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THE PILCHARD FISHERY IN BRITISH COLUMBIA

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Pilchards have been known to occur on the west coast of Vancouver island, and in the strait of Georgia for many years. They have frequented the inlets and they have been fished for bait for halibut. It was observed, however, that they did not appear in the inlets every year, and there is no information as to their occurrence in the coastal waters outside. Since however the canning of pilchards and their more recent utilization for oil and fish meal have become established, more attention has been directed to their occurrence and habits.

Pilchards are present in British Columbia waters throughout the year. During the winter they may be found in certain inlets in small numbers. They come here during the summer in large shoals, and are usually abundant from June to October. In the latter month the majority of the pilchards depart, although some remain here during the winter. Whence they come, and whither they go is not known. They apparently come from the south.

The fishery is conducted in the inlets and in the coastal waters. Some catches have been made offshore up to 50 miles. A noteworthy point about the British Columbia pilchards is that they are adult fish measuring from 9 - 11 1/2 inches in length, and weighing on an average .45 - .5 lb. each. The measurement of length is made from the tip of the snout to the end of the middle rays of the tail fin. Occasionally fishes 7 inches long are met with. Various reports are current of the fishermen having taken small pilchards that meshed in the net. None of these has come under the observation of the writer and it seems probable that in some cases at least anchovies have been mistaken for small

pilchards. The anchovy is a native of these waters; the writer has observed their eggs in the plankton collections.

There is no adequate proof of the pilchard spawning in British Columbia waters. Two instances have been reported of pilchards spawning in Quatsino sound. In one case they are said to have spawned in the S.E. arm in August 1926, depositing their ova on seaweeds. The second case was reported as occurring in Winter harbour in October. The data available are not sufficient to permit one passing a final judgment on the two cases but as the European pilchard spawns a floating egg one must view with some doubt the statement that the British Columbia pilchard deposited its spawn on seaweeds as the herring does.

The question of the pilchard spawning here has not yet been investigated. A large number of plankton collections have been made during the past two years. The fish ova from these collections have been partially examined and so far no pilchard egg has been observed. The writer has had the opportunity of studying the living pilchard egg in European waters and there can be no question as to his overlooking an occurrence.

The British Columbia pilchards are adult fish and a large proportion of them have already spawned. Their ovaries are in a resting condition. Some of the fish do however have developing roes, but no actually ripe pilchard has been observed. The male fish are in many cases a little further advanced in the development of the reproductive organs than are the females and the milt may be white and of about 1/3 full size.

An account of the California Sardine (Sardina sagax) which seems to be the same fish as the British Columbia pilchard, has been published by Thompson (1926). The pilchards are caught in California, close to the shore and up to 15 miles off. The fishing season begins in June or July and is carried on till

March. The commercial catch of pilchards at San Pedro consists as a rule of fish 6 - 11 1/2 inches long, but all sizes of pilchards from 2 - 11 1/2 inches long are to be caught on the California coast. Small and mixed sizes are taken during the summer months. Pilchards 4-7 inches long are caught from June to October for bait. The July and August fish are the smallest, averaging 7 - 7 1/2 inches in length. The average length of the pilchards increases during November, December and January. They are largest in January and February. The average length declines as the end of the season approaches in March. The fluctuation in length, Thompson says, is probably due to the influx to the fishing grounds of schools of larger pilchards. The decline in size of the pilchards captured in March may be due to the disappearance of the larger fish which at this season show unmistakable signs of approaching maturity. The maturing fish may leave the fishing area to proceed to some unknown spawning ground. It is not known whence the shoals come that appear in the Californian fishing grounds nor is it known whither they go when they leave. There is an apparent seaward spawning migration in March at Monterey and a return of lean spent fish in April. In May 1927, an unusual run of pilchards occurred in Californian waters. It consisted, the Pacific Fisherman says, of pilchards which practically all contained roes, showing that they had not spawned. Clark (1928) says that the commercial fishermen off the Californian coast do not at any time, during the season take pilchards in a state of approaching maturity. Thompson (1919) stated that the roe in no case examined was so close to a spawning condition as to justify a belief that it was distant less than a month. It is evident then that the breeding of the Pacific pilchard is still unknown. Along the coast of United States between Monterey and British Columbia no extensive use is made of pilchards.

