Appendix 2b

Dr Krzysztof Banaś

Autoreferat

University of Gdańsk, Faculty of Biology
Department of Plant Ecology

1. Name and surname

Krzysztof Banaś

2. Degrees and diplomas held

1996 – MSc in environmental protection
from the University of Gdańsk, Faculty of Chemistry,
conferred upon the presentation of the thesis *Hydrochemistry of Soft-water Lakes of Western Pomerania;* thesis supervisor: prof. dr hab. Józef Szmeja.

2001 – Doctoral degree (with honours) in natural sciences (biology)
from the University of Gdańsk, Faculty of Biology, Geography and Oceanology, Department of Plant Ecology,
conferred upon the presentation of the thesis *Impact of Humic Substances on the Habitat of Underwater Plants;* thesis supervisor: prof. dr hab. Józef Szmeja.

3. Academic positions to date:

01.10.2002 – 30.09.2012: assistant professor in the Department of Plant Ecology, the Faculty of Biology of the University of Gdańsk.

01.10.2012 – 30.09.2018: senior lecturer in the Department of Plant Ecology, the Faculty of Biology of the University of Gdańsk.

4. Scientific achievement in support of the post-doctoral degree application

Under Article 16 section 2 of the 14 March 2003 legislation on Academic Degrees and Titles and on Degrees and Title in Art (Journal of Law No 65, entry 59, with further amendments), the scientific achievement in question is the monograph: Banaś K. 2016. *The Principal Regulators of Vegetation Structure in Lakes of North-West Poland. A New Approach to the Assembly of Macrophyte Communities*. Wyd. Uniwersytetu Gdańskiego, Gdańsk, 237 pp.

The functioning of a lake ecosystem is based on natural and spontaneous processes, which depend heavily on the structure of aquatic and especially submerged vegetation. This is essentially formed by vascular plants (Spermatophyta) and stoneworts (Charophyta), and to a lesser degree by mosses (Bryophyta) and ferns (Pteridophyta), commonly regarded as *macrophytes*. These are plants that float above or under the water surface, can be anchored to the substrate or may stay in touch with the lake bottom without being attached to it. Their assimilation and reproduction organs may be emerse or not (Szmeja 2006). Some of them are evergreen plants developing ground-level rosettes of short and rigid leaves, resistant to hydrodynamic tearing, like *Littorella uniflora*, *Lobelia dortmanna*, *Isoëtes lacustris*, *Juncus bulbosus* and *Ranunculus reptans,* while others are overwintering species with tall shoots of centrally placed mechanical tissue, which makes them flexible and resistant to bending and stretching, e.g., *Myriophyllum spicatum*, *Elodea canadensis*, *Stuckenia pectinata*, *Potamogeton crispus* or *Nuphar* and *Nymphaea sp. div.*

It should be noted that macrophyte presence is a generally adopted criterion of lake classification and evaluation. This is demonstrated by relevant provisions of the European Water Framework Directive (2000/60/EC directive of 23 October 2000; Pall, Moser 2009), its corresponding US legislation (Beck et al. 2010) as well as other documents and resolutions on nature conservation and rational use of natural resources, adopted by, e.g., the International Union for Conservation of Nature, or the Ramsar Convention on Wetlands – ratified and implemented by Poland. One of the goals of the monograph, now presented for assessment in the post-doctoral proceedings, is to identify macrophyte communities and their environment in NW Poland in order to develop accurate methods of lake evaluation, classification and rational use in the lowlands of central Europe. The results of the studies presented may help to enhance lake and biocenose restoration methods.

Macrophytes form time and space persistent communities, with a common feature which is their simple structure with a dominance of one or, less frequently, two or more species. This is common to emerse, immersed, shallow-water or deep-water habitats. Assembly of communities structured in this way is probably the effect of the operation of environmental (Kraft et al. 2014) and biotic (Grime 1998) filters, notably competition between species and within a population (Lodge et al. 1998; Mitchell, Perrow 1998; Szmeja 2006). Generally recognised abiotic factors in lakes are light, oxygenation, temperature and other physical and chemical properties of the water and the substrate. (Chambers, Kalff 1985; Lodge 1991; Capers 2003; Madsen et al. 2001; Feldmann 2012). Little is known about the role and significance of such factors, especially the ones which may be important regulators of aquatic vegetation structure. Most of the studies to date have focused on the description of proportions between plant community members and on identifying the relationship between community structure and the habitat. They would usually be based on statistical analysis, less frequently aided by the most recent methods of numerical analysis or dedicated computer software.

The primary **aims of the research** in the monograph presented for evaluation **is to identify abiotic factors responsible for the structure of communities (the species content) of submerged plants in lakes.** To this end, an attempt has been made to establish which factors are chiefly responsible for the shape of underwater vegetation in lakes, based on floristic information as well as the physical and chemical properties of the depths water, the water above the substrate and the substrate itself.

The attempt to identify the regulators of aquatic vegetation structure has been based on 15,143 plant samples, each of 0.1 m^2, collected between 2005 and 2014 **in 161 lakes in the Lakeland of Pomerania in Poland**. They were taken by a diver from 775 bottom zones (at an interval of 1 metre in depth), according to the method suggested by Madsen (1993) and Szmeja (1994, 2006). The samples were used to study the species mix in the bottom areas and to seek the relationship between the mix and the habitat, and to build appropriate vegetation patterns and models.

The material to assess the environmental conditions was provided by 4,650 samples of equally divided between those from the water above the substrate and from the substrate itself. Fifteen properties were determined in the former and ten in the latter sample group. The water was tested for pH, redox potential, conductivity, colour, hardness, calcium, nitrogen and phosphorus total concentration, humic acids, CO_2, HCO_3, temperature, oxygenation and photosynthetically active radiation (PAR).

In addition to this, water transparency was determined (Secchi disk) and the depth at which vegetation occurred. Substrate samples were studied for pH, conductivity, redox potential, calcium, nitrogen and total phosphorus, humic acids, organic and mineral matter and hydration.

