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A PRELIMINARY REPORT ON THE USE OF PLASTIC BOBBINS AND OVAL-SHAPED OTTER BOARDS FOR TRAWLING OPERATIONS IN THE WESTERN VISAYAN SEA WITH THE AID OF ECHO SOUNDER

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ABSTRACT

This report seeks to enlighten commercial trawl fishermen on modern fishing techniques involved in trawling on rough and irregular sea bottoms. It is the author's observation that only chartered irregular features of the sea bottom are commercially exploited by Muro-Ami and handline fishermen while the unchartered features of the sea bottom remain virgin grounds waiting for exploitation by commercial fishermen using echo sounders. The author used two types of trawl nets in this fishing experiment to study the adaptability of bobbins and oval-shaped boards for each type of trawling on irregular sea bottom under Philippine conditions. The Western Visayan fishing ground is described in detail. Trawling positions made by M/V Lapu-Lapu are indicated as well as the quantity of catch and its composition. The necessity and principle of echo sounding and its role in the Western Visayan Sea fishing operations are discussed. Echo sounding of the trawled area is roughly interpreted and presented in echograms. Based on the data available, it was concluded that the oval-shaped otter boards is the most appropriate otter board for rigging with any design of trawl net intended for trawling in rough and rugged sea bottom.

INTRODUCTION

The development of otter trawl fishing in the Philippines became a success after World War II. As a result of the successful

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development of the trawl fishery, the number of trawlers have tremendously increased every year so that they have become the predominant fishing outfits for catching demersal fishes. Trawling operations were mostly limited to the flat bottoms of bays, gulfs and shallow open seas because a large portion of the continental shelf is characterized by irregular bottom features which make such areas difficult for trawling operations. Since these shallow flat grounds were subjected to heavy exploitation by hundreds of trawlers from the Visayan Islands and Luzon Island, there was a continuous fluctuation in the amount of catch and even the apparent depletion of these grounds may be traced to overfishing. Consequently, the trawlers had to shift their operations into deeper flat grounds while others had to devise means to exploit various configurations of the sea bottom.

The marginal lines of islands and islets submerged under shallow waters and slopes seaward to a maximum depth of about 200 meters are geologically called the continental shelves. The continental shelf of the Philippine is, in general, rather narrow and the water with a depth of 100 fathoms or less are quite limited. The continental shelf is extremely abundant in aquatic life and the bottom topography is highly diversified. It contains underwater mountains known as seamounts and ridges; volcanic cones, singly, in groups and in rows; plateaus, plains oval and elongated basins, canyons and gorges, and other varied features. These irregular submarine features are covered by soft corals and marine sediments such as clay, silt, sand and accumulations of the skeletons of microscopic organisms. These are the feeding grounds and habitat of the different demersal species of fish.

The acquisition of oval-shaped otter boards and plastic bobbins by the UNDP/Deep-Sea Fishing Development Project in 1968 made it possible for the M/V Lapu-Lapu of the Philippine Fisheries Commission (now Bureau of Fisheries and Aquatic Resources), to conduct experimental trawling on rough and irregular features of the sea bottom. The oval-shaped boards were tested in sandy grounds. After the initial trial, the boards were seldom used for regular trawling operations until the writer used them for trawling operations in Western Visayan Sea in October 1970.

Trawling on rough and irregular sea bottom with a trawl net rigged with oval-shaped boards and bobbins can be successful only if aided by a sensitive acoustical apparatus that will provide advance information on the conditions of the sea floor. The echo sounder

apparatus, commercially named fish finder, contributed so much to the success of the operation described here.

WESTERN VISAYAN SEA FISHING GROUND

Warfel and Manacop (1948), described the Western Visayan Sea (Fig. 1) as having an average depth of 15 fathoms, and the bottom is generally muddy and sandy and is studded with detached submerged reefs. Warfel and Manacop further reported that the US Fish and Wildlife Service exploratory vessel M/V THEODORE N. GILL conducted two successful drags in the area, while the third and fourth drags always fouled out and the cod-end of the net was badly torn by corals. However, in the entire survey of 24 trawling grounds in the Philippines made by M/V THEODORE N. GILL, the Western Visayan Sea area has the second highest rate of catch per hour per fishing ground (Table 1.)

Contrary to the shallow depth operations made by the M/V THEODORE N. GILL, this writer conducted the trawling operations at various depths ranging from 20 meters to 70 meters, characterized by varied bottom configurations.

Operations were conducted in selected areas around Jintotolo Channel and the Northeast of Gigantes Islands (Fig. 2) because these areas are adjacent to the muddy and sandy flat grounds commonly trawled by commercial fishermen. There were reports that some commercial trawlers were operating in the area with the use of rubber or wooden bobbins. This report was confirmed when a large steel trawler rigged with side trawl net passed us by while this writer was supervising the operation.

VESSEL AND EQUIPMENT

The vessel utilized in the exploration was the M/V Lapu-Lapu (Fig. 3), a 139.58 gross-ton steel trawler with an overall length of 90.20 feet; breadth, 20.70 feet; depth 8.85 feet. The vessel is propelled by a 450 h.p. full diesel engine. A 30 KW generating unit is coupled to a 45 h.p. auxilliary engine to supply the electric power requirement of the vessel. It has also a 3 KVA dynamo-unit which is coupled to the flywheel of the main engine to supply the electric power requirement during navigation of the vessel when the main generating unit is put off.

TABLE I. Showing the catch per hour and the composition of the catch per area of the First Six Trawling Grounds (1947-49)

SPECIES	Area I San Miguel Bay (5 hrs.)	Area 2 Western Visayan Sea (2 hrs.)	Area 3 Guimaras Strait (24 hrs.)	Area 4 Sisiran Bay (1 hr.	Area 5 Panay Gulf (7 1/2 hrs.)	Area 6 Carigara Bay (1 hr.)
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Barracudas (Sphyraenidae)	50	27	30		25	
Cow-nosed rays (Rhinobatidae)	183					
Crevalles (Carangidae)	20	6	201		60	15
Croakers (Sciaenidae)	29	107	140	219	568	
Cutlass (Trichiuridae)	3	3	238	11	910	
Drepanids (Drepanidae)	28		772			
Eagle rays (Myliobatidae)					48	
Gizzard shads (Dorosomidae)	23		73			
Groupers (Serranidae)		2	59	7		
Grunts (Theraponidae)		11	238	61		18
Lactarids (Lactaridae)			15	11		
Lizard Fish (Synodontidae)	25	20	51	4	21	18
Mackerels (Scombridae)	21		140			
Mojarras (Gerridae)		4	38			
Moonfish (Menidae)			105		40	
Mullets (Mullidae)	23	143	296	29	317	
Nemipterids (Nemipteridae)		189	22	3	9	
Pomadasids (Pomadasidae)	72	235	2,215			
Sawfish (Pristidae)	480		6			300
Sea Catfish (Ariidae)	26	12	148	16	60	7
Sharks (Galeidae)	15		78			
Slipmouth (Leiognathidae)	1,875	234	3,555	8	56	4
Snappers (Lutjanidae)		45	830	18	48	
Sting Rays (Dasyatidae)			1,168	80		1
Threadfins (Polynemidae)			232		35	10
Turbots (Psettodidae)			152	3		3
Miscellaneous	248	192	1,706	12	880	14
TOTAL	3,125	1,230	12,508	482	3,077	390
Average catch per hour	636	615	520	482	397	390

The vessel has a 10-ton capacity refrigerating unit, sufficient to preserve the freshness of fish inside the 64.53 cubic meter fish hold. The vessel has a combination mechanical winch unit capable of pulling a 10-ton net resistance. The minimum trawling speed of the vessel can be adjusted to about 2.5 knots. The vessel service speed is 10 knots.

NAVIGATIONAL ELECTRONIC APPARATUS AND COMMUNICATION SYSTEM

The M/V Lapu-Lapu has its own magnetic compass for navigation. In addition, the vessel is equipped with modern electronic apparatus for navigation and communication. The Marine Radar could be used for detecting objects on the water surface within 45 miles radius from the vessel. It is also used for plotting the ship's position within 45 miles radius from land. The vessel is also equipped with Loran apparatus and Radio Direction Finder used for plotting and locating the ship's position a hundred sea miles away from a Loran or Radio Station on land.

The vessel has two types of communications system consisting of (1) 50 kilo Hertz Single Side Band voice radio for direct communication and (1) 100 kilo Hertz Wireless Radio for transmitting and receiving coded messages from ship to ship to land based radio stations. The wireless radio also transmits and receives daily weather forecast of the general weather condition for the next twenty four hours.

