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MUSSEL CULTURE IN THE DUTCH WADDENSEA

B. Havinga

Abstract.

Due to the disastrous losses caused by the musselparasite Mytilicola intestinalis to the musselculture in Zeeland since 1950 the musselgrowers had to look for other possibilities. They found a way out by transferring this culture to the western part of the Waddensea. In 1953 by far the greatest percentage of the mussels was produced in the Waddensea. In this paper a description is given of the hydrographical conditions in this area, and of the development of the musselculture. Further it is demonstrated that this culture can contribute very efficiently to the increase of production of human food in the sea.

Hydrography of the Waddensea.

The western part of the Waddensea in which the musselculture is being carried out at present, is situated between the Wadden Islands Texel, Vlieland and Terschelling, the meridian of 5°28'E., the Frisian coast and the enclosing dike between the Waddensea and the Lake Yssel (See chart). The surface of the area is about 1360 km^2.

Like the whole Waddensea this area consists of shallows, mud- and sand banks, more or less emerging above the low water level and channels between them.- The channels belong to three systems: one, Texelstroom, entering between the mainland and the Isle of Texel, one between the Isles of Texel and Vlieland and the third one, Vliestroom, between the Isles of Vlieland and Terschelling.

There is some intermixture of the water in the first and third systeme; the middle one is isolated from the other systems. In the area of the middle system no mussel culture is carried out, because the ships of the musselgrowers cannot pass the flats around it, in which no channels occur.

The difference in level between low and high tide is about 1,5 m.

The currents in the channels are strong 1 - 1,5 m/sec. gradually slowing down towards and on the flats. As the channels are broad and deep, large quantities of North Sea water are transported into the area at each flood.-

At low tide the quantity of water in this area of the Waddensea amounts to 4.5 km^3, during the flood a quantity of 2 km^3 of North Sea water is added by the tidal currents.(Verwey, 1952). In addition an average quantity of 0,014 km^3 fresh water is entering at each tide from the Lake Yssel. The fresh water, however, is for the greatest part discharged in autumn and winter; in spring and summer, the period of food production, the quantity is considerably smaller. Notwithstanding the admixture of relatively great quantities of North Sea water at each tide the area has its own character. e.g. with regard to salinity and temperature the water is different from the North Sea water (Postma and Verwey, 1950; Postma, 1950).

Discharge of fresh water from the Lake Yssel through the sluices at both sides of the enclosing dike, and from other less important sources, exerts and essential influence on the salinity. The lowest values usually occur in the southwestern part, as all the fresh water from the western sluices of the Lake Yssel is discharged through the Texelstroom and in addition a part of the water from the eastern sluices. During the periods of discharge of fresh water the salinity in the SW and central part of the area can be 5‰ lower or even more than the entering North Sea water. The water entering the Waddensea from the sluices is spreading over the salt water, mixture with the underlying salt layers takes place very gradually. Consequently the bottom water has a

relatively high salinity near the sluices.

Observations indicate that under normal wind conditions it takes one to one and a half month to raise the salinity of the Waddensea to the level of the North Sea when discharge of fresh water is stopped (Postma, 1950).

There is also a difference in the temperature of the water. It follows the temperature of the atmosphere faster than that of the North Sea water. In this connection the presence of extensive shallows and bank exerts an important influence. In summer the average temperature is about 3° higher than in the offshore water of the North Sea, in warm periods the difference is still greater; in winter the average temperature is about 4° lower. In severe winters nearly the whole surface is covered with ice.

Another characteristic of the Waddensea water is its turbidity. The average quantity of suspended matter may be estimated at about 25 mg/l (dry weight at 120°C), 3 mg 12% of this quantity is organic substance (Verwey 1952).

The development of musselculture.

The hydrographical conditions of the Waddensea - not only the part that has been described above, but also the part more to the east - form an optimal habitat for the mussel. In many years large quantities of young mussels are produced, that settle on the flats, forming sometimes musselbanks with a surface of many ha. Less extensive musselbanks are also formed along the slopes of the channels under the low tide level. On many places, especially the deeper ones, the young mussels can grow up well under natural conditions, and they can attain such a good quality that they are quite fit for human consumption. these "wild" mussels have from old been fished and landed for the market in moderate quantities.

