

Observations on abundance and spawning seasons of three fish families from an El Salvador coastal lagoon

Peter C. Phillips

Escuela de Ciencias Biológicas. Universidad Nacional, Heredia, Costa Rica

(Received for publication September 30, 1982)

Abstract: During a fish resource survey of Jiquilisco Bay, El Salvador, from September 1975 to November 1976, the three dominant commercially important families were the Ariidae, Gerreidae and Sciaenidae. For combined data, peak capture abundance occurred during the rainy season (May to September) and consisted mainly of pre-adult fishes. Gonadal inspection and occurrence of pre-adults indicated prolonged and variable spawning seasons for most species; only *Galeichthys jordani* (Ariidae), showed a restricted spawning season with young-of-year peak abundance during the mid-rainy season. The 11 sciaenid species probably do not spawn in this coastal lagoon but use it as a nursery area.

The importance of Ariidae (marine catfish), Sciaenidae (croakers) and Gerreidae (mojarras) as dominant fish families in tropical American estuaries and coastal lagoons has been documented in various studies on community structure. These three families are among the more important in terms of abundance and commercial value at Jiquilisco Bay, El Salvador (Phillips and Cole, 1978; Phillips, 1981) and on the Mexican Pacific coast, they are the top carnivores in mangrove lagoons (Warburton, 1978). León (1973) considered Ariidae to be one of the most important components of his "sciaenid community" in the Gulf of Nicoya, Costa Rica, while Bartels (1981) found Sciaenidae and Ariidae to be most important in terms of biomass.

Studies of the spawning seasons of species of these families apparently have been done only on Caribbean populations (Lowe[McConnell], 1962; 1966; Etchevers, 1978a; 1978b). The present paper reports the seasonal abundance and spawning time for a number of species from these three families which were collected at Jiquilisco Bay, El Salvador (Pacific coast).

MATERIAL AND METHODS

Jiquilisco Bay is a mangrove lagoon of mud-bottomed canals which provide a fairly uniform habitat for the fish fauna. Only near

the bay mouth does sand replace the mud bottom. Six sampling stations were located 3 to 22 km from the bay mouth. I sampled each station twice per month from September 1975 to November 1976 with a 5 m trawl (otter trawl) at a standardized towing time of 45 min.

The annual mean precipitation, occurring from May to October, ranges from 1800 to 2000 mm. Peaks in the rains occur in June and October with a temporary halt in July or August. Water temperature (surface and bottom combined [Phillips, 1979]) varied during the study approximately 5 C on an annual mean basis, with a minimum (26.5 C) in January and a maximum (32.0 C) in August. With regard to annual mean salinity, the only significant difference was between values at the bay mouth (Station 1) and those from the interior of the bay (Stations 2-6 combined; Phillips, 1979, Table 6). Since the bay mouth also presents a distinct faunal difference; it is treated separately throughout this analysis.

The reproductive cycles were determined from the few preserved specimens that were stored during the survey (Table 1) and gonadal development was divided following Nikolsky (1963) into three categories; ripening, ripe and spent. Actively spawning individuals were never observed during field work and maturity determinations were done on preserved specimens. Therefore a spawning category was

TABLE 1

Total numbers captured, numbers examined, and with their respective maturity state for Jiquilisco Bay ariids, gerreids and sciaenids

	N captured	N examined	imm.	ripen- ing	ripe	spent
ARIIDAE						
<i>Arius steindachneri</i>	40	18	9	5	—	4
<i>Bagre paramensis</i>	38	12	11	1	—	—
<i>Galeichthys jordani</i>	3513	130	55	28	19	28
GERREIDAE						
<i>Eucinostomus argenteus</i>	1254	155	99	42	14	—
<i>Eugerres peruvianus</i>	1362	202	104	38	10	50
SCIAENIDAE						
<i>Bairdiella ensifera</i>	30	23	4	19	—	—
<i>Cynoscion phoxocephalus</i>	358	63	58	5	—	—
<i>C. squamipinnis</i>	37	5	5	—	—	—
<i>C. stolzmanni</i>	1	1	—	—	—	1
<i>Larimus acclivis</i>	4	4	2	2	—	—
<i>Menticirrhus nasus</i>	20	5	1	4	—	—
<i>Micropogonias altipinnis</i>	48	34	30	4	—	—
<i>Ophioscion sciera</i>	171	7	4	13	—	—
<i>O. typicus</i>	79	30	17	13	—	—
<i>Paralonchurus dumerilii</i>	1	1	—	1	—	—
<i>Stellifer oscitans</i>	745	49	—	48	—	1

