CORAL REEFS OF THE GULF OF MEXICO: CHARACTERIZATION AND DIAGNOSIS

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INTRODUCTION

The Gulf of Mexico is a tropical to subtropical sea, partly oligotrophic and with relatively restricted marine circulation given that it is an interior sea. The ocean dynamic is determined mainly by the Loop Current, which also has an influence on coastal water movement, particularly when eddies that separate from that current contribute to forming other currents close to the coasts. The force of the wind on the surface of the water plays an important role in coastal and ocean water dynamics. In contrast to what happens in most of the Caribbean, there are two different tidal systems in the Gulf per year, one is generated by trade winds during most of the year and the other is generated by the north winds, during the winter season. The Gulf is also characterized by the influence of great riverine systems (from Laguna de Términos to the Mississippi River Delta and the continental shelf of Florida), that create unfavorable environmental conditions for the coral reef biota. Yet even in the northeastern part of the Yucatan continental shelf, where there are no rivers, the effect of upwelling in the Yucatan Channel and perhaps also freshwater inflow from groundwater, also result in an unfavorable environment for forming coral reefs. Thus, on a large part of the Gulf of Mexico continental shelf, conditions for the development of coral reefs are not appropriate; in fact, of the approximately 360,000 km^2 of shallow waters (less than 50 m deep) of the Gulf continental shelf, less than 1% is covered by emergent coral reefs, although the area colonized by coral biota is considerably larger.

This study focuses on emergent and quasi-emergent coral reefs because they have been able to maintain sustained growth during the rise in sea level, during the Holocene transgression. This type of reef can only be found on the Mexican continental shelf inside the Gulf of Mexico and in shallow areas associated with the Florida Straits, as in the Florida Keys and the reefs to the northwest of Cuba. However, the latter are not included in this paper because their development and condition are determined by very different environmental circumstances to those in the Gulf, given that in the Florida Straits there are intense oceanic dynamics as a result of the constant flow of the Yucatan Current towards the Atlantic Ocean. For the same reason, it is unlikely that these reefs interact directly with the reefs within the Gulf.

In the interior of the Gulf there are other formations that do not reach the surface of the sea and do not originate from reefs, characterized by limited or no accretion capacity, despite possibly being densely colonized by coral biota. Such is the case of the submerged banks that form the Middle Grounds in the northwestern part of the Florida shelf and, in particular that of the numerous diapiric banks such as Flower Gardens along the edge of the Texas and Louisiana continental shelf (Rezak *et al.* 1990). Furthermore, these banks are in relatively deep locations (20 m or more), and the environmental conditions that surround them are rather peculiar, resulting in the absence of *Acropora* corals, one of the most important reef builders, and gorgonians, another common component of Caribbean reefs. In the internal basin of the Gulf, there are also some “deep reefs” hundreds of meters below the surface that, in reality, do not have a reef matrix, but are dense communities of non-symbiotic coral, such as *Lophelia*.

EMERGENT CORAL REEFS OF THE GULF OF MEXICO

Emergent coral reefs that exist in the interior of the Gulf of Mexico are found only on the Mexican continental shelf and their level of development is analogous to reefs of the same type in the Caribbean Sea. These reef systems are mainly located in two regions of the shelf: in the Bay of Campeche and on the shelf off the city of Veracruz. Beginning with Heilprin (1890) numerous authors have described the characteristics of these reefs and there is ample literature on the subject (see a review in Jordán-Dahlgren and Rodríguez-Martínez 2003). However, in order to provide the required background a synthesis of their characteristics is provided below.

VERACRUZ REEFS

In the waters off the state of Veracruz, there are four reef groups composed of geomorphologically well-developed reef banks, characterized by relatively steep lower slopes and a shallow upper slope, in three geographically discrete areas (Fig. 17.1): Antón Lizardo (8 reefs); Veracruz (7 reefs); Tuxpan (3 reefs) and Isla de Lobos (3 reefs). These reefs are located relatively near the coast, between a few hundred meters and little more than 20 km. Some, such as Hornos and Gallega in Veracruz, are so close to shore that they have already been severely impacted by anthropogenic coastal expansion. The area of each reef is moderate, less than 10 km^2 and the base of the reef slope is located at depths that vary from 20-45 m. The distributional pattern of these reefs suggests a foundation of fossilized reef remains, although it is not possible to discard the possibility that they have developed on basalt or salt domes (Freeland-Lockwood 1971). Apart from these reefs, coral patches on hard seabed can be found at several points along the coast, characterized by little or no accretionary growth.

