PREFACE

In this book, the authors present topical research in the study of aquatic ecosystems of which there are two main types: marine ecosystems and freshwater ecosystems. Topics discussed include a change of biodiversity in subarctic freshwater ecosystems located in the northwest region of Russia; assemblages of zoosporic true fungi, heterotrophic straminipiles and plasmadiophorids in freshwater ecosystems; aquatic ecosystem health and the causes, effects and rehabilitation of the eutrophication of aquatic ecosystems.

Chapter 1 - Zoosporic true fungi, heterotrophic straminipiles and plasmodiophorids are phylogenetically unrelated groups of microorganisms that belong to the phyla Blastocladiomycota, Chytridiomycota, Neocallimastigomycota, Hyphochytriomycota, Labyrinthulomycota, Oomycota and the Class Phytomyxea and are currently placed into three different supergroups in the tree of life: Opisthokonta, Chromalveolata and Rhizaria. Recently these organisms have been grouped together with the heterotrophic flagellates due to the production of zoospores which are similar in size and morphology. They are ubiquitous and primarily inhabitants of freshwater but they also inhabit brackish, marine and terrestrial habitats, and have similar ecological roles in food webs as saprobes, mutualists or parasites. Saprobes decompose a large variety of substrates derived from plant and animal tissues such as chitin, cellulose, keratin, lignin and sporopollenin; mutualists are found to occur as obligate anaerobes in the digestive system of herbivorous vertebrates; whereas parasites occur on algae, crustaceans, fungi, macrophytes, protists, fishes, amphibians and invertebrates. Although their importance in food webs has recently been highlighted by many authors, there is little information on these organisms in many ecosystems and thus, the diversity, distribution and abundance of these organisms still remains largely unknown. Ecosystems are

being degraded by deforestation, pollution and other anthropogenic actions that affect their biodiversity, long before surveys can be undertaken by mycologists and protistologists. Hence, attempts to gather information about the diversity of zoosporic true fungi, heterotrophic straminipiles and plasmodiophorids are urgently needed. In this contribution the author summarizes the state of knowledge of the different groups, including taxonomic, biogeographic and ecological approaches

Chapter 2 - Ecosystem health is a symbol for a complex set of ecological realities, rather than a condition that can be measured or monitored directly. It is an idea comprising a class of phenomena. Ecosystem health describes the preferred state of sites modified by human activity. The science of ecology has been primarily to the non-cultural elements of ecosystem health, and has focused on such concepts as species distribution and abundance, the structure, stability, and productivity of ecosystems, and the ability of ecosystems to self organize and evolve. Ecosystem health clearly refers to an ecosystem state, where the identity of the system and the integration of its elements, substantially intact and undamaged. It is not expected to observe ecosystem health directly rather many indices are used to measure the ecosystem health.

This chapter describes a number of principles that may contribute to the practical pursuit of ecosystem health as a goal in science based management of natural resources of aquatic ecosystem. Many health indices such as exergy, ascendancy and emergy and their applications to measure the ecosystem organization towards its health are also described

Chapter 3 - This paper aims to outline the basic concepts of eutrophication of aquatic ecosystems, in particular with reference to lakes and reservoirs - causes, stages of development, and effects on water quality and rehabilitation possibilities of damaged ecosystems.

The objectives of this study are multiple and approach issues related to understanding the process of eutrophication, which essentially consist in super fertilization of surface waters. This is one of the most serious problems affecting surface water quality in today's society due to the effects generated in water bodies. Thus, large quantities of nutrients induce excessive growth of plants and hence the associated effects: algae bloom, high quantities of macrophyte, organoleptic changes and impact on aquatic life and even on human health.

Overall, the paper tries to give answers to questions as: What is eutrophication? What are the causes and the effects of this phenomenon, or What are the possibilities for rehabilitation of eutrophic ecosystems. So the paper tries to provide relevant information to lake ecosystem managers on how

to avoid this phenomenon, or when not possible, the possibilities of diminishing its effects on lake water quality.

