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Lobster.

The lobster is very common along the Norwegian coast to the Trondheimsfjord. It occurs as far north as to the Lofoten islands. The lobster inhabits the shallow waters especially along the coast and in the Skjærgård. In the fjords it occurs more sparely. It is not fished for at a greater depth than about 20 fathoms. The lobster prefers rocky bottom, gravel and sandy parties between the rocks. Figure 1 gives the total output of the Norwegian lobster fisheries from 1876-1946. The greatest quantities landed are from the Southern and Western district (Figure 2). The Northern district comprises the Northern limit of the distribution of the lobster. The fishery has been carried on with the same sort of gear during the whole period, and as it commonly occurs in inshore waters, or near the coast, the development of fishing boats and motors has been of little consequence to the output.

The intensity of fishing is to a very high degree dependent on the economic results. The fishermen will carry on the fishing during the season as long as it pays. Here the market price is of importance, and also the possibility of having a more profitable occupation. The weather during the season may also be of importance, especially as stormy weather may occasion heavy losses of gear. For the single season also the biology of the lobster may play a great role. In a year with ordinary summer temperature in the sea water the lobster most commonly will moult in late summer. In the autumn, the foremost fishing season, the lobster will thus be meager and eager to take the bait in the pots. If the summer temperature is low, the casting of the shell may occur late in the autumn, and as a lobster before moulting will take food but sparely this may have some consequence to the output, and relatively few undersized lobsters will have grown to a marketable size. In a year with high summer temperature the lobster on the Southern coast will moult twice. This will augment the stock of commercial lobster. In this way the yearly catches are influenced in different ways. The main variations in the output, however, are surely caused by variations of the stock. From Figure 1 it is obvious that the variations are fairly parallel in all districts, the Northern district, however, lacks the good period in earlier years. It is of course difficult to state the causes of the variations. The declining values during the war may be ascribed to a lesser intensity of fishing - or the catches have passed direct to the consumer. The good catches after the war may be the result of a greater stock accumulated in the previous years. We know, however, that the lobster in Norway is living near its Northern limit, and that the summer temperature of the sea water must be a limiting factor. In Figure 3 we have reproduced the summer sea temperature (May-October) in the Norwegian lobster district from E.Frogner: Means and extremes of sea temperature by the Norwegian coast, Oslo 1948. The temperature is given as a movable mean for 7 years, the time necessary for a lobster to attain a marketable size. It will be seen that high catches correspond to a high summer temperature.

The statistics give no indication of overfishing. This is very interesting as our marking experiments in the Southern districts indicate that at least 50 per cent of the marketable lobster is taken every year. There is evidently a good balance between the intensity of fishing and the stock at hand. When the result of the fishing during the season runs low, there will always be left a stock great enough to provide for the future.

In Southern Norway we have statistics from about 25 fishermen. The individual catches vary in correspondence with the official statistics.

From the same persons we also get some informations as to the occurrence of undersized lobsters. In the years 1937/1945 more than 70% of the fishermen inform us that lobsters under the size limit(21cm.) are getting scarce. At Flødevigen (district II) we have carried on experimental fishing since 1928. The results as to the percentage of undersized lobster confirm the experiences of the fishermen. The scarcity of the small lobsters is somewhat alarming. It may be taken as a warning that the stock of lobster is declining. The problem is, however, complicated. The sea temperature during summer has been relative high during this period, and that

means that the lobster will need fewer years to grow into marketable size than in a cold period. The altered relation between undersized and marketable lobster may be explained in that way. Another point of interest is that the natural reduction must be assumed to be proportional to the length of the period of development. Reasonable high temperature ought thus to give a better result of marketable lobster than a cold period. I am therefore not sure that the occurrence of fewer small lobsters may prove to be any danger to the stock in future, but surely it is a point of the highest interest.

Although we have no indication that the stock of lobsters is overfished, this does not mean that the output cannot be raised. By measuring the lobsters - all sizes - caught by the fishermen, it turns out that it is the individuals just about the size limit of 21cm. which dominate (Fig.4). As the female lobster will not grow fertile till a length of approximately 22cm., it is evident that a very high percentage will not have a chance of reproducing themselves. A higher size limit would permit a higher degree of reproduction.

We have marked lobsters between 21 and 22cm. In 2 years we have recaptured just as many kg. as we liberated. We have therefore in Norway brought into consideration the raising of the size limit with 1cm. At a size of about 21cm. the lobster has its best period of weight increment. When attaining maturity the increment of the females is reduced. It is therefore not sure that a still higher size limit will pay. That problem has, however, not been thoroughly examined.

The Figure 5 indicates the yearly increment in length of lobster in Southern Norway of different sizes. The increment is computed from marked and recaptured specimens.

