The Deep-Sea Prawn \textit{(Pandalus borealis)} in Icelandic Waters

By

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Commercial prawn fisheries first began in Area 4, Ísafjarðardjúp (see Figure 1) in 1936, and a few years later in Arnarfjörður, Area 3.

The deep-sea prawn is very common in Icelandic waters, although it has not yet been found in commercial quantities outside Ísafjarðardjúp (Area 4), Arnarfjörður (Area 3) and Ingólfsfjörður (Area 5). The prawn fisheries in Ingólfsfjörður have, however, been almost negligible.

Age and growth

Since the autumn of 1959, samples of deep-sea prawn from Area 4 have been collected and carapace length and sexual development determined.

The spawning season in this area is September–October and hatching takes place mainly in March and April. If 1 April is chosen as the time of hatching for the deep-sea prawn, the individuals will be 9 months old at the beginning of the following year.

Figure 1.
**Table 1.**

**Sexual development**

<table>
<thead>
<tr>
<th>Males</th>
<th>Females</th>
</tr>
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<tbody>
<tr>
<td>A few males spawn</td>
<td>1 1/2 years old</td>
</tr>
<tr>
<td>Most of the males spawn</td>
<td>2 1/2 years old</td>
</tr>
<tr>
<td>A few males spawn for the first or the second time</td>
<td>3 1/2 years old</td>
</tr>
<tr>
<td>A few females spawn</td>
<td>2 1/2 years old</td>
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<tr>
<td>Most of the females spawn</td>
<td>3 1/2 years old</td>
</tr>
<tr>
<td>A few females spawn for the first or the second time</td>
<td>4 1/2 years old</td>
</tr>
</tbody>
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**Fluctuations in catch**

(a) **Area 4 (Isafjardardjúp)**

Unfortunately there is no information on catch per trawling hour in Area 4 until October 1959, and continuous information exists only from January 1960 (see Figure 3). The catch is evidently decreasing, since in October 1959 it was 273 kg, but in April 1962 it had reached as low as 47 kg.

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**Figure 2.** Length distribution and estimated age distribution of the deep-sea prawn in Álfafjörður, Area 4, in 1960.

- A1 and B1: immature males ––– ––– mature males ––– intersexes ––– immature females ––– mature females

- A2 and B2: length distribution of total sample ––– estimated division between year-classes

**Figure 2A1 and B1** shows the length distribution of immature males, mature males, intersexes, immature females and mature females from two samples collected in Area 4, on 5. February 1960 and 27. October 1960, respectively.

**Figure 2A2 and B2** shows the length distribution (solid lines) of the total samples (see Figure 2A1 and B1, respectively) and a suggested division between year-classes (broken lines).

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**Figure 3. Area 4 (Isafjarðardjúp).**

- PER MONTH
- PER SEASON

**Figure 4. Area 4 (Isafjarðardjúp).**

- S = Spring season.
- A = Autumn season.

Figure 4 shows the fishing effort from the years 1955-1961 and the total catch in metric tons. In 1957 the boats were inactive part of the season because of unfavourable markets, so the total catch was comparatively low.

Up to the autumn of 1959 all prawns were shelled by hand. Up to that time a shortage of labour pre-
vented the prawn stock from being overfished. In the winter of 1959–1960 two canning factories began to use machines to shell the prawns. The effort was immediately increased in order to get sufficient raw material for the machines. Up to this time the maximal catch per boat per day was limited because otherwise the canning factories were unable to process the catch. After 1959 there were no limits on the quantity of the daily catch per boat and more boats went in for prawn fishing.

From 1960 to 1961 the total yearly catch decreased from 1143 to 1079 metric tons, in spite of the increased effort, and the total catch in the spring season of 1962 was only 186 metric tons, which is extremely low.

Considering the increased effort, the decrease in catch per trawling hour from autumn 1959 up to spring 1962 (see Figure 3) plus the decrease in total catch in 1961 and in the spring season of 1962 (see Figure 4), it is evident that the prawn stock in Area 4 has been overfished these last few years.

(b) Area 3 (Arnarfjörður)

Figure 5 shows the average catch per trawling hour in kg, total catch per year in metric tons and the number of boats fishing in Arnarfjörður, Area 3, in the years 1953–1961.

