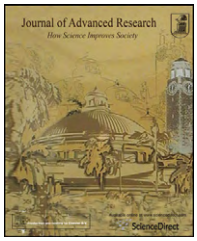
Journal of Advanced Research (2010) **1**, 221–225

Cairo University

Journal of Advanced Research



ORIGINAL ARTICLE

The effect of environmental conditions on coral reef habitat in Balhaf Bay, Gulf of Aden, Yemen

Mohamed S. El-Mashjary [a,*], **Attaala M. Ali** [b]

[a] *Environmental Science & Meteorology, Faculty of Environmental Science & Marine Biology, Hadhramout University of Science and Technology, Mukalla, Yemen*
[b] *Marine Biology Department, Faculty of Environmental Science & Marine Biology, Hadhramout University of Science and Technology, Mukalla, Yemen*

Received 15 September 2009; received in revised form 12 December 2009; accepted 2 February 2010
Available online 1 August 2010

KEYWORDS

Coral reefs;
Upwelling;
Thermal dynamics;
Salinity;
Gulf of Aden

Abstract This paper represents the beginning of a reference data base for the long term assessment and control of environmental impacts on the coral reef habitat of the Balhaf Bay, Gulf of Aden, following the development of an industrial complex on the bay. Present results reveal a high surface water temperature in summer with the tendency for relatively low temperature in the winter months. Bottom water temperature undergoes significant seasonal variation, with the annual difference at the two studied stations found to be up to 13.9 °C in the deep station (D), and 11 °C between August and September in the shallow station (F). Winter salinity variation was found not to exceed 0.5 g/l (measurements between 35.7 and 36.2 g/l), though salinity did vary seasonally: increasing at the beginning of the summer monsoon from 35.7 g/l to reach an annual maximum in this region (36.5 g/l) in the first days of July. The general lack of difference in the index of salinity for the studied depths is worth noting. Whatever the reason, such results call for more detailed studies of the habitats under reference.

Introduction

The water basins of many Arab countries, especially those facing the Red Sea and the Gulf of Aden, suffer from a lack of rigorous environmental studies. Even in the oil-rich countries of the region, where new techniques used in oil exploration have yielded some information, adequate analyses of the environmental and biological data remain weak. Although environmental and biological studies have been carried out in some of the region's water bodies, e.g. Gulf of Aden, they have mainly focused on instantaneous indicators that serve the immediate exploitation of fishery resources rather than more long term, sustainability indicators. Such studies have been limited and seasonal in nature, have mainly concentrated on areas of significant commercial fishing activity, and have never stretched beyond the data that can used as an expected guide for the aggregation and migration of fish schools and some other marine organisms, like cuttlefish and lobsters [1–4]. Thus, our understanding of the physico-chemical oceanography of the Gulf of Aden is still limited, with a critical lack of modern in situ observations. This is despite the fact that the Arabian Sea supports a great variety of reefs and coastal habitats of often-high ecological integrity, housing globally

* Corresponding author. Tel.: +967 5 360768; fax: +967 5 360768.
E-mail address: mss_mashjary@yahoo.com (M.S. El-Mashjary).

Production and hosting by Elsevier

doi:10.1016/j.jare.2010.02.011

significant levels of endemism and biodiversity, and provides a wide range of renewable services to human populations [5,6].

The Gulf of Aden is considered one of the richest and most unique areas of marine biodiversity in the world [7–9]. Its area is marked by three distinctive geographical features. The first of these is its bottom depths differences. These depths (5370 m, mean depth of 1800 m) highlight a rugged bottom topography including the Sheba ridge, which prolongs in the middle of the gulf and continues towards the relatively shallow west (Tadjoura Trench, Tadjoura Gulf of Djibouti). The second key feature is the climate of the region and its effects in the gulf. Here the climate of the gulf is marked by south-westerly winds during the summer monsoons, with these mechanisms leading to the movement of the bottom water masses and the upwelling phenomena. The third feature is its biological peculiarity, with distinct qualitative and quantitative richness in phytoplankton, zooplankton, molluscan, crustacean and fish nektons [10,11].

Crucial to the sustenance of the gulf's environmental and biological richness are the hydrological phenomena controlling its water mass. This control comes through the influence of the main two sources of its water and their seasonal interchanges, the Red Sea and the Arabian Sea [2,12].

The key important characteristic of the health of the gulf is the plentiful and distinctive coral complexities which have developed as patchy distributed groups, mainly occupying the hard and stony bottom, except the Socotra archipelago, which are mainly surrounded by fringing coral reefs which cover about 30% of the Socotra coasts and extend to depths of about 5–10 m. This constitutes about 250 scleractinian species [7].

