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About the mangroves of Banc d'Arguin, Mauritania

Introduction

About twelve years ago, ISME published the pioneer 'World Mangrove Atlas' (Spalding *et al.*, 1997) in which a noteworthy effort was done to produce a graphic synthesis of information on the global distribution and status of mangrove ecosystems. At that time, little information was available on the mangroves of Mauritania. In the revised version of the 'World Atlas of Mangroves' (Spalding *et al.*, 2010), cartographic results and overall understanding of the mangroves of this country have improved. These mangroves are of special interest because they have been described during the last 20 years as they represent the northernmost and most arid mangrove ecosystems on the Atlantic coast of Africa (de Lacerda & Diop, 1993; Saenger & Bellan, 1995; Spalding *et al.* 1997; Lamarche, 2008).

Interestingly, these mangroves have been studied and mapped since 1954. We are now in a position to draw some conclusions related to their evolutionary trends during the last 50 years and to suggest a hypothesis regarding sea level changes in the concerned coastal line. Because of their extremely high importance for biological conservation, ISME has decided to publish this short account focusing on our present knowledge, gaps and evolutionary trends in its Electronic Journal. This review is primarily based on fundamental works carried out by Grandville and Trotignon (1973) and by Lamarche (2008). It is based also on field surveys and discussion with Prof. J.C. Lefeuvre and Dr. M.F. Courel.

Study approach and status

Following the historical works published by French scientists at the beginning of the 20th century (Gruvel & Chudeau, 1909), few general accounts have been given on the harsh environmental conditions of this almost desert coastline of West Africa (e.g. Dadouh-Guebas & Koedam, 2001). Scattered and stunted mangrove stands thrive around the mouth of the Senegal River and its associated tidal flats, and as few tiny stands 300 km further north in the Banc d'Arguin (Fig. 1). *Avicennia germinans* L. is the only mangrove species that can survive in the area (Fig. 2). Both areas bearing mangroves have been declared protected areas and incorporated into Ramsar sites. Banc d'Arguin is now included in the Parc National du Banc d'Arguin (PNBA) created in 1976 and designated a Ramsar site since 1982.

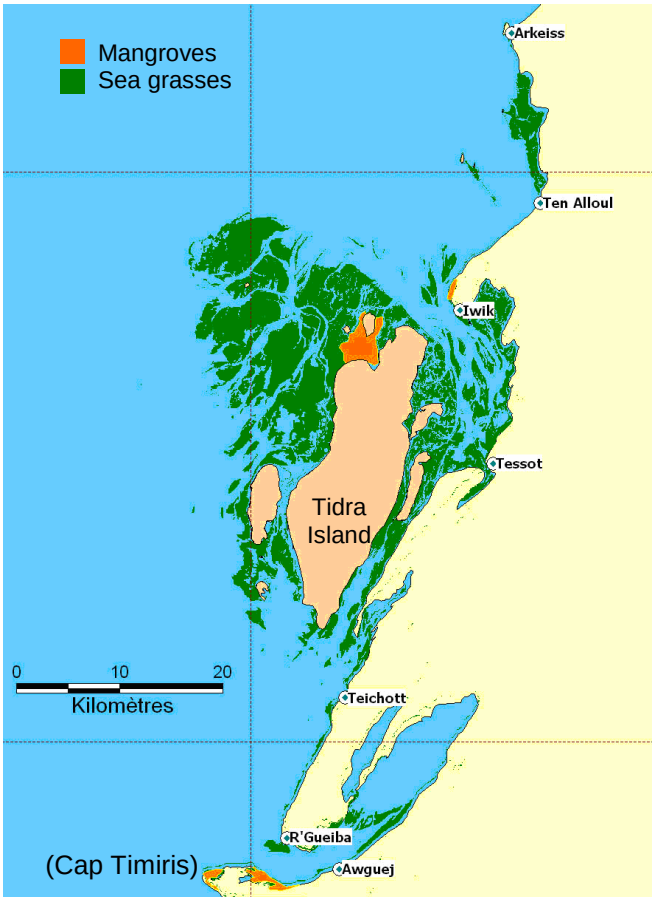

Fig. 1. Mangroves of Banc d'Arguin (From Lamarche, 2008)

The PNBA hosts the world's largest aggregation of wintering waders, some 2.3 million birds and a variety of nesting species. This area is also a UNESCO World Heritage Site since 1989. Recently, Lamarche (2008) has conducted a detailed survey to determine the location and to assess the ecological status of plant communities found in the PNBA. Due to local constraints, these West African mangroves are still poorly known compared with homologous types found in the Arabian Gulf, Red Sea, northern Australia and Mexican Pacific coast.