Biologically, the coral community of these reefs is diverse and abundant, with many species of scleractinian coral (Emery 1963; Horta-Puga and Carricart-Ganivet 1993), and patterns of zonation that vary markedly between the windward and leeward reefs. The external shallow windward part is dominated by extensive monospecific belts consisting of large colonies of branching corals such as elkhorn coral, *Acropora palmata*, whereas on the leeward reef the community alternates between extensive fields of staghorn coral, *Acropora cervicornis* and mixed coral, where massive species predominate. In the intermediate and deep parts, massive coral formations of *Montastraea*, *Diploria* and *Colpophyllia* tend to dominate, but in general the species richness is relatively high. Another important biotic group, that plays a major role in consolidating the reef matrix, consists of various genera of coralline algae that dominate shady and dark environments. In contrast, gorgonians are poorly represented in these reefs, in spite of being a typical component of the Caribbean reef biota.

A significant fact is that practically all the colonies of both species of *Acropora*, that form the extensive coral belts and fields mentioned above, died during the 1980s, probably due to the white-band disease (Gladefelter 1982), leaving only the skeletons standing and being eroded. Jordán-Dahlgren (1992) reported a very slow initial re-colonization process, and subsequent casual observations, made by different researchers, indicate that this slow rhythm has not changed recently. To date, it is not yet known whether other lethal diseases have proliferated in these reefs, and if they have, at what level; but in some of them there is evidence of high levels of bio-erosion in living colonies of *Diploria.*

