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OBSERVATIONS OF COD REACTION TO TRAWLING NOISE

by

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ABSTRACT

Observations made from a stationary echo sounder, passed by a trawling vessel, clearly demonstrate the flight reaction of cod as a response to the noise from the vessel. Horizontal dispersal and downward swimming has been observed to starts as early as 200 m in front of the vessel propeller, and a descent speed of nearly 17 m/min has been recorded. The avoidance reaction was seen at depths from 50 - 170 m depth, gradually diminising with increasing depth. Similar, but and weaker responses were also observed during general passages without trawl.

INTRODUCTION

In several stock assessment methods, trawl sampling is used to obtain information on species composition and size distributions of fish. Near-field effects on trawl selectivity, such as sweep selection, mesh selection and reactions to the trawl gear itself are known to be significant. These have been summarized by Ben-Tuvia & Dickson, (1969) and Wardle, (1984,86), and in recent experiments reported by Engås & Godø, (1987). Under normal conditions the far field reaction pattern of the fish to the trawling operation is equally important when evaluating the total trawl selectivity.
A few reports on the behaviour of demersal and semidemersal fishes in connection with vessel noise are available. Buerkle (1977), Olsen et. al, (1982), Ona & Chruikshank, (1986), Ona & Godø, (1987) all report significant reactions of gadiods to vessel noise, but more data are needed to quantify the effect.

Since cod and other gadoids are very sensitive to low-frequency noise (Hawkins, 1973: Sand & Karlsen, 1986), they can discriminate and localize the noise from a ships engine and propeller at distances of more than one nautical mile (Chapman, 1970; Buerkle ,1977). This paper will present examples of diving reactions by cod at a distance of 200 m in front of the trawling vessel, and discuss its relevance to trawl sampling and catch efficiency.

MATERIAL & METHODS

The experiments were made during the combined acoustic / bottom trawl survey on demersal fish in the Svalbard area, east of Bear Island in September 1987. Fish reactions to the vessel and trawl were studied from a stationary echo sounder mounted on board the 20 feet launch of the research vessel R/V "ELDJARN", a 200 feet combined purse seiner/ trawler with a main engine developing 3400 HP at 600 rpm, using about 1000 HP at 460 rpm when towing the trawl at three knots.
The transducer of the 50 kHz portable FURUNO FE-881, with a nominal full beam width of 12^{o}, was mounted in a 10 mm, 0.36 m^2 , steel plate. With 2 m long backstrops, joined to the transducer cable, the rig was lowered to 5 metres depth directly from the rail of the launch. This prevented acoustic interference from air-saturated wake of the passing research vessel.
The launch, with its engine off during the entire period, was approached by the research vessel from a distance of more than one nautical mile, and passed as close as possible (3 - 5 m), or just enough for safe clearance by the trawl warps. (Fig. 1)
The catch during the experimental hauls using the 16 x 16 fathoms opening standard pelagic capelin trawl showed a clean composition of fairly large cod of the 1982 and 1983 year classes, (Fig.2) ,which in this particular area were pelagically distributed during both day and night (Fig. 3), heavily feeding on the concentrations of krill, amphipodes and 0-group fish in the area.

RESULTS

For comparison of the reaction pattern to a lower noise level than during trawling, two runs were made without trawling, one at low speed, 3 knots, and one at survey speed, 10 knots. In particular in the run made at 3 knots, the fish showed a clear reaction, (Fig. 4), with both horizontal spreading and vertical avoidance. From the top of the registration down to about 140 m depth, the downward speed of descent of fish passing the stationary transducer beam is 8.7 m/min, lasting at least for 7 minutes (Table 1). The total downward displacement of fish during the dive is 50 metres, and 9 - 10 minutes after the passage, the evacuated space is refilled horizontally, the original situation being more or less restored. The reaction is weaker below 140 m depth, but a downward compression can be traced, even in the expanded channel, displaying the nearest 5 m above bottom, at 300 m depth.

As the reaction of the fish and following density reduction starts prior to the propeller passage, we are at the border where also the acoustically determined density in the bow-mounted transducer may be underestimated. At 10 knots, however, the reaction was weaker and too late for this to affect the acoustic results.

Towing the trawl at 120 m depth, (Fig. 5), a sudden decrease in fish density is seen behind the warps and above the sweeps and trawl opening. The downward escape reaction of the upper part of the registration starts approximately 150 meters in front of the propeller, and the steepness of the dive is estimated to 9.2 m/min. As found earlier on haddock, (Ona & Godø, 1987), the dive concentrated the fish below the trawl, and the fish density available for the trawl opening is significantly lower than the undisturbed, actual fish density.