THE FISHING GEAR

Two types of trawl gear of foreign design were selected for alternate trawling operations in the Western Visayan Sea.

a) The Sputnik type (Fig. 4) trawl net is a Norwegian original design. Gear technicians of the Bureau of Fisheries have made some slight changes in the length of the foot and float ropes, which were increased by two meters than the original measurement. The netting material and mesh sizes of the modified trawl net is indeed similar to the original Norwegian design except the length portion of the foot and float ropes.

b) The Granton type (Fig. 5) is another trawl gear, of English original design and construction. The foot rope of the gear is 36.6

meters long or about .07% shorter than the foot rope of the modified Sputnik type trawl net.

The two types of trawl gear are commonly used by Norwegian and English trawl fishermen on all trawlable grounds in the North Sea. The two types of trawl nets were simultaneously rigged with oval-shaped otter boards and plastic bobbins assembly to test the gears and accessories for adaptability on irregular bottom trawling operations under Philippine fishing conditions.

THE BOBBINS ASSEMBLY

The bobbins assembly (Fig. 6) is an essential accessory of a trawl net when trawling on irregular sea bottom. A roller or bobbin may be made of wood, iron, rubber or any hard-wearing material. The bobbin could be made into various shapes, principally round, disc or spherical. They are designed to roll over the rugged or irregular sea bottom. The bobbins used in the operations were spherically shaped, hollow and were made of hard plastic material.

The bobbins assembly consists of a 135 feet long bobbin wire with a diameter of about 3/8 of an inch, divided into three sections. One section is a 65 feet long bobbin wire rope roved through 17 pieces of plastic bobbins, each having a diameter of 12 inches. The other two bobbin wire sections, 35 feet long each, are roved through 13 pieces of smaller plastic bobbins each having a diameter of 6 inches. The distance between bobbins is 25 inches and the space in-between bobbins is maintained by a series of disc-shaped rubber spacers about 2 inches in diameter by one inch thick.

The large plastic bobbins, 16 inches in diameter, is attached to both ends of the lower wing ground rope to act as absorber for rough or protruding objects that the lower wing tip may encounter while the net is being dragged. The thickness of the four sizes of bobbins is 1½ inch. In each bobbin, there are eight holes. Six of these holes are equidistantly drilled to serve as intake opening of water and sea bottom sediments. The weight of the rolling bobbins is controlled by the volume of water and sediments it contains. The other holes which are bigger in diameter are provided for the hard plastic ferrule fittingly countersunk to prevent the wire from directly wearing away the bobbin and enlarging the hole.

The three sections of the bobbins assembly are linked to each other by thimbles and shackles. The bobbins assembly is in turn

attached to the foot rope by a linking chain, 8 inches long, equally distributed throughout the length of the bobbin wire. The space provided by the linking chain permits the plastic bobbins to roll smoothly over the ground as the trawl gear is dragged by the vessel.

OVAL-SHAPED BOARD

The angle of attack of plain otter boards and other hydrodynamic problems encountered in trawling have led to the improvement in the shape and design of otter boards. The hooking up and breaking of transatlantic communication cables by plain otter boards or trawlers is another problem that led to the change of the design of otter boards which would ride more easily over cables.

There are also other types of hydrodynamically shaped otter doors like the Larsen Wingdoor, the Sukerkrub hydrofoil type boards and other radical designs that may also ride more easily over cables. Perhaps the Russians were the first to design the oval-shaped otter boards. Treschev, a Russian fishing gear specialist, reported that the Soviet trawling fleet uses oval-shaped otter boards. He said that this type of board which does not cut so deeply into the bottom, is more durable, relatively light in weight and has 19 percent greater spreading force than the rectangular boards. Kristjonsson (FAO) reported that one-boat trawlers in Japan all used curved otter boards of the Sukerkrub type which are now built of steel but formerly have been of steel and wood.

The introduction of oval-shaped type otter boards (Fig. 7) in the Philippines made it possible for this writer to utilize these types of boards for trawling in irregular features of the sea floor. It has gained popularity in the Visayas particularly in the provinces of Occidental Negros and Iloilo. The number of trawlers using these types of boards is increasing.

THE ECHO SOUNDER

The echo sounder (Fig. 8), commercially called fish finder, is an acoustical apparatus, the major component of which is the voice box, which is made of quarts, nickle or barium titanate. It is called a transducer (transmitter, oscilator or projector). When it is shocked with a strong electric current discharge it expands quickly for a short time, then, a pressure wave is transmitted through the water. When this happens the paper record (echo chart) is marked at one side with a "transmission mark". The pressure wave or sound wave travels downwards through the water at 1.5 m/sec. and is reflected from the sea bottom to the transducer. This is then fed on the pen of the recorder which turns at a constant speed.

Echo sounders were originally fitted to ships by fishermen to find fish. It is the fishermen's third eye — his underwater eye; it can provide invaluable information about the depth of water, the type of sea bottom and quantities of fish that are available. This apparatus has played a very important role in trawling in the irregular sea terrain of Western Visayan Sea. The malfunctioning of an electrical or mechanical component of the apparatus will totally disrupt the fishing operations.

The fish finder installed in M/V Lapu-Lapu has a 50 kilo Hertz transducer made of barium titanate having a beam angle of 42 x 22 degrees. It has a "White Line" circuit for discriminating fishes which are very close to the sea bed. This apparatus is also provided with sensitivity time control circuit to filter sea noise interference, so that fish shoals swimming beneath the water surface can be clearly recorded.

FISHING OPERATION

The writer conducted a total of 11 drags, four of which were crisscrossing each other, and the rest were operated on a scattered pattern at varying depths and different lengths of dragging time. (Table II).

The operation of trawl on irregular sea bottom features require advance information of the sea bottom before any dragging attempt to avoid miscalculation in setting the net on plateau or seamounts or any rugged and irregular sea bottom. The writer allowed the vessel to conduct a preliminary echo sounding run over the area to collect the necessary information on the depth of the water, bottom topography and detection of fishes above or close to the seabed. The echo sounding data reflected in the echogram was studied and analyzed to determine whether the area was favorable for setting the net.

If the condition of the sea bottom favorably warranted the setting of the net, the fishing operation should be undertaken. The dragging time was not uniform because the area of the irregular bottom or seamounts was sometimes not long and wide enough to allow a longer period of dragging. Another factor maybe was that the very steep bank of the seamount would likely endanger the net if it hit the sharp

TABLE II. Showing the trawling position, depth and length of dragging time in each operation.

OPERATION NO.	TRAWL TYPE	TIME (HRS.)		POSITION		TRAWLING DEPTH (m)	TOTAL DRAGGING TIME (HRS.)
		SET	HAULING	SETTING	HAULING		
I	Sputnik trawl	0730	1030	11°43'00" N 122°46'00" E	11°48'30" N 122°51'00" E	36	3 hrs.
II	Sputnik trawl	0900	1220	11°41' 00" N 123°02'00" E	11°48'00" N 123°11'00" E	70	3 hrs. 20 min.
III	Sputnik trawl	1340	1715	11°42'30" N 123°12'00" E	11°44'00" N 123°15'00" E	70	3 hrs. 35 min.
IV	Sputnik trawl	0630	0835	11°41'00" N 123°21 00" E	11°33'00" N 123°25'00" E	20	2 hrs. 15 min.
V	Sputnik trawl	1335	1750	11°28'00" N 123°19'00" E	11°38'00" N 123°03'15" E	25	2 hrs. 15 min.
VI	Sputnik trawl	0635	0800	11°45'00" N 123°23'00" E	11°54'03" N 123°26'00" E	36	1 hr. 25 min.
VII	English trawl	0830	1030	11°52'00" N 123°25'00" E	11°48'00" N 123°26'00" E	30	2 hrs.
VIII	English trawl	1045	1450	11°50'00" N 123°30'00" E	11°42'00" N 123°27'00" E	80	4 hrs. 5 min.
IX	English trawl	1520	1630	11°44'15" N 123°36'00" E	11°47'05" N 123°40'06" E	80	1 hr. 10 min.
X	English trawl	0650	0845	11°46'00" N 123°31'00" E	11°47'00" N 123°41'00" E	70	1 hr. 55 min.
XI	English trawl	1000	1245	11°42'00" N 123°46'00" E	11°43'00" N 123°40'00" E	25	2 hrs. 45 min.

TABLE IV. Showing the weight in kilograms and percentage ratio of fish catch composition according to commercial classification and market value.