In order to define the vegetation structure, species biomass, their frequency in the samples and dominance index were calculated. Patterns of species occurrence were determined by indirect ordination (*Correspondence Analysis*; CA), while the patterns of occurrence that also account for species biomass were determined by Ward's hierarchical (agglomerative) clustering with the Manhattan distance measure (MVSP software). The validity of vegetation units (communities) identified in this way was verified by ANOSIM with the Bray-Curtis distance measure (Bray, Curtis 1957). **The following were included in the description of the vegetation units** (communities) selected: **the Shannon–Wiener diversity index** (*H′*) and the **Pielou evenness index** (*J′*) as well as the **indices of species fidelity** (*FI*), **dominance** (*DI*), **constancy** (*CI*) and **ecological importance in community** (*II*). Species frequency (*F*) was also determined. For each of the communities, the frequency was calculated of both emergent and submerged species, including vascular plants, mosses and stoneworts. Frequency was also defined of single, double, triple and n-species patches, as well as of assemblages of *CI*>5%, but only those with a frequency (*F*) in excess of 1% of the number of plant samples collected in the community.

Environmental diversity was determined by Principal Components Analysis (PCA). The impact of abiotic factors on the occurrence of submerged, emergent and vascular plants as well as mosses and stoneworts (species number and biomass) and on the diversity of communities was determined by means of Redundancy Analysis (RDA) performed by Canoco 4.5 software. Discriminant analysis (Canonical Correspondence Analysis; CCA) was applied to establish the significance of environmental variables for community diversification, while the significance of abiotic regulators for community assembly was determined by Classification and Regression Tree (C&RT), according to the validity coefficient.

In the 15,143 plant samples collected from the 161 lakes, **122 aquatic species were found**. These included eighty-four submerged species (47 vascular, 20 mosses and 17 stoneworts), three pondweeds (pleustonic species) and thirty-five emergent species (Tables 2 and 3, pp. 20-23). Fifteen species are relevant for the assembly of communities and their structure (*F*>5%): *Chara delicatula*, *C. globularis, C. tomentosa*, *Nitella flexilis*, *Drepanocladus sordidus*, *Fontinalis antipyretica*, *Warnstorfia exannulata*, *Sphagnum denticulatum*, *Littorella uniflora*, *Lobelia dortmanna*, *Isoëtes lacustris*, *Myriophyllum alterniflorum*, *M. spicatum*, *Elodea canadensis* and *Ceratophyllum demersum*.

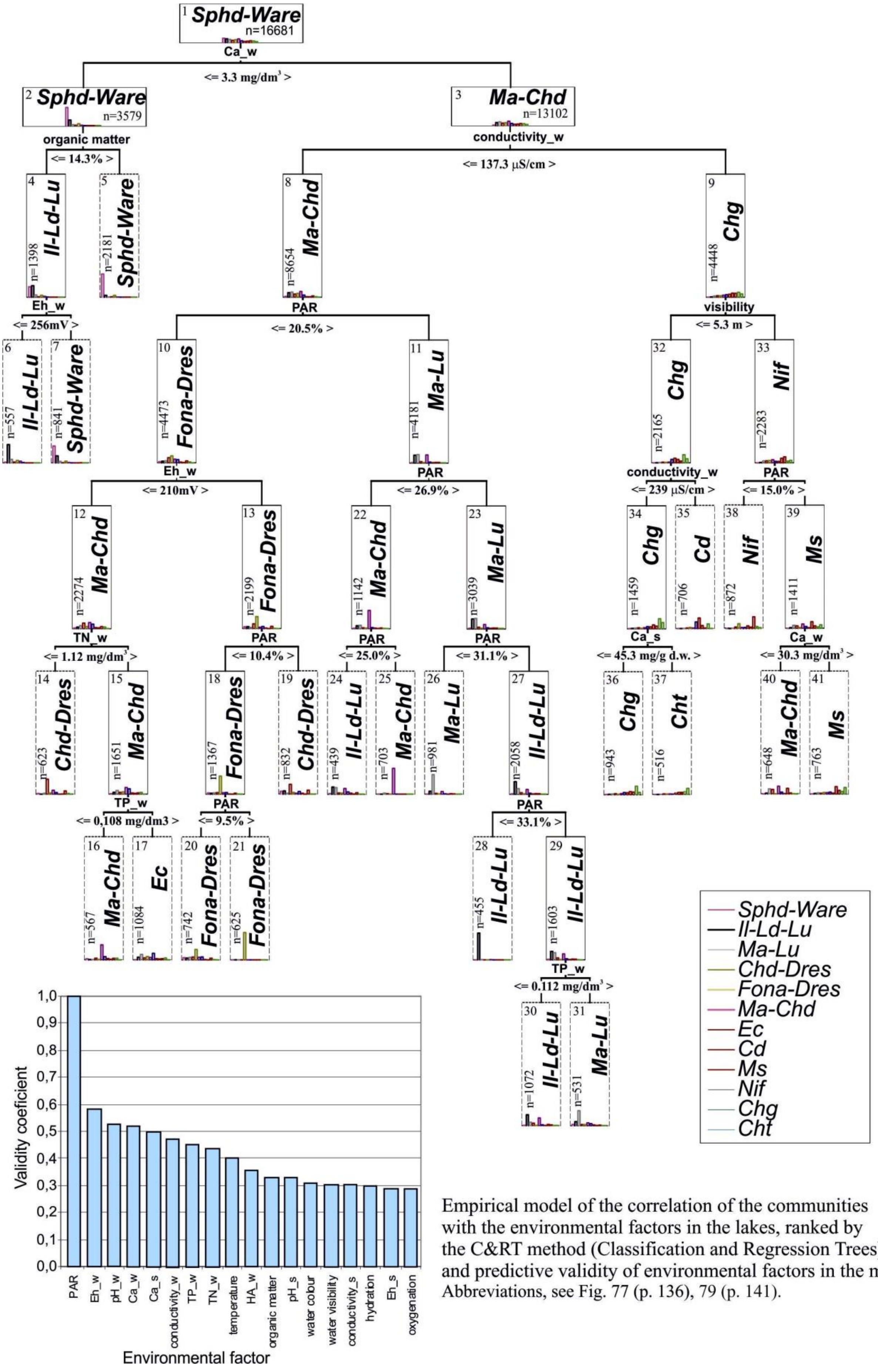
In the 161 lakes, **twelve communities** (repetitive vegetation units) were identified by the methods described on pages 13 and 14. They are: (1) *Sphagnum denticulatum–Warnstorfia exannulata;* (2) *Isoëtes lacustris–Lobelia dortmanna–Littorella uniflora*; (3) *Myriophyllum alterniflorum–Littorella uniflora*; (4) *Chara delicatula–Drepanocladus sordidus*; (5) *Fontinalis antipyretica–Drepanocladus sordidus*; (6) *Myriophyllum alterniflorum–Chara delicatula*; (7) *Elodea canadensis*; (8) *Ceratophyllum demersum*; (9) *Myriophyllum spicatum*; (10) *Nitella flexilis*; (11) *Chara globularis*; (12) *Chara tomentosa* (Fig. 3, p. 33).