Chapter 4 - The full – scale experiments at natural model ecosystems (mesocosms) have been made in Hydrochemical Institute and Southern Division of Institute of Water Problem of RAS for 20 years with the purpose to study an impact of pollutants on intrabasin processes. In the experiment, in particular, an intensity of photosynthetic production and organic matter destruction as generalized thermodynamic parameters of ecosystem state were investigated in the process of polluting of natural models with cadmium in concentration from 25 to 750μg/dm3. The three – dimensional phase pictures of ecosystems on the basis of dynamics of destruction values (R) and gross primary production (P), ratio of destruction to gross primary production (R/P) and rate of change in this ratio (Δ(R/P).t-1) are plotted. Owing to the use of three – dimensional phase space in the dynamics of ecosystem state the critical points – points of bifurcation in which, supposedly, a change in the regimes of ecosystem functioning and transition to a new state occurs are revealed. In all cases it was observed at zero or close to zero rates of change in R/P value and sharp change in the direction of phase trajectories. In general case according to Prigozhin theorem such regularities are characteristic of limit states of dissipative systems and correspond to transition between stability and instability, when production of excess entropy disappears.

An analytical treatment of ecosystem behavior in three – dimensional phase space demonstrated that ecosystems after toxic impact strive to retain an initial balance of the processes of production and destruction regardless of absolute values of intensity of these processes and, to all appearance, when various structural characteristics of biota. Thus, it was revealed that a change in a biotic structure of ecosystem and intensity of production – destruction processes in response to change in environment conditions are directed to the retention of optimum balance of these processes under new conditions. It is also determined that the ecosystems that were disturbed from the stationary state under impact of outside factors (pollution and others) tend to reset in the state characterized not only by the optimum balance of destruction and primary production but the minimum rate of change in the ratio of these parameters. In this case a phenomenon of kind of "ecological hysteresis" manifested both in delay of an ecosystem respond to the outside impact and in a shift of an ecosystem as a minimum in one of three projections of phase space is observed.

The author suggests that a dynamics of ecosystem state suffers anthropogenic impact and described by the values of primary production and

destruction complies with the general laws of evolution of states of dissipative systems. Thus, a ratio of destruction to primary production can consider as a measure of thermodynamic order of ecosystem, and a rate of change in ratio of destruction to production is suggested to consider as a thermodynamic criterion of evolution of ecosystem state.

Using the above mentioned criterion it is possible to reveal typical regimes of ecosystem functioning: stationary states, critical points (points of bifurcation) and transitions from one state into another, and also to determine the limits of aquatic ecosystem stability.

The proposed approach can be taken as a basis of ecological standardization of anthropogenic impact upon natural ecosystems.

Chapter 5 - The long-term data on the change in the state of natural and man-made freshwater ecosystems under the impact of natural and anthropogenic pollution are collected. The man-made aquatic ecosystems – mesocosms – in the process of the long-term experiments were subjected to pollution with the compounds of heavy metals. The volume of mesocosms in various experiments was from 2 to 5 m^3. The mesocosms were polyethylene cylinders deepened into bottom sediments and fixed from above with floats or hand ropes stretched from a planked footway from which the measurements were made. The observations of these ecosystem responses according to various parameters under various experiment conditions were carried out. The compounds of Cu and Hg were chosen as pollutants. Concentrations of compounds in recalculation on pure metals in some experiments were changed, but within the limits from 5 to 100 $\mu g/dm^3$ for Cu, and from 0,1 to 2 $\mu g/dm^3$ for Hg, respectively. The main part of the experiments was made together with the measurement of spectra of brightness coefficients of radiation upwelling from the water. Transformed spectrometric data are presented in the form of trajectories in a space of optic images plotted on the basis of reducing a large number of model and experimental spectra. The trajectories of aquatic ecosystems in this space are quasi-closed curves. The time scale of the processes under various conditions differs by orders. The explanation of such cyclic processes is possible on the basis of the introduction notion of integrated indexes of aquatic ecosystem state and usage of the Le Chatelier-Brown principle. Cyclic change in trajectories in variables of "impact-response" allowed to formulate a concept of ecological hysteresis. If generalized coordinates of optic image are used as variables then by analogy with classic thermodynamic reasoning, it is possible to suppose that the parameters of optic images can be considered as the parameters of aquatic ecosystem state.

Chapter 6 - On the basis of generalisation of extensive materials on surface waters flora and fauna condition in the Kola North (Russia) there is formed the conception of contemporary tendencies in changes of biodiversity under impact of water pollution by heavy metals, eutrophication, acidification and discharge of warm water by nuclear power station (NPS). There are marked both general traits in communities' reorganisation and specific response to the given kinds of impact. There are suggested the indices for monitoring of biodiversity of Subarctic freshwater ecosystems.