# Food Values of New Zealand Fish.

## Part 8.—Stewart Island Oysters.

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ANALYSES of these oysters made in 1911 by the present writer yielded figures for protein, fat, glycogen, and salts, that did not greatly differ from those obtained by workers in other parts of the world. Since then, however, new views as to the nutritive value of foodstuffs have been put forward, and it seemed desirable to investigate the vitamin-A content of the oyster, and to make some preliminary observations on the nature of its nitrogenous substances.

### *Vitamin.*

Only vitamin-A was investigated. Quite recently an abstract of a paper by Jones and Murphy (1) has appeared in which oysters, probably American, are reported to be rich in Vitamins A and B. According to Mme. Randoin (2) vitamin C is also present.

*Method:* Rats were kept from the time of weaning on a basal diet containing casein, starch, fat, vitamin B ("Marmite"), and salts. The fat used in the earlier experiments was well aerated lard, in the later, "Crisco" with the addition of aerated cod-liver oil; in each case the antirachitic factor "D" may be presumed to be present.

In Paper 6 of this series (3) some preliminary experiments on oyster fat were reported. The fat, obtained by alcohol and subsequent extraction with ether, showed no activity, and seemed actually harmful. In the case of fish (tarakihi) investigated last year, good results were obtained by incorporating the fresh material with casein, starch, fat, etc., in such proportions that the composition of the mixture corresponded to that of the basal diet. When this was done with fresh oysters it was soon made clear that they contained vitamin-A.

*Experiments 1—3* were made on a quantity of oysters procured from a fishmonger in June. They were drained, minced, weighed, and analyzed for fat and water percentage. They seem to have been of rather poor quality, for the average weight per oyster was only 7 grm. as compared to the usual 10–12 grm. The fat was low (1.9 per cent.) and the water high (80 per cent.), and the results of feeding were not so striking as were obtained with the later samples.

*Experiment 1:* Three sister rats (Litter Ad. 5) on basal diet showed decline of weight and slight eye symptoms about the eighth week after weaning. One died and the two survivors were put on a fresh oyster diet that would allow each 5.0 to 6.0 grm. oyster per day, assuming that each rat ate 8 to 10 grm. of the whole diet with which the oyster mince was incorporated. In the 12 days during which this diet was given the eye symptoms disappeared and their weight increased from an average of 71 grm. to an average of 89.