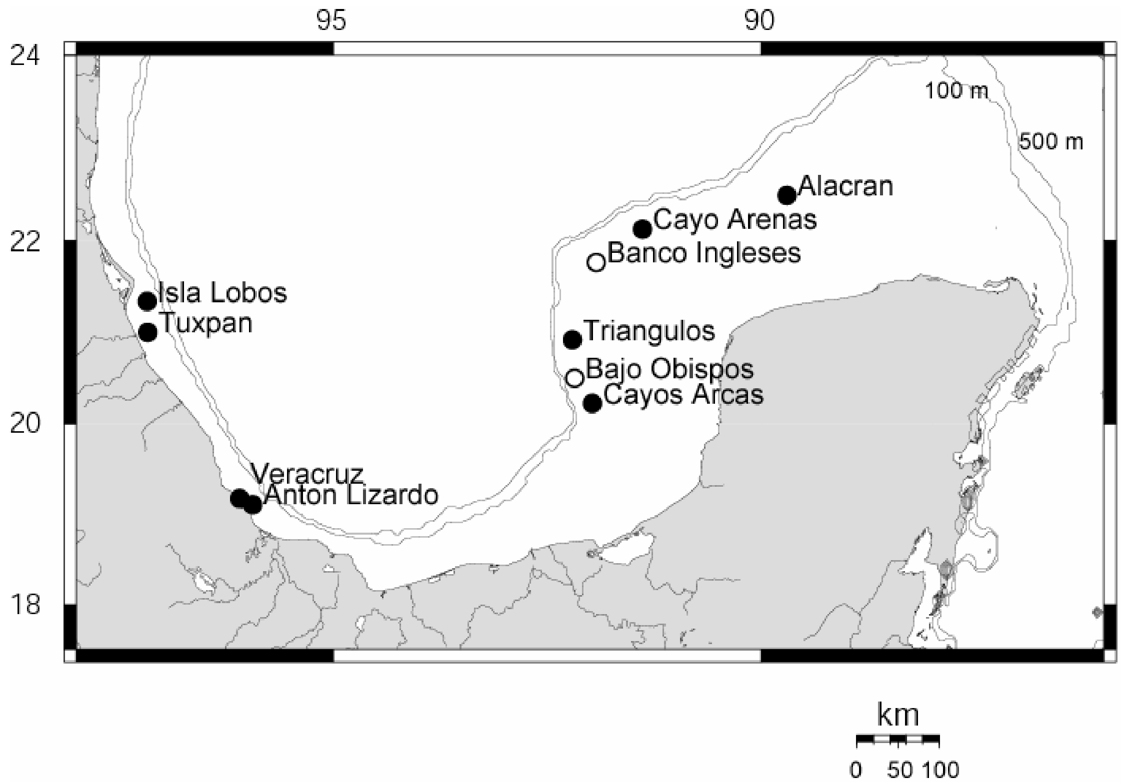

Fig. 17.1. Coral reefs in the southern Gulf of Mexico. Reefs are denoted by black dots, submerged banks by white.

CAMPECHE BANK REEFS

The coral reefs in the Bay of Campeche are mainly located near the edge of the continental shelf, very far from land, although there is a group of three small reefs near the coast, off Sisal, Yucatan (Fig. 17.1). Morphologically these reefs are bank reefs (vs. fringing reefs in Veracruz), but there are structural differences between them and they are generally isolated structures, although there are some reef groups such as the reefs that make up Triángulos. Several of these reefs are emergent and form islands, called keys, while others are a few meters below the sea surface. The areas of the emergent reefs vary between 3-20 km^2, except Alácran Reef, with an area of 650 km^2. Although it has not been confirmed, Logan (1969) postulates that the base on which these reefs have been formed corresponds to ancient dunes and that reef growth occurs during transgressive stages. Recent data shows that the rates of growth are sufficiently high to have maintained reef growth during the last rise in sea level (Blanchon and Perry 2004), and that they are the highest that have been reported for the Holocenic transgression (Macintyre *et al.* 1977). In fact, many of these reefs show marked features of active reef growth, such as spurs and grooves on both windward and leeward sides.

The community of scleractinian corals that colonizes and maintains these reefs is diverse and abundant (Bonet 1967; Logan 1969; Farrel *et al.* 1983), the same as other components of the coral reef biota (Jordán-Dahlgren and Rodríguez-Martínez 2003). The shallow part of the reefs tends to be dominated by *Acropora palmata* and *A. cervicornis* associated with a multi-specific or variable group according to the particular habitat. While *A. palmata* sometimes forms extensive honeycomb type structures in the windward zone, as can be seen in Cayo Arenas, *Acropora cervicornis* forms extensive fields in shallow and protected areas up to a depth of 35 m as seen on the leeward of Triángulos Este. Occasionally, the non-fertile hybrid *A. prolifera* is abundant in shallow parts of these reefs. In the intermediate depth zones, hard substrates of low relief predominate that are colonized by a diverse group of species with coral, gorgonians and sponges. Here, colonies of scleractinians are abundant although relatively small, and thus insufficient to form secondary reef structures. However, even though low relief, hard substrates predominate spatially, there are also areas with well-developed secondary structural features. In fact, the proportion of low relief bottom to high relief bottom is highly variable among the Campeche Bank reefs, but massive coral in the genera *Montastraea*, *Diploria* and *Siderastrea* predominate regardless. In the deepest parts, the same pattern may exist, but in general species dominance is considerably higher, and in several sites *Lobophora variegata*, a fleshy alga capable of competing effectively with coral for control of the substrata, is very abundant. Coralline algae are also very abundant, even in well-lit areas of the upper shelf, where they play an active role in consolidating the remains of *A. cervicornis* skeletons. The gorgonians are relatively well represented, although they show a process of relative isolation with regards to dominant biota in the Caribbean Sea (Jordán-Dahlgren 2002). Of particular note is that in the shallow and protected sandy parts of the reef, pediceled calcareous algae are not abundant and in many reef lagoons marine grasses are absent.

