INTRODUCTION

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Coral reefs are among the most valuable ecosystems on the earth, because of their immense biological wealth, and the economic and environmental services they provide to millions of people. Coral reefs provide shelter habitat, nutrients and breeding grounds for many fishes (including commercial fishes), molluscs, crustaceans, and echinoderms...etc. (Loya, 1972; UNEP/IUCN, 1988). Thereby, coral reef habitats provide humans with living resources such as fishes, molluscs and crustaceans on which many coastal communities in developing countries depend. They are very important in coastal protection, buffer adjacent shorelines from wave action and impact of storms, and prevent erosion of beaches (Dahl, 1981). Coral reefs also contribute strongly to the tourism industry, which is one of the fastest growing sectors of the global economy. They attract millions of tourists for snorkelling, SCUBA diving, recreational fishing...etc. Corals and shells make into jewelry and tourism curios. Live reef fishes and corals are used in aquariums.

Coral reefs play an important role in new medicine. In recent years, human bacterial infections have become increasingly resistant to existing antibiotics. Thus, the scientists are turning to the oceans and seas in the search for new cures for these and other diseases. Coral reef species offer particular promise because of the array of chemicals produced by many of these organisms for self-protection. Corals are already being used for bone grafts, and chemicals found within several species appear useful for treating viruses. Chemicals within reef-associated species may offer new treatment for leukemia, skin cancer and other tumors (Birkeland, 1997).

According to one estimate, one half of all new cancer drug research now focuses on marine organisms (Fenical, 1996; Maragos *et al.*, 1996).

Coral reefs are tropical and shallow water ecosystems, they are largely restricted to the area that lies between the latitudes 30° N and 30° S (UNEP/IUCN, 1988; Rinkevich, 1995). About 60% of the world's reefs occur within the area covered by the Indo-Pacific region, about half of which are found in the Indian Ocean, Red Sea and Arabian Gulf (UNEP/IUCN, 1988).

The term "reef" is used for population of the hermatypic corals (true reef-building corals), primitive animals living in intimate association with unicellular endosymbiotic Dinoflagellate algae, called zooxanthellae (Muscatine, 1980). Zooxanthellae live principally within the cells of coral gastrodermis and contribute to the growth and maintenance of many reef corals (Trench, 1979; Muscatine, 1980). They are photosynthetic, providing a reliable source of fixed carbon to their host. Coral in turn provide nutrients for the symbiotic zooxanthellae through its catabolic pathways (Muscatine & Porter, 1977; Cook, 1983; Davies, 1984). Also, the symbiotic zooxanthellae are able to take up and utilize dissolved inorganic nutrients, particularly dissolved inorganic nitrogen (DIN = $NO_3^- + NO_2^- + NH_4^+$) and dissolved inorganic phosphorus from ambient seawater. The ability to take up inorganic nutrients may be advantageous to the coral–zooxanthellae system when heterotrophic food sources in the surrounding environment are scarce (Falkowski *et al.*, 1984; Snidvongs & Kinize, 1994).

The Red Sea is narrow and semi-enclosed water body, extending between the latitudes 13°N and 30°N. It is located in one of the most arid regions of the world and no river flows into it. Seasonal variations in the Red Sea are more prominent in the northern portion and less clearly defined in the south. The rainy season is generally the winter and the rainfall is extremely low, occasional heavy downpours may cause flash floods resulting in freshwater runoff and large amounts of sediment input (Mancy, 1983). The northerly winds are prevailing throughout the year in the Red Sea region with an average speed of 10 knots (Roberts, 1985). Also, the southerly currents, which are induced by northerly winds, are predominant. Apart from the occurrence of exceptional extreme low tides, which predominantly affect reef-flat communities in the far north (Loya, 1976b), reefs in the Red Sea are subject to few natural disturbances. Storms are rare and cyclonic storms do not occur (Reiss & Hottinger, 1984). Consequently, reefs are not subject to high levels of turbulence. Although the Red Sea is relatively small, not more than an appendix to the Indian Ocean, it nevertheless has very well developed coral reefs.