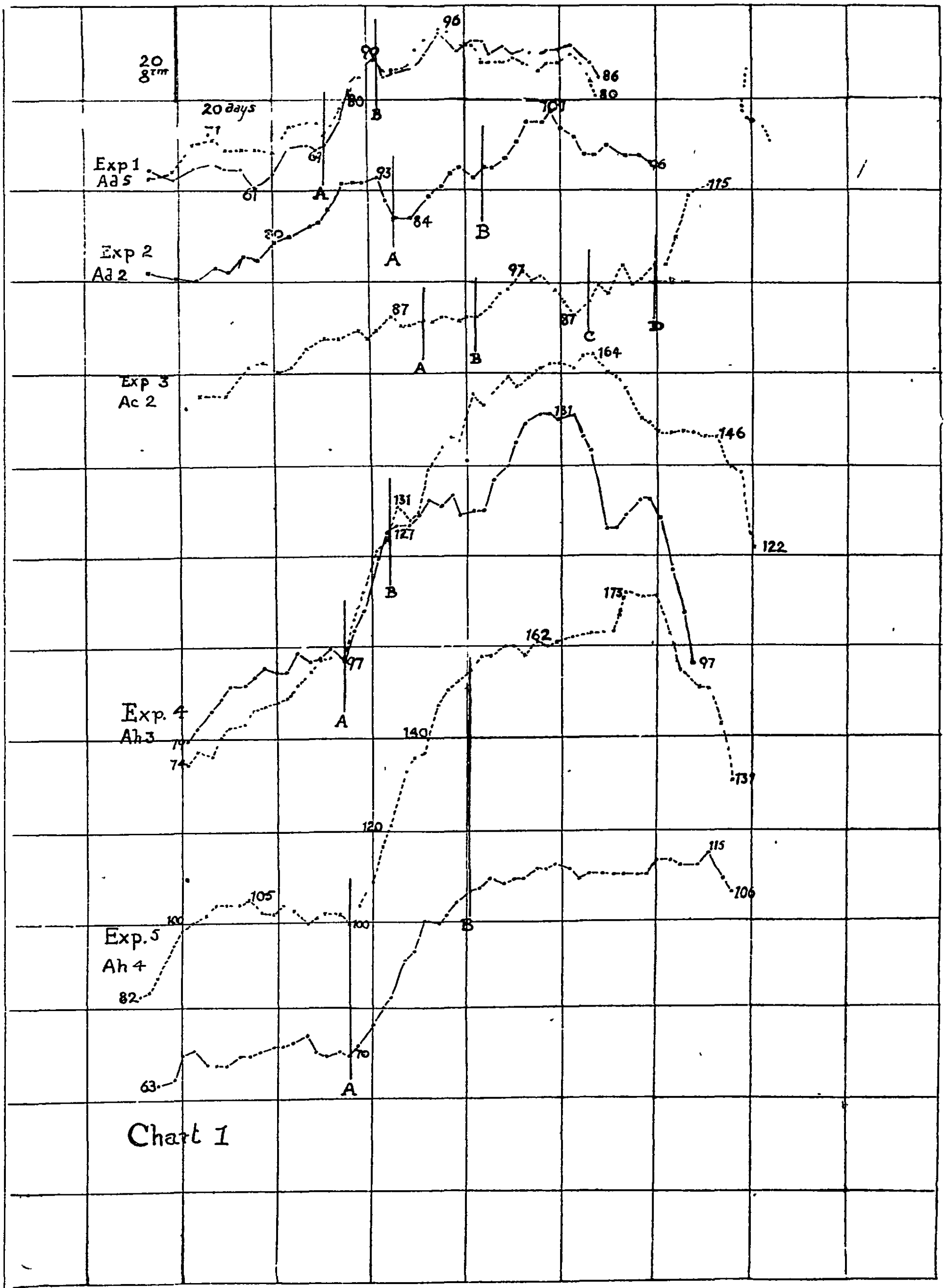
On returning to basal diet the rise continued till they reached about 95 grm., and for five weeks after the special diet ceased their weights were maintained at about the 90 grm. level. Then eye troubles recurred. One died and the other was used for preliminary experiments on another substance. The growth curves of this and of the other experiments are shown on Charts 1 and 2.

*Experiment 2:* A buck rat (Ad. 2, No. 1) of the same litter developed marked photophobia with loss of weight ten weeks after weaning. His brother, on the same diet, had died with marked eye symptoms about the eighth week. He was given a diet containing the whole fat obtained by percolation from the same weight of oyster as was used to make up the diet used in Exp. 1. The method adopted here was to mix the fresh oyster mince with sufficient Plaster of Paris to make it set hard in about 24 hours; the mass was then broken up finely and placed in an inverted glass bottle from which the bottom had been removed. Ether was allowed to pass down through the powder and escape with the dissolved fat from the neck which was provided with a cork and tube. Percolation was continued for one or two days till no more colour appeared in the ether. The ether was removed by distillation and the residue used for the diet. Immediate improvement set in, but the gain in weight was not maximal and was less prolonged than in Exp. 1. But it gave clear proof that the percolation method had extracted some of the vitamin. The amount of percolated fat consumed per day would be about 0.1 grm.

*Experiment 3:* Some of the same oyster material (June lot) was dried in a regulated oven at 52° C. for two days. The " fat" was extracted by the Soxhlet method, and both fat and residue made into diets similar to those used in Exp. 1 except that in one diet the " fat" replaced a corresponding amount of "Crisco," and in the other diet the "residue" replaced a certain calculated amount of protein, carbohydrate, etc. These diets were given in succession to a doe rat (Ac, 2, No. 2). She was one of a group of three sisters; two had developed eye symptoms and had died 7 and 8 weeks after weaning. The survivor at 9 weeks had ceased to grow, and the eyes were apparently beginning to be affected. She was first given a diet containing Soxhlet fat. Little or no improvement resulted in the 12 days during which she received the diet, but on changing it to the " residue" diet a distinct increase was obtained.