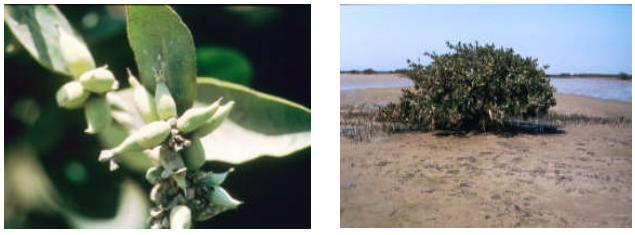

Fig. 2. Fruits and isolated bush of *Avicennia germinans*

Outstanding biological and ecological peculiarities

These mangroves occurring between latitudes 19°20 N (Cap Timiris, north of Mamghar) and 19°50 N (near Iwik) and longitudes 16°00 to 16°30 W, are surrounded by extended beds of submerged sea grasses or marine Phanerograms, especially *Zostera* sp., *Cymodocea nodosa* and *Halodule wrightii*. The trophic links and exchange of nutrients between the communities of sea grasses and mangroves have not been investigated. On the other hand, the exact extent of these mangroves remains unknown because they mainly include stunted *Avicennia* bushes of less than 1 m tall, intermingled with various salt marshes perennial halophytes e.g. *Arthrocnemum macrostachyum*, *Salicornia*, *Sesuvium portulacastrum*, *Suaeda maritima*, and *Zygophyllum waterlotii*.

From an ecological point of view, these sandy and arid coastlines are theoretically not suitable for mangrove species, due to their very warm summers (> 30°C), warm winters (20–30°C), very low annual rainfall (< 150 mm) cum rainfall-evapotranspiration ratio of between 0.03 and 0.20 (Blasco & Legris, 1979). Two meteorological stations have been installed in the PNBA since 2003 but their data do not allow the publication of reliable averages. Meteorological stations at Nouadhibou and Nouakchott are the nearest and have been operating since 1961. In Nouadhibou, there is no rainy season and all months are arid. The ombrothermic diagram of Nouakchott indicates a short rainy season (July–October) but only August with an average of 76 mm can be considered as wet. All data clearly indicate that the local climates are either arid or hyper-arid.

There is no fresh water supply from rivers at present. Water loss due to evaporation is at least 10 times the input from rainfall causing high salinities in open waters (> 60 g/l) during summer especially in inshore lagoons. Tidal amplitude is reduced to about 1.0–1.5 m. Winds especially trade winds, are predominantly north-westerly, with a mean average wind speed about six knots at Cap Timiris. They determine coastal currents of the same direction which have significant dynamic action on the propagation and deposition of organic maters, especially the huge accumulations of debris from *Zostera* and other sea grasses, up to one metre thick. These deposits play two important roles of protecting soft sediments against erosion and providing organic nutrients to higher plants.

At Cap Timiris, where the coastal topography is almost flat, several sandy bars have created small protected coastal lagoons, in which *Avicennia* bushes thrive since decades. They are the only mangroves able to withstand the seasonal stresses induced by prolonged and severe drought periods. A very similar landscape with similar ecological conditions and comparable biological forms are found in several parts of the Pacific coasts especially on the coast of Oman where only one mangrove species survives, *Avicennia marina* (Forssk.) Vierh.

Dynamic properties and cartographic results

In Mauritania, as in almost all arid coastlines, salt concentrations in mangrove soil and water control the germination of seeds, growth of seedlings, ion uptake or nutrient utilisation and the global photosynthetic performance of plants. Dahdouh-Guebas and Koedam (2001) made some interesting observations regarding the regeneration of *A. germinans* in the area. In some places, fruit production was abundant and some successful germination was recorded. But the dynamic processes remain by and large ill-known.

Individual and isolated *Avicennia* bushes which are often the case in the study area, cannot be discriminated from space neither by optical nor by microwaves remote sensing devices because they cannot be differentiated spectrally from non-mangrove contiguous halophytes having practically the same size of 0.3–1.0 m height.

During field surveys conducted by Lamarche (2008) in June and July 2007, all coastal plant assemblages including sebkhas and associated salt marshes have been described using vegetation transects. These data have been displayed on a topographic map at 1/20,000 scale. The provisional conclusion is that total extent of main mangrove patches found at Cap Timiris and further north at Tidra Island is probably in the order of 4 km^2.

We are unable at present to assess whether these mangrove communities constitute pioneering stages or receding relicts. Their natural evolution is extremely slow. From a paleo-geographical point of view, the preponderant development of *Avicennia* in the Indo-Malaysian coasts leads to the conclusion that this is the birthplace of the genus. The natural dissemination of *Avicennia* westwards to the east coast of Africa and eastwards to the Pacific coasts of the Americas is not a matter of debate.

It is highly probable that *Avicennia* found today in West Africa and on the Atlantic coasts of the Americas originated from the Pacific and spread through the Isthmus of Panama which was an open way from the Upper Cretaceous to the Lower Miocene. But why *Avicennia* has been able to diversify into no less than eight species in the Indo-Pacific region and only two species in the Atlantic area (*A. germinans* and *A. schauriana*) remains an open question.

Conclusion

The northernmost *Avicennia* bush in West Africa is located at 19°54’ N. An optimistic sign is found in the southeastern part of the Tasrent Peninsula where many recently settled *Avicennia* shrubs can be observed**.** More generally, a comparison of several studies and maps carried out at Cap Timiris in 1954, 1984, 2007 and 2008 over the same sites bearing *Avicennia* stands indicate that all macro-parameters remained unchanged (Lamarche, 2008).

At least from a geomorphologic point of view as well as from the distribution of the vegetation, it can be said that this coastal area remained very stable during the last 50 years. If we assume that mangroves are good indicators of coastal modifications (Blasco *et al*., 1996), it can be concluded that neither climate nor sea level theoretical changes have markedly affected the concerned arid region during the last 50 years.

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