15.

Shellfish in the Netherlands.

By

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Crustacea.

The only species of Crustacea of general commercial value is the common shrimp (*Crangon vulgaris*); lobster (*Homarus vulgaris*) and crab (*Cancer pagurus*) occur in small quantities and are only of local importance.

Shrimp.

General. Shrimps are caught in all the estuaries of the Scheldt, Meuse and Rhine, in the Wadden Sea and off the open North Sea coast. In all these waters shrimps may be found in great quantities, on the hard barren sand bottom of the North Sea shores as well as on the mud bottom of the inshore waters. They used to occur in great numbers on the very soft mud in the central basin of the now enclosed Zuider Sea.

Shrimps are caught with a fine-meshed otter-trawl or with the old fashioned beam trawl. In the Wadden Sea particularly many fishermen prefer the beam trawl, they fish with 2 nets, one at each side of the vessel.

There are shrimp fishery centres in the southern part of the Netherlands, (Breskens, Arnemuiden, Stellendam) as well as in the north (den Helder, Oudeschild, Harlingen and Zoutkamp). Formerly, when the product was always in sufficient demand, and no restrictions on the fishery were necessary for economic reasons, some villages gained nearly their whole livelihood from the shrimp.

Shrimps are not caught for human consumption only, large quantities of small shrimps being landed for the manufacture of dried shrimps or shrimp meal. In the Lauwer's Sea and Dollart it is customary to dry the greater part of the catches, because there is only a very restricted demand for human consumption. The small shrimps used for drying do not consist only of young ones; mature males, too small for human consumption, occur in great quantities also.

In Table I the catches in the different districts and the totals are shown for a number of years taken at random.

Fluctuations in the stock. The figures in Table I are not always a good measure for the density of the stock. In the years between the two wars especially, restrictions were often necessary in order to avoid glutting of the market. We know from experience, however, that great fluctuations may occur. In some years shrimps are abundant, and one has to be careful that the market is not glutted, while in other years the catches may be so poor that the fishing is scarcely profitable.

In such poor years the fishermen sometimes call for protection of the stock, especially by the prohibition of the landing of small shrimps.

Table I. Catches of shrimps for human consumption and for drying, in different districts of the Netherlands, in 1000 kg.

Year	South. Districts		Zuider Sea	Wadden Sea		Lauwers Sea, Dollart		Total	
	consump.	drying	consump.	consump.	drying	consump.	drying	consump.	drying
1920	4,264	—	1,885	339	—	394	—	6,882	—
1925	3,726	—	1,910	577	—	1,626	—	7,839	—
1930	3,699	2,700	2,313	1,235	900	113	3,602	7,360	8,202
1935	2,213	3,800	—	319	2,200	65	4,965	2,597	10,965
1939	2,348	8,300	—	353	2,700	111	11,272	2,812	22,272
1946	1,648	60	—	573	206	406	2,000	2,627	2,266
1947	2,660	1,450	—	975	700	163	4,900	3,798	7,050
1948	2,683	356	—	691	1,345	595	1,550	3,969	3,251

Investigations (HAVINGA, 1930) did not lead, however, to the introduction of protective measures and up to now the shrimp is not protected at all.

I got the impression that although the fishery is carried out intensively in the Netherlands, it is well balanced by the enormous productivity of the shrimp. This impression was corroborated by the yields immediately after the war. During the war, especially the latter part, the fishery was hampered by the seizing of numerous vessels and by other acts of the Germans. There are no reliable statistics for 1945, but experience showed that the catches then were subnormal. 1946, too, shows rather low figures. The limited activity of the fishery during the years of war, therefore had no favourable influence on the stock.

That fishing apparently has only a slight influence on the stock might be explained by the supposition that the natural mortality is very great as compared with the mortality caused by fishing, and that it is, therefore, the natural influences that are responsible for the variations of the stock. Shrimps are a common food for many species of fishes that are very frequent in the shrimp areas: whiting, dab, *Cottus scorpio*, *Zoarces viviparus*, *Trigla spec. div.* These fishes occur in millions and the quantity of shrimps they take as food will amount to tens of millions of kilogrammes. The extreme abundance of a fish preying on shrimps, e. g., whiting in 1945 and 1946, will presumably do much greater harm to the stocks than an increase in the intensity of fishery.

