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Shellfish.

Statistical Investigations on the Shrimp (*Crangon vulgaris*).

By

B. Havinga.

In this contribution a review will be given of statistical investigations on the shrimp that have commenced in 1951 and that will be continued in the following years.

The shrimp is by far the most important species of Crustacea in the Dutch fisheries. The large individuals are used for human consumption and the small ones are dried and used for poultry food.

Nothing is known about the influence of the fishing on the stock. It is certain that the natural mortality is very great, but in addition an intensive fishery is carried out and large quantities of immature individuals are caught. The question has often been raised whether the mortality caused by this intensive fishing has an important influence on the stock or whether this influence is negligible with regard to the great natural mortality.

This question is very important for the shrimp fishery because, if it could be proved that the recent method of fishing is harmful to the stock, it would be necessary for the benefit of the industry to look for protective measures; it is evident that there are possibilities in this respect as a large percentage of the catches consist of immature individuals.

An attempt will be made to try to find an answer to this question by examining the available statistical data, viz., the statistics of the landings during a long period and the catches per vessel per days absence since 1947. These latter data were kindly procured by the Marketing Board for Fishery Products, the Hague.

Total Landings.

In Table 1 the statistics of the landing sin the most important districts of the Netherlands are given for the period 1916—1950. In order to eliminate the annual fluctuations, averages are calculated for 5-year periods. The figures for small shrimps are included where available: since the statistics are incomplete, a blank in the table does not necessarily mean that no small shrimps were landed.

Considerable variations occur in the annual landings of large shrimps in the western part of the Wadden Sea. In the period 1931—1935 the landings fell to less than 50% of those in previous periods. This was caused by the enclosing of the Zuider Zee which was a very rich fishing ground for shrimps. In the following period, 1936—1939, the catches were extremely low due to lack of sufficient sale facilities. During the post-war years the landings have been fairly constant.

During the pre-war years, in the eastern part of the Wadden Sea, by far the greater part of the catches were used for drying as it was not possible to find a market for them for human consumption. In the post-war years the sale-facilities improved and a much greater part of the catches was sorted for human consumption, and more effort was spent on the catching of large shrimps.

In the estuaries of the great rivers, where there are no special reasons for variations, the catches have tended to decrease in the course of the years. At the end of the period 1916—1950 catches in the estuaries of the Scheldt were about 50% of those at the beginning of the period, and, in the estuaries of the Rhine and Meuse, about 60% of those at the beginning of the period.

It is impossible to make out if the decrease

in the landings has been caused by a diminution of the fishing intensity. In the beginning of the period the whole fishing fleet consisted of sailing vessels and now all the ships are provided with a motor. The number of vessels has declined, but the fishing capacity per vessel has increased owing to the introduction of motor power and larger-sized craft. On the other hand the larger and more powerful type of vessel is also used for catching fish in periods when this is more profitable. Due to these factors it is impossible to ascertain if the intensity of shrimp fishing has changed.

The decrease of the landings during the post-war years, however, cannot be explained by a decrease of the fishing intensity, and later on we shall see that the catches per unit of effort have also decreased during the period 1947—1950.

The decrease of the intensity of the fishery during the war did not give rise to an increase in the catches in the post-war years.

Catches per Unit of Effort.

It is a pity that we are unable to com the landings during the whole period 19 1950 with the catches per vessel per absence. I can only give these statistics fc years 1947—1950.

The figures were collected at 6 landing distributed along the whole coast of the therlands, in each of them 6 vessels, 3 relat large ones and 3 small ones, were selecte

In Figure 1 the means of the catches vessel per day's absence calculated for vessels are given for each landing port. would have cost too much time to collect the for all the fishing days of the year only the ches in the first week of each month are dealt

In spite of the capriciousness of the cı it is clear that there are some regular fea common to each year. This is still more ous in Fig. 2 in which the means of the fi for the northern and for the southern dis are plotted.

