

Original: Fish Division
cc: Mr. Ruhl
Dr. Wolf
Mr. Wilkinson
Mr. Shust

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

A. S. HAZZARD
DIRECTOR

November 13, 1936

ADDRESS
UNIVERSITY MUSEUMS
ANN ARBOR, MICHIGAN

REPORT NO. 395

BROOK TROUT FEEDING EXPERIMENTS AT THE THOMPSON

HATCHERY, MICHIGAN

SUMMER, 1936

During the summer of 1936 feeding experiments were conducted with brook trout fingerlings at the Thompson Hatchery, Michigan. The purpose of these experiments was to shed some light upon (1) the relative merits of a canned fish feed for trout (Balto) and a certain mixture of dry meals, and (2) the relative value of sheep liver and pork melts as supplements for the two afore-mentioned feeds. In connection with the second problem, it should be recalled that it is generally accepted at the present time among fish culturists that some raw meat must be included in the diet of trout. Since pork melts are considerably cheaper than liver, it becomes important to know whether, regardless of their value as a sole feed, they are of equal value as a supplementary feed.

The experiments were started on July 20 and were terminated on September 10, thus running for a period of 53 days. It must be admitted at the outset that 53 days is too short a time in which to prove very much about trout feeds, therefore the expression "shed some light upon" has been used advisedly in the paragraph above.

The fish were kept in troughs, two troughs connected in series being devoted to each of the eleven feeding groups. One thousand fish from a thoroughly mixed group were counted out into each trough, this making two thousand fish in each of the experimental lots. Eleven counts were made of one-pound samples of fish from the various troughs, and the average of these eleven weighings gave the figure 349 fish per pound. This, then, was the size of the fish at the beginning of the experiment.

The diets which were used consisted of the following:

- (1) Balto fed pure six days a week. No feeding was done on Sunday in any of the experiments.
- (2) Balto 5 days, sheep liver 1 day.
- (3) Balto 4 days, sheep liver 2 days (successive).
- (4) Balto 5 days, pork melts 1 day.
- (5) Balto 4 days, pork melts 2 days (successive).
- (6) Dry meals 6 days a week.
- (7) Dry meals 5 days, sheep liver 1 day.
- (8) Dry meals 4 days, sheep liver 2 days (successive).
- (9) Dry meals 5 days, pork melts 1 day.
- (10) Dry meals 4 days, pork melts 2 days (successive).
- (11) Sheep liver 6 days a week.

Balto is a commercial product which we understand consists of cooked mackerel with a small addition of wheat middlings. It was fed directly from the can with no further preparation.

The raw meats were fed by hand without thinning by the addition of water.

The dry meal feed consisted of a mixture of approximately equal parts of cotton seed meal, white fish meal, and dry skim milk. This mixture was moistened with sufficient water to make a very thick paste or cake. It was always mixed up at least one day before feeding so that it would stick together better, and was fed by hand.

Because of the pressure of other work, it was not possible to keep a record of the weights of feed consumed by the fish. They were all fed once a day and were given all they would eat, care being taken not to waste any more feed than could be helped. This absence of any quantitative data naturally lessens the value of the experiment. For instance, the trout always gorged themselves on raw meat days and ate considerably less on dry meal days. It was foreseen that such a situation

might arise and therefore the meat was fed at the end of the week so that the Sunday fast would intervene before resumption of meal feeding, thus causing the fish to be quite hungry when meal feeds were resumed. This may have helped the situation somewhat, but did not wholly overcome the difficulty in getting the fish to take meals when alternated with meat.

A word of explanation is necessary as to our reason for feeding the meat supplement on separate days rather than directly with the meals and Balto. The latter method has the advantage that the raw meat helps bind the meals together, and does away with the disadvantages connected with switching from one diet to another. But the former method, if it proved at all satisfactory, would effect a saving in several respects. In Michigan a number of the trout rearing stations are located in remote areas where it costs a great deal to deliver raw meat twice a week. Refrigeration facilities for holding more than a three-day supply of raw meat are not at present available and would cost a good deal to create. Therefore it would effect a great saving in transportation and refrigeration costs if the necessary raw meat could be fed on a single day, or on two consecutive days in the week, and the meat room remain empty on the other days. This consideration does not affect the Balto or dry meals which are easy to store and of which an entire season's supply could be sent to a rearing station at one time.

In Table I is presented the data regarding the growth of the fish and their mortality on the various diets:

(See Table I)

A comparison between pure Balto, pure meal mixture, and pure sheep liver (diets 1, 6 and 11) shows that the sheep liver was far superior to the other diets in promoting growth. Fish on the liver gained 163% of their initial weight during the period of the experiment. The meal mixture gave better results than the Balto, the fish increasing 61% and 50% in body weight respectively. A knowledge of the amount of food consumed by the three lots would be interesting. We know from observation that the liver-fed fish ate the most and the meal-fed ate the least.

Table I

Diet	No. per Lb. Sept. 10	Total Mortality	% Increase in Weight
(1) Balto 6 days	233	3	50%
(2) Balto 5, Sheep liver 1	197	2	77%
(3) Balto 4, Sheep liver 2	183	5	91%
(4) Balto 5, Pork melts 1	211	3	65%
(5) Balto 4, Pork melts 2	193	1	81%
(6) Meals mixture 6 days	217	30	61%
(7) Meals 5, Sheep liver 1	198	14	76%
(8) Meals 4, Sheep liver 2	183	19	91%
(9) Meals 5, Pork melts 1	202	31	73%
(10) Meals 4, Pork melts 2	196	16	78%
(11) Sheep liver 6 days	133	10	163%

The initial weight of all fish was 349 per pound.