As in the reefs off Veracruz coast and in others of the greater Caribbean, almost all the acroporid colonies died a decade ago, probably due to white-band disease. The process of re-colonization by these species on Campeche Bank reefs appears to be faster than that observed in the reefs off the Veracruz coast (Jordán-Dahlgren 2003). Another situation observed in these reefs is the growing incidence of lethal yellow-band syndrome (Jordán-Dahlgren and Rodríguez-Martínez 2003) that mainly attacks coral in the genus *Montastraea*. This situation is a cause for concern because these species, together with the acroporids, constitute the fundamental group of reef builders in the Caribbean biogeographical region.

ENVIRONMENTAL QUALITY, ANTHROPOGENIC IMPACT & NATURAL DISTURBANCES

Severe changes have occurred in the quality of marine environment in modern times, both locally and globally, that affect coral reefs and communities in the Gulf of Mexico and the rest of the world. The causes of this environmental deterioration are many, but in general it is the accumulated effect of local, regional and global environmental impact that may result catastrophic situations. I will describe the local environmental situation for each of the reef systems described, including the potential regional and global impacts that may be affecting them, then discuss the possible ecological scenarios that could result.

VERACRUZ REEFS

The reef system that has been impacted the most in the Gulf of Mexico is, without doubt, the reefs off the Veracruz coast. This is a result in large measure of their geographic location, given that they are to be found in a marine medium with strong continental influence from the discharge of the large riverine systems that characterize this region of the Gulf, and also because it is one of the zones with greatest urban, agricultural and industrial development in the country. The freshwater discharges affect the reef environment, particularly during the rainy season, because they carry large quantities of suspended sediment that causes a drastic reduction in water clarity of the water and then settles on the bottom covering coral and other sessile organisms of the coral community. The nutrients carried by the water also results in drastic changes in the oligotrophic environment that this biota requires. In addition, riverine discharge also carries large quantities of urban, agricultural and industrial pollutants from runoff in the watershed, that combined with direct runoff from cities and towns along the coasts, results in a highly polluted marine coastal environment in the vicinity of the reefs (Horta-Puga and Barba-Santos 2003). A potential effect of great concern of the input of nutrients and contaminants is the eutrophication of the environment, with excess of nutrients causing greatly increased populations of sessile fleshy algae that can eliminate coral because they have much higher rates of growth and reproduction.

In addition to indirect impacts, there are also direct impacts, and the most important of these are related to extraction activities, particularly fishing (overfishing) and extraction, with little or no control, of coral, shells and other organisms for sale to tourists as souvenirs. These activities have diverse effects on coral communities and are more severe than in other systems for many reasons; one that is very evident is that coral grows very slowly and cannot quickly regrow after removal. Another effect that is potentially very dangerous is overfishing, given that there is evidence that in Caribbean reefs, overfishing associated with other stress factors, can cause a collapse in the coral community (Hughes 1994). Another type of direct impact that has existed for a long time is that of boats running aground, which destroys coral biota in the area of impact, and the impact can subsequently increase as a result of salvage efforts or movement of the boat during storms. Finally, in the case of reefs off the city of Veracruz, an important impact has resulted from modifications to the coast, first from the construction of the San Juan de Ulúa fortress (built partly with reef rock extracted from local reefs) and subsequently from the construction of the port and seawall of city, which drastically changed coastal sediment transport and beach dynamics. The result has been the progression of the coastline over the reefs closest to the coast, an effect clearly observable today on Hornos and Gallega reefs.

CAMPECHE BANK REEFS

In contrast to what happens with the nearshore Veracruz reefs, those of the Campeche Bank (except the small reefs off Sisal), form in an entirely ocean environment because of the great distance that separates them from the coast. Furthermore, sedimentation effects are reduced because the Yucatán Peninsula is a predominantly karstic landmass, with little soil and no surface rivers. The source of the nearest continental influence is from the riverine contribution of the Grijalva-Usumacinta system, but significant effect ends to the south of the northernmost reef in the Bay of Campeche, Cayo Arcas (Logan 1969). The effect of groundwater outflows from the Yucatan Peninsula into the Bay of Campeche and the coral reefs located there is unknown, but it is probably of little importance to the reefs because of the great distance that separates them from the coast. Therefore, indirect anthropogenic impact originating in the Yucatan Peninsula is minimal, if any at all, although there could be pollution from the Caribbean Sea.