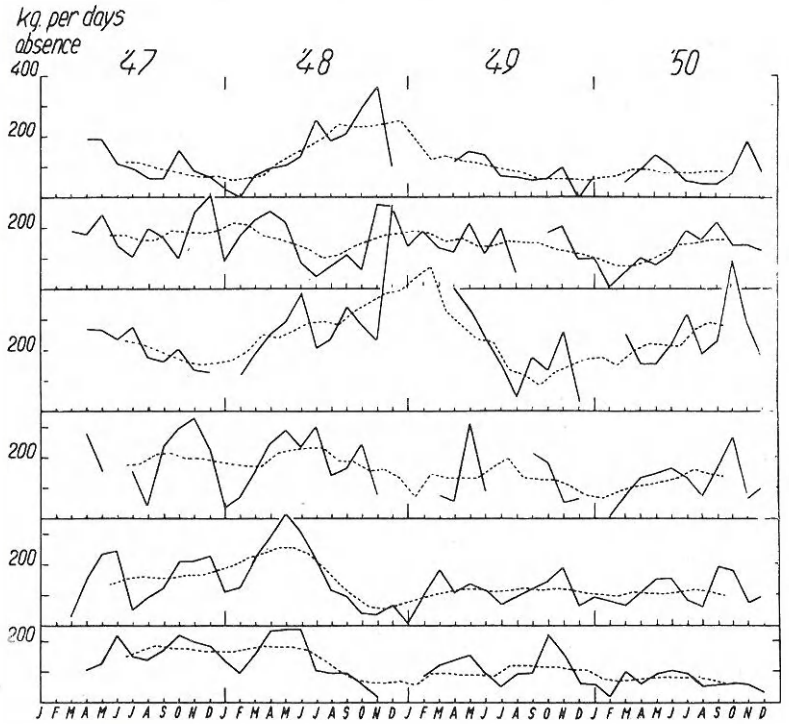


Figure 1. Catches of shrimps per vessel per day's absence. Means of 6 vessels from each of the ports of, (a) Zoutkamp, (eastern Wadden Sea), (b) Harlingen and (c) Texel (western Watten Sea), (d) IJmuiden (North Sea shore), (e) Stellendam (estuaries of the Rhine and Meuse), and (f) Arnemuiden (estuaries of the Scheldt).
Solid lines, daily catches in each month;
broken lines, moving averages calculated for 6 months.

Table 1. Catches of Shrimps Human Consumption and f Drying.

Mean figures for 5-year periods and a figures for the years since 1946 (100 The figures for the landings of small s are incomplete.

Period	Estuaries of the Scheldt. For hum. cons.	For drying	Estuaries of Rhine and M For hum. cons.	di
1916—20	2354	—	850	
1921—29	2029	—	997	
1926—30	2041	—	845	
1931—35	2084	—	840	
1936—39	1585	6315	913	1
1946—50	1360	820	702	
1946	1097	12	451	
1947	1951	854	949	
1948	1400	180	1045	
1949	1163	1685	524	
1950	1188	1367	542	

Period	W. Wadden Sea (and Zuyder Sea) For hum. cons.	For drying	E. Wadder For hum. cons.	di
1916—20	3035	—	130	
1921—29	2246	—	96	1
1926—30	2550	—	115	2
1931—35	1019	—	172	4
1936—39	316	—	83	10
1946—50	617	468	583	3
1946	573	206	406	2
1947	678	701	476	5
1948	645	289	675	2
1949	604	280	682	2
1950	583	863	675	4

In this figure it is quite obvious that there is a marked correspondence in the course of the curves and in the distribution of minima and maxima except, however, in the autumn of 1948. This discrepancy will be discussed later on.

The correspondence in the course of the curves in Fig. 2 is a proof that they are not too much affected by chance and that in both areas the shrimps are subject to the same conditions, save that in one single case a difference has evidently occurred.

One minimum in the landings occurs in winter (Fig. 1); often the fishery is not even carried out at all in January because of its not being profitable. Another minimum occurs in midsummer, either in July or, more commonly, in August. This minimum can be observed to occur with great regularity in every year in all the districts; it appears also very clearly in Figure 2.