Unfortunately, as stated already, this batch of June oysters was not so rich in vitamin-A as had been expected, and the level of intake of vitamin in these three experiments was low, but Experiment 3 shows that in the process of drying the vitamin becomes less soluble in ether—so that now the residue contains more vitamin than the extracted fat.

*Experiment 4:* On August 11 another quantity of oysters was obtained. Some of the material was dried overnight in the oven and extracted with ether (Soxhlet method). The " fat" and " residue" were then combined in one diet corresponding in general composition to basal diet, the object being to see whether material so treated could give a maximal effect. The amount of oyster used was much greater than what was used in Exps. 1—3, and was probably much more than was necessary. Two bucks (Ah, 3 Nos. 1 and 2) developed eye




Exp. 1. From A to B, fresh oyster incorporated with the diet.
Exp. 2. From A to B, percolated oyster fat given.
Exp. 3. At A, oyster fat (Soxhlet); at B, residue of same; at C, basal diet resumed; at D, cod liver oil.
Exp. 4. From A to B, oyster fat (Soxhlet) + residue simultaneously. Dose was larger than necessary.
Exp. 5. From A to B, equivalent of 1 grm. fresh oyster per rat, given separately. The oysters used were non-spawning.

symptoms and began to lose weight 8 weeks after weaning. On administering the oyster diet an immediate rise in weight set in, and within a week no trace of eye trouble could be detected. The diet was continued for 10 days, but on returning to the basal diet the beneficial result remained for 7 weeks; then one developed a lump in the neck and both had recurrence of eye symptoms and loss of weight. No. 1 died at 9 weeks and No. 2 at 11 weeks after the oyster diet had been discontinued. The amount of oyster per rat per day may be stated thus:—342 grm. fresh oyster yielded 6.72 grm. fat (1.96 per cent.) and 58 grm. residue (probably not quite water-free). These were made up into a diet containing about 214 grm. solids—the proportion of proteins was probably a little higher than the 20 per cent. usually present in basal diet. When the amount of water used in making up the diet is taken into account the amount of fresh oyster per day works out at 10 to 12 grm. on the assumption that the rat ate 10 grm. of the diet per day.

*Experiments 5 and 6*: A third quantity of oysters was obtained on October 12. They were in two lots; some were considered edible by the fishmonger, and others, spawning, would not have been sold in the ordinary course of events. These were larger oysters than the June ones (the August samples were not counted and weighed). The average weight of the unspawned was 10 grm., that of the spawning, 8 grm. 200 grm. of each kind was made into a diet corresponding to the basal diet in the proportions of protein, etc.

*Experiment 5:* The rats in this case were offered a certain amount of the diet (3 grm. for the two) corresponding to 1 grm. of fresh non-spawning oyster for each rat in a separate dish. Along with this they received basal diet. Usually the oyster diet was eaten greedily, and was no doubt supplemented by the basal diet. The previous history of the two rats (Ah, 4, 2 and 3) was practically the same as the others of this litter (e.g. Ah, 3). Immediately after beginning the diet their weight rose rapidly, and the eye symptoms gradually disappeared. The diet was continued for three weeks during which the weights increased from 100 grm. to 150 grm. and from 70 grm. to 110 grm. After stopping the diet one continued to grow for six weeks, and reached a weight of 173 grm., the other remained at about 110 grm. for a slightly longer time. At the time of writing both are losing weight steadily and both have eye symptoms. This is the best result obtained with oysters so far, and is a clear proof that the vitamin-A content was high in this batch of oysters: for the 1 grm. of fresh material would not contain more than 0.25 grm. solids and the fat would not be more than 30 milligrm.

