Location by color echosounder of Reef-building on the Asturian Continental slope (NW Spain)

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Abstract: Over the past ten years, researches on Cold-waters coral reefs revealed a wide distribution in areas of the continental shelf and slope and discovered their important role in marine ecosystems which sustain part of the commercial fisheries. After two campaigns of researching and prospecting in deep water fishing off the coast of Asturias (NW Spain), the high power fishing echosounders were very useful to detect coral structures. The analysis of performed transects, correlating acoustic sections and samples obtained, allows a progress in the characterization of buildings made by coral reef species *Lophelia pertusa* (Linnaeus, 1758) and *Madrepora oculata* (Linnaeus, 1758) as well as in the study of distribution according to the seabed types and the depth of the base substratum.

Keywords: Prospecting with high resolution echosounder, Cold-waters coral reefs, Lophelia, continental shelf and slope, North-East Atlantic sea, Bay of Biscay, Asturias.

Resumen: A lo largo de los últimos diez años las investigaciones orientadas al estudio de arrecifes de coral de aguas frías están revelando una amplia distribución en zonas de la plataforma y talud continental a la vez que descubriendo un papel relevante en los ecosistemas marinos sobre los que se sustentan parte de las pesquerías de interés comercial. Como resultado de la realización de dos campañas de investigación y prospección pesquera en aguas profundas frente a las costas del Principado de Asturias (NO de España), se mostró muy válida la utilización de sondas pesqueras de alta potencia para la detección de construcciones coralinas. El análisis de los transectos realizados, correlacionando secciones acústicas y muestras obtenidas, permite avanzar en la caracterización de edificios coralinos construidos por corales de la especie *Lophelia pertusa* (Linnaeus, 1758) y *Madrepora oculata* (Linnaeus, 1758), así como en el estudio de su distribución de acuerdo con los tipos de fondo y la profundidad del sustrato que utilizan como soporte.

Palabras clave: Prospección con sonda de alta resolución, arrecifes de coral de aguas frías, Lophelia, plataforma y talud continental, Atlántico nororiental, Golfo de Vizcaya, Asturias.

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1. INTRODUCTION

Between August 2000 and May 2001 two campaigns were done in deep water exploration financed by the GD of Fisheries of the Government of Asturias. Its purpose was to study the spatial distribution, the fishing potential, the environmental issues and the sustainability of the fishery for crustaceans of commercial interest. These surveys were systematically distributed in the outer edge of the continental shelf of Asturias (from the 200 m isobath) and the upper continental slope to depths of 1,500 m (Fig. 1).

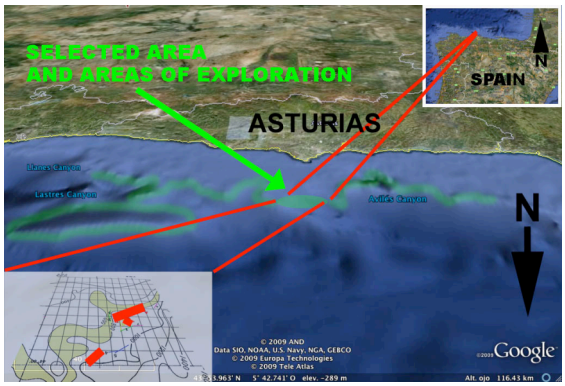

Fig. 1. Location of work area and selected area

A total of 49 study areas were set, whose result was the lifting of over 80 km of profiles with video echosounder. Experimental fishing of target species as well as sampling of fauna and sediment were made. As a result, Cold-water coral was found, consisting of *Lophelia pertusa* (Linnaeus, 1758) and *Madrepora oculata* (Linnaeus, 1758). Samples of coral were obtained in more than 57% of the areas. A significant portion of them can be assigned to the "Lophelia reef biotope" (ICES, 2005), (Murray Roberts *et al*., 2009). The present report describes three significant profiles with different distributions and morphologies of coral buildings, many of them with signs of being affected by fishery (Wilkinson, 2008).

1.1 Equipment used

1.1.a Positioning and Navigation

For positioning and navigation a GPS Compass SILVA ®, XL model 1000 was used, equipped with PLOTTER SILVA- NAVIMAP centering with S / A, located in the fishing boat "Virgen de las Mareas" of Avilés of 19.28 GT and 14. 5 m in long.

1.1.b Background noise recognition

The vessel was equipped with a fishing echosounder color video FURUNO FCV-1500M®

of 15/200 kHz with a 3 kW transducer. This is a dual frequency echosounder that was very reliable to determine accurately the depth sampling and the location of coral structures.

