Description

As it occurs on land, in water too life is organized on the basis of relationships established between some organisms called primary producers and others (herbivorous and carnivorous) called consumers, which include those called degraders or decomposers.

As far as euthrophication is concerned, primary producers are of the utmost interest; they are vegetal organisms that, through the photosynthesis process and in the presence of light, can utilize organic substances (sugars or carbohydrates). Through successive development and assumption of other mineral compounds, primary producers can synthesize more organic compounds of considerable interest (fatty substances, proteins, vitamins, hormones etc) using sugars of their own production as a source of energy for such syntheses.

In an aquatic environment these primary producers are represented by submerged plants or macrophytes, emergent plants with aquatic roots and microscopic algae. In inner, non-running waters, such as lakes, the vegetal group that plays the most relevant role in the primary production of living organic substance or biomass, is represented by microscopic algae that remain in suspension in water; their dimensions are usually in the range of a thousandth of a millimetre (micron). (Marchetti, 1994).

The variation of the mass of vegetal organisms over time depends on five factors

- initial speed at which the initial biomass is reproduced;
- quantity of newly formed algae exported from the environment;
- volume of the allochthonous biomass flowing into that environment;
- rapidity at which the existing biomass of algae is used by primary consumers and the latter are preyed upon by subsequent levels;
- speed at which biomass dies and dead organic substance is decomposed

Although all five factors listed above concur to determine the dimension of the biomass, the priority role that each of them assumes, depends on the physiographic characteristics of the environment under examination, such as: depth, speed at which waters are renewed, volume, etc. (Marchetti, 1994)

In lentic environments, in situations of scarce renewal, production of biomass of algae will depend above all on the autochtonal activity that will increase or decrease mainly according to the available quantity of mineral compounds (carbon, nitrogen, phosphorus) that algae assimilate and turn into organic substances. For this reason the mineral compounds mentioned are called nutritive or nutritional salts, or, more generally, trophic factors.

When there is a shortage of these salts the production of a new biomass slows down until it stops completely while, contrarily, if more salts are available, the biomass formed is also bigger. In this case the growth of algae can take an explosive course and give rise to the formation of huge masses of living material whose presence (and above all subsequent decomposition) causes a whole series of degenerative phenomena. Such phenomena are referred to as "blooms" or "blooming algae".

It appears evident therefore that, other conditions being equal, the most important factor is the concentration of nutritional salts in the water that are available to the initial biomass. If the environment is poor in these salts, it is called oligotrophic; if their quantity is high the environment is defined as eutrophic. There is also an intermediate condition called mesotrophic and two extreme situations of ultra-oligotrophy and hyper-eutrophy or hypertrophy.

The increase in nutritional salts, generally phosphorus and nitrogen salts (main limiting factors), within any aquatic ecosystem, involves an increase in the biomass of algae (primary consumers); this, in turn, causes a proportional increase in the food-chain at successive levels. When the growth of algae is no longer controlled by the reduction of nutritional substances or other factors, an increasingly consistent biomass is formed, that is bound to end up in degradation. This process is called detritus-chain in contraposition with pasture-chain (Marchetti, 1994).

If a sufficient quantity of dissolved oxygen, necessary for the respiration of organisms acting in aerobiosis, is available in the water, the detritus chain is kept active by fungi and bacteria and can proceed to the mineralization of organic substance without any particular problems. Otherwise, processes of demolition of the biomass can start, that are carried out with excessive consumption of oxygen. If the speed of consumption is higher than that of the regeneration of oxygen through photosynthesis and diffusion, the deficit accumulates and with the disappearance of oxygen from the waters, an anaerobic or anoxic condition is established. When a condition of anoxia is reached in the waters, aerobic organisms are replaced by anaerobic decomposer organisms that carry out the processes of demolition of the biomass and release compounds that in most cases are toxic like, for example, ammonia and sulphydric acid.

Therefore, from a hypertrophic condition, recognizable by a higher rate of growth and production of micro-and macro algae, macrophytes, floating, rooted or submerged algae accompanied by conglomerations of bacteria and fungi, we move on to a condition of dystrophy. The waters become turbid and, due to the start of anaerobic processes, bad smells develop and murrains of fish and benthonic fauna occur.

The **main phases of the euthrophication phenomenon** basically are:

1- Increase in the supply of nutritional substances. The phenomenon of euthrophication is due to a surplus of nutritional substances (mainly phosphorus and nitrogen salts). This form of induced fertilization is determined by three factors, nearly always interconnected and directly linked to demographic evolution: increase in population, and consequent increase of urban waste, progressive use of detergents containing polyphosphates; intensification of agriculture and consequent increased use of fertilizers, concentration of livestock breeding; rapid industrialization and consequent increase of industrial waste containing nutritional substances.

2- Blooming of micro-algae. The high concentrations of phosphorus and nitrogen salts introduced in the waters favour a huge increase in the number of micro-algae (microscopic organisms) usually existing there, that can even reach millions of cells per litre. The waters become turbid and assume anomalous colourings, ranging from brick-red, green, etc., according to the prevailing species of micro-alga. Such organoleptic alteration is often accompanied by bad smells, due to degenerative processes. The potential or real damage of the areas that have become euthrophic, isn't just aesthetic, but it often involves fishing and indirectly our health.

3- Murrain and deposit of algae on the ground. Consequences of this abnormal blooming are felt above all in summer and autumn, when the high presence of micro-algae associate with the high temperature of the waters. At the end of their life–cycle, algae die and make a deposit on the ground. There is therefore sedimentation of enormous masses of organic substance made of micro-algae remains that, by decomposing, abstract oxygen from the waters on the ground.

4- Decomposition of dead algae. At the end of the micro algae life-cycle, organic substance that has reached the ground undergoes a process of decomposition carried out by specialised bacteria, which leads to complete mineralisation of organic material. This process requires a considerable quantity of oxygen and goes on until the oxygen coming from the most superficial water strata is sufficient to balance its consumption. Cases of lack of oxygen in the deepest waters occur therefore mostly in summer and autumn.

5- Migration or death of benthonic organisms. In a situation of anoxia, the most vulnerable organisms are those living near the ground (coelenterates, annelides, molluscs), eggs and forms of larvae that are connected to benthonic life. Then come organisms that have limited, both vertical and horizontal, mobility. The formation of areas lacking in oxygen

causes migration of fish to restricted areas where concentration of oxygen reaches acceptable levels.

6- Modification in the composition of the biocoenesis of the ground. Effects produced by recurrent situations of lack of oxygen in deep waters cause modifications in the benthonic ecosystem, above all among the least mobile organisms, such as molluscs, crustaceans, etc, with a reduction of the original populations. Repetition of these phenomena has caused the disappearance of numerous species of molluscs and crustaceans.

7- Death of the lake