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DESCRIBING THE DISTRIBUTION AND ABUNDANCE OF SMALL 0-GROUP COD USING RING-NET SAMPLING AND ECHO-INTEGRATION

by

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ABSTRACT

The recent recruitment failures of a number of cod stocks makes management difficult and there is an urgent need for improved information about recruitment levels, as well as basic understanding of early life events.

Recently a research programme on larval and juvenile cod in the northeastern North Sea has been carried out. The present paper reports on the methodology used in the survey on small 0-group cod (and other gadoids) during that programme. A ring-net of 2 m diameter was used and its catchability investigated. This gear was found to sample the size range 1-4 cm with a reasonable efficiency. 0-group gadoids was also detected by acoustic methods and echo-integration at a given site was correlated to catch of gadoids in the ring-net.

A survey strategy using concurrent ring-net sampling and echo-integration is proposed. This strategy could be investigated further on the International Bottom Trawl Surveys (ICES), the 2nd quarter sampling of these surveys takes place in May when juvenile cod are of an appropriate size-range.

INTRODUCTION

Research on cod fry in the North Sea and adjacent waters dates back to the turn of the century. For example investigations on the distribution of small cod in the danish waters was carried out by Petersen (1902) and Otterstrøm (1906). Other early research initiatives were made by Graham and Carruthers (1925), who focused on eggs and larvae in the central North Sea, and by Poulsen (1931) who investigated cod in the Skagerrak/Kattegat and the Baltic.

The gears used for catching cod juveniles were often small fine-meshed midwater trawls/nets, among which the "Petersen Young Fish Trawl" (Petersen 1902) was one of the frequently used. This gear had a 7 meter long net with a rectangular opening of 3.25 m^2, the two side of the opening were supported by wooden sticks and the gear was kept open by two boards. Another common gear was the "Ring-Net" (described in Poulsen 1931), the opening of this was supported by a 2 m iron ring. Both gears had the same mesh throughout : stramin of seven threads to the centimetre, i.e. a pore of approx. 1.2 mm.

Larger pelagic juvenile cod has been sampled by a larger midwater trawl, the "International Young Gadoid Pelagic Trawl", the IYGPT (Hislop,1970). This gear has different mesh sizes throughout and an opening of approx. 100 m^2 kept open by boards. The IYGPT was developed as a standard for young gadoid surveys (see Daan 1978), and in the eighties this gear was used in an extensive survey programme carried out in June-Juli, aimed at an early estimation of recruitment of the North Sea cod.

In a recent research programme on cod recruitment in the northeastern North Sea the use of ring nets for catching small 0-group cod has been reconsidered. The gear introduced is the MIK, a gear used routinely on the 1st quarter sampling of the International Bottom Trawl Surveys for estimating abundance of large herring larvae and the recruitment to the stock.

The present paper describes studies made on the applicability of the MIK in catching cod larvae/juveniles. The catches in the MIK are compared to catches from the IYGPT and estimates made by echo-integration. The methodological possibilities and problems are discussed.

MATERIALS AND METHODS

THE RING-NET (MIK).

Elements of the design of this gear (MIK) stem from the gear design proposed by Methot (1986). The attachment and length (10m) of the towing bridle ensures that there is no obstacles in front of the ring during the haul. Originally Methot designed a gear with a squared frame (2.2 x 2.2 m) and a dihedral depressor. The version used in the present study has a strong ringed frame of 2m in diameter and the dihedral depressor has recently been replaced by a simpler depressor type, a saddle of approx. 18 kg weight. See Fig.1 for illustration of gear design.

The net is of polyethylene material strengthened by seat belt straps as illustrated (Fig.1). The circular meshes have a diameter of 1.6 mm. In the hindmost meter of the net an extra net of 0.5 mm pore is inserted. Net as well as other parts of the gear are coloured black.

For estimation of densities per area oblique hauls is made. The wire is paid out at a speed of 25 m min^{-1} until the gear is 5 m above sea bed, whereafter the wire is retrieved at a speed of 15 m min^{-1}. Depth of gear is measured by a depth sensor with acoustic transmission (SCANMAR system), if a transmission cable is necessary this could be relieved on an additional bridle also of 10 m length. Volume of water filtered is measured by a calibrated flowmeter placed on a string in the middle of the ring.