In accordance with this supposition no protective measures, such as a minimum size of shrimp or net, or closed seasons, have ever been advised in the Netherlands.

Towards the end of 1948 the shrimp catches began to fall considerably, first in the southern districts, but later on in the Wadden Sea also. The catches decreased to such an extent that many vessels abandoned the shrimp fishery. It is supposed that the drop in catches is caused by downward natural fluctuations in consequence of the low temperature in the severe winter of 1946—47, perhaps accentuated by the great numbers of dabs and flounders on our coast in 1948.

The **migrations** have been described extensively in my paper quoted above, and as no investigations have been carried out in the Netherlands on this subject since its issue, I shall restrict myself now to reference to this paper.

The same migrations as have been found in the Netherlands have been described in a recent paper by LLOYD and YONGE (1947).

It is certain that both salinity and temperature are the stimulating factors for this migration, but, in addition, investigations of BROEKEMA (1941) have shown that there is an interaction between salinity and temperature. She found that with increasing temperature the salinity optimum shifts downwards; in two-year-old animals at 4° a salinity of 33‰ proved to be optimal, whereas at 20° C. the optimal salinity was 29‰. For one-year-old animals the optimal salinity proved to be very low at high temperatures, viz.: about 15—20‰ at 20° C.

In osmosis experiments she could prove that the difference between internal and external concentration is greater at high than at low temperatures; both when the animal is hypotonic or hypertonic with respect to its medium. This explains why extremely low or high salinities can better be endured when the temperature is high.

It seems likely that the results of these laboratory experiments will be of great value in explaining the migrations observed in nature.

Lobster.

General. In a country such as the Netherlands, with its flat shores consisting of sand or mud, one would not expect to find lobsters. Nevertheless a fishery for lobster exists, and although the lobster makes only a very moderate contribution to our inshore fisheries, it seems worth while to mention it here from the point of view of ecology and the measures in force for its protection.

It was not until about 1900 that the attention of the fishermen was drawn to the occurrence of lobsters in the Oosterschelde. This was not because up to that time the fishermen had not observed the existence of the lobsters, but because they were extremely rare.

The lobster, a resident of stony or rocky bottoms, has found an adequate substitute in the large masses of heavy stones that have been dumped at the foot of the dikes in order to defend them against the destructive action of the sea. These stones have been dumped along all the dikes where strong tidal currents occur. But only in the Oosterschelde has a population of lobsters developed, only a few individuals occurring at the mouth of the Westerschelde and a very few at den Helder, at the entrance of the Wadden Sea. In the other areas it is supposed that the periodical presence of water of too low a salinity prevents the lobsters from establishing themselves.

How the first individuals immigrated is not known for certain, perhaps they came by natural means from the North Sea, but it is also possible, that they developed from the rather large numbers of eggs attached to the berried females that are always present in lobsters imported by the trade.

That the lobsters did not live in the Oosterschelde long before 1900 can be demonstrated by the statistics of the catches with weirs, of which a fairly constant number have been in use for a long period. During the period 1888—1897, no lobsters were caught at all in 7 years, the maximum in the remaining years was 3; from 1898—1907 the minimum was 9, the maximum 38; and from 1908—1917 the minimum was 12, and the maximum 52 (HAVINGA, 1921).

Fluctuations in the stock. Nearly all lobsters are caught with lobster pots attached to long ropes in great numbers. The catches, the numbers of pots, and the catch per pot per year, are shown in Table II.

This table demonstrates very distinctly that the

Table II. Catches of lobsters in the Netherlands (Oosterschelde), in 1000 kg, number of pots and catches per pot per season.

