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A comparative analysis of fish assemblages spatio-temporal structure in four West African estuarine ecosystems



Fig 1 – The study area.

INTRODUCTION



Name	Country	Type of ecosystem	Length	References
Sine Saloum	Sénégal	"inverse"	130 km	Diodi, 1996 Simier et al., 2004
Gambia Estuary	The Gambia	"normal"	230 km	Albarete et al., 2004 Simier et al., in press
Fatala Estuary	Guinée	"normal"	60 km	Buran, 1995
Ebrié Lagoon	Côte d'Ivoire	coastal lagoon	164 km	Albarete, 1994 Ecoutin et al., 2005

Tab 1 – The four studied estuarine ecosystems.

Fish assemblages, as indicators of environmental changes, are known to be good tools for determining the state of health of aquatic ecosystems. In estuarine environments, at the interface between riverine and oceanic domains, their composition is highly influenced by the balance of fresh and marine waters inputs. The present work aims to describe tropical fish assemblages structure and dynamics in several datasets from a comprehensive database gathering information collected by IRD since the 80s in West African estuarine ecosystems (Figure 1). These data are representative of various types of estuarine environments (Table 1).

MATERIALS AND METHODS

For each ecosystem, two datasets were used, characterizing the two major hydrological seasons: the "dry" season (February to April) and the "wet" season (September–October). The Sine Saloum Estuary was sampled twice, in 1992–1993, and in 2002–2003. The sampling dates and effort per ecosystem and season are given in Table 2.

All datasets were collected using a purse seine net (250 m long, 20 m deep and 14 mm mesh) without any fish search, in order to provide a reproducible sampling unit: one seine haul (Figure 2). Fish were identified to species level, counted and weighed and environmental data were collected.

The eight bio-ecological categories (Figure 3) defined by Albaret (1999) in the West African estuarine and lagoon fish communities were used to compare the fish assemblages. A correspondence analysis was conducted on the matrix of log-transformed fish numbers (319 samples - 119 species).

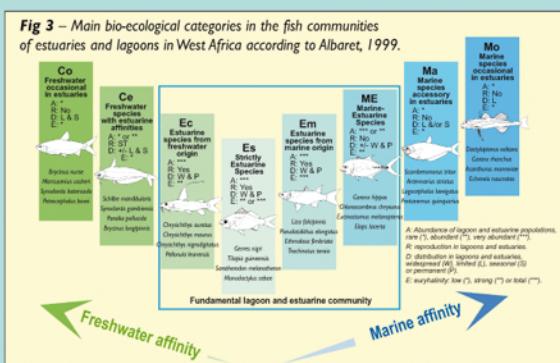
Ecosystem	Dry season		Wet Season	
	Date	Nb seine hauls	Date	Nb seine hauls
Saloum-1992	Feb. 1993	20	Oct. 1992	20
Saloum-2002	Mar. 2003	29	Oct. 2002	30
Gambia	Apr. 2002	44	Sep. 2001	44
Fatala	Mar. 1993	12	Oct. 1993	12
Ebrié	Feb./Mar. 1981	54	Oct. 1980 / Sep. 1981	54
Total		159		160

Tab 2 – Sampling protocol.



Fig 2 – Purse seine sampling.

Fig 3 – Main bio-ecological categories in the fish communities of estuaries and lagoons in West Africa according to Albaret, 1999.



RESULTS

Salinity. The five data sets displayed considerable differences in surface salinity (Figure 4). In all systems salinity was always lower during the wet season. In the inverse Sine Saloum Estuary, salinity was generally higher than seawater and reached 135 during the dry season in the upper hypersaline zone. The higher salinity observed in the Sine Saloum in 2002–2003 was due to a more significant sampling effort in the hypersaline zone compared to 1992–1993. In the other "normal" estuarine systems (Gambia, Fatala and Ebrié), which receive important freshwater inputs during the wet season, salinity never exceeded 30–38, and was close to 0 during the wet season.

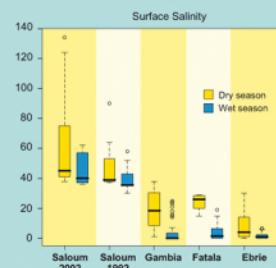


Fig 4 – Spatial and seasonal variability of surface salinity.