Market Value	Commercial Classification	Catch (Kg)	Catch Percentage
Expensive	First class assorted big-sized fishes	482.0	23.68
Expensive	Second class assorted medium-sized fishes	65.5	3.15
Expensive	Squids	33.0	1.61
Less Expensive	Third class assorted medium-sized fishes	258.5	12.53
Cheaf	Small slipmouth fishes	974.0	47.56
Cheaf	Lower class medium and small-sized fishes	196.0	9.58
Cheaf	Small ray fishes	3.0	.14
No value	Trash fishes	36.0	1.75
TOTAL		2,048.0	100%

mining the marketing values of the fish catch, the author reassorted each species by size group.

ECHO SOUNDING RESULTS

For purposes of uniformity, the sensitivity knob of the fish finder was constantly maintained at 5-degree gain count throughout the operations. The white line indicator knob remained in the "on" position throughout the operation, so that any trace of echo close to the seabed margin could be differentiated from each other by the white line effect. The draft of the vessel was added to the echo sounding depth to obtain the true depth of the area. The engine revolution was maintained at 270 R.P.M. in every dragging operation.

The topography of the area 6 miles off (northwest) of Olutaya Island up to 3.5 miles (southwest) off Elcano Shoal is shown in Figure 9. The depth of the area ranged from 45 to 53 meters towards the direction southwest off Elcano Shoal.

In this operation, the trawl net was set on a higher elevated area and gradually dragged down to a flat bottom 42 meters deep. The wider trace and the narrower trace are among the distinctive characteristics in this recording. It will be noted that the echo trace is wider on the higher ground and gradually became narrower until the vessel passes over the flat ground. This is due to the transmission of sound waves that hits rough or rocky bottom, and causes the echo reflection to produce a wider echo trace. If the transmission of sound waves strikes on soft or muddy bottom, the echo reflection is weak, therefore, a narrower echo trace is produced. In general, hard bottom seabed topography are indicated by wide traces, while the soft or muddy bottom topography are indicated by narrow traces.

About 5 meters below the water surface is a long continuous echo trace presumed to be minute organisms swimming down to 33 meters deep. The swimming behaviour of these organisms indicate their vertical migration movement from the seabed to the subsurface level and vice versa. Two groups of dense echo trace presumed to be small compact fish shoal with a tendency to rise is visibly close to the seabed. To the left and right side of the two dense echo traces are light dense echo traces which are presumed to be scattering groups of small fishes close to the seabed.

After three hours of dragging, the net was hauled. The catch was composed of small and medium-sized slipmouths with a total weight of 420 kilograms.

Fig. 10 shows the bottom topography four miles off northeast of Zapato Minor Island up to four miles southeast off Jintotolo Island. The echo sounding of the area at a point latitude 11°41'00" north and longitude 123°02'00" east ranges from 63 meters to 58 meters deep. It becomes shallower toward the direction southeast off Jintotolo Island. From 58 meters deep, a rough and hilly elevation of varied height was encountered by the net until it was hauled at a point latitude 11°48'00" north and longitude 123°11'00" east four miles off southeast of Jintotolo Island.

The echogram of the seabed was characterized by soft sandy bottom as indicated by the narrow uniform dark traces while the traces of the hilly-rough elevation was rocky and covered by soft coral as indicated by the numerous soft coral specimen gathered by the net.

A continuous layer of echo traces of varying denseness below 8 meters from the surface were presumed to be scattered small fishes. Echo traces close to the seabed and in the mid-water level also differed in denseness which indicated the scattering behaviour. The groups of dense echo traces are probably the echo of bigger sized fishes.

The catch yield are big red snappers, parrot fishes, groupers and big cuttlefishes. However, the dominant catch was composed of small-sized species of *nemipterus caranx* and *priacauthus* totalling 70.5 kilograms.

Fig. 11 shows the echogram of the seabed 4.3 miles off Southeast of Jintotolo Island toward a direction eight miles off Northwest of Gigantes Island. The setting of the net started from the deeper area of 68 meters deep and dragged up againt the gradual slope. The depth decreased as the vessel approached 26 meters high seamount whose flat top was 18 meters below the water surface. It was interesting to note that the bobbin rigged trawl net successfully passed over the plateau of the seamount without damaging the net.

The topography of the seabed is differentiated by four types of bottom features, namely; soft sandy bottom area, hard sandy rough bottom area, a rocky irregular bottom and a seamount. The top of the seamount was partly rough, probably rocky as indicated by wide traces similar to rocky irregular bottom. The area on the left of the echogram was a rough bottom probably composed of hard sand as indicated by the echo trace of the seabed margin. On the right side of the seamount was a gentle flat ground whose soft sandy seabed margin was characterized by a narrower echo trace which was very distinct from other echo traces in the echogram.

Echo trace layers of varied denseness were horizontally scattered 7 meters below the water surface down to the mid-water level. The echo traces recorded were presumed to be small fishes. A small dense echo trace spot very close to the seabed was visible to the left and farther right side of the seamount.

When the net was hauled, the catch was composed of big and small-sized groupers, parrot fishes, snappers, etc. Other fishes caught were slipmouths, nemipterids, squids, cuttlefishes, drepanes, etc. The total catch weighed 210 kilograms.

The seabed topography two miles northeast off Gigantes Island toward a point four miles East off Gigantes Island is shown in Fig. 12.

The average depth on the area was about 28 meters. The echogram showed a very rough bottom and irregular features which were covered by a large quantity of soft corals gathered by the trawl net.

It was deduced from the echogram that the uniform wide trace throughout the area strongly demonstrated that the transmission of sound waves as it hit rough or rocky bottom reverberated with strong echo reflections to produce thicker echo trace of the seabed. Otherwise, the echo trace would have been narrower if the transmission of sound waves were weaker to produce a thinner trace. The second or third echo might have been recorded from the bottom when echo sounding was conducted in shallow waters as shown in this echogram. This was the case because in shallow waters, the sound waves after having been reflected from the bottom back to the vessel, were reflected down again by the sea surface, thus, producing a second or third echo.

The dense trace believed to be tiny swimming animals seemed to be equally distributed on the summit of the seamounts. When the net was hauled the total weight of fish caught was 229.5 kilograms. Parrot fishes dominated the catch with 111.0 kg followed by trigger fishes, drepane, groupers, and the rest, assorted fishes.

Figure 13 shows the seabed topography 3 miles northwest off Sicogon Island toward a direction 9 miles southwest off Gigantes Island. The water depth was about 15 meters when the net was set on top of the seamount. The elevation sloped gradually to a soft bottom area 28 meters deep then gradually rising up to an elevation of about 15 meters deep from the surface. The shallowest depth in the area was 5 meters. From this depth, the elevation sloped abruptly toward a couple of low-elevated features characterized by rough bottom.

The thick echo trace of the seabed margin and the second echo registered below the seabed showed that the area was rough. The irregularity of the bottom indicated the characteristic of the ground. On the top of the seamount where the net was set, the echo trace seemed to adhere to each other closely to the seabed. On the other hand, the numerous spots of echo traces visible on the rugged or rough area which were dense, either singly or in groups, were perhaps fish echo traces which seemed to be active and going up.

When the net was hauled, the dominant catch were slipmouth, therapon, parrot fishes, groupers, and snappers. The total weight of fish caught was 232.0 kilograms.

The seabed topogrophy of an area 12 miles northeast off Gigantes Island toward a point 7 miles off northeast of North Gigantes Island is shown in Fig. 14. The depth of the area was about 58 to 78 meters. The seabed was somewhat rough but mostly covered by sticky mud or hard sand as indicated by the echo trace thickness and the scattered second echo reflection.

Six meters below the surface was a scattering layer of echo traces of varied densities which are most probably associated with plankton animals, while the scattered echo traces discriminated by the white line effect were small animals, perhaps fishes swimming in small groups above the seabed.

When the net was hauled, the catch was composed of slipmouth, small groupers, sea catfishes, sea bass, etc. The total weight of fishes caught was 108.5 kilograms.

Fig. 15 shows an inclined bottom topography 13 miles north of Gigantes Island toward a direction 9 miles off north of Gigantes Island. The net was set at 33 meters deep and dragged down to a depth of about 63 meters. The seabed was a hard sandy ground indicated by the uniform thickness of the trace in the entire area. The reflection of a second echo throughout the entire area indicated

its characteristic of a common trawling ground in spite of the inclination. In fact, a couple of trawlers were fishing in the vicinity.

On the left side of the echogram were several plumshape echoes in midwater which were probably echo traces of big fishes. A dense echo trace on the bottom was probably a large fish shoal trace with a tendency to rise from the seabed.

