THE IMPACT OF FISH-KILLING PHYTOPLANKTON BLOOMS UPON MIDEASTERN GULF OF MEXICO REEFFISH COMMUNITIES

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THE IMPACT OF FISH-KILLING PHYTOPLANKTON BLOOMS UPON MIDEASTERN GULF OF MEXICO REEFFISH COMMUNITIES 1/

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ABSTRACT

A 1971 spring-summer Red Tide (Gymnodinium breve) and associated stress conditions resulted in the near extirpation of patch reef biotas from at least 1,536 km^2 of the central West Florida Shelf off Sarasota, Florida. Reeffishes, corals, sponges, polychaetous annelids, mollusks, decapod crustaceans, ascidean urochordates, echinoderms, and benthic algae all sustained heavy mortalities at reefs in 13-30 m, approximately 13-52 km offshore. An estimated 80 - 90% of the fish species inhabiting offshore, deep reefs (18-30m) and 77% (45 of 58) of the fish species occupying inshore, shallow reefs (13-18 m) perished during the Red Tide. Of the commercially important reeffishes, the red grouper (Epinephelus morio) and hogfish (Lachnolaimus maximus) were completely exterminated, but the gag (Mycteroperca microlepis), scamp (M. phenax), jewfish (Epinephelus itajara), and gray snapper (Lutjanus griseus) survived as remnant populations at scattered reef localities.

Certain reeffishes colonized shallow reefs almost immediately after Red Tide conditions abated; others did not appear for 10-12 months afterward. Several fishes previously rare or absent at shallow mideastern Gulf reefs (e.g., red snapper, Lutjanus campechanus) temporarily colonized there in abundance following the Red Tide.

High organic content arising from unusually heavy land run-off, elevated sea temperatures, water column stagnation, and dense phytoplankton blooms (especially Prorocentrum) contributing to anoxia in bottom waters, resulted in nearshore (8-24 km) reeffish kills along 97 km of the Florida west-central coast during July-September 1974.

The possible impact of these fish-killing phytoplankton blooms upon mideastern Gulf of Mexico reef fisheries is discussed.

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INTRODUCTION

Waters overlying the central West Florida Shelf frequently support dense phytoplankton blooms which sometimes cause or contribute to marine animal mass mortalities. Although the Red Tide organism Gymnodinium breve is usually implicated in these mass mortalities, other plankton species are occasionally responsible. During summer 1966, a bloom of the toxic dinoflagellate Gonyaulax monilata produced fish kills in coastal and nearshore waters along the southwest Florida coast (Williams and Ingle, 1972). Unpublished analyses of mollusk and echinoderm collections taken by the Florida Board of Conservation during 1965-67 indicate that this G. monilata bloom resulted in at least limited reef kills. Dense blooms of the dinoflagellate Prorocentrum were thought to be at least partially responsible for a lowered oxygen content in bottom waters, resulting in nearshore (8-24 km) reef kills along the Florida west-central coast during July-September 1974 (Smith, 1975a).

A 1971 spring-summer G. breve Red Tide in the mideastern Gulf of Mexico provided a unique opportunity to document and evaluate its impact upon selected reef communities studied since May 1970. Accumulation of baseline information at specific study reefs off Sarasota, Florida, allowed the unprecedented opportunity to record the degree of faunal and floral mortality and to study patterns of recolonization and succession of reef biotas for several years thereafter (Smith, 1975b).

Patches of discolored water and fish kills were reported between Naples and St. Petersburg along Florida's west coast during April through August 1971. Fish kills and a short-lived Red Tide occurred within Sarasota Bay during April (Steidinger and Ingle, 1972). Coastal and offshore fish kills were initially detected in southern areas of this region, but by early June, moderate fish kills and G. breve concentrations occurred between Sarasota and Ft. Myers, Florida (Steidinger and Ingle, 1972; Smith, 1975b). Subsequently, Red Tide blooms were transported inshore, resulting in massive fish kills within Tampa Bay and Charlotte Harbor (Steidinger and Ingle, 1972; Steidinger and Joyce, 1973). Red Tide conditions persisted in Tampa Bay and adjacent Gulf waters until September.

RESULTS AND DISCUSSION

OFFSHORE REEF KILLS DURING THE 1971 RED TIDE

SCUBA observations at widely scattered localities following the 1971 Red Tide revealed reeffish kills over at least 1,536 km^2 of central West Florida Shelf (Smith, 1975b). Fish kills were not limited to the smaller benthic fishes but included large jewfish and groupers (Serranidae), snappers (Lutjanidae), triggerfishes and filefishes (Balistidae), porgies (Sparidae), and grunts (Pomadasyidae) (Table 1). Although reeffish species demonstrated different tolerances to progressive Red Tide conditions, representatives of virtually every species common on the reefs were observed dead on the bottom and/or surface. Certain reeffishes with reduced or nonexistent swim bladders (e.g., gobiids and blenniids) were not visible in surface kills but were abundant on the bottom.