Direct impact on Campeche Bank reefs is basically that of fishing and grounding. To date, the levels of overfishing correspond to the species of high commercial value, and in this sense this resource is less affected than that of the reefs off the Veracruz coast, while boats running aground are scarce because it is not an area of heavy marine transportation. On one reef in particular, Cayo Arcas, there has been industrial impact associated with the construction and operation of a platform to load petroleum tanker ships. However, our research suggests that if there was damage to the coral community as a result of this activity prior to our studies (1996 to date), evidence of it disappeared due the catastrophic effect caused by the waves generated by the 1995 hurricanes Opal and Roxanne (unpublished data). Currently, there is no evidence of major damage, but it is yet to be known if industrial activity near the Cayo Arcas reef will have a negative and significant effect on the natural recovery of the coral community.

REGIONAL AND GLOBAL EFFECTS ON THE CORAL REEF ECOSYSTEM

On the Gulf of Mexico scale, one of the natural factors of change is the wave action produced by hurricanes and tropical storms in summer and even by "Nortes" (cold fronts with high winds/waves) in winter. This destructive wave action has the capacity to cause changes in the coral community of the reefs and evidently the high intensity cyclones have a greater effect, yet even low category cyclones can provoke catastrophic damage if they move around a reef system, as was the case with Hurricane Roxanne (1995) in the southern Bay of Campeche. According to Jordán-Dahlgren and Rodríguez-Martinez (2003), and based on an analysis of information available for the last 111 years, the period of return for high intensity hurricanes (categories 3 to 5 on the Saffir-Simpson scale) is 37.1 years for the Veracruz coast, but only 12.3 years for the Bay of Campeche. However, if as a consequence of global warming there was a significant increase in the frequency and intensity of tropical cyclones (as predicted by models of the Intergovernmental Panel on Global Climate Change), the effects could be devastating given that the rate of recovery of the coral community is naturally very slow. Another potential effect, particular from strong Nortes, would be that of generating a thermal collision as a result of an abrupt drop in the temperature of the surface of the sea which could provoke massive mortality in some of the components of the coral community, as has been documented for the Florida reefs.

Another potentially important regional effect is that of sedimentation and pollution, that, upon being released into the Caribbean Sea, reach the Gulf reefs, given that the predominant circulation in the Caribbean is toward the Yucatan Channel and from there to the Gulf of Mexico. Even though the relative importance of its effect on coral communities of the interior of the Gulf is unknown, the transport mechanism undoubtedly exists. In fact, a large part of the trash that reaches the beaches of the Campeche Bank reefs islands and of the state of Veracruz comes from the Caribbean, and most of the tar is from petroleum spills in Venezuela or Trinidad and Tobago. On the other hand, recent, although controversial, evidence suggests that the quality of deep-sea water in the Caribbean Sea is being significantly degraded by anthropogenic activity carried out around and within the Mediterranean Sea. However, if this is really the case, it is initially of greater concern for the Campeche Bank reefs than for those of the Veracruz coast, that are already being influenced by high levels of local pollution and sedimentation.

Global climate change, particularly warming of the atmosphere and the increase in UVB radiation, has numerous negative effects on the coral community, although its effect differs between regions and local areas. In addition to its effects on ocean climate, global warming has very serious biological consequences for the stability and health of the coral reef ecosystem. An example of this situation is the increase in bleaching events that affect zooxanthellate corals and other symbiotic organisms. Another example is the emergence of lethal infectious diseases for many coral community species, but especially corals. The bleaching phenomenon is a result of the coral host expelling the symbiotic, zooxanthellate algae when it is under severe stress, which is an unequivocal sign of very difficult environmental conditions. This might happen for many reasons, but the warming of the sea surface is the most important, because it covers great expanses of the ocean. Depending on the severity of the event, bleaching can have a temporary effects or it can provoke mass mortality that could cause the collapse of the coral community, as has happened in several locations in the Pacific, the most recent in 2001. To date, there have been no reports of lethal mass bleaching in the coral reefs of the Gulf of Mexico. However, isolated bleached colonies are commonly seen and in any case, slight bleaching may go unnoticed. Even when the bleaching episode is not lethal, partial loss of zooxanthellate algae reduces the physiological capacity of the affected corals, which, among other things, can result in reduced resistance to competitors, parasites and pathogens.