The number of prawn trawlers in Arnarfjörður rose from 4 in 1952 to 10 in 1953. The increase in fishing effort resulted in a decrease in catch per trawling hour from 150 kg in 1953 to 63 kg in 1954, which again cut down the number of boats fishing for prawns, 5 being active in 1955 and 4 in 1956. Since then the catch per trawling hour has increased and has been fluctuating from 86 to 107 kg, with the number of boats from 3 to 5.

The catch per year reached a maximum in 1959 and 1960. During these years the catch per trawling hour decreased a little. This decrease is so slight that it is impossible to decide whether it can be ascribed to the maximal catch per year or some other factors. Should the former be the case, it shows that the prawn stock in this area cannot support more effort, and it is evident from the 1953–1955 data (see Figure 5) that the fishing of 10 boats was too high an effort. What happened in 1953 was likely to recur in the winter of 1962/63 as an increase in effort was imminent. Consequently, it was decided to permit a total yearly catch based on the average catch during the period 1956–1961, i.e. ca. 180 metric tons.

The low total catch in 1961 was due to a labour dispute during a considerable part of the autumn season.

The by-catch

It has been used as an argument against prawn fishing by trawl that other commercial species, especially young fish, would be caught as well as the prawns. We
have tried to solve the by-catch problem by collecting data both from commercial and research catches.

Figure 1 shows stations worked on six trips, two of which were made by commercial boats in Area 4 during the period October 1959 to March 1962. The waters around Iceland are divided into 12 areas (see Figure 1). The average number of fish per trawling hour from each area is shown in Figure 6.

The histogram in Figure 6 shows both the total number of fish and then specifically the number of cod and haddock (the black part of the columns) per trawling hour in Areas 1 to 12.

Icelandic fishermen have developed a new type of prawn trawl in order to avoid catching other fish. The Icelandic prawn trawl was the only gear used in all areas, except Area 3, where a Danish prawn trawl was also used (see Figure 6, where 3A shows the number of fish per trawling hour caught by the Icelandic prawn trawl, and 3B the catch by Danish prawn trawl). A comparison of columns 3A and 3B in Figure 6 will thus give an idea of the difference in efficiency between the two types of trawl as far as other fish are concerned.

Non-commercial species, as for instance the Norway pout (Gadus esmarkii Nilsson), form the greatest part of the by-catch where it is outstandingly high.

In Area 4, where the most prominent prawn grounds in Icelandic waters are to be found, the average number per trawling hour has been: cod 2.4, haddock 5.2, and the total of all species of fish 10.7. The cod and haddock were practically all one year old.

Assuming that no prawn fisheries took place in Area 4 and that the young fish would not be caught until they were grown up and that the natural mortality $M = 0.10$, then the 7.6 small cod and haddock (otherwise destroyed by the prawn trawl per hour) would not amount to more than 5 kg cod and 5.6 kg haddock, or a total of 10–11 kg. These figures are, however, too high since they presume that none of the cod would be caught younger than 6 years and none of the haddock younger than 5 years.

According to this, it is obvious that the loss of cod and haddock caused by the prawn fisheries in Area 4 is negligible compared with the yield of prawns, since at the time when these investigations were carried out, the prawn catch per trawling hour in this area was 140–270 kg.

Résumé of discussion on the paper

Dr. Lindquist described the reduced abundance and, in one case, complete disappearance, of Pandalus from certain fjords in Sweden. This was attributable to hydrographic changes. He asked the speaker if the changes at Iceland, referred to in the paper under discussion, might not similarly have been due to environmental factors rather than to the effect of fishing. Mr. Sigurdsson thought that the decreasing catch was not attributable to any hydrographic change and emphasized that it had been accompanied by increased effort.

Dr. Cole asked if the stocks in individual fjords were isolated or if they could be recruited from outside. Mr. Sigurdsson replied that he was not certain on this point; fishermen say that there is an influx in late winter. Returning to the question Dr. Cole said he felt that in the particular circumstances the stocks may be very susceptible to natural fluctuations.

Professor Koringa asked if consideration of year-classes gave indications as to the causes of fluctuation. Mr. Sigurdsson replied that mostly two year-classes were represented in the commercial fishery at any time, and he had no additional data bearing on the cause of the fluctuations.

Dr. Lindquist said that in Sweden the stocks of Pandalus showed similar fluctuations in some fjords; he stressed that results from isolated stocks could not automatically be taken as applicable to stocks of wider distribution.

Dr. Jensen asked if there were any differences in the fjords from the aspect of the area of ground suitable for trawling. Mr. Sigurdsson said virtually the whole area of the bottom was suitable for trawling.