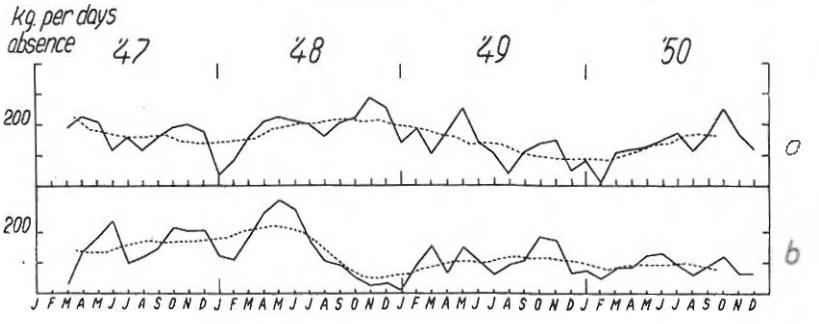


Figure 2. Means of the catches per vessel per day's absence in the northern districts (graphs a—d of Fig. 1) and in the southern districts (graphs e and f of Fig. 1). Solid lines, daily catches in each month; broken lines, moving averages, calculated for 6 months.

The cause of the winter minimum will most probably be the low temperature which induces the shrimps to migrate to deeper water. Presumably they are then dispersed over a wider area which makes the fishery less effective.

The minimum in July or August is more difficult to explain. The fact is known to the fishermen, but it has never before been observed by scientists. Which biological factors are responsible for this phenomenon is not yet quite clear, and it would take me too far to discuss this matter here.

The graphs provide a good picture of the density of the stock in the last 4 years, especially if we look at the moving average.

During the war and in 1945 the fishery was carried out with much restricted intensity; even in 1946 the fleet had not regained its former capacity. If the fishery has a material influence on the density of the stock one might expect large catches per unit of effort in 1947, and perhaps also in 1948. It is true that the catches in all districts were larger in these years than in 1949 and 1950, but the difference is so small that it can quite well be explained by the influence of natural fluctuations.

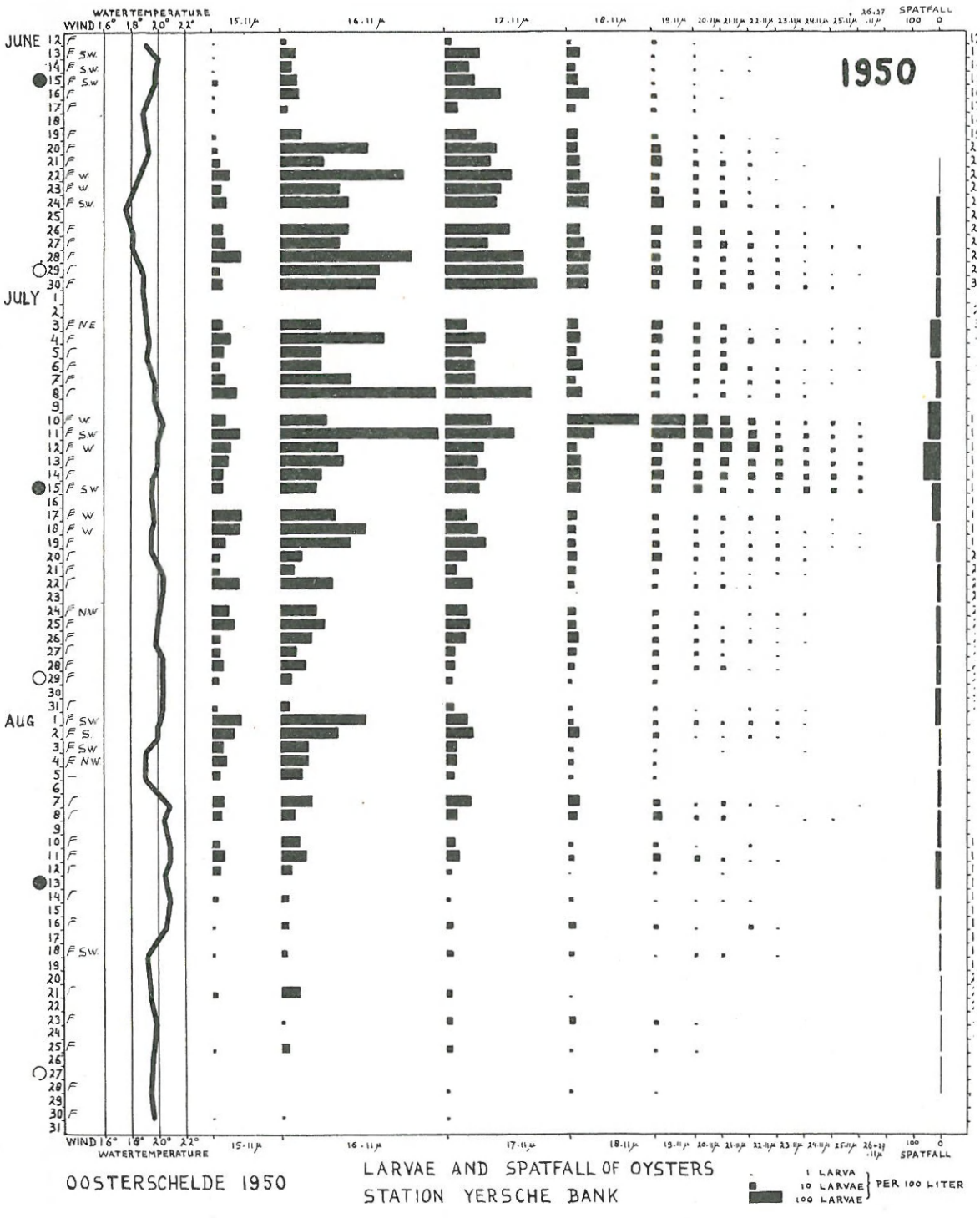
In the southern districts (Fig. 1, e and f) there is a sudden fall in the catches in the summer of 1948, which is a usual feature, but in this case it is not followed by the normal recovery in the autumn. The catches became so poor that in some ports the fishery was discontinued for a few months.

