

# OBSERVATIONS ON THE SCATTERING LAYERS OVER THE CONTINENTAL SHELF OFF KONKAN COAST (INDIA)

by V.S. RAMA RAJU

*Physical Oceanography Division, National Institute of Oceanography, Ernakulam*

The echograms obtained by R.V. "VARUNA" using asdic during the September, 1963 cruise are analysed. Scattering layers observed over the shelf area, off Ratnagiri, are examined and studied in relation to the thermocline layer present. Comparison of the reflections from the layers in the thermocline region with similar observation in the North Sea has indicated that the layers are not directly due to the physical discontinuity.

## INTRODUCTION

Extensive sound scattering layers are observed in many parts of the world oceans in deeper waters (day time layer depths 200—800 m) and few in shallow waters. Hersey and Moore (1948) summarized the results of observations of the scattering layers in the Atlantic Ocean and attributed their origin to biological agency plankton, especially euphausiids from the evidence of net hauls. Weston (1958) reported in his paper a strong and extensive scattering layer at the thermocline depth in shallow water (depth about 37 fathoms) in the North Sea and proved by calculation that these layers are not directly related to physical discontinuity and therefore plankton or fish feeding on plankton is the probable source. Some of the earlier observers noticed the continuity of the layers over wide areas and their location sometimes coinciding with sharp temperature or density discontinuity; and thought the origin is possibly due to physical parameter such as temperature or density. But the more recent investigations have positively contributed to the idea that these layers are due to biological source, although there exist different layer types in different locations and they vary with time. Also the layers are not always caused by the same organisms and the sound reflective physical properties of the organisms under the observation conditions are not certain. It is known that, at least in some cases, the trawling operations conducted at locations where the scattering layers were observed by means of echo sounder or asdic have resulted in increased catches (Barnes 1959).

The present studies have been made from the echo sounder and asdic records of R.V. "VARUNA" obtained during the trawling operations. The scattering layers obtained in these records are quite interesting from the point of view of their occurrence at shallow depths, their vertical movements, their wavy pattern and also because of their double layered characteristics.

## DESCRIPTION AND EXAMINATION OF THE LAYERS

The layers are recorded by asdic (Simrad type) on 20th and 21st September, 1963 and they extend at least over a distance of fifty miles to the north and north-

east of  $16^{\circ}26' N$ ,  $72^{\circ}49' E$  over the continental shelf where the bottom depth varied between 20 and 80 m. The asdic was in use for fish detection at trawling stations and in between the oceanographic stations. It has a scale range of 0-1500 m, frequency 30 KC. per second and chart speed 2 cm per minute. In operation the transducer of the asdic is lowered by about  $1/2$  m below the keel and the beam can be swept through  $140^{\circ}$ . The face of the transducer is slightly inclined from the vertical plane and the ultrasonic sound beam makes an angle of  $3^{\circ}$  downward with the horizontal. The beam width is  $17^{\circ}$ . The signal or ping length expressed as travel distance in water is about 10 m. The draught of the ship is 3.4 m and so only the scatterers below this depth are recorded.

The vertical temperature variation of the waters observed at the same time with reversing thermometers shows a small increase of temperature ( $0.5$  to  $1^{\circ}C$ ) with depth in the surface layer up to 10 m, and the thermocline layer thickness is 10 to 30 m with its upper surface at about 10 m depth. The thermocline layer shoaled towards the shore. The steepest temperature gradient in the thermocline is  $0.33^{\circ}C$  per metre. The thickness of the thermocline layer at different locations is shown in figures 1, 2, 3 and 4 along with the spatial and temporal variations of the scattering layer depths.

