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## Notes on the Biology of the Cornish Pilchard.

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In the accompanying figure are shown some of the results to date of an investigation of the biology of the Cornish Pilchard *Sardina Pilchardus* Walb. These results are calculated as monthly means, for the present purpose.

**Feeding.** These results are obtained by collecting and weighing the stomach contents of 50 specimens in each sample, and then calculating the average weight of food per stomach. It will be seen that the amount of food present in the stomachs was greatest in the months of April, May, June, and July, of each year, that there was a secondary increase in the quantity of food in October of each year, and that feeding was least in the months between November and February.

An investigation into the nature of the food showed that in the months of March and April the food was mainly diatoms, in May and June mainly copepods and decapod larvae, in July, August and September, also, copepods and decapod larvae, together with abundant peridinians and diatoms, and in October chiefly diatoms again. The double nature of the annual crop of diatoms is clearly reflected in the food of the pilchard. The scanty food present in the stomachs in the winter months is mainly unrecognisable, but it includes diatoms, amphipods, and, especially in February, cirripede nauplii.

**Spawning.** The average weight of testis and ovary in fish of 22 cm. is taken to illustrate this cycle. The weight is least in August of each year, and increases to a maximum in April, May, and June. Thus the time of the maximum development of the gonads is also the time of heaviest feeding, a state of affairs contrary to that found in other species of fish.

The male produces a greater weight of gonad than the female, and is ripe over a somewhat longer period.

**Condition.** Fish of 22 cm. will again be taken to illustrate the seasonal change in the mean weight of a gutted pilchard of given length, that is, of the fish without gut or gonads. The amplitude of this fluctuation is great, varying from about 72 to 92 g. The average weight is least in March and April of each year, increases to a high level in July, decreases somewhat until September and October, and then increases to a new maximum in December and January. There is then a very rapid loss of weight until March and April.

These changes may be compared with the income of the fish, in the form of the food, and the expenditure of the fish in breeding and maintenance. The rapid loss in condition between December and January, and March and April, occurs when feeding is at a minimum, and when, nevertheless, the gonads are ripening. In April and May feeding becomes heavy, and suffices to bring about a recovery in the condition of the fish as well as to complete the ripening of the gonads. The reason for the slight loss of condition between July and October may be the decreased rate of feeding in conjunction with the growth which is still taking place at this time of the year, and to an accelerated metabolism due to the high temperature of the sea.

The secondary recovery in condition which takes place in December may be the result of the increased rate of feeding in October, which occurs at the time when growth has ceased, and when the gonads are still quiescent.

It will be seen that, just as the male produces a heavier gonad than the female, the body weight of the female is usually somewhat greater than that of the male.

**Intestinal Fat.** The graph refers to the results given by fish of 20–22 cm.; the fish were classified as fat if abundant fat was present in the mesentery. The seasonal changes in the percentage of fish containing abundant abdominal fat are very similar to those of the mean weight of the gutted fish, but tend to occur slightly later. Thus the condition of the fish begins to improve in April, but the storage of intestinal fat not until May or June. Similarly, the loss of condition of the fish, which begins in July, is not followed by a loss in intestinal fat until August. Possibly the intestinal fat is drawn upon to help to make up the loss in condition of the flesh which occurs in the late summer.

**Fat Content.** This and the other chemical analyses were done upon that part of the fish which is useful to the canning industry, namely, the fish after the removal of the gut, gonads, head and tail, and scales. The flesh was minced, and a portion of the minced flesh taken for analysis. The fat content was determined, firstly by bulk extraction with ether, after digestion with hydrochloric acid; and later, by Soxhlet's method.