1.1.c Sampling through experimental fishing rig

The rig used for sampling lines is made up of 30 experimental metal framed traps and covered with a fish net mesh 1.5 cm wide. The traps are fixed to a main line by independent ropes, separated by 55 m. The fixing is in the middle of one transversal top edge, and when they are hoisted aboard they allow a sampling by bottom trawling whose section is 8.33 m^2. Some of them were equipped with devices for collecting samples of surface sediment. All samples were photographed, noting its position, date of collection and sampling number.

1.2 Storage and processing of information from the video echosounder.

Acoustic profiles of the performed transects were recorded by using a high resolution video card. The most significant sound images were captured from the video, dated and filed for later processing. They were eventually treated by the PhotoShop® program in RGB mode and TIF format.

1.3 Characteristics and interpretation of feedback signals from the video echosounder.

The video monitor echosounder shows a color bar indicating the relationship between echo intensity and color in sound-image. The ratio T / X was set to normal mode using the scales 20 to 1000 pulses / minute. It usually worked in dual frequency mode (Fig. 2).

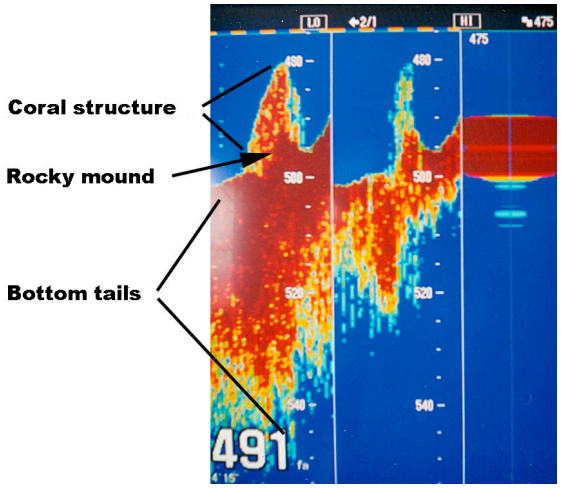

Fig. 2. False-color acoustic profile of low and high frequency (left and center respectively) and signal synthesizer A-Scope (right) of the echo sounder Furuno FCV 1500M. Vertical scale in fathoms

The nature of the bottom was estimated from the high-low frequency contrast, the echo strength (color display), the length of its tail and the signal synthesizer.

1.3.a Color

According to the monitor scale of colors, strong shades (brown-red) (high-strength acoustic returns) were assigned to "hard bottoms" equivalent to rocky outcrops, and weak colors (green and light blue) were assigned, made exceptions, to "soft bottoms" equivalent to outcrops of sand, silt (mud) or clay.

1.3.b Tail

The previous signal was contrasted with the "bottom discrimination mode," meaning "hard bottom" when the bottom tail was long and "soft bottom" when the tail was short. When the tail was short and the color remained brown, it meant the bottom consisted of coarser or more compact sediments.

1.3.c "A-scope" function

The signal synthesizing was always displayed on the monitor. This function generates a histogram of the instant echoes of each transmission, with the color and range proportional to their intensities. It was very useful to discriminate small thicknesses of sedimentary material like sand, silt (mud) or clay resting on "hard bottoms." The coral buildings show a special "texture" on the monitor of the video echosounder, corresponding to a typical structure of thickets of intertwined branches. They show intermediate shades of colors (orange and yellow) on the inner part of the sound-image, and weaker shades (green and light blue) on the edges. The signal indicates a "fuzzy" (diffuse acoustic strength) (Sulak *et al*., 2008) in contrast with the false strong color of the underlying rock, which indicates a high-strength acoustic return (Fig. 2). This texture is better determined in the low frequency mode (<50 kHz) and long pulses (10.0 ms).

2. GEOGRAPHICAL LOCATION OF THE SELECTED AREA

To describe the morphology and distribution of some significant coral structures three profiles have been selected, located in one of the prospected areas situated 17 NM N of "Cabo Peñas" (NW Spain). This area covers part of the fishing ground called "Caño de La Gaviera" and the western end of the fishing ground called "El Agudo de Tierra" (Fig. 1). Both fishing grounds, located on the upper continental slope of Asturias, are at the head of an underwater valley located on the East of the Avilés Canyon. From the isobaths -200 m to about -1500 m, the submarine valley has a N-S orientation, turning to NW from this depth on (Fig. 1). The northeast boundary of the area shows a very steep topography, where the fishing grounds "El Agudo de Tierra" are located. The described profiles (Fig. 3) are made with dynamic topography, but the time spent on lifting them does not interfere with the measurement of coral structures.