A common characteristic of the communities is a small number of differential and typical species, while accompanying or foreign species are numerous (the notions of 'differential', 'typical,' 'accompanying' and 'foreign' species has been explained on page 14). **Species diversity of the communities is low – the *H′* index seldom exceeds 0.6.** It should be noted that emergent plants are rare (*F*<5%), while evergreens dominate among the submerged plants (89.1%), summer species with obligatory diapause being less frequent (53.5%). Vascular plants show a high frequency (67.9%), higher than mosses (43.0%) and stoneworts (42.7%). Plant biomass in the communities is varied, although not very high – the highest in the communities of stoneworts (*Chara tomentosa* and *C. globularis*), much lower in those formed by vascular plants and the lowest in moss patches (*Fontinalis–Drepanocladus* and *Sphagnum–Warnstorfia*). An analysis of importance index values of a species in the community (index *II;* method described on page 15) has shown that there is **always one species only within a given community which is its important component** (index *II* > 30%). It is marked by high values of dominance and constancy indices. It should be stressed that the communities include numerous species with a low importance index (Table 26 p. 94), some of them incidental.

Submerged vegetation is a combination of patches of one, two or three, and less frequently four or more species. This means that **a short sequence of assembling species** (most commonly two or three) **is typical of the studied communities**. Single-species aggregations are frequent, too (Fig. 56 p. 95). **This may suggest weak relations between species in aquatic communities.**

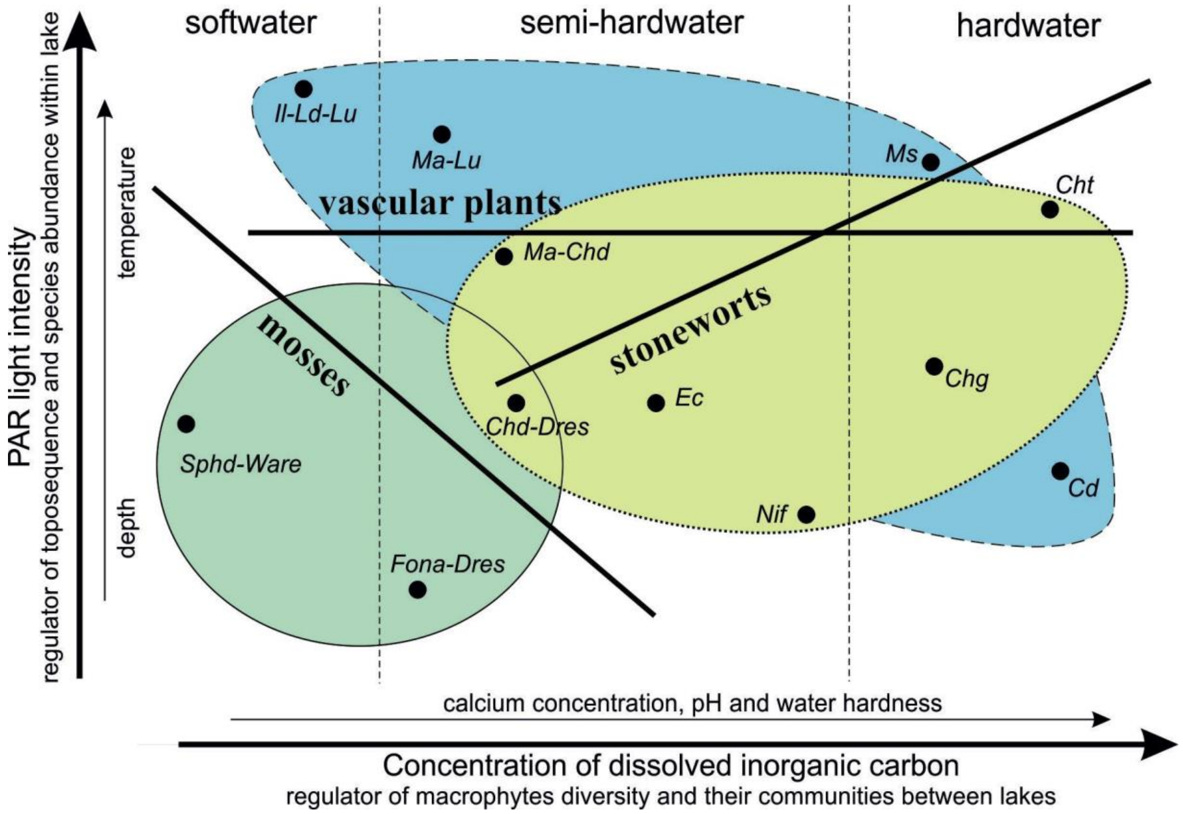
Submerged plant communities develop in specific environmental conditions, at a depth varying from 0.5 m to 11.5 m. The studies described here clearly demonstrate that **water depths and the water above the sediment have a greater impact** on the mix and the number of species, their frequency and biomass **than the substrate**. The structure of the vegetation anchored to the substrate chiefly depends on the properties of the water above it (Table 47, p. 122; Fig. 77, p. 136; discussion of the results p. 162).

The regulators of the structure of submerged vegetation are PAR, water acidity/alkalinity and the resulting calcium concentration as well as the concentration of the appropriate inorganic carbon in the water stratum. Only one of the twelve communities, formed by mosses (*Sphagnum denticulatum–Warnstorfia exannulata*), is more dependent on the properties of the sediment than of the water above (Fig. 77 p. 136). It should be noted that neither nitrogen nor phosphorus concentrations (in the water and the sediment), as a measure of trophic levels, are statistically relevant for plant assembly. They do, however, have an impact on the abiotic conditions of communities, notably of *Chara–Drepanocladus*, *Myriophyllum–Chara*, *Isoëtes–Lobelia–Littorella*, *Myriophyllum–Littorella* (Fig. 78, p. 139 and the model further down the text).



Empirical model of the correlation of the communities with the environmental factors in the lakes, ranked by the C&RT method (Classification and Regression Trees). and predictive validity of environmental factors in the model. Abbreviations, see Fig. 77 (p. 136), 79 (p. 141).

