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Thomas J. Bright
Texas A&M University

Stephen R. Gittings
Texas A&M University

Richard Zingula
Houston Underwater Club

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OCCURRENCE OF ATLANTIC REEF CORALS ON OFFSHORE PLATFORMS IN THE NORTHWESTERN GULF OF MEXICO

The occurrence of Atlantic reef corals on artifical structures on the outer continental shelf in the northwestern Gulf of Mexico, and their general absence from such structures inshore, is of considerable interest in terms of the dynamics of reef coral populations in the region. Comparative study of the coral species inhabiting oil and gas platforms and natural hard bottoms in the northwestern Gulf can provide insight into questions concerning distribution of adult populations, environmental controls, reproductive strategies and timing, larval sources, transport, dispersal and recruitment.

The two major coral reefs in the northwestern Gulf of Mexico, the East and West Flower Gardens, will be designated a national marine sanctuary. From a management standpoint it will be useful to know the degree to which contemporary coral recruitment on these reefs is dependent on larvae produced by local adult populations as opposed to larvae transported into the area from other regions of the Gulf.

Observations

Bull and Kendall (1990) reported hermatypic brain corals, possibly *Diploria*, from unspecified platforms on the outer continental shelf off Louisiana. On January 22, 1989, four small colonies of hermatypic, scleractinian corals of the genus *Diploria* were observed and photographed by the authors on the well lighted, south side of a platform in Exxon's West Cameron lease block 630 at 28°00′N, 93°18′W (Figure 1). One colony of *Diploria strigosa*, about 20 cm in diameter, was found at 13.7 m depth

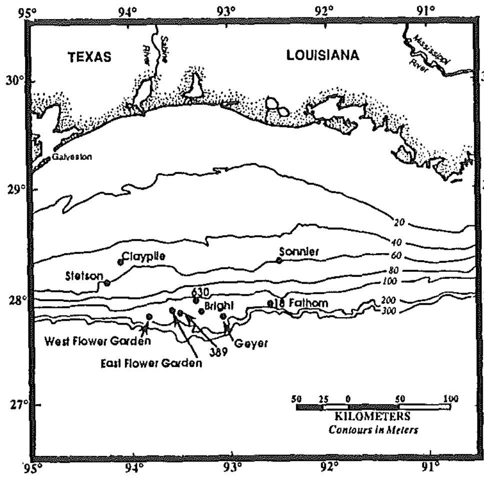

Figure 1. Locations of banks (named) and platforms (numbered) mentioned in text.

(Figure 2). Three colonies of *Diploria sp.* occurred between 3 and 4.3 m, however, specific rank could not be determined. This platform was emplaced in mid-1978, so the maximum possible age of these colonies is approximately 11.5 years.

On November 11, 1990 the authors observed and photographed at least four species of hermatypic, scleractinian corals on the southern legs and cross members of a platform which had been emplaced in Oct. 1981 in Mobil's High Island block A389 at 27°54′N, 93°35′W, approximately 1.2 miles southeast of the coral reef on the East Flower Garden Bank (Figures 1 & 2). These were: *Diploria sp.* (23 m depth), *Porites astreoides* (9 m), *Madracis decatis* (6, 17 and 23 m), and *Madracis asperula* (23 m). During November 1987, and periodically thereafter, patches of the zooxanthellate form of the hydrocoral *Millepora alcicornis* were observed between 1.5 and 9 m depth on platform HI-A389. Zooxanthellate *Millepora* has also been seen by the authors at similar depths on numerous offshore platforms in the region.