not included. Pre-adults were those individuals with an undeveloped gonad, adults had gonads in some stage of active development. In the marine catfish, *Galeichthys jordani*, a precise size at maturity could not be accurately determined since a continuous size series was not collected. However a very distinct, recently spawned group of individuals was identified during a restricted time period. Therefore, these individuals will be referred to as "young-of-year" (YOY), while the remainder of the specimens will be included as "others".

The histograms (Figs. 1-5) reflect the fluctuations in annual abundance and attempt to identify trends in the major species of the three families, separating pre-adults and adults (YOY and "others" in *G. jordani*). In all histograms, fish captured at Station 1 are reported separately from those taken from Stations 2-6. The annual water temperature

variation and the rainy and dry season sequence accompanies each figure.

RESULTS

ARIIDAE

Arius steindachneri (Gilbert and Starks) (N=40). A few ripening individuals were taken in September (4) and November 1976 (1), and spent females from June to August 1976 (4). The remaining 9 examined were immature.

Bagre panamensis (Gill) (N=38). One ripening female was captured in April 1976, the remaining 11 individuals examined were immature.

Galeichthys jordani (Eigenmann and Eigenmann) (N=3513) (Fig. 1). Numbers captured per hour peaked during the rainy season months when water temperature was

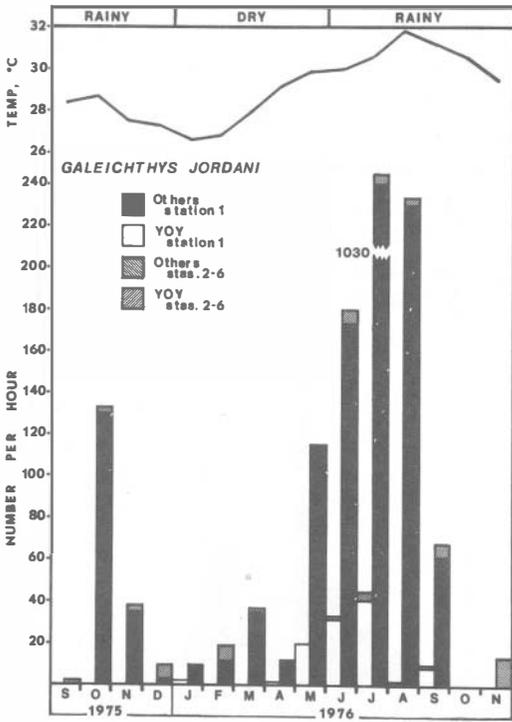


Fig. 1. Annual variation in capture of young-of-year (YOY) and all others of *Galeichthys jordani* with a try net in Jiquilisco Bay, El Salvador in relation to temperature and season. Note that Stations 2-6 are grouped separately from Station 1.

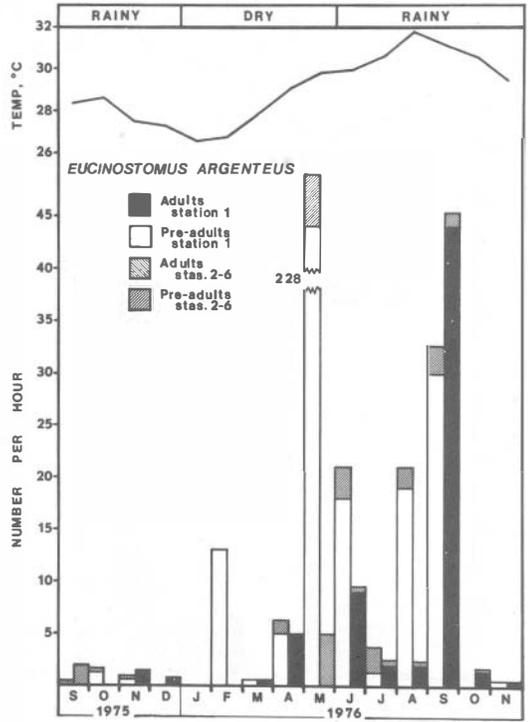


Fig. 2. Annual variation in capture of adult and pre-adult *Eucinostomus argenteus* with a try net in Jiquilisco Bay, El Salvador in relation to temperature and season. Note that Stations 2-6 are grouped separately from Station 1.

also at its maximum. Absence of specimens in October 1976 may have resulted from pesticide applications on adjacent cotton fields (Phillips and Cole, 1978). Individuals were later captured in November 1976 as the rains diminished. Most (86%) were taken at Station 1 near the bay mouth.