It can be observed that the northern parts of the Gulf of Aden – and in spite of the fact that these areas are affected by the seasonal upwelling phenomena – include a healthy growth of coral reefs, especially in areas near Balhaf, Burum and the small islands near Bir Ali. Most of these corals are of the pocilloporids, faviids and poritids types [6]. This peculiarity distinguishes the study area of Ras Balhaf-Bir Ali in particular. All of these areas have been declared marine protected areas (MPA). Further, the particular area in question has been included in the Integrated Coastal Management (ICM) Zoning Plan [7,13,14].

Thus, the present paper can be considered as the inception of a data base designed to establish the environmental status of such sensitive areas, vulnerable as they are to the influence of natural variability and human and industrial intervention. In this, we seek to describe the oceanographical and bio-environmental conditions prior to the activation of the industrial export complex located in Balhaf Bay so as to provide a reference for the control of environmental impacts in subsequent years.

Methodology

Study area

Balhaf Cape and its bays are a continuous group of numerous capes in the Bir Ali coast. The area is exposed to the open sea from the west and east, which exposes it to a variety of natural (because it is located between the edge of the coastal and sea currents) and human effects (because it is an area of intensive fishing). The cape of is located at the intersection point of N13°58″ and E48°10″, and at a distance of about 10 km west of the coast of Bir Ali. Balhaf Cape extends about 800 m × 1000 m, with volcanic rock complexities with hard and sharp edges elevated above sea level to the south,

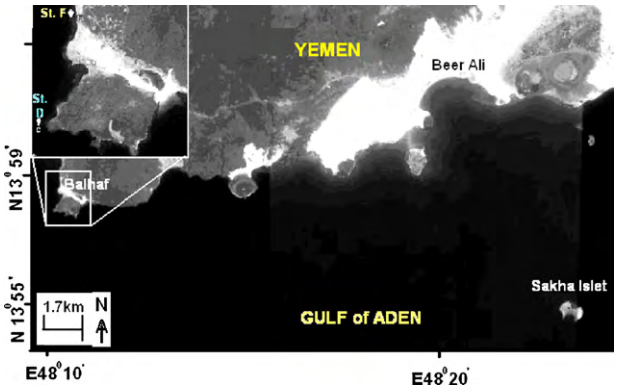


Fig. 1 Locations of the stations within the study area (source: www.GoogleEarth).

and with a gradual slope, including rocky and steep patches, on the east and west banks. The cape includes a long and organic-sandy beach where turtle tracks can be found though without evidence of spawning. Although the slope of the edges of the cape are sharp, it is surrounded by a sea coast, slowly running to tens of meters forming a shallow coral field of 2–12 m on the eastern side. Here initial diagnosis has found 10 genera, the majority of which belong to the families Poritidae and Acroporidae. The coast declines rapidly, reaching a depth of 28–30 m not more than 100 m from the south ground edge. Peninsula Ras Balhaf is free of any organisms, except some wild plants and occasional birds, such as white gulls and cormorants.

The Cape of Balhaf is situated in the path of westerly surface currents in autumn and winter (October–April) and easterly surface currents in spring and summer (March–August). Not far from the cape is the Islet of Skha, located about 28 km to the east.

The shallow intertidal station (F) is characterised by a depth of 2–4 m, about 30 m from a flat beach; the biologically rich bottom is characterised by a combination of organic sandy clay, punctuated by hard rock formations populated by some scattered coral complexities. The station is located about 500 m west of the cape (Fig. 1).

The deep sublittoral station (D) is characterised by a depth of 28–30 m, located south-westward of the cape's rocky steep wing by about 100 m. The bottom sequence is characterised by hard igneous rocks, ledges and boulders. It lacks coral formations; it is exposed to the open sea and its direct relatively strong currents (Fig. 1).

Samples

The key qualitative indicators of the water body are temperature and salinity; values reported here are designed to be used to monitor trends in the longer term.

Sea water samples were collected weekly from February 2006 to the end of January 2007 at two sites in Bir Ali (Balhaf site): Station F—intertidal, 2–4 m depth (N13°59″; E48°10″); and Station D—sublittoral, 28–30 m depth (N13°58″; E48°10″).

Two samples from each site were taken; surface and bottom. Water samples were collected weekly using a 5 l water sampler. Water temperature and dissolved oxygen concentration were measured in situ at each site using a Dissolved Oxygen Meter, Oxi—3310 WTW 2BA301, Germany.

Samples for salinity, turbidity, Total Dissolved Substances (TDS) and Chlorophyll a were transported by ice-cooled box to the laboratory. Sample analyses were done within 4–6 h of sam-