On the right side of the echo chart were small traces close to the seabed which were believed to be small fishes with a tendency to rise from the bottom as indicated by the echo trace recorded from the mid-water layer.

When the net was hauled, the catch was composed of slipmouths, parrot fishes, rays and shark fishes, groupers, red snappers, rastrelliger, lizard fishes, etc. The total weight of the catch was 285.5 kilograms.

DISCUSSION AND COMMENT

1. The oval-shaped board rigged to the Sputnik and Granton trawl net had a relative advantage over the ordinary trawl board with semi-square-shaped edge for being dangerously free to foul out in hard irregular sea bottom. The oval-shaped board could easily slip in and hurdle out of any irregular terrain of the seabed with less danger of fouling out because of its oval-shaped edge. Observations showed that the oval-shaped otter boards did not foul out in any single operation during the exploration period and therefore, it can be concluded that it is the most appropriate otter board for rigging with any design of trawl net intended for trawling in rough and rugged sea bottom.

Two types of trawl nets in this fishing experiment were used to find the adaptability of bobbin and oval-shaped boards for each type of trawling on irregular bottom under Philippine conditions.

2. The two types of trawl nets used in the exploration were too large, and the netting materials used in this operation was expensive. The author plans to design a smaller net using cheaper netting materials for future exploration of other areas. Observations also showed that there were new abrasion marks of the nettings particularly in the lower belly and the cod end every time the net was hauled. This was due to dragging friction between the lower belly and the rough seabed. The lower belly and cod end of the net which could be openly damaged due to friction, can perhaps, be

shielded by a mat-shaped leather or rubber material to protect the meshes from raked up corals and other protruding objects on the seabed. The protecting leather or rubber material would be able to facilitate smooth dragging while the net is being pulled by the vessel.

3. The echo sounder cannot be ignored in the operation because it is the underwater eye of the fishermen. Without the echo sounder, it will be a hit-or-miss operation. In general, the efficiency of fishing operation under these conditions does not depend on the oval-shaped design of otter boards alone; or the rolling bobbins accessories, much less on the design and construction of the trawl net. The accuracy of the operation depends more on the echogram produced by the echo sounder which gives advance information on the conditions of the seabed to guide the fishermen before the trawl net is dragged in the area.

4. The echograms in some areas showed four relative distributions of echo traces namely: (a) 3 to 5 meters below the water surface; (b) mid-water level; (c) at 6 to 7 meters above the seabed. and (d) echo traces very close to the seabed. The author believes that the echoes that were registered at 6 to 7 meters above the seabed could not be covered by the vertical opening of the mouth of either type of trawl net because the mouth could not perhaps attain the maximum height of more than six meters due to variation of the dragging speed of the vessel and the rough and irregular terrain of the ground, otherwise, each haul per drag would have increased or even doubled the catch.

The author believed that better and clearer echogram of the bottom could have been recorded if the transducer of the echo sounder was 7° to 12° beam angle compared to the transducer used in this exploration which had a 22° beam angle.

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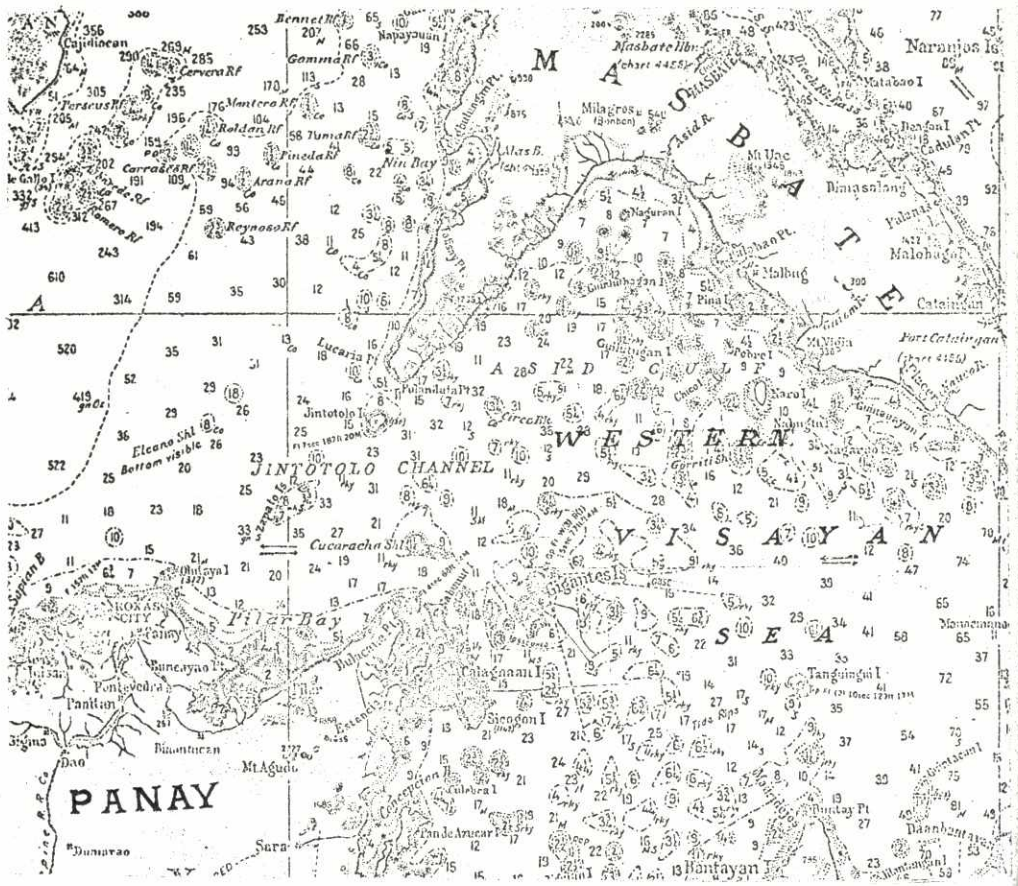

Fig. 1. The chart of Western Visayan Sea fishing grounds.

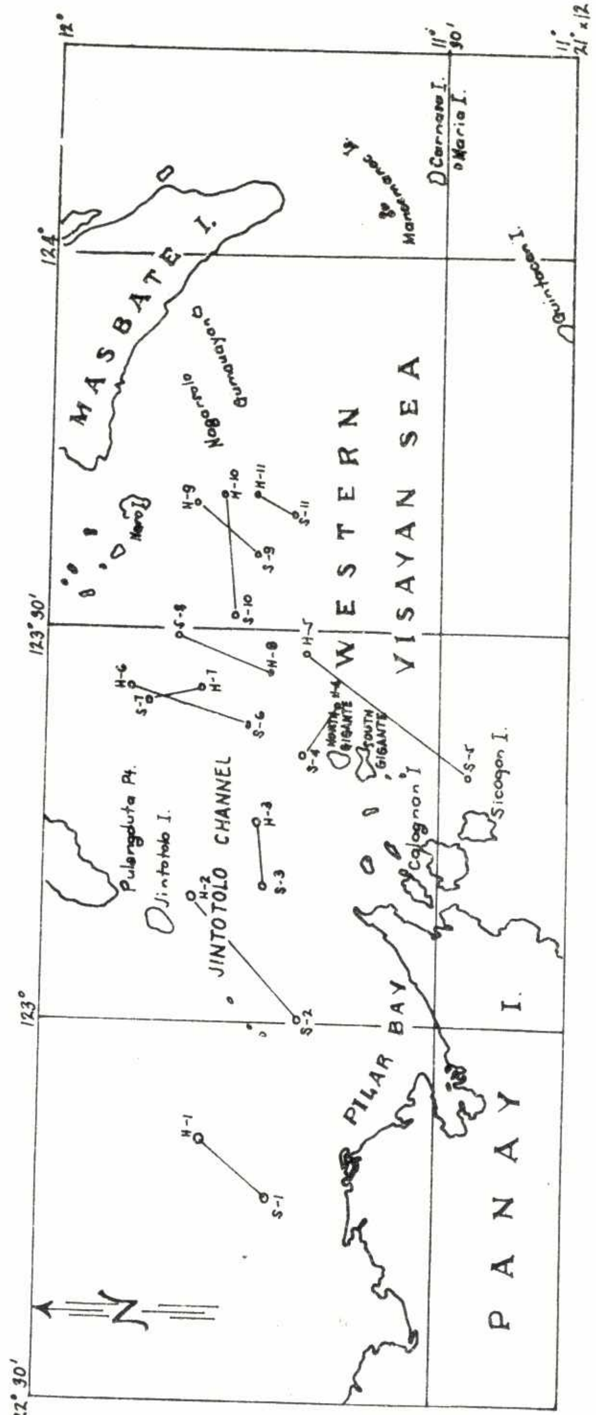

Fig. 2. Showing the areas of Western Visayan Sea where M/V Lapu-Lapu conducted the trawling operations.

