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The Abundance and Diversity of Larval and Juvenile Fish in a Tropical Estuary

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ABSTRACT: The larval and juvenile fish of the Cayenne river estuary (French Guiana, South America) were sampled at two stations from June 1989 until October 1990. A total of 52,989 individuals from 59 species, some still incompletely identified, were collected. Three families, Engraulidae, Gobiidae and Sciaenidae, accounted for over 97% of the total number of juveniles. The analysis of data over this period showed low diversity, and a difference in diversity between the two sampling locations (H' = 1.24 and 1.68). The results conform to some theoretical models of abundance that suggest a relative equilibrium of juvenile assemblages. In contrast, the seasonal variations in diversity and abundance and the results of a correspondence analysis showed significant differences in species distribution and in their relative abundance at the two sampling locations at certain periods, mainly in the rainy season. Our study indicates that, in spite of an apparent stability, the year to year variation in salinity and freshwater inputs could affect juvenile recruitment of some species and induces modifications in the composition of larval and juvenile estuarine fish assemblages.

Introduction

A number of studies deal with fish communities within estuaries and coastal lagoons (see reviews by Yanez-Arancibia 1985; Day 1989). Such systems are known as major nursery grounds for many aquatic species. Generally rich in food, they also provide protection against predators of larvae and juveniles, thus allowing both rapid growth and a low rate of mortality. However, little is known about abundance and diversity of ichthyoplankton in estuaries, and spatiotemporal variation in these assemblages is poorly understood.

Our study was carried out in the Cayenne River estuary in French Guiana. Estuaries may be considered "unpredictable environments" in which physical and chemical factors vary widely in space and time (Bruton 1989; Whitfield 1990). The goals of our study were to characterize this variation in the Cayenne estuary and to answer the following questions about ichthyoplankton assemblages in this environment:

Is the larval and juvenile fish assemblage a stable community within an unstable environment? If only biotic factors, such as interspecific competition, play a role in the composition of a community, such a community is at an equilibrium of species richness. Yet an equilibrium may never be reached if abiotic factors are predominant.

Can this assemblage be described by any of the species abundance models currently in use (Poole 1974; Magurran 1988)? Species richness, species diversity, and equitability provide partial quantitative descriptions of assemblages, but they contain no biological information. Theoretical species abundance models attempt to describe the information gathered in a community (Poole 1974; Magurran 1988) and to explain the spatial distribution of the species within a given habitat and the sharing of the available resources (Magurran 1988).

To what extent can some of the observed variations be related to simple factors like rainfall and salinity?

Materials and Methods

STUDY SITE

The study was conducted in the Cayenne River estuary (French Guiana, South America, 4°80'N 52°20'W), an area 5 km in length and 1–1.5 km in width. There is considerable tidal influence (intertidal range up to 3 m). It is an "homogenous" estuary (Yanez-Arancibia 1987) having almost no vertical salinity gradient. The rainy season occurs from December to June, with maximum rainfall generally observed in May and June.

SAMPLING METHODS

Two locations were chosen based on differences in physical characteristics (position, types of bottom, and water depth). The first (hereafter named middle), located in the middle of the estuary, is characterized by a mud bottom and an average depth of 5 m at low tide. The second location (called sandy), near the river mouth and 2.5 km

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downstream from the first location, is characterized by a sandy bottom and an average depth of 1–2 m deep at low tide. Sampling, conducted with a 1,000-µm mesh conical zooplankton net with a 75-cm diameter mouth, was done once a month during spring tides from June 1989 to October 1990. A 3-min sample (horizontal surface haul) was taken hourly during one 12-h tidal cycle at each location and the sample was then preserved in 5% formalin. The volume of filtered water was measured using a mechanical flowmeter, and salinity readings were taken with an ATAGO refractometer.

Identification

Larval and juvenile fish were categorized according to Hubbs' (1943) terminology (juvenile period begins when the fins are fully differentiated). The captured fish ranged from 5 mm to about 70 mm in standard length. All juveniles were identified to species and larvae to family.

The adult keys used to make family-level identifications were from Eigenmann (1912), Puyo (1949), Le Bail et al. (1984a, b), and Rojas-Beltran (1984). Species identification (whenever possible) was done using Whitehead (1973) and Cervigon (1987) for Engraulidae, and Chao (1978) and Fischer (1978) for Sciaenidae.

Characterization of Juvenile Assemblages: Overall Data

Shannon-Wiener diversity indices (H') (Margalef 1958) were calculated (total number of juveniles of each species in each site) and compared using a Student *t*-test (Hutcheson 1970).

Total number of juveniles caught at each location and the percentage of each species were calculated to plot abundance log curves, and fitted, if possible, to species abundance models (Poole 1974; Magurran 1988).