Year	Total Catch	No. of Pots	Catch per Pot
1911	5	1,810	3·0
1916	11	2,320	4·9
1921	23	3,052	7·4
1926	43	4,435	9·8
1931	15	7,968	1·9
1935	21	5,464	3·9
1938	13	4,440	2·8
1946	5	1,655	3·3
1947	5	1,331	3·6
1948	5	1,842	3·0

catches were rapidly increasing in size up to about 1926, whereas from that year on there was an equally rapid decline, notwithstanding the fact that the number of pots has been increasing considerably up to 1931. Correspondingly the catches per pot show a continuous decline since 1926 when a maximum was reached. The particularly low figure for 1931 was caused by the introduction in that year of another closed season with the special purpose of restricting the fishery.

As other factors that might have affected the stock are not known it seems likely that we have here a typical example of overfishing. This could occur easily in the Oosterschelde, as the grounds suitable for lobsters are not extensive, and the intensity of fishing on these small areas is very great. I have estimated that during the years of intensive fishing 70—80% of the lobsters of legal size were caught annually.

Protective measures. The serious decline in catches was not prevented by a series of protective measures that were in operation from the very beginning of the fishery. The fishery is restricted by a closed season, a legal minimum size and a prohibition on the landing of berried females.

The fishery is only allowed from April until July 15th. The legal size is 11 cm. for the length of the carapace. This is a rather uncommon standard of length, but is proves very satisfactory in practice, since it can be measured very accurately and easily. This length of carapace, from the point of the rostrum to the end of the carapace, corresponds to a total length of about 25 cm.

The saving of berried females is a practice that is not in common use. I think, however, that it is a very effective way of preventing overfishing. This kind of restriction does not only involve the saving of the female herself and her potency to produce one or more following batches of eggs, but also her progeny which, in a stock of constant magnitude, is roughly equivalent to 4 mature individuals.

Against this kind of restriction the objection is often made that illegal removing of the eggs is rather easy. The experience, however, that we have had in the Netherlands is that such illegal removing is not a common practice, it takes a considerable time to brush off the eggs so thoroughly that none are left. In addition the fishermen feel that they are performing a good deed in saving the berried females.

Crabs.

The fishery for crab is of very little importance. Crabs, like lobsters, live at the foot of the dikes on the dumped stones, but the most preferred habitat is not exactly the same as for the lobsters. Generally they occur in greater quantities nearer to the open North Sea than do lobsters. Perhaps they are more sensitive to water of low salinity, and certainly they are very sensitive to low temperatures during severe winters. After a cold winter the catches are always very low, perhaps because of a great mortality, but it is also possible that the low temperature caused a migration seaward such that the animals are not back again by the fishing season of the next spring. If the low temperatures caused a great general mortality, it would be difficult to explain the rather rapid recovering of the fishery.

In the cold winter of 1946—47, however, the crabs died, even in the North Sea at considerable distances from the coast.

Owing to the little value to the fishery no protective measures exist for the conservation of the stock.

Mollusca.

General.

The species that are of commercial value in the Netherlands are: oyster (*Ostrea edulis*), mussel (*Mytilus edulis*), cockle (*Cardium edule*), clam (*Mya arenaria*), whelk (*Buccinum undatum*), and periwinkle (*Littorina littorea*). To these species may be added the slipper limpet (*Crepidula fornicata*). This species, however, forms the subject of a special paper prepared for this meeting by KORRINGA.

In most of the species mentioned above a decline in production has occurred in the last 3 or 4 decennia. This is partly due to economic factors, partly to biological factors. With the exception of oysters and mussels, of which small quantities are eaten in the Netherlands, nearly all of the Mollusca have to be exported. Consequently the industry depends almost exclusively on the export facilities.

Oyster.

In value the oyster is the most important mollusc in the Netherlands. Up to about 1920 considerable quantities of oysters were caught on the public banks in the Wadden Sea; in some years a catch of 2 million oysters was obtained. Overfishing and the disease in 1920 and following years depleted the banks to such an extent that the fishery was discontinued. Now the oyster is one of the rarest species in the Wadden Sea.