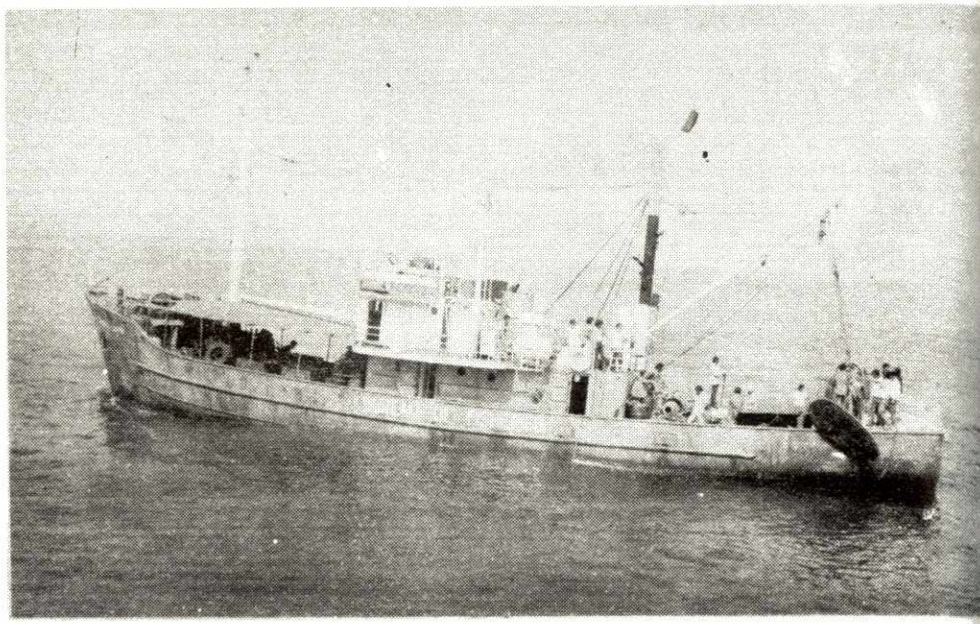

Fig. 3. M/V Lapu-Lapu (Trawler).

PARTICULARS:

Over-all length	30.80 meters
Length between perpendiculars	27.00 meters
Draft	2.50 meters
Gross Tonnage	139.58 T
Net Tonnage	60.40 T
Main Engine	450 H.P. (Matsui) diesel
Auxiliary	45 H.P. (Yanmar) diesel
Generating Set	32 KVA
Refrigerating Unit	10 Tons (Genesa Canpressor)
Fish hold capacity	64.53 cubic meters
Freshwater tank capacity	7.83 cubic meters
Fuel Oil tank capacity	46.60 cubic meters
Trial speed	10.60 knots
Service speed	9.00 knots

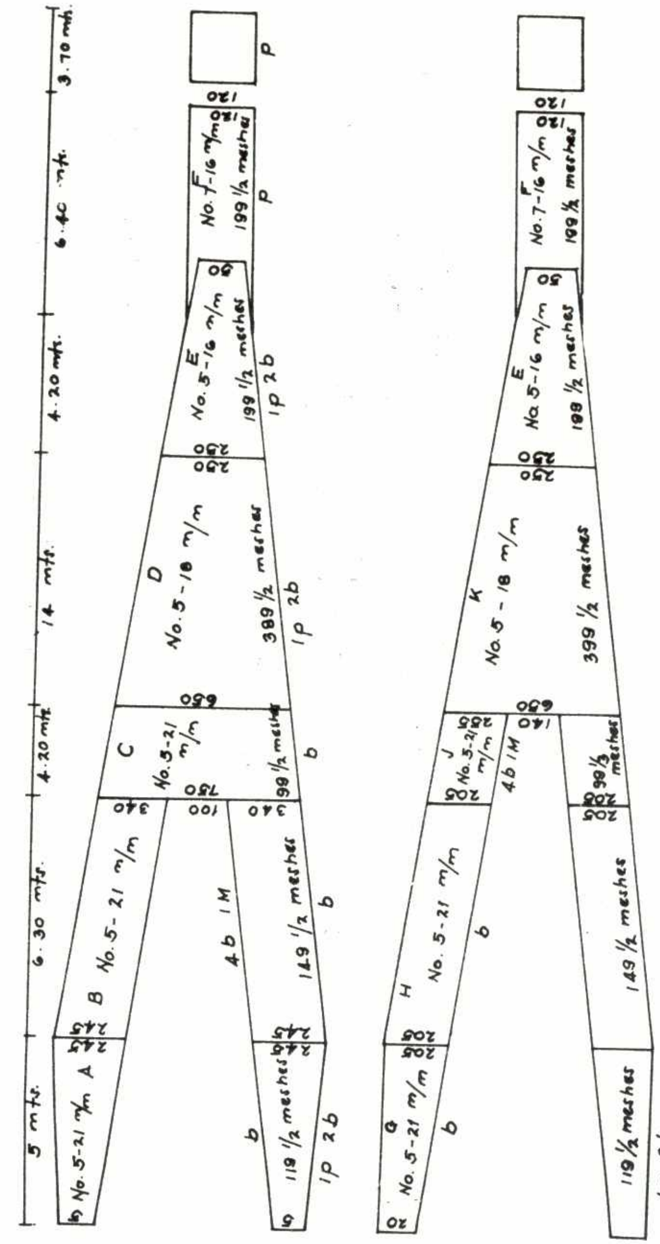

Fig. 4. Design and specifications of Sputnik type trawl net.

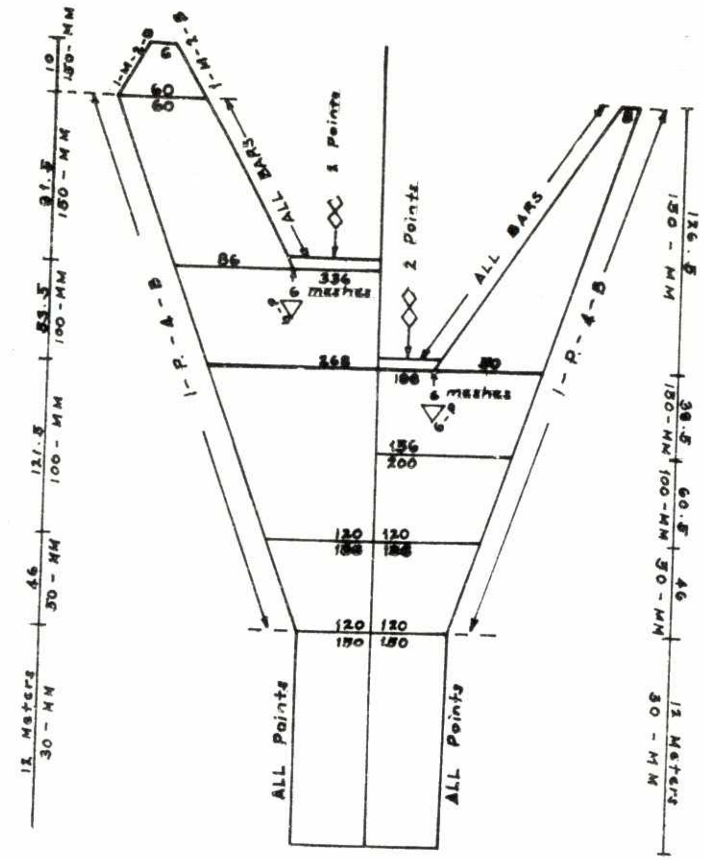

Fig. 5. Design and specifications of Granton trawl net.