The cost of the liver was 9 cents per pound, the Balto 6 cents, and the meal mixture 4.47 cents. It is obvious, therefore, even in the absence of quantitative data, that when price is taken into consideration the liver does not have such a great advantage over the other feeds as the gain in weight would indicate. By the same reasoning the meals increase their advantage over the Balto.

In both the Balto and the meal experiments, a two-day raw meat supplement produced better growth than did a one-day supplement, and in both cases the liver produced better growth than the melts. It is interesting to observe, however, that in all cases a two-day melts supplement was better than a one-day liver supplement. Since liver, at the time of the experiment cost almost three times as much as did the melts, this would indicate that two supplements of pork melts per week were more economical in producing trout flesh than one supplement of sheep liver.

While the pure meals made a better showing than did the pure Balto (Experiments 1 and 6), the meals plus meat gave almost identical results with the Balto plus meat - certainly the differences are too slight to be significant. Thus experiment 2 and 7, in both of which sheep liver was fed one day, gave almost identical results. The same is true of experiments 3 and 8 where sheep liver was fed two days. In experiments 4 and 9, where melts were fed one day, the results are quite close; and the same holds true of 5 and 10 in each of which pork melts were fed two days. This might indicate that in all eight experiments the fish were eating only the raw meat, and entirely rejecting the Balto and meals. But if this had been so, the ratio of food consumed in experiments 2, 3, and 11, and in 7, 8, and 10, should have been about 1 : 2 : 6, and the growth might have been expected to have occurred approximately in some such ratio. Actually the ratios for growth are roughly 1 : 1.2 : 2.1. In fact, the single feeding per week, in the absence of all other food, might have been largely used up in meeting the maintenance requirements of the trout and therefore have given rise to no weight increase whatever. In that case the actual ratio of increase departs even more widely from that expected on the theory that the fish ate no Balto or meals. Of course, there is

the possibility that on the pure liver diet the fish were grossly overfed and that therefore the conversion of feed into flesh was very inefficient. It may be that feeding fingerling trout all the liver they will eat six days a week is gross overfeeding, but would the fact that the fish which were fed meat twice a week did not gain twice as much as the group fed only once also be attributed to overfeeding of the former?

As regards mortality during the experiment, the advantage was clearly on the side of the Balto. Why this should be so cannot be explained from our data. No examinations were made of the dead fish, and it is possible that such examinations might have yielded clues. Particularly surprising is the fact that the mortality was higher in the liver-fed group (pure liver) than in any of the Balto-fed.

The experiments yielded data upon one other point which was not incorporated in Table I. It has been explained that each experimental group consisted of 2000 fish of which 1000 were in an upper trough and the other 1000 in a lower trough connected serially with the upper. In Table I the data on each 2000 fish have been combined and treated as though each entire group had been in one trough. However, at the termination of the experiment each trough full of fish was weighed separately. These weights are given in Table II.

(See Table II)

It will be noted that in all but one case the fish in the upper trough were larger at the conclusion of the experiment than those in the lower. This difference runs all the way from less than 1% to 18%. The exception to this trend was diet 9. Probably anyone who has had experience weighing fish in a hatchery will agree that a difference of five fish in a lot which runs 200 to the pound is too small to be significant. Such differences occur in consecutive weighings of the same sample and are not to be overcome except by methods which are extremely laborious and imperil the life of the fish. Therefore we may well exclude lots 6, 9, and 11 and state that these groups showed no significant size differences between the upper and lower troughs, but that the remaining eight groups showed an advantage in favor of the upper trough.

Table II

Group Number (See Diets)	Number of Fish per Pound		% Advantage of Upper Trough
	Upper Trough	Lower Trough	
1	214	253	+ 18
2	190	205	+ 8
3	176	190	+ 8
4	204	218	+ 6
5	185	201	+ 9
6	215	220	+ 2
7	191	206	+ 8
8	176	191	+ 9
9	204	201	- 2
10	193	200	+ 4
11	133	134	+ 1

The explanation for these results is not obvious. Pollution could hardly have been a factor as there was very little of it. Lack of oxygen in the lower troughs may have influenced the results, but the troughs were not over crowded even at the end of the experiment. However, the latter possibility is the only one which occurs to us.

Conclusions

It might not be amiss to repeat what was said earlier in this account, that perhaps the experiments here described did not run long enough to prove anything. The following conclusions are therefore advanced as being suggestive rather than final.

(1) In promoting growth of brook trout fingerlings, a diet of pure sheep liver proved far superior to a dry meal or a canned fish diet. When costs are considered, the advantage of the liver is diminished, and that of the meals is increased.

(2) Meat supplements given in place of meals or canned fish one or two days a week caused increased growth of the fish. A two-day supplement proved superior to a one-day supplement, though the difference was only in the ratio of 1.2 : 1.

(3) When supplemented by raw sheep liver or by raw pork melts, the canned fish produced as good growth as did the mixed meals. Price considerations still favored the latter.

(4) Sheep liver proved superior to pork melts as a supplementary feed, but when price is considered the advantage is little, if any.

(5) Canned fish proved better than sheep liver or meals in holding down mortality. Meals made the poorest showing in this respect.

(6) Fish in the upper trough of a series of two grew better than those in the lower in 8 out of 11 cases.

INSTITUTE FOR FISHERIES RESEARCH

By: Louis E. Wolf