Populations on Natural Reefs and Banks

Off Louisiana and Texas, natural

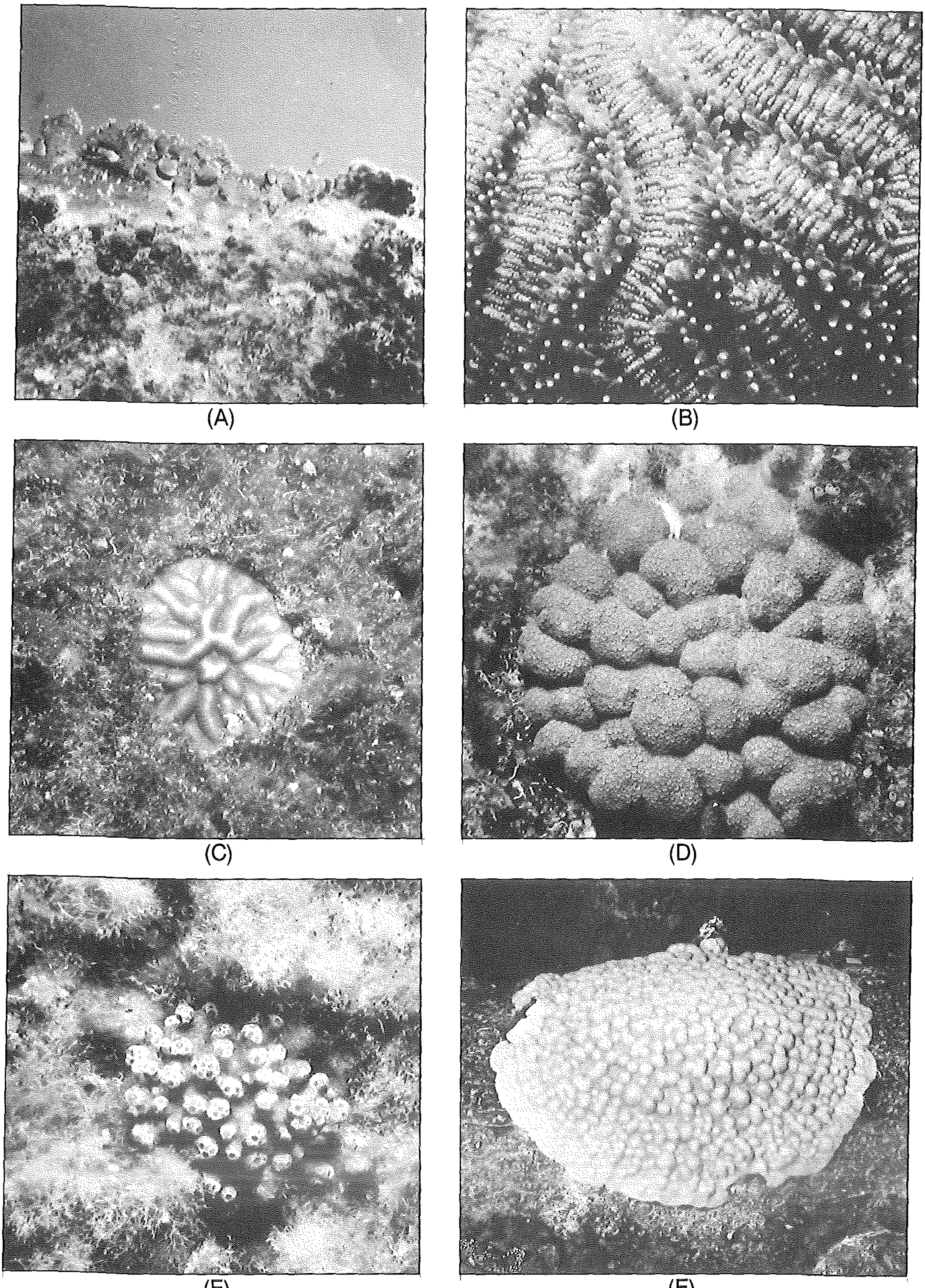

Figure 2. Hard corals from outer continental shelf oil and gas platforms. (A). *Millepora alcicornis*, 6 m depth, HI-A389. (B). *Diploria strigosa*, 13.7 m depth, WC-630. (C). *Diploria sp.*, 23 m depth, HI-A389. (D). *Madracis decactis*, 6 m depth, HI-A389. (E). *Madracis asperula*, 23 m depth, HI-A389. (F). *Porites astreoides*, 9 m depth, HI-A389.

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coral reefs have been reported from four continental shelf-edge banks. These banks are near both WC-630 and HI-A389 (Figure 1). Relatively high-diversity coral reefs with 18 species of reef-building corals occupy the crests of the East and West Flower Garden Banks above 36 m depth (Bright *et al.*, 1984). Deeper, lower-diversity coral reefs occur on the Flower Gardens between 36 and 52 m, on Bright Bank at 37 m and on 18 Fathom Bank between 45 and 47 m (Figure 1).