Monthly Data

Monthly calculations of several diversity indices were used to highlight seasonal variations, each index being more sensitive to a different component of diversity:

Species Richness: S

This index gives only rough information and does not take into account the second component of diversity, the relative abundance of different species. Richness is calculated as the number of species.

Berger-Parker's Dominance Index: $d = N_{max}/N$

This index is more sensitive to the abundance of the most common species and has the advantages of being easy to calculate and of giving an intuitive image of species distribution. N_{max} is the number of individuals of the most abundant species; N is the total number of individuals.

Shannon-Wiener's Diversity Index: $H' = -\Sigma\ (p_i \ln p_i)$

This index is more sensitive to the presence of rare species, and thus to species richness. p_i is the proportion of individuals of the ith species.

Shannon Evenness Index: $E = H'/\ln S$

This index shows the relation between the observed diversity and the maximum diversity (when all species are equally abundant).

Statistical tables in Magurran (1988) and Rohlf and Sokal (1981) were used in determining significance.

Juvenile and Larval Assemblages: Correspondence Analysis

The larval component being important in some samples, a correspondence analysis (CA), using the program ADDAD (Association pour le Développement De l'Analyse de Données), was done on the monthly mean densities including juveniles and larvae from both locations (monthly densities of 55 taxa over 17 mo). This essentially descriptive multivariate method has the advantage of simplifying large data sets with little loss of information and identifying interrelations among variables. The analysis produces composite factors: the first explains the maximum of variance (or inertia) in the data set along a single axis, and all subsequent factors explain the maximum amount of the remaining variance. These new factors (or axes) allow plotting of the variability of multidimensional data in a reduced space.

Results

Juvenile Assemblages

Overall Data—Abundance and Diversity

The list of different species collected, the total number of juveniles per species, and their relative abundance and ranking are given in Table 1. A total of 33,361 juveniles (and 19,629 larvae) from 59 species from both locations were collected and sorted. Three families, Engraulidae, Gobiidae and Sciaenidae, comprised over 97% of the total number of juveniles.

Diversity indices (H') calculated for the middle (H' = 1.24) and sandy (H' = 1.68) locations differed significantly (t = 29.14; with df = 31,379; critical value at 1%: 2.576). As a rule, Shannon diversity indices vary from 1.5 to 3.5 in the field (Margalef 1972). The Cayenne River estuary is thus a low density habitat with respect to the num-

TABLE 1. List of the species collected at the middle and at the sandy locations. Number of individuals of a given species (N), total of juveniles (N_j), percent of a given species (N/N_j %), and rank.

Species (Juveniles)	Middle			Sandy		
	N	N/N_j %	Rank	N	N/N_j %	Rank
Anchoviella lepidentostole	10,539	67.688	1	7,106	39.942	1
Anchoa spinifer	1,980	12.717	2	1,347	7.571	3
Gobiidae sp. 2	1,316	8.452	3	5,809	32.651	2
Gobiidae sp. 1	487	3.128	4	1,173	6.593	4
Stellifer rastrifer	351	2.254	5	110	0.618	11
Engraulidae sp. 4	194	1.246	6	270	1.518	7
Odontognathus mucronatus	123	0.790	7	18	0.101	19
Engraulidae sp. 2	120	0.771	8	412	2.316	6
Atherinidae	113	0.726	9	133	0.748	9
Gobiidae sp. 4	56	0.360	10	35	0.197	13
Macrodon ancylodon	49	0.315	11	29	0.163	14
Gobiidae sp. 3	44	0.283	12	53	0.298	12
Colomesus psittacus	32	0.206	13	146	0.821	8
Micropogonias furnieri	23	0.148	14	782	4.395	5
Congridae	21	0.135	15	15	0.084	22
Isopisthus parvipinnis	19	0.122	16	24	0.135	16
Arius sp. 1	12	0.077	17	17	0.096	21
Soleidae	11	0.071	18	18	0.101	19
Oligoplites saliens	10	0.064	19	12	0.067	24
Lycengraulis sp.	8	0.051	20	14	0.079	23
Cynoscion acoupa	6	0.039	21	126	0.708	10
Mugil curema	6	0.039	21	25	0.141	15
Belonidae	5	0.032	23	22	0.124	17
Cynoglossidae	5	0.032	23	20	0.112	18
Amphichtys cryptocentrus	4	0.026	25	7	0.039	25
Serranidae	4	0.026	25	6	0.034	26
Stellifer microps	3	0.019	27	5	0.028	29
Trachinotus cayennensis	3	0.019	27	2	0.011	36
Trichiurius lepturus	3	0.019	27	0	—	—
Bothidae	2	0.013	30	4	0.022	33
Murenosocidae	2	0.013	30	2	0.011	36
Sardinella sp.	2	0.013	30	1	0.006	40
Arius sp. 2	2	0.013	30	1	0.006	40
Selene vomer	2	0.013	30	0	—	—
Aspredinichtys filamentosus	1	0.006	35	6	0.034	26
Spheroides marmoratus	1	0.006	35	5	0.028	29
Unidentified/38	1	0.006	35	3	0.017	34
Arius sp. 3	1	0.006	35	3	0.017	34
Lonchurus lanceolatus	1	0.006	35	1	0.006	40
Anchoviella guianensis	1	0.006	35	1	0.006	40
Anchovia surinamensis	1	0.006	35	1	0.006	40
Pimelodus blochii	1	0.006	35	0	—	—
Unidentified/42	1	0.006	35	0	—	—
Scombridae	1	0.006	35	0	—	—
Unidentified/41	1	0.006	35	0	—	—
Brachyplatystoma vaillantii	1	0.006	35	0	—	—
Nannostomus sp.	1	0.006	35	0	—	—
Chloroscombrus chrysurus	0	—	—	6	0.034	26
Aspredo aspredo	0	—	—	5	0.028	29
Pterengraulis atherinoides	0	—	—	5	0.028	29
Arius sp. 5	0	—	—	2	0.011	36
Polydactylus sp.	0	—	—	2	0.011	36
Unidentified/27	0	—	—	1	0.006	40
Unidentified/40	0	—	—	1	0.006	40
Aspredinidae sp. 3	0	—	—	1	0.006	40
Arius sp. 4	0	—	—	1	0.006	40
Caranx latus	0	—	—	1	0.006	40
Unidentified/19	0	—	—	1	0.006	40
Pleuronectidae	0	—	—	1	0.006	40
Total of juveniles (Nj)	15,570	100	—	17,791	100	—
Total of larvae	13,313	—	—	6,316	—	—
Larvae and juveniles	28,883	—	—	24,107	—	—

