FOODS FOR YOUNG SALMONOID FISHES

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In laying out schemes for the feeding of Salmonidæ, as well as most other fishes, it is to be borne in mind that they are by nature dependent for nourishment on living animals. Any departure, therefore, from a live-food regimen must be regarded as having the presumption against its entire suitability; and the general experience of fish culturists tends to the conclusion that even so slight a departure from nature as the substitution of the flesh of mammals for the natural food is followed by deterioration in some of the most important functions of the fish.

Perhaps the function most seriously affected is that of procreation. It has been found that fishes which have been reared on mammal flesh in artificial inclosures do not produce offspring of normal vitality and vigor, and while the possibility of there being other important factors in the case has not yet been disproved it is the consensus of opinion that the deterioration observed is due mainly to the unsuitability of the food. The view taken of this matter by the best German authorities is well expressed in the concluding chapter of a serial treatise on the feeding of salmonoids by the editor of the Allgemeine Fischerei-Zeitung, January 1, 1907, as follows:

> Assuming that the fishes grown in a wild natural state have the healthiest offspring, it follows that for breeding fishes under all circumstances live natural food is the most suitable. * * * There is a large list of fish breeders who reject wholly the feeding of breeding fish and for egg production use wild fish only. For brook trout this is beyond doubt the correct standpoint, and it would be also for the rainbow and American brook trout if we could get wild fish enough to supply the demand for eggs and fry. As, alas, we can not get them, whoever wishes to breed these fishes must of necessity resort to artificial feeding of breeders.

The experience of American fish culturists will support this view.

Under these circumstances it behooves us to look for food supplies as near to nature as possible, and a conviction that duty leads in this direction has been the inciting motive to the efforts at the Craig Brook station to produce some living insect food which could be substituted for the chopped liver and lights from slaughterhouses and the flesh of old horses, which have been the main dependence thus far.

THE LARVÆ OF FLIES.

The experiments at Craig Brook have included a considerable list of insects and crustacea, but the most attention has been given to the larvæ of flies, especially of two species of flesh fly, the bluebottle fly (*Calliphora erythrocephalon*) and the green flesh fly (*Lucilia cæsar*). During some eight years this work was made especially prominent and on a scale sometimes equivalent to the feeding of as many as 100,000 fingerlings wholly on this food. In most cases there was a mixed ration of fly larvæ and chopped meat, but the exclusive use of the larvæ here and there affords data for definite and accurate statements of the comparative influence of the two regimens on the rate of growth, which is as far as data now available enable us to go.

The methods of the work may be thus briefly described:

Some kind of fresh animal matter, mainly slaughterhouse refuse and such parts of animals slaughtered or dressed at the station as were not available for direct feeding, were exposed to the visits of the flies, and, when well stocked with eggs, placed under the shelter of a building protected as far as practicable from marauding insects, such as carrion beetles, in specially constructed boxes, in which the larvæ assembled themselves when fully grown in masses conveniently handled. These were fed to the fish in troughs or ponds, mainly in wooden troughs about 10 feet long and 1 foot wide, sometimes in conjunction with other articles and sometimes alone, but in the latter case the fry had gone through a preparatory stage of feeding on chopped liver or similar meat for a few weeks, during which they had attained sufficient size to swallow young larvæ. The fry generally began to take food about June 1. The feeding of larvæ was generally begun early in July and was continued till some date in October, when the fish were counted, weighed, and liberated. The weighing was done in this way: A pail of water was suspended from a spring scale and its weight accurately noted. Then 200 fish or less by count were held in a soft net until the water had drained from them, when they were turned into the pail of water and the increase in weight noted. In case of very small numbers, each fish was weighed separately on a very delicate balance. The record is therefore very accurate. Sometimes the larvæ were given alternately with chopped meat, and in many other cases there were changes sufficient to forbid deductions as to the influence of the food on the growth of the fish, but here and there are cases giving positive evidence of importance.