Certain data regarding the European pilchard (Clupea pilchardus) are not without interest. Cunningham found that the pilchard spawned in the English channel from June to late autumn. The eggs are abundant in the sea during that time. Dantan found the eggs in May and June 3 miles off the French coast (Atlantic) and Hefford found them in April 7 miles off the Eddystone and also some inside Plymouth sound in September. The commercial catch of pilchards in Cornwall seldom contains a ripe pilchard. The drift nets and seines are used as a rule within 10 miles of the shore. Ripe pilchards are however caught in Mackerel nets 20-40 miles out at sea from May to October--commonest in July and August. Spent fish 8 2/5-10 inches long were got in August. In the Mediterranean (at Marseilles) the pilchard is ripe from December to March even on till May. According to Fage the eggs of the pilchard have been found up to 70 miles off the coast. Cunningham (1898) considered that the pilchards 5-7 inches long got in May and November were one year old and that pilchards measuring 8-10 inches in length are probably two years old. He concludes that some pilchards spawn when two years old, when they are about 8 inches long.

Scofield (1926) says that there is no method at present available for determining the age of the pilchard. According to Clark such scanty data as are available seem to indicate that maturity of the Californian pilchard is attained between 7 and 8.8 inches of length and that the spawning season occurs in spring or early summer. In California a considerable portion of the catch appears to consist of pilchards that have not yet arrived at maturity whereas these captured in British Columbia waters have in the majority of cases already spawned.

What brings the pilchards to British Columbia waters? It may be that the food present in these waters attracts the fish. Sometimes the pilchards when they are first taken in British Columbia are thin and comparatively poor in fat content. This year (1928) however the earliest fish were unusually fat. The food of the pilchard consists of plankton, minute animals and plants which occur in huge quantities in certain places and seasons. The principal food of the pilchard in British Columbia waters consists of diatoms, (microscopic plants) but the pilchard also feeds on Crustacea and young fishes, e.g. herring and lance. According to Thompson, Swithinbank and Bullen record that the pilchards avoid the localities in which phytoplankton predominates. That is contrary to our experience on the British Columbia coast. The phytoplankton whether it directly attracts the fish or not, is there sometimes in great abundance and it is eagerly devoured by the pilchards. As mentioned above it is by far the commonest food found in the stomachs of the pilchards here. It is not likely to be a mere accident that the pilchards come to British Columbia waters. Do they come here because there waters are specially rich in plankton, and excel in this respect the waters to the south? Is this special richness a permanent character of British Columbia waters, or may it happen that some years the plankton may not be so abundant? Is the plankton native to these waters or are the shoals of plankton brought here by currents? Are the waters of British Columbia specially suitable for the reproduction of the diatom and their multiplication into huge shoals? These are questions that are being investigated at present. During the past two years an investigation of the plankton of these waters has been carried on with a view to determining the nature of the plankton, the variations in its quantity and quality in different parts of the area throughout the year. It is desired to know whether the distribution of the pilchards in these waters can be correlated with abundance of

this food and whether the entry of the pilchards into the inlets, where their capture is so much facilitated, depends on the plankton conditions within the inlets. It will be a subject of study how far the currents that impinge on the West coast of North America may have a bearing on the existence of specially rich plankton in British Columbia waters. The temperature, specific gravity and pH of the seawater have been recorded throughout the year and will be later on studied in connection with the plankton and the appearance of pilchards in British Columbia. The occasional appearance of certain marine forms i.e. Velella, in abundance on this coast has been ascribed to some change in the Pacific Ocean currents. That may be so, but the visit of these countless Velella may not be the result of one season's special conditions, but may be due to causes that operated two or more years earlier. There may have existed conditions that favoured the multiplication of this species, and it overflowed in quantity into neighbouring waters.

Factors other than food have been credited with having an influence on the migration of the pilchards. Thus, according to Barron #, the pilchards had for 10 years previous to 1926 practically failed to appear on the recognized Cornish summer fishing grounds except on rare occasions and for short periods. During their prolonged absence many theoretical opinions had been expressed, the following amongst other reasons were given for this fact, viz. the warm Gulf Stream having changed its direction in some small degree, the large quantities of oil deposited by oil-tankers, or the increased disturbance of the water by mechanically propelled craft. Notwithstanding that conditions during 1926 were the same as had existed during their absence pilchards had again appeared on these grounds. A naturalist from the Plymouth Biological Station said that the increased warmth of the water would account for the return of the pilchards and

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mackerel to the fishing grounds. A very high temperature of the seawater viz. 65° F had been recorded during the season.

For some years sardines and tunny fish had been absent from some of the fishing grounds off the coast of Brittany. The opinion of French Scientists who were engaged in research work was that the water in which shoals were formerly found had become colder, and the fish had consequently migrated.

McIntosh and Masterman (1897) state that it is many a year since pilchards were found in any abundance off the east coast of Scotland: in obedience to some natural laws of which we know nothing this fish has disappeared from our shores. Few appear to have occurred since 1916. Day states that off the coast of Cornwall and Devon they are said to remain all the year, moving near the bottom in January and in the summer migrating some 20-50 miles off shore probably in connection with spawning.