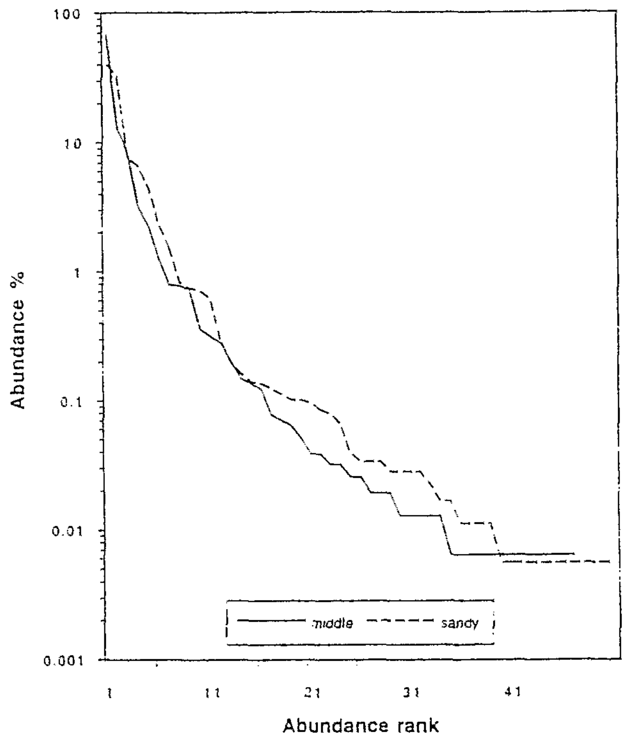

Fig. 1. Rank abundance plots of middle and sandy locations.