In 1888 the record shows that lots no. 10 and 11 were fed through the season exclusively on chopped meat of various kinds (almost wholly butcher's offal), and lot no. 13 was fed on larvæ exclusively after June 2. In detail the treatment of the several lots was as follows:

Lot 10, Atlantic salmon numbering (June 7) 1,196, kept in one trough and treated as follows:

June.—Fed until 9th somewhat irregularly on wild live food collected from pools and other open waters; from 9th to 30th on chopped meat 2 to 4 times daily; mud baths on 5 occasions; cleaned daily.

July.—Fed chopped food 4 times daily the entire month; mud baths daily till 29th; cleaned daily.

August.—Fed chopped food 4 times daily; cleaned daily.

September.—Treated as in August, but on 29th transferred to a 5-foot white varnished trough outdoors.

October.—Treated as in September until the 17th, when they were counted.

The losses by death in lot 10 from June 18 to October 17 were 611, leaving 585[a] survivors, which were found October 20 to average in weight 30.66 grains (199 centigrams).

Lot 11, Atlantic salmon, numbering (June 7) 1,195, was treated almost exactly the same as lot 10, the points of variation being quite unimportant. Counted October 17 and weighed October 23. There were 538 survivors, and their average weight was 26.83 grains (173 centigrams).

Lot 13. Atlantic salmon, numbering (June 7) 1,864; treatment as follows:

June.—Kept in 2 troughs; fed on entomostracans and insects till June 9, after that chopped meat, 6 times daily; mud bath 3 times.

July.—Fed on liver until 3d, on which day feeding of larvæ was begun; mud bath daily until 29th; cleaned daily.

August.—Fed fly larvæ 6 times daily (with some irregularity); cleaned every other day.

September.—Treated as in August.

October.—Treated as in August until 23d, when counted and weighed. The 1,447 survivors weighed on the average 43.84 grains (284 centigrams).

It will thus be seen that the fish fed on butcher's offal attained a mean weight of 30.66 grains (199 centigrams) in one lot, and 26.83 grains (173 centigrams) in the other lot; while the fish fed on fly larvæ attained a mean weight of 43.84 grains (284 centigrams), a difference of 53 per cent in favor of the larvæ regimen.

A similar comparison between several lots of landlocked salmon reared the same summer shows a slight difference in favor, also, of the larvæ regimen.

The record for 1891 affords data for the following tabular statement, which exhibits the results obtained from the feeding of 39 lots of Atlantic salmon in wooden troughs of the standard size, all treated alike except in the matter of food. Butcher's offal was given to 14 lots of them through the entire season and the other 25 lots received fly larvæ exclusively from June 22 to the date of counting and weighing, which was from October 15 to October 29.

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[a] This heavy loss in numbers was the result of an epidemic that attacked the fry in June, irrespective of the food or special mode of treatment. Of the total mortality in lot 10, there were 561 deaths in June, 45 in July, 3 in August, 2 in September, and none in October.

TESTS OF FISH FOOD AT CRAIG BROOK STATION, SUMMER OF 1891.

