

## THE STAGNONE LAGOON (WESTERN SICILY): AN ECOLOGICAL APPROACH TO THE MANAGEMENT OF ITS NATURAL RESOURCES

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**SUMMARY** - The results of an ecological survey on the Stagnone Lagoon are reported. Examination of the benthic macrophytic associations, of the Eh values in the sediment layer as well as of its chemical constitution allows the authors to draw some overall conclusions on the dominant hydrodynamic patterns. A simple mathematical model of the water circulation in the lagoon is proposed.

Since very ancient times the shallow bottoms along the coast of western and southeastern Sicily have been primarily exploited for salt production and secondarily for fish culture. The present crisis of the traditional economy has caused the abandonment of most salt basins which are now unproductive wasteland or have been appointed as areas of urban growth.

Rising interest in aquaculture has pointed to new ways of exploiting the natural resources with a minimum alteration of the environment, provided the plants are carefully planned and well coordinated. The Stagnone Sound, a shallow lagoon enclosed between the west coast and the rocky platform of Isola Grande, and widely open to the Sea North and South, is a biotope of particular value, where cultural - due to an archaeological punic site - scientific, aesthetic and economic interests, which are often in reciprocal contrast, converge. A correct management of such a biotope is therefore a challenge to ecologists planning an exploitation of the resources in the perspective of a severe conservation of the environment.

To pursue such an objective a program of data collection on the biota was undertaken which has included a hydrological and botanical survey; a recognition of the benthic fauna as well as of the nurseries and fishing grounds is now being carried out.

The distribution map of the submerged vegetation shows the prevalence of rhizophytes and aptophytes, with a conspicuous presence of the taxa showing benthopleustophytic habits. All the species are typically marine, with the exception of *Lamprothamnium papulosum*, a Characean weed

characteristic of brackish waters and a colonizer of unstable substrata, which in the Stagnone is associated with *Caulerpa prolifera* and *Cymodocea nodosa*. The *Lamprothamnium* facies is limited to a depression in the north-western channel between the Isola Grande and Isola S. Maria, probably in relation to a freshwater upsurge and in a water body affected by intense silting rate. Two of the dominant taxa are rhizophytes - namely *Posidonia oceanica* and *Cymodocea nodosa*. The main associations show a remarkably distinct distribution. The Cymodocetum nodosae in which *Caulerpa prolifera* is always present in varying densities and is often dominant, is especially luxuriant in the northern section of the lagoon and along the eastern banks, whereas the Cystoseiretum barbatae is restricted to the central and southern basin; the Posidonietum oceanicae thrives only in the southern portion where *Posidonia* makes impressive ring-shaped growths at surface level, which look like small atolls of partially floating leaves.

A broad stripe of algae growing in the *aegagropyla* type - i.e. in ball shape - stretches on the soft bottom between the two major isles, showing a shift of the overall hydrodynamic pattern towards a rotating and oscillating movement. The most typical species in ball form are *Rytiphloea tinctoria*, *Cladophora echinus*, *Valonia aegagropyla*, *Lithothamnium fruticosum* and *L. calcareum*. *R. tinctoria* and *C. echinus* have been included in the new Cladophoro-Rytiphloetum tinctoriae association (CALVO e al., 1981; CALVO e al., in press).

A rich invertebrate fauna is associated with *Rytiphloea* balls, with a dominance of few groups made by several hundreds of individuals. Gammarid Amphipods, Sphaeromatid Isopods and Tanaidacea are the most common groups.

*Aapseudes latreillii*, *Parapseudes latifrons*, *Leptochelia savignyi*, and *Paratanais batei* are very frequent among the Tanaidacea. Syllid and Nereid Polychaetes are abundant both inside the *Rytiphloea* balls and in the very numerous Chertose sponges which are found everywhere in the lagoon.

As the other bottoms are much poorer in animal species, the *Rytiphloea* stripe may be considered a refuge area. A sensible discontinuity in the mosaic of benthic associations exists between the eastern and western half of the lagoon, which has been referred to as a "reviving effect" of the sea water inflow, missing from the innermost bodies of water.

The influence of the main abiotic factors on the distribution of the macrophytic components and also, to some extent, of the faunistic assemblages, has been investigated by salinity monitoring, Eh measurement and analysis of the main chemico-physical parameters in the sediment layers.

Marked differences in salinity are recorded between the two portions of the lagoon respectively north and south of S. Maria Isle.

Whereas water with 40-41‰ salinity is found in the northern half,

greater salinities with peaks as high as 46‰ characterize in summer the southern part. Such a hyperhalinity is very likely consequence of a slowing-down of the N-S water current in the impact with the emerging leaves of the *Posidonia* atolls. Results of Eh measurements and physico-chemical analysis point to a possible relation of the benthic communities to the water movement - which has been estimated on the base of salinity distribution - and to the physical nature of the substratum, whereas no correlation with the chemical composition of the sediment is evident. (GENCHI e al., in press).