Table 1. List of Common and Scientific Names of Fishes Mentioned in the Text.

Family Serranidae	
Epinephelus morio	Red grouper
E. cruentatus	Graysby
E. itajara	Jewfish
Mycteroperca microlepis	Gag
M. phenax	Scamp
Serranus subligarius	Belted sandfish
Centropristis melana	Southern sea bass
Family Labridae	
Lachnolaimus maximus	Hogfish
Halichoeres bivittatus	Slippery dick
H. caudalis	Painted wrasse
Family Scaridae	
Scarus croicensis	Striped parrotfish
Family Lutjanidae	
Lutjanus griseus	Gray snapper
L. campechanus	Red snapper
Family Pomacentridae	
Pomacentrus variabilis	Cocoa damselfish
P. partitus	Bicolor damselfish
Family Grammistidae	
Rypticus maculatus	Whitespotted soapfish
Family Ephippidae	
Chaetodipterus faber	Atlantic spadefish
Family Blenniidae	
Blennius marmoreus	Seaweed blenny
Family Sparidae	
Archosargus probatocephalus	Sheepshead
Family Batrachoididae	
Opsanus pardus	Leopard toadfish
Family Pomadasyidae	
Haemulon plumieri	White grunt
Family Balistidae	
Balistes capriscus	Gray triggerfish
Family Chaetodontidae	
Chaetodon ocellatus	Spotfin butterflyfish
C. striatus	Banded butterflyfish
C. capistratus	Foureye butterflyfish

Reeffishes were not the only biotic elements to be adversely affected by the Red Tide. Corals, ascidean urochordates, mollusks, decapod crustaceans, sponges, echinoderms, and benthic algae all suffered heavy mortalities within the Red Tide area. Invertebrate mortalities were presumably due to secondary stresses (e.g., anoxia and hydrogen sulphide poisoning) rather than the direct action of G. breve toxin(s).

An estimated 80 -90% of the fish species inhabiting offshore, deep reefs (18-30 m) perished during the Red Tide. At inshore, shallow reefs (13-18 m), 77% (45 of 58) of the resident fish species probably perished. Fishes surviving as remnant populations at certain shallow reefs included the serranids Mycteroperca microlepis, M. phenax, Epinephelus itajara, and Serranus subligarius; the lutjanid Lutjanus griseus; the pomacentrid Pomacentrus variabilis; the ephippid Chaetodipterus faber; the grammistid Rypticus maculatus; the blenniid Blennius marmoreus; the sparid Archosargus probatocephalus; the batrachoidid Opsanus pardus; the pomadasyid Haemulon plumieri; and the balistid Balistes capriscus. Territoriality and thigmotaxis exhibited by most reeffishes certainly contributed to their nearly complete annihilation during the Red Tide. Fishes not ethologically or physiologically confined to bottom waters (e.g., L. griseus and B. capriscus) survived in greatest numbers, possibly by moving above the thermocline into more oxygenated waters. Reeffishes most susceptible to the Red Tide, as indicated by the early and complete eradication, were benthophilic sciaenids, chaetodontids, pomacanthids, labrids, and the serranid Epinephelus morio.

RECOLONIZATION AND SUCCESSION OF REEFFISHES

Certain reeffishes colonized shallow reefs almost immediately after Red Tide conditions abated (e.g., Chaetodon ocellatus, Epinephelus cruentatus, and Acanthurus chirurgus); others did not appear for 10-12 months thereafter (e.g., Halichoeres bivittatus, H. caudalis, Lutjanus campechanus, and E. morio). The early appearance of species of chaetodontids and acanthurids probably reflects their ability to utilize ocean current transport mechanisms due to their protracted planktonic larvae.

Several fishes previously rare (e.g., Chaetodon capistratus, C. striatus, and Acanthurus chirurgus) or absent (e.g., E. cruentatus, Scarus croicensis, Pomacentrus partitus, and L. campechanus) at shallow reefs colonized there following the Red Tide. Many of these latter fishes are deep water members of species pairs demonstrating bathymetric exclusion prior to the Red Tide. The shoreward expansion of species' ranges possibly reflects relaxed competition from congeneric and ecologically similar species exterminated or decimated at shallow reefs during the Red Tide. For example, juvenile red snapper (L. campechanus) became established only at shallow water reefs unoccupied by remnant populations of gray snapper (L. griseus).

IMPACT OF PREVIOUS RED TIDES ON MIDEASTERN GULF REEF COMMUNITIES

Direct SCUBA observations at mideastern Gulf reefs, both before and after the 1971 Red Tide, indicated that, under the appropriate environmental situation, certain G. breve blooms are capable of exterminating reef biotas. Seasonal progression and true ecological succession following reef kills result in a

procession of qualitatively and quantitatively distinct ichthyofaunas. Despite this, earlier speculations assumed that the effects of Red Tides are "negligible and short-lived" (Springer and Woodburn, 1960), they "only temporarily affect inshore and nearshore reef fisheries" (Steidinger and Ingle, 1972), and the "percentage kill is undoubtedly low" (Rounsefell and Nelson, 1966).

