when fish first "feel the desire" to feed, in order to achieve maximum sustained growth and effective utilization of food. Thus if hatcheries are to be used in sockeye salmon propagation, the time of initial food introduction for this species must be clearly defined.

Even in streams and spawning channels the need for an external food source prior to emergence has been suggested by some investigators. In a study on the early feeding of young sockeye, Dill (1967) concluded that the poorer growth observed in sockeye fry emerging from Nanika incubation channel compared with that of wild fry of the same stock from Fifteen Mile Creek could be attributed to feeding by the wild pre-emergent alevins or fry, although supporting evidence was not forthcoming from stomach analyses. Similarly, other authors have suggested that feeding before emergence among young coho (O. kisutch) and chinook salmon (O. tshawytscha) could account from the higher survival of channel and wild fry over that of hatchery-incubated stocks (Salo and Bayliff, 1958; Thomas and Shelton, 1968).

It is difficult, however, to assess the role of early feeding when using emergence as a criterion. With respect to utilization of yolk reserves, emergence is a poorly defined period, being influenced by the type of incubation environment and also varying considerably between different

rates within the same species. Certain populations of sockeye fry emerge from the natural environment with considerable yolk material, while other populations are characterized by virtually no yolk reserves at emergence (Brannon, 1967; McCart, 1967; Mead and Woodall, 1968). Therefore, emergence in different populations of sockeye fry appears to have been shaped by natural selection for their specific environments, timed to occur at different stages during the period of yolk absorption, and hence the nutritional requisite for an external food source prior to emergence becomes debatable.

The present study was undertaken to obtain more information about the initiation of feeding in sockeye fry, to determine when young sockeye would first take food into their stomachs, and to measure the effect on growth of food consumption prior to yolk absorption. Early feeding behavior of wild sockeye fry was then compared with that noted in the experimental stocks.

#### MATERIALS AND METHODS

Throughout this report the terms "alevin" and "fry" are used constantly. In order that no confusion arises in the use of these terms, a short definition of each is given here. "Alevin" is the term used to denote the fish during the period from hatching to the completion of yolk absorption, and thus includes the body of the fish and the attached or encased yolk. The term "fry" denotes the fish after its yolk supply has been totally used and the fish must rely solely on an external food source.

The sockeye alevins and fry used in this study were incubated in Sweltzer Creek Field Station from eggs of Cultus Lake stock obtained November 20, 1964. Eggs were incubated to hatching in darkness in screen baskets (4 by 10 by 16 in.) placed in 7-ft hatchery troughs. Water temperatures during incubation were the same as Cultus Lake surface temperatures which dropped from 47°F in November to 39°F in January and February, and rose again to 42°F in March. By March 15, 1965, 50% of the eggs had hatched after accumulating 1050 to 1100 temperature units.

On April 1, 15 days after hatching, six groups of alevins, each numbering 600, were placed in separate troughs with an area of 2 sq ft per trough. Fresh lake water was supplied to each compartment with a flow maintained at a velocity of 15 mm per sec. The feeding study began on April 2 and continued under normal diurnal light conditions for a period of 98 days. During this period the water temperature rose from 48° to 58°F, and averaged 52°F.

The food initially supplied was 50 ml of live plankton per day, consisting of Copepoda, Cladocera and Rotifera obtained by screening water pumped from Cultus Lake. Because of physical abuse incurred through the pumping system it was suspected that some of the nutritional value of the plankton could have been lost. Hence about one week after the first feeding, the daily plankton diet was supplemented with 50 ml of homogenized beef liver. Initially, the alevins were fed at 2-hr intervals but as fish grew larger the frequency was reduced to three or four times per day.

Among the six experimental groups of alevins, feeding was started at different intervals to correspond with different degrees of advancement. Thus food was introduced to the first group at 1200 temperature units (about 100 temperature units past hatching) and subsequently at intervals of 100 to 200 temperature units to the five other groups, covering the period from just after hatching until well beyond yolk absorption (TABLE 1).

TABLE 1 - Feeding and sampling schedule for sockeye feeding study, 1965.

GROUP	FOOD INTRODUCED		SAMPLING INITIATED	
	Date	Temperature Units	Date	Temperature Units
A	April 2	1200	April 8	1200
B	April 14	1400	April 19	1500
C	April 19	1500	April 25	1600
D	April 25	1600	May 2	1600
E	May 7	1800	May 13	1800
Control-F	May 31	2350	April 8	1200

In most cases, sampling began when food was first introduced to each trough and was repeated every 100 temperature units thereafter up to 2000 units. Beyond 2000 temperature units, samples were taken every 200 units until the study ended on July 8 at 3200 temperature units.