The studies presented here demonstrate that the **difference in photosynthetic irradiance of the whole range of vegetation patches** (Fig. 79, p.141) **may be a regulator of species replacement in communities**. **An important regulator is also the concentration of inorganic carbon available for photosynthesis** (Fig. 83, p. 153). A change in the carbon form (from free CO_2 to HCO_3^-) fosters species replacement, leading to the restructuring of communities, e.g. the dwindling moss number and biomass coupled with a rising occurrence of stoneworts and/or alkaline vascular plants (Fig. 84, p. 161 and the model further down the text).



Conceptual model for macrophyte communities in lakes.
Community: *Sphd-Ware* (*Sphagnum denticulatum–Warnstorfia exannulata*); *Il-Ld-Lu* (*Isoëtes lacustris–Lobelia dortmanna–Littorella uniflora*); *Ma-Lu* (*Myriophyllum alterniflorum–Littorella uniflora*); *Chd-Dres* (*Chara delicatula–Drepanocladus sordidus*); *Fona-Dres* (*Fontinalis antipyretica–Drepanocladus sordidus*); *Ma-Chd* (*Myriophyllum alterniflorum–Chara delicatula*); *Ec* (*Elodea canadensis*); *Cd* (*Ceratophyllum demersum*); *Ms* (*Myriophyllum spicatum*); *Nif* (*Nitella flexilis*); *Chg* (*Chara globularis*); *Cht* (*Chara tomentosa*), by Banaś (2016).

Photosynthetic irradiance is crucial for the occurrence or non-occurrence of certain plant species in lakes, particularly the shallow ones (e.g., *Eleocharis acicularis*, *Ranunculus reptans*, *Juncus bulbosus*, *Littorella uniflora*), and usually in deep lakes (e.g., *Nitella flexilis*, *Drepanocladus sordidus*, *Fontinalis antipyretica*), **regarded as stenotopic in terms of light requirement**. For plants with a broader range of light requirement (in this sense eurytopic), which include most macrophytes, it is minimum photosynthetic irradiance that matters in the first place. According to the tests performed, it should be close to 5% PAR (p. 121). This is decisively shown by humic lake vegetation, almost entirely formed of sciophytic (stenotopic in terms of light) mosses, like *Warnstorfia exannulata*, *Sphagnum denticulatum* and *S. cuspidatum*. The structure-forming role of eurytopic macrophytes, including most vascular plants is small in humic lakes, limited to the role of highly incidental components. It should be added that **water oxygenation** – a factor of major importance from the biological point of view – **is insignificant as a regulator of vegetation structure** (Fig. 79, p. 141).

The properties of aquatic environment, like pH, calcium concentration, conductivity and the depth at which the community is located, are an element of the 'environmental background', which may (or may not) foster species assembly and the development of communities. The conditions of the 'background' seem to be greatly responsible for the number of species forming the community, yet it should be observed that the diversity of the communities measured by the *H'* index and the abundance of its components (biomass) show little dependence on the properties of the 'environmental background.

Apart from the physical and chemical properties of the habitat, biotic factors are most likely to be important; mainly the dynamic of the population of the species involved in community assembly and the duration of their residence in the lake. My plans for the nearest future are to extend my studies to cover the role (function) of the biotic factor in the development of plant structures, including competition between species and within populations as well as the duration of residence of particular species in lakes and communities.

5. Other scientific achievement

My research has until now concentrated mainly on the like:

A/ Humic substance impact on the habitat of submerged plants;

B/ Environmental conditions and spatial organisation of plants in meso- and eutrophic lakes;

C/ Life histories of aquatic plants;

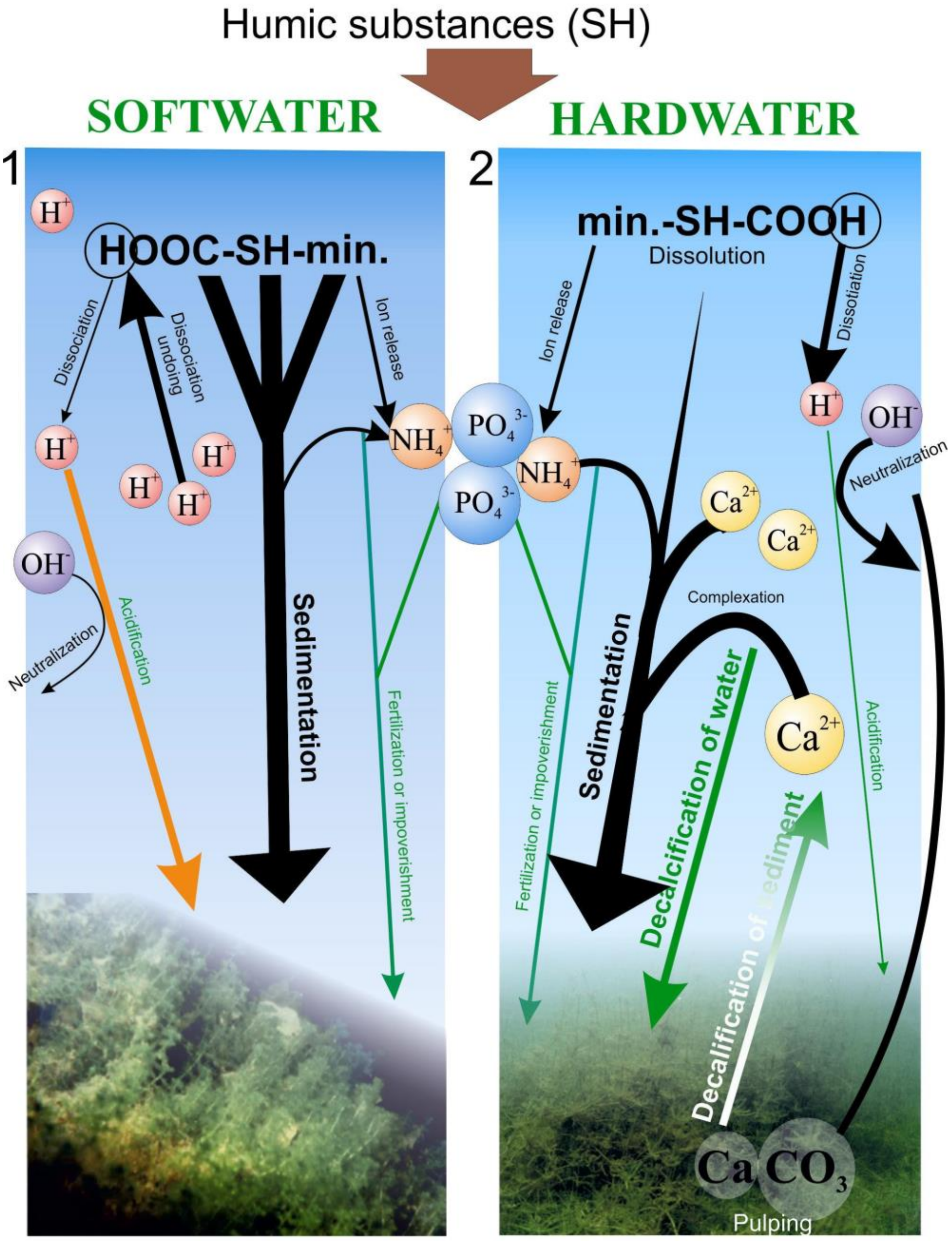
D/ Environmental impact on the structure of vegetation in peatland lakes;