The prohibition of berried lobsters has also been discussed in Norway. This would of course improve the stock to a high degree, but it should mean a very heavy tax on the catches of the fishermen. It has been brought into consideration that the Government during the spring should buy all the berried lobsters from the fishermen and liberate them at the beginning of the closing season. That should mean high expenses to the Government, and the result will be problematic. When the berried lobsters are kept in confinement, the eggs very often will be attacked by parasites. And when some lobsters are kept in the same confinement, many eggs are lost. A better method is to take care of the eggs, hatch them and liberate the fry. In Norway we have been experimenting to raise the fry to the bottom stage. Apparatus and methods work well, but the experiments to verify the results in nature came to an end at the outbreak of the war. They are now renewed, but as it takes approximately 7 years before the liberated lobsterlings attain a marketable size, we can till now say nothing about the results.

A detailed report on the rearing of lobster larvae is given in: "Alf Dannevig: The rearing of Lobster Larvae at Flødevigen. Rep. Norv. Fish. and Mar.Invest. Vol. III, No. 9, Bergen 1928". In 1933 a new rearing plant was built at Flødevigen on the same principles. We now dispose of 3 old apparatuses as described in the paper mentioned and 20 new ones each of a dimension of 1,28 x 1,45 and 0,96m. deep. The output of lobsterlings in the bottom stage has varied between 10.000 and 80.000 a year. The new appartment has functioned satisfactorily.

The total output depends mainly on: a) the number of larvae at disposal. b) The supply of convenient food. c) The occurrence of parasites. d) The cannibalisms.

It has turned out that the berried lobsters bought in the market in early summer may have very few eggs left. Most of them have been lost when the lobster has been kept by the fishermen in narrow boxes or during transport. The eggs may also be attacked by parasites. In this way the number of larvae acquired has varied between 200-1200 a lobster. This difficulty has in the latest years to some degree been overcome by securing the lobsters at an early date and putting them, one in each box, in the hatching apparatus. Here great cleanliness is afforded and a good current of fresh sea water.

The best food for the larvae is the soft parties of the crab (Cancer pagurus). Those have, however, been difficult to obtain at reasonable prices. We then turned to fine-grained ox-liver. This is also very suitable. The lobster larvae will be very eager to take it, and it keeps suspended in the sea water. The larvae will grow quickly. This sort of food, however, has in the after-war years been difficult to obtain in sufficient quantities, and therefore we are now also feeding with fine

grained fresh fish. The results are not so satisfactory when feeding with fish. The cannibalism is greater than when feeding with crabs or liver. The expenses, however, are lower.

The method of cleaning the rearing apparatus by means of fine airbubbles pressed into the water-inlet for half an hour in the morning and afternoon, will clean off all food remnants, skins, excrements etc.

In some years, however, the lobster larvae have been attacked by a protozo Ephelota sp. This protozo is very common in nature, and the larvae are brought into the hatchery by the water current from the pumps. A moderate attack will not be of any consequence as the protozo is cast off with the skin by the moulting. If the attack is very strong, it seems that the process of moulting is inhibited. The larvae will not grow and may succumb. It is difficult to tell what the causes may be for such a heavy attack, but we are inclined to believe that the suction pipe has not been led far enough from the sewage. Thus some of the larvae of the parasites from the rearing boxes may be pumped back into the apparatus. Heavy attacks occurred in the special warm summer of 1947, when the sea water in the bay was very stagnant. In normal years the attack is negligeable. We will now try to lengthen the suction pipe, in this way the water inlet comes further away from the sewage.

In normal years the reduction of the number of larvae during the rearing process is brought about by cannibalism. When dealing with lobster larvae this is not to be avoided. The degree of cannibalism depends on the following:

1. The concentration of larvae
2. Suitable food.
3. The mode of the circulation of the sea water. Eddies where the larvae may accumulate are detrimental.

Oysters.

At the beginning of this century we in Norway had some natural oyster on a few localities especially on the Southern coast, but also in favourable localities up to the polar circle. At the present time there are but few individuals left. When the stock of old individuals were taken away, the few left were not able to reproduce the stock. The localities where the oyster survived till the present time, are all in narrow waters where the temperature may rise high during summer. The small stocks are to be regarded as relicts from an earlier geological period when the mean air temperature of Southern Norway was about 2 degrees higher than at the present time.

At present we have practically only artificially raised oysters. The oysters are grown in baskets of galvanized iron netting, 75 x 75cm., suspended in bays by means of buoys. This method is of course somewhat expensive. On the other hand the oysters are under full control and we are free from star fishes and snails. There may, however, be some food competition by anelids, ascidians and mussels. The oysters are therefore cleaned once or twice a year. Each basket may hold 250 spats or 100 fullgrown oysters.