*Experiment 6:* The "spawning" oyster material was similarly prepared and administered in a separate dish to a doe (Ah 2, No. 2), but the diet when made was less concentrated than the other and in order to obtain the same amount of oyster the rat had to eat a larger quantity, viz., 3 grm. She was offered 7 grm. daily because at the time of commencing the diet it was uncertain how much would be required for either group. Almost from the first dose of oyster diet her weight began to rise, and it continued to rise rapidly in the three weeks during which the diet was given; she did not always consume the full ration of oyster diet. About three weeks after the return to basal diet the weight began to drop. A striking feature of the experiment was the persistence of the eye symptoms throughout the six weeks of rising weight. Although the quantity given here was larger than in Experiment 5, the good effect lasted only for three weeks against six weeks for the others, so that one can be tolerably certain that "spawning" or "spawned" oyster has less vitamin-A. This is also supported by the result of the next two experiments.

*Experiments 7 and 8:* The fourth batch of oysters was obtained on October 30, very near the end of the oyster session in New Zealand, and the fishmonger had no difficulty in supplying some that were spawning as well as some that were considered edible. On draining the former through cheese cloth, a milky-looking fluid containing spawn passed through—this was also seen in the other case, but much less marked. Diets were made with each kind of material, and given in the same way as in the last mentioned experiment. The rats used were two groups of two each belonging to the same litter (Ak.). They had begun to decline in weight, but had no observable eye symptoms. The amounts given were the equivalents of 1 gr. fresh oyster per rat per day. The result on growth was not so striking as in Experiments 5 and 6, but there was a distinct difference between those receiving the "non-spawning" oyster as compared to the "spawning." The former increased in weight during the time of administration (3 weeks), and continued to grow for at least a fortnight longer, while the others showed little increase in one and a very irregular curve in the other; on stopping the diet both began to decline and to show eye symptoms. At the time of writing one of these is dead and the other is steadily losing weight, while the two on non-spawning oyster continue to grow.

## *Analytical Data.*

Although no attempt at complete analysis of these oysters was made, in order to make up diets correctly it was necessary to know the approximate percentage of fat and water. Some nitrogen estimations were also made. These data are presented here in Tables 1 and 2.

*Table 1.*

| Date | Average weight per oyster. | Fat percentage | Glycogen percentage | Remarks. |
|---|---|---|---|---|
| Aug, 1924 | 10 grm. | 2.58 | — | |
| June, 1925 | 7 grm. | 1.90 | — | |
| Aug., 1925 | ? | 1.96 | — | |
| Oct. 12, 1925 | 10 grm. | — | 2.6 | non-spawning |
| Oct. 12, 1925 | 8 grm. | — | 2.2 | spawning |
| Oct. 31, 1925 | 9.5 grm. | 2.44 | 4.1 | non-spawning |
| Oct. 31, 1925 | 6.4 grm. | 1.57 | 1.6 | spawning |