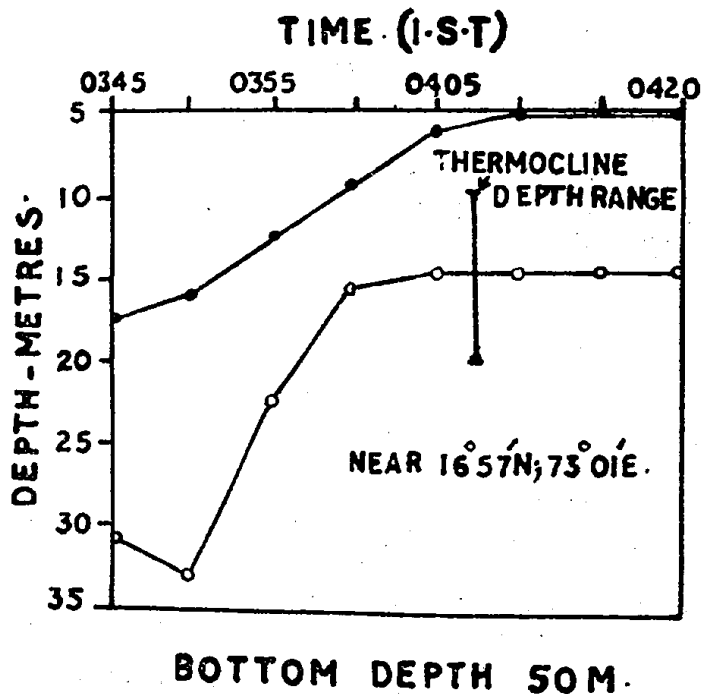
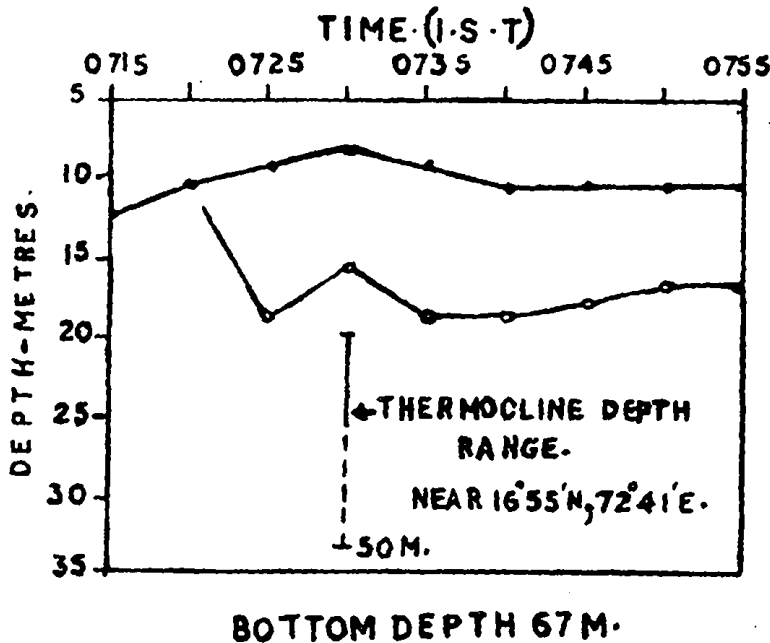
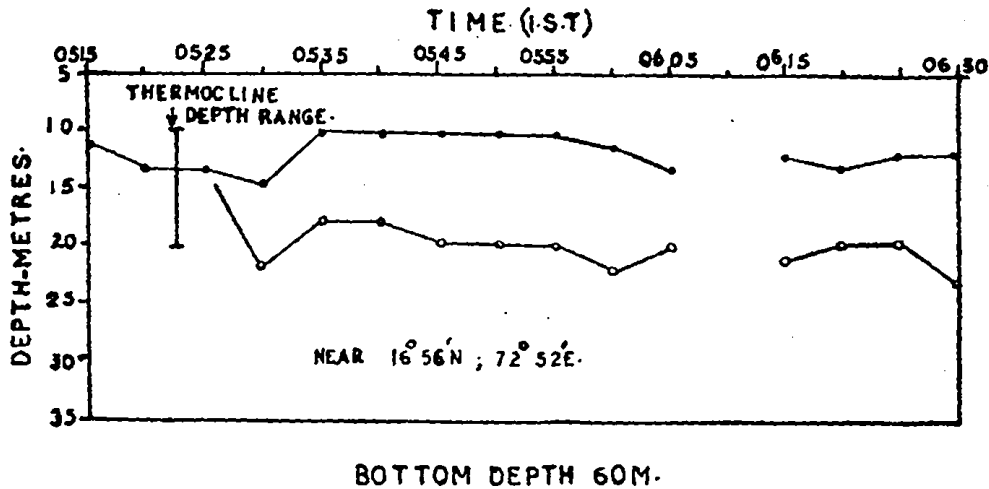


FIG. 1. Spatial and temporal variations of the depths of the scattering layers showing upward migration on 20th Sept, 1963. Ship underway at 8 Knots.

An examination of the records taken on 20th September by the asdic run in between the oceanographic stations from 0345 to 0735 hrs. (IST) reveals clearly the two reflective layers in the mid water and the sea bottom sounded by the echo sounder is definitely at a greater depth. These two layers are at a mean depth

of 11 and 18 m. As the ship sailed west-ward, the upper layer present at 17 m at 0345 hrs. moved to the surface by 0400 hrs. and merged with the signal record of the outgoing pulse; and the lower layer also moved upwards from 30 m to 14 m depth. Similar vertical migration of the layers that do not seem to have any clear relation with the illumination of the water can be observed in all the figures. An interesting point noted from the records is that the sound scatterers observed in shallow water at a single level bifurcated to two levels, one moving upward and the other downward and later on maintained separate levels more or less parallel to one another, at least for some time. The bifurcation is clearly illustrated in figures 2 and 3.