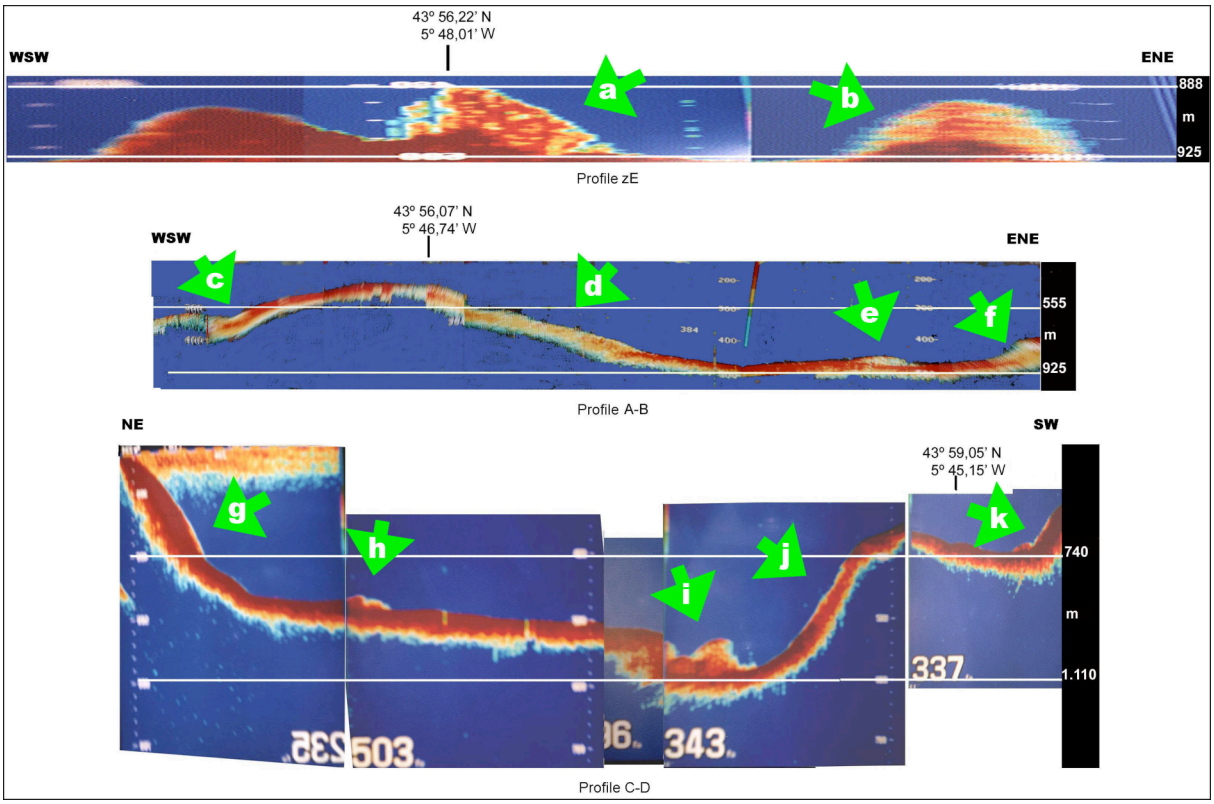

Fig. 3. Selected Profiles "zE", "A-B" and "C-D" and location of Reef-building. (Scales H = V)

2.1 Profile zE

Its length is 612 m, and it is performed in azimuth 60º (Azc) through position 43º 56.22' N / 5º 48.01' W (Fig. 3). At its WSW end a first rocky mound is located, whose coronation is about 898 m deep, protruding from the bottom 27 m regarding its west margin. The base of the mound in the traversed profile is more than 130 m. After crossing a small depression on a rocky bottom about 916 meters deep, the first reef construction appears (Fig. 4. "a" in Fig. 3) located on another rocky mound, and its coronation is about 888 m deep.

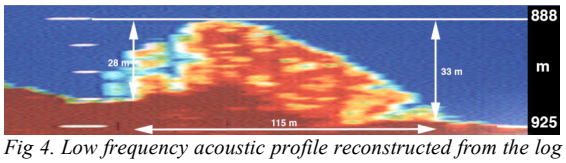

Fig 4. Low frequency acoustic profile reconstructed from the log scale in Figure 2. Details of the first coral formation ("a" in Figure 3) located in the Pefil zE. (ENE at right)

In the traversed section the construction has 115 m of horizontal development, 28 m high at its WSW front, which appears to be eroded (Wilkinson, 2008), and 33 m high at its ENE front, the latter having a uniform slope 20º inclination. The maximum vertical power in the coral formation has more than 24 m from the underlying hard rock. Following in the azimut 60º a second rocky depression is traversed, reaching about 925 m deep and consists of rocky outcrops with a small coating of sediment. Finally, there is a third rocky mound colonized by another coral structure ("b" in Fig. 3) 28 meters high at its WSW front, more than 31 meters at its ENE front and whose maximum thickness from its underlying bedrock is higher than 18 m. In the traversed section both slopes have a uniform slant of about 30º, giving a symmetrical profile.

