# Proceedings of the Second Workshop on Scientific Results of *FORV Sagar Sampada*

Editors

*V.K. Pillai*
*S.A.H. Abidi*
*V. Ravindran*
*K.K. Balachandran*
*Vikram V. Agadi*

**Department of Ocean Development**
**Government of India**
**New Delhi**
**1996**

Department of Ocean Development (DOD)
Government of India
Mahasagar Bhavan, Block No-12
C.G.O. Complex, Lodi Road
New Delhi-110 003
India

ISBN : 81-900656-0-2

**Citation Styles**

*For entire volume*

Pillai, V.K. Abidi, S.A.H., Ravindran, V., Balachandran, K.K. & Agadi, V.V. (Eds.) 1996. *Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada*, (Department of Ocean Development, New Delhi), pp. 564.

*For individual article*

Goswamy, S.C. & Shrivastava, Y. 1996. Zooplankton standing stock, community structure and diversity in the northern Arabian Sea, In: *Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada*, edited by V.K. Pillai, S.A.H. Abidi, V. Ravindran, K. K. Balachandran & V.V. Agadi, (Department of Ocean Development, New Delhi), pp. 127-137.

**Designed and Printed by:**

Publications & Information Directorate
Council of Scientific & Industrial Research
Pusa Campus, New Delhi-110 012
India

*Proc. Second Workshop Scient. Resul. FORV Sagar Sampada, 1996, pp.505–512*

# Underwater acoustic instrumentation for investigating deep scattering layer

S. Natarajan, K.G. Girijavallabhan & M.S. Rajagopalan

Central Marine Fisheries Research Institute P.B. No 1603, Cochin-682014

## ABSTRACT

The instruments used for the DSL studies were scientific echo-sounder for detection, Isacc's Kid Midwater trawl for sampling mesopelagics and the trawl sonde to lower the IKMT to the exact depth at which the DSL appeared. Opening of the IKMT and the temperature of the seawater at which the DSL appeared was also recorded on the trawl sonde system. The echoscope connected to the echosounder showed the DSL in different colours depending upon its density. The continuous monitoring on echogram revealed that the DSL observed at surface during night and at 600 m depth during day.

## INTRODUCTION

Developments in hydro acoustic instruments for fish detection locating fishing grounds and fish resources estimation have been taken place during the last four decades. Starting from simple echosounders and sonars, the present day equipments, help in qualitative and quantitative assessment with better resolution and precision. In India, the era of application of acoustics in fisheries investigations began in the late fifties with the import of few vessels from Norway for fisheries research and surveys along the west-coast of India. The arrivals among them were *R.V.M.O. Christensen, R.V. Kalava,* and *R.V.Varuna* (Silas, 1969). They were fitted with echosounders and simple sonar. *R.V. Conch* of the University of Kerala fitted with echosounder (Simrad, Norway) was also available for fishery research. In the beginning these instruments were used in general for quantitative studies of the fishery resources, plankton distribution, deep scattering layer (DSL) and in limited way for gross quantification of certain demersal fish resources. The UNDP/FAO Pelagic Fishery Project (1971-1979), Cochin, for the first time used the full range of acoustic instruments for the pelagic fish resources survey of southwest coast of India. The instruments consisted of Simrad (Norway) series of equipments namely Scientific Echosounder EK-120, the external dry paper recorder EX-70, Survey Sonar SU/SR2, Trawl sonde and Echo integrator QM installed on two vessels. They were *R.V. Rastrelliger*, a 152' steel stern ramp trawler cum Purse-Seiner and *R.V. Sardinalla*, a 54' fibre glass vessel of similar operational capabilities. Some important observations were made by making use of the above acoustic instruments and the results were published elsewhere. In due course, the instruments were replaced by next generation type of EKS system of echosounders with EQ/EK recorders (Vitullo *et al.* 1980). In 1982 *R.V. Skipjack*, a 107' steel stern ramp trawler fitted with Simrad EQ/EX echosounders and SU Sonar was acquired by CMFRI, Cochin for fishery research. In the absence of the echo-integrator it was possible to use the instruments only for echo location and sonar survey for the surface schools.