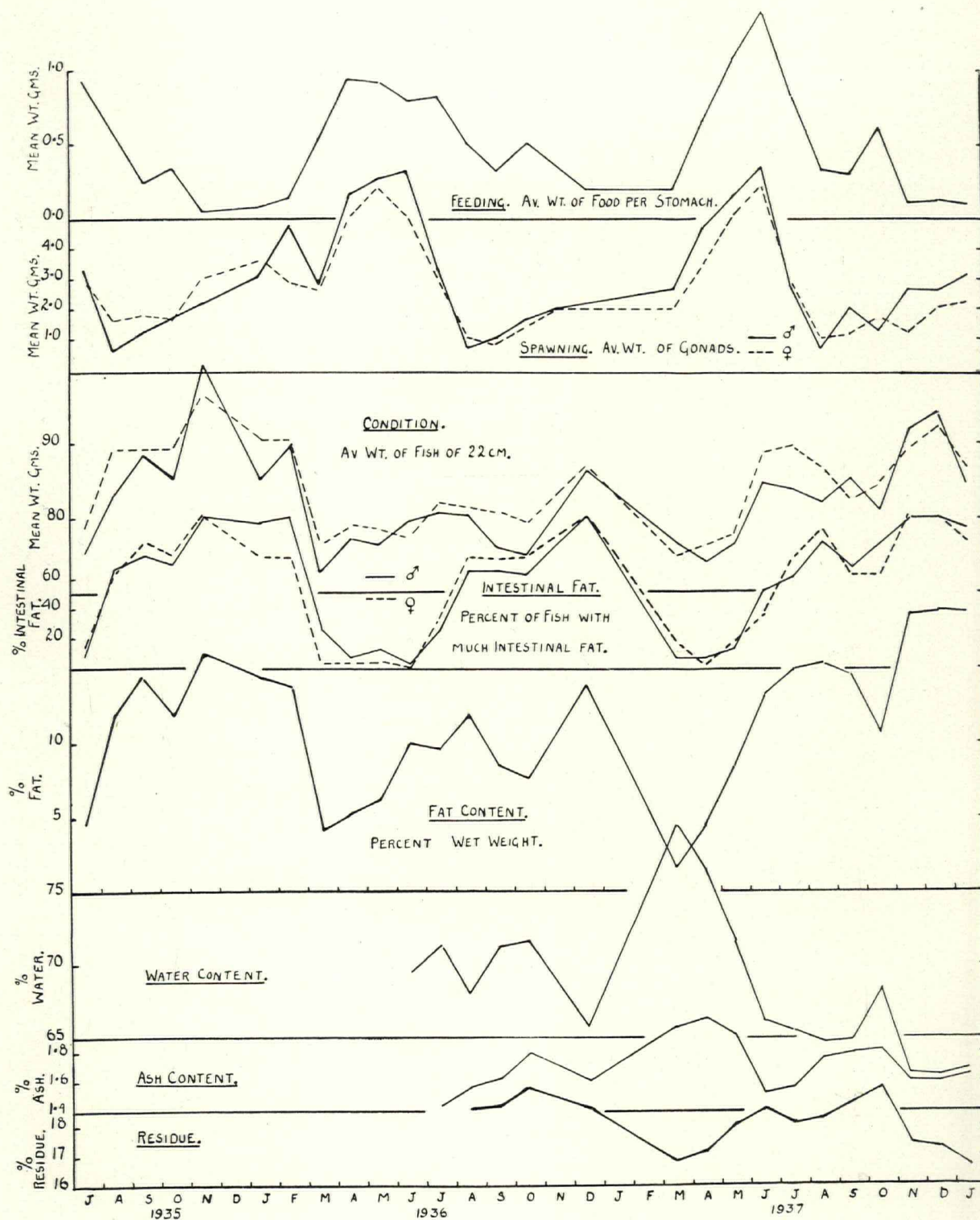


Fig. 1.



The graph shows that the fat content, expressed as a percentage of the wet weight, fluctuates seasonally in a way almost identical with the fluctuations in condition.

**Water Content.** The water content, as determined by evaporation to a constant weight, first on a water bath, and finally in the electric oven at 80°C., varies inversely with the fat content.

**Ash Content.** This was determined by combustion, and the graph shows that the ash content fluctuates in a manner similar to the water content, and therefore inversely with the fat content and the average weight of the fish.

When the water, fat, and ash content of the flesh are raised to the average weight of the fish, it is found that, subject to experimental error, there is little seasonal variation in the weight of water and ash present in a fish of given length. Water and ash,

therefore, form a frame into which fat is stored, and from which it is withdrawn, these changes being largely responsible for the changes in weight of the fish.

**Residue.** Water, fat, and ash, added together, do not make up a constant percentage of the total composition of the fish, and there is a seasonal fluctuation in the percentage of the residue. This, which is presumably mainly protein, appears to reach a maximum in October, and to decrease to a minimum in March. It may be that protein is used up in the nourishment of the gonads, and to help to maintain the fish during the winter, when feeding is at a minimum.

This article is a preliminary note only. The full results will be published when the series of observations is complete, when they can be compared with those of RAMALHO and others.