The most vigorous reaction to vessel noise was recorded on run no. 4, (Fig. 6), were the fish were more dense at the top of the distribution, as in the overview in Fig.1. Already 200 meters in front of the propeller, i.e. 130 m in front of the vessel bow, the fish started to dive. The vertical speed is now increased to 16.6 m/min, lasting throughout the passage, for nearly 8 minutes. Almost no fish is left in the track of the trawl, most of them being on the sides and below the opening, and not displayed on the sounder at the defined phased range of the sounder.

DISCUSSION

The observations clearly indicate that noise produced by the trawling vessel creates a fish behaviour pattern that will affect the efficiency and selectivity of the trawl, also for demersal or semidemersal fish. Considering the difference in swimming capacities among specimens and size groups of the same fish species (Blaxter, 1969;Wardle, 1975,1977), the selection process during horizontal and vertical vessel avoidance is felt to be of main importance to trawl sampling, at least at shallow trawl stations.

The long detection range of low frequency noise (Olsen, 1969:Buerkle, 1977; Sand & Karlsen, 1984), and the directional hearing (Schuif, 1975)
among gadoids, are strongly supported by the observations of pre-vessel avoidance. The dominating part of the noise from the vessel is propeller noise, which during trawling is increased by cavitation (Urick, 1975). The directivity pattern of vessel noise, indicated in Fig.1, shows that less energy is directed in the fore-and-aft plane than transversely, a consequence of the screening effect from the hull and the wake (Urick, 1975). This will tend to increase the horizontal speed of the fish to the

sides of the vessel, while a sudden increase in noise intensity below the vessel seems to create the diving response.
Compared to the previously reported experiments on smaller gadoids (Ona & Chruickshank, 1986, Ona & Godø, 1987), the response is stronger and the swimming speeds higher in these particular experiments on cod of a mean length of 55 cm. As the experiments also were made during daytime, the possible effect of light from the passing vessel is excluded.
The pre - vessel avoidance and horizontal dispersal observed in this experiment may elucidate or explain some of the problems of combining acoustically determined densities and swept area estimates of cod in the Bjørnøya / Svalbard area, in particular from the shallower parts, typically less than 100 m deep. If the fish start reacting by radial aviodance more than 100 m in front of the vessel, the probability of loosing them horizontally in the narrow acoustic observation field of 9 to 18 meters width (for 5 and 10 opening angles) are several times larger than loosing them outside the trawl doors, wich at these depths are typically sweeping fish together from a field of 50 - 70 m, depending on door itself, and the used sweep length.(Godø & Engås, 1989). nearly a magnitude is larger than observations, particularly during trawling on cod, indicate that care should be taken when evaluating trawl efficiency from acoustically determined density from the trawling vessel, at least when working in shallow waters.

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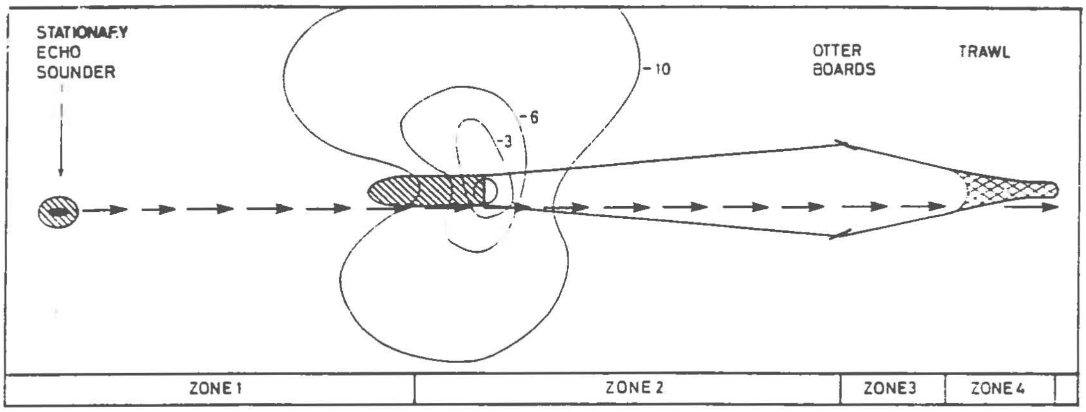

Fig.1. General set-up during passage of the stationary echo sounder with the referred selection zones indicated. Approximate -3, -6 and -10 dB contours of the propeller noise directivity pattern, measured 12 meters below the vessel are shown (from Urick 1975).