Since 1984, *FORV Sagar Sampada* (LOA-71.5 m) is engaging for fishery and oceanographic research in Indian waters. Most modern and sophisticated acoustic equipments such as scientific echo-sounder (Simrad EK-400), echo-integrator (Simrad QD), sonar (Simrad SM-600), trawl eye (FR-500), hydrography echosounders (Simrad EA-200), speed log (Simrad-NL) with electronic data processing facilities are available onboard the vessel which can be used for location of fish schools, quantitative and qualitative studies of the fishery resources, plankton distribution in the DSL and aimed trawling in the Exclusive Economic Zone (EEZ) of India. Connected instrumentations, their specifications, optimum settings of the equipment parameters for the DSL studies and the interpretation of the echogram on DSL are discussed in this paper.

## MATERIALS AND METHODS

The acoustic survey equipment system onboard *FORV Sagar Sampada* used for DSL studies consist of scientific echosounder EK-400 for detecting fish schools, DSL and finding their depth, echo- integrator for quantifying the biomass, trawl sonde for lowering the net to the desired depth, distance speed log for providing log mark for everyone nautical mile while sailing and data terminal TI-703 for providing the integrator output as a print-out. The salient feature of these equipments are described below.

*Scientific echosounder (Simrad-EK-400)* – This is designed to meet the scientific demands for an echosounder that can do more than just present a fish or bottom echo on an echogram paper. The most modern technology is used in designing this equipment. Introduction of micro-processor technique has also made it possible to eliminate the use of number of switches and potentiometer controls in the front of the control panel. Yet so many parameters are possible to select through the 4x4 position key board. Simple and straightforward menu, together with an unambiguous interactive display are mounted on the front of the separate control unit. The main units of this are recorder units, control units, transreceiver unit and either for single beam or two dual beam transducers. Any other auxiliary equipments with parallel B, C, D, ten digits sources can be connected to this echosounder and the respective data will be printed out on the top of the echogram. Also this could be equipped with supplementary equipments like slave recorder, tape recorder, Simrad QX integrator processor, Simrad QD echo- integrator etc. It can operate on either 38 kHz or 120 kHz. Other technical specifications are as follows (Anon, 1980a):

| *Parameters* | 38 kHz | 120 kHz |
|---|---|---|
| Power supply | 250 V 50Hz±5% | 250 V 50Hz±5% |
| Power consumption | 435 W | 435 W |
| Receiver gain | 85 dB | 85 dB |
| Attenuation | 010 and 20dB | 010 and 20dB |
| Noise level | + 15 dB IV RMS | +15 dB IV RMS |
| Output impedance | 50 ohms | 50 ohms |
| Pulse width | 0.3,1,3 & 10 MS | 0.1,0.3,1 & 3 MS |
| Power output | 2500 W | 1000 W |
| TVG | 20/40 Log R | 20/40 Log R |
| Beam width | | |
| Narrow | 8° | 4° (circular) |
| Wide | 22° | 4° |
| Main Range | 0-1000 M | 0-1000 M |
| Mode of operation | Normal, dynaline and contour line | Normal, dynaline, and contour line |

*Trawl sonde (Simrad-FR-500)* – It gives the information on the opening of the net and also the position of the net with respect to the surface of the water and the sea bottom. After observing the depth of the fish shoal by the echosounder the net could be positioned in the right depth to trap the fish shoal with the help of trawl sonde. Also a temperature sensor placed in the transducer, which is tied on to the head rope of the trawl net, gives the temperature prevailing along the path of the net to establish the relations between the fish biomass and the temperature of the seawater.

