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Oceanography of the Gulf of Aden John Murray–Mabahiss Expedition 1933–1934 Revisited

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Abstract Oceanography of the Gulf of Aden was the focus of several recent publications using STD casts, XBT and AXBT. The present paper is based on the unpublished data set of John Murray–Mabahiss Expedition to the Indian Ocean 1933–1934. In addition to its historical value, these bottle data have an exceptional significance. Unlike most cruises, the data were collected in two successive monsoon seasons and in cross sections between the African and Arabian coasts of the Gulf, in addition to the longitudinal section along the ship's transit. This gave a rare glimpse of what the density and oxygen were in 1933/34. The paper describes the water masses and circulation in the southern Red Sea and Gulf of Aden before the Second World War, or in other words, the state of the art at that era, when oceanographic data were very scarce. The study reveals pronounced spatial and seasonal variability in the hydrographic structure and circulation pattern in late summer and winter monsoons. Upwelling and frontal zones, which are known to be characterized by a high biological productivity, are developed during the summer season. The deep high saline outflow from the Red Sea into the Gulf of Aden is stronger in winter.

Several water masses are identified as: the Surface Water Mass (SW) of high salinity, the Gulf of Aden Subsurface Water Mass (GASSW) of intermediate minimum salinity, the Red Sea Water Mass (RSW) of intermediate maximum salinity, the Persian Gulf Water Mass (PGW) and the Deep Water Mass (DW). The Gulf of Aden subsurface water mass (GASSW) is poor in oxygen ($<0.5 \text{ ml l}^{-1}$). This subsurface water of anoxic oxygen concentration occurs at shallower depths ($<20 \text{ m}$) in summer, particularly in the upwelling regions. The deoxygenating process and its impact on the ecosystem and communities, as well as the oceanic variability, are key elements in managing the living resources of the region.

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The conclusions reached from this work are in general agreement with those obtained from the more recent studies. The broad features of the oceanography of the region could have been made available to oceanographers 80 years ago, if the data and results of John Murray–Mabahiss Expedition (JMME) had been timely published following the return of the expedition.

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Introduction

The Gulf of Aden (Fig. 1a) is connected at its northwesterly extremity to the Red Sea through the Strait of Bab El Mandab and is opened at its easterly end to the Arabian Sea through a wider and deeper mouth. The actual separation between the Gulf of Aden and the Red Sea lies at the sill near Great Hanish Island (≈ 150 km NW of Bab El Mandab) where depths are of the order 50 m except for a 6 km wide trench 160 m deep at mid channel (Murray and Johns, 1997).

The climate of the Gulf of Aden is dominated by hot and extremely arid conditions. The area is subjected to reversing monsoons. During the NE monsoon (October to May) the prevailing wind over the Arabian Sea is northeasterly veering to easterly in the Gulf of Aden and southeasterly towards the Strait of Bab El Mandab and Southern Red Sea. The stronger winds during the SW monsoon (June–September) are from WSW over the Gulf of Aden and Arabian Sea and from NW over the Southern Red Sea.

According to published literature including direct observations and modeling, the monsoonal reversal of winds coupled with the thermohaline circulation result in changes in circulation in the Strait of Bab El Mandab and Gulf of Aden. In Bab El Mandab, during the winter monsoon, there are two layers system, while during summer there are three layers system of water exchange between the Red Sea and the Gulf of Aden (Thompson, 1939b; Siedler, 1968; Morcos, 1970; Patzert, 1974; Poisson et al., 1984; Murray and Johns, 1997; Sofianos et al. 2002; Sofianos and Johns, 2002). The subsurface warm and high saline outflow from the Red Sea into the Gulf of Aden is distinctly seasonal. It increases during winter (October to May) and attenuated or blocked in summer (July–August) (Seri, 1968; Patzert, 1974; Osman, 1985; Maillard and Soliman, 1986; Murray and Johns, 1997; Bower et al., 2000; Beal et al., 2000; Peters et al., 2005). In a study of the Red Sea budget of salinity, Souvermezoglou et al. (1989) found a gain for the Red Sea in summer, and a loss in winter. In the Gulf of Aden, the winter northeasterly winds cause surface water to