The catch was sorted just after each haul and all fish larvae preserved in 96 % ethanol. Gadoids were later identified to species and their standard length measured.

THE IYGPT.

The design of this gear follows the description in Hislop (1970). The gear has an opening of approx 100 m^2. The meshsize is 100 mm (stretched) at the opening and decreases to 5 mm at the cod end. In the tow the vertical opening was about 7 m.

The procedure during the tow used in this study was the following: Ships speed were set to 3.5 knots and the IYGPT was lowered to approx. 10 m above sea bed. The wires were hereafter retrieved gradually until the gear was at the surface after 20 min towing time, thus the haul integrated most of the water column.

THE ACOUSTICS.

Acoustic backscattering strength was measured with a SIMRAD scientific echosounder EK400, 38 kHz connected to the echo signal analyzer system ECHOANN (Degnbol et. al. 1990). The squared echo signal amplitude was integrated and converted to volume backscattering strength by use of instrument parameters obtained through calibration with a standard target. Volume backscattering strength was integrated over depth to give an index of the overall abundance of acoustically reflecting biomass under one square meter sea surface. Two integrals over depth were obtained : one covering the entire water column, one covering the layer between 9 and 45 meters from the surface. Direct sampling indicated the pelagic 0-group gadoids to be most abundant in this upper layer.

RESULTS

The size range of cod the MIK is able to catch with some efficiency is illustrated by the histogramme in Fig.2. This distribution show the total catches made during a survey programme performed in the northeastern North Sea and the Skagerrak/-Kattegat in May 1992. Both day and night hauls are represented. Sizes of cod ranged from 5 to 45 mm, the majority were of sizes 10 to 25 mm.

At surveys in the northeastern North Sea in May 1991 and May 1992 the differences between night and day catchability was estimated by replicate hauls at a number of stations. Six sets of day/night hauls were available. The day hauls were made in the period between 4 and 14 GMT, the night hauls between 22 and 3 GMT. For each haul the density of cod was estimated within 5 mm size intervals. The ratio between density estimates from either day or night hauls were calculated, and a mean of these ratios found. In Fig.3 the results are shown.

Larvae of about 10 mm length are caught with the same efficiency at day or night whereas the avoidance at day becomes evident at the larger sizes. At about 15 mm the day catchability is 70% of the one at night and a linear decrease to zero at size 40 mm is indicated. The relationship for potential conversion between hauls is inserted in Fig.3.

The catchability at night was evaluated in a comparison between a MIK and a IYGPT haul, the MIK haul made immediately after the IYGPT haul towing over the same position (57°N, 5°48'E). Density estimates (assuming a 100 m^2 opening of the IYGPT) were calculated within 2 mm length intervals and the ratio between the estimates found. Results are shown in Fig.4.

The MIK was more efficient than the IYGPT at sizes below 35 mm, whereas the relative efficiency of the MIK decreased markedly when size get larger than 35 mm. The IYGPT did not catch any cod below 26 mm, while the MIK represented sizes down to 14 mm at the site of investigation.

At the cruise in May 1992 a transect of sampling crossed an area were cod dominated in the catch (in relation to macroplankton and other fish species). In Fig.5 examples of echo-grammes made during this transect are shown. Cod density were estimated from MIK hauls and estimates for each echogramme-section are inserted (Fig.5). By visual inspection it is evident that the two measurements are related along this transect. At the cruise in May 1993 echo-integration was performed. Integration values (back scattering strength) from a part of the stations on this cruise is related to a relative figure of gadoid abundance in Fig.6. The value for gadoid abundance considers size of the fish by multiplying estimates of density (m^{-2}) by the square of the 0-group mean length.

DISCUSSION

The MIK of the described design has proven to be a robust and reasonably handable gear for routine use during a survey. Of cause the easiness of delivery and recovery are dependent of ship type and facilities. Problems that have to be solved are related to the heaviness of the frame and the fragility of the net material. Earlier problems with the relatively large dihedral frame suggested by Methot (1986) are now overcome by replacing this by the smaller type. The function of the new depressor is predominantly to prevent the ring from turning, the heaviness of the ring is sufficient to take the gear down.