One hundred and thirty preserved specimens were examined of which 55 were immature. Ripe (19) *G. jordani* were taken from February to July, coinciding with the appearance of very small individuals (YOY) in the catch. Ripening, for the next spawning cycle, also increased toward the end of the rainy season (September and November). Of the 39 mature individuals examined, 20 were ripening and the remainder were spent. Spent individuals were taken in most months, peaking in June around the time of greatest fry capture. Individuals to 80 mm TL (referred to as YOY) were occasionally captured from January to April but were recruited in much larger numbers in May,

peaking in July, and were not captured after September.

GERREIDAE

Eucinostomus argenteus (Baird and Girard) (N=1254) (Fig. 2). Few individuals were taken in the latter part of the 1975 rainy season through the 1976 dry season. *E. argenteus* preferred more saline waters, with 85% of the capture at Station 1 (bay mouth). The greatest capture, principally of pre-adults, occurred in May, with abundance fluctuating through September. Of the 155 individuals examined, all of the adults (14) that were from the latter part of the dry to early rainy season (February to June) were ripe. This probably accounts for the subsequent large capture of pre-adults through the rainy season. The remaining 42 adult specimens were captured from late rainy to early dry season (August to November). Data are insufficient for analysis in the remaining months.

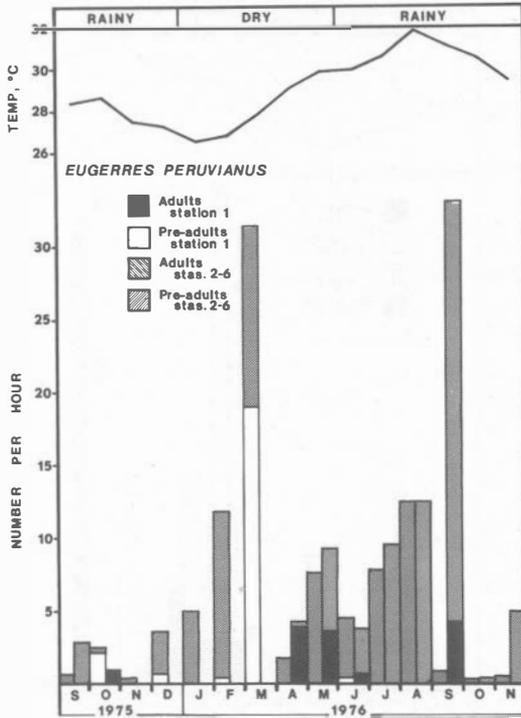


Fig. 3. Annual variation in capture of adult and pre-adult *Eugerres peruvianus* with a try net in Jiquilisco Bay, El Salvador in relation to temperature and season. Note that Stations 2-6 are grouped separately from Station 1.

Eugerres (Diapterus) peruvianus * (Cuvier and Valenciennes) (N = 1362) (Fig. 3). Capture occurred principally (74%) at the less saline interior Stations 5 and 6, indicating a minimal overlap in habitat between this species and *Eucinostomus argenteus*. Fluctuations in abundance are difficult to relate to seasonal factors. Pre-adults and adults were commonly captured in each month of the study. Of 98 adult individuals examined, 10 were in a ripe condition in January, March and November 1976. Greater numbers (35) of ripening specimens were present in the mid-rainy to early dry season. Spent individuals (50 examined) were found generally throughout the study, but more so in the same months that ripe individuals peaked (March, September).

* Originally identified as *Diapterus* by me. Dr. Carl L. Hubbs re-identified the genus as *Eugerres*, 28 November 1977. Nevertheless, the species generally appears as *Diapterus peruvianus* in the literature and is presented here as *Eugerres (Diapterus)* to avoid confusion.