E/ Phenotypic plasticity in clonal aquatic plants;

F/ The nature of community assembly of aquatic plant species and functional diversity of lake vegetation.

Re A. *Humic substance (SH) impact on the habitat of submerged plants* was the topic of my first scientific research which took several years and pertained to the assessment of natural impact of lake humification, on the basis of the data collected from 35 Pomeranian lakes, and the sources of their SH feeding. The analyses were based on vast factual evidence (2,172 plant samples, 262 water samples from above the substrate and 524 sediment samples). One of the effects of the research was the model of plant habitat transformation, as presented below, for: (*1*) softwater lakes (JM), where water is subject to strong colouring and fertilization, while the acreage of deepwater plants population is shifted towards shallow littoral; and also (*2*) hardwater lakes (JT) where vegetation habitats are subject to decalcification, fertilization, acidification, overshadowing, cooling, and also shifting towards shallow littoral. It was established that the transformation of stonewort habitat is consistent with the JT model, moss habitat – with the JM model, while vascular plant habitat may be transformed according to both models.

One of the tasks I performed within another grant (including my individual one) was the determination of the environmental impact on deposit sedimentation rate and on the stability of vegetation habitats in humic lakes. The author defines the impact of each of these properties on the direction of vegetation and environment transformation within JM and JT. The main factor limiting the occurrence and development of vegetation in such lakes is the deficiency of light in the water. This fact should be used in lake protection, revival and sustainable utilisation plans.



The model of the transformation of submerged plant habitats under the influence of humic substances (SH) in softwater (1) and hardwater (2) lakes.

It should be noted that during the research on deposit sedimentation rate, the impact of pH, temperature and UV radiation on the process and on the stability of the sediments at different lake depths was determined. It has been established that the pace at which SH is removed from the water is most effective in highly acidic, cool and well irradiated environment. Moreover, the organic silts created under these conditions are the most stable. In relatively warm, alkaline waters part of SH is dissolved, thus making the habitats of alkaline plants (mainly stoneworts) unfavourable. One of the research results was the finding of criteria to distinguish between anthropogenic and natural humification results.

Sub-topics and sources to fund them: (*1*) *Impact of humic substances on lake macroflora habitats* (6P04G 027 15), **individual grant**, 1998-2001; (*2*) *Transformation of the structure and spatial organisation of submerged plant populations in the process of anthropogenic humification of lakes* (6 PO4G 099 18), **head researcher**, 2000-2002; (*3*) *Impact of the environment on deposit sedimentation rate and on the stability of submerged vegetation habitats in humic lakes* (3 P04 G 062 24), **individual grant**, 2003-2006; (*4*) *Diversity and activation potential of banks of submerged plant diasporas in humic lakes* (3 PO4 G 081 22), **researcher**, 2002-2005.

On the basis of the research concerning the impact of SH on submerged plant habitats, I have been the author or a co-author of:

1. Banaś K. 2002. Impact of humic substances on *Sphagnum denticulatum* habitats. Acta Societatis Botanicorum Poloniae 71: 63–69.
2. Banaś K. 2004. Tendencies in changes of physicochemical properties of water in Pomeranian humic lakes (Tendencje zmian cech fizyko-chemicznych wody w jeziorach humusowych Pomorza), pp. 7-17. [In:] A. T. Jankowski M. Rzętała M. (eds.) Jeziora i sztuczne zbiorniki wodne – funkcjonowanie, rewitalizacja i ochrona. Wyd. UŚ, Katowice, 234 pp.
3. Banaś K., Gos K. 2004. Effect of peat-bog reclamation on the physico-chemical characteristics of the ground water in peat. Polish Journal of Ecology 52: 69-74.
4. Merdalski M., Banaś K. 2005. The effect of allochthonous organic carbon on the hydrochemistry of hardwater lakes. p 149-159 [In:] A. T. Jankowski and M. Rzętała, Lakes and artificial water reservoirs - natural processes and socio-economic importance. Wyd. UŚ, Katowice, 284 pp.
5. Banaś K. 2005. The effect of dissolved organic carbon on pelagial and near-sediment water traits in lakes. Acta Societatis Botanicorum Poloniae 74: 133-139.

Re B. *Environmental conditions and spatial organisation of plants in meso- and eutrophic lakes* – the research within a KBN grant (KBN - State Committee for Scientific Research) and two grants from BW/UG (Research Project of Gdańsk University). The research identified spatial organisation of vegetation, threats to species diversity and methods of vegetation protection, as well as directions of vegetation transformation caused by autogenic and allogenic factors in both categories of lakes in Pomerania. Habitat preferences for selected species of *Charophyta* were also determined, e.g. *Chara delicatula* and *Nitella flexilis* occur in the lakes with low calcium concentration in water, while the other 16 species occur under higher calcium concentration. In the shallow littoral of the lakes with relatively high calcium concentration, we can observe the growth of *Chara aspera* in the first place, then at greater depths, *C. tomentosa*, *C. rudis*, *C. hispida* or *C. contraria*.

Sub-topics and sources of their funding: (*1*) *Distribution, resources and the protection of endangered and threatened with extinction species of plants, lichens and macroscopic fungi in Gdańsk Pomerania* (6 PO4G 099 18), **researcher** in the project coordinated by the UG Department of Plant Taxonomy and Wildlife Conservation, 1999-2002; (*2*) *Environmental conditions and spatial organisation of Charophyte population in meso- and eutrophic lakes* (BW/UG 1490-5-0085-7), **individual grant**, 2007; *(3) Environmental conditions and spatial organisation of sphagnum populations in lobelia lakes* (BW/UG 1490-5-0366-8), **individual grant**, 2008.

