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First observations of the structure and megafaunal community of a large *Lophelia* reef on the Ghanaian shelf (the Gulf of Guinea)

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ABSTRACT

The distribution of cold-water coral reefs is relatively well known in the North-east Atlantic as compared to the Central-east Atlantic, where only a few documentations exist from low latitudes. In 2012 an initial survey was conducted on a reef situated at 400 m depth on the continental shelf off Ghana. The reef corals and fauna were visually documented using a Video Assisted Multi Sampler (VAMS) coupled with an ROV. Here we present the results from three dives on the 1400 m long and 70 m high reef with an ambient temperatures between 9 and 10 °C. The banana shaped reef was oriented perpendicular to the main current, the convex side facing the current and there was no sign of human impact. The great height of the reef is probably a result of undisturbed growth for more than 20,000 years. On the Norwegian continental shelf the largest reefs are around 30 m high and have been aged to ~9000 years. The reef morphology resembles that of Northeast Atlantic *Lophelia* reefs. The main reef building coral was *Lophelia pertusa* with contribution from *Madrepora oculata*, *Solenosmilia variabilis,* and occasional occurrences of *Dendrophyllia* cf. *alternata*. The skeleton of *Aphrocallistes beatrix* (Hexactinellidae) contributed to the reef framework and the reef consisted of 46% coral blocks 22% sediment, 13% coral rubble, 11% sponge skeleton and 8% live corals.

A rich megafauna of 31 taxa was recorded and most frequent was *Acesta excavate* (bivalve), *Aphrocallistes beatrix* (with an associated Zooanthida on 39% of the colonies), squat lobsters, hydroids and bryozoans. Six fish species were recorded of which the Sebastidae *Helicolenus dactylopterus* and *Nettastoma melanurum* were found amongst coral blocks. The reef community showed several similarities with the northern reefs with sponges, *Sebastes* spp., squat lobsters, and *Acesta excavata* being common megafauna associates. In contrast the gorgonian corals that are characteristic of the northern reefs seemed to be lacking and Hexactinellidae rather than Demospongia were common on the reef and contributed to the reef framework. Crabs that are uncommon on northern reefs were frequently encountered.

1. Introduction

In the North-east Atlantic the distribution of cold-water corals is relatively well known compared with the Central-east Atlantic, and only a few documentations exist of cold-water coral from this area (LeGuilloux et al., 2009; Westphal et al., 2012). The coral reef on the Ghanaian continental shelf was discovered during multibeam bathymetric mapping with R/V Dr. Fridtjof Nansen in 2009. The survey was part of an environmental baseline study related to possible future development of offshore petroleum industry. The first survey of the reef was conducted in November 2012 in order to provide information on the reef structure and fauna It was undertaken with RV Dr Fridtjof Nansen using the Video Assisted Multi Sampler (VAMS). The survey was lead by the Institute of Marine Research (Norway) in co-operation with the Environmental Protection Agency of Ghana and the Food and Agriculture Organization of the United Nations (FAO) as part of the Ghanaian marine environmental monitoring (Serigstad et al., 2015).

Cold water coral reefs are recognized as biodiversity hotspots, providing a wide range of habitats for invertebrates and fish (Costello et al., 2005; Husebø et al., 2002; Jensen and Frederiksen, 1992; Mortensen and Fosså, 2006). These reefs are complex

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habitats constituted by coral colonies up to ca. 2 m high and fragments of dead skeleton with variable size and age (Mortensen et al., 1995; Mortensen and Fosså, 2006 Wilson, 1979). Habitats within the reefs can be defined at different spatial scales (Jonsson et al., 2004; Mortensen et al., 1995). At a broad scale a reef typically consists of three vertical zones, or reef habitats: (1) "The live coral-zone" (LC) typically occurs near the summit of the reef and consists of mainly living scleractinian colonies separated by areas with dead broken skeletons. (2) "The coral block-zone" (CB) is found between the top and the foot of the reef. The bottom here is characterised by large fragments of dead corals, and a high diversity of megafauna (Mortensen et al., 1995). (3) "The coral rubble-zone" (CR), has small skeletal fragments mixed with sediments flanking the foot of the reef. The horizontal extent of this zone varies from only a few metres to several tens of metres. The cold water coral reefs are also highly vulnerable to bottom fisheries (Fosså et al., 2002; Koslow et al., 2001), and protection areas have been established at various locations in the North Atlantic (Breeze and Fenton, 2007). In Norway, 18 coral reef areas have been protected pursuant to the Marine Resources Act (Norwegian Government, 2016) and one area to the Norwegian Nature Conservation Act (Norwegian Government, 2013).

Here we present the structure of the reef and the megafauna associated with the different reef habitats based on the video records from the ROV that is part of the VAMS. The results are compared with observations from *Lophelia* reefs on the Norwegian shelf that holds the largest number of reefs known in the North Atlantic (Buhl-Mortensen et al., 2015) and the few existing observations made by LeGuilloux et al. (2009) and Westphal et al. (2012) from coldwater coral remnants off Atlantic Africa.

