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ABSTRACT

To find out environmental factors influencing distribution and formation of its prespawning patches an analysis of silver hake distribution is presented depending on near-bottom temperature and zooplankton. Data were collected within the Russia-Canada research programme between 59° and 65°W where 174 stations were made. Feeding and prespawning aggregations were shown to be formed on the warm side of the hydrological front where the near-bottom temperature ranged between 7° and 10.5°C. It was stressed that zooplankton density and qualitative composition reflected density of the silver hake aggregations not always equivalently. Although statistical estimates of correlation between the parameters under investigation were turned out to be rather low qualitative dependence of CPUE on temperature and zooplankton was noticeable at the tendency level and could be seen in the correlation plots. Silver hake density decreased when number of Calanoida increased in the samples; its aggregations became more dense when Euphausiidae turned out to be more numerous. Reasons for low statistical correlation estimates are pointed out. In this respect much attention should be paid to the procedure of zooplankton collection and silver hake food selectivity and "patch"-like distributional pattern.

INTRODUCTION

Study of conditions for formation of fishery silver hake concentrations on the Scotian Shelf began in 1988 within the framework of the USSR-Canada program. The present paper should be considered as its continuation where the data collected by R/V EVRIKA in May-July 1990 are partly summarized. The first survey was carried out on May 20-31. Totally 55 stations were made. The second survey was conducted on July 7-18 with total number of stations 66. (Fig. 1, 3). The transects crossed the shelf slope and covered its southern part between 59° and 65°W. This pattern was similar to that employed in 1988. From June 26 to July 12 six surveys were carried out within the restricted area between 60°30' and 61°20'W. Totally 12 stations were made during each survey. The surveys pursued the following objectives:

1. to obtain data on silver hake distribution and environmental conditions (water temperature,salinity, phosphates, circulation and zooplankton) within the prespawning and spawning periods;

2. to estimate hydrological situation within the fishing areas and control silver hake biological state and spawning migration.

The main objective of the surveys conducted within the restricted area was to control the variations of silver hake distribution pattern and the abovementioned environmental parameters.

At each station within shelf area research trawlings were made and temperature and salinity were measured. In most cases phosphate content was determined and zooplankton samples were taken. For the present paper data on silver hake research catches, near-bottom temperature and abundance of large (Euphausiidae) and small (Calanoida) zooplankton at the stations were used.

MATERIALS AND METHODS

Data collected at 174 stations were used. They included 30-min silver hake reserch catches, near-bottom temperature and biomass size for Calanoida and Euphausiidae. Unlike the 1988 survey (Sigaev, 1990) the trawl "Hake-815 M" was employed as a fishing gear used for the commercial silver hake fishery. Thus, the Evrika research catches were comparable with those of the commercial vessels. To conduct hydrological observations a cable probe of the STD type was used. Zooplankton samples were taken either with the 61cm-diameter Bongo or with the 80cm-diameter conical egg net. The samplers were provided with the current meters and attached to the upper part of the trawl. Thus, sampling was conducted simultaneously with haulings and directly along the trawling route. At each station total wet weight of the zooplankton biomass was estimated as well as prevailing species composition. Following the completion of the cruise a special group of experts from AtlantNIRO analysed the samples including zooplankton species composition in each sample and calculation of the biomass principal components basing individual wet weight values in mg/m^3. Fig. 2 and Fig. 3 contain data of zooplankton analysis, made during the cruise. Statistical analysis included the Calanoida and Euphausiidae biomass estimates obtained in the laboratory.

RESULTS AND DISCUSSION

Distribution of near-bottom temperature and silver hake catches during the first survey is presented in Fig. 1. As far as temperature is concerned two areas may be singled out:

1. to the east of 61°30'W, where a frontal zone between the cold intermediate layer around Sable Island and warm slope waters is clearly pronounced;

2. to the west of 61°30°W where only warm slope waters occurred flowing to the Scotian Trough.

The highest silver hake catches were taken at the depths close to 200 m with the near-bottom temperature between 7° and 10.5°C. In the eastern part silver hake was not available to the north of the front where cold waters predominated.

