

STUDY TITLE: Determining the Geographical Distribution, Maximum Depth, and Genetic Affinities of Corals on Offshore Platforms, Northern Gulf of Mexico

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BACKGROUND: There are approximately 3,200 oil and gas platforms in the northern Gulf of Mexico (GOM). These platforms provide hard substratum that extends from the bottom of the continental shelf up through the sea surface, in a region where such substratum has been rare in recent geological time. Major exceptions to this are the Flower Garden Banks (FGB), coral reefs which occur ~200 km S-SE of Galveston, Texas. An earlier study of 13 platforms surrounding the FGB demonstrated that the presence of these platforms has facilitated the biogeographic extension of Caribbean reef fauna. There is also a question about the origin of those corals and their genetic affinity of coral populations on the platforms and the FGB. Earlier studies suggested that hermatypic coral populations were highly independent, most likely due to Founder Effect. Patterns of genetic affinity among coral populations throughout the entire northern Gulf of Mexico were not known.

OBJECTIVES: In this study, the range of occurrence of corals on oil/gas platforms in the northern GOM, their distribution and abundance over this broad geographic range, and their species richness patterns were determined. In addition, the patterns of genetic affinity in these populations— or both hermatypic corals and for ahermatypic ones—have also been determined.

DESCRIPTION: Thirty five platforms along four transects spanning from 20 km offshore to the edge of the continental shelf or beyond were examined. Transect I was in the Matagorda Island (MI) lease, extending S-SE from Corpus Christi, TX; Transect II bisected the High Island (HI) lease area, running S from Lake Sabine, TX to 10 km beyond the shelf edge; Transect III ran across the South Timbalier (ST) lease area, S of Terrebonne Bay, LA; and Transect IV extended across the Main Pass (MP) lease area, S-SW from Mobile, AL. Transect II was closest to the FGB. Coral density and species richness data were also included from our previous Phase I study, encompassing an additional 13 platforms in the FGB area to provide as complete a picture as possible of these variables in the northern GOM. Visual surveys of corals were conducted down to a maximum depth of 37 m by teams of SCUBA divers. An attempt was made to determine whether extensive scleractinian coral populations have colonized these platforms, quantifying the distribution and abundance of scleractinian corals (hermatypic and ahermatypic) and determining population characteristics.

With respect to the genetic analyses, tissue samples were preserved in SED buffer to preserve the DNA and returned to the laboratory for processing. Genetic variation was assessed using the DNA replication/PCR technique of Amplified Fragment Length Polymorphisms (AFLPs) - a DNA-fingerprinting technique that detects polymorphisms based upon the selective PCR amplification of a subset of numerous restriction fragments. All samples were checked for zooxanthellar DNA contamination using the PCR techniques developed earlier in our lab. Extra caution was taken in processing samples through all procedural steps to maximize repeatability of results. Samples were processed in large lots containing members from all populations to distribute any error potentially introduced by reaction conditions uniformly between populations in an unbiased fashion. All PCR reactions were done using one machine and the same thermal cycle profiles. The large number of polymorphic markers generated by AFLPs allowed for the use of highly sensitive statistical analytical techniques. We used the population allocation techniques AFLPOP and STRUCTURE.

SIGNIFICANT CONCLUSIONS AND STUDY RESULTS: Corals occurred on many of the platforms in the northern GOM. Coral species richness (number of species) in the northern GOM peaked on the coral reefs of the FGB and was three times higher than the maximum species richness observed on any individual oil/gas platform. Coral species richness was very low on inshore platforms. Twelve species of coral were found, encompassing nine hermatypic corals and three ahermatypic corals. In order of abundance, the most abundant zooxanthellate hermatypic corals found on platforms were *Madracis decactis*, *Diploria strigosa*, and *Montastraea cavernosa*. The other hermatypes observed on platforms were *Porites astreoides*, *Madracis formosa*, *Colpophyllia natans*, *Stephanocoenia intercepta*, *Stephanocoenia michelinii*, and *Millepora alcicornis*. All were members of the Scleractinia, except for *Millepora*, which is a member of the Hydrozoa. The three ahermatypic corals found on platforms were *Tubastraea coccinea*, *Oculina diffusa*, and *Phyllangia americana*. All of these three were scleractinians. *T. coccinea* was the most abundant, by far.