2.2 Profile A-B

The second significant profile (Fig. 3) corresponds to a transect of more than 5 km long, starting near the axis of the submarine valley "Caño de La Gaviera" in azimuth 240° (Azc), and ending at about 740 m. deep. The route passes through the position 43° 56.07' N / 5º 46.74' W. Four coral buildings are located ("c","d","e" and "f" in Figure 3). Outstanding by its size is "d" (Fig. 5), placed forming a slope with an average gradient of 16°, a vertical drop of 370 m and a horizontal development in the cut section more than 1,100 m. In this case the video echosounder has failed to outline the bedrock where the coral building is placed.

2.3 Profile C-D

It was selected a third profile 2,037 m long (Fig. 3); path in azimuth 200° (Azc) that crosses position 43º 59.05' N / 5º 45.15' W. Its NE limit is the climb to "El Agudo de Tierra" and its SW limit ends on a “beach trawling”. In areas of the southwest steepest slope coral formations appear ("g" in Fig. 3). In the valley, with a more uniform topography between 920 and 930 m deep, there are more reef structures, more isolated in their distribution and attached to small protrusions on the bottom. The one named "h" in Fig. 3 is more than 35 m. high at its

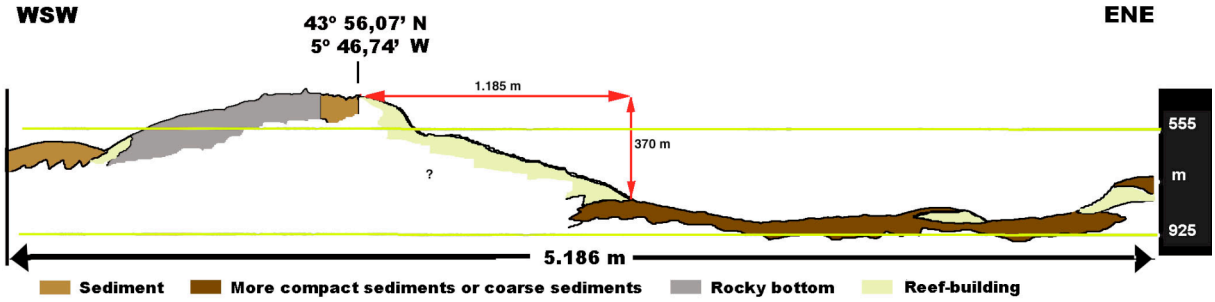

Fig. 5. Interpretation of profile A-B in Figure 3, of 5,186 m of travel

southwest margin. Near the foot of the first northeast slope there is a reef construction located in a groove ("i" in Fig. 3), whose height from the southwest margin (apparently eroded) exceeds 90 m, presenting a colonization base of over 300 m in the traversed section (Fig. 6).

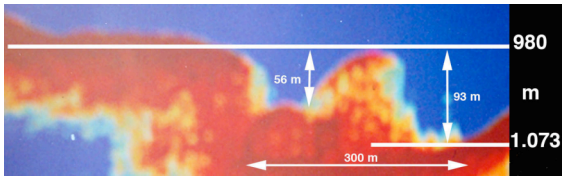

Fig. 6. Low frequency acoustic profile. Detail of the deeper coral formation ("i" in Figure 3) located in the C-D profile. (SW at right)

Following the aforementioned azimuth there is a new reef colonization area on a slope that rises to a second level of the valley. In its southwest end, at the foot of the second southwest slope, is the fifth colonization ("k" in Figure 3) probably gorgonacean, though it has not been sampled.

3. DISCUSSION

The assignations from the video echosounder records to bottom types and reef building coral were usually consistent with the obtained samples. Those ones corresponding to bioconstructors coral showed colonies in life position, sometimes alive and sometimes dead, and examples of silt-clay coated sediments have been detected. These coral samples are associated to a large number of sponges, bryozoans, hidroids, etc. and confirm the existence of important coral structures, mainly located on the rocky bottom and on the walls of slant slopes. It is remarkable, in the vicinity of some coral structures, the absence of colonization on rocky mound apparently suitable for this purpose. This is probably due to the erosive effects of different bottom-fishing nets used in the area. Minor coral constructions may exist, but they are difficult to detect with the echosounder in use. High-resolution geomorphological maps detailing the seabed between 1 and 10 m. as well as the study of oceanographic conditions are basic requirements for further progress in the study of Cold-waters coral reefs distribution. The study of the lateral distribution and mapping requires using other geophysical techniques, including Side-scan sonar combined with Multi-beam echosounder, visualization and direct sampling with AUV. In order to reverse the impact of industrial fishing, it is possible to use restoration techniques. They consist in implementing juvenile corals in artificial reef structures to re-colonize areas of special interest. (NOAA, 2001) (Fig. 7).

Fig. 7. Artificial reef structure for implementation of juvenile corals

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