# SPECIES COMPOSITION AND ABUNDANCE OF ICHTHYOPLANKTON AT BEACHFRONT AND SALTMARSH ENVIRONMENTS

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*Abstract:* Ichthyoplankton communities of Galveston, Texas barrier island environments were characterized from 22 January through 27 August 1979. Beachfront and saltmarsh sites were sampled with a Renfro beam trawl to determine seasonal and diel trends in species composition and abundance of subadult fishes. Beach and saltmarsh constituted important temporary habitats for many ichthyoplankton species. Most larvae initially penetrated beach and tidal pass habitats but sought nutrient-rich saltmarsh environs. The beachfront yielded the highest number of taxa while the saltmarsh produced the greatest catch per effort. Peak ichthyoplankton abundances at both sites occurred during winter and early spring. Day and night sampling at the beach yielded similar catch statistics while peak yields at the saltmarsh consistently occurred during the day.

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Barrier islands and adjacent estuaries play an integral part in the early life history of many commercially and recreationally important marine fishes (Reintjes and Pacheco 1966, Tabb 1966, Fore and Baxter 1972, Sabins and Truesdale 1974, Shenker and Dean 1979). Approximately 90 percent of all commercial and 70 percent of all recreational species in the Gulf of Mexico are spawned offshore and transported by currents into estuaries via natural passes in the barrier island system (King 1971, Lindall and Saloman 1977). Many fishes frequent these locales only as larvae and juveniles (Oviatt et al. 1977) while other species such as the spotted seatrout *(Cynoscion nebulosus)* are spawned in estuaries and spend their entire life history in the immediate vicinity (Tabb 1966).

Data on dynamics of ichthyofauna inhabiting barrier island environments along the Gulf of Mexico are restricted to a limited number of commercially and recreationally important species. Abundance and distribution of nekton in beach and shore zone habitats have been studied by Anderson et al. (1977) and Naughton and Saloman (1978). King (1971), Sabins and Truesdale (1974) and Conte et al. (1979) have characterized diel and seasonal occurrence of larval fishes in tidal passes and open bays. Even fewer data are available on species composition, abundance and recruitment of larval fishes associated with barrier-island beachfront and saltmarsh ecosystems.

The study reported herein characterizes ichthyoplankton assemblages of the Galveston, Texas barrier-island complex. Diel and seasonal comparisons of species composition, abundance and distribution are presented for larval fishes inhabiting beach and saltmarsh environments. Effects of hydrological fluctuations upon ichthyoplankton composition and abundance at these sites also are discussed.

## METHODS

Ichthyoplankton sampling was conducted at beach and saltmarsh environments in the Galveston Island system from 22 January to 27 August 1979. The beach station was located near the northeastern tip of Galveston Island approximately 40 m southwest of the South Jetty and Galveston Ship Channel (Bolivar Roads). This station incorporated barren, forebeach surf and swash zones characterized by small, diffuse waves and a fine-grained, terrigenous sand and shell substrate. Saltmarsh samples were taken from a tidally-influenced strandplain on West Bay, 4.6 km north of the Galveston Island city limits. This marsh was typified by abundant cordgrass stands *(Spartina alterniflora* and *S. patens)* and a silty sand-clay bottom. Water depth at both sites varied with tidal stage and usually ranged from 0.5 to 1.3 m.

Beach and saltmarsh stations were collected at least biweekly between 0800 and 1300 (day samples) and 2100 and 2400 (night samples). Sampling was conducted with a 2.0-m wide Renfro beam trawl (Renfro 1963) constructed of 1-mm bar mesh in the wings and body and 0.38-mm bar mesh in the codend. A 1.0-liter plastic collection jar wsas attached to the codend to contain the sample. The trawl was manually towed parallel to shore for 15 m to filter an average water volume of 6 $m^3$. Water temperature (°C), salinity (ppt), and dissolved oxygen content (ppm) were measured prior to sampling.

Each sample was washed into the collection jar before taking the net ashore. The sample was preserved onshore in a 7 percent buffered formalin solution, stained with Rose Bengal and allowed to cure for at least 24 hours. Samples were then washed through a no. 35 sieve and all fish removed. All larvae and juveniles were identified to the lowest possible taxon and enumerated. Fish eggs were counted but not identified.

The Shannon-Wiener index was selected as the best overall index of diversity (Bowman et al. 1970). Collection data were tabulated by number of species and number of individuals and the index was estimated following Pielou (1966):

$$H'' = -\Sigma \frac{n_i}{n} \log_e \frac{n_i}{n}$$

where $n_i$ is the number of individuals in the $i^{th}$ species and n is the total number of individuals in the collection.

## RESULTS

### Hydrological

Water temperatures at beach and saltmarsh stations were lowest during late winter through early spring and exhibited steady increases through summer (Figs. 1 and 2). Beach water temperatures varied between 8.0 (day, 29 January) and 31.0 °C (night, 16 July) and averaged 23.8 °C. The saltmarsh exhibited a wider temperature range (2.0 °C on 5 Feb - night to 35.0 °C on 4 July—day) and a lower mean temperature (23.5°C) than the beach. Night temperatures averaged 0.4 and 0.8°C warmer than those recorded during the day at the beach and saltmarsh, respectively.

Beach and saltmarsh salinities fluctuated widely and exhibited no consistent seasonal trends (Figs. 1 and 2). Salinities at the beach, ranging from 14 (night, 23 April) to 30 ppt (night, 23 July), were noticeably higher than those from the saltmarsh (5 ppt on 22 August—night to 27 ppt on 29 January—night). Beach and saltmarsh salinities averaged 22.5 and 13.7 ppt, respectively. No appreciable differences were noted between diel salinity readings.

Dissolved oxygen levels at the beach and saltmarsh ranged between 3.0 and 9.0 ppm. Few dissolved oxygen readings were below 5.0 ppm during the study.

### Biological

A total of 4593 individuals representing 63 taxa was taken during the study (Tables 1 and 2). Beach samples yielded 52 taxa and 1886 individuals compared to 39 taxa and 2707 individuals in saltmarsh catches. Twenty-seven taxa were common to both sites.