A haul takes about 20 minutes at 50 m depth. With the densities of cod found in the present study area (mean approx 0.4 m^2) sample size will be in the order of 20 to 50 specimen.

Thus the gear is applicable as such, however, the absolute efficiency of the gear is not known. The studies reported here indicate a high night catchability of cod in the size range 1 to 3 cm. Other studies also show the applicability of intermediate sized gears to this size range of cod. Potter et. al (1987) compared the IYGPT catchability with the catchability of a MOCNESS, a 10 m^2 opening-closing net of 3 mm mesh size. They also found that the IYGPT had a lower size limit of about 25 mm, the MOCNESS was more efficient than the IYGPT at sizes below 35 mm. Suthers and Frank (1989) used a number of different gears in their study of larval and juvenile cod. They conclude that the used Tucker Trawl (4.5 m^2 opening, 1.6 mm mesh) was more efficient to cod above 10 mm than any of the other used gears (a 0.25 m^2 Bioness of 0.3 mm mesh and a 0.5 m ring net of 0.4 mm mesh).

One of the problems in surveying 0-group cod (and other gadoids as well) is the patchiness of its distribution. The echogrammes shown in Fig.5 illustrate the degree of patchiness, the stations are only 10 nm apart. Thus, the variation in density estimates across a given area can be quite high. In order to improve the interpretation of distribution patterns and potentially direct sampling, acoustic methods are introduced on a preliminary basis. The findings illustrated in Fig.5 and 6 show that

-the 0-groups in sizes 1-4 cm to some extent are registered by acoustic methods. In the attained relationship there are a number of cases where integration overestimate the abundance. On the other hand, underestimation by the integration is not apparent, this is illustrated by the dotted line in Fig.6. Thus, during a survey a low integration value indicate low abundances and that only extensive sampling is necessary, whereas with larger integration values intensive sampling should be performed in order to verify existence of high concentrations.

In conclusion, the use of concurrent ring-net sampling and echo-integration is a promising method for describing abundance and distribution of 0-group cod. Both methods are, however, apt for further improvement and continued studies are suggested. Specifically the methods could be investigated during the ICES coordinated International Bottom Trawl Surveys which 2-quarter sampling takes place in May-June, in the first part of this period the young North Sea cod are of the size-range 1-4 cm.