In contrast to the Pacific, in the Caribbean and the Gulf of Mexico the incidence of infectious diseases in coral and other organisms, is relatively high and furthermore, widely distributed. This situation is probably the result of a combination of the effects of many direct and indirect factors, but increased sea surface temperatures in particular is very important, because many pathogens increase their activity and their rates of reproduction at higher water temperatures (Dazsak *et al.* 2001; Harvell *et al.* 2002). Since corals may be physiologically weakened by deterioration in the environment, while pathogen activity is increased by the same conditions, there is a tendency toward high levels of disease incidence and coral mortality. The Gulf of Mexico reefs are already suffering from the effects of these diseases as shown by the 1980s mass die-off of acroporids (Jordán-Dahlgren 1992, 2003) and the growing incidence of other diseases such as yellow-band disease (Jordán-Dahlgren and Rodríguez-Martinez 2003). Some of the pathogens identified as cause of the diseases that we have identified in Gulf of Mexico reefs originate on land, such as the fungus *Aspergillus sidowii*, or a common bacteria in human digestion and other marine and land animals (*Serratia marcescens*; Paterson *et al.* 2002), which indicates a combined effect of local and global effects. Another lethal disease that has proliferated in the Gulf reefs, as well as in those of the Caribbean, is that which caused the mass death of the sea urchin *Diadema antillarum*, a very important herbivore in the reef environment that is capable of controlling the growth of fleshy algae and whose importance increases significantly when there is overfishing of herbivorous fish.

GENERAL CONSIDERATIONS & POSSIBLE SCENARIOS

Based on the above, currently there is significant deterioration marine environmental quality as a result of local, regional and global impacts. This deterioration affects, to varying degrees, the coral reefs and communities of the Gulf of Mexico. The biggest potential problem is that key species will be decimated causing catastrophic collapse of the coral community. Evidently, the reefs off the Veracruz coast suffer the greatest environmental pressure, due to multiple local impacts, and thus the possibility of mass mortality produced by lethal diseases and/or bleaching is potentially high. Campeche Bank reefs are not immune to this threat, but the level of ecological risk is probably lower because the impact of local effects is low (Table 17.1).

Table 17.1. Relative impacts of local and external factors on reefs of the Gulf of Mexico. 0 = None; +++ = High; ++ = Medium; + = Low; ND = No data

	Reefs	
Impacts	Veracruz	Campeche Bank
Anthropogenic Factors		
Overfishing[1]	+++	+++
Destructive fishing methods	0	0
Specimen collection	+++	ND
Coral mining (historic)	+++	0
Dragging	+++	0
Grounding	+++	++
Anchor damage	++	+
Local deforestation	+++	0
Tourism	++	+
Urban pollutants	+++	0
Industrial pollutants	+++	+ to ++
Oceanic pollutants[2]	++	+
Terrestrial pollutants[3]	+++	0
"Natural" Events[4]		
Loss of acroporids	+++	+++
Loss of *Diadema*	+++	+++
Overgrowth of macroalgae	++	++
Tropical cyclones[5]	+++	+++
Bleaching	ND	ND

[1] Mainly carnivorous fish of high value.
[2] Trash and other materials transported to these reefs by currents of western Caribbean.
[3] Trash and materials carried by rivers.
[4] Conditions that may be induced or exacerbated indirect anthropogenic impacts.
[5] Current condition of the reefs after recovering from the impact of hurricanes.

