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CONCENTRATION OF MARINE ORGANISMS ON THE HYDROLOGICAL BACKGROUND - ACOUSTICAL SURVEYS

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This paper presents the result of backscattering layers investigation and correlation with their occurrence and hydrological conditions in the Baltic Sea. Two interesting places are described: the end of Hel Peninsula and the sill of Slupsk Furrow. Figures show the set day - night disturbance by influence of water masses all over the end of Hel Peninsula, and the overflow of water from the North Sea over the sill of Slupsk Furrow. Obtained results are shown as echograms.

INTRODUCTION

The knowledge of temperature, salinity and density conditions are the primary information for all oceanographers. It determines the dynamics of water masses and the behaviour of live organisms. The research of spatial distribution and time changes of STD (salinity, temperature, depth) fields is rather difficult, because these are not remote methods. Acoustic remote methods are not able to measure the temperature in a fixed place, but thanks to live organisms and their inclination to aggregate in layers, e.g. at the strong temperature gradient, we could observe water layering - especially in the Baltic Sea. In spite of this, there is still a big effort made on the acoustic thermometry of large areas - acoustic thermography of the oceans.

The Baltic Sea is a perfect place for backscattering layer research. Changes of thermocline location and occasionally the North Sea flows, control the distribution and behaviour of marine organisms. The Baltic sea can be presented as a two layers sea. [2] The upper, isohaline layer, is connected with thermal changing caused by seasonal climate cycle. And the lower, salty layers depend on the oceans flows (from the North Sea) and moving waters between neighbouring basins. Strong vertical gradients of temperature and/or salinity make the barriers for migration, and induct in some seasons (spring and autumn) concentrations of marine organisms in layers.

For marine live forms, water is an environment shaping their behaviour mainly in the scope of survival, food collection and reproduction. Some spectacular movements of plankton and micronekton are diurnal migration - changing depth of laying organisms during sunset and sunrise - described many times in literature.

Although a single plankter is too small to be seen at lower ultrasound frequencies, multiple echoes from thick aggregation of these organisms can be compared with signals obtained from bigger objects. Small zooplankton form schools or wide layers in water. Additionally, despite little dimensions, in case if organisms possess gas bubbles, they give the strong echo at low frequencies, due to resonance features. **Since the plankton itself are not able to move horizontally, spatial distribution is described by a movement of water masses, so the acoustic detection of biological aggregation allows us to observe various marine dynamic processes.**

Main part of acoustic scattering in water, is connected with plankton and micronekton, which spatial and temporal distributions show significant variability.

Obtained images from echosounder are partly shaped because of behaviour, and partly of mesoscales marine physical processes.
This is a basic problem for biologists and physicists: how to distinguish the source of volume reverberation: is it due to backscattering by organisms, or by the physical structure of the sea.
This paper aims in presenting the data from two regions: vicinity of Hel Peninsula (Gulf of Gdańsk) and Slupsk Furrow (central part of South Baltic Sea).

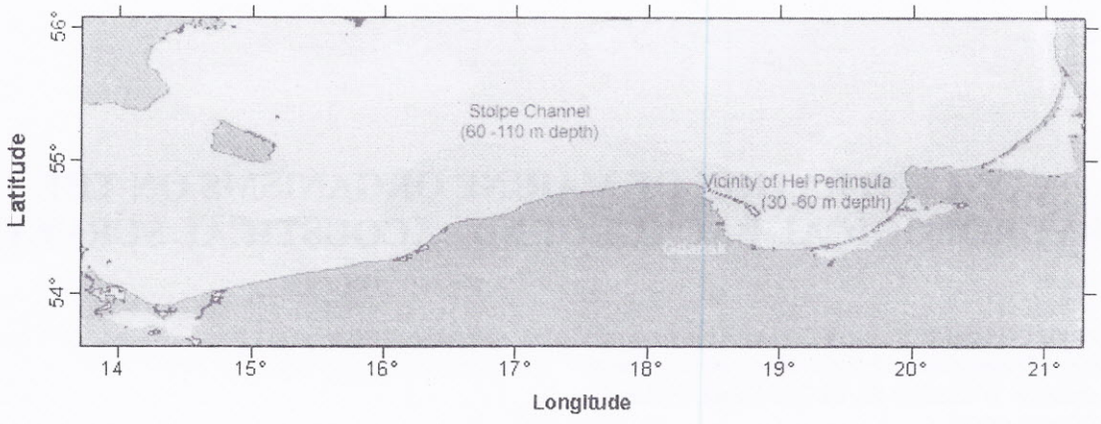

Fig. 1. Map of surveys area.