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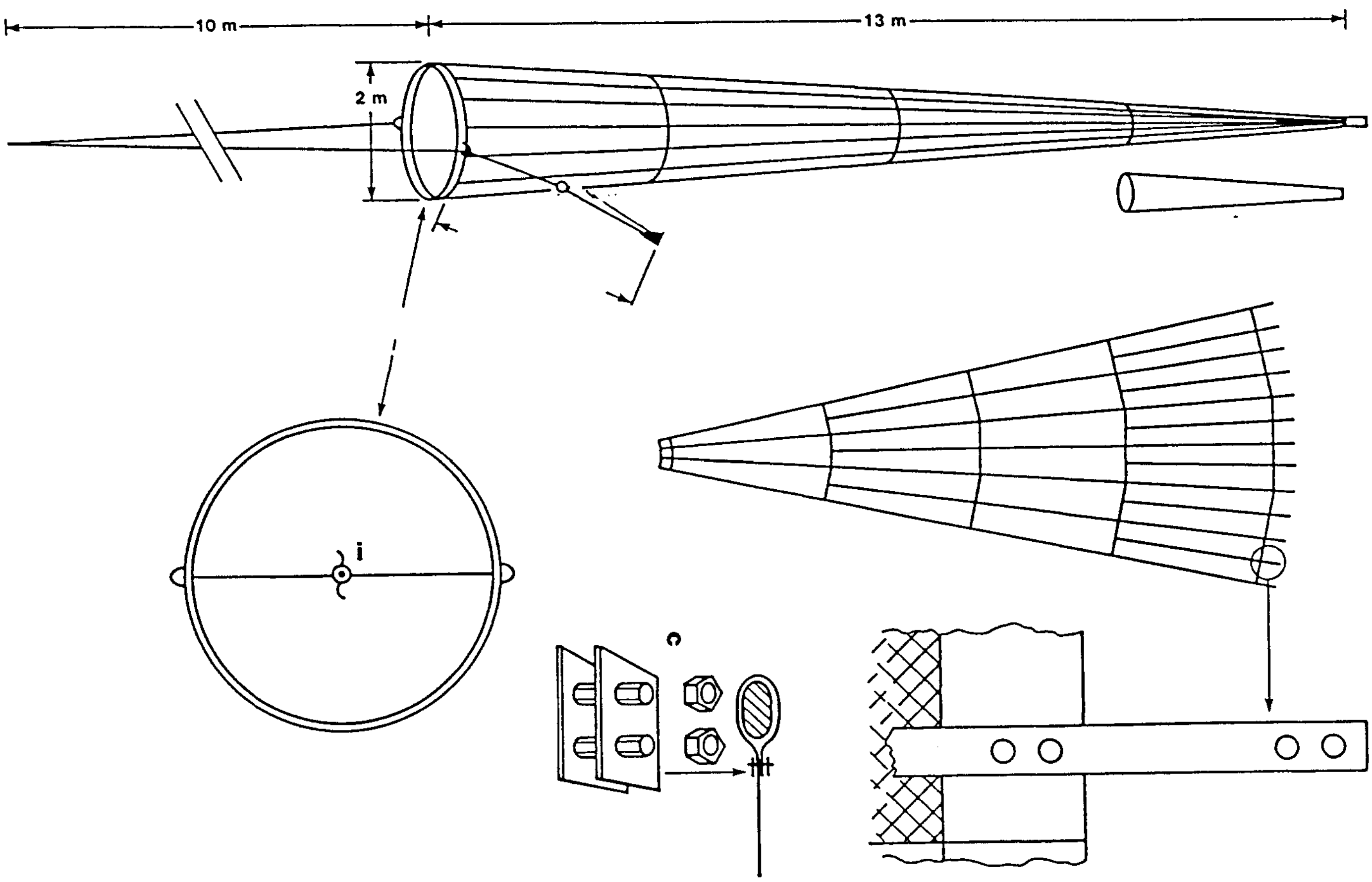

FIGURE 1.

The design of the ring net (MIK). On a 2 m ring a 13 m long net is mounted using seat belt straps. the 10 m long bridle has only two attachment points. I a bridle below the net is attached a small depressor. Flow of water is measured by a flowmeter mounted in the ring opening.

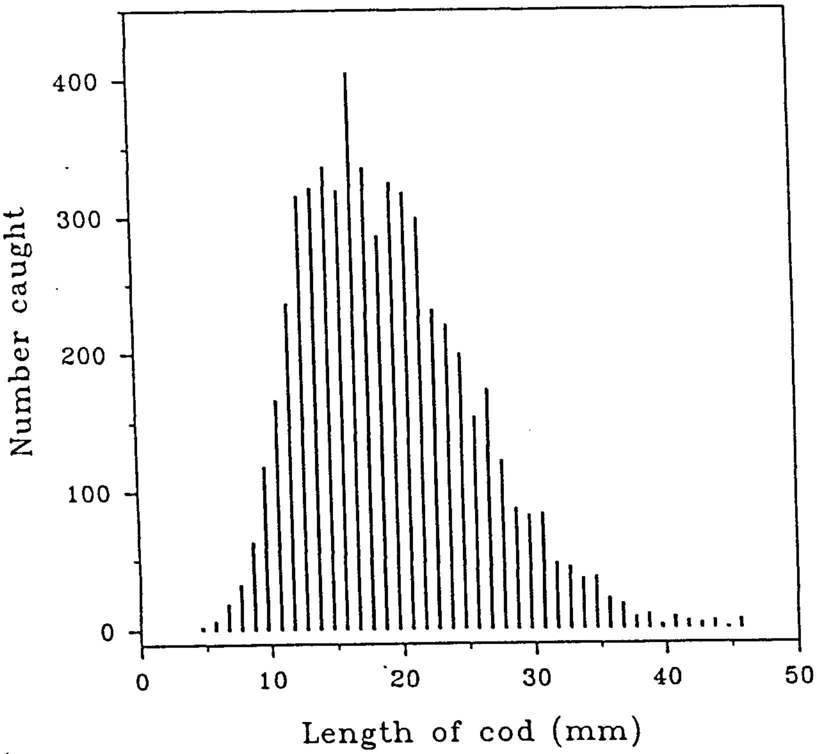

FIGURE 2.