ZONE 1	-	Pre-vessel avoidance zone
ZONE 2	-	Propeller noise and warp avoidance zone
ZONE 3	-	Herding zone
ZONE 4	-	Mesh selection zone

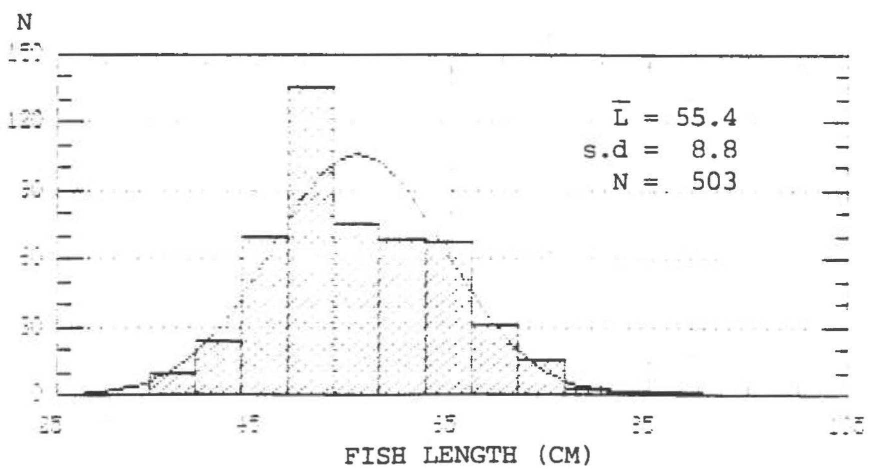

Fig. 2. Catch of cod in PT 585, during the experiments.

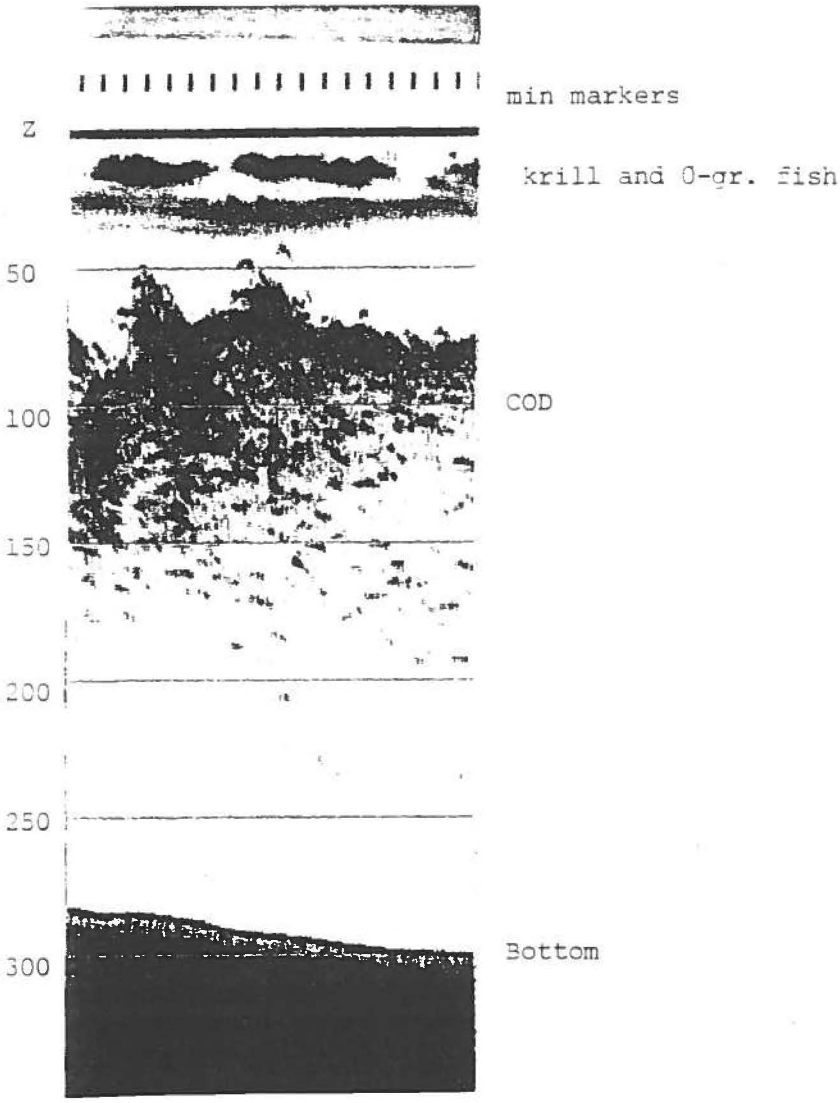

Fig.3. Overview of the cod concentrations on wich the observations were made. Taken from the stationary echosounder prior to run 1.