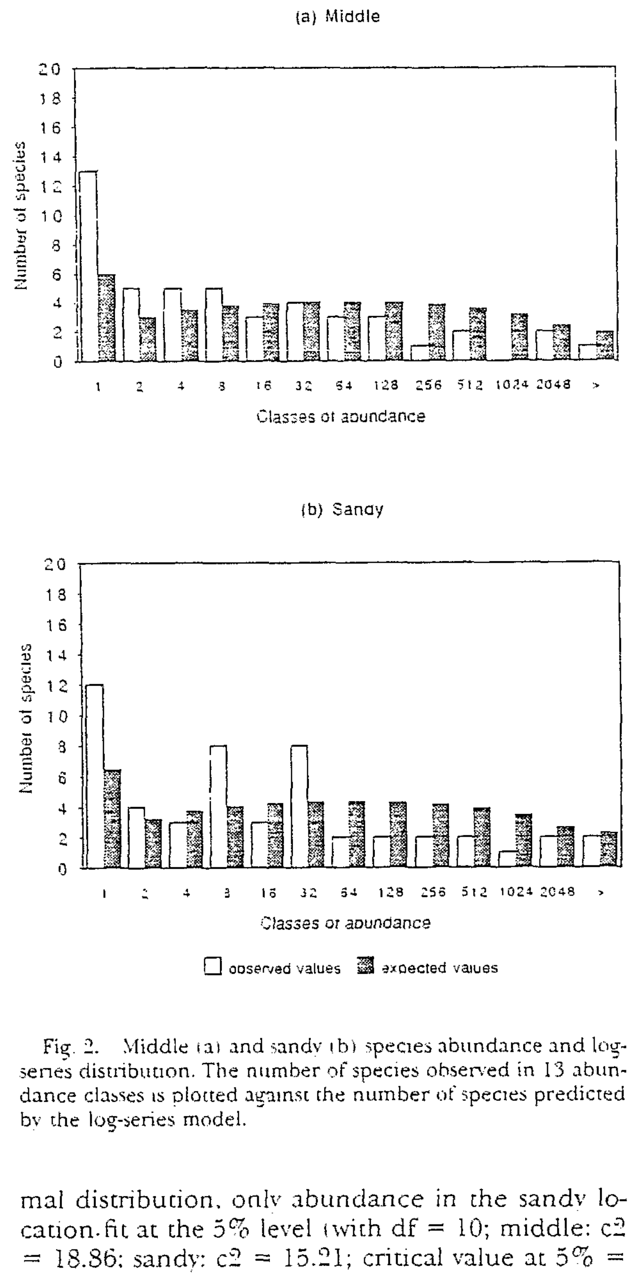

Fig. 2. Middle (a) and sandy (b) species abundance and log-series distribution. The number of species observed in 13 abundance classes is plotted against the number of species predicted by the log-series model.

ber of individuals collected. Fifty-nine taxa were collected, though most were represented by only 1 or 2 individuals. These can be considered as "incidental". As the Shannon-Weaver index is particularly sensitive to the presence of rare species, this measure probably overestimated diversity in our study.

The abundance of each species is plotted on a logarithmic scale against the species' rank, from the most abundant to the least abundant species (Fig. 1). It should be noted that abundance ranks for single species differed between locations (see also Table 1).

The abundance curves are obviously not straight lines (i.e., they do not fit a geometric series). Models predict that such abundance curves occur in a situation in which species arrive at an unsaturated habitat at regular intervals of time, and occupy fractions of the remaining niche hyperspace (Magurran 1988).

In Fig. 2, the observed values are compared with the theoretical log-series model. This pattern would result if the intervals between the arrival of the species were random rather than regular (Magurran 1988). In both the sandy and the middle locations, the observed values fitted the log-series model (with df = 12; middle: c2 = 17.83; sandy: c2 = 18.97; critical value at 5% = 21.03).

When abundance is compared with the log-normal distribution, only abundance in the sandy location fit at the 5% level (with df = 10; middle: c2 = 18.86; sandy: c2 = 15.21; critical value at 5% = 18.30).

The log-series model is more adapted to less diverse communities than is the log-normal model (Magurran 1988). In our case, the goodness-of-fit of abundance in the sandy location was best with the log-normal distribution and that of the middle abundance was best with the log-series model.

Monthly Data—Seasonal Variations

The monthly mean densities of juveniles for the most common species are given in Table 2. Two species were highly dominant in the samples: *Anchovella lepidentostole*, a pelagic species restricted to estuaries (Rojas-Beltran 1986; Cervigon 1987) and Gobiidae sp.2. The most abundant species was al-

TABLE 2. Average density (per 1,000 m³) of the most common species.

Year/Month	89 06	89 07	89 08	89 09	89 10	89 11	89 12	90 01	90 02	90 03	90 04	90 05	90 06	90 07	90 08	90 09	90 10
								Middle									
A. lepidentostole	661	1,166	275	1,800	494	892	478	129	61	345	200	642	1,343	411	1,513	2,299	1,248
A. spinifer	313	110	37	19	347	29	55	13	63	6	117	74	108	64	262	1,091	224
M. furnieri	0	5	15	0	0	0	0	0	0	0	2	0	0	0	2	0	0
S. rastrifer	2	52	245	26	54	7	8	1	1	1	1	1	0	1	0	0	7
Gobiidae sp. 2	5	3	21	15	17	39	91	248	100	0	38	0	2	1	5	2	16
Gobiidae sp. 1	5	65	155	345	31	14	411	416	132	1	9	4	0	9	3	7	67
Engraulid larvae	3,104	1,007	405	393	562	474	967	1,288	500	339	620	1,512	871	951	579	844	435
Sciaenid larvae	559	166	244	80	97	46	124	26	10	58	44	353	37	215	164	13	269
								Sandy									
A. lepidentostole	232	764	176	770	375	522	748	40	42	207	40	390	1,193	631	1,083	1,094	951
A. spinifer	106	35	26	6	121	24	18	1	14	3	25	55	701	15	411	248	40
M. furnieri	542	199	125	13	4	1	10	31	3	4	2	16	16	12	7	0	16
S. rastrifer	0	5	51	58	7	1	1	0	3	2	0	0	0	0	0	0	7
Gobiidae sp. 2	47	19	3	81	28	133	72	414	516	3	55	27	2	2	10	4	75
Gobiidae sp. 1	69	96	216	2,997	22	24	2,048	1,075	697	3	45	21	0	17	24	23	370
Engraulid larvae	346	215	289	164	920	113	744	298	116	263	233	647	129	945	249	215	138
Sciaenid larvae	415	119	316	133	193	33	111	30	14	25	15	132	39	75	115	11	158