The group used as the control (T) was sampled regularly throughout the study. During the first six weeks after hatching, fish in the control compartment were not fed, but when starvation threatened to eliminate the entire number, food was introduced and the recovery of those remaining was recorded.

To keep the numbers of fish similar in each trough, 25 fish were removed from each experimental group on every sampling date. In those troughs where food had not been introduced prior to the sampling date, the fish were discarded. All other samples were preserved in 10% formalin and 20 fish from each sample were weighed and measured (fork length) individually within two weeks after sampling. Alevins were dissected before weighing and both wet and dry weights of body and yolk were recorded. Dry weights were determined after oven drying for 24 hr at 98°C. Differences between groups were evaluated by an analysis of variance at several developmental intervals, and differences between the means at these intervals were compared using Duncan's multiple-range test (Steel and Torrie, 1960). The remaining fish from each sample were examined for evidence of feeding.

To compare the extent of feeding in the experimental situation with that occurring naturally, sockeye alevins and fry were sampled from several different streams in the Fraser watershed. The wild fish examined covered the range of development from alevin to post-migrating fry. In all cases, the extent of feeding was recorded by assigning a minus sign where no obvious evidence of food was observed in the digestive tract, up to a maximum of four plus signs if the stomach and intestine were reasonably full of food. One plus indicated some food consumption, such as a portion of an insect, either in the stomach or intestine, and two or three plus signs indicated successively greater quantities.



## RESULTS

## Growth

Dry weight measurements of yolk during the study showed that yolk was completely absorbed between 1600 and 1700 temperature units in both fed and unfed fish (FIGURE 1). Therefore groups A, B, C, and D received their first food respectively at approximately 450, 250, 150, and 50 temperature units before complete yolk utilization, and groups E and F were first fed at approximately 150 and 700 units after yolk absorption.

Alevins in the control group (F) increased in both length and dry weight until the yolk stores were absorbed. After yolk utilization, length remained the same while the dry weight decreased to 59% of its former value, prior to the introduction of food at 2350 temperature units (TABLE 2). The groups fed before yolk absorption showed the same trend in growth before complete yolk utilization as the control group. Thus groups A, B, C, D, and F showed no statistically significant differences in dry weight ( $F = 1.45$ ) or length ( $F = 1.54$ ) at yolk absorption, irrespective of the presence or absence of food.

After yolk absorption, comparison of these groups showed the effects of early and delayed feeding on subsequent growth. Groups A, B, C, and D, having received food initially at different times prior to complete yolk absorption, continued to grow without significant differences occurring among the four in either length or weight throughout the study (TABLE 2). Using Duncan's multiple-range test, no significant differences were found at the 5% level. Initially there appeared to be a tendency for alevins fed earlier to be larger than their succeeding group, however, this tendency eventually reversed itself.

Groups E and F, which were not fed prior to yolk absorption, were affected successively more severely as feeding was delayed. Group E fry, denied food 150 units (9 days) after yolk utilization, were considerably smaller when food was first presented at 1800 temperature units than either