Abundance trends for beach and saltmarsh stations differed seasonally. Ichthyoplankton catches at the beach peaked during January through March and declined

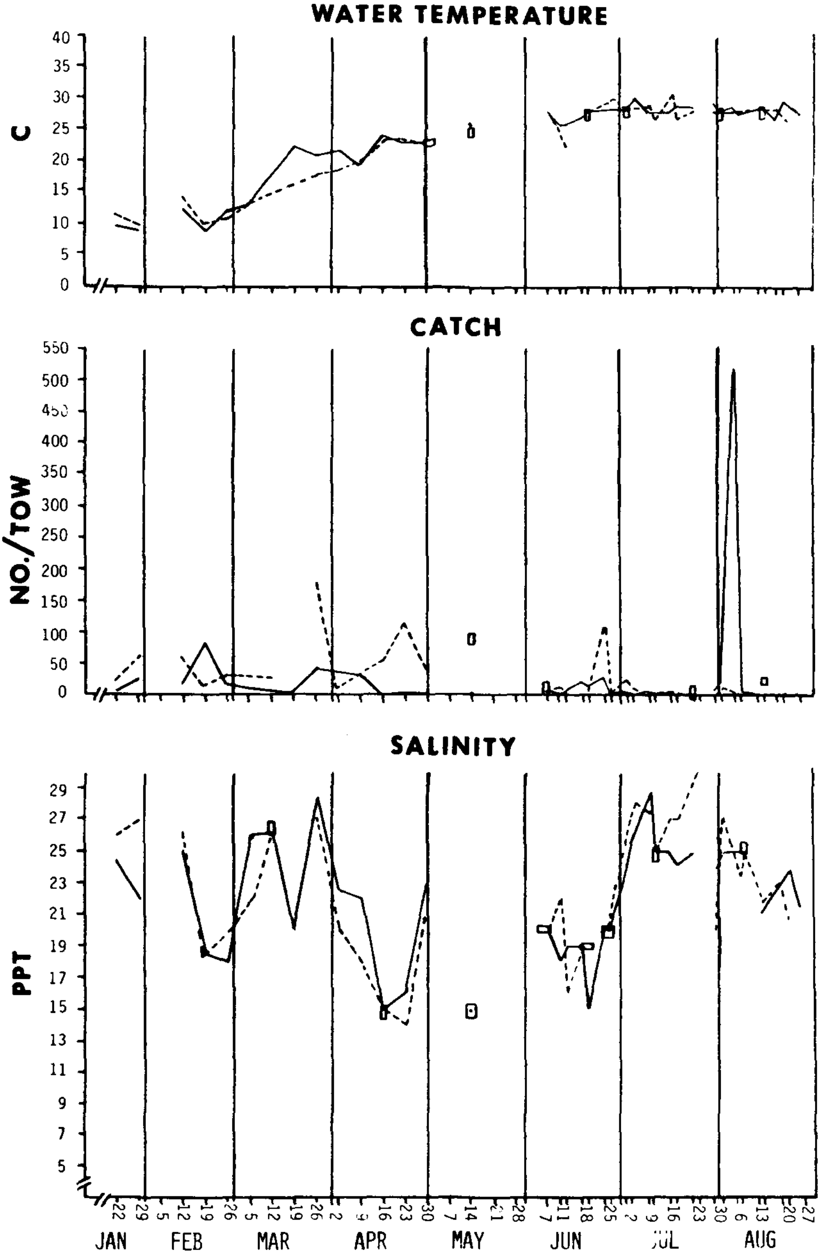


Fig. 1. Water temperature, number of fish per tow and salinity at beach during January - August 1979. Daytime values ( • ) are connected by solid lines and nighttime values ( □ ) are connected by dashed lines.