On other places, however, the young mussels accumulate so densely that the food supply for each individual is insufficient for a good growth. They can live here for some years reaching a length not exceeding 3 or 4 cm. This phenomenon is generally seen on the flats falling dry at low tide. In deeper water the density on the banks is often substantially reduced by starfish.

The task of the musselgrower consists in selecting a suitable ground, regulating the growth by creating a density of population in accordance with the food supply, combating enemies, especially starfish and harvesting at the appropriate age. To get the opportunity for this whole business the musselgrower must dispose of exclusive rights on a part of the sea bottom.

Previous to 1950 only one person carried out musselculture in the area. The yield varied generally between 500 and 1000 tons. That this opportunity was not more extensively used must be ascribed to the position of the market. The Zeeland musselgrowers were able to produce enough mussels to fulfill the requirements of themarket. This changed as in 1950 the Mytilicola disaster caused a serious depletion of the musselstocks (Korringa 1952). To satisfy the requirements of the market the Zeeland musselgrowers began fishing the wild mussels from the Waddensea banks. These mussels, however, were the traditional material for the Waddensea fishermen who delivered them mostly to the duck farms. When, due to the intensive fishing, the wild mussels became scarce these Waddensea fishermen received the right of musselculture on plots of ground leased to them in private use, for compensation. The plots were situated in the S.W. part of the area.

Besides some other Zeeland musselgrowers had found favourable grounds south of the Isle of Schiermonnikoog. Their effort led to a complete success; the culture, however, had to be discontinued here as Mytilicola was also detected, sporadically, in the extreme eastern part of the Dutch Waddensea, and it was deemed undesirable to accumulate large quantities of mussels in the neighbourhood of infested grounds.

Consequently the whole culture was concentrated in the western part of the Waddensea, the area drawn on the chart.

In the spring of 1951 a number of plots were allotted to Zeeland musselgrowers. The results they got were very satisfactory and as the situation in the Zeeland waters did not show any sign of lasting recovery the number of plots increased steadily. In 1954 a number of 273 plots were reached. They have all been drawn on the chart.

The plots are not uniform in size, and besides most of them can only partly be used for the culture. It is perhaps a good estimate taking 5 ha as the average surface per plot suitable to culture.

The course of the development of the culture in the Waddensea is shown in the table.

Development of the musselculture in the Waddensea.

Year December	no. of plots	quantity in tons	value in 1000 guilders
1950	14	1.500	150
1951	76	21.000	2000
1952	133	28.000	2800
1953	184 +)	47.000	4800

+) In the first half of 1954 this number increased to 273, on which during 1954 mussels are being cultivated.

There is a great demand for more plots, but it is not always possible to satisfy it. Firstly the hydrographical conditions and the bottom must be favourable, and further the traditional rights of other fishermen, fishing for shrimps, anchovy, whelks etc. must be safeguarded.

A good growth and a good quality can only be obtained on grounds situated on the slopes of the channels where the velocity of the current is sufficient to warrant a rich supply of food. On the flats, even when they are below the low water mark, the mussels do not fatten well. These grounds, however, are quite suitable to the growing of young mussels, which after they have got a medium size can be relaid on the fattening ground along the deeper channels.

The growth of the mussels is excellent: mussel seed, born in the previous spring and settled under natural conditions when relaid on the plots in the early spring, can attain a marketable size, about 5,5 cm length, and prime quality in the early winter of the same year. This can, however, only be reached on the deeper grounds, and the shells are then usually very thin and fragile.

The question arises whether the excellent growth and the fertility of the water causing it, must be ascribed to the admixture of fresh water from the Lake Yssel. This water is rich in plankton in summer and contains a considerable amount of nutrient salts in winter. It can be supposed that this exerts a favourable influence on the food production in the Waddensea.

In this fresh water exerts a considerable influence on the fertility, the conditions for good growth and fattening would be more favourable in the western part of the area than in the eastern part. It shows, however, that the growth and the quality on the plots near the Isle of Terschelling, where the direct influence of the fresh water can be neglected, is about the same as in the western part where the influence of the fresh water is maximal. As mentioned above a good growth was attained also still farther to the east, near the Isle of Schiermonnikoog.

One may, therefore, conclude that in the whole Dutch Waddensea conditions for growth are favourable independant of the admixture of considerable quantities of fresh water.