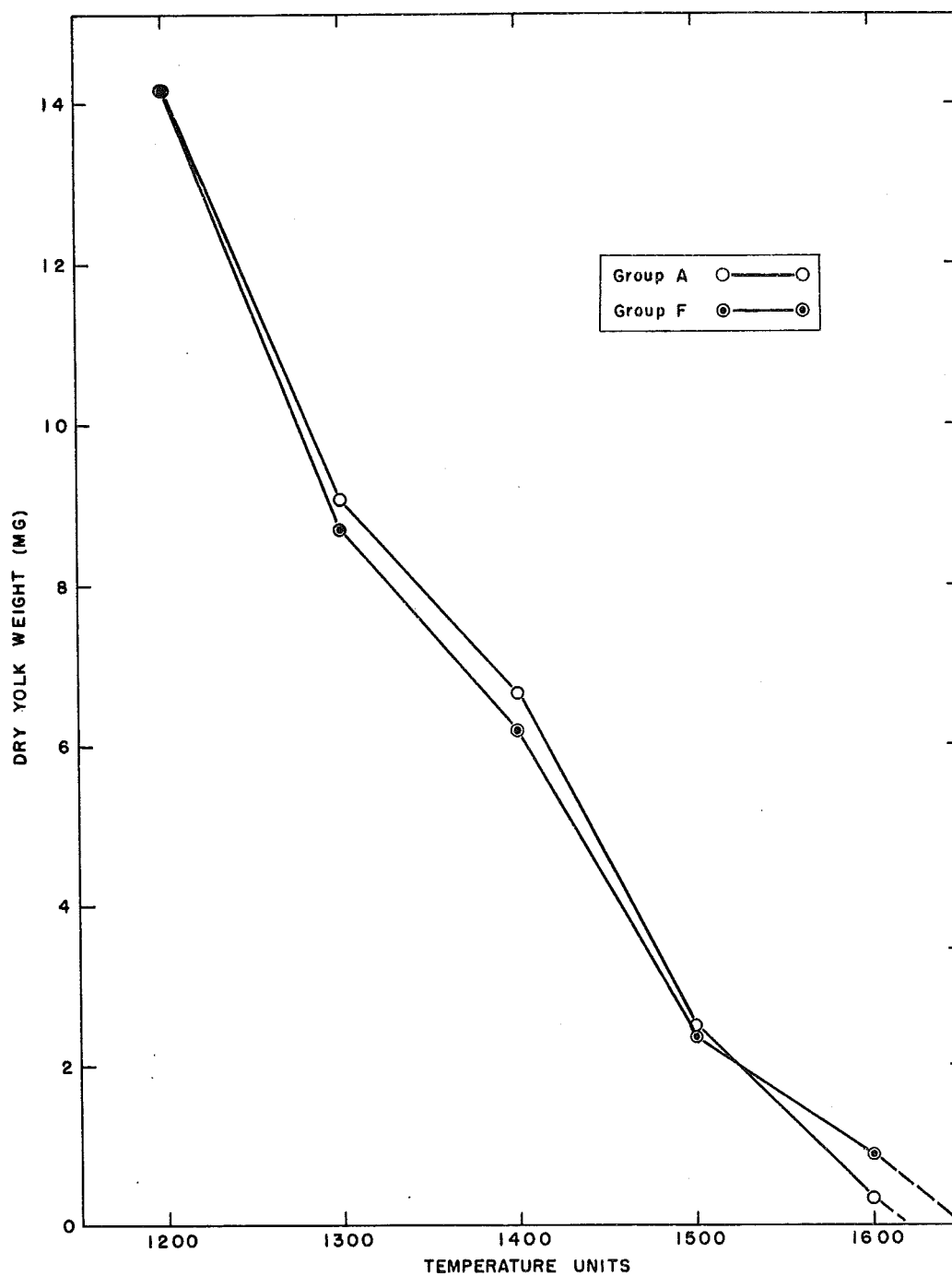


FIGURE 1 - Decreasing weight of yolk during period of yolk absorption in alevins from groups A and F.

TABLE 2 - Mean dry body weights and lengths, with standard error of mean, of alevins and fry from the six experimental groups sampled at intervals of 200 temperature units. Temperature units (TU) at first food introduction shown for each group.

Temp. Units at Sampling	Experimental Group					
	A (1200 TU)	B (1400 TU)	C (1500 TU)	D (1600 TU)	E (1800 TU)	F (2350 TU)
	<u>Dry Body Weight (mg)</u>					
1200	9.8± 0.3	9.8± 0.3	9.8± 0.3	9.8± 0.3	9.8± 0.3	9.8± 0.3
1400	16.5± 0.4					15.2± 0.2
1600	20.0± 0.7	19.7± 0.6	19.2± 0.6	18.4± 0.3		19.0± 0.4
1800	22.3± 0.8	24.4± 0.6	23.6± 0.7	22.2± 0.8	19.1± 0.5	20.2± 0.6
2000	32.3± 1.0	34.0± 1.6	34.6± 1.4	30.1± 1.1	26.7± 0.7	14.7± 0.4
2200	43.8± -	54.0± 3.1	47.3± 2.4	39.1± 2.0	34.6± 1.6	13.4± 0.4
2400	59.3± 2.7	73.6± 2.7	63.7± 4.1	61.0± 2.3	51.1± 1.4	11.9± 0.6
2600	78.8± 4.2	72.4± 5.3	74.5± 4.0	70.5± 3.7	66.3± 2.8	13.8± 0.6
2800	93.4± 6.0	112.3± 7.8	110.4± 4.0	91.0± 5.4	84.0± 3.1	23.3± 2.2
3000	140.4± 7.0	138.3± 6.9	127.8± 6.0	108.6± 6.0	98.4± 5.7	41.1± 2.5
3200*	158.4± 6.3	176.4± 9.0	160.5± 7.7	179.6± 8.2	160.1± 5.8	67.8± 6.3
	<u>Length (mm)</u>					
1200	22.3± 0.1	22.3± 0.1	22.3± 0.1	22.3± 0.1	22.3± 0.1	22.3± 0.1
1400	25.1± 0.2					24.9± 0.1
1600	27.5± 0.2	26.9± 0.2	27.1± 0.2	26.9± 0.1		27.0± 0.3
1800	28.0± 0.2	28.7± 0.2	28.0± 0.2	28.2± 0.2	27.4± 0.2	28.0± 0.2
2000	29.6± 0.2	30.1± 0.2	30.4± 0.2	29.7± 0.2	29.1± 0.4	27.4± 0.2
2200	33.0± 0.5	34.1± 0.4	32.6± 0.4	31.4± 0.3	30.9± 0.3	27.1± 0.3
2400	34.1± 0.4	35.9± 0.3	33.6± 0.6	33.7± 0.4	31.5± 0.2	28.2± 0.3
2600	37.4± 0.4	36.2± 0.6	36.3± 0.6	35.2± 0.4	35.7± 0.4	27.8± 0.2
2800	39.4± 0.7	40.7± 0.8	40.6± 0.5	38.0± 0.6	37.6± 0.5	28.7± 0.3
3000	44.3± 0.7	44.6± 0.6	43.6± 0.6	41.7± 0.6	40.6± 0.7	31.3± 0.5
3200*	45.6± 0.5	46.7± 0.6	46.0± 0.6	47.6± 0.7	45.4± 0.5	34.8± 0.6