Total density of hermatypic/zooxanthellate corals peaked on platforms in Transect III, south of Terrebonne Bay, LA. These high densities extended to the north, towards

shore in this region. Higher densities were also noted in the vicinity of the FGB, in Transect II. Coral densities on platforms dropped to low levels outside of this region. In no case were hermatypic corals observed within ~50km of shore. Densities of *Madracis decactis* were found to drive overall density of hermatypic corals, peaking on platforms in the north central Gulf at the edge of the continental shelf, south of Terrebonne Bay, LA, in Transect III. Densities of *Diploria strigosa*, the second dominant in the platform coral community, peaked around the FGB. Its densities extended northward towards Port Arthur/Lake Sabine (Transect II). Densities of *Montastraea cavernosa* were bimodal, with a higher peak near the FGB (Transect II) and a lower peak on east side of the Mississippi River mouth off Mobile, AL in Transect IV.

Density of all corals combined, including hermatypic/zooxanthellate and ahermatypic/azooxanthellate types, was *four orders of magnitude* higher than density of hermatypes alone. This density peaked on platforms in the central and eastern regions of the northern GOM, with tens of thousands of colonies occurring south of Terrebonne Bay, LA and Mobile, AL (Transects III and IV). This density pattern was driven entirely by ahermatypic/azooxanthellate corals, which far surpassed hermatypic corals in density. The pattern of total ahermatypic/ azooxanthellate corals in the northern Gulf was driven entirely by densities of *Tubastraea coccinea*. Densities of this species were tens of thousands per 1,000 m².

Ahermatypic coral species richness was highest in the far western sector of the northern GOM, south of Matagorda Island, TX (Transect I). In three of the transect areas, unlike the hermatypes, species richness peaked in mid-shelf and inshore areas. The peak in Transect I was further offshore. Richness generally decreased from west to east. The peak in Transect I indicated that the FGB were most likely not the source of ahermatypic corals in the northern Gulf and that the ahermatypic corals most likely are derived from the southern GOM off Mexico or from the Caribbean.

With respect to molecular genetic analyses, STRUCTURE revealed that genetic affinity between *Madracis decactis* populations on the platforms was highest south of Port Arthur/Lake Sabine, TX (Transect II) and decreased with distance to the east. An increase in genetic affinity in the eastern sector indicated some isolation between the populations from different sides of the Mississippi River (Transects III and IV). A point-drop in genetic affinity at the shelf edge south of Terrebonne Bay, LA indicated a population differing from all others in the northern GOM, probably being derived from elsewhere.

STRUCTURE also revealed a similar genetic affinity pattern between populations of *Tubastraea coccinea*, which was highest in the west, off Matagorda Island, TX (Transect I). It generally decreased to the east. A precipitous drop in genetic affinity off of Mobile, AL indicated a dramatic difference in populations between that area and other populations to the west of the Mississippi River, indicating that this hydrographic feature most likely represents a formidable barrier to coral larval dispersal in this region.

In *Madracis decactis*, STRUCTURE also identified a point drop in genetic affinity offshore from Terrebonne Bay, LA - more pronounced than that observed in *T. coccinea*. This indicates that a population very different from the others in the northern Gulf exists here. It is possible that these populations could have been seeded by the Loop Current derived from the Caribbean Current, or a jet current originating from the southern Gulf of Mexico.

AFLPOP analyses revealed that *Madracis decactis* populations off of Terrebonne Bay, LA and those off of Mobile, AL were almost 100% distinct from each other, exhibiting almost no cross-population recognition. Home population recognition was extremely high but cross-site recognition was extremely low. These results indicate that larval dispersal across the river mouth and even between populations on platforms within a transect on either side of the river was highly limited. This same trend of no population recognition across the river mouth was even stronger in *Tuabastraea coccinea*. Self-allocation to home sites, however, was more highly variable, and cross-site recognition was higher than in *M. decactis*. This indicates that *T. coccinea* has higher larval dispersal and recruitment capabilities than *M. decactis* and therefore exhibits greater gene flow.

STUDY PRODUCT: Sammarco, P. W. 2014. Determining the geographical distribution and genetic affinities of corals on offshore platforms, Northern Gulf of Mexico. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico Region, OCS Study BOEM 2014-011. pp. 75.