The choice of the locality is of the highest importance. By lots of experiments on the Norwegian Skagerack coast it is demonstrated that in many localities it is not possible to raise the oysters at all, they will not grow, and the mortality may in a few years be total. In other places the spat ordinarily will grow to a marketable size during 3 summers. In one locality we have observed oysters with a weight of 60-70g. 18 months of age. The experiments point to the fact that the variation in the salinity of the sea water is detrimental to the oyster. Therefore, the best localities are found in bays with a narrow and shallow inlet where the salinity below the threshold is very constant. When the depth of water in the entrance is about 1m., the baskets are placed inside at a depth of about 3m. below the water surface. In earlier years the oysters were placed 1-2m. below the surface, and we then had a heavy mortality caused by accumulation of fresh water in the upper layers. This might occur in periods with much rain - or in very cold winters. In earlier years the mortality in cold winters was ascribed to the low temperatures, near zero. But later we have confirmed that during cold winters fresh water may be stowed under the ice. In this way it has been the fresh water and not the temperature which has been the detrimental factor. Temperature about zero is not detrimental to our oyster, and it may sustain temperatures as low as 1.5 C. degrees

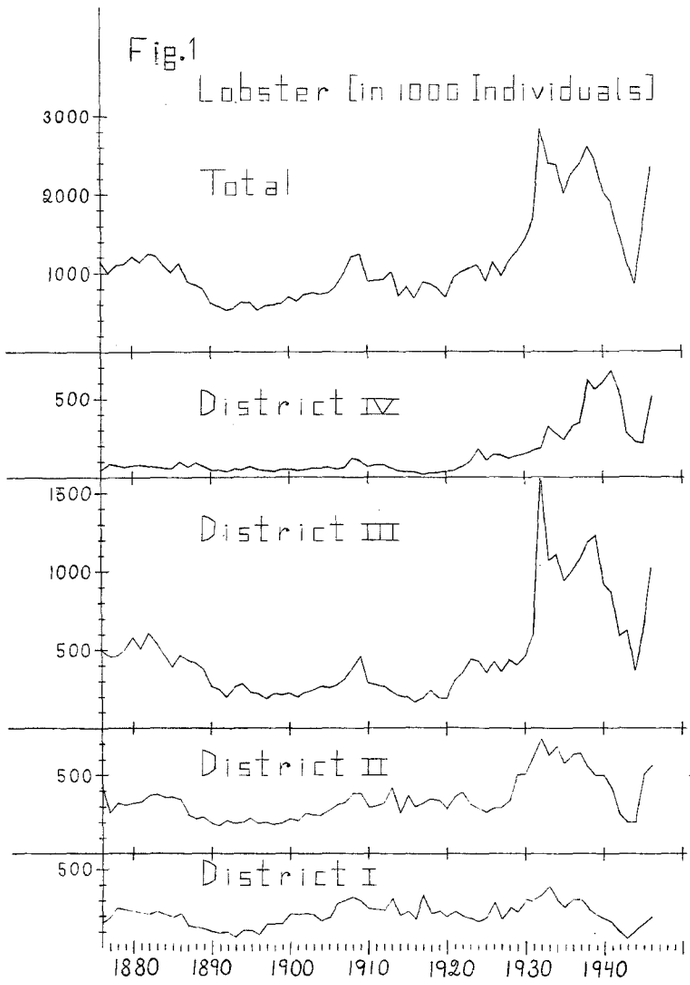
below zero. During the winter 1941-1942 the temperature in our oyster pond was below zero from January 8th to March 7th, and more than 1 degree below zero between January 28th and February 18th. We had then a stock of oyster in the pond. The mortality was great, but a fair percentage survived.

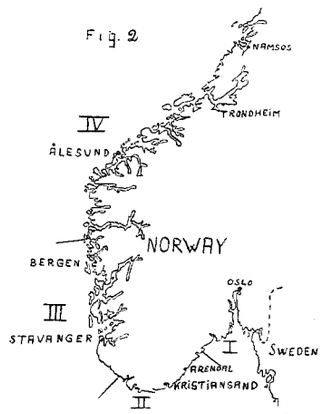
By our experiments it has also turned out that oyster spat bought from the Western coast of Norway for our ponds on the Skagerack coast is much more liable to mortality than the oyster reared in our own ponds. This mortality is hardly caused by the transport. The spat will thrive for some time, but the mortality is so high that the output of grown up oysters may be very poor. The oyster spat reared in Western Norway has been acclimatized to more saline water than normally occurs on the Skagerack coast.