Fed on chopped meat the entire season.					Fed on fly larvæ from June 22 to October 29.				
Lot no.	Date of weighing	Number of fish.	Total weight.	Average weight.	Lot no.	Date of weighing.	Number of fish.	Total weight.	Average weight.
	1891.		*Lbs. oz.*	*Grains.*		1891.		*Lbs. oz.*	*Grains.*
283	Oct. 15	1,844	11 3	42.47	279	Oct. 15	1,387	10 1	50.78
284	Oct. 15	1,833	10 11	40.81	280	Oct. 15	1,870	13 13	51.70
285	Oct. 15	1,840	11 2	42.32	281	Oct. 15	1,855	11 11	44.10
286	Oct. 15	1,707	11 4	46.13	282	Oct. 15	1,887	12 15	47.94
287	Oct. 15	1,936	12 4	44.29	297	Oct. 17	1,719	12 10	51.41
288	Oct. 16	1,897	10 9	39.98	298	Oct. 19	994	8 12	60.60
289	Oct. 16	1,472	10 11	50.82	299	Oct. 19	1,707	12 13	53.13
290	Oct. 16	1,394	7 13	39.59	300	Oct. 19	1,864	13 5	49.99
291	Oct. 16	1,815	10 9	40.74	301	Oct. 19	1,571	12 0	53.47
292	Oct. 16	1,801	9 14	38.38	302	Oct. 19	1,629	12 7	53.48
293	Oct. 16	1,813	10 3	39.33	303	Oct. 19	1,646	12 13	54.49
294	Oct. 16	1,824	10 15	41.97	304	Oct. 19	1,767	12 10	50.01
295	Oct. 16	1,798	9 11	37.72	305	Oct. 19	1,691	11 9	47.86
296	Oct. 16	1,574	9 9	42.52	306	Oct. 15	1,284	10 11	58.27
					307	Oct. 15	1,775	14 2	55.70
					308	Oct. 15	1,763	13 6	53.11
					309	Oct. 15	1,628	13 0	55.90
					310	Oct. 15	1,664	13 6	56.26
					311	Oct. 19	1,690	13 2	54.36
					312	Oct. 29	2,048	15 0	51.27
					313	Oct. 29	1,752	14 0	55.93
					314	Oct. 29	1,754	14 2	56.38
					315	Oct. 29	1,814	14 9	56.19
					316	Oct. 29	1,841	14 10	55.61
					317	Oct. 29	1,836	14 6	54.81
Total		24,548	146 6	41.76	Total		42,435	321 13	53.09

Thus the growth of the fish fed with the fly larvæ for about four months exceeded that of the meat eaters by 27 per cent.

For further illustration of the potency of fly larvæ in promoting growth, I will cite the record of 13 lots of Atlantic salmon fingerlings that were fed in 1895, 6 lots on fly larvæ exclusively after July 8 and 7 lots wholly on chopped meat of various kinds. In all other respects the treatment was very closely the same in all cases. The essential facts are embodied in the following table:

TESTS OF FISH FOOD AT CRAIG BROOK STATION, SUMMER OF 1895.

Fed on chopped meat the entire season.					Fed on fly larvæ exclusively after July 8, inclusive.				
Lot no.	Original count.	Survivors in October.	Average weight.		Lot no.	Original count.	Survivors in October.	Average weight.	
			Grains.	Centi-grams.				Grains.	Centi-grams.
732	4,500	3,425	21.17	137	724	4,000	2,592	62.79	407
733	4,825	3,510	27.76	180	725	4,000	2,813	59.41	385
734	4,825	2,083	29.06	188	727	4,000	3,164	50.75	329
735	4,000	3,001	25.80	167	728	4,000	3,312	53.50	347
736	3,000	2,916	27.91	180	729	4,000	2,929	49.14	318
737	4,000	2,242	34.34	222	731	4,500	2,740	45.51	295
738	3,500	3,119	31.14	202					
Total	28,650	20,296	28.17	182	Total	24,500	17,550	53.62	347

It will be noted that in this statement not only is the general average weight of the larvæ-fed fish 91 per cent higher than that of the meat-fed fish, but the best of the 7 lots of meat fish was materially below the poorest of the 6 lots of larvæ fish.

Other data might be cited, but the above will suffice to demonstrate that for increase of size of young fish, fly larvæ constitute a far superior food to chopped meat. There is reason to believe that the superiority does not end here, but extends to the quality of the growth—that it induces a more healthy condition of the tissues and functions of the fish, among other functions especially those of the reproductive organs. A demonstration of the correctness of this view must, however, wait for further experiment.

Fly larvæ are available for use during the greater part of the year. The blow-fly (*Calliphora*) was found engaged in egg laying as late as November 24. They have been actually used at Craig Brook as early as June and through the autumn and winter and as late in the spring as the month of April. For winter use, meat well stocked with very young larvæ, or even with unhatched eggs, is stored in pits or cellars where development can be retarded or hastened, as may be desired, by changes of temperature. In this way sufficient larvæ were kept during the winter of 1889–90 to feed, exclusively, nearly 10,000 young salmon to April 20, inclusive, with a loss of less than 1 per cent between December and May.