There are only three areas in the world with more than 50 genera of hermatypic scleractinian corals. One of these is the Red Sea (Schuhmacher, 1976). About 194 species belonging to 70 different genera were recorded in the Red Sea, of this 161 (51 genera) belonging to hermatypic scleractinian corals and 33 (19 genera) are ahermatypic (Scheer & Pillai, 1983). The Red Sea coast of Egypt stretches for a distance of 2420 km long and the major reefs along it are shown in Figure 1 (UNEP/IUCN, 1988). Since coral reefs occur in areas with increased light intensity and water clarity, nutrient-poor conditions, high levels of dissolved oxygen, and narrow ranges of salinity and temperature; any changes in these surrounding physico-chemical conditions, whether natural or man-made, outside their narrow tolerance range leading to coral deterioration (Johannes, 1975; Pearson, 1981; Rogers, 1988a; Riegl & Velimirov, 1991; Peters & McCarty, 1996).

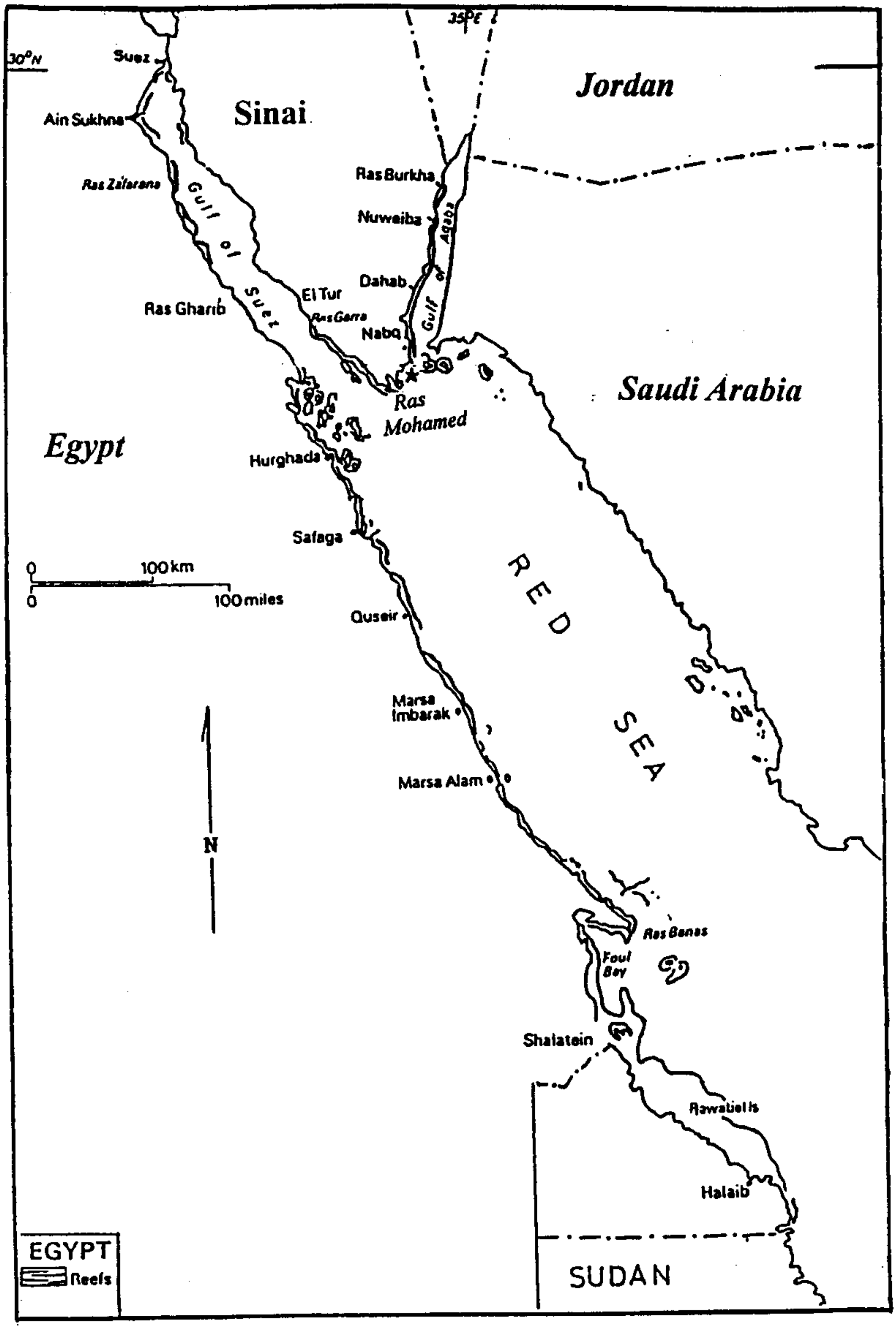

Fig. 1. Map of the northern Red Sea showing the distribution of the major coral reefs along the Egyptian Red Sea coast.