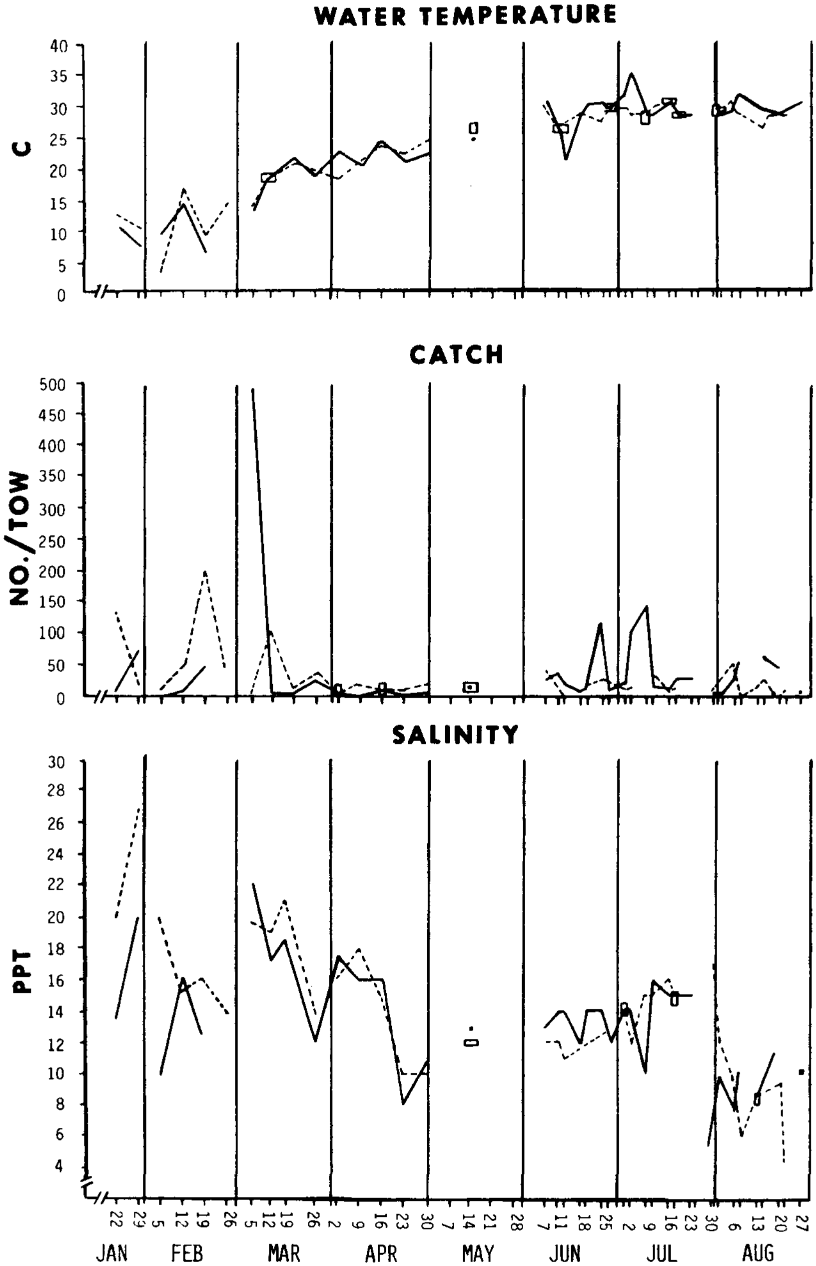


Fig. 2. Water temperature, number of fish per tow and salinity measurements at saltmarsh during January - August 1979. Daytime values ( • ) are connected by solid lines and nighttime values ( □ ) are connected by dashed lines.

Table 1. Diel abundances of ichthyoplankton taken from the beach study site January-August 1979.

| | Jan-Mar | | Apr-Jun | | Jul-Aug | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| Taxa | Day | Night | Day | Night | Day | Night | Day | Night | Occurrence |
| *Myrophis punctatus* | 6 | 24 | 0 | 0 | 0 | 0 | 6 | 24 | JAN-MAR |
| *Brevoortia* sp. | 124 | 111 | 26 | 129 | 0 | 0 | 150 | 240 | JAN-JUN |
| *Brevoortia patronus* | 9 | 1 | 2 | 0 | 6 | 0 | 17 | 1 | MAR, MAY, JUL-AUG |
| *Anchoa mitchilli* | 1 | 1 | 70 | 261 | 16 | 19 | 87 | 281 | JAN, MAR-AUG |
| Family Sparidae | 0 | 5 | 4 | 9 | 0 | 0 | 4 | 14 | MAR-MAY |
| Family Sciaenidae | 6 | 36 | 28 | 11 | 0 | 16 | 34 | 63 | MAR-APR, JUL-AUG |
| *Bairdiella chrysoura* | 0 | 0 | 0 | 0 | 5 | 2 | 5 | 2 | JUL-AUG |
| *Cynoscion arenarius* | 0 | 0 | 0 | 5 | 504 | 9 | 504 | 14 | JUN, AUG |
| *Cynoscion nebulosus* | 0 | 0 | 0 | 1 | 10 | 4 | 10 | 5 | APR, JUN-AUG |
| *Leiostomus xanthurus* | 21 | 45 | 0 | 11 | 0 | 0 | 21 | 56 | JAN-MAR, MAY |
| *Micropogonias undulatus* | 8 | 101 | 1 | 7 | 0 | 0 | 9 | 108 | JAN-JUN |
| *Mugil cephalus* | 0 | 10 | 1 | 0 | 0 | 0 | 1 | 10 | JAN-MAR, JUN |
| Family Gobiidae | 0 | 20 | 0 | 5 | 0 | 0 | 0 | 25 | MAR-APR, JUN |
| *Gobiosoma bosci* | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 7 | JUL |
| Family Bothidae | 0 | 18 | 0 | 3 | 3 | 2 | 3 | 23 | JAN-APR, JUL-AUG |
| Other Taxa | 2 | 7 | 6 | 11 | 8 | 10 | 16 | 28 | FEB-AUG |
| Unidentified fish eggs | 59 | 0 | 12 | 17 | 15 | 0 | 86 | 17 | MAR-APR, JUN-AUG |
| Unidentifiable larvae | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 15 | APR |

Table 2. Diel abundances of ichthyoplankton taken from the saltmarsh study site January-August 1979.

| Taxa | Jan-Mar | | Apr-Jun | | Jul-Aug | | Total | | Occurrence |
|---|---|---|---|---|---|---|---|---|---|
| | Day | Night | Day | Night | Day | Night | Day | Night | |
| Brevoortia sp. | 432 | 85 | 6 | 44 | 0 | 0 | 438 | 129 | JAN-APR |
| *Brevoortia patronus* | 0 | 0 | 0 | 1 | 15 | 2 | 15 | 3 | APR-AUG |
| *Anchoa mitchilli* | 1 | 12 | 27 | 32 | 84 | 45 | 112 | 89 | FEB-AUG |
| Family Cyprinodontidae | 0 | 15 | 0 | 0 | 2 | 0 | 2 | 15 | JAN-FEB, JUL-AUG |
| *Cyprinodon variegatus* | 10 | 255 | 0 | 0 | 0 | 0 | 10 | 255 | JAN-MAR |
| *Menidia beryllina* | 0 | 9 | 2 | 0 | 11 | 1 | 13 | 10 | FEB-MAR, JUN-AUG |
| Family Sciaenidae | 2 | 20 | 0 | 5 | 0 | 1 | 2 | 26 | JAN-FEB, JUN, AUG |
| *Bairdiella chrysoura* | 0 | 0 | 1 | 0 | 20 | 21 | 21 | 21 | APR, JUL-AUG |
| *Cynoscion arenarius* | 0 | 0 | 1 | 5 | 1 | 7 | 2 | 12 | JUN-AUG |
| *Cynoscion nebulosus* | 0 | 0 | 3 | 0 | 2 | 8 | 5 | 8 | JUN-AUG |
| *Leiostomus xanthurus* | 211 | 236 | 1 | 10 | 1 | 0 | 213 | 246 | JAN-MAY, JUL |
| *Micropogonias undulatus* | 3 | 36 | 4 | 13 | 0 | 0 | 7 | 49 | JAN-APR |
| Family Gobiidae | 0 | 3 | 22 | 8 | 67 | 19 | 89 | 30 | JAN, MAR-APR, JUN-AUG |
| *Gobiosoma bosci* | 0 | 1 | 185 | 54 | 384 | 174 | 569 | 229 | MAR-AUG |
| Family Bothidae | 14 | 24 | 0 | 1 | 0 | 1 | 14 | 26 | JAN-APR, AUG |
| Other Taxa | 1 | 5 | 7 | 12 | 0 | 1 | 8 | 18 | JAN-FEB, APR-JUL |
| Unidentified fish eggs | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | FEB-MAR |
| Unidentifiable larvae | 0 | 0 | 6 | 0 | 9 | 1 | 15 | 1 | JUN, AUG |