The whole production is now restricted to the oyster culture in the Oosterschelde. A description of this

culture has been given by HAVINGA (1932) and by KORRINGA (1946, 1947, 1949).

The production of oysters is shown in Table III. There is a distinct difference in the quantities produced up to about 1930 when the production varied between 2 and 3 million kg. annually, and afterwards when it did not reach 1·5 million kg. The principal reasons for this decline were the invasion of *Crepidula* and the outbreak of a serious disease, both described by KORRINGA in contributions to this meeting.

In 1934 a minimum of 555 tons was reached, but the industry soon recovered, thanks to the results of research and to the relaying of imported young French oysters. Up till now, however, it has not been possible to reach the level of the period previous to 1930, and to maintain the present production of about 1·5 million kg., it is still necessary to import young oysters from France for relaying.

KORRINGA has shown that the productivity of the Oosterschelde is not unlimited. If there are too many oysters on the banks, as has sometimes been the case, growth and quality are affected.

Mussels.

The quantities fished and produced in the Netherlands can be seen from Table III. There are 2 centres for this industry; the Wadden Sea and the Oosterschelde. In the Wadden Sea by far the largest quantities are fished from natural banks, artificial culture is insignificant. The mussels from the Wadden Sea are not used only for human consumption, but also for poultry food, especially on the duck farms.

Before the enclosure of the Zuider Sea the productivity of the Wadden Sea was much greater than it is now. The reason is not exactly known; perhaps the increased velocities of the tidal currents make the habitat more unfavourable; it is also possible that the intensive fishing has a marked influence.

The figures in Table III denote only the quantities of mature mussels, but in addition large quantities of young from the natural banks in the Wadden Sea are fished and transported to Zealand for relaying on the mussel beds there. The Wadden Sea is the most important source of young mussels needed for the mussel culture.

During recent years it has often been difficult to obtain a sufficient quantity of young mussels for this purpose. It will, however, be far from easy to develop methods to improve this, especially as the young mussels for relaying must be produced at a very low cost. Some work has been done on the setting of the larvae and the young (MAAS GEESTERANUS, 1942).

The whole of the production in Zealand comes from artificial culture. A description of this culture has been given by HAVINGA (1932).

In the period from 1898 until 1918 the mussels in Zealand were often affected by a very serious disease that depleted a great part of the banks. The symptoms were that the mussels became extremely meagre, and that the byssus was released so that the clusters were broken up. The cause of the disease has never been found. It is supposed that the large scale introduction of motor vessels, that entailed a much more intensive cleaning of the banks, is responsible for restoring the banks.

Table III. Production of commercial Molluscs in the Netherlands in 1000 kg.

Wadden Sea, W; Zealand, Z; Total, T.

Year		Oyster	Mussel	Cockle	Clam	Whelk	Periwinkle
1912	W	83	3,328	320	—	321	1,853
	Z	2,953	37,730	500	138	32	253
	T	3,036	41,058	820	138	353	2,106
1925	W	7	26,496	688	—	494	1,104
	Z	1,310	46,308	336	270	44	127
	T	1,317	72,804	1,024	270	538	1,231
1930	W	1	24,720	262	—	181	1,065
	Z	2,381	36,695	145	50	72	116
	T	2,382	61,415	407	50	253	1,181
1935	W	—	28,186	193	—	233	90
	Z	643	38,800	246	8	123	227
	T	643	66,986	439	8	356	317
1939	W	—	25,911	—	—	113	56
	Z	930	39,385	355	12	83	221
	T	930	65,296	355	12	196	277
1946	W	—	2,001	—	—	140	27
	Z	1,334	31,015	177	85	32	79
	T	1,334	33,016	177	85	172	106
1947	W	—	12,412	—	—	92	9
	Z	1,149	56,196	192	?	24	65
	T	1,149	68,608	192	?	116	74
1948	W	—	23,856	2	?	91	47
	Z	1,458	50,647	232	?	26	92
	T	1,458	74,503	234	?	117	139

Early in September of this year (1949) an outbreak of a disease was again reported from one part of Zealand that caused a very great local mortality. The symptoms were the same as mentioned above.