In case there is a severe reduction in the population density of key species, as in the case of the acroporids, the capacity for local reproduction is reduced or eliminated. In this situation maintenance and/or eventual restoration of adequate population density will depend on the immigration of larvae from distant areas (the Caribbean, for example). However, in order for this mechanism to have a significant effect on the population, a high level of ecological connectivity is required, which depends on the reproduction effort of the species in distant production areas, and also on the efficiency of the larval transport mechanism. The degree of ecological connectivity is a fundamental element in the rational management and conservation of the reef systems. However, there is very little information on this topic. There is some evidence that levels of ecological connectivity among reefs in the Gulf of Mexico is low, as suggested by the the existence of decreasing gradients in gorgonian species richness and abundance of the Caribbean to the interior of the Gulf of Mexico (Jordán-Dahlgren 2002), which shows. These patterns seem to be best explained by models of ocean and coastal circulation in the Gulf that show that barriers to the dispersal of larvae exist that extend from the Yucatán Channel (due to the effect of upwelling), to the western coast of the Gulf (due to the effect of river discharge). Both types of information, that of decreasing gradients in gorgonians and the models of circulation, allow us to consider that an efficient ecological connectivity at the population scale is sporadic and infrequent, particularly between the Caribbean and/or Campeche Bank and the reefs off the Veracruz coast.

As proposed above, one of the dangers of the massive loss of key species is the high probability of community collapse, that is replacement of coral by another type of organism (e.g., macroalgae, sponges or colonial zooanthids), that are not reef constructors, and can dominate the reef substrata. Among the many ecological consequences of a change in community of this type, would be the difficulty of successful recolonization by corals and associated biota, because the alternative community would tend to be stable while the conditions that allow their colonization of the reefs are maintained (Done 1992). In fact, should original environmental conditions be restored, the slow rate coral recolonization would mean that coral communities might take decades to be reestablished. While the changes of state in the coral community are possible when there is a significant change in the quality of the environment (Knowlton 1992; Wilkinson 2000), it is difficult to predict how and when this change would take place in a given reef. This difficulty is due to the complex nature of these ecosystems. They do not respond monotonically to stress, because there are many elements that act synergistically, and there are several routes for the flow of energy within and between the different trophic levels, which among other things, eliminates the possibility of finding a species that indicates the global condition of the community.

In addition to the above, the possibility of coral community collapse and its substitution with another community that does not contribute to reef structure growth and maintenance, is very worrying because the upper part of the reef can be rapidly eroded. This would happen because, while the reef matrix is mainly formed and maintained by coral biota, the high relief structures that are formed also regulate the environmental setting of the coral community, which contributes to its development. In fact, while the coral community of a coral reef tends to be very stable, the community that exists on hard substrates adequate for but not colonized by coral biota is transitory (Jordán-Dahlgren 1992). Suitable substrates and environmental conditions for coral growth are important because they guarantee formation and maintenance of reef structure, by ensuring a balance between constructive processes and erosive processes, which produce the material required to form the reef matrix. If, on the contrary, erosive processes predominate, then the superficial reef structure is rapidly destroyed by the combined effect of bioerosion and wave action, given that while constructive processes require coral (and other carbonate producing organisms) growth and proliferation, erosive processes only require the existence of reef limestone.

CONCLUSION

Based on all of the above, it is evident that the environmental degradation caused by local, regional and global effects on the reefs of the Gulf of Mexico, particularly those that are on the continental shelf off the city of Veracruz, could result in collapse of the coral communities that maintain them. The main problem is that not only might the reef environment be colonized by organisms incapable of maintaining the reef structure, but also the slow pace of coral recovery, which even in optimum conditions, determines complexity of the coral community.

In terms of the accelerated human impacts, a change of this nature could well imply the loss of the coral reef ecosystem for many generations. To date, methods of artificial restoration are clearly insufficient to face problems at the reef scale and even less so if environmental deterioration, the original cause of the problem, persists or increases. This situation, with progressive deterioration of the environment and in which the technological resources available are inadequate to achieve effective artificial restoration at reef scale, means that there is only one feasible strategy for conservation of these coral reef ecosystems, as outlined in the following recommendations.

RECOMMENDATIONS

1) Guarantee no increase in the intensity of direct and indirect local impacts that currently affect coastal water quality and the coral community that inhabits the reefs;
2) Reduce the magnitude of impacts through strict enforcement of existing regulations; and
3) Prevent new impacts and/or reduce the effects of previous or ongoing impacts that degrade coastal water quality and the coral community that inhabits the reefs.

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