ways *A. lepidentostole* except when Gobiidae sp.2 predominated at the sandy location in August, September, and December 1989 and at both locations in January and February 1990. Of the other Engraulidae, only *Anchoa spinifer*, which is an euryhaline species (Whitehead 1973; Cervigon 1987), was well represented. Sciaenidae as a whole (of which the adult population is actively fished on a small scale by local Cayenne fishermen) dominated in June, July, and August 1989. The two main species collected were *Micropogonias furnieri* and *Stellifer rastrifer*.

Figure 3 gives the variations over time for several diversity indices. Species richness (the number of collected species) showed monthly variations between 9 and 17 at the middle location and from 10 to 22 at the sandy site. The number of species found at the sandy location was significantly higher (ANOVA on species richness: df = 1.32; Fs = 11.96; critical value at 5%: 4.15).

All the other indices showed similar trends. The Shannon diversity index varied from 0.5 to 2, and evenness varied from 0.2 (the clear dominance by a single species) to 0.7 (a more homogenous distribution of species). Indices calculated for the sandy location were generally close to or superior to those for the middle one, except in December 1989 and January and February 1990. Shannon indices (H′) differed significantly between the two locations for these months (critical value at the 5% level = 1.96 with df = ∞; December 1989: t = 2.07; January 1990: t = 6.56; February 1990, t = 10.51). These differences reflect the species distribution and the relative dominance of Gobiidae sp.2. The total number of species collected at the sandy location was high in January and February 1990, but Gobiidae sp.2 dominated to such a degree that diversity remained low. Although Gobiidae sp.2 also dominated at the middle location, other species were also abundant and the diversity indices were higher.

LARVAL AND JUVENILE ASSEMBLAGES—CORRESPONDENCE ANALYSIS

A total of 19,629 larvae accounted for 37% of the total number of individuals. The distribution of larvae and juveniles of the three main families from the two sampling locations showed a consistently higher percentage of larvae at the middle location (Table 3).

The first three axes in the correspondence analysis accounted for 68% of the total inertia (respectively 34%, 19%, and 15%). They are retained hereafter to interpret the variance within the data. The most important contributions of species to total variance of each axis are given in Table 4. Go-