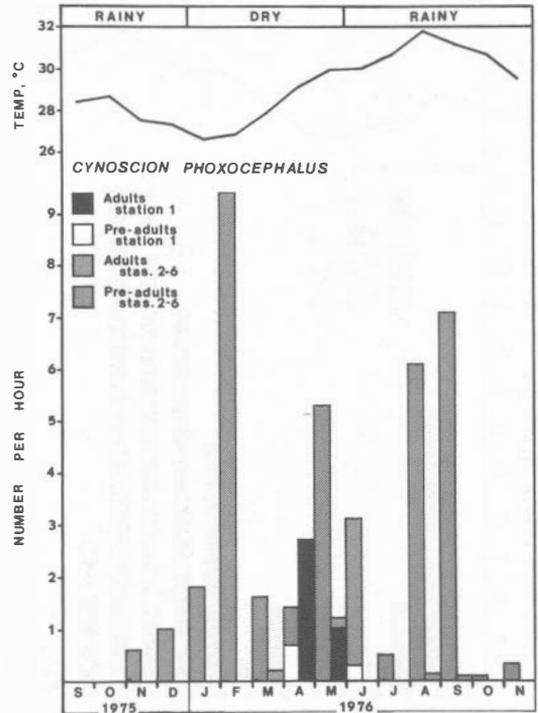


Fig. 4. Annual variation in capture of adult and pre-adult *Cynoscion phoxocephalus* with a try net in Jiquilisco Bay, El Salvador in relation to temperature and season. Note that Stations 2-6 are grouped separately from Station 1.

The peak in pre-adult abundance was in March 1976, reflecting the presence of ripe individuals in this and previous months. Apparently, the spawning season of this species was more prolonged but peaked earlier than that of *Eucinostomus argenteus*.

SCIAENIDAE

Bairdiella ensifera (Jordan and Gilbert) (N=30). Ripening specimens (19) were collected from May to August but no ripe individuals were noted.

Cynoscion phoxocephalus Jordan and Gilbert (N=358) (Fig. 4). This species was collected continuously with peaks in pre-adult abundance in both rainy and dry seasons. Most of the capture was at interior stations; only in the early rainy season were specimens taken at Station 1. Pre-adults comprised 95% of all captured specimens. A few ripening adults were noted in May (2), June (1) and August (1), September (1) 1976 of 63 individuals examined.

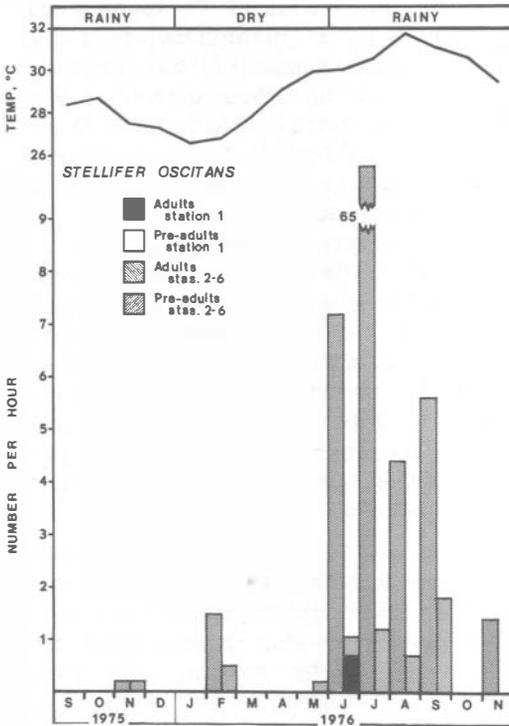


Fig. 5. Annual variation in capture of adult and pre-adult *Stellifer oscitans* with a try net in Jiquilisco Bay, El Salvador in relation to temperature and season. Note that Stations 2-6 are grouped separately from Station 1.

Cynoscion squamipinnis (Gunther) (N=37). Only pre-adults of this species were captured and only in rainy season months. Five individuals were examined for maturity state.

Cynoscion stolzmanni (Steindachner) (N=1). One female with spent ovaries, was captured (June 1976).

Larimus acclivis Jordan and Bristol (N=4). One ripening female was captured in February 1976 and one in April 1976. Two pre-adults were also captured.