In the recent decades, numerous anthropogenic activities have threaten the coral reefs in the Red Sea, particularly in the countries concerned with expansion of coastal tourism, petroleum activities (exploration, production and transport) and increasing coastal urbanization. Coral reefs along the Northern Red Sea coast are suffering from substantial damage caused by man-made disturbances of various sorts. These disturbances include increasing terrestrial sedimentation and high water turbidity that resulted from landfilling concomitant with shoreline construction activities, oil and heavy metals pollution, excessive inputs of nutrients and organic matter through releasing untreated sewage and siltation, destructive fishing methods, inshore and offshore recreational activities, and heavy collection of reef invertebrates. Corals respond to the stress events by changes in growth rates, loss of zoxanthellae, aberrant fecundity, reduced larval survival, changes in metabolism (Brown & Howard, 1985), and enhanced coral diseases (Antonius, 1995a).

The anthropogenic factors may interact with natural disturbances causing tremendous damage to coral reefs (Johannes, 1975; Sebens, 1994; Done, 1999). Wells (1992) indicated that human-induced damage to reefs exacerbates damage caused by natural events such as temperature rising, coral predator outbreaks, diseases and impairs regeneration. Wilkinson (1996) and Chadwick-Furman (1996) estimated that the global climate change (such as temperature rising) may interact with regional anthropopgenic processes to create additional impacts on coral reefs. Major reef destruction has followed the outbreaks of coral predator seastars, *Acanthaster planci* (crown of thorns). Although this is considered part of a natural disturbance, there are indications that reduction of their predators (some reef fishes and mollusca) by overfishing, changing land use and increasing eutrophication may increase the severity of *Acanthaster planci* outbreaks (Bell, 1992; Sebens, 1994; Zann, 1994). An exceptional severe low tide may interact with oil pollution to cause multiplicative stress on coral reefs (Fishelson, 1973b; Loya, 1975). The prospect of synergism between the natural events or global climate change and man-made stresses introduces significantly greater problems for people who live on or use reef resources. Reefs with lowered diversity, topography and living cover result in reduced fishery yield and potentially reduced income from recreational activities (Wells, 1992; Sebens, 1994).

Sedimentation:

Sedimentation and suspended matter are among the very significant factors in determining the coral reef community structure and overall coral reef development (Hubbard, 1986). Excessive sedimentation can adversely affect the structure and function of the coral reef ecosystems by altering both physical and biological processes (Loya, 1976a; Rogers, 1990). The damaging effects of increasing sedimentation rate and suspended sediments on the growth and growth forms, distribution, net productivity, recruitment and survival of mature coral colonies have been reported in numerous studies (Marshal & Orr, 1931; Rogers, 1977, 1983, 1990; Lasker, 1980; Peters & Pilson, 1985; Hubbard, 1986; Abdel-Salam & Porter, 1988; Hodgson, 1990; Babcock & Davies, 1991; Te, 1992; Stafford-Smith, 1993; McClanahan & Obura, 1997; Wesseling *et al.*, 1999; Woolfe & Larcombe, 1999).