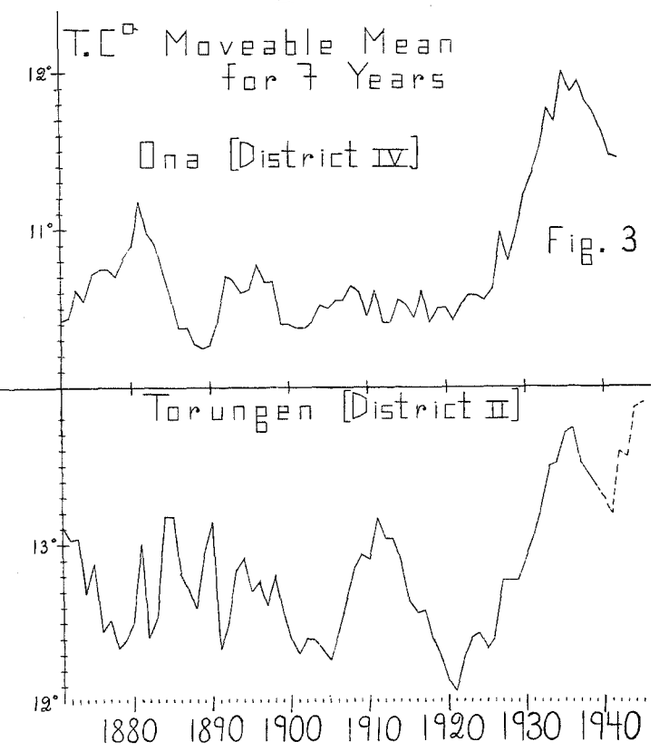
In our artificial oyster pond we have tried to raise oyster spat, but the results hitherto have not been satisfactory. In some years we have had great success, in other years the output has been poor. As to the causes for the varying output, we can say very little. By experiment it has turned out that in some years egg collectors dipped in lime have given a far greater number of spat than collectors without lime. We have till now worked on the hypothesis that the amount of suitable food was the main problem. But although we by means of artificial manure (phosphates and nitrates) have had a rich plankton, we have not been able to stabilize the output. By lack of assistance, however, the experiments have not been followed in a suitable way. We are now inclined to believe that the gas content of the sea water plays a considerable role.

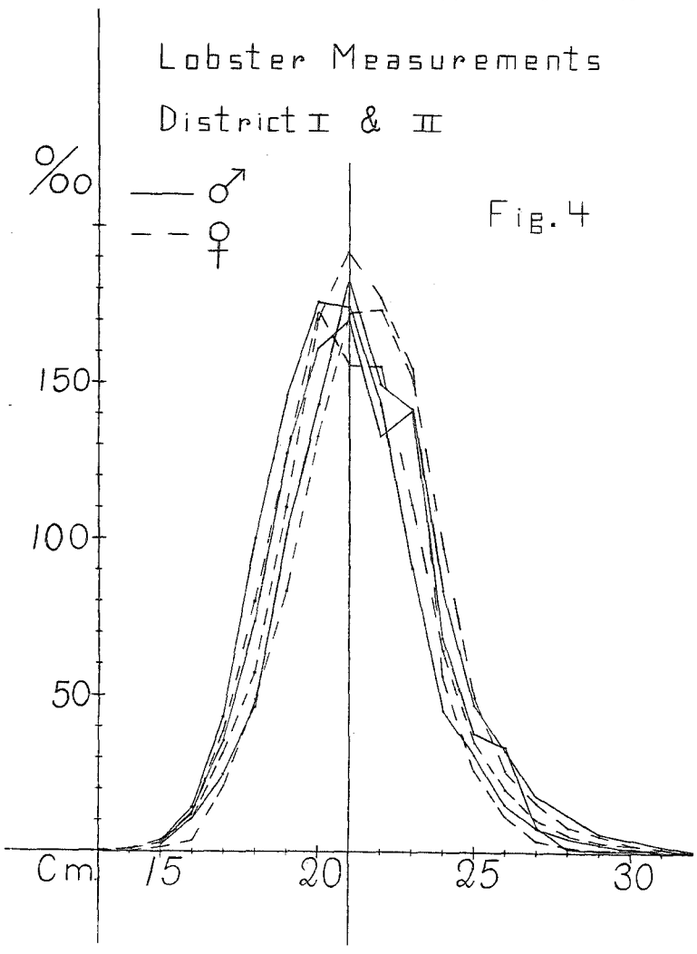
In the laboratory Else Fagerland Dannevig has made some experiments to rear the oyster larvae in petri dishes. It turned out that success only was attained when using a culture of naked brown flagellate for food.

In order to lengthen the season of having oyster larvae at hand, some grown up oysters are brought into the laboratory in January. The temperature of the circulating sea water is gradually raised to about 20 degrees during February, and in March the oysters will spawn. No food is given except what is contained in the circulating sea water.









Yearly Increment in Length of Lobster in different Size-groups computed from marked Specimens 1919-1948.

Fig. 5