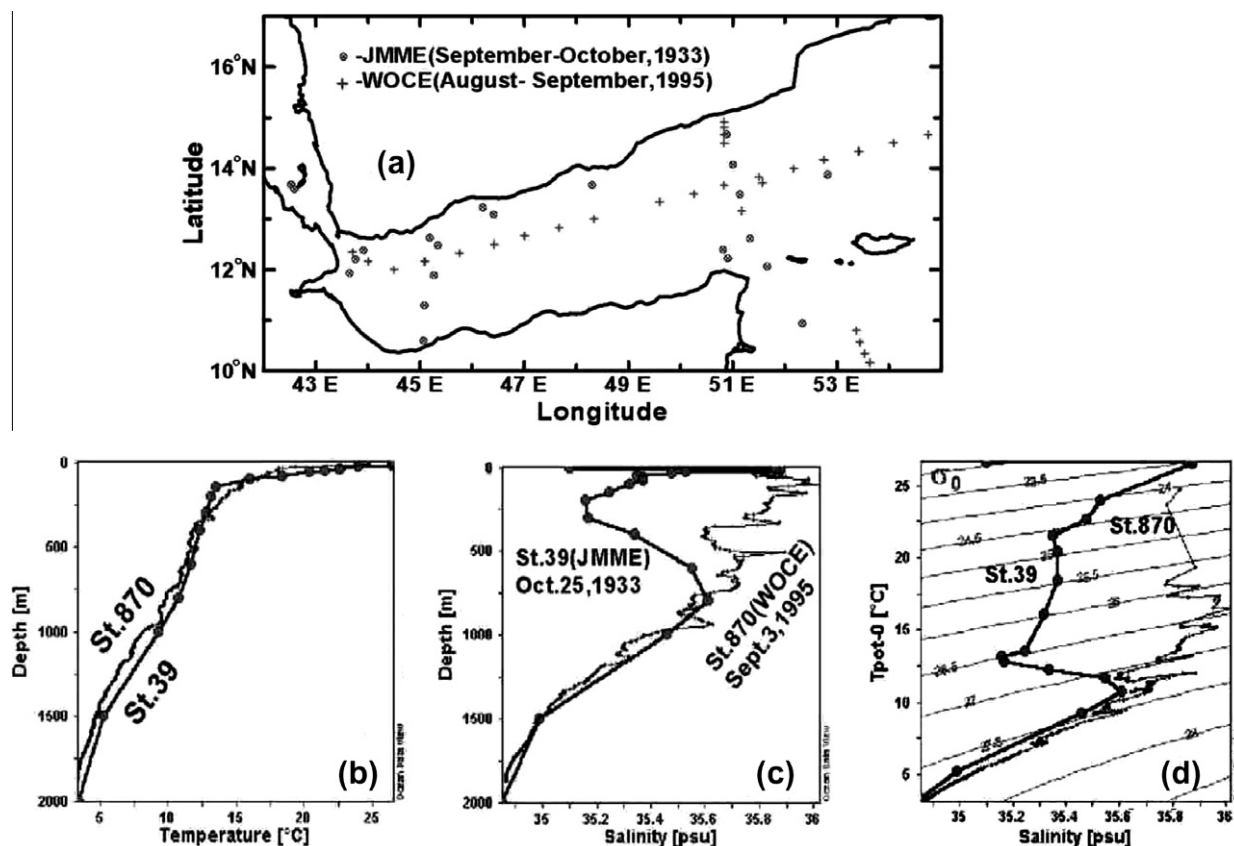


Figure 1 John Murray/Mabahiss Expedition (Station 39: $13^{\circ}53'N$, $52^{\circ}54'E$) compared to recent observations of Knorr (Station 870: $14^{\circ}09.67'N$, $52^{\circ}46.33'E$), (a) Location of stations in Gulf of Aden in summer: • JMME/Mabahiss, September–October, 1933, + WOCE/Knorr, August–September, 1995, (b) Temperature profile, (c) Salinity profile, (d) Temperature–salinity diagram.

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