The severity of the 1971 Red Tide is probably not unprecedented. The present study, as well as Project Hourglass (Joyce and Williams, 1969) indicates that thermoclines may persist late into the year, particularly in deep water, and that isothermy may not occur until late summer. Accordingly, hydrological conditions have probably favored oxygen depletion in waters overlying reefs during past Red Tides, particularly those starting or re-initiated during spring and summer (e.g., 1947, 1954, and 1967).

Eyewitness reports and indirect evidence also suggests that events similar to those observed during the 1971 Red Tide have occurred in the past. Springer and Woodburn (1960) related reports that the southern sea bass (Centropristis melana) was common at nearshore reefs off Tampa Bay prior to the 1957-58 Red Tide, but rarely caught thereafter. Local fishermen also noted the red grouper (E. morio) to be more abundant than the gag (M. microlepis) prior to the 1957-58 Red Tide. Two years later, however, Springer and Woodburn (1960) found M. microlepis to be more abundant at local reefs. This seeming discrepancy is consistent with differential mortalities of E. morio and M. microlepis following the 1971 Red Tide. At shallow water reefs, E. morio populations were completely exterminated while M. microlepis survived as remnant populations. Capt. Andrew Rasmussen (pers. comm.)[2/] recollected that the hogfish (Lachnolaimus maximus) was not represented in inshore party boat catches off Cortez, Florida for 3-4 years following the 1957 Red Tide. Local fishermen have reported that certain reef areas "have the characteristics of productive (i.e., hard) bottom" in fathometer traces but are "nortoriously unproductive," possibly representing "dead bottom" areas devastated by Red Tides (Moe, 1963). A considerable quantity of dead sponges and alcyonarian corals observed at a reef site off Tarpon Springs, Florida, was thought to be linked to Red Tide conditions and fish kills persisting from November 1946 to August 1947 (Anonymous).[3/]

Nearshore (8-24 km) reeffish kills occurred along 97 km of Florida's west-central coast between Bayport and Sarasota during July-September 1974 (Smith, 1975a). However, G. breve was not implicated in these particular reef kills. High organic content, arising from unusually heavy land run-off, elevated sea temperatures, water column stagnation, and dense phytoplankton blooms (particularly Prorocentrum), undoubtedly facilitated oxygen depression in bottom waters overlying reefs.

2/ Andrew S. Rasmussen, party boat operator, 2600 Gulf Drive, Bradenton Beach, FL 33510, pers. comm.

3/ Anonymous, 1948. Survey of the sponge grounds north of Anclote Light. Unpublished report prepared by the University of Miami for the Florida State Board of Conservation, 21 p. Marine Research Laboratory, Florida Department of Natural Resources, St. Petersburg, FL 33701.

RED TIDES AND GULF REEF FISHERIES

Data analysis for two severe Red Tides (1947 and 1953) revealed landings of commercial and sport fishes to be largely unaffected (Springer and Woodburn, 1960; Steidinger and Ingle, 1972). However, the relationship of Red Tide to Gulf reef fisheries requires re-evaluation (Smith, 1975b). Following the 1971 Red Tide, for example, Sarasota-based party boats expended greater fishing effort farther offshore at unaffected reefs, thereby maintaining catches satisfactory to their clientele. Since these offshore, deep water fishes yielded more fishes and a greater incidence of larger fishes, the local sportfishing catch may even have increased after the Red Tide. Most commercial bottom fishermen are not immediately affected since most Red Tides occur inshore of their regular fishing grounds. Some fishermen, however, believe their future fishing success will be adversely affected by Red Tides, due to reduced recruitment through extermination of small groupers or depletion of breeding stock at shallower, inshore reefs (Moe, 1963). Catch statistics should be analyzed to see whether major Red Tides are accompanied 2-3 years later by reduced catches of groupers and gray snapper, due to diminished recruitment to the offshore, deep water commercial fishery of those species affected at inshore, shallow water reefs. Examination of hogfish (*L. maximus*) commercial landings from the Florida west coast between 1950 and 1974 reveals that the Red Tides of 1953, 1957, 1959-60, and 1971 were followed 1-2 years later by significantly reduced catches. The hogfish is particularly vulnerable to Red Tides because juveniles prefer inshore, shallow reefs and are acutely sensitive to early Red Tide conditions. During the 1971 Red Tide, the hogfish and all other labrid species were completely annihilated at shallow reefs.

Differential species tolerances during Red Tides and successional advantages of certain species thereafter may contribute greatly to year class fluctuations in reeffish populations. It is predicted, for example, that the expanded habitat available to juvenile red snapper following the 1971 Red Tide will be reflected by increased catches when these fish recruit to the deep water commercial fishery.

CONCLUSION

Compelling evidence has been presented to suggest that the occurrences of Red Tides and certain other phytoplankton blooms are important and hitherto underestimated phenomena, regulating composition, abundance, and distribution of reeffish assemblages on the central West Florida Shelf.

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