In the western part at the entrance to the trough hake occurred to the north of the 200m-isobath where the temperature was about 10°C though the catches in this were lower as compared to those within the slope. This fact should be considered as one more striking demonstration of relationship between the temperature and silver hake distribution pattern. A special attention should be paid to concentrating silver hake around the patch resulted from the upwelling between 62°30' and 63°00'W. A low temperature at the centre of the patch was registered. The abovementioned peculiarities of the near-bottom temperature field are reccured in the distribution of the near-bottom salinity and phosphates but this information is not presented here. Distribution of the wet biomass total weight and predominant zooplankton species in the samples are indicated in Fig. 2. The lines for the equal weights were drawn using the method of linear interpolation. Though this method is not quite correct for the patch-like zooplankton distributional pattern it allowed to single out patches of different zooplankton concentrations. To compare zooplankton biomass and silver hake catches the latter were marked on the plane board for each station where hake was available. As it can be seen from the figure Calanoida prevailed in the catches especially in the western area. This facr may be treated as a peculiarity of the zooplankton species composition registered during the first survey. As to the western area Calanoida occurred in the samples too but together with amphipods, themisto and hyperiids. As always the second peculiarity is a patchiness. The densiest zooplankton patches were found in the eastern slope at the hydrological front and in the west within the high temperature gradient area. The high silver hake catches were taken within the areas of both high and low zooplankton concentrations.

The repeated survey within the slope area was carried out on July 7-18 i.e. the same period as the 1988 survey (July 3-16). The general character of the near-bottom temperature distribution in July 1990 was similar to the situation observed in May i.e. such phenomena as a clearly pronounced zone of the cold water masses, acute hydrological front during the second half of the survey and absence of the front in the western area could be seen. The latter could be explained by the intrusion of the warm waters to the shelf area through the entrance to the trough (Fig. 3). In July unlike May the temperature greatly decreased in the east to the north of the front. The area within which the temperature was 2-3°C increased; a zone with the temperature less than 1°C appeared.

Such intensification of the cold water advection, possibly, resulted in the intensification of the hydrological front and delay in silver hake concentrating within the fishing box in spite of the commencement of the spawning in the western area. Distribution of the catches and near-bottom temperature were similar to those observed in May. In the eastern part the catches were found on the warm side of the hydrological front; in the western part they occurred within the slope waters where the temperature varied between 8° and 10°C. Zooplankton distribution pattern underwent noticeable qualitative and quantitative changes as compared to the pattren observed in May. As far as zooplankton species composition is concerned clear distinquishing features were found between the western and eastern parts of the survey (Fig. 4). In the west Calanoida continued to prevail; in the east the large forms of Euphausiidae, Themisto and Shrimp were predominant. Patchiness revealed more vividly when biomass amounted to more than 1,000 g/trawling. If to compare zooplankton biomass and hake catches at each station we may sey that they are not comparable in July i.e. high zooplankton density does not often correspond to the high density of silver hake. This situation can be explained at least by three reasons. The first reason a technical one is that unclosing nets attached to trawl were used to sample zooplankton and sampling continued during the upheaving of the trawl. The second reason is food selectivity of silver hake. Hake concentrations, for instance, could feed upon fish within the given area or could select numerous large zooplankton being within the dense Calanoida patch at this very moment. The third and the most important reason may be resulted from the water temperature. In most cases hake concentrations occurred at the hydrological front within the narrow temperature range irrespective of the species or quantitative zooplankton composition. In spite of all this the front is a mechanism providing both optimum temperature and feeding conditions. The indications of this hydrological border may be found within the Scotian Shelf area where the depth exceed 120 m.

