Preliminary Assessment of the Association of Larval Fishes with Pelagic *Sargassum* Habitat and Convergence Zones in the Northcentral Gulf of Mexico

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ABSTRACT

Surface plankton samples were taken adjacent to concentrations of pelagic *Sargassum* during May and July 2000 in the northcentral Gulf of Mexico. Sampling was conducted next to *Sargassum* located both along convergence zones (fronts) and in areas not associated with particular hydrographic features. In addition, collections were taken up to 1.5 kilometers away from the sampled *Sargassum* as a control. A total of 1453 larvae/postlarvae comprising 22 families were collected. Collections were dominated by carangids and exocoetids, but also included specimens of tuna (including bluefin in May), dolphin and billfishes. Species composition and abundance were generally similar for collections taken both adjacent to *Sargassum* located along frontal zones and “control” collections taken within a few hundred meters of the sampled front. These preliminary observations indicate the potential influence of both *Sargassum* habitat and the convergence of water masses associated with frontal zones. The supposition that the convergence of water masses affects the diversity and abundance of fish larvae is further strengthened by the relatively low diversity and abundance of larvae found in collections taken adjacent to large patches of *Sargassum* not associated with particular hydrographic features. Larvae may accumulate in frontal zones both with and without *Sargassum*, but the growth and survival of the larvae of many species may be quite different in both areas.

KEY WORDS: *Sargassum*, fronts, habitat

INTRODUCTION

In the western North Atlantic and Gulf of Mexico pelagic brown algae of the genus *Sargassum* (Family Sargassaceae) forms a critical floating habitat for a diverse assemblage of flora and fauna (Butler et al. 1983, Coston-Clements et al. 1991). In the North Atlantic the center of distribution of pelagic *Sargassum* is in the Sargasso Sea located near the center of the North Atlantic gyre southeast of Bermuda (Sieburth and Conover 1965). This *Sargassum* is comprised primarily of *S. natans* and *S. fluitans* (Winge 1923, Parr 1939), although detached algae of five other species occur in low frequency (SAFMC 1998). The floating algae is transported into the Gulf of Mexico by the Yucatan current, which is termed the Loop current
as it passes through the Gulf. Sargassum is often concentrated in long rows by the convergence of surface waters along fronts, Langmuir circulation, or internal waves (Langmuir 1938, Shanks 1988, Kingsford 1990). When currents and winds are negligible, Sargassum is generally found in broad irregular mats or scattered clumps. Aggregations of this algae provide refuge for small fish and invertebrates, represent a source of concentrated prey for many organisms, including such diverse taxa as planktivorous invertebrates and large piscivorous fishes, provide a unique nursery habitat for numerous oceanic organisms, and may serve as a spawning substrate for certain marine species (Dooley 1972, Coston-Clements et al. 1991).

Pelagic Sargassum habitat has been the focus of considerable attention in recent years relative to its status as essential fish habitat (EFH). In December 1998, the South Atlantic Fishery Management Council (SAFMC) in the final draft of its Fishery Management Plan (FMP) for pelagic Sargassum habitat (SAFMC, 1998) recommended restricting, and then phasing out, the harvest of Sargassum in south Atlantic marine waters based upon its importance as EFH. After consideration, the National Marine Fisheries Service (NMFS) voted against such a measure unless it included a provision for limited commercial harvest of the algae. The need for protection of this offshore fish habitat is further emphasized in the current draft of the FMP for the dolphin and wahoo fisheries of the Atlantic, Caribbean, and Gulf of Mexico (SAFMC 2000).

Several studies have examined the diversity of macro-organisms associated with pelagic Sargassum habitat (Fine 1970, Dooley 1972, Bortone et al., 1977, Butler et al. 1983, Coston-Clements et al. 1991, Settle 1993, Moser et al. 1998), and only one of these studies (Bortone et al. 1977) was conducted in the Gulf of Mexico. Collectively, these studies found over 145 species of invertebrates, four species of sea turtles and 100 species of fishes associated with Sargassum, including various life history stages of several important fishery species such as cobia (Rachycentron canadum), greater amberjack (Seriola dumerili), common dolphin (Coryphaena hippurus), tripretail (Lobotes surinamensis), wahoo (Acanthocybium solandri), tunas (Thunnus sp.), and billfishes (family Istiophoridae) (SAFMC 1998). The extent to which these fishes are dependent upon Sargassum as a habitat likely varies among their life history stages, but for many species Sargassum may play a more significant role in the survival and growth of larval and juvenile life stages than for adults.