*Echo-integrator(Simrad QD)* – Generally an echo-integrator in conjunction with scientific echosounders provides numerical estimate of the echo abundance. It measures the combined strength and number of echoes received from a selected volume of a seawater. The integrated values are displayed as a raising line across the echogram alongwith fish and bottom echoes, particularly the echo-integrator (Simrad QD), interfaced to scientific echosounder EK-400. This system consists of Simrad QX integrator preprocessor and two micro computers that are programmed to measure, present and log the mean volume backscattering strength ($S_V$) and mm deflection (Anon, 1980b).

*Data terminal No. TI 703* – It is the primary means of data input to the computer and data output from the computer. The system parameters and the integration layer selection is fed through this terminal. The integrator output is available as printout in

A4 format at the rate of 10.2 characters per inch (CPI)/80 characters per line in its standard printing configuration. In its compressed configuration the terminal prints 17 CPI (132 characters per line) (Anon, 1988).

*Simrad NL Doppler speed log* – This provides analog speed indication of the vessel and digital distance read out. Working frequency is 1 MHz. It has two speed ranges of 0-10 and 0-20 knot. The accuracy of the speed is better than 2 percent. The output signal of the log is fed to the echosounder EK-400 and echo integrator QD for providing mile marker and resetting the integration respectively for each nautical mile distance sailed by the vessel (Anon, 1979).

*Isacc's Kid Midwater trawl* – It was a gear, onboard *FORV Sagar Sampada*, used to collect the mesopelagic samples on observation of DSL recording in the echosounder. This was made of nylon webbing with four sections of different mesh sizes of 25 mm, 16 mm, 11 mm and 5 mm and length of 500 mm, 500 mm, 8250 mm and 1750 mm respectively, totalling 11 m. The width was tappered from 2500 mm at the mouth opening to 750 mm at the codend. A specially designed 2.5 m length, aluminium depressor weighing 25 kg was attached to the gear in order to maintain the proper opening of the net to the maximum of 4 m. A 5 litre capacity bucket was attached to the codend where the samples of DSL components get collected.

The towing speed was 3 knots. The fishing warp was paid out at the rate of 25 meters per minute and retrieved at 12½ meters per minute. The vessel was sailed along the predetermined track having all the instruments preset for the required programme as given below:

| | | |
|---|---|---|
| Frequency | : | 38 kHz for deep water, 120 kHz for shallow water |
| Pulse length | : | Narrow (0.3 MS for 38 kHz and 1 MS for 120 kHz) |
| Receiver band width | : | Wide |
| Beam width | : | Wide |
| Power output | : | High for deep water and low for shallow water |
| Attenuation | : | 'O' dB |
| Time varied gain (TVG) | : | 20 Log R |
| Main range (depth) | : | As required |

The echosounder was run continuously day and night. Log marker was set to mark everyone nautical mile sailed. Latitude and longitude against time and date were recorded on the echogram for every two hours in order to refer back and locate geographically. The echo mark of the DSL was observed constantly. They appeared like a smoky layer with small grains (Natarajan *et al.* 1980) which could be easily distinguished from fish echo by experience. The depth range at which the DSL appeared was determined by observing the echogram. When significant DSL appeared, the Isacc's Kid Midwater trawl was lowered with trawl sonde, transducer