Heavy sedimentation and suspended sediments can kill coral directly by smothering and reducing the incident light intensity available for zooxanthellae photosynthesis (Johannes, 1975; Rogers, 1977, 1990; Brown & Howard, 1985; Neil, 1990; Wittenberg & Hunte, 1992). High turbidity and sedimentation rate decrease the net productivity and increase respiration rates of corals (Abdel-Salam & Porter, 1988; Rogers, 1990), as well as cause coral bleaching, loss of zooxanthellae (Rogers, 1979). Rapid sediment deposition may lead to burial, abrasion and eventually death of corals (Neil, 1990; Rinkevich, 1995). The accumulated sediments on substrate surfaces may inhibit or reduce the coral larval settlements and growth rates, where coral planulae larvae will not be able to settle and survive on an unconsolidated substrate which have been covered with loose, shifting sediments (Sheppard, 1982; Sammarco,1980 and 1991; Babcock & Davies, 1991; Te, 1992; Woesik & Done, 1997). Hodgson (1990) reported that higher levels of sediment loads prevented settlement of *Pocillopora damicornis*. Increasing sedimentation rates lead to the expenditure of energy in sediment shedding processes "instead of utilization of this energy by corals for calcification and growth" (Lasker, 1980; Sheppard, 1982; Abdel-Salam & porter, 1988). Walker & Ormond (1982) stated that sedimentation might be a critical factor both in causing a decrease in light intensity and in requiring the expenditure of energy by the coral, since sediment removal is a mucus-driven process. Higher levels of sedimentation may also prevent or delay the coral recolonization and recovery (Maragos *et al.*, 1985; Brown & Howard, 1985; Rogers, 1990). Cortes & Risk (1985) showed that the results of high sediment load at Cahuita reef, Costa Rica were: decreased growth rates, depressed spat recruitment and sometimes coral death. They suggested that reduction in growth rates would hamper a coral's ability to overcome sediment accumulation, and under high sediment loading, recovery from any wound or injury is likely to be hindered. High sedimentation may also cause polyp retraction; this would reduce the coral's capacity for zooplankton capture (Peters & Pilson, 1985).

Landfilling accompanied with increasing coastal construction activities, and resuspension of bottom sediments due to human trampling, SCUBA divers, tourist boat anchoring and destructive fishing methods are the major anthropogenic sources of heavy sedimentation and high suspended sediments in coral reef areas along the Egyptian Red Sea coast (Hawkins & Roberts, 1994).

Oil pollution:

Extensive and serious oil pollution problems are observed along the coasts of the Red Sea, which is ranked among the heavily polluted marine environments. The major sources of oil pollution in the Red Sea are offshore oil production, using inefficient equipment, cleaning of oil and gas separators (both offshore and onshore), and illegal discharges of dirty ballast water from tankers (Hanna, 1983). Also, oil pollution may originate from accidental oil spills due to tanker collision, pipeline damage, or production accidents (Said, 1996). Since the Red Sea is a semi-enclosed water body, the pollutants do not readily withdraw from it but will tend to accumulate. Localized oil pollution problems are due to fishing and tourist boats that discharge the used oil and/or oil mixed with water in the vicinity of reefs (Mancy, 1983).

The impact of oil pollution on coral reefs has been the subject of intensive research. The first evidence was provided by Johannes *et al* (1972). They stated that some reef building corals could be seriously damaged if they are adhered or coated with oil. Peters *et al* (1981) indicated the pathological responses of Caribbean coral reefs during exposure to petroleum hydrocarbons. The most deleterious subtle effect of chronic oil spills on coral reefs is that may leave reef communities more vulnerable to the other types of disturbances (IUCN/UNEP, 1985; Guzman *et al.*, 1994; Brown, 1997). Birkeland *et al* (1973) noticed deleterious effects on some corals over one month following exposure to oil. Oil pollution decreases numbers of corals, species diversity and total live coral cover (Johannes *et al.*, 1972; Fishelson, 1973b; Loya, 1975; Bak, 1987; Loya & Rinkevich, 1987; Guzman *et al.*, 1991). Oil pollution can cause damage to reproductive system of corals, reduce the size of gonad and inhibit fertilization, and decreasing coral recruitment (Rinkevich & Loya, 1977; Peters *et al.*, 1981; Loya & Rinkevich, 1979, 1980; Bak, 1983; Stearns, 1992; Guzman & Holst, 1993).