Previous studies have concentrated on the macrofauna associated with Sargassum habitat, and little is known about the importance of this habitat for the early life-stages of fishes. The present study is a preliminary effort to assess the diversity and abundance of larval and postlarval fishes found adjacent to Sargassum located both along convergence zones and in large isolated mats not associated with particular hydrographic features.
MATERIALS AND METHODS

Sampling Locations and Shipboard Procedure

Sampling was conducted during May and July 2000 in the northcentral Gulf of Mexico (Figure 1). Surface samples were taken with a 1m x 2m neuston frame fitted with 947 μm mesh Nitex. Tows were of 10 minutes duration at a ship speed of approximately 2 knots, and the net was approximately 50% submerged, i.e. fished the surface layer to a depth of approximately 0.5 m. In addition, several surface collections of five minutes duration were taken with a 0.73 m diameter ring net fitted with 333 μm mesh Nitex and a mechanical flowmeter to measure volume of water filtered. Samples were washed into buckets, concentrated with a sieve, preserved in 95% ethanol and returned to the laboratory for sorting and identification.

![Map of Gulf of Mexico showing sampling locations in May and July 2000](image)

Figure 1. Sampling locations during May, July and 2000 in the northcentral Gulf of Mexico.
RESULTS

A total of 1453 larvae/postlarvae comprising 22 families were found in surface plankton collections taken during May and July 2000. The relative abundance and diversity of young fishes varied both spatially and temporally. Collections were generally dominated by carangids and exocoetids, but also included specimens of tuna (including bluefin in May), dolphin and billfishes.

May

During May two fronts with associated Sargassum were sampled. At the first location surface collections were taken immediately adjacent to a continuous row of Sargassum patches with both the ring and neuston nets, and for comparison a neuston “control” collection was taken approximately 100 m from the front (Table 1). Sphyraenid larvae were the most abundant family collected at the front adjacent to the patches of Sargassum with both the neuston and ring nets, but no sphyraenid larvae were found in the neuston “control” collection. Carangids and exocoetids were the next most abundant taxa in all three collections, with exocoetids being the most abundant larvae in the neuston “control” collection. All five scombroids (tuna) and the single istiophorid (billfish) and coryphaenid (dolphin) were collected adjacent to the Sargassum habitat (Table 1).

Table 1. Larval and post-larval fishes collected in the northcentral Gulf of Mexico with both a neuston and ring net adjacent to Sargassum located along a frontal zone and with a neuston “control” collection taken 100 m from the front. Neuston abundances are numbers of larvae per 10 minute collection, and ring net abundances are numbers of larvae per 100 m².

<table>
<thead>
<tr>
<th>Family</th>
<th>Neuston “Control”</th>
<th>Neuston</th>
<th>Ring Net</th>
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</thead>
<tbody>
<tr>
<td>Sphyraenidae</td>
<td>0</td>
<td>65</td>
<td>13</td>
</tr>
<tr>
<td>Carangidae</td>
<td>17</td>
<td>31</td>
<td>9</td>
</tr>
<tr>
<td>Exocoetidae</td>
<td>132</td>
<td>20</td>
<td>7</td>
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<tr>
<td>Mugilidae</td>
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<td>0</td>
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<td>Echeneidae</td>
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<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Scombridae</td>
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<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Monocanthidae</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Serranidae</td>
<td>0</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Istiophoridae</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Coryphaenidae</td>
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<td>0</td>
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<tr>
<td>Myctophidae</td>
<td>1</td>
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<td>0</td>
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<tr>
<td>Ostraciidae</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scorpaenidae</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
Figure 2. Larval and post-larval fishes from surface ring-net collections taken in the northcentral Gulf of Mexico during May 2000. Collections were taken both adjacent to Sargassum located along a frontal zone, and approximately 100 m from the front on both sides. Abundances are numbers of larvae per 100 m$^3$.

At the second location sampled in May, surface ring-net samples were taken on both sides of a front containing Sargassum and approximately 100 m from the front on each side (Figure 2). Surface salinity and temperature on either side of the front differed by 0.8 $^\circ$C and 0.3$^\circ$C. Carangids were the most abundant taxa collected; 186 specimens were found in the four collections and a density as high as 103 larvae per 100 m$^3$ was found in a surface collection approximately 100 m from the front (Figure 2). Densities of carangid larvae were lower on the north side of the front, but larvae were again more abundant approximately 100 m from the front than adjacent to Sargassum along the frontal zone. Exocoetid larvae were also relatively abundant and were found in all four collections; the highest abundance was found on the south side of the front adjacent to the line of Sargassum. Six scembrids were collected and all specimens were larger than 6 mm and could be positively identified as bluefin tuna. It is coincidence that the reported density of these larvae (Figure 2), i.e., number of larvae per 100 m$^3$, is the same as the actual number collected. Scombrids from the previously sampled front were smaller and could only be identified as Thunnus sp.