FIGS. 2, 3. Spatial and temporal variations of the depths of the scattering layers showing bifurcation of a single layer recorded on 20th Sept, 1963. Ship underway at 8 Knots.

The scattering layers are not always found in the region of the thermocline. Also it is difficult to ascertain exactly from the available data, from which part of the thermocline the reflections are arising. However, the records taken from 0515 to 0550 hrs. (IST) on 20th September, show that the scatterers are mostly confined to the thermocline and the bifurcated levels of the layers are situated near the top and bottom of the thermocline. And the temporal variation of the layer observed on 21st September shows that its level is mostly confined to the upper half of the thermocline. This particular record also shows superimposition of wave form on the layer suggesting that the scatterers are plausibly riding on an internal wave. The analysis reveals that the wave has periods varying between 2.5 and 7.5 minutes and heights between 2.0 and 8.0 metres. The mean period calculated is 3.5 minutes and wave height 4.5 metres. Well-defined wave forms superimposed on scattering layers caused by small organisms were recorded by echo sounder of frequency 30 KC per second in the shelf area off the Angola Coast (Vasco Valdez 1960).

The layers observed are, in general, diffuse in character and the few records obtained in the early hours of the day missed observations at sun rise. But the migration of the Deep Scattering Layers in the vertical with changes in illumination in the Sea water is well known.

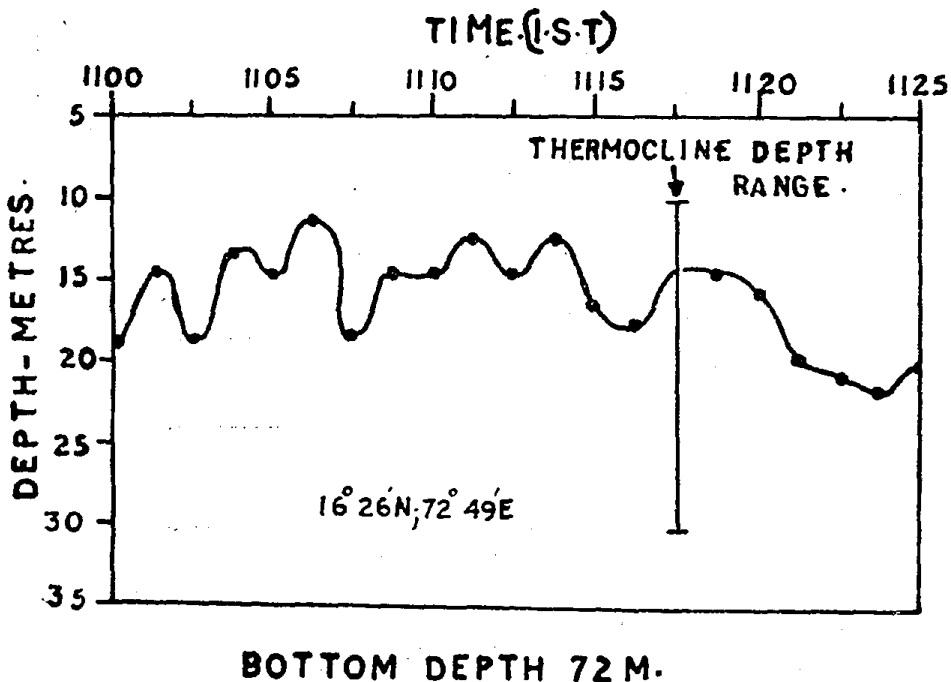


FIG. 4. Wave pattern of the shallow scattering layer recorded on 21st Sept. 1963. Ship trawling at about 0.5 Knot.

#### DISCUSSION

Ever since the scattering layers were recognized in 1942, various attempts are made to find out by direct and indirect means the exact source responsible for

causing these so-called phantom bottoms on the echograms. These layers exist in most parts of the deep oceans (Dietz 1962). There are two main possibilities for a sound pulse sent down from a transducer getting reflected from the water layers. These are (1) a thermocline layer in which the temperature decreases rapidly with depth and consequently increases the density of the water column acting as a semi-reflector of sound waves and, (2) the presence of organisms containing air bladders which act as effective reflectors or organisms present in sufficient concentration and having chitinised carapace. Weston (1958) in his study of the scattering layer in the North Sea observed with a transducer of frequency 10 KC. per second at a thermocline of exceptionally steep gradient ( $2^{\circ}\text{C}$  per metre) has proved that the density discontinuity is ineffective reflector. Comparing the present observed physical conditions clearly reveals that the reflections cannot be due to the physical discontinuity. Therefore, the shallow scattering layers observed must be due to some small organisms (such as euphausiids, myctophids, etc.).

#### ACKNOWLEDGEMENTS

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