The total range of small cod caught during a survey in May 1992 covering the northeastern North sea and the Skagerrak/Kattegat. Standard length of cod from all hauls are given, abundances within 1 mm length intervals.

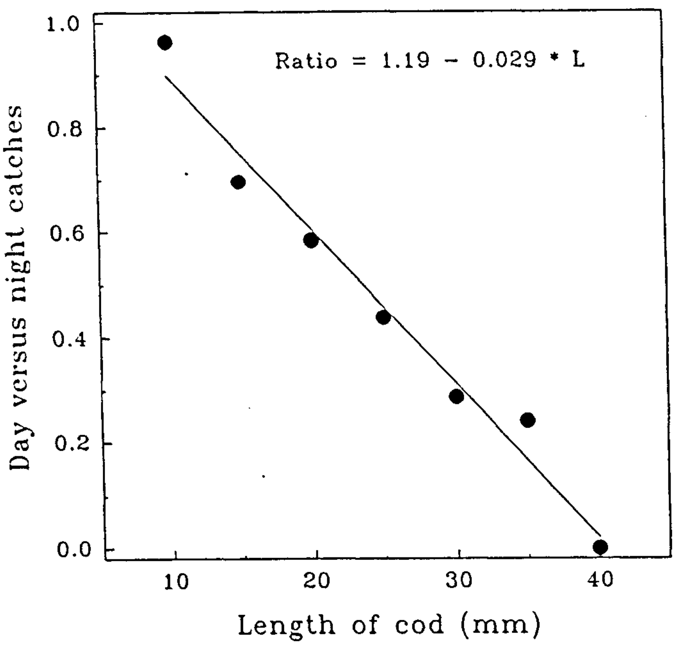

FIGURE 3.

The ratio between density estimates based on MIK sampling either at day or at night (day/night). Each pair of day-night sampling was carried out within 24 hours at the same position. Results from sampling in May 1991 and May 1992. Intervals of standard length 7.7 to 12.5 mm given at tickmark 10 mm etc. Linear regression

