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Current challenges and the recommended directions of research in the ecology of freshwaters

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Abstract – The basic methodological division of modern ecology into population and species ecology (inspired by Darwin's natural selection) and that of ecosystem and landscape also affects the directions of studies within the scope of modern limnology. Among the actual directions in research the following are discussed: habitat and biological diversity of the different space and time scale (microhabitats versus landscape systems), border (interface) systems, effects of climatic changes, influx of alien and extinction of native species. The ecology of humic and macrophyte-dominated lakes and of wetland belts is emphasized. The need to integrate with research and actions of uniting Europe is stressed.

Key words: limnology, biodiversity, ecotones, microhabitat, humic lakes.

Where are we?

It is worth while remembering that limnology – or in other words (traditionally) hydrobiology – is a division of ecology. This is the ecology of freshwaters approached in the aspect of the hydrosphere. As its mother science limnology belongs to biological or, in a broader sense, to natural sciences. It significantly contributes to the development of ecology both in the sense of the scientific material and (perhaps above all) in the formulation of theories, paradigms, and models comprising all the aspects of ecology and biology. As a natural science it is constantly engaged (perhaps even to a greater degree than land ecology) in activities on behalf of the protection and management of the environment. Therefore, as "the first lady of ecology" limnology takes part in discussions, controversies, and methodological quarrels among the ecologists throughout the world.

Currently we are confronted or rather we unconsciously participate in the fundamental division of ecology. Jones and Lawton (1995) brilliantly discussed the problem in their book significantly entitled "Linking species and ecosystems". Here the present author wants to give a short outline of the problem on the basis of her comprehensive review of the book (Hillbricht-Ilkowska 1998*a*). We have to discern two types of ecology: the ecology of population and species and that of ecosystem and landscape. Their parallel yet separate development frequently occurs in conditions of the sharp local competition for funds, students and workers. The two types use different methods and belong to different research schools. The ecology of the first type identified with the "proper" or theoretical ecology, concentrates on the individual, population, species, and interspecies relations in biocenosis such as competition and predation. It is strongly associated with evolutionary ecology and the Darwinian idea of selection and adaptation. For many years its favourite object of studies, i.e. the behaviour of individuals in various conditions aiming at the optimisation in the "food-reproduction-predation-survival" system, has been exceedingly popular as shown by the number of publications and new journals. The other type of ecology is chiefly concentrated on the ecosystem (productivity, decomposition, and transformations of organic matter, the cycling of elements, the trophic web, and trophic communities). With a kind of nostalgia we remember the golden age of ecosystem studies on the productivity and also the International Biological Project of the '60-ties. The current boom manifested by the number of publications and new journals concerns the landscape ecology understood as the spatial distribution of ecosystems and their border areas (ecotones) associated with the processes of transport and exchange of matter. This type of ecology is identified with biogeochemistry, being strongly associated with Earth sciences (e.g. geography). It is engaged in the problems of protection and management of the environment to a higher degree than the "competitive" ecology discussed above.

It is obvious that the two branches of ecology do not present research problems excluding each other. They are rather complementary, concerning the processes and structures of the real world surrounding us. It is worth while mentioning the definition of ecology given by Professor G.E. Likens, the limnologist and pioneer of landscape-catchment basin studies (the renowned investigation of the Hubbard Brook ecosystem in the '70-ties). In the preface to the book by Jones and Lawton (1995) he wrote that ecology is the scientific investigation of the processes which influence: the distribution and abundance of organisms, the relations between organisms, and the relations between organisms and the fluxes and transformations of matter and energy. Therefore, one of the basic challenges of modern ecology, including freshwater ecology, is the proper selection of problems and research projects. They should document the mutual effects and relations between the life strategy and behaviour of individuals and species and the processes (e.g. matter cycling) occurring in the ecosystem or landscape. In the above-mentioned book we find numerous examples of such aquatic studies, e.g. the investigation on key-stone species affecting the survival and selection of other species and hence the flux of matter in the given fragment of the trophic net. Another example concerns the "ecosystem engineers" with a pronounced role in the shaping of the environment, e.g. the beaver. The book is a rich source of research ideas "connecting the species with the ecosystem" and can be used as an inspiration for both passionate ecosystemologists and Darwinists.