The materials which can be used in this work are sufficiently abundant and accessible in most localities. Among them may be mentioned the refuse of all sorts from slaughterhouses and fish markets, the refuse fish taken by all classes of fishermen, domestic animals dying from accident or old age, especially old horses, etc.

The cost of fly larvæ comes mainly from the labor involved. On one occasion it was found that 40 pounds of horse meat, costing 40 cents, produced 8 quarts, or 16 pounds of larvæ, the material costing thus about 3 cents for a pound of larvæ. It has been found that the mean cost of the labor through an entire season was 7.3 cents per pound of food. Both labor and materials therefore cost 10.3 cents for a pound of larvæ.

One important feature requiring mention is the evil odor generated in the process. However fresh and unobjectionable the materials may be when exposed to the flies, they become, if handled in the usual way, exceedingly malodorous before the larvæ have completed their growth. This is sufficient to forbid the location of the work near human habitations unless some means can be found to suppress the odor. It is claimed that this can be done by the use of smoke. It is also quite possible that the nuisance can be largely abated by the use of earth as a cover of the meat and the larvæ during the later stages of their growth. In Europe several methods have been brought forward which it is claimed will secure the desired result.

Before leaving the subject of fly larvæ I beg to call attention to the possibility of utilizing for fish food the larvæ of other flies, especially those of the house fly (*Musca domestica*) and of the stable flies (of the genera *Stomoxys* and *Muscina*). Their use would not be attended with the objectionable carrion odor, and it is possible that these or some other species might be grown largely on vegetable materials.

SPRATT'S FOODS.

Several of the Spratt foods have been tried at Craig Brook station, the "fish food" in 1905, the "fibrine fish food" and the "cereal fish food" in 1907. The tests were all made in comparison with chopped hogs' liver.

In 1905, two lots of brook trout fingerlings of the same origin and character were set apart for the experiment, placed in two ponds which were also of precisely the same character, and kept under the same conditions. Each lot numbered August 1 about 20,000. These fish had been fed alike on hogs' plucks and in all respects had been treated alike until the beginning of the test, August 5, from which date one lot (no. 1736) was fed with Spratt's "fish food," while the other (no. 1738), as a control lot, was fed on hogs' plucks, mainly the heart and lights. This contrasted feeding, with otherwise identical treatment, was kept up through August 26, having thus continued twenty-two days, after which the feeding on hogs' plucks was resumed. Each morning the ponds were carefully searched, and each dead fish found was at once taken out and recorded. A few days after the test began it was noted that the mortality was increasing in the lot fed on Spratt's food (no. 1736), while in the control lot (no. 1738) it was diminishing. Thus the Spratt's food lot lost during the first ten days of the test as follows: 0, 0, 3, 4, 5, 6, 11, 11, 13, 10; total, 63; while during the same days the control lot lost 2, 6, 2, 0, 0, 0, 2, 1, 0, 0; total, 13. The disparity in losses continued to increase to the end of the test, and carrying the record forward to the second morning after the close of the feeding we have the following daily losses from August 25 to August 28, inclusive: Of the lot fed on Spratt's food, 38, 69, 76, 148; total, 331. Of the control lot, 0, 0, 0, 2; total, 2. The total mortality from the beginning of the test to the second morning after the abandonment of the Spratt's food regimen was, for the Spratt's food lot, 542, and for the control lot, 21. During the next ten days, ending on the morning of September 7, the deaths were: In the Spratt's food lot, 77, 13, 54, 24, 12, 3, 6, 13, 9, 7; total, 218; in the control lot there were no losses. By the 10th of September the mortality in the Spratt's food lot had so far subsided that from that date to the end of the month there were but 9 deaths, against 1 in the control lot. The resultant weights of these fish were not ascertained; but the record of losses seems to indicate in a very positive manner that the food tested was quite unfit for salmonoid fish to eat.