Menticirrhus nasus (Gunther) (N=20). *M. nasus* was the only sciaenid collected principally (55%) at Station 1 near the bay mouth. A few ripening adults, of 5 specimens examined, were observed in October 1975 (1) and May (2), June (1) 1976.

Micropogonias altipinnis Gunther (N=48). Pre-adults dominated the catch. Of 34 specimens examined, only 4 early ripening adults were taken from January to March 1976; the remainder being immature.

Ophioscion sciera (Jordan and Gilbert) (N=171). Three ripening adults (7 individuals examined) were taken in March, June and August 1976. Pre-adult abundance, though common throughout the study, was highest during the rainy season.

Ophioscion typicus Gill (N=79). Thirteen ripening adults were collected in August and September 1976. Pre-adults dominated from mid to late rainy season.

Paralonchurus dumerilii (Bocourt) (N=1). One ripening female was taken in March 1976.

Stellifer oscitans (Jordan and Gilbert) (N=745) (Fig. 5). This was the most abundant sciaenid, with capture principally during the rainy season. Most adults (49) examined for maturity stage (February and May-September 1976) were ripening (48), indicating a protracted spawning season. Pre-adults dominated the try net catch (93%) of this species.

DISCUSSION

The results indicate that spawning seasons are generally protracted among these three important families in Jiquilisco Bay. The greatest capture of individuals and especially the great increase in numbers during the mid-rainy season was due mainly to pre-adults, with the exception of adult *Galeichthys jordani* and *Menticirrhus nasus*. This would indicate an increase in spawning intensity from approximately mid-dry to mid-rainy seasons. In another El Salvador brackish mangrove estuary, Burns and Flores (1981) reported a similar pattern for the "cuatro ojos", *Anableps dowi*. The predominance of juvenile fishes was also noted in the Huizache-Caimanero Mexican coastal lagoon complex (Pacific) (Warburton, 1978). More complete inspection of individuals and of greater numbers of individuals was not possible in the present study.

The pattern of abundance and spawning for each family is as follows. The marine catfish, Ariidae, with the principal species, *Galeichthys jordani*, inhabits almost exclusively the higher salinity, sand-bottom, bay mouth area. On the contrary, along the British Guiana continental shelf, Lowe (McConnell) (1962) reported catfishes in habitats of variable salinity due to fresh water intrusion and with bottoms of soft mud or sand-mud. León (1973) captured ariids predominately in mangrove estuaries in the

interior lower salinity areas of the Gulf of Nicoya, Costa Rica (Pacific). A related species, *G. caerulescens*, is a dominant component of the fish community, and highly associated with *Diapterus* (Gerreidae), in coastal lagoons of the Mexican Pacific coast (Yáñez-Arancibia *et al.*, 1976; Warburton, 1978).

At Jiquilisco Bay, adults dominated the ariid catch which peaked in July 1976, coinciding with the peak capture of young-of-year individuals. Spawning, therefore, was probably from mid-dry to mid-rainy season. This partially coincides with *G. caerulescens*, which presents spawning peaks in May and another in October in Mexico (Yáñez-Arancibia *et al.*, 1976). Another ariid, *Arius spixii*, also spawns only once a year from July to October near Margarita Island, Venezuela and the young are usually found near mangrove lagoons (Etchevers, 1978a). In Jiquilisco Bay, the actual location of spawning fishes was not determined. Young-of-year were mainly found at the higher salinity bay mouth, though Yáñez-Arancibia *et al.*, (1976) reported spawning for *G. caerulescens* in waters of less than 15‰ in Mexico.

The mojarras, Gerreidae, were represented by two equally abundant species. *Eucinostomus argenteus* preferred the higher salinity bay mouth. This same species is widely distributed in the Atlantic. Its preference for high salinity waters was also reported by Austin (1971) in Puerto Rico and by Waldinger (1968) in Everglades National Park (Florida). Linares-Amezcuca and Yáñez-Arancibia (1980) report it as an occasional visitor to Laguna de Términos, perhaps indicating its preference for more saline waters of the Gulf of Mexico. Capture, high throughout the rainy season, was dominated by pre-adult fishes except in September, toward the end of the rains. A protracted spawning season at least from mid-dry through the rainy season is suggested. Austin (1971) reported a population of *E. argenteus* from Puerto Rico that presented continuous breeding.