Oil pollution can adversely affect on the viability of coral planulae larvae, inhibiting them from successful settlement and development by changing some physical properties of reef substrate which interfere with normal settlement of larvae, eventually reducing the number of breeding colonies (Rinkevich & Loya, 1977; Jackson, 1986; Bak, 1987; Te, 1991). Loya (1975) suggested that chronic oil pollution at the northern Gulf of Aqaba, Red Sea, results in either one or a combination of the following: 1) damage to the reproductive system of corals; 2) decreased viability of coral larvae; 3) change in some physical properties of the reef substrate, which interfere with normal settlement of coral larvae. Corals exhibit much higher levels of injury, reduced recolonization and slower growth rates on heavily oiled reefs (Cohen *et al.* 1977; Barrat, 1982; Dodge *et al.*, 1984; Stearns, 1992; Guzman *et al.*, 1994). Loya & Rinkevich (1980) reported that the direct contact of petroleum hydrocarbons with coral tissue due to coating or ingestion can impair the coral colonies, growth rates, damage reproductive system, reduce viability of coral larvae, and cause coral death.

The detrimental influences of oil pollution on photosynthesis include loss of symbiotic zooxanthellae, destruction of chlorophyll *a,* and disruption of membranes and chloroplasts (O'Brien & Dixon, 1976;

Peters *et al.*, 1981; Rinkevich & Loya, 1983a; Cook & Knap, 1983; Fucik *et al.*, 1984).

Eutrophication:

One of the major factors influencing the survival and stability of reef communities is eutrophication, as a result of increased sewage discharge and terrestrial sediment input (Doty, 1969; Fishelson, 1973b; Walker and Ormond, 1982; Rogers, 1988a; Bell, 1992; Öhman *et al.*, 1993; FAO, 1994). The term eutrophication refers to a situation where an increase in nutrient levels has occurred through anthropogenic activities, which has resulted in algal growth (Bell, 1992; Bell & Elmetri, 1995). The anthropogenic activities that enhance nutrient inputs to the vicinity of coral reefs along the Egyptian Red Sea coast are sewage outflow, seepage of waste waters, high terrestrial sedimentation and inefficient loading of phosphate in the ports (Hawkins *et al.*, 1991; Riegl & Velimirov, 1991; Hawkins & Roberts, 1994). Johannes *et al* (1983) noted that an increase in dissolved nutrient concentrations associated with sewage enrichment is well known to stimulate the growth of macroalgae at the expense of corals. Thus, the eutrophication can favor macroalgae in their competition with corals for free space. In cases where corals are overtopped by algae an extensive corals damage occur (Fishelson, 1973b; Tomascik & Sander, 1987a; Riegl & Velimirov, 1991; Wittenberg & Hunte, 1992). The rapid growth of fleshy algae stimulated by nutrients and organic matter can also adversely impacted hard corals by direct smothering, causes oxygen depletion, and promote coral diseases (Johannes, 1975; Brown & Howard, 1985; Pastorok & Bilyard, 1985; Antonius, 1995a; Bell & Elmetri, 1995).

Various studies have shown that coral growth and reproduction are severely restricted by increased eutrophication and associated sedimentation, even when hard coral substrate is available (Banner, 1974; Smith *et al.*, 1981, Walker & Ormond, 1982; Tomoscik & Sander, 1985, 1987b; Hunte & Wittenberg, 1992). Increased macroalgae growth due to high eutrophication can decrease the ability of corals to reproduce by reducing recruitment, settlement of coral larvae, survival of juveniles and recolonization (Fishelson, 1973b; Tomoscik & Sander, 1987b; Hunte & Wittenberg, 1992; Bell & Elmetri, 1995; Wilkinson, 1996). Sewage pollution can also enhance the growth of filter-feeding animals such as ascidians, sponges and soft corals which either outcompete corals or result in increased bioerosion via burrowing molluscs, sponges, sea urchins and polychaete worms (Kinsey, 1988; Bell & Elmetri, 1995). Smith *et al* (1981) found that after increase in biomass of macroalgae, as a consequence of increased nutrient input, benthic community structure shifted away from corals towards filter feeders, such as bryozoans, sponges, tunicates, soft corals… etc.