Among those species detected on the platforms, *Diploria strigosa* is also known from 15 to 55 m depth at the East and West Flower Garden Banks, where it forms large heads and ranks second in abundance to *Montastraea annularis* among the hermatypic corals of the shallower reefs [approximately 30% cover for *M. annularis* vs. 10% for *D. strigosa*, (Rezak *et al.*, 1985)]. Heads of *Diploria sp.* up to 1 m across were seen in the summer of 1989 by the authors at the edge of Stetson Bank, which is composed of claystone and siltstone outcrops and is not a coral reef (Figure 1). *Diploria spp.* do not occur in the northeastern or north central Gulf (Bright *et al.*, 1984).

Zooxanthellate *Millepora alcicornis* is abundant between 15 and 55 m depth at the Flower Gardens, where it ranks fifth in terms of percent cover of hard corals on the shallow reefs (2-4% cover). It is co-dominant with the scleractinian *Stephanocoenia michelini* on the deeper reefs of the Flower Gardens, as well as those on Bright Bank, and 18 Fathom Bank. *M. alcicornis* also occurs as an encrusting species in zones not considered to be coral reefs. As such it is reported from 53 m on 28 Fathom Bank (Bright and Rezak, 1978) and from the Florida Middle Ground in the northeastern Gulf of Mexico (Hopkins *et al.*, 1977). It is the dominant hard coral on siltstone outcrops on Stetson Bank (20-52 m), Sonnier Banks (18-52 m), Claypile Bank (40-45 m), and Geyer Bank (37-52 m) (Rezak *et al.*, 1985) (Figure 1).

Porites astreoides is sixth in abundance at the Flower Gardens, accounting for 2.25% of the hard bottom between 21 and 40 m depth. It has not been reported elsewhere in the northwestern Gulf.

Madracis decactis ranks seventh in abundance at the Flower Gardens, covering approximately 2% of the hard bottom between 15 and 41 m depth. The species is also locally abundant at drop-offs on Stetson Bank, with a significant population at 24 m (Bright & Rezak, 1977; Rezak *et al.*, 1985).

Though present on the carbonate terrace below the coral reef, *Madracis asperula* is not a conspicuous species at the Flower Gardens. However, it is widely distributed on outer continental shelf carbonate banks from South Texas to Louisiana in depths ranging from 47 to 128 m (Rezak *et al.*, 1985).

Larval Sources

Mass spawning of the star coral *Montastraea cavernosa* was observed at the East Flower Garden coral reef in August 1990 (Bright, 1991). Hermatypic coral settlement and recruitment at the Flower Gardens has been detected during all seasons, with a Spring-Summer peak (Baggett & Bright 1985). The Flower Gardens are therefore a major, local source of hermatypic coral larvae.

Other regional coral reefs which may reasonably provide a source of reef-building coral larvae for recruitment in the northwestern Gulf are located (a) in the western Gulf of Campeche off Cabo Rojo and Tuxpan in the state of Veracruz, Mexico between 21°00′N and 21°30′N (over 400 nautical miles SSW of the Flower Gardens), (b) in the southern Gulf of Campeche off the cities of Veracruz and Anton Lizardo at approximately 19°00′N (550 nautical miles SSW), and (c) on the central and western Yucatan shelf south of 22°30′N (at least 370 nautical miles SSE).

Diploria strigosa, Porites astreoides, Madracis decactis and *Millepora alcicornis* are common on all of these reefs (Logan *et al.*, 1969; Tunnell, 1988). *Diploria clivosa* and *D. labyrinthiformis* are also reported from the Gulf of Campeche but not from the northern Gulf of Mexico (Tunnell, 1988).

Currents and Larval Transport

Sturges and Blaha (1976) suggested the existence of a northward flowing, western boundary current (Mexican Current) in the Gulf of Mexico. Strongest flow is in the winter and summer, reaching peak speeds of 70 to 100 cm/sec at the inshore edge of the boundary current. However, in spite of locally high velocities, movement of near surface water masses along the shelf edge from reef tracts on the Yucatan shelf and off Tampico into the vicinity of reef coral populations in the northwestern Gulf typically requires 4 to 9 weeks and rarely takes less than 3 weeks (Kirwin *et al.*, 1984; Kelly, personal communication).

Survival time for hermatypic scleractinian coral larvae is on the order of 1-10 weeks (Fadlallah, 1983). Therefore, as was suggested by Hopkins *et al.* (1977), viable larvae probably reach coral reefs and platforms in the northwestern Gulf of Mexico from the southwestern Gulf reef tracts.