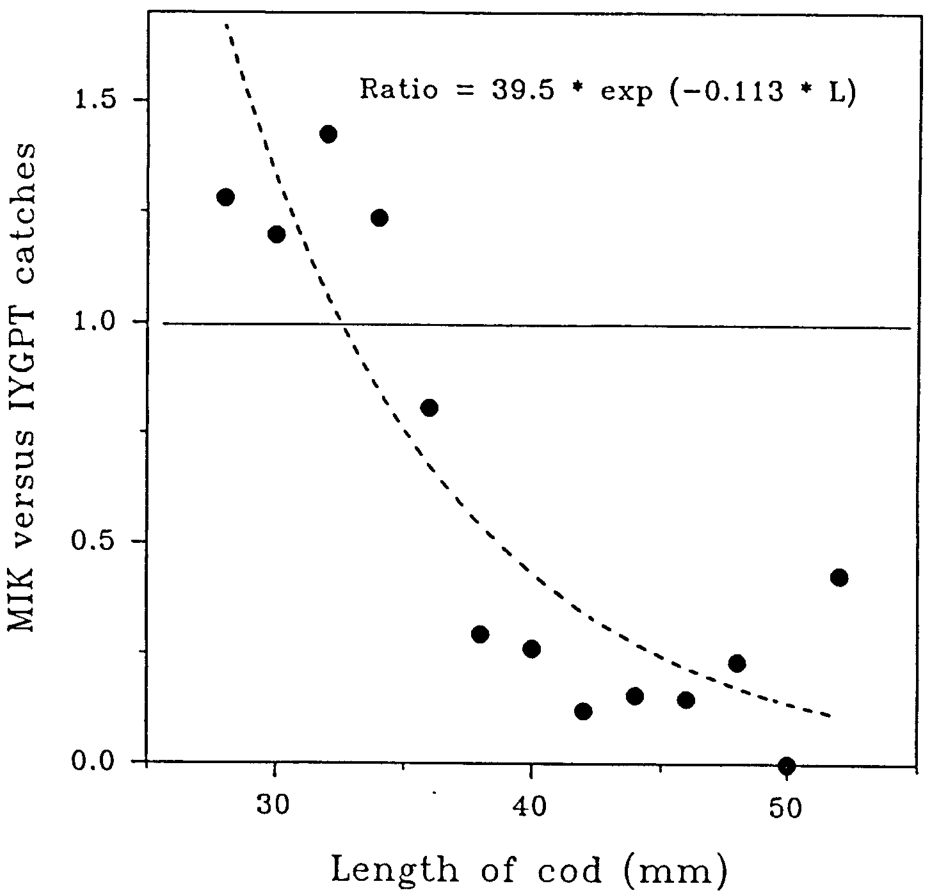

FIGURE 4.

The ratio between density estimates based either on MIK-sampling or IYGPT-sampling (MIK/IYGPT). Interval of standard length 27.00-28.99 mm are show at tickmark 28 mm etc. Exponential decline indicated.