But this time a parasitic copepod, *Mytilicola intestinalis*, could be found in great numbers in the intestine of the diseased animals and it is fairly certain that they were the cause of the mortality.

Cockles and Clams.

These species are of very little importance in the Netherlands. The production could certainly be increased, but the trade, exclusively export, can only deal with small quantities. It was customary to export the Wadden Sea cockles to England and the Zealand cockles to Belgium. As the Belgian demand was the more stable one, the production in Zealand was more stationary while in the Wadden Sea it was practically discontinued through lack of export facilities (Table III).

Whelk.

The whelk, too, shows a decrease in catches, but in this case a declining demand is not the cause, and presumably the stocks have been overfished. In the Wadden Sea there is a fairly intensive fishery exclusively for whelks during the winter, and as they only occur on a special type of bottom, preferably hard sand mixed with shells, the area in which they are found is small, and due to the high prices the fishermen get for the product, overfishing may easily result.

As long as oysters were present, there was a combined fishery for oysters and whelks, as both species prefer the same type of bottom.

In Zealand the greater part of the landings are caught during cleaning operations and fishing on oyster and mussel banks, direct fishing for whelks is no longer of great importance. Correspondingly, the catches have not decreased a great deal.

Periwinkle.

The landings of periwinkles have shown a sudden and considerable drop since 1932. The main source was the extensive eel-grass fields in the Wadden Sea. On the leaves lived enormous quantities of periwinkles and they were fished with a kind of small dredge from sailing vessels.

In 1932 the eel-grass died away suddenly through a disease, and together with it the fishery for periwinkles. The relatively small catches afterwards are being made by collecting by hand along the dikes and on the flats at low tide.

References.

Broekema, M. M. M. Seasonal movements and the osmotic behaviour of the shrimp, *Crangon Crangon* L. Arch. Néerl. de Zool. T. VI. Livr. 1, 1941.

Havinga, B. Austern- und Muschelkultur. Handb. der Seefischerei Nordeuropas, Band VI, H. 5, Stuttgart, 1932.

— Rapport over de kreeftenvisserij in Zealand en de kunstmatige kreeftenteelt. Meded. en Verslagen van de Visscherij Inspectie, No. 30, 1921.

— Der Granat (*Crangon vulgaris* Fabr.) in den holländischen Gewässern. Journ. du Conseil, Vol. V, No. 1, 1930.

Lloyd, A. J. and Yonge, C. M. The biology of *Crangon vulgaris* L. in the Bristol Channel and Severn Estuary. Journ. Marine Biol. Ass., Vol. XXVI, No. 4, 1947.

Korringa, P. Experiments and observations on swarming, pelagic life and setting in the european flat oyster, *Ostrea edulis* L. Arch. Néerl. de Zool. T. V. Livr. 1 et 2, 1941.

Korringa, P. Oyster culture in Holland. Holland shipping and trading, Rotterdam, Vol. I, No. 13, pp. 5—8, 1946.

— Les vicissitudes de l'ostréiculture Hollandaise élucidées par la science ostréicole moderne. Ostréiculture, Cultures Marines, Paris Vol. XVI, No. 3, pp. 3—9, 1947.

— The shellfish industry in Holland. To be published in the reports of the United Nations Economic and Social Council, 1949.

Kreger, D. On the ecology of *Cardium edule* L. Arch. Néerl. de Zool. T. IV, Livr. 2 et 3, 1940.

Kuenen, D. J. On the distribution of Mussels on the intertidal sand flats near den Helder. Arch. Néerl. de Zool. T. VI, Livr. 2 et 3, 1942.

Maas Geesteranus, R. A. On the formation of banks by *Mytilus edulis* L. Arch. Néerl. de Zool. T. VI, Livr. 2 et 3, 1942.

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