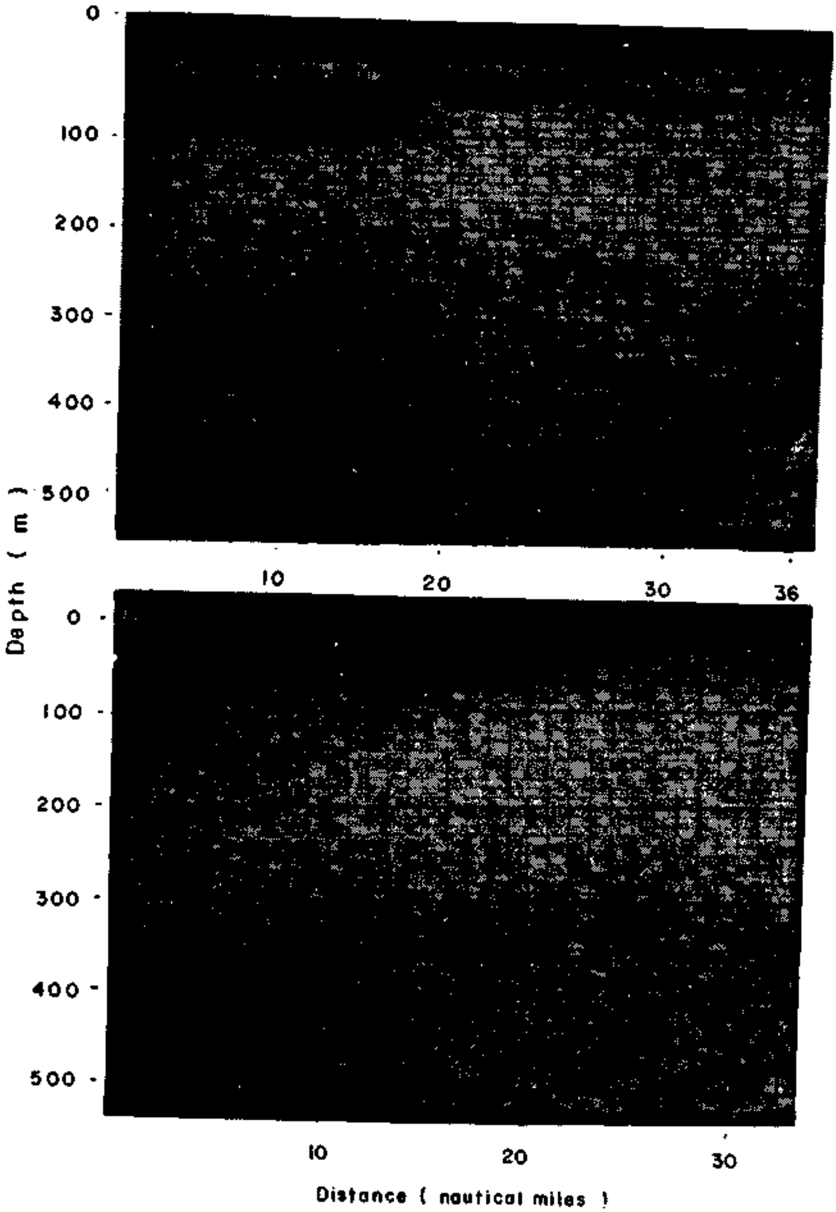


Fig. 1 — Echogram of DSL recorded in the early morningtime (A), lat. 12° 11'N, long. 81° 47'E range 500 m., time 0600 hrs. and noontime (B), lat. 13° 29'N, long. 80° 50'E range 500 m., time 1200 hrs