It would be interesting to estimate the popularity of the two research directions among the Polish hydrobiologists. We can use for this aim the carefully elaborated directory of about 740 scientists, equipped with corresponding indices (Rybak and Węgleńska 1977). About 430 hydrobiologists on the list regard the ecology of population and species (behaviour, genetics, ethology, physiology, evolution, predation, biomanipulation etc.) as the chief scope of their research. About 550 scientists are chiefly interested in the problems of ecosystems and their chemistry, the catchment basins, hydrology, matter cycling, succession, etc. This result was surprising at least to the present author. I was convinced that a greater difference would appear in favour of aquatic ecosystem ecology on account of the great interest in problems of water protection. On the basis of the answers formulated by the scientists asked it may be conjectured that Polish hydrobiologists develop fairly uniformly the two directions of ecological sciences.

What about biodiversity!

The word "biodiversity" is used as the master key as was formerly the case with the word "productivity". Its career began towards the end of the '80-ties (and particularly from 1992, the year of the Rio Conference) in science, education, economy, and politics. Diversity also became the central problem of modern ecology. The term can be used in numerous senses, though the most frequently investigated problems are the number and diversity of co-occurring individuals and taxa in a habitat, community, biocenosis, trophic net, or link, and also the occurrence of rare, endangered, endemic, new, and invading taxa (see Hillbricht-Ilkowska 1998*b*).

An attempt at monitoring the fauna and flora of lakes (in other words the periodical recording of their biodiversity) (Hillbricht-Ilkowska 1998*c*) convinced us of the differences between the philosophy of biodiversity and the philosophy of, let us say, productivity. The latter was chiefly concerned with numerous species or mass taxa or those distinctly forming the habitat and the functioning of an aquatic ecosystem. The former concerns the entire taxonomic variety of communities, thus also the rare, less numerous, ephemeral, exotic species and their role in biocenosis dominated by more numerous competitors. It was found that the limnologists knew very little about many important constituents of aquatic biocenoses when compared with the usually investigated components of benthos or plankton. This particularly concerns many groups of insects of littoral habitats. The number of species known in Poland (owing to the research of entomologists not limnologists) does not exceed 100–400 in the particular groups, the estimated degree of knowledge of their ecology reaching 20–30% in spite of the fact that most of them are predators and thus the key species of aquatic biocenoses. A similar situation is found with respect to the smallest invertebrates (e.g., protozoans) or non-vascular plants (see Hillbricht-Ilkowska 1998*b*). It is obvious that in the wide sense biodiversity is not only concerned with a complete list of all the organisms living in a given lake, although the preparation of such a list frequently begins the inventory of diversity. According to Carpenter (in: Mooney et al. 1996), the chief problem is the association of the species diversity of biocenosis with the ecological complexity and diversity of functions within an ecosystem. The main point is to attribute every species to a specific function in the community (i.e. in the gildia according to the modern terminology), trophic net, biocenosis, and ecosystem. This is one of the challenges of modern ecology. It can be determined as the association of the biodiversity with the ecosystem and landscape, this being a slightly different version from that formulated in the preceding chapter.

The editors of the list of Polish hydrobiologists (Rybak and Węgleńska 1997) did not propose the term "biodiversity" in the list of problems (perhaps all of the participants of the inquiry would declare interest here!). As many as 500 hydrobiologists, however, carry out investigations on the taxonomy, zoogeography, phytosociology, floristic, and faunal studies, and also on the feeding of various species. Only a small group of hydrobiologists is interested in protozoans!

... and other diversities!

In recent years new methodological propositions have been marshalling our ideas of the habitat in general, its factors and resources, variability, and effects on organisms. The habitat diversity, i.e. the spatial heterogeneity and time variability of the habitat, are determined as patchy, i.e. composed of patches or islands, distinguishable in the respective (spatial and time) scales. The approach to the habitat as to a mobile patch pattern can be used both with regard to the landscape and to a water mass of a few millilitres, depending on the scale of the process or the size of the organisms with which we have to do. The connection of biological diversity with spatial diversity and variability of the habitat or habitats seems obvious.