In 1907 a test was made at the same station of the merits of Spratt's "aquarium fish food" and "fibrine fish food." In submitting them for a test, the general manager of the Spratt's Patent Company said:

> Our pure-food law guaranty serial number is 1632, and I wish to reiterate the statement I have made previously, that the above-mentioned foods are purely meat, and cereal and meat, respectively, and no preservative, coloring matter, or chemical, etc., whatsoever, has been added to them.

The aquarium food, it was understood, was in part cereal, the other wholly meat. Both of them, as well as the food tested in 1905, were received directly from the company. The fishes selected for the experiment were brook trout, all derived from the same source. Six lots of 500 each were counted out to be fed with Spratt's foods, and several other lots of equal size to serve as control lots, and to be treated in various experimental ways. Three lots of 500 each were to be fed with the aquarium fish food and three with the fibrine fish food.

The experience of 1905 having indicated that it might be difficult to induce fry to take these foods well from the start, the whole six lots were as a preparatory step fed from May 20 to June 30 on finely ground hogs' liver, such as the other fry and fingerlings at the station were receiving. On June 30, therefore, the feeding of the Spratt's foods began, two of the lots receiving the aquarium food and two of them the fibrine food, while the liver regimen was continued with the other two until July 20.

Of the four lots beginning the new food June 30, one was given the fibrine food until October 19 and no other food; another lot was given the same fibrine food and liver on alternate days; a third lot received the aquarium food solely until October 19; and the fourth lot received the aquarium food and liver on alternate days. Of the two lots that continued to eat liver until July 20, one was fed from that date until October 19 on the fibrine food and the other for the same period on the aquarium food. All were fed three times daily.

Of the other lots of trout derived from the same original source, two may be regarded as control lots, numbered respectively, $1939Z^1$ and $1939Z^3$. Both of these, consisting of 1,000 fish each, began to feed May 21, and were fed three times daily through the season to October 9, hogs' liver until the end of July and hogs' plucks from that date to the close.

All of these lots were treated alike, all in troughs fed by water of the same quality, having trough room in proportion to their numbers at the start, the two control lots of 1,000 each having troughs twice as long as the lots having 500 each. Two exceptions were made in favor of two small lots, $1939K^1$ and $1939N^1$, which had much more room—each a 5-foot trough. The following table is a full exhibit of the lots in the experiment and the principal facts in their history:

EXPERIMENTS WITH SPRATT'S FOODS IN 1907.

Lot no.	How treated—Feeding 3 times daily in all cases.	Original number of fish.	Taken out alive in August.	Close of experiment.		
				Date.	Fish left.	Average weight.
						Grains.
1939K	Liver to June 30; fibrine to October 19	500	15	Oct. 19	4	24.1
1939L	Liver to July 20; fibrine to October 19	500		Oct. 19	14	21.7
1939M	Liver to June 30; then fibrine and liver on alternate days to October 19	500		Oct. 19	466	87.3
1939N	Liver to June 30; then aquarium cereal to October 19	500	100	Oct. 19	4	29.3
1939O	Liver to July 20; aquarium cereal to October 19	500		Oct. 19	37	23.6
1939P	Liver to June 30; aquarium cereal and liver on alternate days to October 19	500		Oct. 19	441	77.4
1939K[1]	Rescued from 1939K August 16, and from that date fed on liver exclusively; kept in a 5-foot trough	15		Oct. 19	5	158.5
1939N[1]	Rescued from 1939N August 16, and from that date fed on liver exclusively; kept in a 5-foot trough	100		Oct. 19	48	154.9
1939Z[1]	Liver to end of July; then liver, hearts, and lights to October 9	1,000		Oct. 9	826	72.6
1939Z[3]	Liver to end of July; then liver, hearts, and lights to October 10	1,000		Oct. 10	768	82.6