July

During July, plankton sampling was conducted at both a well-defined front with associated Sargassum (Figure 3), and adjacent to a large patch of Sargassum that was not associated with a particular hydrographic feature. Sampling at the front was conducted with both the ring and surface nets, and collections were taken adjacent to Sargassum on both sides of the front and approximately 1.5 km south of the front (Figure 3). Of the fourteen families of fishes collected, carangids were again the most abundant larvae, and highest abundances were found in collections taken adjacent to Sargassum habitat. The distribution of carangids was patchy, however,
as evidenced by the neuston collection taken adjacent to *Sargassum* on the north side of the front in which no carangids were found. Exocoetids were again the second most abundant taxa collected, and highest abundances were found in collections taken adjacent to *Sargassum*. The ichthyofauna was more diverse in collections taken adjacent to *Sargassum* with both the ring net and neuston net (Figure 3), and the few specimens of scombrids, coryphaenids andistiophorids were only collected adjacent to *Sargassum*.

A second station sampled in July was adjacent to a large mat of *Sargassum* that was not associated with a frontal feature. The patch of algae was approximately 100 m long and 50 m wide. Surface collections were taken with both a neuston net and a ring net within a few meters of the edge of the mat. No fish were found in the ring net collection, and only 23 specimens comprising four families were collected with the neuston net. Fifteen of these fish were exocoetids, and the remaining few specimens were pomacentrids (4), balistids (3) and a single gerrid larva.

![Figure 3. Larval and post-larval fishes from both surface ring-net (R) and neuston (N) collections taken in the northcentral Gulf of Mexico during July 2000. Neuston abundances expressed are numbers of larvae per 10 minute collection, and ring net abundances are numbers of larvae per 100 m$^3$.](image)
DISCUSSION

The aggregation of fish larvae at fronts may be caused by the spawning behavior of adults and/or the passive accumulation of larvae due to the convergence of surface waters in frontal zones (Kirobe et al. 1988, Sabatés and Masó 1990, Grimes and Finucane 1991, Govoni and Grimes 1992, Brandt, 1993). It is not known how Sargassum, which frequently accumulates along fronts, influences the distribution and abundance of fish larvae, but Sargassum habitat has certainly been shown to support many species of juvenile fishes (Dooley 1972, Bortone et al. 1977, Constan-Clements et al. 1991, Settle 1993). Only one dated study (Bortone et al. 1977) has examined the abundance and diversity of young fishes associated with Sargassum in the Gulf of Mexico, and no studies have examined the ichthyoplankton assemblages found adjacent to Sargassum habitat along frontal zones.

Previous studies have shown that juvenile fishes associated with Sargassum are usually dominated by the families Balistidae, Monacanthidae and Carangidae (Dooley 1972, Bortone et al. 1977, Settle 1993). This species composition was not reflected in plankton collections. Although present in plankton collections from the present study, balistids and monacanthids were not abundant. Carangids were abundant in plankton collections, but they were dominated by the Atlantic bumper (Chloroscombrus chrysurus), a carangid that is not commonly found in Sargassum. Exocoetid larvae were also quite abundant, which is expected because the eggs of many species develop in Sargassum.

The diversity in plankton collections was generally quite high, and 22 families of larvae/postlarvae were found in this limited study. Several commercially and recreationally important species were collected, including billfishes, dolphin and tuna. The diversity and abundance of fishes was higher in neuston collections than ring net collections because of the larger mouth-opening and longer tow-time for the neuston net. Collections taken as “controls” in May, i.e. collections taken away from a front with its associated Sargassum, were removed from a front by approximately 100 m. Results from these “control” collections were inconclusive: carangid and exocoetid larvae were abundant both adjacent to Sargassum and at the “control” locations. In addition, all five tuna larvae found at the first station sampled in May were collected adjacent to Sargassum at the front, and no tuna larvae were found in the “control” collection. However, at the second front sampled, five of the six tuna larvae were collected at a “control” site.

A total of eleven scombrid larvae were collected in the seven May collections, and all specimens larger than approximately 6 mm (n = 6) were identified as bluefin tuna based on the presence of one or more melanophores on the dorsal surface of the body (Richards et al. 1990). This species of tuna is expected to occur in these waters during this time based on reported spring spawning (McGowan and Richards 1989). The five smaller scombrids were too small to have developed this pigment and could only be identified as tuna larvae, although it is likely that some of these specimens were also bluefin tuna. The distribution of tuna larvae also brings into question the usefulness of our “control” sites; at the first station sampled in May all five tuna collected were found adjacent to Sargassum located along a front, but
at the second front five of the six tuna larvae collected were found at the two “control” sites approximately 100 m from the front.