thereafter (Table 3, Fig. 1). Mean catch per effort at the beach during winter (36.2 fish/tow) was nearly twice that observed in summer (21.9 fish/tow). Saltmarsh ichthyoplankton catches were high in the winter, declined during spring and early summer and increased through late summer (Table 3, Fig. 2). Winter saltmarsh samples produced the highest seasonal catch rate (72.6 fish/tow) recorded from both study sites. Daily catch totals in excess of 100 fish/tow were common at the saltmarsh during winter (Table 4). These large catches were primarily responsible for the difference in overall catch rates (Table 3) for the beach (26.6 fish/tow) and saltmarsh (38.7 fish/tow).

Diel abundance trends were different for beach and saltmarsh communities (Table 3).

Table 3. Catch statistics for day and night ichthyoplankton samples from each and saltmarsh stations during January-August 1979.

| | BEACH | | | |
|---|---|---|---|---|
| | JAN-MAR | APR-JUN | JUL-AUG | TOTAL |
| Total Catch-Day | 236 | 147 | 567 | 950 |
| Total Catch-Night | 379 | 488 | 69 | 936 |
| Total Catch-Combined | 615 | 635 | 636 | 1886 |
| Mean Catch-Day | 26.2 | 11.3 | 37.8 | 25.7 |
| Mean Catch-Night | 47.4 | 40.7 | 4.9 | 27.5 |
| Mean Catch-Combined | 36.2 | 25.4 | 21.9 | 26.6 |
| # Taxa-Day | 11 | 14 | 14 | 31 |
| # Taxa-Night | 19 | 27 | 15 | 44 |
| # Taxa-Combined | 22 | 32 | 22 | 52 |
| # Samples-Day | 9 | 13 | 15 | 37 |
| # Samples-Night | 8 | 12 | 14 | 34 |
| # Samples-Combined | 17 | 25 | 29 | 71 |

| | SALTMARSH | | | |
|---|---|---|---|---|
| | JAN-MAR | APR-JUN | JUL-AUG | TOTAL |
| Total Catch-Day | 674 | 265 | 596 | 1535 |
| Total Catch-Night | 706 | 185 | 281 | 1172 |
| Total Catch-Combined | 1380 | 450 | 877 | 2707 |
| Mean Catch-Day | 74.9 | 20.4 | 42.6 | 42.6 |
| Mean Catch-Night | 70.6 | 15.4 | 23.4 | 34.5 |
| Mean Catch-Combined | 72.6 | 18.0 | 33.7 | 38.7 |
| # Taxa-Day | 9 | 15 | 12 | 23 |
| # Taxa-Night | 19 | 17 | 14 | 34 |
| # Taxa-Combined | 20 | 23 | 18 | 39 |
| # Samples-Day | 9 | 13 | 14 | 36 |
| # Samples Night | 10 | 12 | 12 | 34 |
| # Samples-Combined | 19 | 25 | 26 | 70 |

Table 4. Ichthyoplankton taxa comprising peak diel catches at the beach and saltmarsh during January-August 1979.

| DATE | TIME | TAXA | # CAPTURED |
|---|---|---|---|
| | | BEACH | |
| 26 MAR | Night | *Micropogonias undulatus* | 49 |
| | | Fish Eggs | 39 |
| 23 APR | Night | *Brevoortia* sp | 64 |
| 25 JUN | Night | *Anchoa mitchilli* | 99 |
| 6 AUG | Day | *Cynoscion arenarius* | 504 |
| | | SALTMARSH | |
| 22 JAN | Night | *Leiostomus xanthurus* | 84 |
| 19 FEB | Night | *Cyprinodon variegatus* | 192 |
| 5 MAR | Day | *Brevoortia* sp | 334 |
| | | *Leiostomus xanthurus* | 150 |
| 12 MAR | Night | *Brevoortia* sp | 52 |
| 25 JUN | Day | *Gobiosoma bosci* | 87 |
| 9 JUL | Day | *Gobiosoma bosci* | 125 |

Day and night sampling at the beach yielded similar overall catch per effort values (25.7 and 27.5 fish/tow, respectively). However, diel catch patterns at the beach differed with season. Night samples produced nearly 70 percent of the combined January-June catch while day samples yielded 89 percent of the July-August total. Peak diel catch rates for the saltmarsh consistently occurred during the day.

Taxa totals for the beach and saltmarsh exhibited different catch trends (Figs. 3 and 4). Largest assemblages at the beach occurred during months of milder water temperatures (March, April, June and July). Taxa totals during these months ranged from 15 to 20 while months exhibiting lowest and highest temperatures yielded 8 (January) to 13 taxa (August). Monthly taxa totals for the saltmarsh varied between months and were usually lower than those for the beach. Except for May (when only one sample was taken), lowest (9) and highest (16) taxa totals were taken during cool-water months of January and February. Other monthly taxa totals for the saltmarsh ranged between 10 and 15.

Monthly mean species diversity indices for the beach (Figs. 5 and 6) exhibited trends similar to those for catch per effort. Species diversity peaked during January through March (0.99 to 1.18) and declined through August (0.42). Trends in species diversity at the saltmarsh also varied with catch per effort. Highest diversities (0.98 to 1.06) at the saltmarsh coincided with peak fish densities in January and February. Diversities fluctuated erratically as catch rates declined (during March through June) and increased with increases in population size during July and August. Mean monthly species diversity for the saltmarsh exceeded that for the beach in 5 of 8 months.