Before the end of the first month there developed an abnormal mortality in the lot of trout fed on Spratt's fibrine, the dead picked out on the last seven mornings of the month being as follows: 4, 2, 8, 11, 14, 21, and 34; total, 94; as contrasted with the following deaths in the two large control lots,[a] namely: 2, 0, 1, 1, 2, and 1; total, 7; the rate of mortality being thus, for those seven days, forty-eight times as heavy with the fish eating fibrine as with those eating liver. The heavy mortality in this lot continued till August 16, by which time 480 of the 500 had been picked out dead, the losses in two control lots to that date being only 29 in the aggregate, out of an original 2,000.

The lot receiving liver till July 20 and fibrine for the rest of the season did not develop any excessive mortality until September, but during that month 434 out of the 500 died.

The lot fed on aquarium cereal suffered less, but they too had lost nearly four-fifths of their numbers before the end of August, in the lot taking up this food June 30, and in September an equally heavy loss befell the lot that began this food July 20.

On the 16th of August, as a sort of experimental rescue or secondary control, there were taken out of the first fibrine lot of fish (1939K) 15 of the survivors, and from the first aquarium cereal lot (1939N) 100 of the survivors. These two rescue lots were henceforth fed on liver. The object was to see whether they could, by a return to normal food, be rescued from the mortality that was fast

[a] These two control lots embraced in all four times as many fish as the fibrine-fed lot with which they are compared. The rate of mortality in these control lots was 3½ per thousand, while in the fibrine-fed lot it was 168 per thousand.

sweeping away the original lots. The result was that in the case of the fibrine fish the rescue effected essentially nothing, having apparently come too late; but in the aquarium-cereal lot 48 were saved up to October 19, out of the original 100 taken out in August, or 48 per cent; while of those left to their fate with the aquarium-cereal food only 4 were saved during the same period out of 207, or 2 per cent.

In the cases of the lots fed on Spratt's foods and liver on alternate days, the mortality was not excessive, being only 7 per cent in the fibrine lot and 12 per cent in the other.

It remains to see what effect the Spratt's foods had on the growth of the fish receiving them. As none of the dead fish picked out from time to time was weighed or measured, we can only note the weight attained by the survivors, remarking, however, that the dead fish taken out from time to time were, judging by the eye, never larger than the average of lots from which they were taken, and were generally smaller. All of these weighings were done in the usual way in water, except the smaller numbers, 14 and less, which were weighed singly on a delicate balance. The weighings showed that the 4 survivors of the lot (1939K) beginning the fibrine food June 30 weighed, October 19, on the average, 24.1 grains (155 centigrams) and the lot (1939L) that was given liver till July 20 and fibrine afterwards averaged 21.7 grains (140 centigrams). These are to be compared with the average weights of the fry of the two control lots ($1939Z^1$ and $1939Z^3$), whose average, October 9 and 10, was 72.6 grains (470 centigrams) and 82.6 grains (535 centigrams), respectively; and it appears that the survivors of the Spratt's food regimens had made only from one-fourth to one-third of the normal growth, notwithstanding the fact that they had enjoyed from August 16 to October 19 a greatly enlarged area of trough room and a proportionably very large volume of water.

In growth the fish fed on Spratt's foods with liver on alternate days made a growth fully up to the average of liver-fed fish, the two lots attaining 87.3 grains (565 centigrams) and 77.4 grains (501.6 centigrams), respectively.