The most spectacular (and the earliest in the historical sense) use of the term "patchy" we find in the description of a mosaic structure of landscape (Forman and Gordon 1986). The patchy or mosaic structure was expressed in the number and size of various sites and plant communities and in the length of their border zones, i.e. ecotones. All kinds of wetland habitats play an exceedingly important role in maintaining the diversity of sites in the landscape. Here we have to do with small, ephemeral, and transitional water bodies and natural ponds, bogs, and small marshes, riparian sites and flooded areas (e.g. meadows), periodical streams, springs, seepage of ground waters, and other astatic systems whose variability is unpredictable and whose life-span is sometimes limited to a week or a month. Within this type of variable ecosystem we may classify permanent low-order streams, i.e. characterized by the strongly varied bed and discharge, shape of the banks, pattern of stagnant and current parts, etc. The maintenance of the natural diversity of these habitats in the landscape is the aim of numerous actions (e.g. the pan-European convention of landscape diversity) (see: Hillbricht-Ilkowska 1997), while the habitats themselves are investigated on different scales and are the subject of theoretical generalisations.

The specific patch pattern and time variability of these habitats permits the testing of numerous hypotheses concerning the strategy of life of organisms. Southwood's concept (from 1977 though highly valued now, cf. Statzner et al. 1997) of the *habitat template* is based on the interesting idea of comparing all the factors and resources of the habitat to the system of two axes of changes: spatial and temporal. They force the appropriate strategy of life of individuals in the population. The popular hypothesis of "*intermittent disturbance*" is frequently applied in the investigation of aquatic ecosystems (Faholle et al. 1997, Townsend and Scarsbrook 1997). It postulates that the greatest taxonomic or trophic diversity occurs in conditions of moderate variability and a patchy character of the habitat. In describing changes in river systems, Junk et al. (1997) introduced the idea of "*the pulsing system*", i.e. subjected to periodical effects of floods disturbing, changing, or recolonising successive habitats and communities.

The scientific productivity of limnologists concentrated on the general problems of running waters is surprising. It is worth mentioning here that the theory of *river continuum* is still applied and that the so-called *nutrient spiralling* (see Allan 1998) is very useful in describing changes in habitats and communities occurring along the development of the river system. The patch pattern, or in general the heterogeneous character of the habitat, can also be described in the nanoscale (10–100 microns). It is formed, for instance, by the agglomerations of bacteria (Krembs et al. 1998), particles of detritus, and excrements and secretion of organisms. The heterogeneity of the habitat in the scale of centimetres is originated by zooplankton assemblages sometimes being transitorily formed as a defence against predators (Pijanowska 1994). Hence, a lakewater drop of a few millilitres can be a mobile and heterogeneous habitat!

Of the nearly 740 hydrobiologists in the list mentioned above only 275 declared that their research was concentrated on lakes, i.e. that they were chiefly interested in fairly stable habitats. The remaining scientists investigated rivers, dam reservoirs, streams, astatic waters, and wetland (a total of 570), i.e. habitats where it was possible to apply the phenomena of patch pattern and variability in ecological studies in order to test the above theories.

The "new" lakes?

In the historical aspect the limnology grew (or rather emerged!) from investigations on pelagic water masses and the sediment in the profundal of large and deep lakes. The first typological studies of lakes (Alpine *versus* Baltic ones), and also the eu-meso-oligotrophic typology, are still the basis of arranging all the structures and processes in lakes and of their classification. In the last 10–15 years we have been witnessing intensive studies on lakes determined as "shallow lakes" and those determined as "humic lakes". The last term slowly replaced the previously used dystrophic lakes. It seems that in such lakes it is possible to study numerous phenomena and processes and also to test research hypotheses whose corroboration is not possible in typical lakes of the eutrophic series.

In the case of humic lakes it is possible to investigate the energetic system and the trophic net based on the constant supply of organic matter (humus of coniferous forests and peat from *Sphagnum* moss) from the surrounding land. The organic matter chiefly consists of poorly decomposable humic compounds and those decomposed by enzymes (Hessen and Tranvik 1998, Górniak et al.1996) or in photochemical processes (Reitner et al. 1997). The acid reaction of water and sediment is thereby maintained and as a strong environmental factor significantly affects the habitat by controlling the species selection in each trophic link (particularly of predators, e.g. fish and large herbivores of the genus *Daphnia*). They control the cycling of nutrients, particularly of phosphorus by blocking its circulation and hence maintaining the low productivity of such lakes. The trophic net is based on the bacterial productivity utilizing a part (though a small one) of the organic matter made available by the enzymatic and the UV decomposition of high-molecular humic compounds. The small amounts of utilised phosphorus are competitively acquired from plankton algae. The latter organisms require higher concentrations of this element. The trophic links are chiefly composed of bacterial detritivores and omnivores, therefore the regulation of the "top-down" type is limited. Humic lakes, the typical component of coniferous forests and moderate and high-moor bogs, frequently constitute unique protected ecosystems on account of the occurrence of rare species in them (e.g. *Lobelia dortmana*). They are sensitive to changes in the catchment basin (forest clear-cutting, fertilization, and particularly the neutralization of the acid conditions) (Hillbricht-Ilkowska et al. 1998).