According to Thompson one finds in the literature statements concerning a nearly immediate reaction of the sardine to the abrupt changes of its environment. Such are persistent rains, sometimes a heavy storm which closes the fishery season finally; sometimes a precocious spring coincides with their coming equally precocious. It has been suggested that excessive rains have the effect of making the seawater fresh and this keeps the pilchards offshore.

So far as the fishery in British Columbia is concerned, there is not yet any indication of adverse fluctuations. Since the active fishery for reduction purposes commenced the catch has each successive year increased. No doubt that may be ascribed to the larger number of boats operating.

It is common to all fisheries to experience ups and downs from year to year and that will probably be the lot of the British Columbia pilchard fishery. No two fishing seasons are alike and there will always be unforeseen difficulties

depending on the distribution of the fish along the coast and the weather. For the pilchards do not distribute themselves uniformly over the sea, not every year at least. How far is man responsible for the fluctuations in the yield of a fishery? Is it possible to take time by the forelock and take measures to prevent poor years in the future? It is difficult to answer these questions and to justify any immediate interference with the fishing operations. Thompson says with reference to the British Columbia pilchards--"In view of the fact that pilchards were only occasionally seen in British Columbia previous to 1916 and the uniformity of their size would appear some ground for believing the abundance to be due to one or several unusually successful year classes which will ultimately reach a very large size and disappear. This cannot be told, without some study of the age of those composing the run. Thompson's suggestion seems to imply that for some reason this group of adult pilchards have undertaken a special migration to British Columbia waters and that the next generations of pilchards will not do likewise. It does not take cognizance of the fact that there must be a reason for the pilchards coming here in quantity. It might be that there is an excessive number of adult pilchards in the sea and that they overflow as it were by accident into British Columbia waters. But that supposition does not seem likely to be the true explanation. This proposition cannot be profitably discussed in the present state of our knowledge. It is no doubt the case that there are sometimes long periods of desertion of particular fishery grounds in Europe, but some confidence is derived from the fact that the pilchard fishery of California has not so far shown any sign of interruption. We have no reason to suppose that the British Columbia pilchards form the whole adult stock of any particular race of pilchards.

The stock of fish of any species will vary in amount from year to year,

even if the species is not fished by man. Fage tends to the opinion, Thompson says, that it is an unequal birthrate which is responsible for the fluctuation of the French Atlantic sardine fishery. May man in some respects influence adversely the spawning of a species by the toll he takes of the adult fish? The only point that need by emphasized is that all fisheries destroy large quantities of adult forms and still the fishery does not suffer permanently. It is not likely that the number of adult fish varies directly with the number of eggs spawned. We cannot tell the relation of the birthrate to the number of eggs spawned. One might a priori assume that as in many animals, the number of young varies directly with the number of incubating eggs. It will be necessary to find out the mortality rate of the incubating eggs. It may be that Fage considers that the index of destruction of the eggs varies in different years, and it may be sometimes so great that it has a greater determining effect in the numbers of young fish than does the number of eggs spawned.

If it were possible by restricting the amount of fishing annually to ensure a steady regular fishery in the years to come that would be an advantage. But will such an arrangement eliminate the fluctuations? It may be asked is it possible to lessen the fluctuations, and further does man through his fishing worsen the fluctuations that are sure to come?

One cannot tell what the fluctuations are in the numbers of a species that is not fished, but such a species does not go on increasing in numbers. There is a limiting number to which it may attain and that is determined by the balance of life in the sea. It may be that man can disturb the balance in regard to certain species for a time but it is bound to stabilise over a cycle of years. So far we have no experience of man's fishing operations causing the extermination of any marine species of fish. That is, his continued efforts do not depress any stock to such an extent that it cannot maintain its position

in the balance of life in the sea. But it may be asked can man intensify the fluctuations? That one cannot answer but if it be the case one need not be surprised. It is merely a consequence of carrying on a fishing industry. We have no reason however to assume that if man did not fish this year he would have a bigger catch next year. It is unscientific to say that man's operations must have an appreciable effect on the fluctuations of the fishery in the case of every species of fish. It is necessary to show the links in the evidence and these are wanting. Care must be taken in distinguishing between fluctuations in the number of fish in the sea and fluctuations in the catch. There is no constant relationship between the two and whether man takes more fish than the stock can afford can only be told after a number of years' operations. It may happen in the case of one species and not in that of another. Each fishery has to be studied by itself. While it may be admitted generally that when the stock of a particular species is abundant on the fishing grounds there will likely be a big catch, it does not follow that when the catch is small, the stock in the sea is less than in the former case.