The mesoscale swirling which is a characteristic feature of the front promotes zooplankton patch formation. Hake often feeds on those zooplankton patches. The silver hake feeding studies (Vinogradov, 1983) showed that such zooplankters as large forms of Euphausiidae were the most frequent in the hake stomachs though sometimes small forms of Calanoida also occurred. There were cases when small zooplankton prevailed in the plankton samples and either large zooplankton or fishing objects were predominant in the hake stomachs. In spite of all this the catches were high. It was noted that when the near-bottom temperature was higher or lower the mentioned range the catches used to be low irrespective the number of zooplankton. Thus, qualitative analysis of silver hake, near-bottom temperature and zooplankton distribution indicates that unlike the hydrological conditions zooplankton quantity and quality in the samples do not always reflect hake concentrations especially in our case when unclosing nets were used as a sampling gear. To check this statement an attempt was made to quantify correlation between the values under investigation basing pair correlation of statistical rows consisting of 174 values for silver hake catches, near-bottom temperature and zooplankton quantity. For all this zooplankton was used in the form of values calculated separately for Calanoida and Euphausiidae as mg/m^3. The analysis demonstrated no quantitative relationship between the catches of silver hake and the selected environmental factors. However, a number of peculiarities may be seen in the correlation plots. So, in the hake catches near-bottom temperature plot characteristic temperature range for hake is clearly pronounced (Fig. 5). The plot in Fig. 6 demonstrates the tendency of the catch increase when the Calanoida density is decreasing. At the bottom of the plot the cases of low hake catches may be explained by the low near-bottom temperatures at the stations. In Fig.7 (hake catches - Euphausiidae density) the situation is more uncertain due to the large dispersion of the point though direct relationship between these values could be expected. The points located close to the axis of abscissae and axis of orditates attract a special attention. They correspond to the absence of hake under various zooplankton density values and comparately high hake abundance (in Euphausiidae absence), respectively. According to the checking results no hake in the catches in the first case may be explained by the low near-bottom temperature values. In the second case the high hake catches in zooplankton absence may be explained by the favourable temperature conditions. In Fig. 7 those points are lettered as "T". If to exclude the cases mentioned above a direct relation of hake catches to Euphausiidae density can be seen, i.e. in those cases when hake concentration is within its water temperature range. Thus, the analysis made indicates relationship between the catches and near-bottom temperature and weak relationship between the hake catches and zooplankton. Taking into account technical shortcomings of the sampling procedure which inevitably influenced the analysis results further data on silver hake stomach content are required. In the survey those data were collected during the biological analysis. More information is needed to analyse it simultaneously with data on near-bottom temperature and zooplankton density. For this purpose an express-analysis of silver hake stomach content is to be done at each trawling station.

The express-analysis includes lehgth-frequency measurements and stomach index determination concerning prevailence of the following components: small zooplankton, large zooplankton, fishing objects. To fulfill this not more than 100 hake specimens from randomly taken sample will be needed.

Summing up the results of the analysis of distribution and density for silver hake feeding and prespawning aggregations in connection with the environmental conditions we may consider the temperature as a major prerequisite. Hake aggregations migrate along the warm side of the "shelf-slope" hydrological front in the quest of food and they try to avoid its cold part. At the same time zooplankton distribution, density, qualitative composition and accessibility to silver hake are regulated by the "Shelf-slope" front dynamics and its macro- and mezoscale spatial-temporal variability.

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REFERENCES

1. Report on investigations conducted during the 28-th scientific research cruise of RTMA-7111 EVRIKA to the Nova Scotian Shelf area. May-August 1990. 1990. AtlantNIRO. Kaliningrad. 83 pp. (in manuscript).

2. Sigaev, I.K. 1990. Ecological studies of conditions of silver hake distribution on Nova Scotian Shelf within the USSR-Canada program. NAFO SCR Doc. 90/14, Serial No. N 1729, 31 pp.

3. Vinogradov, V.I. 1983. Food relationship between silver and red hakes and other fish species on Georges Bank in adjacent waters. NAFO SCR Doc. 83/1x/80. Serial No. N746, pp.18-19.

