The Blue-green Algae of the Mangrove forests of Sinaï

by

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Mangroves are among the few emergent plants that can tolerate open sea salinities; however, these forests usually grow in brackish waters of estuaries. Such associations, which typically develop in the equatorial regions, are composed of more than 20 different species of higher plants. Under the shady, moist, tropical heat of this particular tidal environment, typical hothouse conditions prevail. The characteristic epiphytic flora which develops on the aerial roots of the trees is composed of numerous red algae : the well known *Bostrichia-Caloglossa* community. Frequent tropical rains contribute in establishing a damp climate, while also supplying freshwater to wet the intertidal epiphytic algae and cause a further decrease in salinity.

The mangrove forests of Sinaï are different from the other tropical mangroves, since they are found in dry desert conditions which lead to strong transpiration and desiccation of the exposed pneumatophores. The single arborescent species forming these forests — *Avicennia marina* — is a xeromorphic tree, only about 2-5 m high, with a rather good penetration of light under the canopy of its branches. In addition, in an area in which rainfall is minimal or absent, evaporation is high in the shallow lagoons in which the mangroves grow, and therefore, salinities are definitely metahaline to hypersaline.

The epiphytic algae growing on the aerial roots of *Avicennia* are thus exposed to strong illumination and to changing values of increased salinity. Consequently, the sciaphilous Rhodophyceae preferring a humid environment and brackish water, which grow on the mangroves elsewhere, have been replaced in the Sinaï mangroves by Cyanophyceae — a group rather photophilic and much better adapted to desiccation and high salinity.

The absence of the " Bostrichietum " community in the Sinaï mangroves has been emphasized and discussed at the 1957 Symposium on Ecology of Marine Algae held in Paris. The algologists participating in the discussion there — T. RAYSS, M. FELDMANN and M. CHAPMAN — failed to reach any conclusion explaining this absence. The peculiar ecological conditions mentioned above might serve as an explanation for the replacement of the red algae by blue-greens.

Two groups of mangrove are found along the Sinaï coasts of the Red Sea : the mangrove of Nabq, extending over some 20 kilometers and forming four well developed mangrove thickets, and to the south — the sparse mangrove growth of Ras Muhammad.

The pneumatophores of the quite dense Nabq mangrove forests are inhabited by a more diversified algal flora, including besides blue-greens also a few green algae like *Microdictyon* and *Caulerpa* and some large red algae like *Spiridia* and *Digenea*, growing as epiphytes. These additional algae, however, are present on the lower always submerged parts of the pneumatophores.

In the reduced mangrove of Ras Muhammad, the conditions are most extreme and, accordingly, the epiphytic flora is composed exclusively of Cyanophyceae.

The quite diverse blue-green algae community presents a definite pattern of zonation on the roots : the highest level, which undergoes the longest period of exposure, is inhabited by *Scytonema*. The dark, few centimeters long and large " muffs " of this alga have a coarse texture and high porosity. The ramified heterocystous filaments are arranged in a radial pattern with respect to the central pneumatophore.

Rapp. Comm. int. Mer Médit., **23**, 3, pp. 109-110 (1975).

They have thick lamellate yellow sheaths, characteristic of the species of this predominantly terrestrial genus. The active living part of the thallus is formed by a layer, a few millimeters thick, on the periphery of the colony. The inner mass is made of empty sheaths which probably form a capillary system absorbing water during the high tide and holding it during the next twelve hours of exposure. Efficiency of this simple water-supply system enables *Scytonema* to grow 20-40 cm higher than the other algae — practically out of competition.

The lower level of the pneumatophore, separated from the upper one by a few tens of centimeters of bare pneumatophore surface, is occupied by several species of *Rivularia*, which form small densely crowded colonies with the typical globose organization, heterocysts on the bases of the numerous radial branches and ample pectic envelopes. Besides *Rivularia* there are two other heterocystous algae at this level : *Calothrix* and *Brachytrichia*. These are well attached their plane and gelatinous thalli coalesce with the surface of the pneumatophores.

Below the permanently submerged low tide level, there are several non-heterocystous blue-green algae. The most remarkable are species of *Lyngbia*, which form large brown and yellow mats entangled between the roots, as well as *Symploca*, which grows in the form of bundles, agglutinated into bulky dark thalli around the bases of the pneumatophores.

On the bottom, between the aerial roots, grows *Phormidium* which stabilizes the soft sediment, and the powder-like *Aphanocapsa*.

A rare alga — *Cyanohydnum* — reported until now only from the hot springs of Yellowstone, merits special emphasis. This alga appears in great quantities both in Nabq and Ras Muhammad. It forms gelatinous compact balls, like some sort of pebbles or grey truffles, 2-10 cm in diameter. A most remarkable form of this alga appears as masses of free lying " pebbles " on the bottom of the channels between the mangrove thickets, at unusually high salinities (up to 54 $^{o}/_{oo}$). The massive thallus of *Cyanohydnum* shows, in section, concentric lamina resembling annual growth rings. Every lamina is 1-3 mm wide and formed of *Phormidium*-like filaments and a huge amount of empty sheaths arranged in parallel vertical rows. The plant seems to be slowly growing with a seasonal or different rhythm of growth.

The presence of numerous heterocystous blue-green algae on the exposed parts of the pneumatophores may indicate that the exposed community performs nitrogen fixation, while the lower submerged community of non-heterocystous algae do not fix atmospheric nitrogen, but uses dissolved nitrate.

This epiphytic community represents a natural collection of species, arranged according to the increasing gradient of extreme conditions, and well adapted to this environment in various ways. The high diversity of this flora, the well established zonation and definite specialization, indicate a balanced and stable climax community.