In the immediate vicinity of the northwestern Gulf of Mexico coral reefs, Vastano (unpublished) tracked water movement with drifters drogued to 3 m depth from the East Flower Garden Bank northeastward to within a few miles of platform WC-630 in a period of five days in March 1989. Therefore, viable coral larvae can easily traverse the relatively short distances between the existing coral reefs in the northwestern Gulf, all of which occur in a narrow band south of 28°00′N at the extreme outer continental shelf between 92°00′W and 94°00′W. Offshore platforms in the same area are likely targets for coral settlement and recruitment because of proximity to the reefs and the nature of their environment. The two offshore platforms upon which reef-building corals have been found are located within this area (Figure 1).

Environmental Conditions and Regional Reef Development

Rezak *et al.* (1990) indicated that environmental conditions in the aforementioned shelf edge area are generally favorable for coral reef development above 50 m depth. Winter temperatures are typically higher than 19°C. Below 15 m depth, salinities are rarely less than 35.5 ppt. Water clarity and light penetration are comparable to or better than in tropical Caribbean waters most of the time. All of the shelf-edge natural substrates in this area in depths less than 50 m have some degree of coral reef development.

Coral reefs have not developed further inshore on the Texas-Louisiana shelf in spite of the availability of naturally occurring hard substrates at shallower depths, nor have reef-building corals been detected on any of the thousands of offshore structures on the middle and inner shelf, many of which have been in place for decades. Coral reef development and recruitment of most hermatypic, scleractinian corals is probably precluded on the middle and inner parts of the shelf by (a) unfavorable currents (b) winter water temperatures below 16-18°C, (c) periodic or chronic high turbidity and (d) periodically reduced salinity (Rezak *et al.*, 1990).

DISCUSSION

Dispersal of scleractinian coral

larvae from reefs in the southwestern Gulf of Mexico into the northwestern Gulf for settlement on offshore platforms or suitable natural habitats is possible. Survival times for the larvae in the water column (up to 10 weeks) are similar in duration to measured transport times (3-9 weeks) for water masses moving from the western Gulf of Campeche to reef areas in the northwestern Gulf. Local dispersal of larvae between coral reefs in the northwestern Gulf, or transport from the reefs to nearby offshore platforms, is more likely due to the short time intervals required for transport (<5 days) and the expected positive relationship between time spent in the water column and larval mortality. However, even on offshore platforms emplaced at the shelf edge in favorable environmental conditions, recruitment of reef corals from any source has been very low. Platform WC-630 has been in place since mid-1978, with only four small colonies known to have successfully recruited.

Therefore, it is probable that the *Diploria strigosa* on platform WC-630 and all of the scleractinians on platform HI-A389 (*Diploria sp., Porites astreoides, Madracis decactis, Madracis asperula*) originated from either the East or West Flower Garden coral reefs. *Diploria sp.* and *Madracis decactis* could have come from Stetson Bank, and *Madracis asperula* may be derived from any number of the shelf-edge banks in the northwestern Gulf. If, after their further growth and development, it is determined that some of the small colonies of *Diploria sp.* on platforms WC-630 and HI-A389 are other than *Diploria strigosa* (possibly *Diploria clivosa*), then contemporary recruitment from the southwestern Gulf will be strongly inferred (*Diploria strigosa* is the only known representative of the genus on natural reefs in the northwestern Gulf).

The *Millepora alcicornis* on platform HI-A389 was probably derived from the East Flower Garden because of the 1.2 nautical mile proximity. However, the species is the most pervasive of those considered here, providing many possible sources of propagation in the northwestern Gulf, including numerous other platforms.

Continued examination of shelf-edge offshore platforms in the northwestern Gulf will help answer questions relating to (a) origins and transport of larvae for reef coral recruitment in the area, (b) recruitment rates in relation to distance from the nearest source, (c) the relationship between reproductive strategies and dispersal, and (d) the influence of season, light, temperature, currents, substrate conditioning, substratum orientation and availability, depth and other environmental factors on recruitment and distribution of adult populations.

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Vastano, A. Unpublished. Department of Oceanography, Texas A&M University, College Station, Texas, 77843.

Thomas J. Bright and Stephen R. Gittings, Texas A&M University, Department of Oceanography, College Station, Texas 77843#4115.

Richard Zingula, Houston Underwater Club, P.O. Box 3753, Houston, Texas 77253#3753.

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