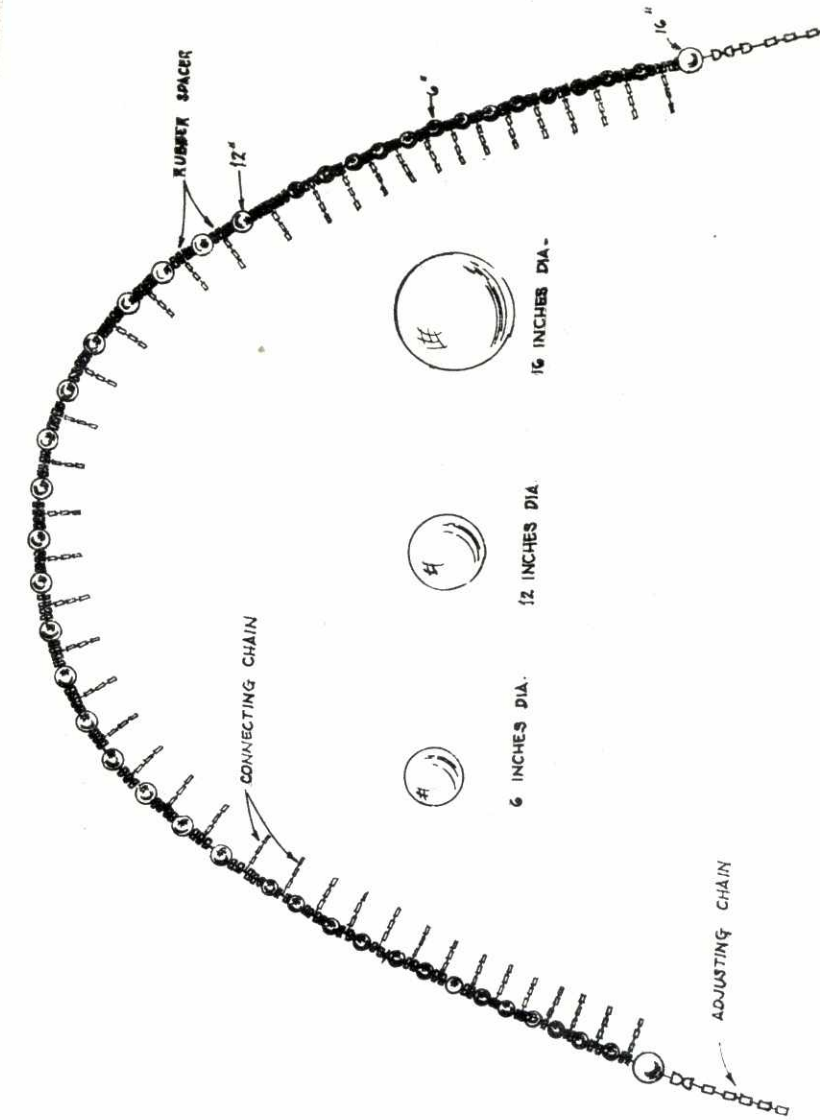

Fig. 6. The plastic bobbins assembly.

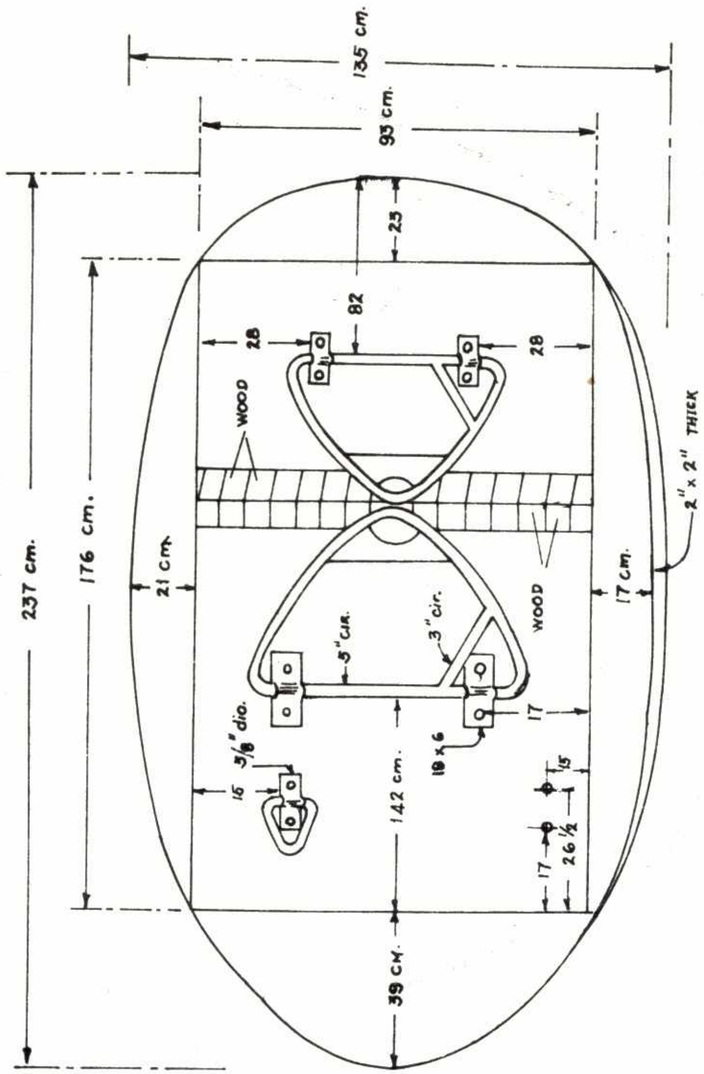

Fig. 7. A diagramatic drawing of the oval-shaped otter board used by M/V Lapu-Lapu in the Western Visayan Sea.

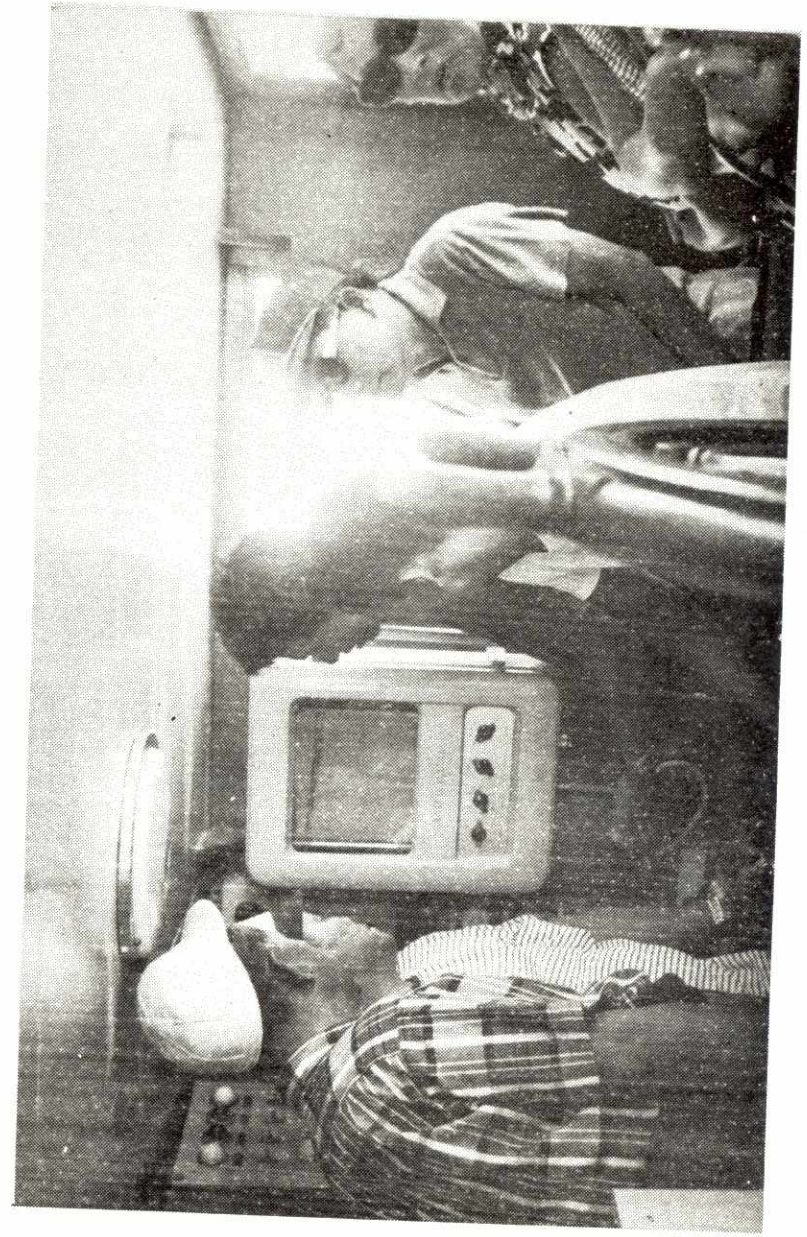

Fig. 8. A 50 Kc/s echo sounder used by the writer in Western Visayan Sea trawling operations.

