Introduction
Over the last 1000 years, but before the industrial revolution, CO₂ concentration was relatively stable, fluctuating by about ±10 ppm at around 280 ppm (Friedli et al. 1986; IPCC 1996). During the industrial period, the increased use of fossil fuel and deforestation led to a rise in CO₂ concentration, exceeding 369 ppm in 2000 (Keeling and Whorf 2001). Since anthropogenic CO₂ has a highly negative carbon-isotope composition, the δ¹³C of the atmosphere has decreased in the last two centuries by about 1.4% ulg as deduced from the air bubbles trapped in ice cores (Francey et al. 1999). This decrease is imprinted on the δ¹³C signal of the dissolved inorganic carbon (DIC) in the ocean. Long-term variations in seawater δ¹³C have been estimated from shallow-dwelling corals, sponges and planktonic foraminifera (e.g., Nozaki et al. 1978; Böhm et al. 1996; Beveridge and Shackleton 1994).

Present study
We have investigated the variations in the stable carbon isotope composition of seawater (DIC) as recorded by the planktonic foraminifera G. sacculifer and G. ruber and the sedimentary organic matter from the northern Gulf of Aqaba during the last 1000 years (Fig. 1). Sedimentation rates in the area are high (40-65 cm/kyr) providing a high temporal sampling resolution of about 10 years (Fig. 2).

Results
Figure 3 shows the δ¹³C record of the planktonic foraminifera G. sacculifer and G. ruber from the three multicores. These records display similar trends. The values before the 1750’s have a fairly uniform δ¹³C pattern, ranging between 1.28 and 1.35‰ with an average of 1.31‰. An initial slow decline begins in the middle 1700’s, from 1.31‰ in the sediments older than A.D. 1750 to about 0.68‰ near the top of the cores.

Discussion
Results from this study show a decline in the δ¹³C of planktonic foraminifera (G. sacculifer) of roughly 0.63‰ from the beginning of the 1750’s. The δ¹³C record of the same species in a gravity core from the same area (GeoB 5810-2) shows a consistent δ¹³C pattern over the last 3000 years BP (mid-late Holocene). The values are similar to their counterparts from the lower parts of the multicore and the sediments older than A.D. 1750. If we assume that the intraspecific range of foraminiferal δ¹³C values attributed to vital effect remained rather constant since the late Holocene, then changes in the δ¹³C composition of the foraminiferal shells should be still proportional to changes in the carbon-isotope composition of DIC in seawater (Beveridge and Shackleton 1994). Therefore, the 0.63‰ decrease during the last two centuries can be partially attributed to the invasion of fossil fuel CO₂ into the surface waters, which caused a decrease in the δ¹³C of DIC.

Seawater δ¹³C
Direct measurements of seawater in the northern Gulf of Aqaba show that the δ¹³C of the dissolved inorganic carbon (DIC) has decreased by about 0.54‰ during 1979-2000 (Friedli et al. 1999). The average annual decrease is 0.021‰, which is similar to values measured in the Pacific and Indian Oceans (Quay et al. 1992; Sonnerup et al. 2000).

Sedimentary organic carbon
The organic carbon in our samples is contributed predominantly from primary producers, and the content increase near the tops of the cores is not related to an increase in productivity but can be attributed to preservation effects (Fig. 5). The quite uniform C/N values (-9) throughout the cores and the lack of a relationship between δ¹³C and C/N ratio, as well as the consistent carbonate content (Fig. 5), suggest comparatively low terigenous organic matter contribution to the sediments.

Figure 1. Map of the northern Gulf of Aqaba, Red Sea, showing the location of the multicore GeoB 5810-3, GeoB 5807-2 and GeoB 5801-3 investigated in this study.

Figure 2. Age-depth relation of the investigated multicore from the northern Gulf of Aqaba, Stairs indicate the calibrated 14 C ages dating position.

Figure 3. Stable carbon isotope composition (δ¹³C) of the planktonic foraminifera G. sacculifer and G. ruber over the last 1000 years from three multicore collected in the northern Gulf of Aqaba, Red Sea. The yellow bar indicates the transition zone between the pre-industrial and industrial periods.

Figure 4. δ¹³C of DIC in the surface waters of the northern Gulf of Aqaba. Filled montsnes are measurements during 1979-1980 (Shaposhnik et al. 1994): open circles are values during 1999/2000 (This study). The offset between the two records seems to represent the decrease in δ¹³C of seawater in the past 25 years due to uptake of anthropogenic CO₂ in surface waters.

Figure 5. Variations of organic carbon, δ¹³C of the planktonic foraminifera (G. sacculifer), carbonate content and C/N ratio in the multicore GeoB 5810-3 from the northern Gulf of Aqaba. The organic carbon increase in the upper part of the core is most likely due to preservation effect.

Figure 6. Stable carbon isotopic record of the planktonic foraminifera G. sacculifer and the sedimentary organic matter (δ¹³Corg) during the last 1000 years from the multicore GeoB 5810-3 from the northern Gulf of Aqaba. The thick lines represent a five-point running average.

Figure 7. Comparison between δ¹³C planktonic foraminifera (G. sacculifer) from the three multicores with other published records from different proxies, showing the decrease in δ¹³C of the atmosphere (tree ring and ice core records) and surface water δ¹³Corg (sclerosponge and foraminifera records) over the last two centuries due to the increase of anthropogenic CO₂ input into the atmosphere.