In July a single front with associated Sargassum was sampled and the “control” site was moved further away (1.5 km) from the front. The abundance and diversity of fishes was greater for both ring and neuston net surface collections taken along the front than at the “control” location; fishes collected along the front represented 14 families, whereas fishes from only seven families were found at the “control” location. It is likely that the increased abundance and diversity of larvae and young juveniles along the front is due to both the convergence of surface waters in this region, and the presence of Sargassum habitat. The supposition that the convergence of water masses affects the diversity and abundance of fish larvae is further strengthened by the relatively low diversity and abundance of fishes found in both the ring and neuston net collections taken in July adjacent to large a large patch of Sargassum not associated with a front. In addition to the passive accumulation of larvae in frontal zones, several species may spawn in the vicinity of Sargassum located along fonts. Results from this ongoing study are limited because of the relatively few collections. Future planned research will not only increase the sample size but will include collections taken along fronts with no associated Sargassum. Larvae may accumulate in frontal zones both with and without Sargassum, but the growth and survival of larvae may be quite different in both areas.

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The Across-shelf Larval, Postlarval, and Juvenile Fish Communities Associated with Offshore Oil and Gas Platforms West of the Mississippi River Delta

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ABSTRACT

The fisheries aggregation value of oil and gas platforms in the continental shelf waters of the northern Gulf of Mexico is well recognized, but the assessment of early life stages associated with these structures has not been adequately addressed. Ichthyoplankton assemblages were sampled at three offshore platforms: Green Canyon 18 (GC 18; 230 m depth, shelf slope); Grand Isle 94 (GI 94; 60 m depth, mid-shelf); and South Timbalier 54 (ST 54; 20 m depth, inner shelf) with passive plankton nets and light-traps. Family richness was highest at GC 18 (52), followed by GI 94 (43), and ST 54 (42). At the genus level, richness was highest at GI 94 (114), followed by ST 54 (86) and GC 18 (82). Clupeiforms dominated samples at all sites, comprising 59-97% of the total catch. Carangids and scombrids dominated the reef-associated fish assemblages at all sites, with blemnids becoming prominent in inshore collections. Other relatively common reef-associated fish were serranids and lutjanids (GC 18), pomacentrids and opisthognathids (GI 94), and Rhomboplites auroxalus (ST 54). The ichthyoplankton assemblages sampled at each site were relatively dissimilar, based on Schoener's Index of Similarity, with the highest index value for any two sites being 0.45 for GI 94 and ST 54 (0-1 scale). No significant difference was observed between mean Shannon-Weiner diversity indices calculated for plankton net samples at each site. For light-trap samples diversity was lowest at GC 18, significantly higher at GI 94, and then decreased inshore at ST 54. The presence of early preflexion larvae and presettlement postlarvae and juveniles in our collections indicate that both local spawning and settlement/recruitment may be occurring at these platforms.

KEY WORDS: Gulf of Mexico, oil and gas platforms, ichthyoplankton

INTRODUCTION

The introduction and proliferation of offshore oil and gas structures in the northern Gulf of Mexico has undoubtedly affected the marine ecosystem. The central and western Gulf is dominated by a mud/silt/sand bottom with little relief or hard bottom habitat, and there are approximately 4,000 oil and gas structures in
these federal waters. Parker et al. (1983) reported only 2,780 km² of natural available reef in the central and western Gulf. Although Gallaway (1998) calculated that oil and gas platforms in the northern Gulf provided 11.7 km² (or 4.0%) of the total "reef" habitat, the fact that platforms represent vertical artificial substrate that extends from the bottom to the surface (photic zone), regardless of location and depth, increases their significance. Since fish populations are usually limited by available energy, recruitment, or habitat, it is important to determine if platforms:

i) Provide critical habitat for early life history stages;
ii) Serve as new or additional spawning habitat; and
iii) Influence energy flow through the ecosystem by aggregating prey.

Oil and gas platforms can enhance fisheries by providing attachment substrate for habitat-limited sessile invertebrates, thereby creating food and habitat for reef-dependent species that are trophically-dependent on sessile and motile invertebrates associated with reefs (Gallaway 1981, Bohnsak and Sutherland 1985, Stephan et al. 1990, Bohnsak 1991). Since reef fish assemblages are among the most diverse and taxonomically rich in the aquatic biosphere (Sale 1991), platform communities may significantly enhance biodiversity. In addition, oil and gas structures may offer refugia for species which are trophically-independent of the biofouling community (i.e., reef-associated species; Choat and Bellwood 1991), but are ecologically-important resident, seasonal, or transient members of the hard substrate fish community (Gallaway et al. 1980). The extensive range (latitudinally and longitudinally) of this artificial substrate may also serve as migratory routes for tropical and subtropical species.

The objective of this study was to characterize and compare the larval, postlarval, and juvenile fish assemblages, particularly reef-oriented taxa, associated with three offshore oil and gas platforms off Louisiana representing different depth zones across the continental shelf. This objective was accomplished by collecting a wide variety of taxa and sizes utilizing two sampling techniques, light-traps and passive plankton nets. These methodologies complemented each other, since nets effectively sample yolk-sac, larval, and some postlarval fishes, whereas light-traps sample photopositive species at overlapping and larger sizes to give us more complete estimates of sizes (cohorts or inferred ages) and developmental/early life history stages present (Choat et al. 1993).