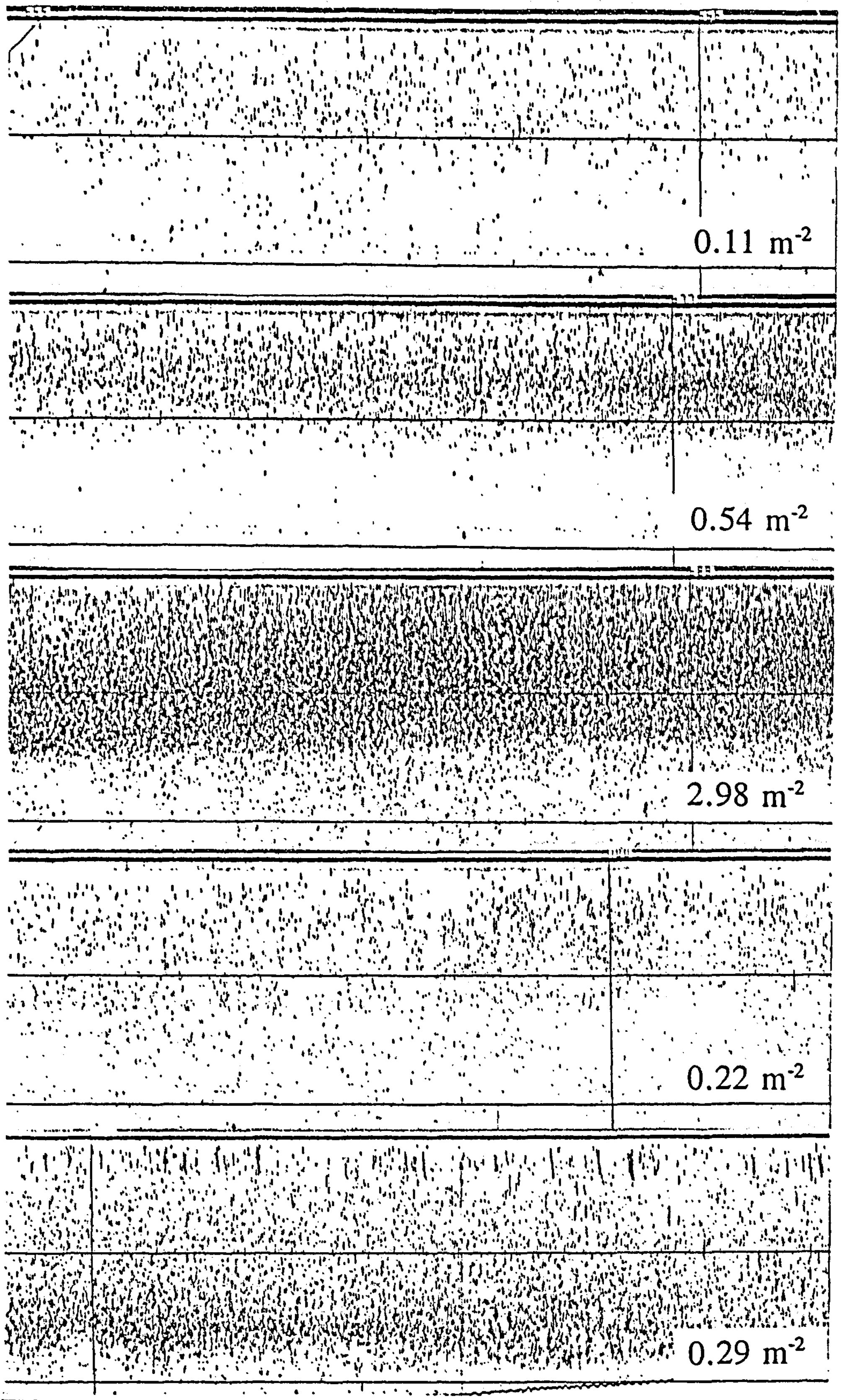

FIGURE 5.

Examples of echogrammes (38 kHz) produced east of 4°30' along 56°20' in May 1992. Echogrammes (upper 40 m) made during the MIK haul at ships speed of 3 knots. Distance between hauls were 10 nm, the last station taken at daylight. Density estimate (no m^{-2}) from the given MIK haul is inserted.

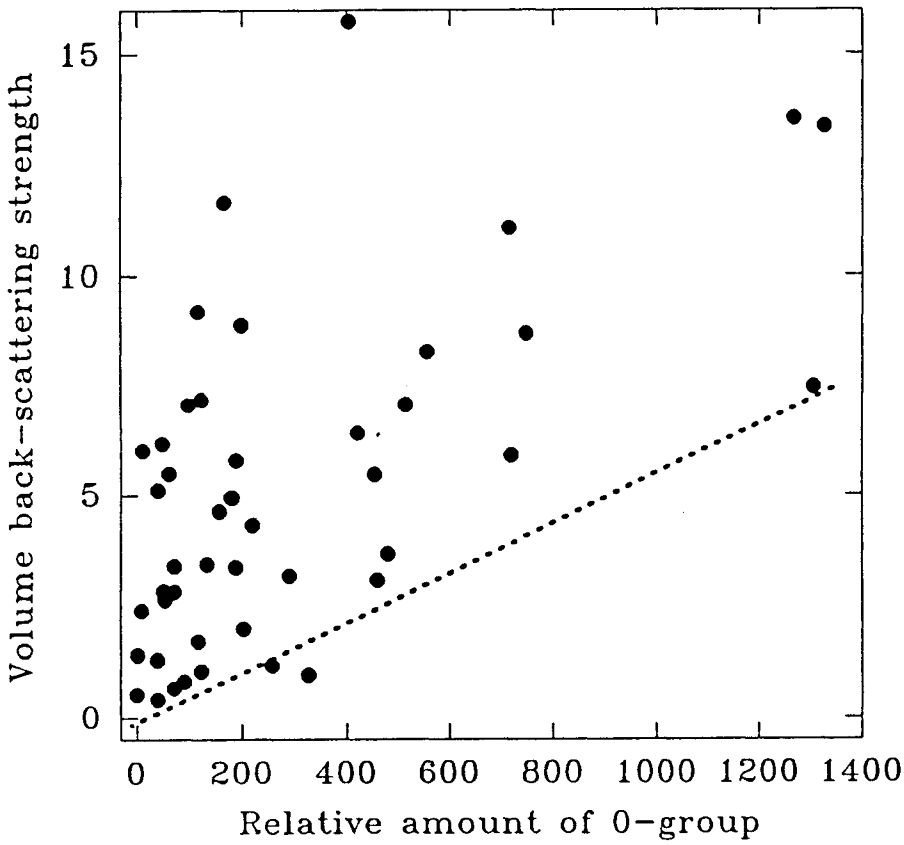

FIGURE 6.

The relationship between estimates of gadoid abundance (density weighted by the square of gadoid mean length) and acoustic integration (back-scattering strength). The area below the dotted line with no points show that while integration often overestimate the abundance it seldom underestimate this.