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Spatial versus temporal patterns in fish assemblages of a tropical estuarine coastal lake: The Ebrié Lagoon (Ivory Coast)

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Abstract

The fish assemblages of the Ebrié lagoon (Ivory Coast) were sampled by experimental fishing over the entire lagoon using a purse seine net. The sampling was conducted in the two main hydroclimatic seasons for this ecosystem, i.e. in the dry season (March–April) and in the wet season (August–September). The results obtained showed a fish assemblage organized around a consistently occurring group of twenty species. When analysed in terms of ecological categories, the seasonal influence led to a cycle in the assemblages from freshwater to marine around this permanent species pool, with a seasonal renewal of the assemblage. At the scale of the lagoon, there were variations in the composition of the assemblages that clearly distinguished the western part from the eastern one. The limit was situated at the Vridi canal, a wide artificial channel permanently connecting the lagoon to the sea. To the west, the assemblage was characterised by a strong spatial uniformity and low seasonal variability. To the east, the assemblage formed two different entities; one assemblage with pronounced freshwater affinities occurring in a side arm and the other assemblage with great seasonal variability under the alternating influence of seawater in the dry season and freshwater in the wet season. This part of the lagoon functioned somewhat like a typical estuary.

Keywords: fish assemblages; tropical lagoon; spatio-temporal pattern; correspondence analysis; West Africa

1. Introduction

In estuarine and lagoon environments, that are extremely variable because they are subjected to freshwater and marine influences at various time scales, the equilibria are unstable and therefore easily changed by human activities or major climatic disturbances (Blaber, 2000). A better understanding is needed in order to produce conservation management plans and for sustainable management (Blaber, 2002).

Many authors have suggested that fish communities, as indicators of environmental changes, are good tools for determining the state of health of ecosystems (Paller et al., 1996; Whitfield, 1996; Soto-Galera et al., 1998; Attrill, 2002; Whitfield and Elliott, 2002). The basis for using biological monitoring of fishes to assess environmental condition is that the relative health of a fish community is a sensitive indicator of direct or indirect stress on the entire aquatic system (Fausch et al., 1990). Knowledge of the composition and dynamics of the permanently resident fish communities in estuarine and lagoon environments and those that use these environments on a temporary basis, would allow such ecosystems to be monitored both spatially and temporally.

Recent studies on the fish assemblages of tropical estuarine and lagoon environments have demonstrated the great species richness of these ecosystems, situated at the interface between the freshwater and marine

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domains (Albaret, 1999; Blaber, 2002 for review). In a given geographical region, the fish communities of estuarine environments consist of a constantly occurring pool of marine coastal species, strictly estuarine species and species of freshwater origin. Depending on the degree of connection with adjacent environments (size, shape, seasonal changes and history of the connections), the fish community of a given estuary or lagoon can be close in its composition and structure to those typical of the neighbouring environments. The marine and freshwater influences are not however symmetrical and do not have the same weight. Some studies have for example emphasized the fundamental role of the marine influence on the composition and species richness of estuarine and lagoon environment assemblages, that is mainly related to the size and permanence of the connection to the sea (Cowley and Whitfield, 2001; Blaber, 2002; Vorweck et al., 2003).

The temporary or more lasting occurrence of rare or infrequent, freshwater or marine, migratory species makes the structure of fish assemblages in estuarine and lagoon environments more complex. To make the analysis easier, various authors have recommended an approach based on classifications into ecological categories taking into account the geographical origin, the length of occurrence, the seasonality and the likelihood of the species breeding (Whitfield, 1999; Blaber, 2000; Garcia et al., 2003). Analysis of the spatial or temporal changes in these ecological categories provides a new means of identifying the structure of these assemblages, at a higher level of integration than that of the species. It allows comparison to be made between environments with differing fish species composition. A classification into eight categories was proposed by Albaret (1999) for West Africa. In addition to the degree of euryhalinity, which depending on the individual case was either a main or secondary criterion, the classification was based on the characteristics of the reproductive cycle of each species, including: the distribution, breeding site, and location and respective abundance of ecophases. The concepts of spatial stability and temporal variability are discussed on the basis of this classification from a study of the fish assemblages of the Ebrié lagoon in the Ivory Coast.