Heavy metals pollution:

In natural aquatic ecosystem, heavy metals occur in low concentrations normally at nanograms per liter level (FAO, 1994). In recent years, however the occurrence of heavy metal contamination in marine environment in excess of natural loads has become problem of concern. This situation has arisen as a result of the increasing coastal urbanization, expansion of industrial activities, offshore and inshore oil activities, and overexploitation of marine resources, as well as lack of environmental management. Unlike other pollutants, heavy metals neither created nor destroyed by organisms, but they may accumulate unnoticed to toxic levels inside the marine organisms. Some heavy metals such as Zn, Cu, Mn, Co and Fe are essential for the growth and survival of living organisms in low concentration, but may be toxic in high concentrations. Other heavy metals or metalloids such as Hg, Pb, Cd, Sn and Cr are not essential for metabolic activity and are toxic at quite low concentrations (FAO, 1994). Most published data on the effects of heavy metals on marine organisms, however reported adverse effects at concentrations higher than usually found in the environment (Heyward, 1988; Abdel-Salam, 1989; FAO, 1994). Persistent pollutants such as heavy metals can remain in the environment unchanged for years and may thus pose a potential threat to man and marine organisms. Also, heavy metals pollution is considered as indication of different anthropogenic contamination (Matson, 1989; Guzman & Jimenes, 1992; Metwally *et al.*, 1997).

Beltagy (1982) studied the seasonal variations of three trace elements namely, Fe, Cu and Mn in the Red Sea water at Al-Ghardaqa. He attributed the seasonal variations of these elements to three reasons: 1) the selective utility of the element by marine organisms, 2) air-borne material transported to the sea by strong winds during winter, 3) decomposition and oxidation of dead organic matter. Beltagy (1984) analyzed samples from northern Red Sea for the elements Co, Cu, Mn, Pb, and Zn. Saad and Kandeel (1988) showed that the mean concentrations of dissolved Cu, Mn, and Fe in the front of Al-Ghardaqa, Red Sea were 5.1, 0.83 and 16.2 $\mu g\ L^{-1}$, respectively. Hamed (1996) investigated the trace metal concentrations in water and sediment in the northern Red Sea. He concluded that there are a general decrease in trace metal concentrations Viz: Cu, Zn, Pb, Cd, Cr, Ni, Co, Fe, Mn, Hg and Ag towards the southern part of Gulf of Suez and the northern Red Sea proper.

Land-based pollution and expansion of human activities such as sewage and waste products runoff from coastal cities and tourist constructions, oil spills during production and transfer, terrigenous sediment inputs, and the use of antifouling and anticorrosive paints to protect vessels are probably the main anthropogenic sources of heavy metals on the Egyptian Red Sea coast (Hamed, 1996).

The effects of heavy metal pollution on coral reefs have received limited coverage in the literature (Howard & Brown, 1984; Brown, 1987; Guzman & Jimenez, 1992). Coral bleaching (Zooxanthellae expulsion) has been reported as a stress response to heavy metals (Harland & Brown, 1989). The growth of zooxanthellae may also be adversely affected by exposure to heavy metals (Kayser, 1976). Heyward (1988) has shown experimentally that complete inhibition of coral fertilization at higher concentrations of copper and Zinc sulphates (0.5 mg L^{-1} and 1.0 mg L^{-1}, respectively). Also, Abdel-Salam (1989) noticed that higher concentrations of copper sulphate (1.0 mg L^{-1}) resulted in complete death of two hard coral species, *Montastrea annularis* and *Diploria strigosa*. Brown and Holley (1982) quantitatively surveyed reef flats in the vicinity of tin dredging and smelting activities in Thailand. They found that dead coral cover on the reef below tin smelter, although high, was not significantly different from values observed on reefs at several kilometers away from the smelter, which were not apparently under the influence of such increased metal loads. Soluble metals in seawater represent the most obvious and direct route of metal uptake available to corals. Heavy metals and probably other pollutants, are expected to be absorbed more rapidly at higher temperatures (Rainbow, 1990).

Recreational and fishing activities:

Coral reefs provide a major impetus for tourist development throughout the tropical areas and the reef-related tourism offers a major opportunity for fast returns on investment is inevitable. Tourism development and the associated recreational activities in coral reef areas if not with careful planning and control result in heavy deterioration on the coral reef communities (Sudara & Nateekarnchanalap, 1988; Rogers, 1988b; Rinkevich, 1995; Rajasuriya *et al.*, 1995; Jameson *et al.*, 1999). The physical damage to coral reef organisms caused by anchoring, divers, trampling and illegal destructive fishing activities has become a major concern of coral reef managers. Researches on evaluating the mechanical damage and the ecological impacts of the recreational activities and the destructive fishing methods on the Red Sea coral reefs is almost scarce (Hawkins & Roberts, 1996).