Monthly taxa totals (Fig. 4) and mean species diversity indices (Fig. 6) for both study sites were consistently higher during the night. Differences in diel statistics were most pronounced in beach samples which yielded 6.8 (day) and 11.9 species (night) per month and diversity indices of 0.45 (day) and 1.03 (night).

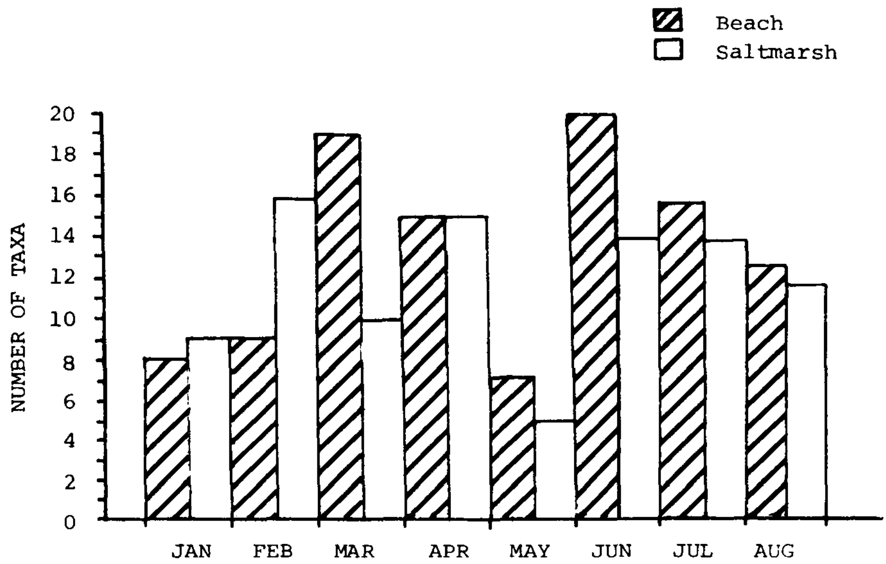


Fig. 3. Monthly number of ichthyoplankton taxa taken from beach and saltmarsh stations during January - August 1979.

Species composition of ichthyoplankton assemblages at both sites varied with season and diel sampling period (Figs. 7 and 8). Winter catches at the beach were dominated by postlarval menhaden *(Brevoortia* sp) which accounted for nearly 53 and 30 percent of day and night catches, respectively (Fig. 7). Despite the difference in percent of total catch during diel sampling periods, mean menhaden abundance in day and night tows (Table 1) was similar (14.4 and 14.0 fish/tow, respectively). Other dominant winter constituents (Fig. 7) included fish eggs, Atlantic croaker *(Micropogonias undulatus)* and spot *(Leiostomus xanthurus)*. Fish eggs were taken only during the day while more motile croaker and spot exhibited highest catch rates at night.

Adult sheepshead minnows *(Cyprinodon variegatus)* and postlarval menhaden and spot accounted for over 89 percent of the peak winter catches at the saltmarsh (Fig. 8). These 3 taxa, however, displayed different diel catch trends. Larger, faster-swimming sheepshead minnows dominated night samples (36.1% of total catch) but were virtually absent from day tows (Table 2). Menhaden ranked first and third in total abundance during day and night sampling, respectively. Menhaden densities taken from the saltmarsh during the day (48 fish/tow) were nearly 6 times those for night samples (8.5 fish/tow) and noticeably higher than those recorded at the beach. Percent of total catch and mean catch per effort for spot were essentially the same during day and night. Spot catch rates (23.4 and 23.6 fish/tow during day and night, respectively) at the saltmarsh also were much higher than those at the beach (2.3 and 5.6 fish/tow during day and night, respectively).

Bay anchovy *(Anchoa mitchilli)* replaced menhaden as the dominant taxon at the beach during spring (Fig. 7). Anchovy dominated diel catches at essentially the same rate (48%—day and 54%—night) but were nearly 4 times more abundant at night (5.6 and 21.9 fish/tow for day and night, respectively). Menhaden, exhibiting sharp reductions in density, ranked second in total abundance (Table 1). Like that for anchovy, catch per effort for menhaden was noticeably greater at night (10.8 compared to 2.2 during the day).