The so-called shallow lakes, constituting at least a half of all the lakes in our climatic zone, were the subject of periodically organized international conferences. Thus we can already define the ecology of the shallow lakes (Shaffer 1998). In this case it is not their small depth (10 m maximum, usually not stratified) that matters but the fact that a large part of their area is covered by vascular plants. Usually they are determined as macrophyte-dominated and the mutual macrophyte-phytoplankton relations are decisive for the production of the lake and the rate of its eutrophication. The submerged macrophytes and the periphyton not only constitute the basic community of producers but also serve as a refuge for the prey (e.g. the zooplankton) from their predators (non-predatory and predatory fish). This refuge habitat analogous to the disphotic zone in deeper lakes necessitates a specific type of behaviour, migration, and the matter cycling within the ecosystem. The bottom sediment illuminated on a large area frequently controls an alternative system of producers (the biofilm).

The two "new" types of lake are popular in the modern ecology owing to their special ecological situations (as discussed above) whose recognition offers the opportunity of testing various research hypotheses.

Interfaces (border habitats) and microstructures

In limnological studies the traditional border system (the interface, i.e. the system appearing on the border of two faces) is of course that of "bottom sediment – water" with its specific communities of organisms and processes deciding the matter cycling in the lake ecosystem. They also constitute an important element in the survival strategy of numerous organisms. As in the case of shallow lakes, the periodically organized international symposia stress the progress in investigations of this border system.

In recent years the research on different kinds of interface has become very popular, not only in the form of interesting faunal and floristic contributions. Attempts are made at a holistic description of the interface habitats, their functions, and role in the entire aquatic ecosystem. Among such systems is the "water – air" interface (Maki 1993), whose product is a microlayer or a film (the water layer several microns in thickness) produced on the surface of lake or pond waters. This is the habitat of neuston and of the specific trophic net based on organic matter and nutrients (derived both from the deeper layers of lake water and from the precipitation and air) accumulated in a given place, and on the bacterial production. The discussed habitat is extremely astatic and frequently strongly polluted (heavy metals) yet it is ubiquitous, also occurring in seas and oceans (where the first studies on this specific environment were conducted).

The structure of the biofilm is another kind of the interface. This is an organic-bacterial-algal film developed on the surface of tough substrates such as stones, submerged branches, or bottom sediment (e.g. Tank and Webster 1998). It can be also suggested that psammon, i.e. the communities of organisms living in wet sand in the shore zone of lakes and rivers, is a border system. It occurs in interstitial water saturated with organic matter, particles of detritus, and bacterial flora adhering to the surface of sand grains. According to Threkeld et al. (1993), exciting studies can be conducted on epibionts, i.e. assemblages of algae, protozoans, and other invertebrates accompanied by bacteria, clinging to the carapace of a crustacean. They sweep with their host, making use of the facilitated feeding, though they have to regenerate the entire assemblage after each moulting.

The studies on the organisms of micro and nano size provide extremely interesting research problems. Investigations on the picoplankton, the smallest (the order of 0.2–2 μm) fraction of the phytoplankton, became a routine part of studies on plankton producers (Wilde and Cody 1998). It was found that in spite of their small dimensions and biomass they participate significantly and can even decide about the primary production (Jasser 1993, Carrick and Schelske 1997). The abundance of viruses and phages can reach as high as 10^6 mL^{-1} and they can aggregate in the surface film (as described above) or in other border structures and be responsible for the pronounced mortality of heterotrophic bacteria (Tapper and Hicks 1998). The studies in oceanic and lacustrine habitats were followed by investigations on the so-called lake snow, i.e. soft structures of the order of even

1 mm filled with particles of detritus and bacterial flora. They originate from the coagulation and aggregation of dissolved and disintegrated organic matter and its secondary colonization by bacteria. The number of such flakes may reach 10^5 in 1 mL^{-1} of the lake water. They form specific mobile centres of bacterial activity in the water (Grossart and Simon 1997).

The current interest in the above and other microhabitats and microstructures seems to be associated with the intense development of studies started in the '80-ties on the so-called *microbiological loop*, i.e. a short trophic chain. It is based on the dissolved organic matter, bacterial production, and its small consumers such as flagellates, ciliates, rotifers etc. (in: Lampert and Sommer 1996).