TABLE 1. Preliminary results from analysis of diving speed and duration of dive on cod avoiding the propeller noise during passage and trawling. Startpoint of the downward reaction is indicated by the distance from the point of propeller passage in metres.

RUN NO.	TRAWL	V (kn)	STARTPOINT OF DIVE	SPEED OF DIVE (m/min)	ANGLE OF DIVE (degr.)	DURATION OF DIVE (min)	RESTORE TIME (min)
1	NO TRAWL	3	p - 10	8.7	-5.3	7	9
2	NO TRAWL	10	p + 30	7.5	-4.6	3	5
3	PT	3	p - 150	9.2	-5.6	7	10
4	PT	3	p - 200	16.6	-10.2	8	11

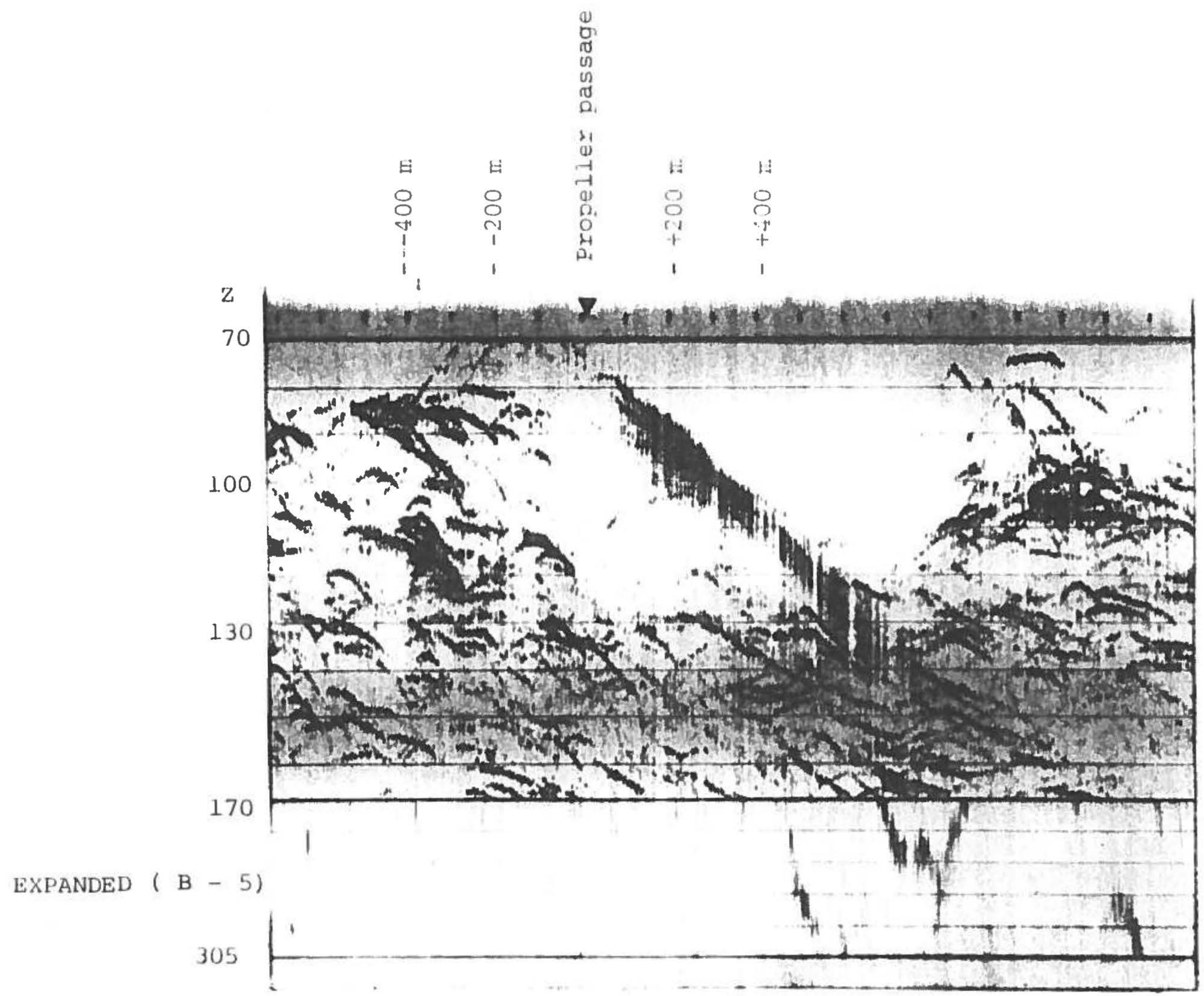

Fig. 4. Echogram from the stationary transducer, showing strong reaction from cod when the research vessel passes without trawl at 3 knots.

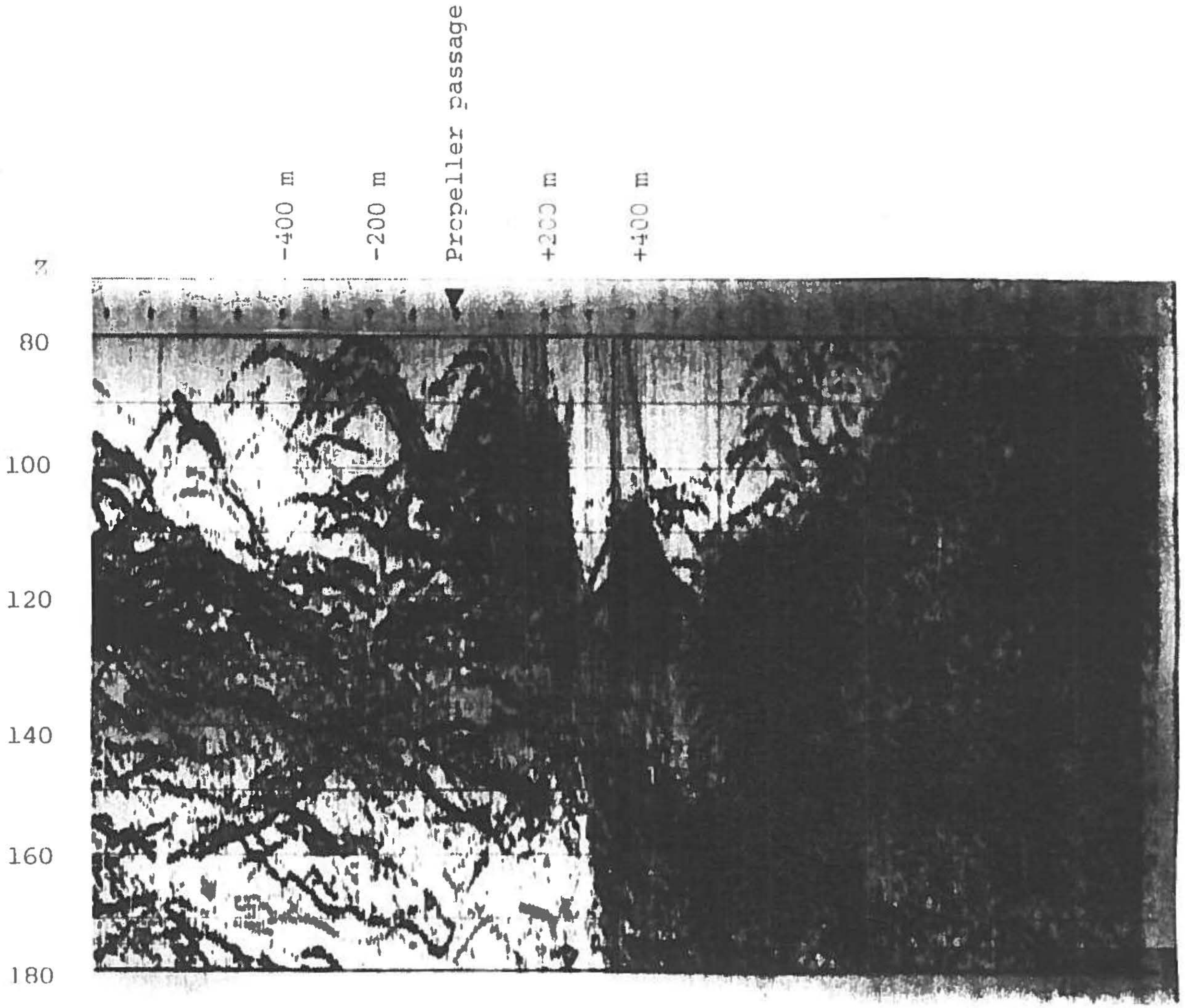

Fig.5. Echogram from the stationary transducer on RUN NO.3, with the pelagic trawl at 120 m. The sweeps, trawl and trawl eye cable can clearly be seen. Note that the reaction starts in front of the vessel, and the increased density below the trawl.