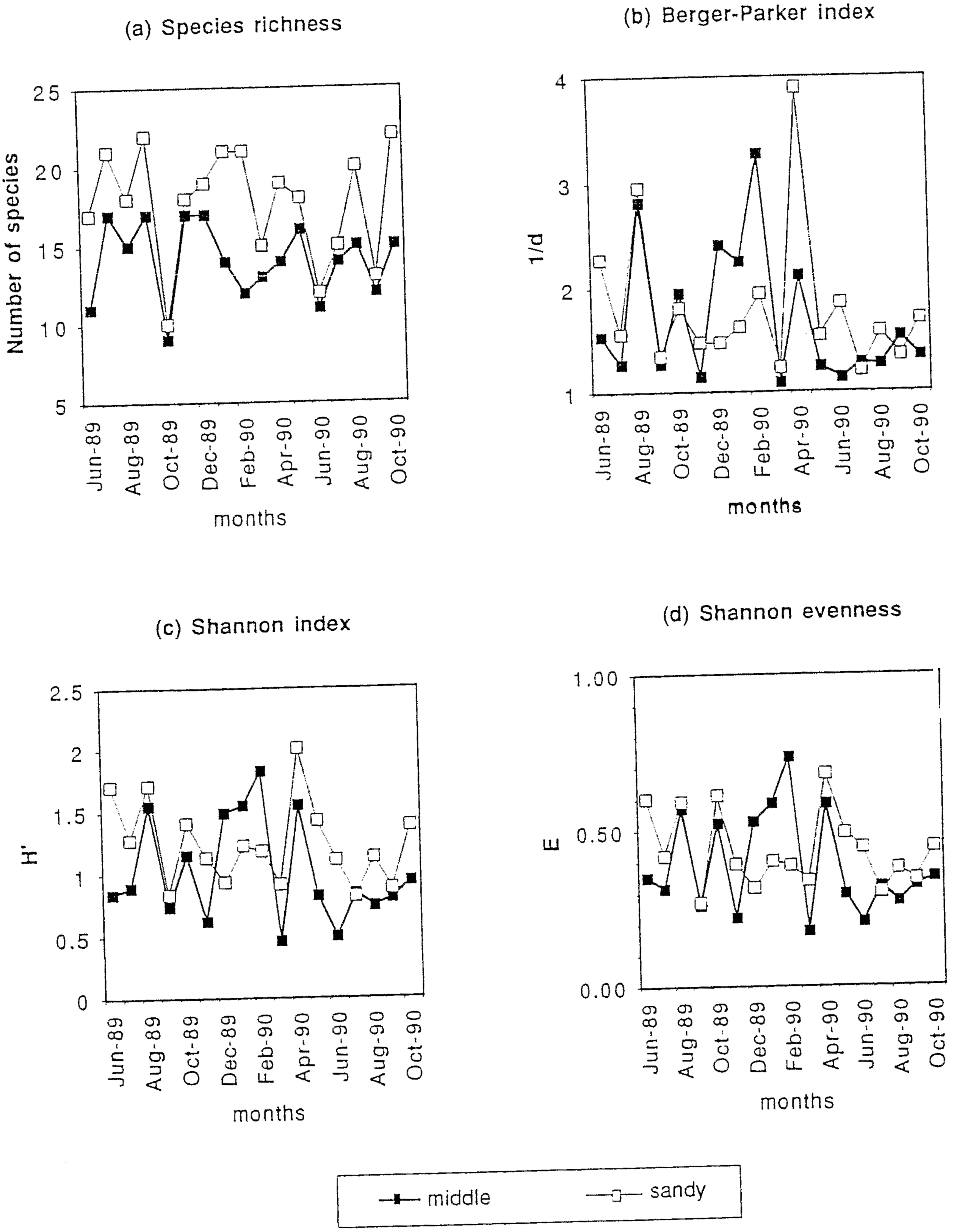

Fig. 3. Temporal distribution of diversity indices of the juvenile fish assemblage. (a) Species richness, S. (b) Berger-Parker index, 1/d; (c) Shannon index, H'; (d) Shannon evenness, E.

TABLE 3. Larvae and juvenile distribution at the two sampling locations. N = total number; Percent = 100·N/(N larvae + N juveniles).

	Middle		Sandy	
	N	Percent	N	Percent
Engraulidae larvae	11,309	47	4,776	34
Engraulidae juveniles	12,843	53	9,156	66
Sciaenidae larvae	1,993	82	1,538	58
Sciaenidae juveniles	452	18	1,099	42
Ariidae larvae	11	42	2	4
Ariidae juveniles	15	58	54	96
Total larvae	13,313	50	6,316	38
Total juveniles	13,310	50	10,309	62

biidae sp.2 contributed to 68% of the inertia of the first axis.

Contributions of stations to axes are also given in Table 4 (samples from the sandy location are indicated by S and those from the middle location by M; 1989 by A and 1990 by B). For example, the samples of sandy location in June 1989 (SA6: S = sandy location; A = 1989; 6 = June) contributed to 75% to the total variance of axis 2.

Figure 4 shows the factorial plans 1 and 2, where seasonal differences between the two locations are particularly enhanced (codes as in Table 4). On axis 1, there is a contrast between the sandy and middle samples in September (SA9 vs MA9) and in December (SA12 vs MA12) 1989, and in January (SB1 vs MB1) and in February (SB2 vs MB2) 1990. These four samples from the sandy location account for 72% of the variance of axis 1 (Table 4) and are the months with high densities of Gobiidae sp.2. On axis 2 there is a contrast between the sandy and middle locations in June (SA6), July (SA7), and August (SA8) 1989 (months with the highest numbers of *M. furnieri*). *M. furnieri*, a benthic species (Isaac 1988), was clearly dominant in June 1989, having an important juvenile recruitment. This was not observed the following year in the Cayenne River (no similar contrast on axis 2 was observed during the same period as no *M. furnieri* were present in 1990). Precipitation during the rainy season was much greater in 1989, with much higher freshwater inputs than in 1990. Observed salinities were thus lower in 1989 than in 1990 (Table 5). In contrast to the Cayenne River, recruitment of *M. furnieri* was observed in the Sinnamary River estuary (100 km east of the Cayenne River) in 1990 (unpublished data). The Sinnamary River is larger than the Cayenne River and has a much greater freshwater flow, so freshwater input was considerable even in the less severe rainy season in 1990. High-level recruitment of juveniles of *M. furnieri* and other Sciaenidae (e.g., *S. rastrifer*) seemed to be dependent on low salinity water (see periods of low salinities in Table 5).