Selected publications of which I have been a co-author:

1. Bociąg. K., Gos K., Banaś K., 2007. Floristic diversification of the lakes in the Kashubian Landscape Park (Zróżnicowanie florystyczne jezior Kaszubskiego Parku Krajobrazowego), Chapter 14, pp. 241-250, [In:] D. Borowiak (ed.), Jeziora Kaszubskiego Parku Krajobrazowego, Ser. Bad. Limnol. 5, Wyd. KLUG, Gdańsk.
2. Banaś K., Bociąg K. 2006. Submerged vegetation and habitat properties in Lake Piecki (Roślinność podwodna i cechy środowiska w jeziorze Piecki). p. 101-117, [W:] J. Banaszak, K., Tobolski (red.) Park Narodowy „Bory Tucholskie” u progu nowej dekady, Wyd. UKW, Bydgoszcz.
3. Bociąg K., Rekowska E., Banaś K. 2011. The disappearance of stonewort populations in lobelia lakes of the Kashubian Lakeland (NW Poland). Oceanol. and Hydrobiol. Studies 40: 30-36.

Re C. *Life histories of aquatic plants* – one of the topics studied in 2004-2007 (with Prof. Bernard Clement, Laboratory of "Ecobio" University of Rennes, France) by researchers and PhD students of the UG Department of Plant Ecology, my participation consisted in environmental samples collection and labelling as well as assistance in the interpretation of the results of a research in which populations of eleven species where studied for selected aspects of life histories, as understood by Stearns (1992). I consider this project and my involvement in it significant as I was a consultant on environmental conditions in lakes, particularly in areas of plant communities like *Chara delicatula* Ag. (=*Ch. fragilis* Desv. *subsp. delicatula* A. Br.), *Chara fragilis* Desv., *Hydrocharis morsus-ranae* L., *Juncus bulbosus* L., *Luronium natans* (L.) Raf., *Nymphoides peltata* (S.G. Gmel.), *Potamogeton natans* L., P. *pectinatus* L., *P. perfoliatus* L., *Spirodela polyrhiza* (L.) Schleid. and *Salvinia natans* (L) All.

In the project *Life histories of aquatic plants. Analysis, synthesis and application in species and ecosystems protection* (2 PO4 G 001 27), I was a **researcher** dealing with sub-tasks concerning the assessment of environmental conditions in plant communities (in 2004-2007).

Selected publications of which I have been a co-author:

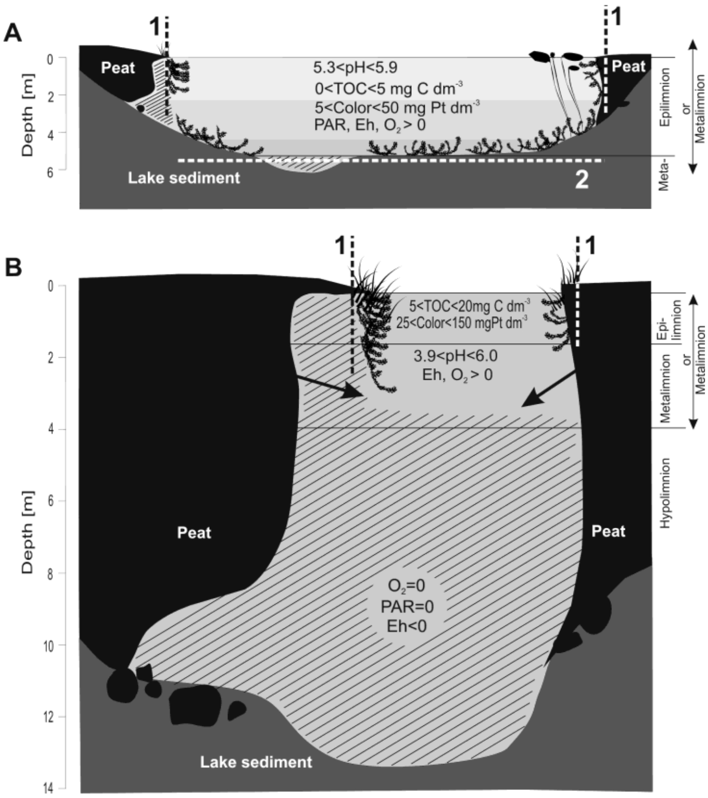
1. Bociąg K., Banaś K., Gos K., Merdalski M. 2007. Habitat conditions and underwater vegetation in Wielki and Mały Staw in the Giant Mountains. Opera Corcontica 44: 271-280.
2. Banaś K., Durmaj E. 2006(2007). Stability of humic substance deposit in hardwater humic lakes (Trwałość depozytu substancji humusowych w twardo- wodnych jeziorach humusowych). Acta Bot. Cassub. 6: 61-70.
3. Banaś K. 2006 (2007). Transformation of isoetid habitats under the influence of humic substances (Transformacja siedlisk isoetidów pod wpływem substancji humusowych). Acta Bot. Cassub. 6: 93-106.
4. Chobot M., Banaś K. 2008. Seasonal changes of environmental conditions in the phytolittoral zone of Lake Ostrowite in the Bory Tucholskie National Park. Limnol. Rev. 8: 87-96.

Re D. *Environmental impact on the structure of vegetation in peatland lakes*. The research covered 42 lakes where 1,680 plant samples, 126 water samples and an equal number of sediment samples were collected. The research resulted in the assessment of vegetation in such lakes in relation to morphometric features of their basins. One of the effects of the research was two conceptual models of vegetation: (*A*) in shallow, relatively big peatland lakes, with water slightly coloured by SH, vegetation is dominated by *Sphagnum denticulatum*, with the occurrence of *Nymphaeaceae;* and (*B*) in deep, usually small lakes, where water is strongly coloured by SH and the bottom slopes vertically, vegetation forms a curtain freely hanging from the edge of peat moss floating mat, or occur in the form of small and scattered clusters on steeply declining walls of peat deposit.

Grant's topic: *Origins and environment-forming role of small peat-lake systems in the moraine and sandur areas of Pomerania* (2 PO4 G 066 27), **researcher**, in cooperation with Poznań UAM (2004-2007).