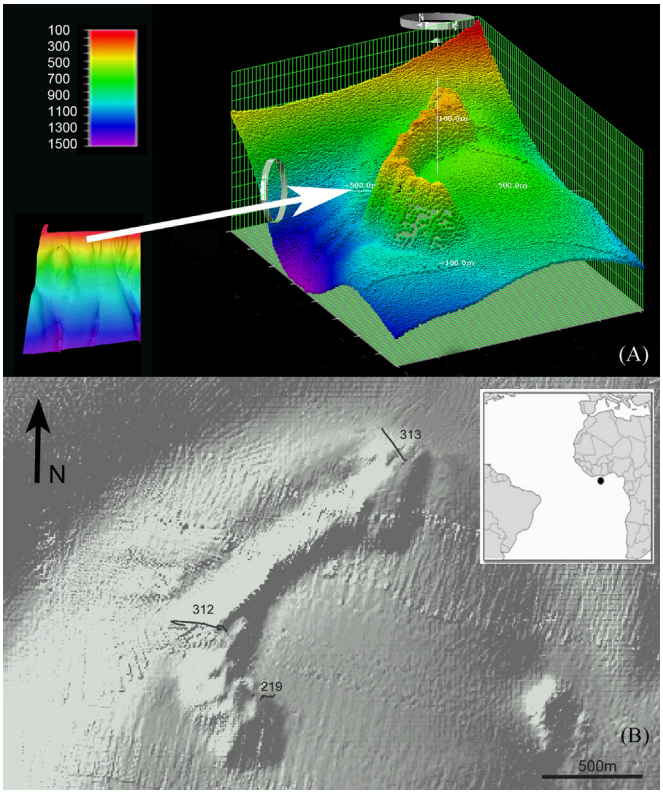

Fig. 1. The position of the 70 m high and 1400 m long *Lophelia* reef. A. The reef is curved and is located at 400 m depth on the continental slope off Ghana (colours indicates depth in metres). B. Position of the three video stations with the VAMS tracks indicated with dark lines. Inserted map shows the general location off Ghana.

2. Material and method

2.1. Description of the area

The elongated, banana-shaped reef is situated at the upper continental slope at around 400 m depth just off the narrow continental slope off Ghana at 4° 46 N and 3°09 W. The coral reef oriented perpendicular to the west coast of Ghana and occurs within the depth range dominated by South Atlantic Central Water (SACW) – the source water mass that feeds the West African upwelling. SACW is rich in nutrients, exhibits the pronounced oxygen minimum zone (OMZ) and the linear temperature–salinity relationship. During the survey, the measured temperature range in the vicinity of the coral reef was of 8.5–9 °C and the salinity range was 34.8–34.85 psu. The multibeam bathymetric mapping conducted in 2009 indicates that the reef is 70 m high, 1400 m long and around 250 m wide at the base (Fig. 1).

2.2. Sampling

Three sites on the reef were inspected using an ROV that is part of the VAMS developed by the Institute of Marine Research (IMR) in co-operation with Argus-Remote System A/S (www.argus-rs.no). It consists of: 9 sediment samplers; CTD with mounted sensors (salinity, temperature, oxygen and fluorescence); sonar; ADCP current metre; altimeter; and an ROV (with high resolution video camera) (Fig. 2). The three video inspections together covered 900 m in length (1 h and 50 min), at depths from 373 m at the summit to 442 at the base of the reef (Fig. 1). The speed of the ROV varied, with an average of 0.25 knot. Of the recorded videos, three hours represented inspection of the seafloor at a close distance allowing for analysis of substratum and megafauna (Table 1). The near bottom video record from station 312 was short due to strong currents that made it hard to keep the vessel in position.

2.3. Video analysis

Video analysis was conducted in the lab after the cruise and records were split into 76 video sequences of approximately

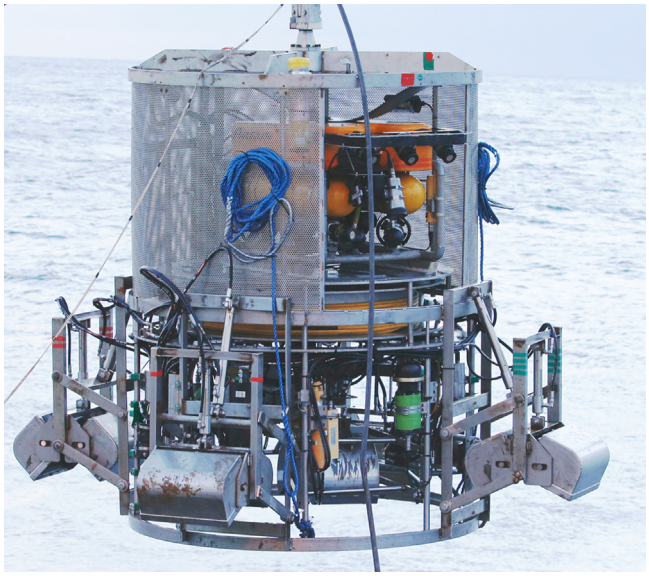

Fig. 2. The VAMS is an integrated sampling unit consisting of 9 parallel sediment samplers as well as a set of sensors to monitor the surrounding ocean to a depth of 2500 m. An ROV with high resolution video and still camera is attached to the sampling unit with a 50 m umbilical. The equipment is designed to collect samples for benthic biodiversity, chemical analyses and video observations.