EXPERIMENT

The measurements were carried out with the help of Honeywell-Elac LAZ-4700 echosounder working on 30 kHz frequency with pulse length equal to 1 ms and repetition rate of 1 second. Transducer was fixed on a towed body. Echo envelope was sampled with frequency 3-5 kHz, then 64-pings blocks of data were recorded with date, time, GPS - position, and echosounder parameters (power, gain, pulse length, TVG, etc.) on a hard disk. This data allow to make echograms and to process the data for further analysis. In many cases STD (salinity, temperature, depth) probing was carried out together with echosouding.

RESULTS

The first of described areas - Gulf of Gdansk, is the closest to us. It is a very interesting place, because of big non - homogenity of bathymetry, biology and hydrology on a small spatial scale. The shape of coast line of the gulf, especially the location of Hel Peninsula, causes interesting hydrodynamic phenomenon. For example we can see a sudden upwelling of thermocline, caused by flow in and then flow out surface water resulting from strong storm. [2]. Hel Peninsula is a strong obstacle which separates Puck Bay from water masses flowing into Gulf of Gdansk. Its location limits the penetration of inner Gulf of Gdansk and Puck Bay only to the water from the east direction. Water masses move northward or southward along the peninsula, mainly depending on atmospheric conditions like wind force and direction. We also should mention the influence of flows from the Vistula River on hydrological conditions of this area.
Echograms in Fig. 2 display two profiles obtained in September 1995, at the day and night time, in the same place - south of Hel Peninsula. The first of them, daytime profile, shows an interesting phenomenon. Usually the difference between day and night is that during the day all plankton dive deep into sea, while it moves upward forming layers during night time. In this case it is partly similar. We see schools of plankton above the bottom and many scatterers in the water column. Accumulation of plankton in the bottom part of the sea is limited only to the space, where the peninsula ends. The surface layer is thinner during the day than during night, but in the western part of the transect it immerses as a result of water circulation in that region. The second echogram shows the nightly image. We can see well very strong and thick backscattering layer spreading down to 30 m depth (the depth in this place is 55 m). The shape of the layer is the result of interaction of various water masses. In the central part we could see the influence of the disturbance of water movement, caused by the peninsula, on backscattering layer. Other surveys confirm the change in the layer's shape in this place, among others, by atmospheric conditions (wind) [2, 5]. Figures show the set day - night disturbance by influence of water masses all over the end of Hel Peninsula.

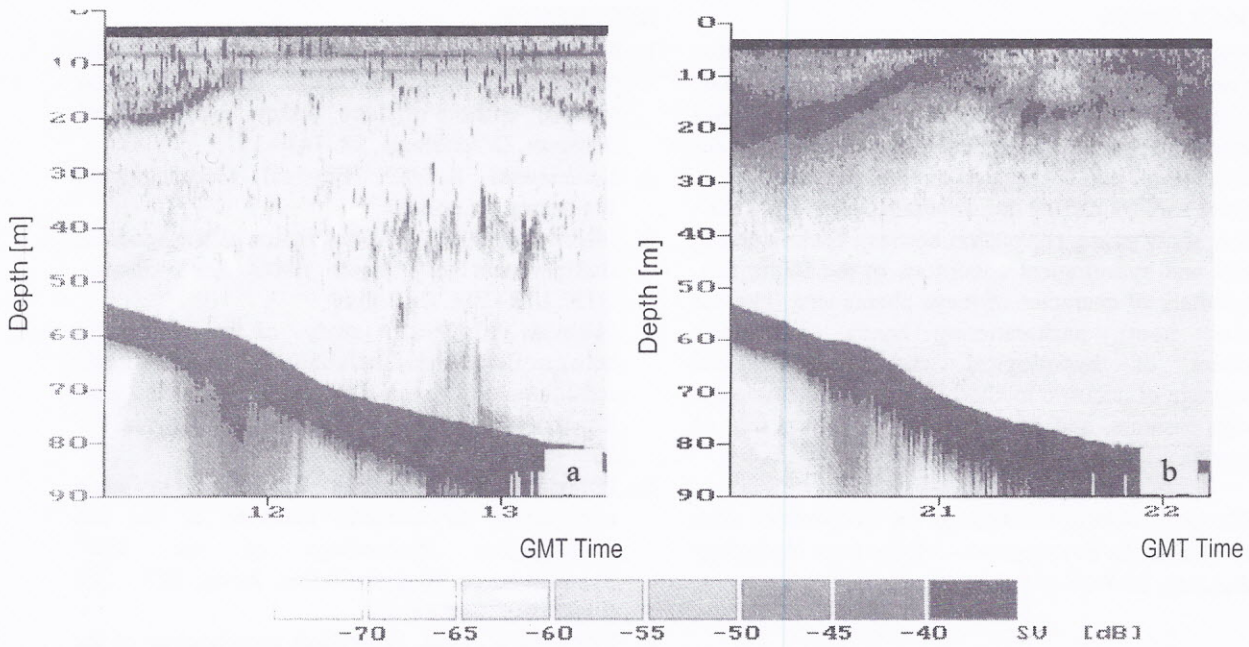

Fig. 2. Profiles obtained south of Hel Peninsula: a - day, b - night.

