

Qualitative Approach of Plankton Communities Behaviour in a Mediterranean Bay :

a Contribution to Some Biological and Mathematical Aspects

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The biological point of view

Seasonal variations of the plankton community (phytoplankton and zooplankton) in the Toulon Bay (Var, France) have been studied since 1995 [1, 2]. Plankton samplings have been carried out regularly in two sites (little bay and large bay) differently affected by anthropogenic inputs of Toulon area. The abundance and the diversity of plankton community during annual cycles have provided some data which exhibit inherent features as the pattern shape of limit cycles as well as the apparent period of intrinsic evolution of phytoplankton and zooplankton separately considered. We have also some data of average concentrations of nitrates and orthophosphates in the bays.

Modelization

The first aim of this contribution is to establish a model able to transcribe the observed behaviour. We consider the Rosenzweig-Mac Arthur model [3] for a three trophic level interaction involving nutrients (nitrates and orthophosphates, N), planktonic algae (phytoplankton, P) and herbivorous zooplankton (Z)

This is a NPZ model composed of a logistic prey (N), a Holling type II predator (P), and a Holling type II top predator (Z). Predator's per-capita predation rate has the Holling type II form [4]

All parameters used are chosen in a biological range.

Note that the Rosenzweig-Mac Arthur model was developed from the previous works of Lotka [5] and Volterra [6]. Some simplifications are brought to the general Rosenzweig-Mac Arthur model so as to lead to the simplest model taking in account the experimental features.

Mathematical aspects

Under certain conditions, the dimensionless system is singularly perturbed with three times scales. The rates of change for the prey, the predator and top-predator range from fast to intermediate to slow, respectively [7, 8].

We give the equation of a slow manifold on which the attractor lies. Since, a state equation relying the three variables is established.

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