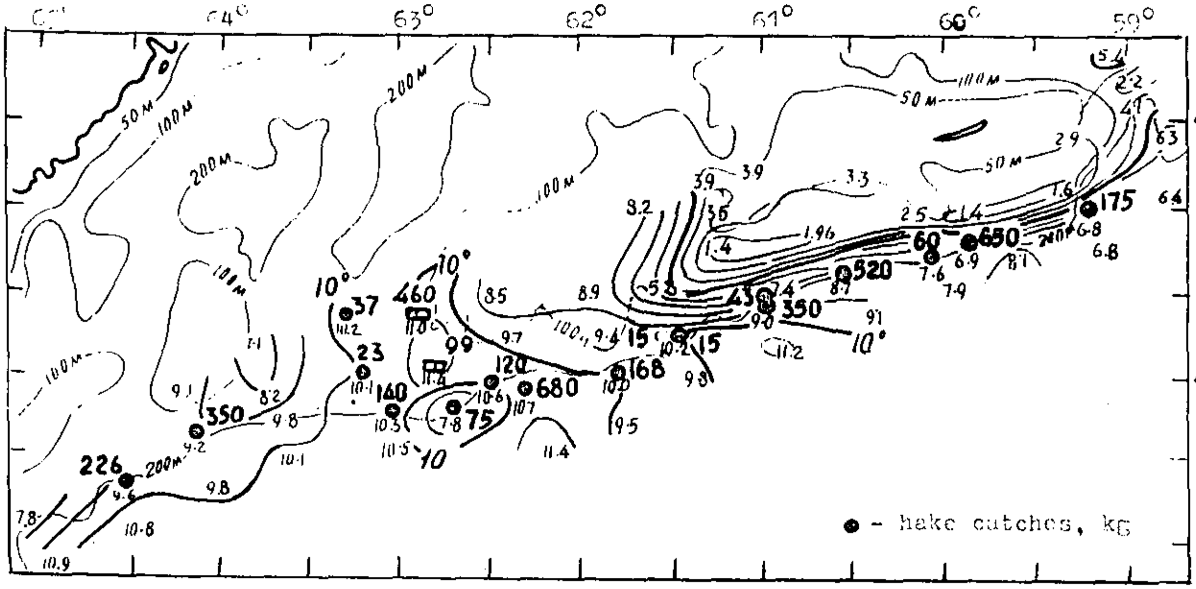


Fig. 1. Distribution of silver hake research catches (kg) and near-bottom temperature (°C) on May 20-31, 1990.

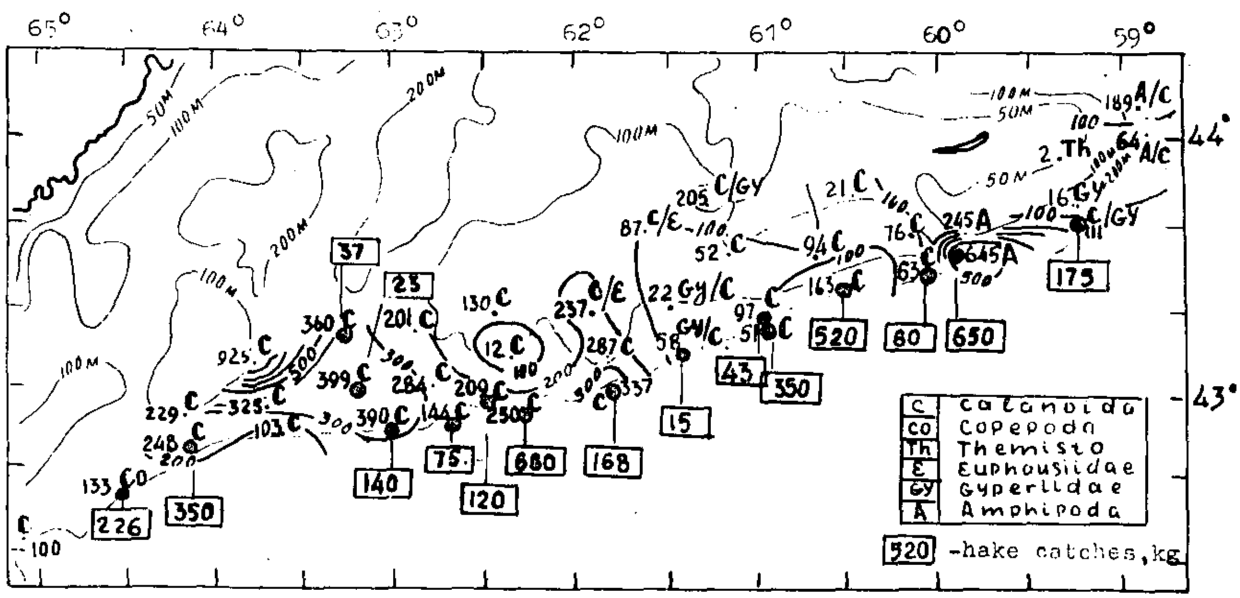


Fig. 2. Distribution of silver hake research catches (kg) and zooplankton wet biomass (g) in the samples taken on May 20-31, 1990.