Eugerres (Diapterus) peruvianus was similarly abundant but with a more protracted spawning period, and was confined to interior stations. This same species is also a dominant member of the fish community of Mexican Pacific coastal lagoons (Warburton, 1978). Waldinger (1968) reported a low salinity preference for a related species, *Diapterus plumieri* from

Florida, while Austin (1971) found a similar preference for *D. olisthotomus* from Puerto Rico. Lowe (McConnell) (1962) reported ripe *D. rhombeus* throughout the year in British Guiana. Etchevers (1978) also found *D. rhombeus* from Venezuela to be a continuous breeder, with spawning peaks in April to June and September to November.

The croakers, Sciaenidae, are the more abundant of the three families in terms of species. The general pattern is that of greatest capture in the rainy season and in interior stations and almost complete domination by pre-adults, the exception being *Menticirrhus nasus*. In British Guiana, Lowe (McConnell) (1962) also reported a tendency for fishes in the "sciaenid zone" to move inshore during the rainiest months.

From my data, continuous or prolonged spawning was indicated for the following species: *Cynoscion phoxocephalus*, with at least three peaks in pre-adult abundance throughout the year; *Stellifer oscitans*, with greatest intensity in spawning in late dry-early rainy seasons; *Ophioscion sciera*, where peaks in pre-adult abundance may indicate three separate spawning peaks; *Menticirrhus nasus*, with spawning from late rainy through the dry season; *Bairdiella ensifera* and *Cynoscion squamipinnis*, spawning from late dry through mid-rainy season; *Micropogonias altipinnis*, where simultaneous capture of pre-adults and ripening adults indicate spawning from about late rainy to beginning of the following rainy season; *Ophioscion typicus*, simultaneous capture of ripening adults and pre-adults indicated spawning throughout the rainy season.

Results on the spawning seasons of the sciaenids must be considered tentative. In some cases erroneous conclusions may be drawn if one takes into account what Lowe (McConnell) (1962) calls a "place effect". She found ripe ovaries in some sciaenids throughout the year in British Guiana but in other cases only rarely, and suggested that certain species congregated in shallower waters for breeding and therefore were not sampled. She implied these to be seasonal spawners since inactive adults were taken offshore. But, in a later publication, Lowe (McConnell) (1966) noted that many sciaenids seasonally migrate inshore, and that they appeared to be continuous spawners.

Longhurst (1963; 1964), working with sciaenids in tropical west Africa, reported on their spawning seasonality. Maximum spawning generally occurred at a surface temperature of at least 27.5 C and was continuous, but with peak periods of intensity. He pointed out that for the species *Pseudolithus senegalensis* and *P. typus*, spawning occurred inshore but not in the estuaries. He compared these species with *Pseudolithus elongatus* in the Sierra Leone River estuary, where spawning occurred only in the mid-dry season when temperature and salinity were maximum.

Of sciaenids taken in substantial numbers in Jiquilisco Bay, only *Menticirrhus nasus* occurred most often near the bay mouth, whether as a pre-adult or adult. It may be considered a stray to Jiquilisco Bay, and may not be dependent on the estuary for larval and juvenile development. Other sciaenids (*Ophioscion sciera*, *Cynoscion phoxocephalus*) may spawn continuously in the nearshore and then migrate to the bay in greatest numbers during the rainy season. Still others appeared only in the dry season (*Micropogonias altipinnis*) or rainy season (*Bairdiella ensifera*, *Stellifer oscitans*, *Cynoscion squamipinnis*, *Ophioscion typicus*). Probably none are permanent residents, but spawn in the nearshore area, with larval and juvenile migration to the bay. This may be the case for most species of these three families since actively spawning individuals were never noted during the field work. Further research in the nearshore area outside of Jiquilisco Bay would be necessary to locate actual spawning sites and substantiate data presented here.

ACKNOWLEDGMENTS

I am grateful to John R. Burns for suggestions and revision of the manuscript.

RESUMEN

Desde Septiembre de 1975 hasta Noviembre de 1976 se realizó un inventario de los recursos pesqueros de la Bahía de Jiquilisco, El Salvador. Se encontró que las tres familias de peces de importancia comercial dominantes fueron Ariidae, Gerreidae y Sciaenidae. La captura más alta utilizando todos los datos combinados se registró durante la estación lluviosa (mayo a septiembre) y se debió principalmente a la

presencia de peces pre-adultos. El análisis de las gónadas y la presencia de pre-adultos indicaron épocas prolongadas y variables de desove para la mayoría de las especies; solamente *Galeichthys jordani* (Ariidae), demostró una época de desove definida con una mayor abundancia de juveniles durante la mitad de la época lluviosa. Las 11 especies de esciaenidos probablemente no desovan en esta laguna costera sino la utilizan como un criadero.