MATERIALS AND METHODS

Sampling occurred along a transect west of the Mississippi River Delta with site selection for platforms based upon the work of Gallaway et al. (1980) and Gallaway (1981) who reported that nekton communities around platforms could be categorized by water depth in the northern Gulf. Three communities were characterized: a coastal assemblage (water depths < 27m), an offshore assemblage (water depths 27 to 64 m), and a bluewater/tropical assemblage (water depths > 64m). The platforms selected encompass all three zones. Mobil's Green Canyon (GC) 18, which lies in about 230 m of water on the shelf slope (27°56'37"N,
91°01'45"W), was sampled monthly during new moon phases over a 2-3 night period during July 1995 - June 1996. Mobil's Grand Isle (GI) 94B, which lies in approximately 60 m of water at mid-shelf (28°30'57"N, 90°07'23"W), was sampled twice monthly during new and full moon phases over a three night period during April - August 1996. In addition, during May extra samples during the first quarter and third quarter moon phases were collected. Exxon's South Timbalier (ST) 54G, which lies in approximately 20 meters of water on the inner shelf (28°50'01"N, 90°25'00"W), was sampled twice monthly during new and full moon periods in during April - September 1997.

Sampling protocols for GC 18, GI 94, and ST 54 were similar. At GC 18, all sampling began one hour after sunset and was completed one hour before sunrise. The major sampling station for each platform was located in the internal central region along a stainless steel, small diameter guidewire (monorail) tethered to the first set of the platform's underwater, cross-member, support structures. At this central station, replicate trap collections (N = 2) were taken three times each night at near-surface (1 - 2 m depth) and at a depth between 15 and 23 m, depending upon the individual platform's underwater configuration of the first set of cross-member supports. Subsurface samples were collected by lowering a trap without flotation. Light-traps were deployed for 10 minute periods. Passive, horizontal plankton net collections were taken three times at both depths during each night at the central station using a metered, 60 cm diameter, 333µm mesh net. The nets had a vane (to help orient into the current) which was fixed to a gimbaled attachment on the net ring, which allowed the net to be set and retrieved closed for the at depth deployment. In addition, three collections each night were made with a floating light-trap which was tethered and free drifted away (off-platform) from the platform (approximately 20 m) on the down current side of the platform. Sampling effort was modified at GI 94 and ST 54 to obtain one (rather than two) replicate subsurface and surface collection per gear, and one off-platform light-trap collection per set, with still three sets taken per night.

Community similarity between sites was measured using Schoener's Index of Niche Overlap (Schoener 1970) which was calculated by combining fish collected by all gears within each site. Only fish identified to at least the genus level were used in the similarity analyses. Since this type of analysis can be heavily influenced by large abundances of a single species, it was done without the most dominant taxa at each site included. At times, the sampling efforts differed temporally between sites, so the samples used for comparisons were limited to only those months where samples were collected for both sites in a pairing. Only April-August samples were used to compare GC 18 to GI 94 and ST 54. Full data sets were used in comparisons between GI 94 and ST 54. Shannon-Weiner diversity indices (Magurran, 1988) were calculated for each sample collected at GC 18, GI 94, and ST 54. Differences in mean diversity between sites were analyzed with ANOVA models using gear as a main effect. Post-ANOVA tests (Tukey's Studentized Range, α=0.05) were used to determine which sites where significantly different. Only fish identified at least to the level of genus were included in the diversity analyses.
RESULTS

A total of 67 families were represented in our plankton net and light-trap collections from the three platform sites. The number of families represented in passive plankton net collections decreased from 45 at GC 18 (shelf slope) to 40 at GI 94 (mid-shelf) and 34 at ST 54 (inner shelf). In contrast, the number of families represented in light-trap collections was fairly consistent, from 37 at GC 18 and GI 94 to 34 at ST 54. The number of taxa collected, however, peaked at GI 94 for both plankton nets (83) and light-traps (90). The number of taxa collected in plankton nets and light-traps at GC 18 (64 and 59) and ST 54 (59 and 65) were similar. At GC 18, plankton nets collected fish from more unique families (15) and taxa (25) than the light-traps (7 and 18, respectively). At GI 94, plankton nets collected twice as many unique families as the light-traps (6 vs. 3), but light-traps collected more unique taxa (31) than plankton nets (26). At ST 54, plankton nets and light-traps collected equal numbers of unique families (8), while the light-traps collected more unique taxa than the plankton nets (27 vs. 19).

Reef-dependent and reef-associated fish (Choat and Bellwood 1991) made up a relatively small percentage of the total plankton net and light-trap collections (with clupeiforms removed from the total catch) at the three platforms (Table 1). At GC 18, these groups of fish comprised 18% and 32% of the plankton net and light-trap collections, respectively. Dominant groups included scombrids and carangids, as well as Holocentrus spp., Pomacentrus spp., and Pristipomoides aquilonaris. At GI 94, reef-dependent and reef-associated fishes comprised 10% of the plankton net catch and 17% of the light-trap catch. Blenniids were prominent in light-trap collections, while carangids were dominant in plankton nets. At ST 54, these fishes comprised less than 1% of the plankton net collections and only 8% of the light-trap collections. Carangids, blenniids, and scombrids were the dominant reef-associated taxa.