Slupsk Furrow is the gate to the eastern part of the Baltic Sea. This way, salty water from the North Sea flows from Bornholm Basin into Gotland Basin and Gdansk Deep. [3]. There is a local shallow place - sill of Slupsk Furrow on its western end. This sill blocks flows water into deeper parts of the Baltic Sea. Slupsk Furrow has a significant influence on fish distribution [4] Several surveys, taken on r/v „Oceania", bring valuable acoustic material from these places and hydrological as well.

The transect in Fig. 3 presents the profile obtained over the sill of Slupsk Furrow in February 1995.

We recorded an interesting moment of warm and salty water overflowing from Bornholm Basin. Simultaneously with acoustic recording, there was a profile carried out by towed STD Guildline probe. The data of temperature are presented above. We can perfectly see comparable change of strong gradient of temperature with backscattering layer. Crossing sill, overflow wave breaks and makes turbulence. This profile was repeated, and we could see the eastward movement of the wave breaking.

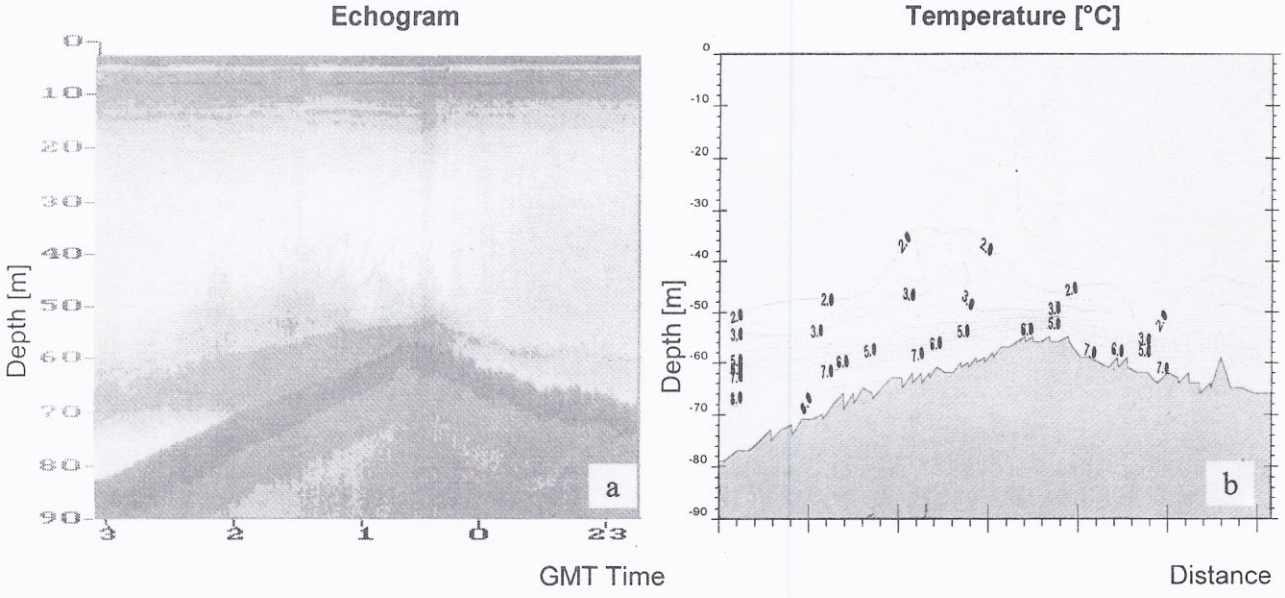

Fig. 3. Sill of Slupsk Furrow: a - echogram, b - temperature.

CONCLUSION

Carrying out acoustic research, we are able to confirm the well known facts, e.g. that the Hel Peninsula makes the barrier dividing the water in Gulf of Gdansk and also record an unusual phenomenon - overflowing oceanic water into deeper part of the Baltic Sea.

Several surveys carried out simultaneously with STD - probe, show strong correlation between backscattering layers and hydrological conditions in the Baltic Sea. Regardless of character of these phenomena (internal waves, front), backscattering layers are perfect markers of hydrological changes. Additional advantage of acoustic method is time of obtaining the result, easiness, and least but not last lower cost of research.

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