\* At 3200 temperature units, 40 fry sampled from groups A to E, 14 fry from group F. At all other intervals each sample included 20 fish.

A, B, C, or D. Fry in group E were unable to overcome this size difference during most of the course of the study but reached the same size as groups A and C by 3200 temperature units (see FIGURES 2 and 3 where, for clarity, groups B and D have been omitted). The fry in group F were denied food the longest and hence were smallest. However, although the fry were starved 32 days and severely emaciated, the mean dry weight increased at about the same rate as the other groups, once food was introduced. By the end of the study, however, variability in dry weight was much more pronounced in group F fry (67.8 mg, SD 23.6) than among other groups when compared at a similar size (66.7 mg, SD 14.3). Also, since death had removed such a large number of the small and weak fish, those remaining in group F probably presented a very biased sample.

Wet weights followed the same trend as dry weights, increasing from approximately 140 mg at 1600 temperature units to over 900 mg in groups A to E and to 450 mg in group F by the end of the study.

### Mortality

Mortalities of alevins and fry during the study formed a trend in both total loss and time at which death occurred within each of the six experimental groups. With the exception of group F, fish which received food earliest experienced the highest mortality, with progressively fewer deaths occurring among those fed later (TABLE 3). The mortalities among these fish were not characteristic of losses caused by starvation. Alevins fed early (A and B) experienced higher mortality just after food was first found in their stomachs, whereas those initially fed near yolk absorption (D and E) showed very low mortality after feeding.

Fry from group F were not given the opportunity to feed until several fish had died from starvation. Although fed regularly during the following three weeks, most of these pinhead fry refused to respond to food and thus experienced the greatest mortality.