At GC 18, light-traps (n = 319) and plankton nets (n = 125) collected 1,114 and 3,943 fish, respectively, over the course of the year (Table 1). Clupeiform fishes, primarily unidentified engraulids, Opisthonomus ogilvii, Anchoa nasuta/tetus, and Engraulis eurystole dominated the samples, comprising 59% of the total catch for both gear types combined. Dominant non-clupeiform fishes included the reef-associated Auzis spp., Caranx crysos, and Caranx hippos/tatus, and the sciaenid Sciaenops ocellatus.

At GI94, light-traps (n = 474) collected 31,353 fish and plankton nets (n = 329) collected 14,401 fish. Clupeiforms dominated the total catch (66%). The most common taxa collected included Anchoa spp., A. nasuta, Engraulis eurystole, and Opisthonomus ogilvii. Among the most common non-clupeiform fishes were demersal taxa such as synodontids (primarily Symodus foetens and S. poeyi), and Symphurus spp., as well as the reef-associated blenniids (Hypseblennius invemar and Parablennius marmoreus) and scombrids (Auzis spp. and Euthynnus alleteratus).
Table 1. Size ranges (SL in mm) and percent of the total catch by gear for dominant taxa (>1%) collected by at least one gear type. Percentages are calculated after the exclusion of clupeiform fishes. Asterisks (*) indicate taxa from reef-associated or reef-dependent families.

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<th>Taxon</th>
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Grand Isle 84 (April-August 1996)

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<td>Parablennius marmoratus*</td>
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<td>Scartella/Heyphleurochilus*</td>
<td>3.6-12.5</td>
<td>1.7</td>
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<td>Microdesmus lanceolatus</td>
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<td>Etropus crossoptus</td>
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<tr>
<td>Syacium spp.</td>
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<tr>
<td>Symphurus spp.</td>
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South Timbalier 54 (April-September 1997)

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<td>2.2-11.7</td>
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<td>Caranx crysos*</td>
<td>6.5-24.5</td>
<td>2.0</td>
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<tr>
<td>Caranx hippocampus/fatus*</td>
<td>5.5-35.0</td>
<td>3.8</td>
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<tr>
<td>Chloroscombrus chrysurus*</td>
<td>2.5-25.0</td>
<td>1.5</td>
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<td>Cynoscion arenarius</td>
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<tr>
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<td>3.4-12.5</td>
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<tr>
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<tr>
<td>Scartella/Heyphleurochilus*</td>
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<td>Microdesmus lanceolatus</td>
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<td>Auxis spp.*</td>
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<td>9.1</td>
</tr>
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<td>Sphoeroides spp.</td>
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At ST 54, light-traps (n = 194) and plankton nets (n = 89) collected 6,116 and 91,583 fish, respectively. Overall, clupeiforms, primarily clupeids, dominated the collections at ST 54, comprising 97% of the total catch for both gear types combined. Of the non-clupeiform fishes collected, sciaenids (Cynoscion arenarius), synodontids (Synodus foetens), and the reef-associated carangids (Chloroscombrus chrysurus) were dominant.

Schoener's Index of Similarity values range from 0 (no similarity) to 1 (identical taxonomic compositions). Similarity values between the sites were relatively low, with the highest similarity occurring between the mid-shelf site, GI 94, and the inner shelf site, ST 54 (0.45). The next highest value was between GC 18 and ST 54 (0.35), followed by GI 94 and GC 18 (0.29). Shannon-Weiner Diversity Index
values for plankton net collections were not significantly different between the sites (Tukey's Studentized Range test, $\alpha = 0.05$; Figure 1). Diversity peaked for light-trap samples at GI 94, where index values were significantly higher than the other sites. Light-trap collections at GC 18 had a significantly lower mean diversity index than the other sites, while diversity at ST 54 was intermediate.

DISCUSSION

Overall, reef-dependent taxa (chaetodontids, pomacentrids, labrids, and scarids) were relatively rare and never comprised over one percent of the total catch for either gear at any site. Pomacentrids and chaetodontids were collected only at the shelf slope and mid-shelf sites, while labrids and scarids were also collected at the inshore site. Our total of 67 families collected at oil and gas platforms throughout the course of this study is comparable with previously published surveys from the Gulf of Mexico (61 families, Ditty et al. 1988; 74 families, Richards et al. 1984), but is generally less than surveys that included more tropical waters (85 families, McGowan, 1985; 91 families, Limouzy-Paris et al. 1994; 96 families, Richards 1984; 100 families, Richards et al. 1993). While reef-dependent fish were uncommon, reef-associated fish (e.g., carangids, scombrids, blenniids) were much more common and many times represented a significant component of the community assemblage at each site.