It is supposed that in the severe winter of 1946—47 the eggs or larvae were killed[1]). Shrimps with dead and decaying eggs were actually observed. If this explanation is right it is, however, difficult to understand why in the northern districts (Fig. 1, a, b, c), very large catches occurred in the autumn of 1948.

There is another difference between the northern and southern districts. In the southern districts (Fig. 2, b) the moving average in 1947 and in 1948 up to July is varying around 175 kg., in 1949 it varies around 100 kg. and in 1950 it does not even attain that value. Such a considerable fall is not observed in the northern districts. At the end of 1950 the moving average is at about the same level as in 1947 and only a little below the high level of 1948.

It is impossible to give an explanation of this difference with the data at hand. The cause may be sought either in the influence of natural fluctuations such as changes in natural mortality e.g. due to varying numbers of predatory animals or in the effect of the fishery. It is expected that a continuation of this investigation will give an answer to this question and to the other ones that have been mentioned above. It is especially the statistics of the catches per unit of effort over a longer period that will be of much value in this investigation.

[1]) Shrimps take about 2 years to attain a size at which they are fit for human consumption. (HAVINGA, B. "Der Granat (*Crangon vulgaris* Fabr.) in den holländischen Gewässern." Journ. du Cons., V, 1, 1930.)


WATERTEMPERATURE
WIND 16° 18° 20° 22°
SPATFALL
100 0
JUNE
JULY
AUG
1950
LARVAE AND SPATFALL OF OYSTERS
STATION YERSCHE BANK
1 LARVA
10 LARVAE
100 LARVAE
PER 100 LITER
OOSTERSCHELDE 1950

Larvae and Spatfall of Oysters in the Oosterschelde (Holland) in the Year 1950.

By

P. KORRINGA

Bergen-op-Zoom, Holland.
Government Institute for Fishery Investigations.