The above-discussed border habitats and microhabitats maintain the communities whose energetic resources are based on the centres of activity of the heterotrophic bacteria located in them (the microlayer, biofilm, and lake snow). The substrate of the bacterial production is the organic matter released and excreted by all the organisms and also that supplied from outside the system and enzymatically utilised by bacteria. It seems that in the last 25 years the most important methodological innovation of limnology has been the change in the approach to the bacterial microflora and organic matter. Bacteria are no longer the reducers only. They are consumers changing the organic matter into the biomass accessible for the basic trophic net of the aquatic ecosystem.

In the quoted list of hydrobiologists 110 workers investigated micro-organisms and microhabitats (fungi, bacteria, periphyton, protozoans, psammon, and picoplankton) against the number of 330 scientists declaring the traditional objects of interest such as benthos, zooplankton, or fish. However, 10 hydrobiologists have concentrated on the studies of the picoplankton!

Landscape – catchment basin – wetland – lake (river)

In other words "beyond the shore line" as was the lapidary formulation by Professor Gene Likens in his speech inaugurating the limnological congress in Lyons in 1983 (Likens 1983).

The current investigation of the biogeochemical and biological contacts of rivers or lakes with their catchment areas, or in general with the surrounding land, have resulted in numerous cognitive achievements and form an ecological basis for landscape management. The aim of the management is to minimize the export of pollution and eutrophogenic compounds (see Hillbricht-Ilkowska 1997, 1999). For a modern ecologist the lake is a patch, i.e. an element of the landscape structure associated with the processes of transport and exchange of mater and energy, and also of the ecological information (in the form of individuals and species) with other components of the landscape. The spatial system supplying the matter and ecological information to lakes and rivers is the direct or indirect catchment area (in the form of permanent streams or fluvial tributaries). The water-logged habitats in the neighbourhood of waters, i.e. swamps surrounding the lake or occurring along the river banks and maintaining a hydraulic contact with them, constitute the border habitats (ecotones) between the land and the water (Naiman and Decamps 1990). Since the '70-ties the rapid development of studies has been observed with respect to wetland habitats constituting (together with the littoral) a compact ecotonal system isolating the lake from agricultural areas (Wetzel 1987). The floristic composition, phytosociological communities, zonal structure, and seasonal dynamics have been documented for numerous lacustrine wetlands (e.g.

Kłosowski 1993). It was found that, depending on its width, the composition and biomass of the vegetation cover, the degree of moisture in the soil and resources of organic matter in it, this habitat retained to 90% of the nitrogen (particularly nitrate nitrogen) supplied by the surface and subsurface runoff. The basic processes are the denitrification and the uptake in the process of plant growth (e.g. Haycock et al., Rzepecki 1998). A less effective process (being only periodical) is the removal of phosphorus (chiefly by sedimentation and by fixing on particles of soil, iron, or aluminium) supplied with the overland and subsurface runoff and with the products of erosion (*ibidem*). All these processes are strongly connected with the local hydrology, precipitation, discharges, land use, and agriculture (see: Hillbricht-Ilkowska 1997, 1999). Their identification is the basis of current actions on behalf of the protection of wetlands, their renaturalization or even complete reconstruction. This can be accomplished by the development of belts of swampy vegetation and of controlled flooded areas, by the reconstruction of river bends and widening of flooded valleys by destroying embankments, etc. (Eiseltova and Biggs 1995, Waal et al. 1998). There are firms which specialise in the above technologies, e.g. the River Restoration Company in Great Britain.

Also Polish limnologists are interested in the questions discussed above to the degree adequate to the importance of the presented problems. According to the list, about 20 hydrobiologists investigate wetlands and about 40 others conduct research on the ecotones. Several scientists investigate catchment basins while hydrology is the subject of studies by more than 50 workers. 430 persons declare interest in water protection, about 150 in the human impact and the quality of waters, while 50 workers are interested in the restoration of aquatic ecosystems. This is an optimistic system of scientific interests, also beneficial for studies and actions "beyond the shoreline". It would not be an exaggeration to postulate that the formation of the ecological quality of rivers and lakes through the maintenance of the diversity of the surrounding landscape, and particularly of wetland habitats along the shoreline, is a modern approach promising far-reaching effects. This approach should be a complementary element of direct techniques such as biomanipulation, inactivation of sediment, or aeration. It may stimulate complex studies carried out by professional limnologists and scientists working in other branches of ecology.