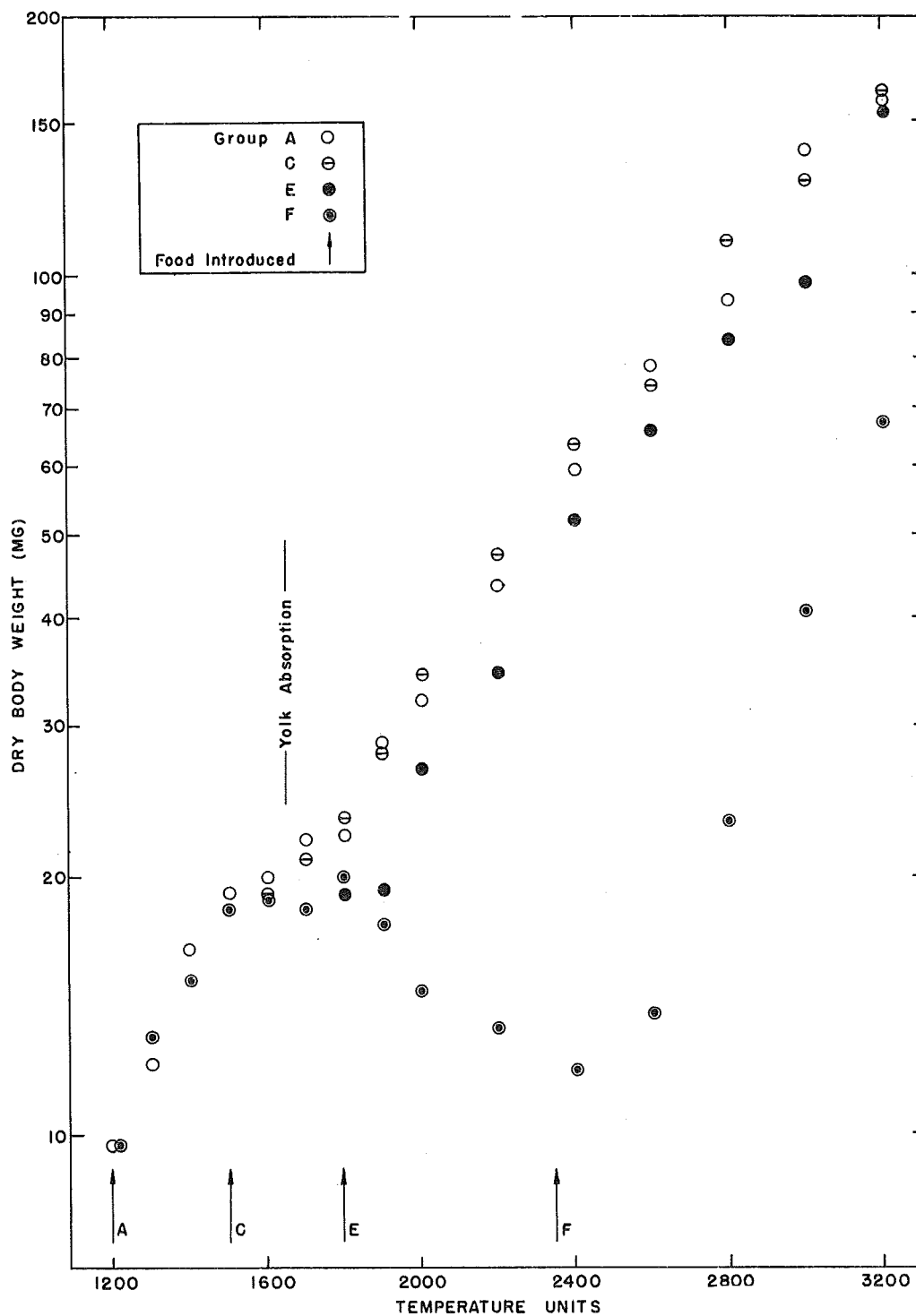


FIGURE 2 - Increase in dry body weight of sockeye alevins and fry fed before and after yolk absorption.