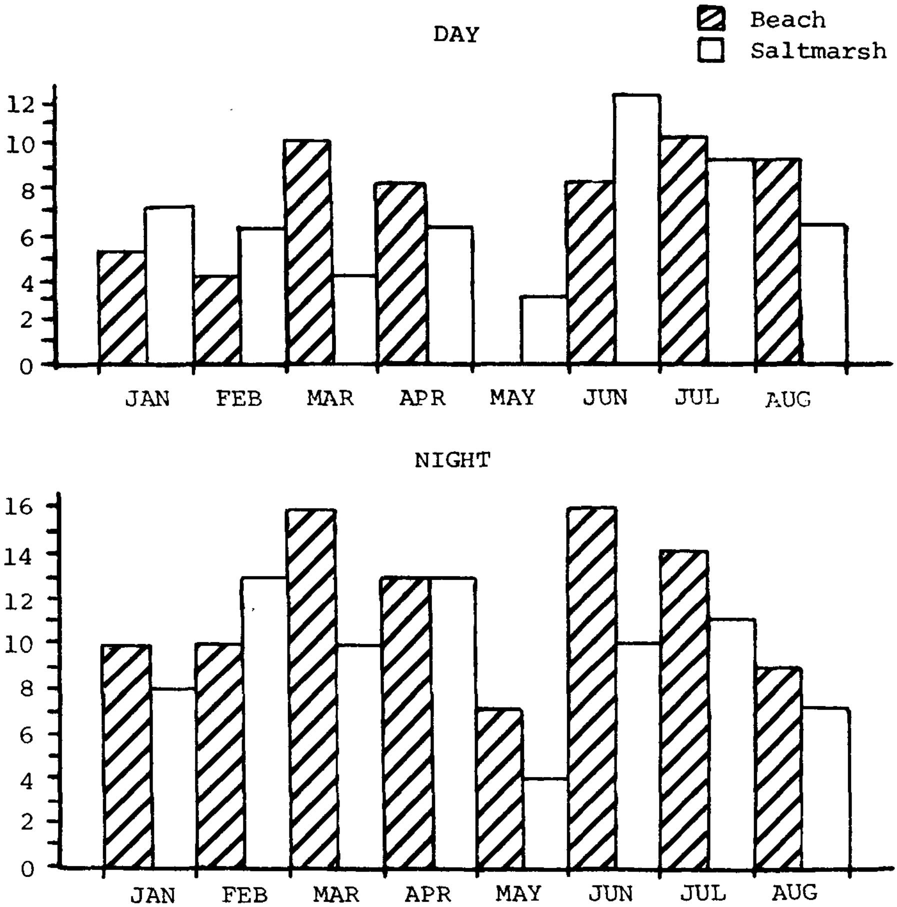


Fig. 4. Monthly number of ichthyoplankton taxa taken in diel samples from beach and saltmarsh stations during January - August 1979.

Population reductions at the saltmarsh during spring and early summer were accompanied by a noticeable shift in dominant ichthyofauna (Table 2 and Fig. 8). Spot and menhaden were captured less frequently and were replaced by naked gobies *(Gobiosoma bosci)* which comprised over 53 percent of the total spring catch. Goby abundances were much higher in day tows (14.2 versus 4.5 fish/tow at night). Larval bay anchovy and remnants of the winter menhaden spawn which dominated beach catches were the only other taxa frequently taken at the saltmarsh. These fishes, like those at the beach, exhibited higher abundances at night.

Sand seatrout *(Cynoscion arenarius)* comprised nearly 81 percent of the summer catch totals at the beach (Table 1 and Fig. 7). However, about 98 percent of the entire seatrout catch was represented by 504 larvae taken in a day sample on 6 August (Fig. 1). Omitting these sand seatrout reduces the overall summer catch rate at the beach to 4.2 fish/tow.

Resident species including naked gobies and bay anchovy were primary contributors to increased catch rates at the saltmarsh during summer (Table 2 and Fig. 8). Gobies and

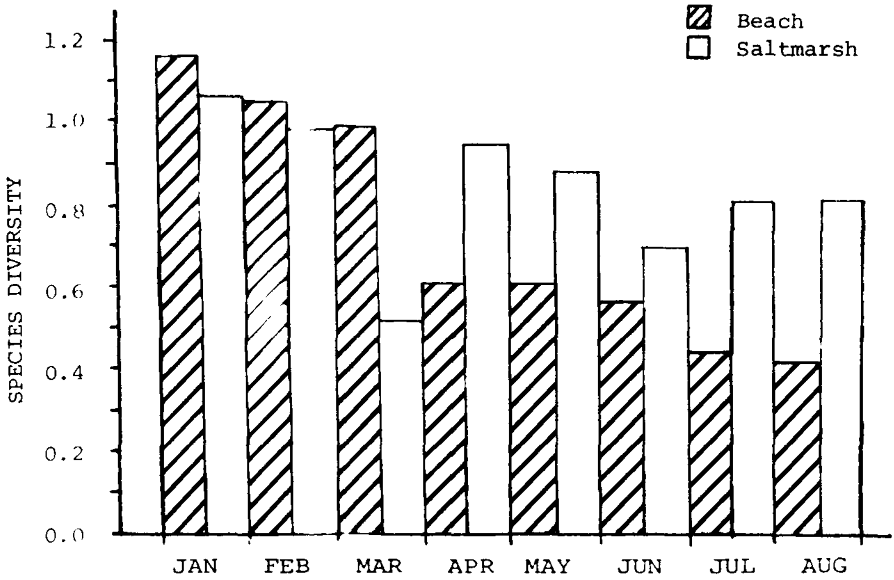


Fig. 5. Mean monthly species diversity indices for ichthyoplankton taken from beach and saltmarsh stations during January - August 1979.

anchovy, comprising over 63 and 14 percent, respectively, of the total catch, dominated both day and night totals. However, day catch per effort for both species (27.4 and 6.0 fish/tow for gobies and anchovy, respectively) was about twice that recorded at night.

## DISCUSSION

The 63 taxa taken during the 8-month study constitute a majority of the most abundant inhabitants of shallow offshore and estuarine waters of the Gulf of Mexico (Hoese and Moore 1977). Furthermore, most of these taxa represent the young of species described by Parker (1965) as dominant seasonal inhabitants of Galveston Bay estuarine environs. Comparison of our species list with that of Parker's indicates that at least 40 percent of the species annually inhabiting Galveston Bay are utilizing it as a nursery ground. This percentage probably would have been higher had the study lasted 12 months.

Beach and saltmarsh constitute important temporary habitats for many ichthyoplankton species. Taxa dominating winter and early spring assemblages at both sites represent fishes spawned offshore and carried inland by currents. These larvae initially penetrate beach and tidal pass habitats but seek the nutrient-rich saltmarsh. The saltmarsh provided ichthyoplankton with a relatively stable, nutrient-rich habitat which was preferred over a high-energy environs at the beachfront. These larvae are taken in highest abundances at the saltmarsh through late winter and early spring and later vacate these environs or avoid ichthyoplankton sampling gear. Reduced abundances at the saltmarsh during spring and early summer can be attributed to termination of spawning and recruitment by abundant taxa such as gulf menhaden and spot. Increased catches during summer reflect spawning pulses of resident taxa which include bay anchovies and naked gobies.