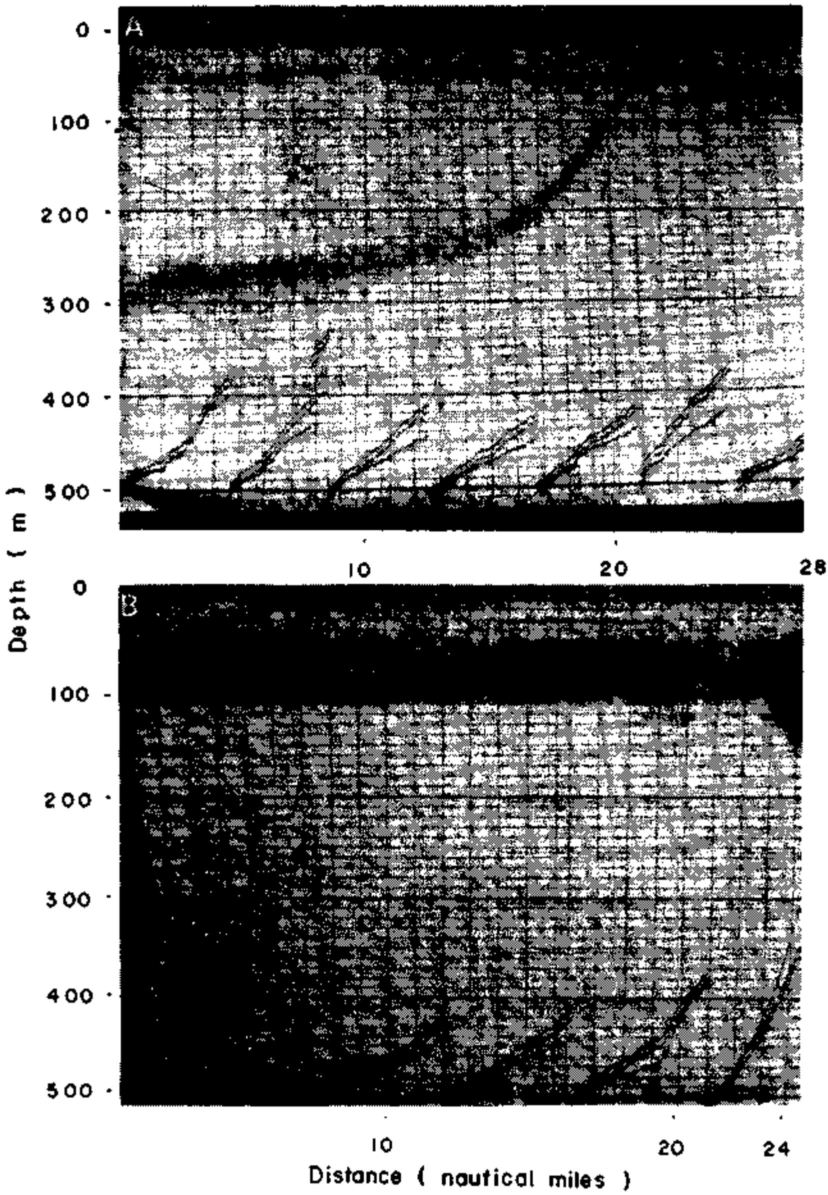


Fig.2 — Echogram of DSL recorded in the eveningtime (sunset time) (A) lat. 12° 30'N, long. 81° 42'E., range 500 m. time 1630 hrs and night-time (B), lat. 14° 06'N, long. 80° 29'E., range 500 m., time 2400 hrs.

fixed on to the head-rope. The IKMT was lowered to the depth at which the DSL appeared by observing the trawl sonde recorder. It recorded the vertical opening of the net and also the temperature of the seawater all along the path of the net. The vessel speed and warp length of the net were manoeuvred in such a way that net followed the DSL and trapped them. After dragging the net for a specified time, it was hauled. The sample was preserved and analysed by conventional methods. The echo- scope with colour display was used to discriminate the size and density of the organism based on the colour which was the function of echo energy level.

## RESULTS AND DISCUSSION

The continuous monitoring on the behaviour of DSL carried out (cruise No. SS/116A for 24 hours) from the echogram along the east coast, revealed that DSL oscillated between surface and 450 meter depth. It was found that the first symptom of descending of DSL started as early as 0600 hrs and it formed into three distinguished layer by 0800 hrs, the first one being between 300 m and 360 m. The second layer was formed between 390 m and 410 m. The third layer was between 420 m to 450 m (Fig. 1A). Thereafter, around 1200 hrs, all the three layers merged into one covering 300 m to 400 m (Fig. 1B). By about 1600 hrs the DSL started ascending and reached the surface by about 1800 hrs (Fig. 2A). During night, the layer remained between 40 m and 100 m (Fig. 2B). It was also confirmed that on sunny day the DSL penetrates up to 600 m depth. The time and rate of ascending and descending of DSL