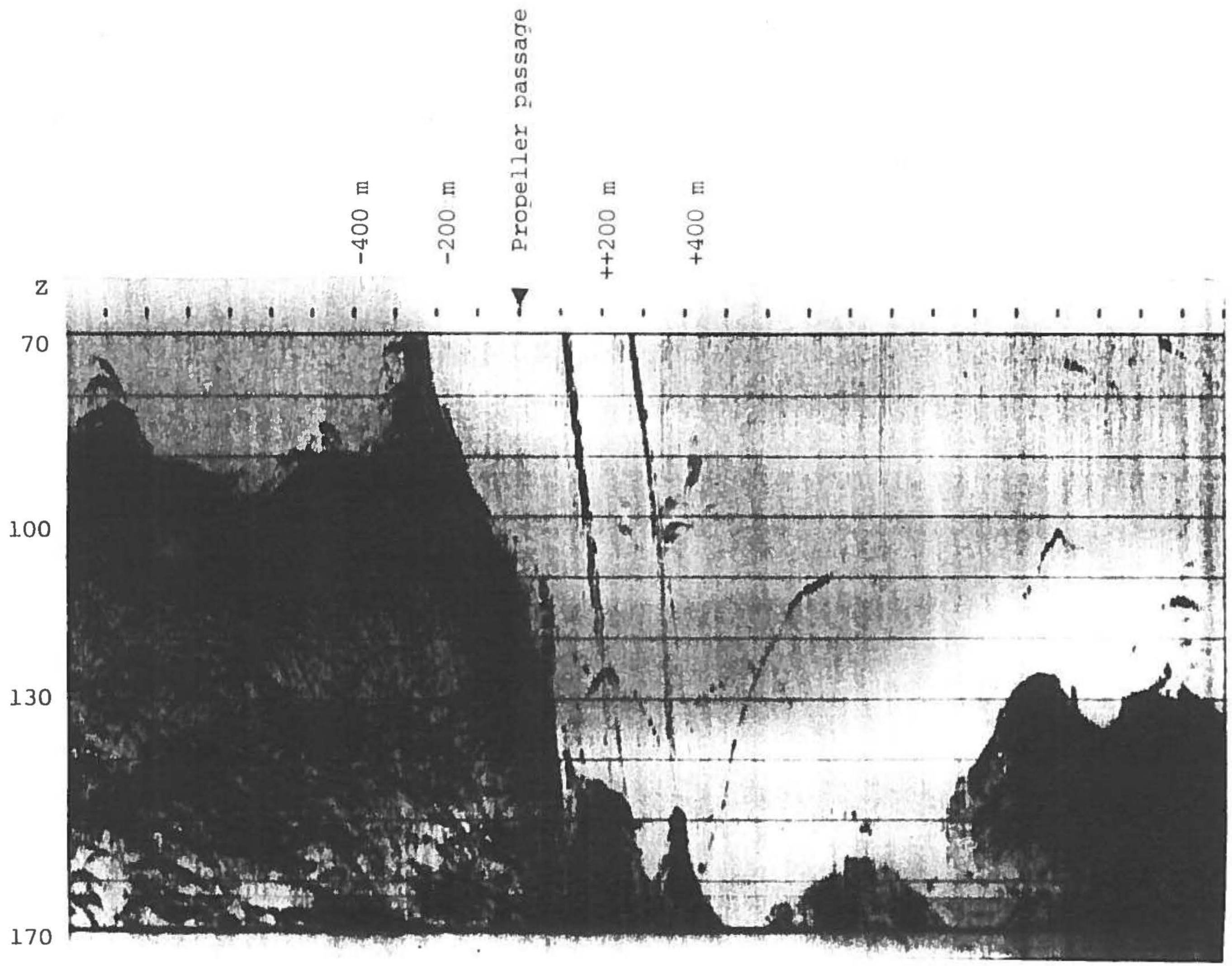

Fig.6. Echogram from the stationary transducer on RUN NO.4, showing early pre-vessel reaction and fast downward swimming in front of the warps and trawl. The vertical flow of fish is here 16.6 m/min, lasting for about 8 minutes. The fish below the trawl is not shown at the used phased range.