Large fluctuations were evident between catches at both sites. These variations could be attributed to schooling behavior of dominant taxa. Pacheco (1973) reported that schooling

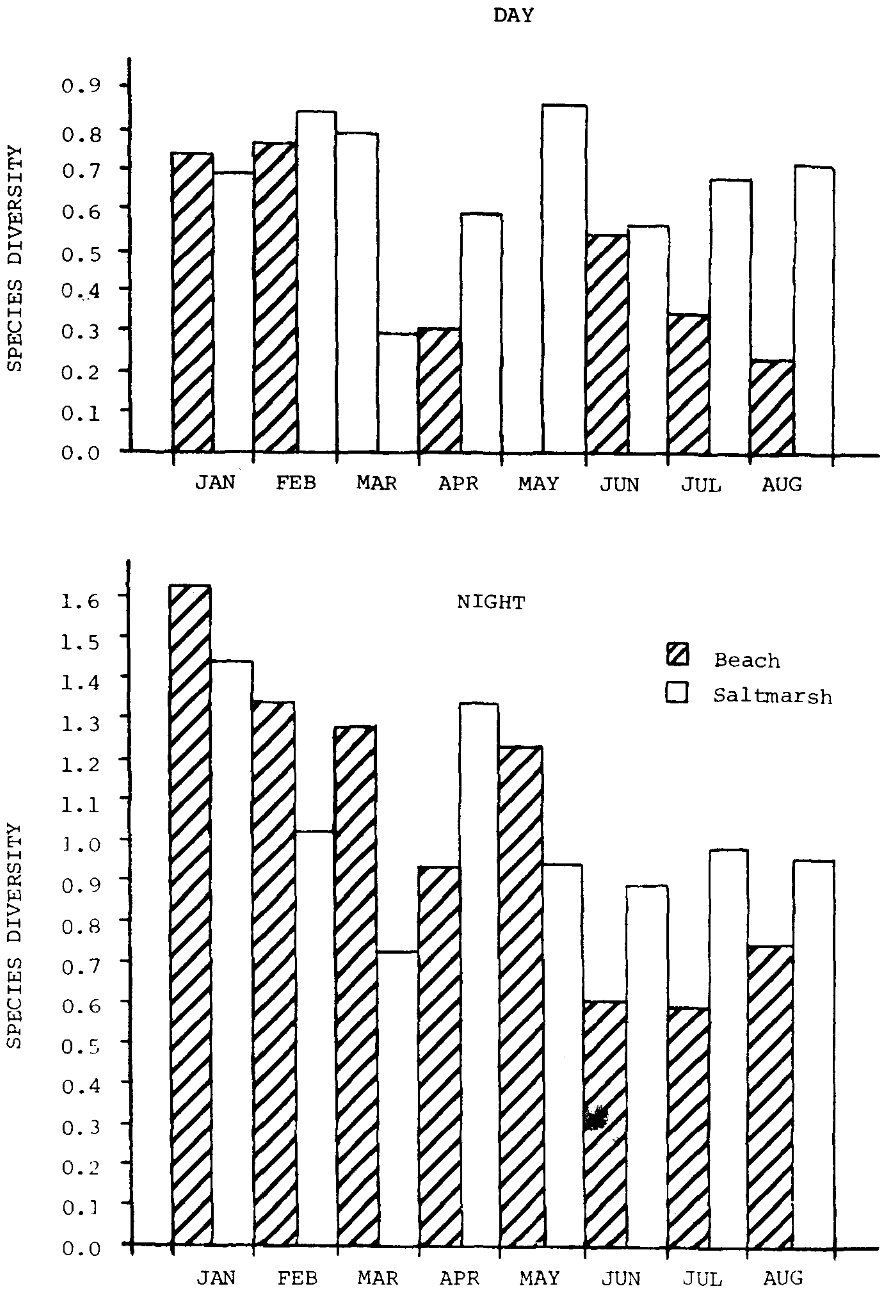


Fig. 6. Mean monthly species diversity indices for ichthyoplankton taken in diel samples from beach and saltmarsh stations during January - August 1979.