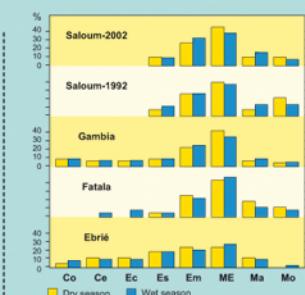


Fig 5 – Spatial and seasonal distribution of the eight bio-ecological categories (percentage of the total number of species).

Fish assemblages. A total number of 119 species were identified. The number of species in each bio-ecological category is given for each ecosystem at both seasons in Figure 5. The freshwater affinity species (Co, Ce and Ec) were totally absent from the Sine Saloum Estuary, and very rare in the Fatala Estuary. On the opposite, the marine affinity species (Ma and Mo) were present almost everywhere. The ME category always comprised the highest number of species, followed by the Em category. The strictly estuarine component (Es) was present everywhere but only with a small number of species. The composition of the fish assemblages was similar for the two sampling periods in the Sine Saloum Estuary (1992 and 2002).

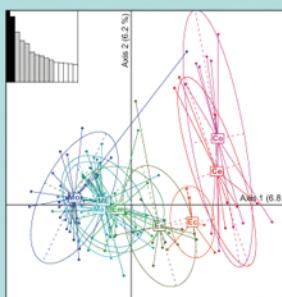


Fig 6 – Correspondence analysis of the matrix of fish numbers. Eigenvalues diagram and projection of species (left) and samples (right) on the factorial axes 1 and 2. The species are grouped by bio-ecological category. The samples are grouped by season (d = dry, w = wet) and Ecosystem (E = Ebrié, F = Fatala, G = Gambia, S = Saloum 1992, R = Saloum 2002).

The low percentage of inertia summarized by the first two axes (13 %) of the correspondence analysis (Figure 6) revealed the complex structure of the fish assemblages. The first axis was related to the marine-freshwater gradient, while the second axis opposed different assemblages among freshwater affinity species. The freshwater affinity component was mainly observed in the Ebrié Lagoon and the Gambia Estuary. According to the ecosystem, the main species from these categories were different: mainly Bagridae and Schilbeidae in the Ebrié Lagoon, and Synodontidae in the Gambia. The marine affinity component was largely predominant in the Fatala and especially in the Sine Saloum Estuary. The fish assemblages of the Sine Saloum Estuary at both seasons and at both periods (1992 and 2002) were similar, with a more marked estuarine affinity in 2002, probably due to the higher sampling effort in the upper Saloum. The assemblage of the upper Saloum, particularly during the dry season, was characterized by few species belonging to both ME and Em categories (such as Mugilidae), and Es category (such as Cichlidae). The Ebrié Lagoon was characterized by the fundamental estuarine categories (Ec, Es, Em, ME) and its seasonal variability was weak. Only the two "normal" estuaries (Fatala and Gambia) presented a clear seasonal variability, with the apparition of a marked freshwater affinity in the assemblages in the wet season.

CONCLUSION

According to their ichthyofaunal structure and dynamics, and related to the shape of the ecosystem and to its salinity pattern, three types of ecosystems were clearly identified in this study of fish assemblages in four West-African estuarine systems:

> a large coastal lagoon (the Ebrié Lagoon), with salinity between 0 and 30, all bio-ecological categories being represented, and low seasonal variability.

> two "normal" estuaries (the Fatala and Gambia Estuaries), with salinity between 0 and 38 and a high seasonal variability of both salinity and fish assemblages due to the river discharge. All marine and estuarine affinity species are present in the estuary. The importance of the freshwater component depends on the length of the estuary.

> an "inverse" estuary (the Sine Saloum Estuary) with very low freshwater inputs and no river flood. Salinity is generally higher than seawater and seasonal variability is weak. The freshwater affinity component is totally absent and the assemblages are dominated by marine and estuarine affinity species.

The marine and estuarine ichthyofauna are the same in the whole West African area, but the freshwater species differ according to the origin of the river: the Gambia and the Fatala Rivers come from the Fouta Djalon, while the Ebrié Lagoon receives the Comoé River (of Sudano-Sahelian type) and small coastal rivers.