Almost all tourism to the Red Sea occurs in the north within Egypt and Jordan. In Egypt, rapid tourism development over the past 20 years has dotted the coastline with numerous recreational resorts, and ambitious plans will potentially quadruple the number of tourists visiting the area by the year 2005 (Hawkins and Roberts, 1994). The most deleterious anthropogenic activities for tourism development along the Egyptian Red Sea coast are 1) Enhancing construction activities (hotels, seaside recreational resorts, roads, expansion of coastal cities.... etc.). 2) Boats anchoring and grounding or striking on coral reefs. 3) Snorkelling and SCUBA diving. 4) Trampling by inexperienced divers and snorkellers, and non-swimming visitors and residents on reef flats. 5) Recreational fishing of reef fishes for aquariums. 6) Destructive fishing methods such as the use of explosives, spears and bottom-set nets to catch spiny lobster and reef fishes. 7) Excessive collection of corals, shells and other reef invertebrates to sale as souvenirs.

Increased coastal tourism can also be expected to increase coastal urbanization, which poses additional threats to coral reefs. Most fishing in the Red Sea is focused on adjacent reefs. The illegal destructive fishing, particularly blast fishing, using poisons or intoxicants, bottom-set nets and spearfishing which are widespread in the Red Sea, causes substantial mechanical damage to coral reefs (UNEP/IUCN, 1988; Öhman *et al.*, 1993; Glynn, 1994; Rajasuriya *et al.*, 1995; Riegl & Luke, 1998). Cyanide fishing is probably the most destructive and efficient mechanism of harvesting reef fishes, but kills most of reef invertebrates including corals, thereby diminishing chances for new fish recruitment (Wilkinson, 1996). Heavy collection of shells and other invertebrates (for marine curio trade) on the reef will change the community structure, which will result in changing the condition of the reef at the end (Sudara & Nateekarnchanalap, 1988).

Infrastructure, like widespread seaside construction of hotels, recreational resorts, roads, beaches…etc. poses a potential threat to the coastal zone and coral reefs. For example sediment released by construction can kill corals directly by physical smothering and burying coral fragments within sediments, and reduce coral growth rates and their ability to settle (Rogers, 1990; Hawkins & Roberts, 1992a). Nutrient enrichment caused by sewage disposal or seepage of wastewater from these tourist centers can cause algal blooms, which overgrow and kill corals (Walker & Ormond, 1982; Riegl & Velimirov, 1991).

Physical damage to corals from boat anchoring and grounding has been identified as a major cause of reef destruction in many reef areas of the Egyptian Red Sea coast (Riegl & Velimirov, 1991; Hawkins & Roberts, 1992a; Ali, 1993; Jameson *et al*, 1999). The fast growing corals are broken to a great extent by repeated anchoring. In addition, viewing of corals through glass-bottom boats is a popular recreational activity in the Red Sea. Glass-bottom boats cause considerable physical damage to the reef as they may break corals by running over shallow coral patches (Rajasuriya *et al.*, 1995).

In recent years, Egypt has produced an ambitious program for tourist development around the Red Sea coast, in which diving and snorkelling play a central role. Divers and snorkellers accidentally or intentionally break corals by bumping, standing, kicking, trampling and holding onto them (Rogers, 1988b; Hawkins & Roberts, 1992b, 1996; Rinkevich, 1995).

A number of studies have looked at the effects of trampling on coral reef flats (Woodland & Hooper, 1977; Antonius, 1984; Rogers, 1988b; Kay & Liddle, 1989; Hawkins & Roberts, 1993). All found that trampling physically damaged coral colonies and increased loose fragments of live corals. Also, Trampling increased the percentage cover of bare rock and rubbles, while it reduced number of hard coral colonies and total percentage of live hard coral cover. Smaller coral colonies with shorter and thicker branches were higher in heavily-trampled compared to little-trampled areas.