Although it is possible to obtain marketable mussels after a sojourn on the plots of one summer under favourable conditions, in many cases it is necessary to leave them there for a second summer. In a well established culture it is even desirable to have at least 2 plots at disposal, one for growing of half grown mussels, and one for fattening. Although the mussel seed can be fished on the public grounds, it is a safer procedure to have a stock of young mussels in private possesion. For in some years the mussel seed is scarce, especially in spring, when on many places the natural stocks are depleted by storms, ice and starfish. These risks can be avoided by fishing the halfyear old mussel seed in autumn, and relaying it on selected plots, where they are protected against unfavourable influences. The rate of survival can then be increased considerably. In this year, 1954, there is a scarcity, because during the severe winter nearly all the mussels were carried off from the flats by the ice at the very low tides that occurred at that time.

Productivity of the area.

The table above shows that in the year 1953 nearly 50 million kg mussels have been produced in the western part of the Dutch Waddensea, containing an edible portion of 9 million kg, with a value of 4.8 million guilders. The whole production of fish in this area for direct human consumption is about 0,5 million kg, of shrimps 1,2 million kg, equivalent with 0,4 million kg of meat, and of other shellfish 0,4 million kg, containing 0,1 million kg of meat. So the whole production of edible animal substance originating from fish and shellfish amounted to be about 1 million kg or 7 kg per ha. In addition about 3 million kg of fish and shrimps are caught for reduction to fishmeal; if the value for human food of this quantity is estimated at 0,8 million kg, the whole production would amount to 1,8 million kg human food, or 13 kg per ha.

The introduction of musselculture has caused an increase of production of animal human food with 9 million kg, nearly 70 kg per ha, an increase, therefore, of about 450%. If a market could be found for the product and if the interests of the fishermen catching fish and shrimps had not to be safeguarded, the production could perhaps be doubled.

With this yield the productivity is, however, not exhausted. Verwey (1952) states that between 6 and 12 milliard adult cockles occur in about the same area as is being dealt with here. Part of this stock could be fished annually without interfering seriously with the density of the population. It may be assumed, therefore, that cockles can yield another 10 or more million kg food substance annually. This would increase the potential annual yield per ha with 70 kg and the total potential production per ha in the Waddensea would then be 140 kg mussels, 70 kg cockles and 7 kg of other fish and shellfish together 217 kg.

The explanation that such a high production per ha in our latitude is possible, is certainly that mussels, and also other bivalves, take as food the primary product of assimilation, the phytoplankton and its disintegration products. Although it is not known which part of the phytoplankton mussels can use as food, it may be assumed that they can utilize a considerable portion of it. It is also very probable that the minced and disintegrated parts of larger algae play an essential part in the supply of food. These algae, especially Ulva lactica, are growing in enormous quantities in the whole area in summer.

Strictly taken the plankton needed for the high yield is not produced really in the area itself. Each flood tide transports a relatively large quantity of North Sea water into the Waddensea containing plankton and nutrient salts that can be converted into phytoplankton. When passing the cockle- and musselbeds this is partially taken as food and digested, partially deposed as faeces and pseudofaeces. Disintegration and mineralisation of the animals and the (pseudo)faeces yields new substance for the assimilation by the phytoplankton. The Waddensea, therefore, acts as an accumulating basin. Verwey (1952) has described this phenomenon extensively, and I may refer to his paper.

The important share of the North Sea water in the supply of food for bivalves implies that the production of bivalves in the Waddensea is not exclusively dependant on the autochtone productivity of this area. Considering the enormous quantities of organic material and nutrient salts that are flowing into the area at each tide, one may be optimistic about the possibility of maintaining the present yield in the future, or even of extending it.

It is often claimed that the production of animal protein should be increased as the diet of so many people shows a deficit of this substance. On the other hand the plankton of the sea provides an inexhaustible source of food and the only problem is to collect and to convert it into edible substance.

Our musselculture in the Waddensea is an example how this problem under certain conditions can be solved, and generally speaking we may say that in those parts of the sea where bivalves can be cultivated this culture provides a very effective opportunity for converting plankton into human food in great quantities, a source of food that otherwise is completely lost.