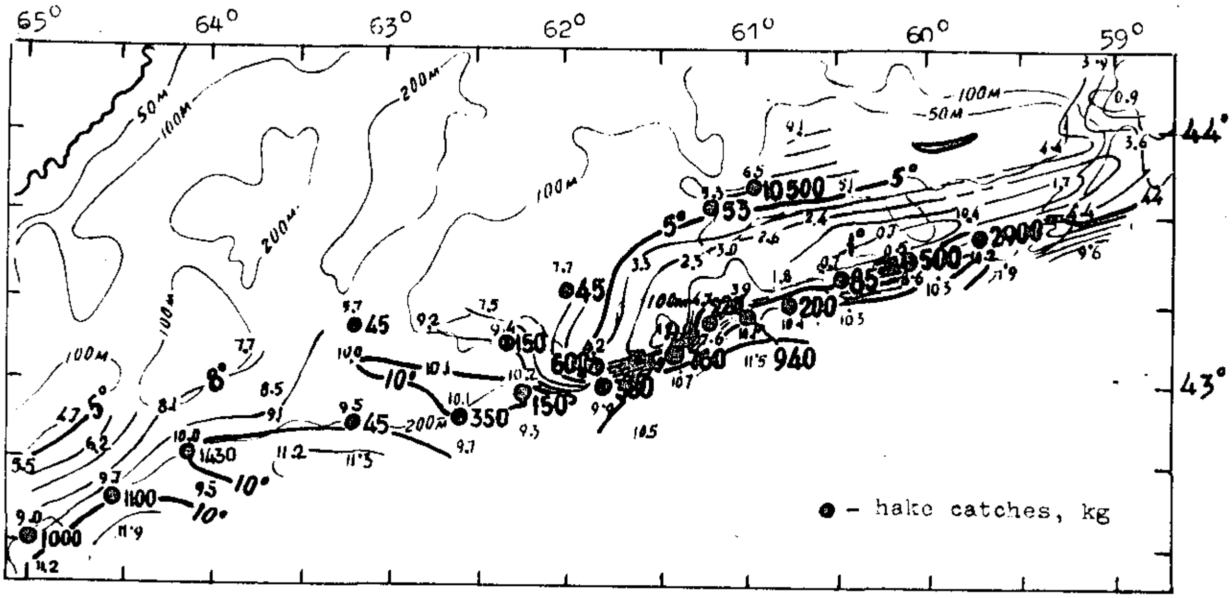
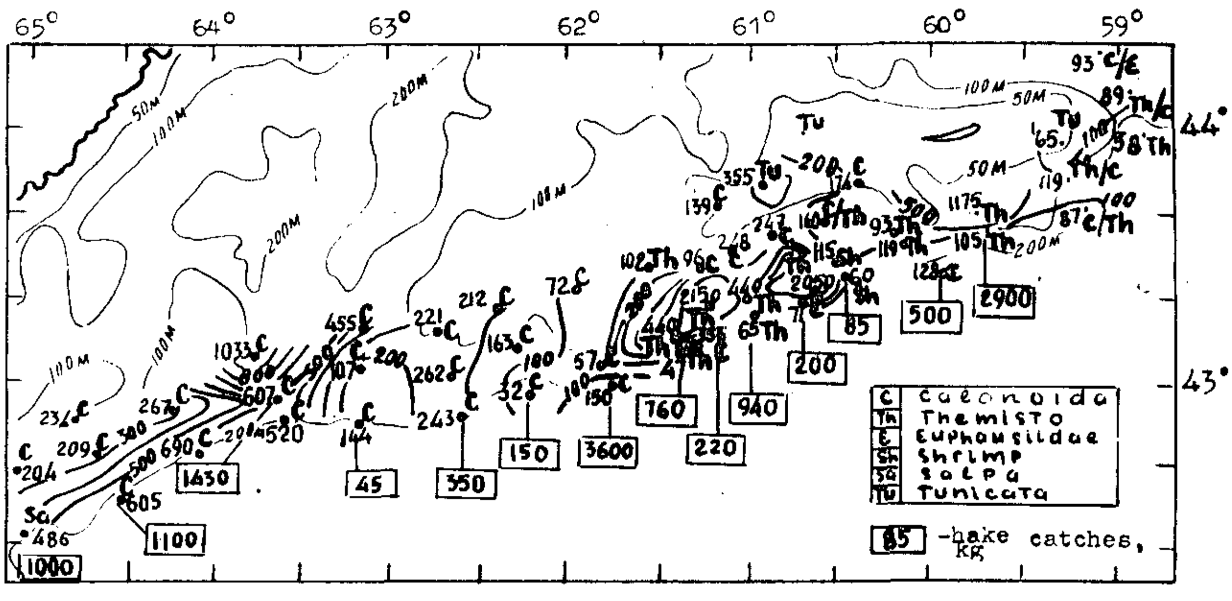