LITERATURE CITED

- Austin, H.M. 1971. A survey of the ichthyofauna of the mangroves of western Puerto Rico during December, 1967–August, 1968. *Carib. J. Sci.*, 11:27-39.
- Bartels, C.E. 1981. Occurrence, distribution, abundance and diversity of fishes in the Gulf of Nicoya, Costa Rica. M.Sc. thesis. University of Delaware, Newark.
- Burns, J.R. & J.A. Flores. 1981. Reproductive biology of the cuatro ojos, *Anableps dowi* (Pisces: Anablepidae), from El Salvador and its seasonal variations. *Copeia*, 1981: 25-32.
- Etchevers, S.L. 1978a. Contribution to the biology of the sea catfish, *Arius spixii* (Agassiz) (Pisces-Ariidae), south of Margarita Island, Venezuela. *Bull. Mar. Sci.*, 28:381-385.
- Etchevers, S.L. 1978b. Contribution to the biology of *Diapterus rhombeus* (Cuvier) (Pisces-Gerreidae), south of Margarita Island, Venezuela. *Bull. Mar. Sci.*, 28:385-389.
- León, P.E. 1973. Ecología de la ictiofauna del Golfo de Nicoya, Costa Rica, un estuario tropical. *Rev. Biol. Trop.*, 21:5-30.
- Linares Amezcua, F., & A. Yáñez-Arancibia. 1980. Ecología de los sistemas fluvio-lagunares asociados a la laguna de Términos. El hábitat y estructura de las comunidades de peces. *An. Centro Cienc. del Mar y Limnol. Univ. Nal. Autón. México*, 7: 69-118.
- Longhurst, A.R. 1963. The bionomics of the fisheries resources of the eastern tropical Atlantic. *Fish. Publ. Colonial Office Lond.*, no.20: 1-66.
- Longhurst, A.R. 1964. Bionomics of the Sciaenidae of tropical west Africa. *J. Cons. Explor. Mer.*, 29: 93-114.
- Lowe (McConnell), R.H. 1962. The fishes of the British Guiana continental shelf, Atlantic coast of South America, with notes on their natural history. *J. Linnean Soc. London*, 44:669-700.
- Lowe (McConnell), R.H. 1966. The sciaenid fishes of British Guiana. *Bull. Mar. Sci.*, 16:20-57.

- Nikolsky, G.V. 1963. The Ecology of Fishes. New York: Academic Press, 352 p.
- Phillips, P.C. 1979. Studies on the fishes of Jiquilisco Bay, El Salvador. M.Sc. thesis. University of Massachusetts, Amherst.
- Phillips, P.C. 1981. Diversity and fish community structure in a Central American mangrove embayment. *Rev. Biol. Trop.*, 29:227-236.
- Phillips, P.C. & C.F. Cole. 1978. Fisheries resources of Jiquilisco Bay, El Salvador. *Gulf Carib. Fish. Inst.*, Proc. 30th Ann. Sess.: 81-94.
- Waldinger, F.J. 1968. Relationships of environmental parameters and catch of three species of the mojarra family (Gerreidae), *Eucinostomus gula*, *Eucinostomus argenteus*, and *Diapterus plumieri*, collected in 1963 and 1964 in Buttonwood Canal, Everglades National Park, Florida. M. Sc. thesis, University of Miami.
- Warburton, K. 1978. Community structure, abundance and diversity of fish in a Mexican coastal lagoon system. *Estuarine Coast. Mar. Sci.*, 7: 497-519.
- Yáñez-Arancibia, A., J. Curiel-Gómez & V.L. de Yáñez. 1976. Prospección biológica y ecológica del bage marino *Galeichthys caerulescens* (Gunther) en el sistema lagunar costero de Guerrero, México (Pisces: Ariidae). *An. Centro Cienc. del Mar y Limnol. Univ. Nal. Autón. México*, 3:125-180.