In general, the dominant reef-associated fish at all sites were carangids and scombrids, although the relative abundances of taxa within these families changed across the shelf. Caranx crysos, C. hippos/latus, and Auxis spp. were dominant taxa at GC 18. Euthynnus alleteratus were more prominent at GI 94, while Chloroscombrus chrysurus and E. alleteratus were dominant at ST 54. While these taxa are pelagic predators as adults, they attain high numbers near reefs and serve as an energetic link that returns nutrients from off-reef feeding to the reef environment via defecation (Choat and Bellwood 1991). A wide size range was represented by these fish as well, from small preflexion sizes to larger juveniles, suggesting that both local spawning and juvenile recruitment and settlement may be occurring at these sites.

Reef-associated and reef-dependent taxa, though rare, were present at the platform sites, and differed in some respects across the shelf. At GC 18, serranids were present, most of which were from the poorly known subfamily Anthiinae. Antherine adults are residents of rocky reefs on the outer shelf and are not usually found on shallow, inshore reefs (Thresher 1984). Other serranids included Epinephelus spp. and Mycteroperca spp. Lutjanids were also present, primarily Pristipomoides aquilonaris, one of the most common residents of mid- and outer shelf reefs (Hoese and Moore 1977). Other noteworthy taxa included unidentified blennies, Holocentrus spp., (reef-associated) and Pomacentrus spp. (reef-dependent). Based on the adult community description of offshore artificial and natural reefs (Gallaway 1981), we expected this site to have the most speciose and diverse reef fish assemblage, but that was not the case with our larval and juvenile
collections. This may be because reef fish communities are limited, in part, by the
supply of pelagic larvae, usually from upstream sources rather than the resident
populations (Sponaugle and Cowen 1996, Victor 1986). Reefs and platforms
located on the shelf slope would theoretically have significantly fewer upstream
sources of potential recruits than those on the mid-shelf, where other natural hard-
bottom or reef habitats may be more abundant, or where the density of platforms is
orders of magnitude greater. Therefore, the extremely remote location of GC 18
(shelf slope) is probably the limiting factor with regards to the pool of available
larvae to be sampled.

At GI 94 there was greater taxonomic richness among reef fish than at GC 18.
By far the most dominant reef-associated fish taxa at GI 94 were blenniids,
particularly Parablennius marmoreus and Hypoblennius invemar. These fishes are
perhaps one of the most common taxa affiliated with oil and gas platforms, but are
probably underestimated in visual surveys due to there small size, cryptic coloration,
and tendency to hide in attached barnacle shells. At GI 94, unidentified gobids and
pomacentrids, primarily Chromis spp. and Pomacentrus spp. were also present.
Unique to this site was the collection of opisthograptids in surface waters (plankton
nets as well as surface and off-platform light-traps) during the spring-early summer.
Adult Opisthograptus aurifrons are reported to be tropical (south Florida, Bahamas,
northern South America) and rarely collected on the mid-to-outer shelf (Hoese and
Moore 1977, Robins et al. 1986). Adult O. ionchurus are also reported to inhabit
the northeast Gulf as well as tropical waters (Robins et al. 1986). The presence of
these larvae reinforces the notion that oil and gas platforms may play a role in
extending the ranges of more tropical forms that would otherwise be habitat limited
in the northcentral Gulf.

Other taxonomic differences in reef-associated fish composition were observed
between GI 94 (mid-shelf) and GC 18 (outer shelf). At GI 94, lutjanids were also
relatively common, with Rhomboplites aurorubens the dominant species, followed
by Lutjanus spp. While Pristipomoides aquilonaris was the primary lutjanid at GC
18, none were collected at this mid-shelf site. With regards to serranids, the
dominant group was serranines (e.g., Diplectrum spp., Centropristis spp., and
Serranus spp.), while relatively few anthines were collected. Also noteworthy was
the relatively high abundance of mullids collected at GI 94, particularly Upeneus
parvus, a common species on the mid-to-inner shelf (Hoese and Moore 1977).

At ST 54, the most abundant reef/structure-associated fishes were blenniids and
gobiids. Unlike GI 94, Parablennius marmoreus was relatively uncommon. The
dominant species at ST 54 were Scartella/Hypeurochilus spp., Hypoblennius
hentz/ionthas, and H. invemar. Difficulties in identification prevent us from
confidently separating H. hentz from H. ionthas and Scartella spp. from
Hypeurochilus spp. but all of these taxa are common in nearshore areas and hard-
bottomed habitats, such as oyster reefs and pilings (Hoese and Moore 1977). In
general at ST 54, reef fish, although not abundant, were relatively well represented
in terms of number of taxa, rivaling that of GI 94. However, other than blenniids
and gobiids, abundances of other reef fish were very low (less than a total of 10
individuals collected per taxa) but included *Rhomboplites aurorubens* and unidentified pomacentrids, serranids, and ephippids.