Selected publications of which I have been a co-author:

1. Banaś K., Gos K. 2008. Features and diversity of pomeranian peatland lakes. p. 13-17, [In:] E. Bajkiewicz-Grabowska, D. Borowiak (eds), Anthropogenic and natural transformations of lakes. Vol. 2., Wyd. KLUG-PTLim, Gdańsk.
2. Banaś K. 2010. Morphology of peatland lakes. Limnol. Rev. 10: 3-14.
3. Banaś K., Gos K., Szmeja J. 2012. Factors controlling vegetation structure in peatland lakes. Aquatic Botany 96: 42-47.



Graphic models of plants zonation in shallow and relatively large (**A**), deep and usually small (**B**) peatland lakes.
Explanations: steeply inclined (1) and horizontal (2) substrate, TOC - total organic carbon; Eh – redox potential; O_2 – concentrations of oxygen; PAR – relative irradiance, HA – humic acids; /// - lake zone without macrophytes; by Banaś et al. (2012; Aquatic Botany 96: 42-47).

Re E. *Phenotypic plasticity in clonal aquatic plants –* in populations, guilds, single- and multi-species assemblages (communities) of clonal aquatic plants, trends were established for changes in the architecture of equal-age specimens, diapause incidents, biomass allocation to reproductive, assimilation and anchoring organs. The research was conducted in 68 lakes and 17 watercourses in Pomerania and Żuławy Wiślane. The research determined the impact of environmental factors, including pH, photosynthetic irradiance, calcium concentration, biogenic and humic substances in water and lake sediment, and also the impact of waterflow rate in watercourses on characteristic features of specimens, populations and communities, particularly on phenotypic plasticity, phenology and development, architecture and form of growth, the birth rate, mortality and the dynamics of abundances, as well as hydrodynamic disturbances and pressure from competitors.

Grant topics: (*1*) *Phenotypic plasticity of clonal aquatic plants. Regulators and standards of reaction, changeability in populations and guilds, application in lake biodiversity protection* (N N304 4116 38), **head researcher**, 2010-2013; (*2*) *Plasticity reactions of Charophytes to hydrodynamic disturbances and light deficiency in the littoral of lakes* (N N304 4113 33), **head researcher**, 2007-2010.

Selected publications of which I have been a co-author:

1. Bociąg K., Rekowska E., Banaś K. 2011. The disappearance of stonewort populations in lobelia lakes of the Kashubian Lakeland (NW Poland). Oceanol. and Hydrobiol. Studies 40: 30-36.
2. Banaś K., Gos K., Szmeja J. 2012. Factors controlling vegetation structure in peatland lakes. Aquatic Botany 96: 42-47.
3. Bociąg K., Robionek A., Rekowska E., Banaś K. 2013. Effect of hydrodynamic disturbances on the biomass and architecture of the freshwater macroalga *Chara globularis* Thuill. Acta Bot. Gallica 160(2): 149-156.
4. Banaś K. 2013. The hydrochemistry of peatland lakes as a result of the morphological characteristics of their basins. Oceanological and Hydrobiological Studies 42: 28-39.
5. Chmara R., Szmeja J., Banaś K. 2014. Factors controlling the frequency and biomass of submerged vegetation in outwash lakes supplied with surface water or groundwater. Boreal Env. Res. 19: 168-180.
6. Chmara R., Banaś K., Szmeja J. 2015. Changes in the structural and functional diversity of macrophyte communities along an acidity gradient in softwater lakes. Flora 216: 57-64.

Re F. *The nature of community assembly of aquatic plant species and functional diversity of lake vegetation* – these are two currently carried out team research projects with me as head researcher. So far, we have identified part of the sequences of species assemblage, the length of such sequences, their occurrence and environmental conditions in which they develop. One of the results of the research are the pattern of coexistence of species and their abundance in lakes in NW Poland. A model of submerged vegetation, based on the assumed module (zonal) structure of communities has also been formulated. The model explains limited exchange of species inside lakes and between them, it also constitutes a starting point for research on functional diversity of submerged plants within lakes. The research has proved that environmental gradients influence the structural diversification of communities, the changes in composition of the features of life histories of species in communities, and may also influence the functional diversity of plants. By combining structural and functional approaches, the diversity of submerged plants, not only in lakes, can be described more thoroughly and fully.

One of my responsibilities since I joined the UG Plant Ecology Department has been cooperation in collecting material for the computer database *AquaPlant – Roślinność Jezior Pomorza (Pomeranian Lakes Vegetation).* The database, which is annually upgraded, has been conceived and organised by Professor Józef Szmeja, Head of the Department, my teacher and research supervisor, who started it in 1996. The first publication based on the database appeared in 2013 (Chmara R., Szmeja J., Ulrich W. 2013. Patterns of abundance and co-occurrence in submerged plants communities. Ecological Research 28: 387-395), i.e., seventeen years after its creation. In December 2017, the database contained 1,311,672 records (entries) containing measurements of architectural features of 116 species of submerged plants (almost all the species in Poland), as well as records of 10 features of the sediment and 16 features of water depths and water above the substrate, including photosynthetic irradiance PAR in depth zones of 1.0 m intervals (in total, ca 7,000,000 fields in the database network). The core of the database consists of 46,118 vegetation samples (0.1 m^2 each), fully related to the features of sediment, near-sediment water in vegetation patches and the depths of 275 lakes.

Sub-topics with my participation and the sources to fund them: (*1*) *Regulators of pair formation of assemblage species of submerged plants* (BW/UG/L 145-5-0403-0), **individual grant** (2010); (*2*) *Biology and ecology of aquatic and wetland vegetation* (530-L145-D024-12-17), **researcher** (2012-2017).

Publications of which I have been a co-author, including those with the use of the *AquaPlant* database, and manuscripts with my co-authorship, submitted to scientific journals

1. Robionek A., Banaś K., Chmara R., Szmeja J. 2015. The avoidance strategy of environmental constraints by an aquatic plant *Potamogeton alpinus* in running waters. Ecology and Evolution 5(16): 3327-3337.
2. Chmara R., Szmeja J., Banaś K. 2017. The relationships between structural and functional diversity within and among. Journal of Limnology, online first, s. 1-19, doi: 10.4081/jlimnol.2017.1630
3. Szmeja J., Banaś K., Chmara R., Ronowski R., The light inside lakes as an environmental factor for macrophytes (manuskrypt złożony w Journal of Limnology).
4. Banaś K., Chmara R., Szmeja J., Rank of core and satellite species in the assembly of macrophyte communities (manuskrypt złożony w Plant Biosystems).
5. Banaś K., Chmara R., Ronowski R., Szmeja J., Annual photosynthetic irradiance as a regulator of vegetation inside lakes (manuskrypt złożony w Environmental Monitoring and Assessment).