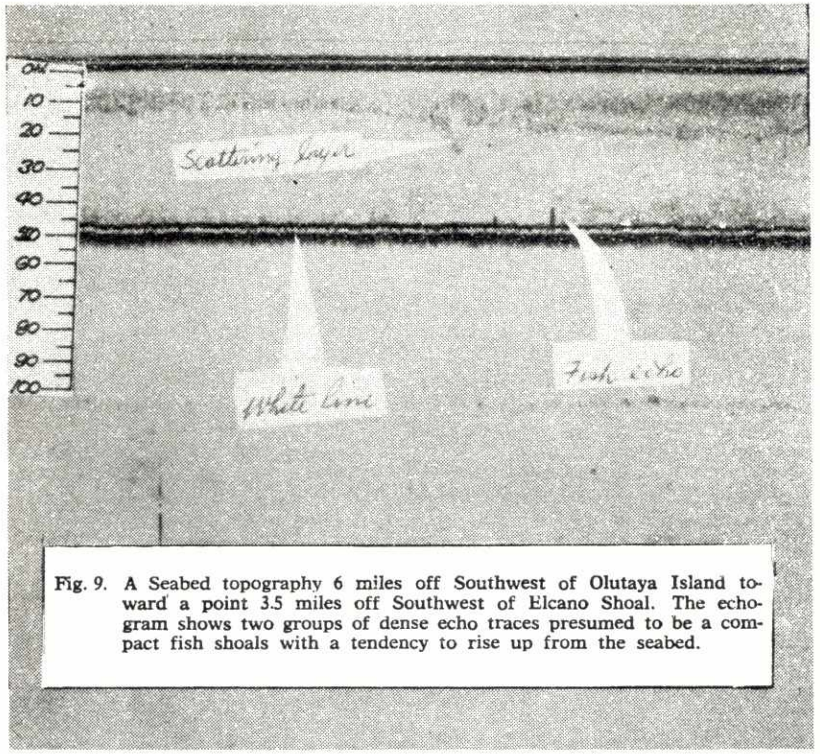

Fig. 9. A Seabed topography 6 miles off Southwest of Olutaya Island toward a point 3.5 miles off Southwest of Elcano Shoal. The echogram shows two groups of dense echo traces presumed to be a compact fish shoals with a tendency to rise up from the seabed.

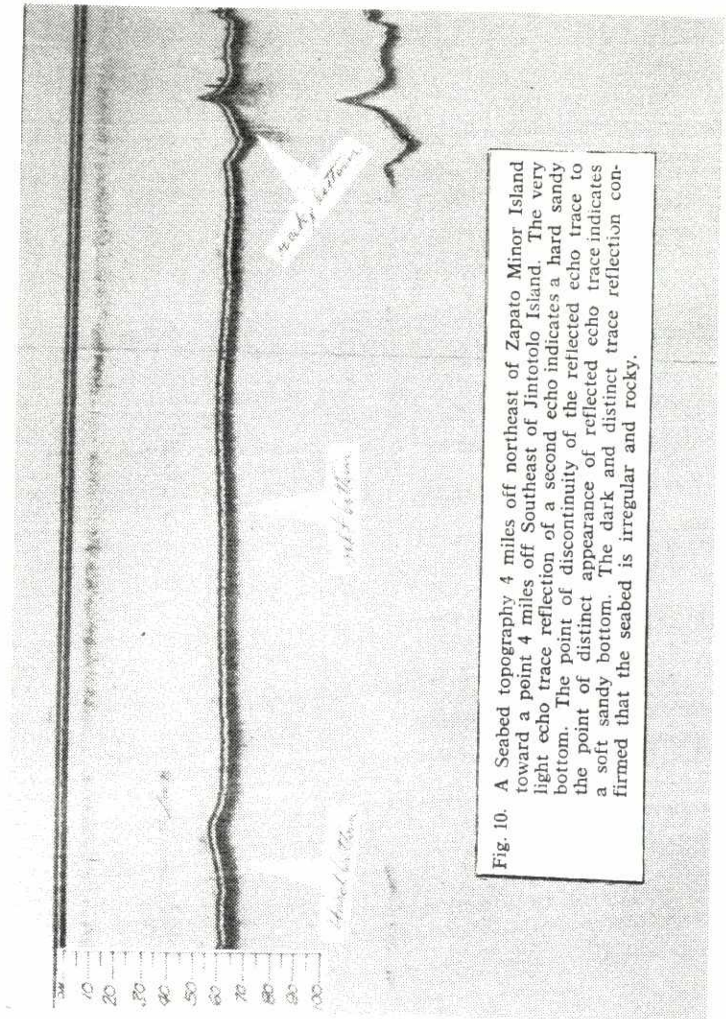

Fig. 10. A Seabed topography 4 miles off northeast of Zapato Minor Island toward a point 4 miles off Southeast of Jintotolo Island. The very light echo trace reflection of a second echo indicates a hard sandy bottom. The point of discontinuity of the reflected echo trace to the point of distinct appearance of reflected echo trace indicates a soft sandy bottom. The dark and distinct trace reflection confirmed that the seabed is irregular and rocky.

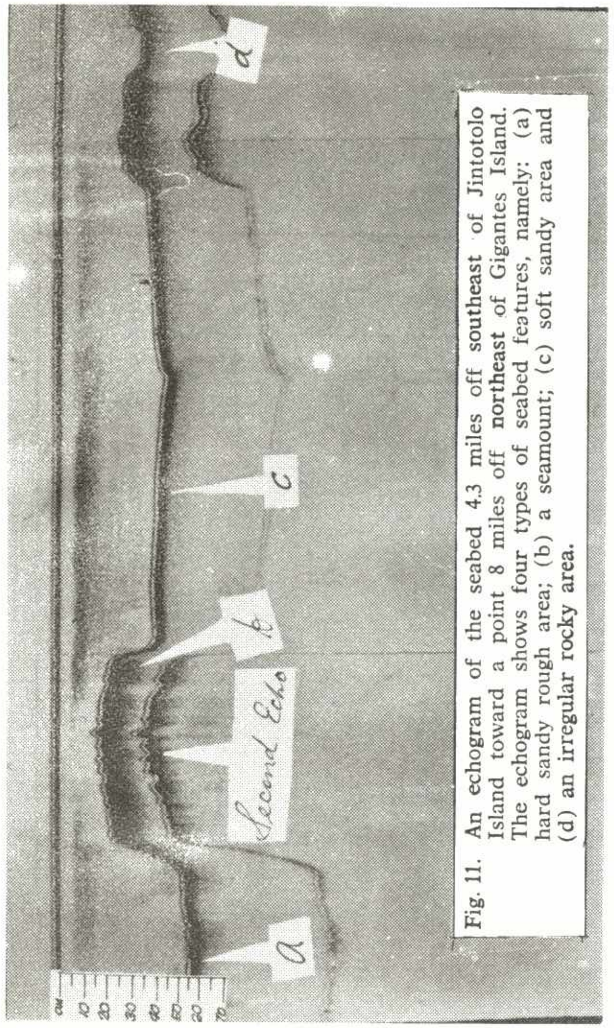

Fig. 11. An echogram of the seabed 4.3 miles off **southeast** of Jintotolo Island toward a point 8 miles off **northeast** of Gigantes Island. The echogram shows four types of seabed features, namely: (a) hard sandy rough area; (b) a seamount; (c) soft sandy area and (d) an **irregular rocky area.**