Fig. 3. Distribution of silver hake research catches (kg) and near-bottom temperature (°C) on July 7-18, 1990.



Fog. 4. Distribution of silver hake research catches (kg) and zooplankton wet biomass (g) in the samples collected on July 7-18, 1990.

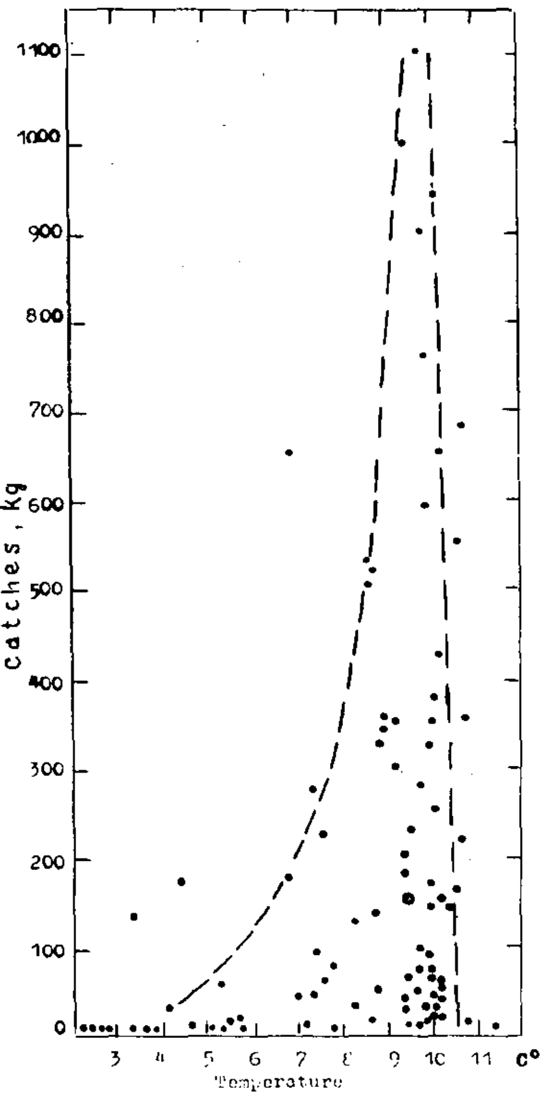


Fig. 5. Correlation plot for silver hake research catches (kg) and near-bottom temperature (°C).