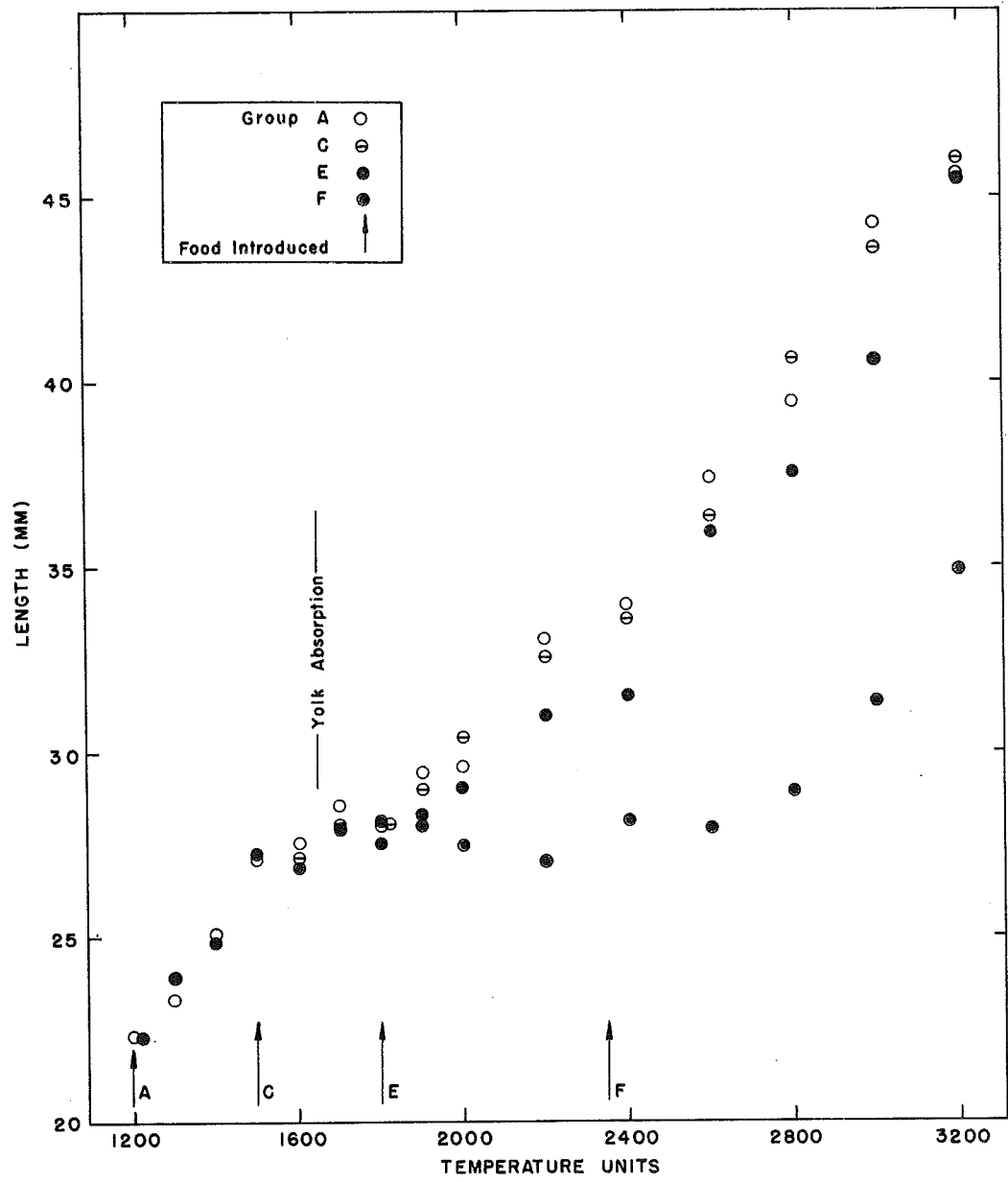


FIGURE 3 - Increase in length of sockeye alevins and fry fed before and after yolk absorption.

TABLE 3 - Mortality of sockeye alevins and fry in groups A to F at intervals of 100 or 200 temperature units. Temperature units (TU) at first food introduction shown for each group.

Temperature Units at Sampling	Mortality					
	A (1200 TU)	B (1400 TU)	C (1500 TU)	D (1600 TU)	E (1800 TU)	F (2350 TU)
1300	1	4	1	3	3	0
1400	2	5	2	2	1	5
1500	29	9	0	0	0	1
1600	4	3	4	2	1	0
1700	2	2	1	1	0	0
1800	0	0	4	1	0	0
1900	0	1	2	1	0	0
2000	1	0	0	0	0	0
2200	0	1	0	0	0	0
2400	0	0	1	0	0	84
2600	0	0	0	0	0	83
2800	2	1	1	1	0	27
3000	3	2	3	1	1	3
3200	7	7	2	4	2	0
Total	51	35	21	16	8	203
*Adjusted % Mortality	13.5	9.6	5.5	4.3	2.0	84.7

\* Adjusted for the 25-fish samples removed at intervals throughout the study.

### Feeding

Although food was presented to the alevins in certain experimental groups shortly after hatching, the newly hatched alevins did not exhibit the pronounced feeding behavior observed among older alevins in this study. To determine when food was first eaten and estimate the amount of food consumed, stomach contents of fish from each trough were examined periodically. Results indicated that the alevins in group A were not feeding at 1300 temperature units, 100 temperature units after the first food was supplied. However, by 1400 temperature units, food was present in the stomachs of three of the four alevins examined (TABLE 4). In contrast, the other groups fed later in development consumed food shortly after it was made available.

Examination of stomach contents also indicated that those fish given the opportunity to feed earliest appeared to consume more food later in development than fish denied early association with food. On every sampling date the quantity of food found in the stomachs formed a trend, with most food consumed by fish from group A and progressively lesser amounts in alevins from groups fed later (TABLE 4).

It should be noted that while the water supply was screened to collect plankton, it was not completely filtered and thus there may have been some food material available to the alevins in the control group. However, no evidence of food consumption was found during the period when food was withheld, although the stomachs of some alevins contained small quantities of debris.

To compare the feeding behavior noted in this study with that of alevins and fry in their natural environments, young sockeye from several different streams in the Fraser watershed were examined for evidence of feeding. Alevins from Adams River, Chilko River, and Weaver Creek were sampled from their redds; fry from the same streams, from Stellako River, and from Seven Mile Creek were sampled while migrating shortly after emergence; Adams River fry were sampled from their nursery lake.