We have no means of estimating the number of pilchards in the sea. Even on the fishing grounds it is difficult to get even a rough estimate. The pilchards are found in shoals consisting it may be of a couple of tons, or of as much as 100 tons of fish. The catch made in an area is not a measure of the quantity of fish there. If one boat captures 70 tons in a set it does not follow that another boat working at the same time will get 70 tons in a set. If a boat fishing one day in an area takes 50 tons and next day with the same gear 10 tons in the same place, it does not follow that there were five times as many fish there on the former as there were on the latter occasion.

Before the pilchards can be captured they must show themselves at the surface. Even when seen their capture is not an easy matter; many blank hauls

are made by the fishermen. The area of the coastal waters over which the pilchards roam involves an intensive prospecting. No doubt when the pilchards enter and remain in the inlets the fishing is more easily carried on but even then their capture is not a simple matter. It is possible from the appearances of the pilchards to know that there are lots of fish in an area, but one cannot conclude that they are absent although they do not show up.

It is the difficulty of correlating the catch with the stock in the sea that prevents one estimating the effects of man's operations. It is palpable that the catch of pilchards may vary quite irrespective of the size of the stock in the sea. New difficulties may arise each year and the catch may depend on the individual skill of the fisherman in tackling the new situation. To prove that the amount of the catch, in any particular case is a measure of the size of the stock one must demonstrate that fishing operations were carried on everywhere, where the fish were. A light catch at one part may mean that many of the fish are for the time being elsewhere and this is a very reasonable hypothesis in the case of a migratory fish like the pilchard. Weather also may militate against the success of the fishery. A fishery does not repeat itself from year to year. The average of a cycle of years is the only tone index of its profitable nature.

There is one form of fluctuation which is to be directly attributed to man's operations and that is that the fishery tends to reduce in some cases the number of the larger individuals caught from year to year. But this is a result which must be accepted if there is to be a fishing industry at all. How far it may be justified to restrict the fishery of one year in order that there may be a good stock of large fish the following year is a question. Time alone can show whether the fishery will result in a reduction in the numbers of the larger pilchards. We cannot tell whether, even in years when the catch is small, that

the fisherman's operations will worsen the situation for the future. Man must not destroy all the spawning adults. But there seems no likelihood of that happening. If the spawning grounds were known it would be possible to find out whether they were frequented by spawning fish each year and it might be possible to estimate roughly the comperative abundance of eggs in different years. It is not possible at present to estimate what proportion of the pilchards actually spawn. We cannot at present tell that it is necessary to in any way restrict the capture of the adults. It may be that man may capture as many as he can, without adversely affecting the stock. We do not know, for example, that the surviving pilchards of the British Columbia fishery actually spawn again, though it may be presumed they do. We do not know what proportion they form of the general adult stock which spawn. The pilchards are not compelled to spawn in definite bays as herrings are. They have, one would suppose, a large proportion of the ocean in which to find suitable spawning conditions. It may be the case that certain conditions of the water are necessary and therefore particular portions alone of the ocean are suitable. Still the available spawning area is no doubt very extensive.

If one assumes that the British Columbia pilchards are the total stock of spents of a particular race, and that a proportion of them at least are required to spawn a second or third time in order to keep up the supply for British Columbia waters, what are the risks that the stock may be exhausted?

The migratory habits of the pilchard are a restrictive measure on fishing operations. These migrations are no doubt dependent on the food supply and possibly physical conditions of the sea. There is no doubt however, but that food must be a prime factor. We do not know of the variations in quantity and distribution of the food in the ocean. The fish are moreover not too easily

caught by the present fishing methods. At present the British Columbia fishery depends upon the migration into the coastal waters of adult fish.. We do not know what proportion these shoals form of the total stock of the adults in the sea. We know of the enormous destruction of fish life especially in the younger stages. The stock of adults has had to run the gauntlet of many dangers and it is not unlikely that it will vary in numbers from year to year. Can we assume that the survivors of the British Columbia fishery will return to British Columbia in the following year? Have we any reason to believe that a very large proportion of the pilchards in British Columbia are captured during the season? Towards the end of the season (October) the appearances of the pilchards become fewer. Is that because the majority of the fish have already been captured? Or is it due to the fact that fish have been departing? There is a possibility that during the summer some of the pilchards may become ripe and leave for the spawning grounds. It is not possible to answer these questions at present, but from general observations and study of the fishery it may be asserted that the fishermen do not at present capture as large a majority of the fish on the grounds. There is no reason at present to assume that the capture of these spent fish can have any important effect on the permanency of the stock of pilchards.

It is important to have a knowledge of the spawning of the pilchards and it is desirable that investigation be carried on off the coast of British Columbia with a view to discovering if pilchards spawn in this region.

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