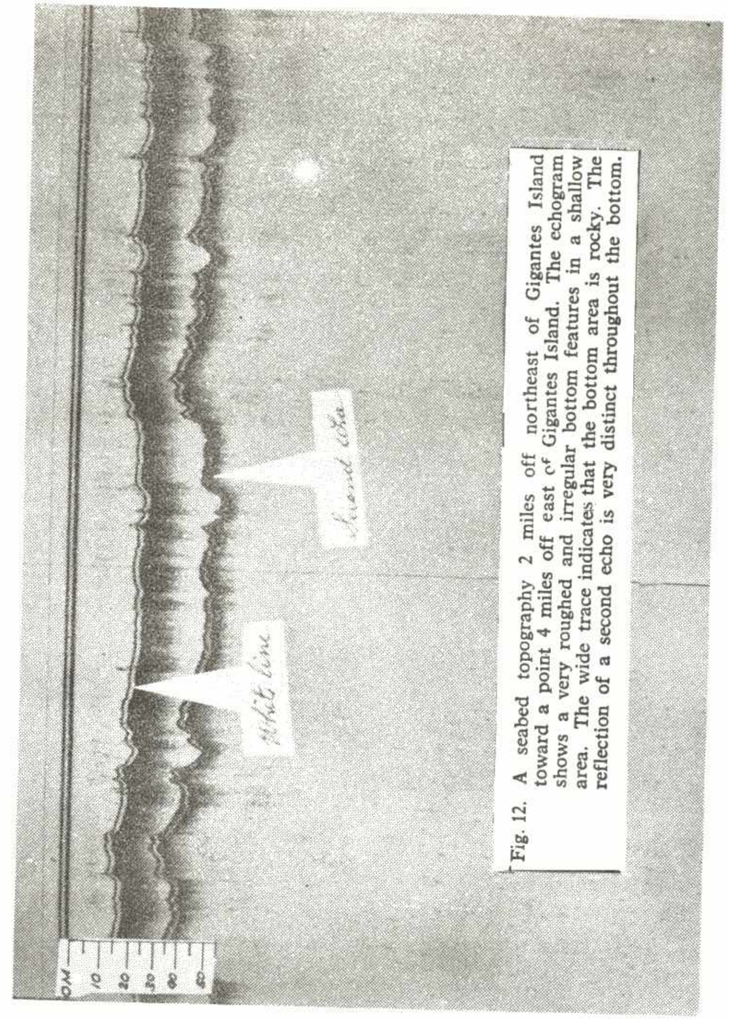

Fig. 12. A seabed topography 2 miles off northeast of Gigantes Island toward a point 4 miles off east of Gigantes Island. The echogram shows a very roughed and irregular bottom features in a shallow area. The wide trace indicates that the bottom area is rocky. The reflection of a second echo is very distinct throughout the bottom.

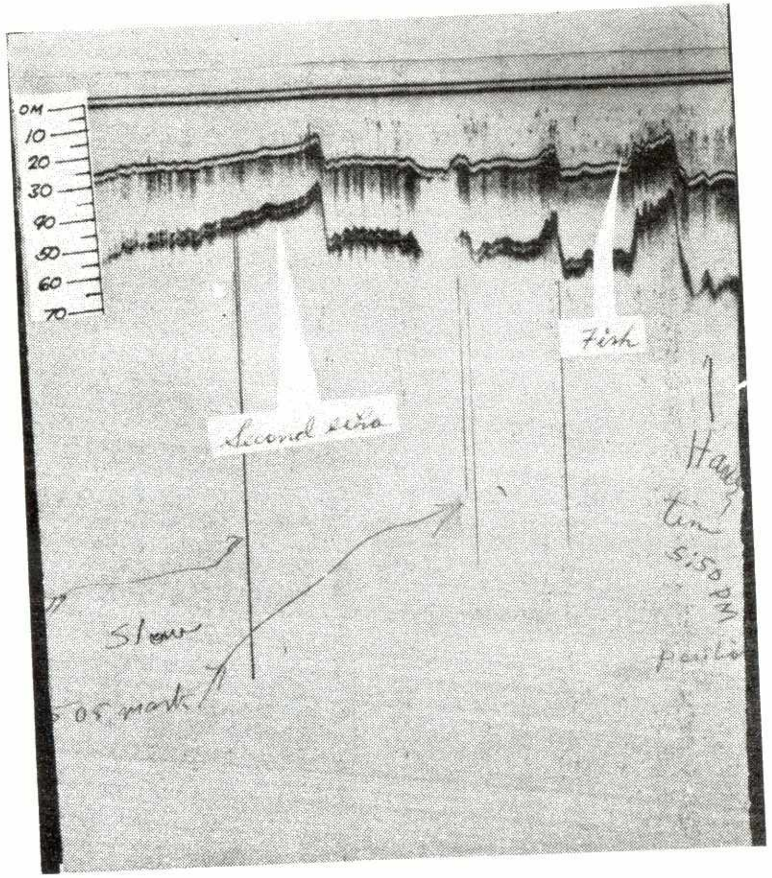

Fig. 13. A seabed topography 3 miles off northeast of Sicogon Island toward a point 9 miles off southeast off Gigantes Island. The echogram shows a roughed irregular bottom. The dark spots of echo traces presumed to be fish are visible in the entire irregular bottom.

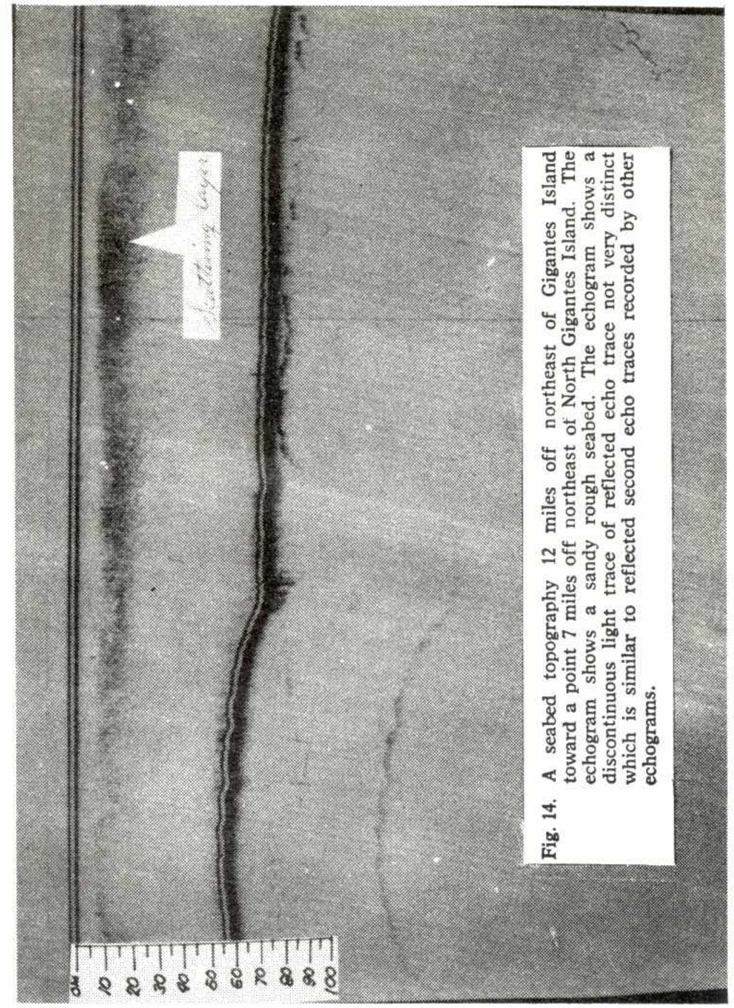

Fig. 14. A seabed topography 12 miles off northeast of Gigantes Island toward a point 7 miles off northeast of North Gigantes Island. The echogram shows a sandy rough seabed. The echogram shows a discontinuous light trace of reflected echo trace not very distinct which is similar to reflected second echo traces recorded by other echograms.

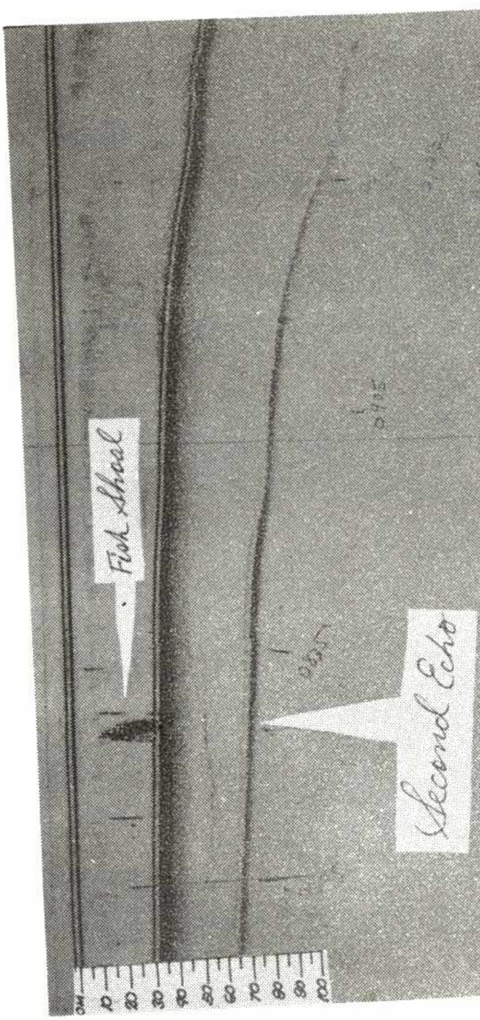

Fig. 15. An inclined bottom topography 13 miles off North of Gigantes Island toward a point 9 miles off North of Gigantes Island. The reflection of a second echo in the entire bottom area indicates the characteristic of a hard sandy bottom. The long plume trace are individual fish. The dense spots of echo traces on the seabed is probably a fish shoal with a tendency to rise up.