Results indicated no evidence of feeding in alevins prior to emergence from the gravel (TABLE 5). In fact, even after emergence, samples of



TABLE 4 - Number of fish feeding\*\* and averaged relative volume of food found in stomachs of all fish sampled at intervals during the study. Temperature units (TU) at first food introduction shown for each group.

Temperature Units at Sampling	Feeding Frequency and Volume Consumed					
	A (1200 TU)	B (1400 TU)	C (1500 TU)	D (1600 TU)	E (1800 TU)	F (2350 TU)
1300	0/4 -					0/4 -
1400	3/4 ++					0/5 -
1500	5/5 +++	2/4 ++				3/5 -
1600	4/5 +++	4/5 ++	5/5 ++			1/5 -
1700	5/5 ++++	1/1 +++	5/5 ++++	4/5 ++		1/5 -
1800	2/2 ++++	5/5 ++++	3/4 +++	4/5 +++	1/5 +	0/5 -
1900	5/5 ++++	4/5 +++	3/5 ++	4/5 ++	4/5 ++	1/5 -
2000	5/5 ++++	5/5 ++++	4/5 +++	5/5 ++++	5/5 ++	1/5 -

\*\* Number fish containing food/number fish examined. Fish in group F contained small quantities of debris.

TABLE 5 -- Body and yolk weights, and relative amounts of food in stomachs of sockeye alevins and fry sampled in their natural environments.

Location	Date Sampled	No. of Fish Examined	No. With Food	<u>Dry Weight</u>		Relative Amount of Food Present
				Body (mg)	Yolk (mg)	

ALEVINS

Adams River	Apr. 5/68	14	0	24.1	3.30	-
	May 2/68	7	0	24.6	0.53	-
Chilko River	May 8/68	7	0	21.5	0.66	-
Weaver Creek	Feb. 27/67	5	0	20.7	17.96	-
	Mar. 28/68	24	1	26.8	7.00	-
	Apr. 17/68	7	0	24.6	0.00	-

MIGRATING FRY

Adams River	Apr. 22/68	7	0	25.5	0.82	-
Chilko River	May 2/68	7	0	21.2	0.50	-
	May 5/68	7	3	21.9	0.00	+
Stellako River	May 12/68	14	3	19.3	0.33	-
Weaver Creek	Apr. 10/67	20	8	32.3	0.34	+
	Apr. 13/67	26	8	31.1	0.00	+
Seven Mile Creek*	Apr. 23/67	6	1	34.1	2.23	-
	Apr. 30/67	20	0	40.0	2.34	-

POST-MIGRATING FRY

Adams River	May 18/68	35	25	23.3	0.00	+++
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\* Pitt River system.

migrating fry as a whole showed little evidence of having eaten and many still showed the dark green bile in the intestine characteristic of the pre-feeding alevins. It was not until the post-migrating Adams fry had reached the nursery lake that the quantity of food consumed even approached that found in alevins from the experimental feeding study. Furthermore, there was considerable variation in the stomach contents of these lake-resident fry. Some fry captured several miles from the mouth of Adams River showed little evidence of food consumption while others had eaten considerable amounts.

### DISCUSSION

The purpose of this study was to determine whether sockeye alevins would consume food prior to complete yolk absorption, and if so, whether growth would be influenced accordingly. Under the laboratory conditions maintained in this study, the data have established that alevins can and will feed prior to complete yolk absorption if given the opportunity. Visual observations during the study showed that the alevins were actively feeding. In addition, examination of the stomach contents revealed that food was present when the alevins still possessed relatively large amounts of yolk.

However, with respect to the effects of early feeding, no support was forthcoming for the premise that some size advantage is thus gained for the alevin. There was no evidence during the early stages of growth covered in the investigation that feeding prior to complete yolk utilization made any contribution to the immediate or subsequent size of the fish. In fact, in view of the mortalities observed in groups A and B, it would appear that early feeding may be a disadvantage to the alevin. Furthermore, considering the absence of food in stomachs of the wild alevins and fry examined, not only does the significance of feeding before emergence become questionable, but it is doubtful that it even occurs sufficiently often to influence the growth or condition of this species in the natural environment.