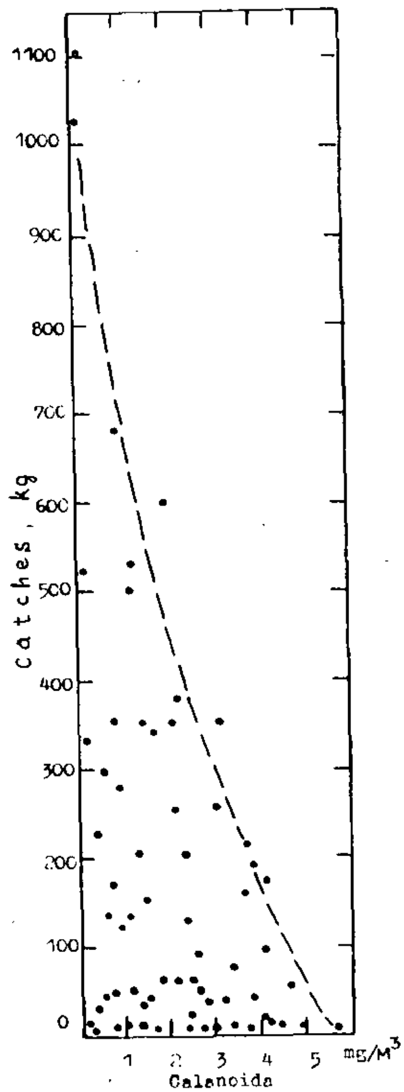


Fig. 6. Correlation plot for silver hake research catches (kg) Calanoida density (mg/m³).

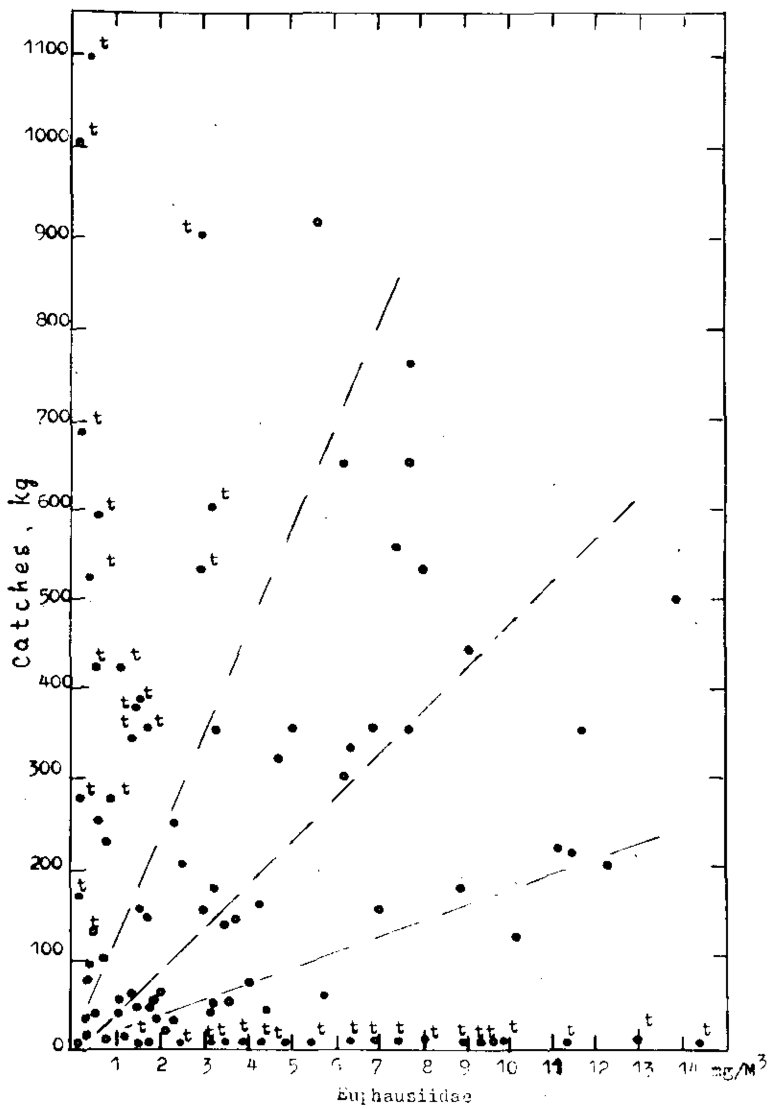


Fig. 7. Correlation plot for silver hake research catches (kg) and Euphausiidae density (mg/m^3).