The water renewal in the Stagnone is mainly dependent on the inputs from the northern channel between Isola Grande and Punta S. Teodoro, and it is driven by the dominant northwestern winds, whereas a secondary role is played by the tides and the southeastern winds. The winds and the flow from North set into motion the whole water mass which is slowed down by friction with the low bottom and by the impact with the emerging mechanical obstacles such as the isles and the crowns of leaves of the *Posidonia* beds. Assuming: (a) the northwestern winds as the sole cause of water movement; (b) a horizontal flow in the wind-driven circulation with only one speed component  $u(x,z,t)$  in the wind direction,  $x$ ; (c) a variation of the water speed with depth,  $z$ ; the conservation of the water mass and of the quantity of moving water may be expressed by the following set of differential equations (DI PISA e RIGGIO, in press):

$$\frac{\delta u}{\delta t} + \frac{u \delta u}{\delta x} = - \frac{g \delta e}{\delta x} + \frac{\delta}{\delta z} \left( \frac{\mu \delta u}{\delta z} \right)$$

$$\frac{\delta e}{\delta t} = - \frac{\delta}{\delta x} \int_0^h u dz$$

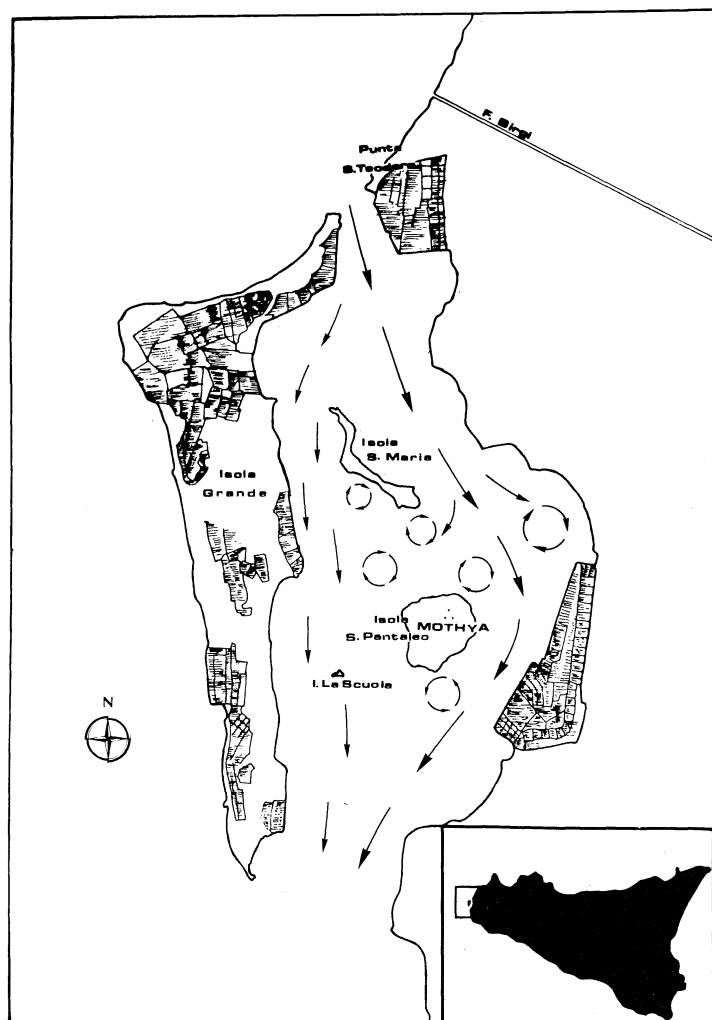
where  $e(x,y,t)$  is the uplift of the free surface,  $h(x,y)$  the depth and  $\mu$  the turbulent viscosity. Such a set of differential equations may be solved by the method of numerical approximation (REAS e DI PISA, 1980).

An activation of the hydrodynamism would take place at the reciprocal contact of water masses with different salinities, which would explain the presence of *Posidonia* in the lower portion of the lagoon.

From our simplified model it follows that every modification of the overall pattern of water circulation might lead to an excessive silting of the basin or to a massive eutrophication of the waters which are still remarkably clear. Great damage is now caused by the turbid currents from Birgi Creek, whose mouth has recently been displaced north of the lagoon thereby carrying huge amounts of silt and detritus during winter floods.

New hazards are implicit in plans for the promotion of tourism, in the development of intensive greenhouse agriculture as well as in the uncontrolled growth of building areas.

Aquiculture is a means of fully exploiting the abandoned salt basins, provided it is carried out without altering the lines of the landscape



and the hydrological balance of the lagoon. Natural fish-nurseries have been detected in the basin which should be protected from illegal fishing, and rationally cultivated by means of small artificial reefs: they could provide at least part of the necessary fry to be grown in semi intensive plants run in the saltworks. In future management plans the building of new houses in the area should be prohibited and severe restrictions to fishing and intensive agriculture should be imposed. The transformation of the lagoon into an archaeological and natural park is a necessary measure to be taken, and which could ensure the protection of the biotope without preventing the rational exploitation of its productive potential.

Fig. 1 - Map of the Stagnone Lagoon: schematic representation of the circulation pattern.

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