A first multidisciplinary review of information acquired on the Ebrié lagoon was conducted by Durand et al. (1994). With 153 species of fish recorded (Albaret, 1994), this estuarine and lagoon environment has one of the most diverse estuarine-associated fish populations in Africa or even in the world (Albaret, 1999; Blaber, 2002). A study of the assemblages in an urban bay in the maritime part of this lagoon showed that at both an annual and long-term scale (1962–1981), there was a group of twenty species that formed a remarkably stable permanent core of the assemblage in an environment that is extremely variable at various scales (Albaret and Ecoutin, 1990). In addition to this constant component, an increase in the marine component of the assemblage was identified and was interpreted as the result of a drought in the region during the study period. An increase in the marine component of the lagoon assemblages was also demonstrated in the ecological impact study of the temporary reopening of a former connection to the sea (Albaret and Ecoutin, 1989). The area close to the capital Abidjan (Fig. 1) has been the subject of special studies because of its ecological importance as a breeding area and migratory route for young fish recruited in the lagoon and because of the effects on both the fish communities and populations of the chemical, organic and bacteriological pollution that occurs here (Albaret and Charles-Dominique, 1982; Albaret and Ecoutin, 1990; Dufour et al., 1994; Guyonnet et al., 2003).

This article, using data collected in the 1980s on the fish assemblages of the Ebrié lagoon (Albaret, 1994), concentrates on the analysis of the spatial structure of these assemblages at the scale of the entire lagoon. The distribution and spatial organisation of the communities in the lagoon at the two main hydroclimatic seasons in

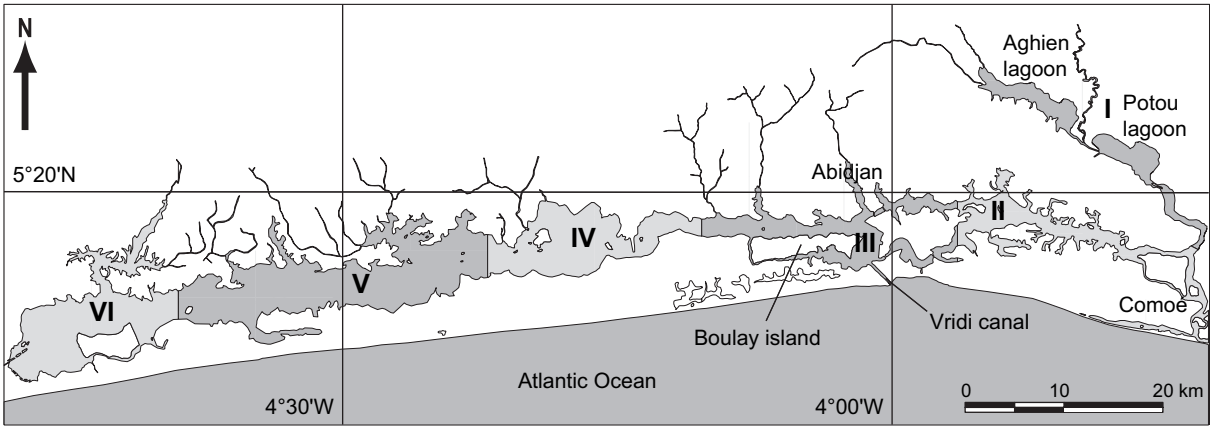

Fig. 1. Map of the Ebrié lagoon. Labels I to VI represent the six sectors defined by Durand and Skubich (1982) and derived from the hydroclimate, primary and secondary production and the fisheries.