New threats – new challenges

In the general opinion the effects of such typical threats as acidification (due to acid rains) damaging sensitive habitats characterised by a limited buffering capability, or contamination (radioactive, heavy metals or pesticides) are being thoroughly investigated. Even such general threats as the eutrophication of lakes and the saprobic conditions in rivers are well recognized and can be neutralized (e.g. by liming) or controlled by removing sewage, purification of waters, application of biogeochemical barriers (restoration of wetland habitats), etc. However, new dangers arise, potentially bringing about unpredictable changes – probably negative ones. They consist of climatic changes and the effects of human activity on large territories and are defined by the general term of global changes. Some changes result from the appearance of new alien elements of the fauna and flora and from the disappearance of the components of the native nature. Significant consequences of these two groups of changes may be expected.

Irrespective of the reliability of different climatic models applied in our climatic zone, the analyses of many years' climatic and meteorological series already show the changing thermal-mictic regime of lakes. The land use in catchment basins is also changing, affecting the condition of aquatic ecosystems (Hillbricht-Ilkowska 1993, 1997, Zalewski and Wagner 1997). The observed phenomena concern the shortening of the period with ice cover, and its timing, increases in the average temperature of surface layers, sharper and earlier summer stratification, increased frequency of extreme phenomena (torrential rain, storms, dramatic short-term cooling, mixing of waters). The possible consequences of these phenomena are unknown, e.g. with respect to the winter survival of organisms, their growth, development, and migration. It may be expected that fairly permanent changes will occur in the land surrounding lakes and in river valleys. The wet habitats will disappear owing to periods of drought. The intensity of long-lasting erosion owing to dry weather and periods of rapid torrential rain and the increasing use of pesticides also belong to phenomena whose effects in the time scale are difficult to anticipate. An increase in the efforts of limnologists is desired to investigate the effects of extreme phenomena as well as the variability of these phenomena where they can be associated with the climatic and meteorological conditions. In Poland, the limnologists unjustly manifest a reluctance to discuss the probable effects of the changing climate. The international literature deals with innumerable prognoses and reinterpretations of results of research conducted in various branches of science.

We also witness an increasing rate of expansion and emergence of new species including species new to our flora and fauna. The most spectacular example is the appearance of the mollusc *Dreissena polymorpha* in the fauna of Canadian lakes during the last ten years. In Polish waters we observe the occurrence of alien species of bottom crustaceans (e.g. *Corophium*), of a snail (*Potamopyrgus jenkinsii*), and of introduced fish. In the waters of heated lakes (by the cooling system of power plants) new species of molluscs and fish have appeared while in lagoons (of the Rivers Oder and Vistula) Baltic polychaetes have begun to dominate. On the other hand, the recession can be observed of numerous species sensitive to oxygen conditions (e.g. large relict crustaceans) or to the chemical condition of the water (e.g. charophytes) (see also: Hillbricht-Ilkowska 1998*b*). Not much is known about the consequences of these diversity changes. Here may be quoted the example of *Dreissena polymorpha* whose introduction in American lakes reduced the numbers and area of occurrence of the native Unionidae. It is possible that in most cases the consequences are currently undetectable and will be determined in the course of long and difficult studies carried out over many years.

"Link or die"

The author heard this motto during a conference devoted to the organization of the Pan-European Long-Term Integrated Monitoring Site Network (Oxford, 24–26 March 1999). Its significant acronym is NoLIMITS meaning the Network of Long-Term Integrated Monitoring in Terrestrial Systems. The aim of the project is to connect the ecological monitoring networks of separate countries into a single European system of monitoring the effects of global environmental changes in land and aquatic systems. We all encounter such initiatives distinctly propagated by the European Union. They form the framework of various research projects depending on the collaboration of scientists from different countries and concerning not only the common research programmes but also various actions. The Society for European Freshwater Scientists (Boech 1998) was organized as a forum for the discussion and formation of pressure groups for ideas and experience of European limnologists. The first conference (Antwerp, 23–25 August 1999) proposed the following scope of the currently most important problems: physiological ecology of organisms, biogeochemistry, trophic relations and trophic nets, and the biocenosis--community system.

It may be that the necessity of joining research projects and actions among the activities of the European Union will be the most important challenge of Polish ecologists!

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