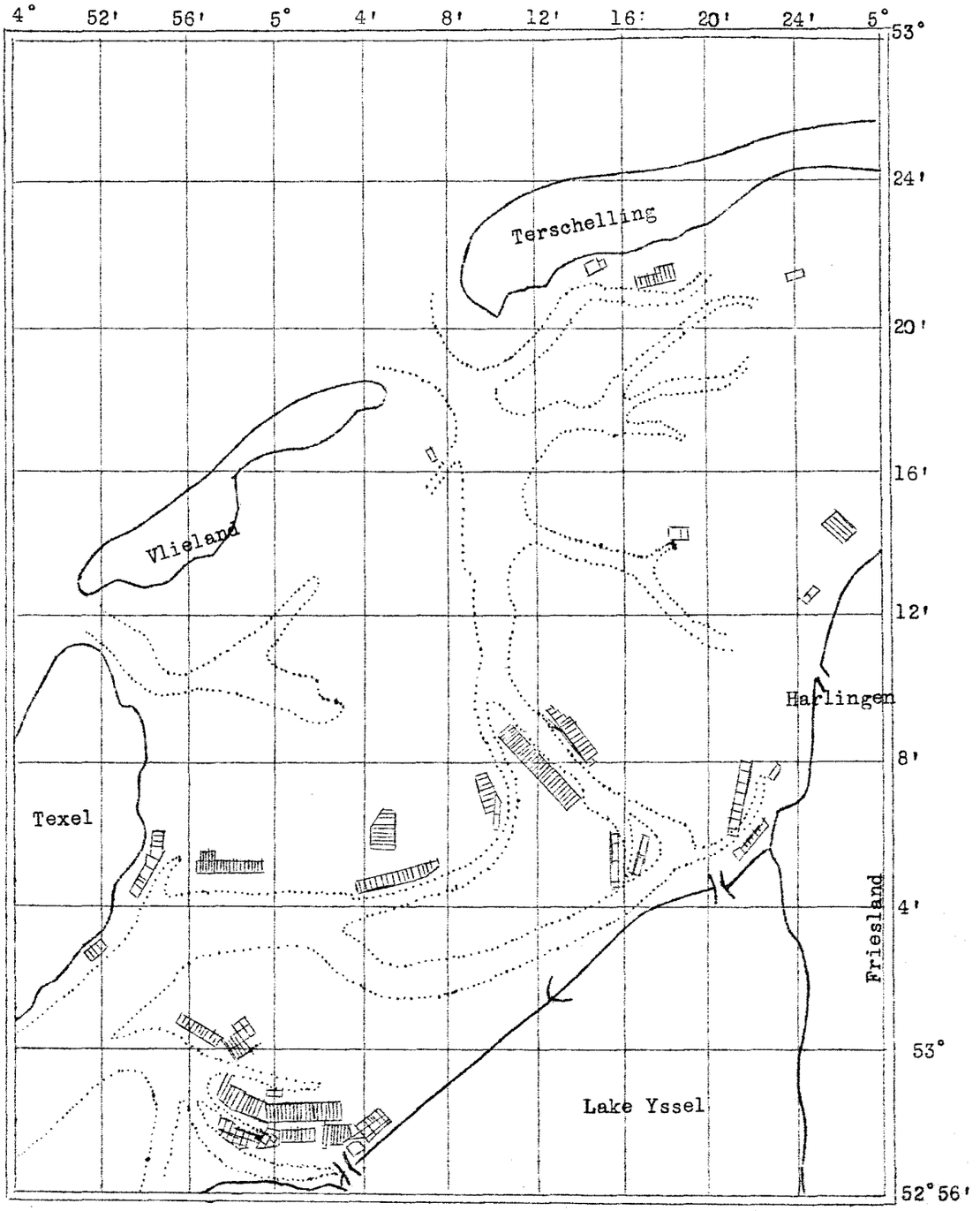
REFERENCES

KORRINGA, P. 1952 "Epidemiological observations on the mussel-parasite Mytilicola intestinalis, Steuer, carried out in the Netherlands 1951."
Ann.Biol.Vol.VIII(1951). pp.182-185.

POSTMA, H. 1950 "The distribution of temperature and salinity in the Waddensea."
Tijdschr. Kon.Ned.Aadrijksk.Genootschap.67.pp.34-42.

" " & VERWEY,J. 1950 "Resultaten van hydrografisch onderzoek in de Waddensea."
Ibid. pp.3-33.

VERWEY, J. 1952 "On the ecology of distribution of cockle and mussel in the Dutch Waddensea, their role in the sedimentation and the source of their food supply."
Arch.Néerl.de Zool.T.X,2e livr.pp. 171-239.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