One of the most striking of the results obtained was the extraordinary growth of the two "rescue" lots mentioned above—$1939K^1$ and $1939N^1$; the first of these, numbering at the October counting only 5 fish, had by that date acquired an average weight of 158.5 grains (1027 centigrams), and the other, numbering 48, an average weight of 154.9 grains (1003.7 centigrams). These weights are almost unparalleled in the station records of trough-reared fish. It is more than double the weight attained by the fish of the same origin fed through the season on the usual hogs' plucks, as shown in the case of lots $1939Z^1$ and $1939Z^3$. To what shall it be attributed? So far as the comparison is with the ordinary feeding we may safely say that the extraordinary rate of growth during this "rescue" period is the result of the increased space accorded the rescue lots. One of them ($1939K^1$) had, at the beginning of the rescue period, the 16th of August, when there were 15 fish, 44 square inches of trough room per fish, and at its close, October 19, when there were but 5 fish, 166 square inches, equivalent to 105 square inches for the entire period; and the other lot ($1939N^1$) had in like manner the equivalent of 20.4 square inches space for each fish during the entire period; while the two control lots ($1939Z^1$ and $1939Z^3$) had during the same period a mean of only 1.7 square inches per fish for the first and 1.9 square inches per fish for the other.

It is interesting to note, further, that while the lots of fish that were kept on the Spratt's food regimen until the October count had a generous allowance of space, they failed utterly to receive benefit from it in the matter of growth. Thus the lot of fish fed on the aquarium cereal (1939N), although enjoying through the rescue period a mean of 12 square inches of space per fish against 9 square inches per fish accorded to the liver-fed rescued lot, attained a weight less than one-fifth that of the liver-fed fish; and in the case of the fish fed on fibrine the disparity was still greater, the fibrine fish attaining less than one-sixth the weight of the rescued fish, although the space accorded them per fish was almost exactly the same for the two.

The conclusion to be drawn from the results of these experiments can not be otherwise than this: That all of the commercial foods tried, the "fish food," the "fibrine fish food," and the "aquarium fish food," are entirely unfit for food for young salmonoid fishes. Their value for other kinds of fish is not considered here.

FRESH FISH AND RYE MEAL.

Considerable quantities of fresh fish have been used from time to time at the Craig Brook station, both as material for the growth of fly larvæ and as direct food. In a few instances there have been made exact observations and records, which furnish limited data for demonstrations of their value. In 1907 such data were preserved of a brief trial of the use of fresh fish and rye meal. The subjects of these experiments were 18 lots of brook trout, all from the same original stock, all treated alike in respect to quarters, water, and attendance, except that 6 of the lots contained originally half as many fish as the others and were quartered in troughs half as large. All were fed on chopped hogs' liver until September 5. At that date began the experimental feeding, which continued to October 9 to 12, when the survivors in all these lots were counted and weighed. During this period 6 of these lots were fed on chopped fresh herring, 5 others on herring for ten days and then on a mixture of herring and rye meal, and 7 others, as control lots, on liver until August 1, after which hogs' hearts and lights were added to their fare. Though the period of this experiment was very short, the results seem to indicate that the continuous nourishment with hogs' plucks was the most favorable, that fresh herring came next, and that rye meal stood at the foot of the list. The 7 lots of fish fed on the plucks alone, originally consisting of 1,000 fish each, or 7,000 in all, and numbering 5,926 in October, weighed 67 pounds 5 ounces, an average of 79.5 grains (515.1 centigrams).

The 6 lots fed on herring alone, numbering originally in all 3,000 and at the close 2,579, weighed on the average 75.3 grains (488 centigrams).

The 5 lots fed on the herring and rye meal, 5,000 at the start and 4,425 at the close, attained an average weight of 68.3 grains (442.6 centigrams). Though these data indicate, as stated, the inferiority of fish and rye to plucks as promoters of growth, a final conclusion in the matter should await more extended trial.

Though in these experiments the only fish used was fresh herring, it is safe to assume that other fresh fish would be equally potential in nourishing the fish, and the cheapest kinds are no doubt for such purpose of equal value with those of higher cost. The cheapest fish that can be obtained in fresh condition is therefore probably the most desirable, provided it can be easily prepared for use. Herring are especially easy to prepare, as they can be chopped into the desired form without any dressing whatever. This fact and that of their abundance and wide distribution render them perhaps the most available of all species of fish. Their cost is also very moderate, those used at Craig Brook costing 1 cent per pound.