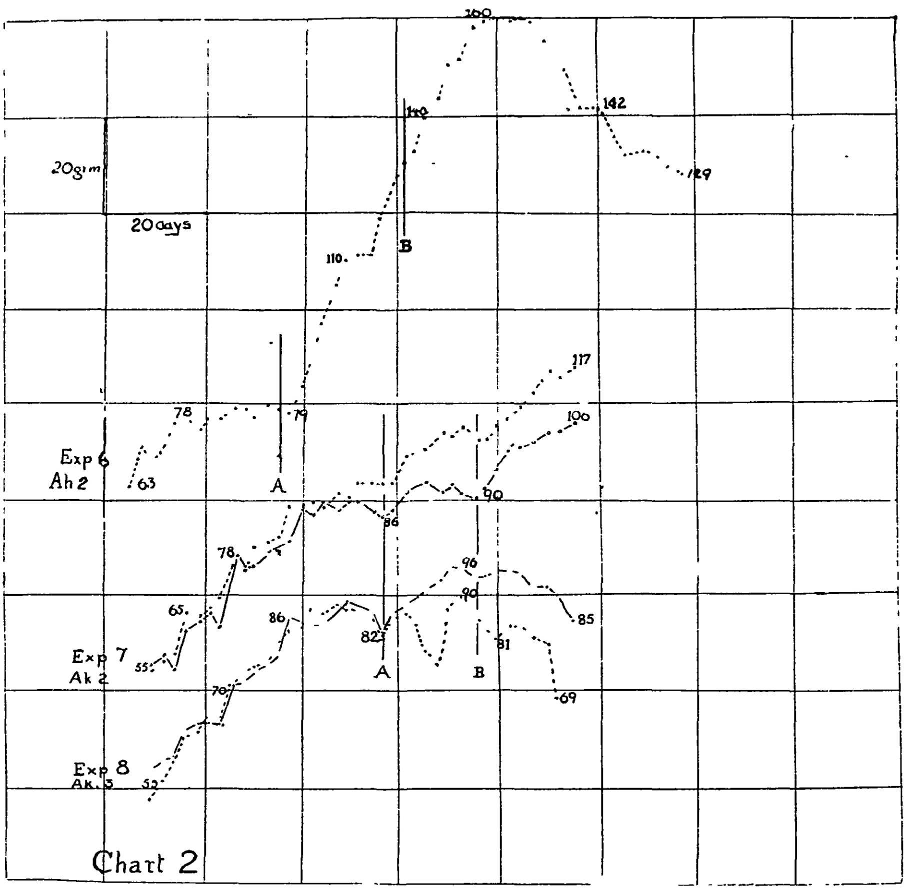
*Table 2.*

Nitrogen in Oysters of October 31st.

| | Non-spawning. | Spawning. |
|---|---|---|
| In form of protein .... .... | 1.60% | 1.53% |
| In extractive form .... .... | 0.69% | 0.52% |
| | 2.29% | 2.05% |

It may be noted that the fat in these oysters was lower than that previously reported in 1911 and less than the estimation made in 1924. The glycogen and fat of the fourth batch of oysters was higher than the others, which may be due to the fact that they were from new ground. While these variations may be expected when the oysters are not dredged from one special area, and when no note of age is taken, one feature of the analysis is a striking one, viz., the difference between the "non-spawning," and the "spawning" or "spawned." This difference is seen in the average weight per oyster, the fat and the glycogen, while we have just shown that the spawned oyster has less vitamin-A.

A large proportion of the nitrogen of the oyster is present in non-protein form and this is probably the case in all shell fish for the




Exp. 6. From A to B, equivalent of more than 1 grm. fresh oyster (spawning or spawned) given separately.—Compare to Exp. 5.

Exps. 7, 8. From A to B, equivalent of 1 grm. fresh oyster per rat daily.
Ak. 2 (upper) received non-spawning oyster.
Ak. 3 (lower) received spawning or spawned oyster.

same result in nearly the same relative proportion was found in the paua as reported Paper 4 of this series. The method of distinguishing the two forms of nitrogen was as follows:—10 grm. fresh oyster had added to it 40 cc. water and the whole brought to boiling point. 150 cc. of 98 per cent. alcohol was then added and the mixture allowed to stand for a day at room temperature, then filtered, washed with alcohol, and nitrogen estimation made in both residue (protein) and filtrate plus washings (extractives).

*Summary and Conclusions.*

1. The oysters examined varied to a considerable extent, due probably to food, age, season and condition, but all showed presence of vitamin-A as tested on rats that were supplied with the antirachtic factor. In one experiment (5) it was found that a diet containing so little as 1 grm. fresh oyster produced maximal growth and probably maximal storage. In another (7) the same quantity produced submaximal but considerable effects, while 5 to 6 grm. (calculated intake Exp. 1) in another batch of oysters failed to produce maximal growth.

2. Dried oysters also produced effects in doses that were equivalent to larger doses than those used for fresh, e.g., in Exp. 4, where the equivalent was probably about 10 grm. fresh oyster, growth was maximal.

3. The method of dehydration of the food material by Plaster of Paris followed by ether percolation gave much better results than ordinary drying of the material followed by Soxhlet extraction with ether. In one experiment (3) there was more vitamin effect obtained with the residue than with the Soxhlet extract.

4. There is a distinct loss of food value of the oyster in the process of spawning. The average weight, the fat, the glycogen, and the vitamin-A content are all diminished.

5. The proportion of the total nitrogen that exists in the non-protein form in the oyster is relatively large.

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