The resuspended sediments due to SCUBA Divers, snorkellers, trampling by innocent reef visitors and residents, and boat grounding may also exert a severe stress on corals (Neil, 1990; Rogers, 1990).

Coral diseases:

Diseases of reef corals are known since about 30 years (Antonius, 1973). The first four diseases were listed and described by Antonius (1981a) are Bacterial Infection (BIN), Black Band Diseases (BBD), White Band Diseases (WBD), and Shut-Down-Reaction (SDR). BBD was the first disease reported to affect scleractinian corals (Antonius, 1977, 1981b; Peters, 1997). It was first discovered in the Caribbean Sea (Garret & Ducklow,1975; Peters, 1993; Edmunds, 2000) and Western Atlantic reefs (Rutzler *et al.*, 1983; Rutzler & Santavy, 1983; Santavy & Peters, 1997). Subsequently, it was reported in Indopacific (Antonius, 1985; Littler & Littler, 1996), Red Sea (Antonius, 1985, 1987, 1988a, b) and Great Barrier Reef (Miller, 1996). The causal agent has been identified as a cyanophyte algae *Phormidium corallyticum* (Rutzler *et al.*, 1983; Rutzler & Santavy, 1983; Antonius, 1985, 1987, 1988a and b; Edmunds, 2000). The BBD appears as a black band (mat), a few mm to a few cm in width, separating bare coral skeleton from living tissues (Antonius, 1988b; Peters, 1993; Santavy & Peters, 1997). Black Band Disease was followed by observations on bacterial attacks on corals (Mitchell & Chet, 1975; Ducklow & Mitchell, 1979; Antonius, 1981a) and the description of a WBD, the name refers to a band of white coral skeleton (Antonius, 1981b, 1985, 1987; Peters *et al.*, 1983). Bacterial growth increases with increased production of coral mucus and could cause death by sulfide poisoning, oxygen depletion and attack of coral tissue (Ducklow & Mitchell, 1979; Peters, 1993). Glynn (1983, 1984) investigated the widespread phenomenon of Tissue Bleaching (TBL) or Coral Bleaching in Panama, followed by observations in the Caribbean (Williams *et al.*, 1987) and culminated in a special issue of coral reefs containing eleven contributions devoted to coral bleaching (Brown, 1990). Antonius (1988a) recorded the coral bleaching in the Red Sea and attributed this phenomenon to the unfavorable natural and man-made influences. The term "bleaching" refers to a loss of color of the coral tissue, brought about by a reduction in the number of zooxanthellae, by a loss of photosynthetic pigment, or by a combination of both.

Antonius (1995a) reviewed the pathologic syndromes on reef corals and fell them into two categories: diseases without and diseases with pathogens. In the first group, no pathogen is involved in the progress of the disease, but the pathologic condition (or reaction) is caused or triggered by outside influences. This is the case in Tissue Bleaching, Shut-Down-Reaction, and White Band Disease, these diseases are also lumped under the term white syndromes (WS). In the second group, progress of the disease depends on the pressure of a distinct pathogen. This group includes Black Band disease, Black Overgrowing Cyanophyta (BOC), Black Aggressive Band (BAB), Bacterial Infection and Fungal Infection (FIN). So far, BBD has been described exhaustively, while BOC and BAB have only been mentioned recently (Antonius, 1993). Since the pathogen in these diseases is usually visible as a dark band or dark overgrowth, they are jointly referred to as Black Syndromes (BS). It is possible to use coral diseases as a diagnostic tool for the assessment of reef health (Antonius, 1985, 1987, 1995b; Antonius & Weiner, 1982; Antonius & Riegl, 1997).

The objectives of this study are:

1- To determine the effects of increased sedimentation, suspended particulate matter, eutrophication, oil and heavy metal pollution, and the recreational activities associated with tourism development on coral reefs in the northwestern part of the Egyptian Red Sea coast.
2- To provide base-line data on coral community structure of the studied reef sites at this time, so that future changes due to natural or man-made influences can be monitored through further studies.
3- To assess the occurrence and distribution of four coral diseases (White Band Disease, Black Band Disease, Coral Bleaching and Bacterial Infection) as indicators of reef health status in the area of study.