TABLE 4. Results of correspondence analysis. Contributions of the main species to the variance of each axis (in percent) (i.e., inertia (or variance) explained by species to total inertia of one axis). Contributions of the main samples to the variance of each axis (in percent) (i.e., variance explained by samples to total variance of one axis). Samples and species are independent.

Axes	Species	Percent	Samples	Percent
Axis 1	Gobiidae sp. 2	68	SA9	30
			SA12	14
			SB1	15
			SB2	13
Axis 2	*M. furnieri*	59	SA6	75
Axis 3	Engraulid larvae	50	MA6	18
	A. lepidentostole	19	SB6	11

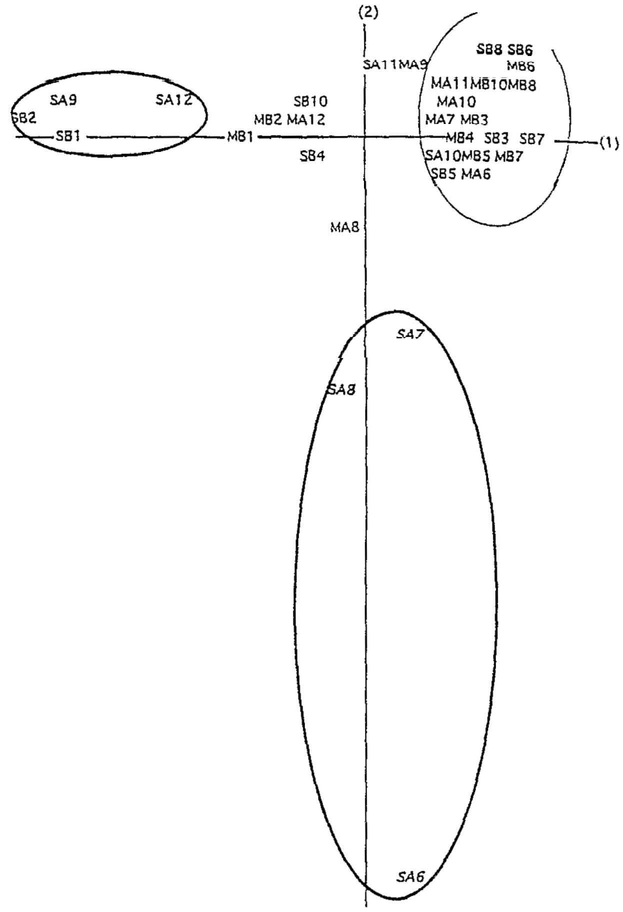

Fig. 4. Correspondence analysis performed on both stations: relative position of the monthly samples (total number of larvae and juveniles captured per 1,000 m^3 in each month) on the axes 1 and 2. Codes: M (middle), S (sandy), A (1989), B (1990), 1–12 (months) (see text).

Two taxa contribute to the variance of axis 3, *A. lepidentostole* and unidentified Engraulidae larvae (the majority are probably *A. lepidentostole*). The peak of abundance of larvae was in June 1989 (MA6), with smaller peaks in January (MB1) and

TABLE 5. Monthly maximum of salinity (parts per thousand) at middle location (sources our data and Lhomme personal communication).

	1989	1990
January	12	10
February	18	16
March	8	15
April	9	10
May	10	14
June	8	22
July	24	27
August	30	30
September	31	32
October	27	34
November	32	—
December	20	—

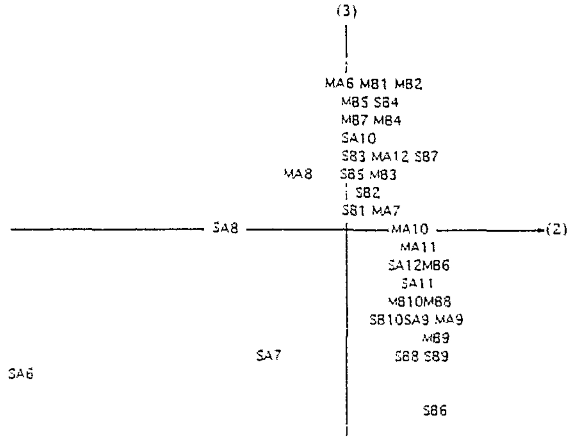

Fig. 5. Correspondence analysis performed on both stations: relative position of the monthly samples (total number of larvae and juveniles captured per 1,000 m³ in each month) on the axes 2 and 3. Codes: M (middle), S (sandy), A (1989), B (1990), 1–12 (months; (see text).