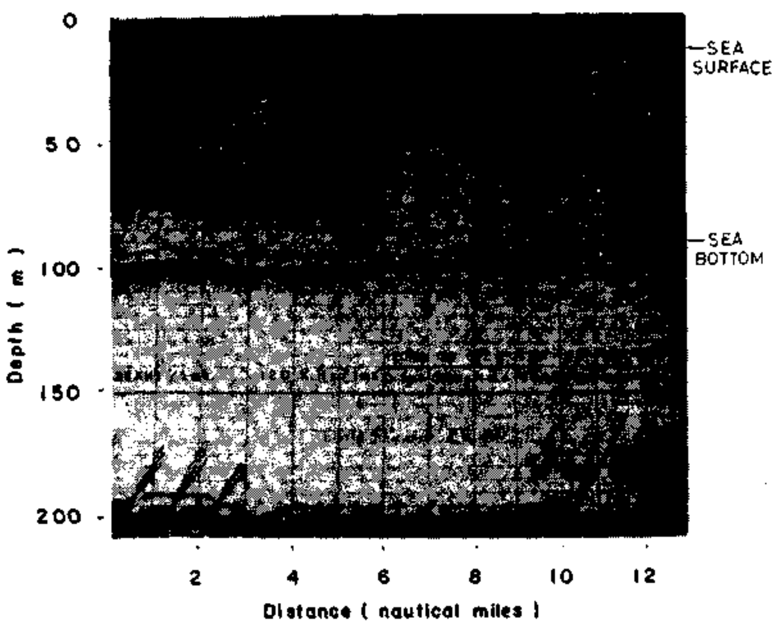


Fig. 3— Echogram of DSL recorded for different frequencies and pulse length

also depend upon the sunlight (Mathew & Natarajan, 1990). Figure 3 shows the effect of frequency and pulse length on the echogram. It was found that 0.3 mS pulse length for 38 kHz frequency and 1mS pulse length for 120 kHz were more suitable. Also, special station was conducted by lowering the CTD and found (by observing the graph of light transmission in %) that the light attenuation was more at the depth corresponding to the DSL observed in the echogram. Hence it is possible to identify the existence of the DSL and to know the depth by observing the % of light transmission by casting the CTD.

The DSL studies using the echosounder, have brought to the light the existence of two vast resources viz. the mesopelagic resources composed of smaller fishes, other crustaceans and invertebrates (Mathew & Natarajan, 1990). It is possible to make use of the echo-integrator for the quantification of the DSL also. It is suggested to attempt by conducting acoustic survey and allotting the mm deflection value of echo-integrator corresponding to DSL and compare with estimation by other conventional method in the future.

## ACKNOWLEDGEMENT

Authors are thankful to the Director for the kind co-operation and permission for presenting the paper. Thanks are also due to the Captain of *FORV Sagar Sampada*, the fishing masters and the participating scientific staff of the cruise No. SS/116A for their co-operation in the successful conduct of the cruise.

## REFERENCES

Anon. 1979. *Simrad NL Doppler speed log instruction manual*, (P1110E) (Simrad Subseas A/S Horten, Norway).

Anon. 1980a. Simrad EK-400 scientific echosounder instruction manual, (P 1308E) (Simrad Subseas A/S Horten, Norway).

Anon. 1980b. *Simrad QD echo-integrator instruction manual*, (Simrad Subseas A/S Horten, Norway).

Anon. 1983. *Instruction manual, Silent 700 Model 703*, (Data Terminal Texas Instruments, Houston, USA).

Mathew, K. J. & Natarajan, S. 1990. Investigation on the DSL of the Indian EEZ with special reference to euphausiids as a component, In: *Proceedings of First Scientific results FORV Sagar Sampada*, edited by K.J. Mathew, (CMFRI, Cochin), 355-375.

Natarajan, S., George, K.C., & Bande, V.N. 1980. Echo location of fish, *Mar. Fish. Infor. Serv. T&E Ser.* 7: 1-12.

Silas, E.G. 1969. Exploratory fishing by *R.V. Varuna, Bull. Cent. Mar. Fish Res. Inst.* 12: 1-86.

Vitullo, A.N., Natarajan, S.& Daniel, E. 1980. Live fish calibration of hydro-acoustic equipment onboard *R.V. Rastrelliger*, FI:DP/IND/75/038 Field document Vol. 7, (FAO, Rome) pp. 87.

* * *