FOLLOWING the usual observations on the number and size of oyster larvae in the water of the Oosterschelde (Holland), in our efforts to aid the local oyster industry by predicting the intensity of setting, plankton samples were collected and examined in the year 1950. The methods used in collecting samples of 100 litres of water and in counting and measuring the larvae in such samples have been described previously (KORRINGA[1])). The samples were collected at the station Yersche Bank in the centre of the Basin of the Oosterschelde. Daily samples were taken at high slack water from 12. June up to 24. June inclusive; twice-daily samples were taken, at high slack and low slack water, in the height of the season from 26. June up to 28. July inclusive. To follow the events in the remainder of the season which is, as a rule, of very limited practical importance, sampling once a day was carried through from 27. July up to 12. August inclusive, and every other day from 14. August up to 30. August inclusive. For technical reasons it was impossible to collect plankton samples on Sundays. Where two plankton samples were taken in a day, the average number of larvae in each size-class has been computed per 100 litres, and is depicted in the diagram. The intensity of setting was measured by exposing lime-coated glass slides at an angle of 45° in concrete containers for periods of 3 days, in the manner described by HAVINGA[2]) and KORRINGA[1]).

Our predictions, based on the number and size of the larvae, and on water temperatures, ran as follows:

In the general outlook (based on the size of the oyster population and on lunar periodicity, KORRINGA[3])), a fair production of larvae was predicted, which could lead in a not too cold season to a reasonably good set. A maximum in the production of larvae was predicted about 9. July, though it was considered probable that numerous larvae would appear already around 25. June.

Although by as early as 14. June the number of larvae was considered rather high for the time of the year, a set of commercial magnitude could not yet be announced. On 20. June an increase in the number of larvae was reported, and it was stated that the very first spatfall could be expected towards the end of that week, which spatfall could not yet be of commercial interest. On 24. June the number of larvae was given as fair, but the water temperature was unfavourable at that time so that no set of practical importance was expected. On 28. June the spatfall to be expected was still described as of moderate intensity. On 1. July a further increase in the number of larvae and a reasonable water temperature were said to co-operate in ameliorating spatfall prospects, so that the intensity of setting would improve towards the end of the next week. On 5. July the developments were described as satisfactory, though a really abundant set could not yet be announced. On 11. July the set was said to be fair or good at that moment and was said

[1]) KORRINGA, P. 1941. Experiments and observations on swarming, pegagic life and setting in the European flat oyster, *Ostrea edulis* L. Arch. Neerl. de Zool., Vol. V, pp. 1—249.

[2]) HAVINGA, B., 1939. Prediction of the time of setting of oyster spat and a method of control. Journ. du Cons., Vol. XIV, pp. 394—400.

[3]) KORRINGA, P., 1947. Relations between the moon and periodicity in the breeding of marine animals. Ecol. Monogr., Vol. XVII, pp. 347—381.

to be expected to remain of commercial interest for the next days, notwithstanding the rough weather. On 15. July a decrease in the intensity of setting was announced. On later occasions it was said that spatfall prospects were poor and no further set of practical importance was predicted.

The results obtained by the oystermen with shells and tile collectors were fair in the year 1950, locally even good. Practically all the collectors were placed early in July, so that all of those could benefit under the maximum in setting around 13. July.

It can be derived from the diagram that the measured intensity of setting agreed well with our predictions. The total production of larvae was fair with high figures around 9. July, and a more diffuse, but important maximum in swarming from 20. June up to 30. June, inclusive. The latter production did not lead to a spatfall of commercial magnitude, probably because of the rough weather and rather low water temperatures prevailing at that time. Roundabout 10. July larval development was considerably better and led to a set of commercial magnitude, which had its maximun tensity from 12. July up to 15. July inclu Considering the rather high water temperat prevailing in the second and third decac July, the percentage of the larvae reachin setting stage and the resulting intensity of ting were somewhat disappointing, comp with other years. Maybe the weather, w was frequently very rough and rainy (th not affecting salinity perceptibly) had an favourable influence on larval developmer

As the number of large and mature la observed correspond well with the meas intensity of setting (as usual) and as our s fall predictions can be said to give a reli outlook for the setting prospects, it is c dered that our methods are satisfactory this purpose. Although a greater frequenc sampling and a greater number of sta certainly could lead to a more detailed pi and to a greater statistical reliability of the depicted, we confine ourselves for reasor economy to the minimum frequency in sa ling required for a reliable prediction of intensity of the spatfall.

NIELSEN & LYDICHE (M. SIMMELKIÆR)
KØBENHAVN