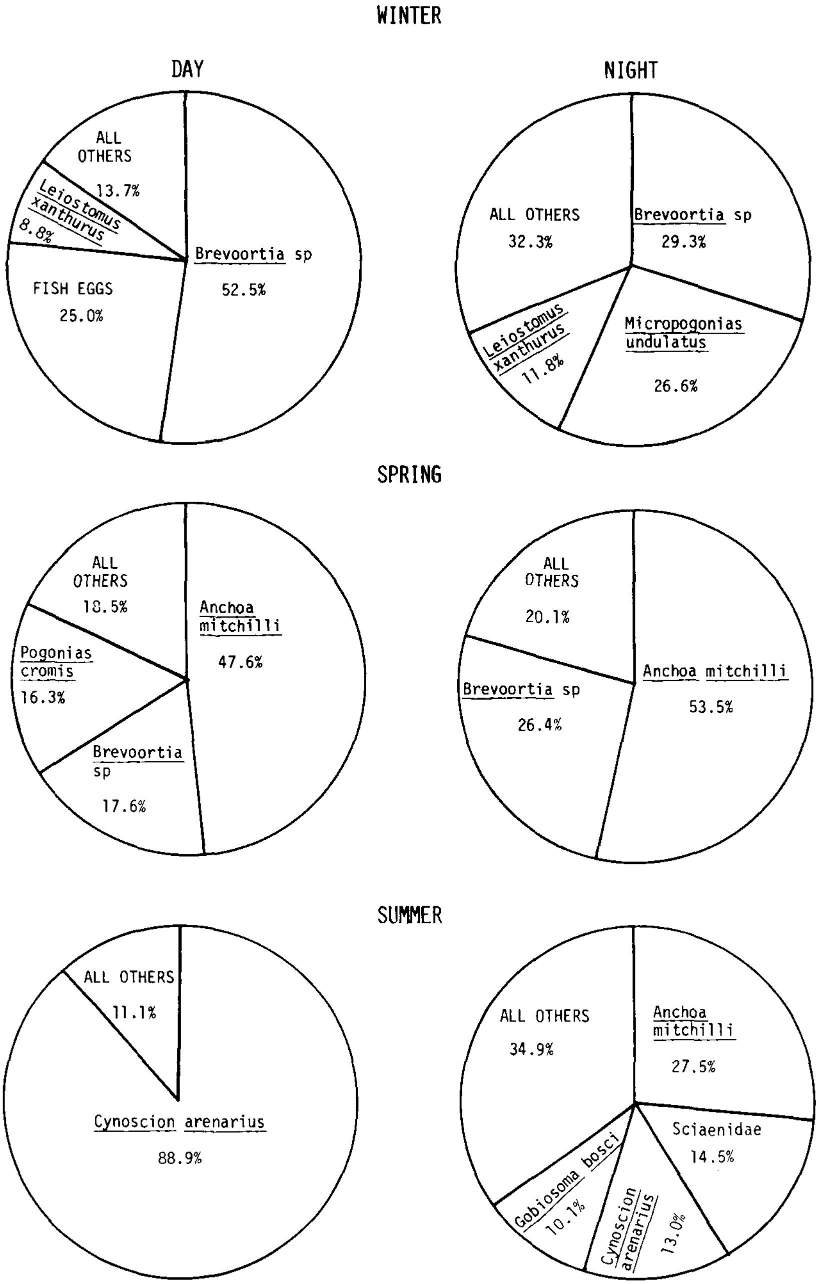


Fig. 7. Percent of total catch for dominant ichthyoplankton taxa from the beach during winter through summer 1979.

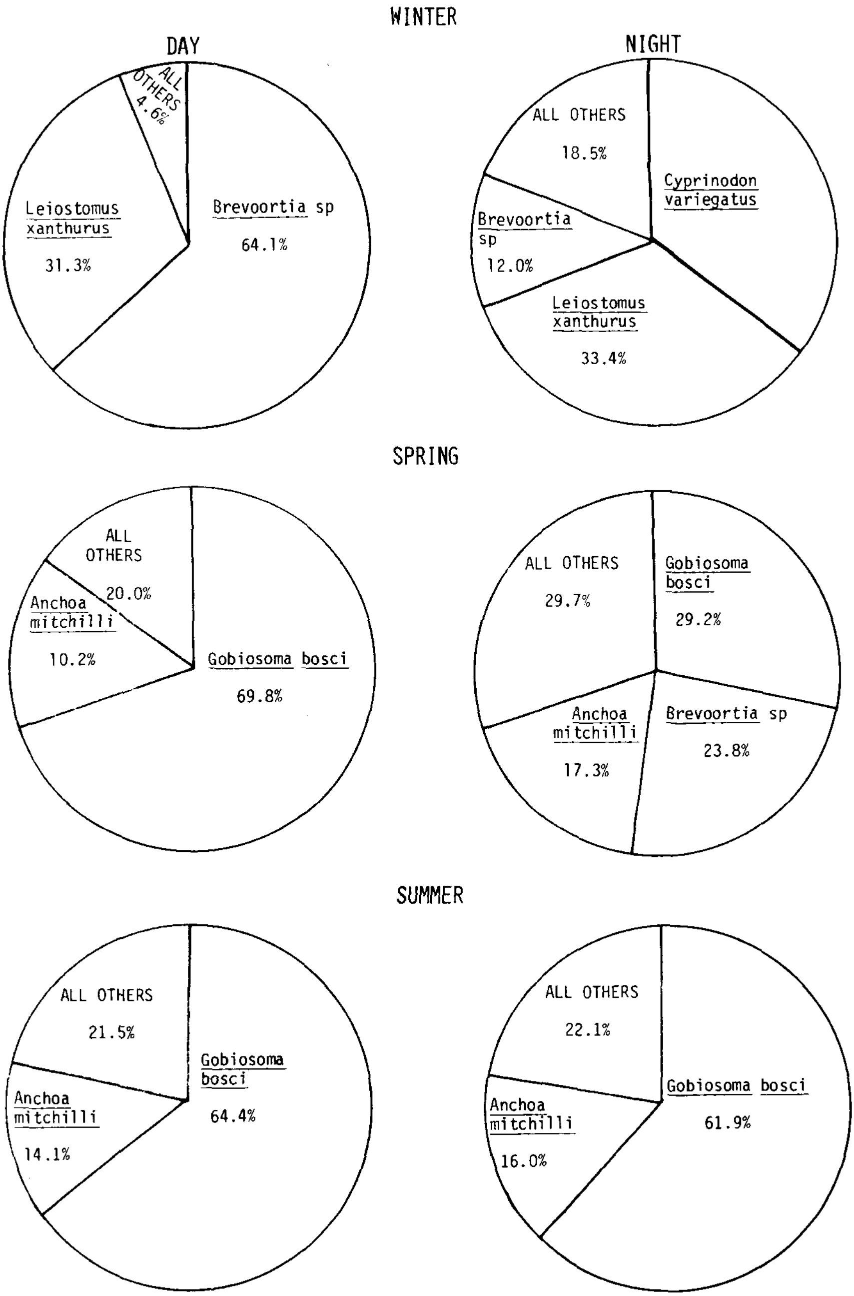


**Fig. 8. Percent of total catch for dominant ichthyoplankton taxa from the saltmarsh during winter through summer 1979.**

behavior and net avoidance behavior of some fishes often prevent adequate sampling of estuarine ichthyoplankton assemblages. Dominant taxa such as menhaden, spot, Atlantic croaker and bay anchovy exhibit schooling behavior as larvae. Over 97 percent of the entire catch of sand seatrout (518 individuals) at the beach represented schooling larvae taken in an August sample.

Distinct day-night differences in catch were noted at both sampling sites. Larger number of taxa and individuals captured at the beach during night sampling may be attributed to increased net avoidance during the day. High turbidity from suspended organic detritus reduced net avoidance at the saltmarsh during the day and enhanced capture of gulf menhaden, bay anchovy, spot and naked goby. The high number of taxa taken in night tows at the saltmarsh was probably due to decreased net avoidance and a diverse assemblage of nocturnal species at this site. Net avoidance also accounted for approximately 60 percent of the species at both sites exhibiting greater abundances during the night.

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