May (MB5) 1990 at the middle location (top of Fig. 5). These are periods of heavy rains in the wet season.

Conclusions

Results from Shannon diversity indices and from models of abundance suggest a relative equilibrium of species at the two locations. The sandy location seemed to be more diverse and this was also confirmed by the abundance models. In a different tropical system, Pinto (1988) studied an adult fish community in a relatively stable environment (a Philippines mangrove system). He showed that species abundance conformed to the log-normal model except when an important environmental disturbance (a typhoon) disrupted the community.

Correspondence analysis and seasonal variations of diversity indices showed significant differences in species distribution and in the relative abundance of species at the two sampling locations at certain periods. Our analysis indicates that salinity and freshwater inputs played an important role.

Based on a study of a tropical brackish-water lagoon in West Africa, Albaret and Ecoutin (1990) showed that seasonal changes in the composition and the structure of fish communities are induced mainly by abundance and distribution of freshwater inputs. Similarly, different field studies in South African estuaries have shown effects of the occurrence and severity of floods on ichthyofaunal communities (Plumstead 1990).

Two types of hypotheses, deterministic and stochastic, have been considered to explain the regulation of fish assemblages (Grossman et al. 1982; Herbold 1984; Rahel et al. 1984; Yant et al. 1984). The former type emphasizes the role of biotic factors like interspecific competition that are more favorable to the settlement of a stable assemblage. These factors are the basis of the biological explanations generally applied to abundance models, but these are statistical rather than biological models (Magurran 1988). The second type of hypothesis emphasizes the role of physical and chemical factors that are seldom stable enough to allow the settlement of a stable community.

Compared to other environments, estuaries are known as unpredictable environments where unstable physical conditions do not favor stable communities. This was shown for adult fish assemblages by Whitfield (1990), and seems to be even more important for assemblages of juvenile fish: Schlosser (1985) showed that physical (i.e., stochastic) factors are important to riverine juvenile fish abundance, species richness, and species composition; older age classes are more influenced by biological (i.e., deterministic) factors. Freeman et al. (1988) obtained similar results when changes in stream flow apparently affected young-of-the-year recruitment. Our study had indicated a relative stability over all the period, but year-to-year variations in the intensity of the rainy season and the level of freshwater inputs may affect juvenile recruitment of some species and lead to modifications in the composition of larval and juvenile fish assemblages.

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APPENDIX. Taxonomic list of the collected species. (Six unidentified species are not listed. See Table 1.)

Order	Family	Species
Anguilliformes	Congridae	One unidentified species
	Murenosocidae	One unidentified species
Clupeiformes	Clupeidae	*Sardinella* sp.
		Odontognathus mucronatus
	Engraulidae	*Anchoa spinifer*
		Anchovia surinamensis
		Anchoviella guianensis
		Anchoviella lepidentostole
		Lycengraulis sp.
		Pterengraulis atherinoides
		Engraulidae sp. 2
		Engraulidae sp. 4
Cypriniformes	Lebiasinidae	*Nannostomus* sp.
Siluriformes	Ariidae	*Arius* sp. 1
		Arius sp. 2
		Arius sp. 3
		Arius sp. 4
		Arius sp. 5
	Aspredinidae	*Aspredinichthys filamentosus*
		Aspredo aspredo
		Aspredinidae sp. 3
	Pimelodidae	*Brachyplatystoma vaillantii*
		Pimelodus blochii
Batrachoidiformes	Batrachoididae	*Amphichthys cryptocentrus*
Atheriniformes	Belonidae	One unidentified species
	Atherinidae	One unidentified species
Perciformes	Serranidae	One unidentified species
	Carangidae	*Caranx latus*
		Chloroscombrus chrysurus
		Oligoplites saliens
		Selene vomer
		Trachinotus cayennensis
	Sciaenidae	*Cynoscion acoupa*
		Isopisthus parvipinnis
		Lonchurus lanceolatus
		Macrodon ancylodon
		Micropogonias furnieri
		Stellifer microps
		Stellifer rastrifer
	Mugilidae	*Mugil curema*
	Polynemidae	*Polydactylus* sp.
	Gobiidae	Gobiidae sp. 1
		Gobiidae sp. 2
		Gobiidae sp. 3
		Gobiidae sp. 4
	Trichiuridae	*Trichiurus lepturus*
	Scombridae	One unidentified species
Pleuronectiformes	Bothidae	One unidentified species
	Pleuronectidae	One unidentified species
	Soleidae	Probably *Achirus achirus*
	Cynoglossidae	One unidentified species
Tetraondontiformes	Tetraodontidae	*Colomesus psittacus*
		Sphoeroides marmoratus