Therefore the only significance that one might place upon the precocious feeding observed in this study is that it was simply a manifestation of an important motor act in response to a stimulus presented too early under

abnormal circumstances. This does not circumvent the possibility, however, that the act of taking food as an alevin, although of no significance to growth, may be important in the ontogenetic development of feeding behavior. Through learning, coordination of the motor responses involved in the feeding act could provide an advantage to the fry under competitive circumstances once emergence occurs. Stomach analysis indicated that fry would consume more food if they had an early association with food as alevins. Moreover, among fry denied food longest there was a decided reluctance to start feeding once food was available, which implies that learning is involved in feeding behavior, and if denied the opportunity to feed beyond a particular period, fry could refuse to feed altogether. Therefore, although this study has shown that sockeye receive no immediate physical enhancement from early feeding, there is evidence that some benefit may be derived from association with food shortly before yolk absorption is complete.

Delay in feeding can and does occur in nature. Fry can be trapped in the gravel beds when winter low water levels fail to rise soon enough to allow fry to emerge. If the periods of delay are extensive, it is common to find stunted fry dead or dying from starvation. This has been observed among pink (O. gorbuscha), chum (O. keta) and chinook salmon fry in the Harrison River and sockeye fry in the Adams River. Based on experimental results, it appears that even if rising water levels eventually release these fry and provide access to feeding areas, many may not recover.

Wild fry sampled following emergence at normal water levels from several areas of the Fraser River system showed little indication of feeding before entrance into their nursery lake. Individual fry, however, occasionally showed evidence of food consumption either just before or at emergence. Similarly, recently emerged sockeye fry sampled from other river systems have shown evidence of feeding. McCart (1967) reported food in 40% of the yolk fry and 90% of the non-yolk fry examined after emergence in the Babine River. Rogers (1968) reported considerable food in the stomachs of fry captured in Bear Creek, tributary to Lake Aleknagik, Alaska. In all instances, however, presence of food in post-emergent fry offers little evidence of the magnitude of feeding prior to emergence from the gravel.

Other investigators have reported extensive incidence of early feeding in other species of salmon. Thomas and Shelton (1968) reported that from 70 to 100% of the chinook salmon fry migrating from the Abernathy incubation channel were found to have been feeding on plankton in the gravel before migration, and suggest that this may explain the better survival among wild migrants compared with unfed hatchery releases. Salo and Bayliff (1958) also suggested that feeding by wild coho fry might account for their higher survival as compared with hatchery-reared fry. What is believed to be true for other species of Oncorhynchus, however, is not necessarily applicable to sockeye. Unlike sockeye, chinook and coho salmon are stream dwellers and may exhibit different behavior before leaving the vicinity of the redd site than the lake-dwelling species. As indicated by the field data and experimental results of this study, any assumption of increased survival due to growth from feeding prior to emergence is not warranted for sockeye. And thus in advancing the view that survival could be enhanced by feeding prior to emergence, it is suggested that this applies only to the behavioral implications of early feeding, based on the populations examined.

One assumption which should be mentioned is the conviction on the part of many of those involved in hatchery operation that feeding prior to yolk absorption assists in giving the fish a good start and greatly decreases the occurrence of stunted or pinhead fry. In general, the results of this study do not justify this assumption about sockeye. However, with normal variability in the time of yolk absorption among fry from even one day's egg take, a delay in feeding until approximately mean yolk absorption would inevitably result in the faster developing fry experiencing a period of starvation, and tending to become pinheads. Also, under highly competitive and crowded circumstances, the opportunity to learn by timely association with food prior to its nutritional requirement could reduce the occurrence of fry stunted from competitive isolation.

The results of this study indicate that although sockeye alevins will consume food long before the end of yolk utilization, food consumed at this time will not directly enhance growth. From the standpoint

of behavioral considerations, however, food availability might be required prior to the nutritional requisite for an external food source, and with respect to the hatchery situation, food should be present when the first fish have reached the "buttoned-up" stage.

#### SUMMARY AND CONCLUSIONS

1. A study was made to determine how soon after hatching sockeye alevins would consume food and what influence it would have on growth. Shortly after hatching, 3600 alevins were divided equally into six groups, each of which was placed in a separate trough and reared under identical experimental conditions for 98 days. The first food was introduced to each group at different stages of development from just after hatching to beyond complete yolk absorption.

2. Alevins consumed food shortly after hatching, but under the experimental conditions growth was not significantly influenced unless food was withheld until after yolk reserves were utilized.

3. Among the alevins fed prior to yolk absorption, those fed earliest had the highest mortality, with progressively fewer deaths occurring among alevins fed later.

4. Alevins having experienced an early association with food seemingly consumed food more readily as fry than those from which food was denied until yolk absorption. When food was denied until after yolk utilization some fry would refuse to feed altogether. Thus it is suggested that early association with food could influence feeding behavior through learning.

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