![Graph](image)

**Figure 1.** Mean Shannon-Weiner diversity index values (with standard error bars) for plankton net and light-trap collections from each sampling site. The same letter above each bar indicates no significant difference between sites based on Tukey's Studentized Range tests ($\alpha = 0.05$). Different letters indicate significant differences.
The low reef fish abundances are not surprising, particularly for the more tropical taxa such as haemulids, labrids, and scarids. The adults of these taxa are more typical of the outer shelf assemblages (Gallaway 1981). Similarly with regards to reef fish larvae and juveniles, this trend of decreasing taxonomic richness towards the more inshore environments is supported somewhat by our study, particularly with regards to scarids. Even though an inner shelf platform would be downstream from potentially more offshore sources of larvae and recruits, perhaps the relatively greater distances involved necessitate extended pelagic larval durations and the potentially less favorable inshore environmental conditions may result in increased mortality (Leis 1991).

In an effort to examine the relative similarity in taxonomic assemblages between the different sites we computed Schoener's Index of Similarity for each site. In general, the index values indicate that the sites were not very similar, with the highest similarity value between any two sites being 0.45 for GI 94 and ST 54 (mid- and inner shelf). This is not unexpected since we purposely chose sampling sites in different depth zones across the shelf where there should be some faunal transitions (Gallaway et al., 1980; Gallaway, 1981). The highest similarity index for GC 18, however, was with ST 54, the inner shelf platform, whereas we might have expected GC 18 to most similar to GI 94. This somewhat unexpected result is probably due to the previously mentioned, large number of reef taxa collected at GI 94 that were unique to that site. Reef fish taxa such as *Chromis* spp., *Abudesdus taurus*, *Mullus auratus*, *Ophiobellus mactidus*, *Pseudopneus maculatus*, *Opisthognathus aurifrons*, and *Opisthognathus lonchurus* were collected only at the GI 94 platform. Other taxa (cephippids and scarids) were collected at GC 18 and ST 54, but not at GI 94.

The mean diversity indices for the plankton net collections taken at the platform sites were not significantly different from each other, ranging from 0.73-0.83 (Figure 1). In general, observed statistical differences in Shannon-Weiner diversity indices between sites were limited to light-trap collections. Light-trap collections were significantly more diverse at GI 94, a result of being less dominated by clupeiform fishes than ST 54, and of collecting more taxa, particularly reef fish taxa, than GC 18. In general, taxonomic richness in light-traps was highest at GI 94, with 90 taxa identified to genus as compared to 65 taxa at ST 54, the platform with the second highest number of taxa. Inshore (particularly estuarine) areas are generally characterized as having lower diversity than adjacent shelf waters and are dominated by a few highly abundant taxa (Nybakken 1988). This pattern is generally attributed to the fluctuating nature of the nearshore environment, particularly with regards to salinity and temperature, and the lack of physiological specializations needed to deal with this estuarine environmental variability (Nybakken 1988). This, in part, may explain the relatively low diversity indices for ST 54 the inshore site. In contrast, species richness and abundance is generally relatively low on the outer shelf, due to the homogeneity of the bottom substrate (Bond 1996). As previously discussed, topographical relief is disjunct throughout the northcentral Gulf (especially west of the Delta) and the sea floor is basically dominated by expanses of mud and silt.
Again, this homogeneity and the previously discussed lack of a large amount of upstream supply of larvae may in part explain the low taxonomic diversity observed in the light-trap collections at GC 18.

This study represents the first comprehensive look at the ichthyoplankton assemblages associated with oil and gas platforms in the northern Gulf of Mexico and is also a first (yet preliminary) attempt at comparing such assemblages across different depth zones and geographical regions. It is apparent that a diverse recently spawned larval, postlarval, and juvenile fish community can be captured in the waters within and near platforms, and these structures may therefore be important to reef-associated and reef-dependent fish. Though many taxa were represented in our collections, it is difficult to discern the reasons why some fish were present at these artificial structures. Some, like the clupeiforms, are extremely abundant, very photopositive, and may be behaviorally attracted to such structures with a large, consistent light-field. Other taxa like blennies may be attracted to the numerous habitats created by the biofouling community (e.g., barnacles) on the platform legs and cross-members, as well as the associated zooplankton food resources. Pelagic species, like carangids and scombrids, have more generalized habitat requirements, but may also be attracted to the structure (reef-associated) or to concentrations of zooplankton and forage fish that are inhabiting the platform and immediately surrounding waters. For whatever reason, based on the results from this study the oil and gas platforms serve a potentially important function as a hard-substrate habitat and could, therefore, lead to increased production.

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