Upcoming research plans

The mechanism of the development of repetitive species combinations (communities) in time and space is not yet fully known. One of my most immediate research projects will be to perfect the method of assessing the role of biotic factor in this process. It seems reasonable to make a more comprehensive analysis of the pace of species exchange within lakes and between them as well as the time of residence of individual components of communities. It is also important to implement some of the results in order to strengthen the scientific foundations of lake protection and the methods of forecasting vegetation development trends in lakes, particularly in the context of current climate changes and increasing human pressure exerted on lakes.

Bibliography

Banaś K. 2002. Impact of humic substances on *Sphagnum denticulatum* habitats. Acta Societatis Botanicorum Poloniae 71: 63-69.

Banaś K. 2004. Tendencies in changes of physicochemical properties of water in Pomeranian humic lakes (Tendencje zmian cech fizyko-chemicznych wody w jeziorach humusowych Pomorza), pp. 7-17. [In:] A. T. Jankowski M. Rzętała M. (eds.) Jeziora i sztuczne zbiorniki wodne – funkcjonowanie, rewitalizacja i ochrona. Wyd. UŚ, Katowice, 234 pp.

Banaś K. 2005. The effect of dissolved organic carbon on pelagial and near-sediment water traits in lakes. Acta Societatis Botanicorum Poloniae 74: 133-139.

Banaś K. 2006 (2007). Transformation of isoetid habitats under the influence of humic substances (Transformacja siedlisk isoetidów pod wpływem substancji humusowych). Acta Bot. Cassub. 6: 93-106.

Banaś K. 2010. Morphology of peatland lakes. Limnol. Rev. 10: 3-14.

Banaś K. 2013. The hydrochemistry of peatland lakes as a result of the morphological characteristics of their basins. Oceanological and Hydrobiological Studies 42: 28-39.

Banaś K. 2016. The principal regulators of vegetation structure in lakes of north-west Poland. A new approach to the assembly of macrophyte communities. Wyd. Uniwersytetu Gdańskiego, Gdańsk, 237 pp.

Banaś K., Bociąg K. 2006. Submerged vegetation and habitat properties in Lake Piecki (Roślinność podwodna i cechy środowiska w jeziorze Piecki). p. 101-117, [W:] J. Banaszak, K., Tobolski (red.) Park Narodowy „Bory Tucholskie" u progu nowej dekady, Wyd. UKW, Bydgoszcz.

Banaś K., Durmaj E. 2006(2007). Stability of humic substance deposit in hardwater humic lakes (Trwałość depozytu substancji humusowych w twardo- wodnych jeziorach humusowych). Acta Bot. Cassub. 6: 61-70.

Banaś K., Gos K. 2004. Effect of peat-bog reclamation on the physico-chemical characteristics of the ground water in peat. Polish Journal of Ecology 52: 69-74.

Banaś K., Gos K. 2008. Features and diversity of pomeranian peatland lakes. p. 13-17, [In:] E. Bajkiewicz-Grabowska, D. Borowiak (eds), Anthropogenic and natural transformations of lakes. Vol. 2., Wyd. KLUG-PTLim, Gdańsk.

Banaś K., Gos K., Szmeja J. 2012. Factors controlling vegetation structure in peatland lakes. Aquatic Botany 96: 42-47.

Banaś K., Chmara R., Szmeja J., Rank of core and satellite species in the assembly of macrophyte communities (manuskrypt złożony w Plant Biosystems).

Banaś K., Chmara R., Ronowski R., Szmeja J., Annual photosynthetic irradiance as a regulator of vegetation inside lakes (manuskrypt złożony w Environmental Monitoring and Assessment).

Beck, A. J., Cochran, J. K., & Sañudo-Wilhelmy, S.A. 2010. The distribution and speciation of dissolved trace metals in a shallow subterranean estuary. Marine Chemistry, 121(1-4): 145-156.

Bociąg K., Banaś K., Gos K., Merdalski M. 2007. Habitat conditions and underwater vegetation in Wielki and Mały Staw in the Giant Mountains. Opera Corcontica 44: 271-280.

Bociąg. K., Gos K., Banaś K., 2007. Floristic diversification of the lakes in the Kashubian Landscape Park (Zróżnicowanie florystyczne jezior Kaszubskiego Parku Krajobrazowego), Chapter 14, pp. 241-250, [In:] D. Borowiak (ed.), Jeziora Kaszubskiego Parku Krajobrazowego, Ser. Bad. Limnol. 5, Wyd. KLUG, Gdańsk.

Bociąg K., Rekowska E., Banaś K. 2011. The disappearance of stonewort populations in lobelia lakes of the Kashubian Lakeland (NW Poland). Oceanol. and Hydrobiol. Studies 40: 30-36.

Bociąg K., Robionek A., Rekowska E., Banaś K. 2013. Effect of hydrodynamic disturbances on the biomass and architecture of the freshwater macroalga *Chara globularis* Thuill. Acta Bot. Gallica 160(2): 149-156.

Bray J.R., Curtis J.T. 1957. An ordination of the upland forest communities of Southern Wisconsin. Ecological Monographs 27: 325-349.

Capers R.S. 2003. Macrophyte colonization in a freshwater tidal wetland (Lyme, CT, USA). Aquatic Botany 77: 325-338.

Chambers P.A., Kalff J. 1985. Depth distribution and biomass of submerged aquatic macrophyte communities in relation to Secchi depth. Canadian Journal of Fisheries and Aquatic Sciences 42: 701-709.

Chmara R., Banaś K., Szmeja J. 2015. Changes in the structural and functional diversity of macrophyte communities along an acidity gradient in softwater lakes. Flora 216: 57-64.

Chmara R., Szmeja J., Banaś K. 2014. Factors controlling the frequency and biomass of submerged vegetation in outwash lakes supplied with surface water or groundwater. Boreal Env. Res. 19: 168-180.

Chmara R., Szmeja J., Banaś K. 2017. The relationships between structural and functional diversity within and among. Journal of Limnology, online first, s. 1-19, doi: 10.4081/jlimnol.2017.1630

Chmara R., Szmeja J., Ulrich W. 2013. Patterns of abundance and co-occurrence in submerged plants communities. Ecological Research 28: 387-395

Chobot M., Banaś K. 2008. Seasonal changes of environmental conditions in the phytolittoral zone of Lake Ostrowite in the Bory Tucholskie National Park, Limnol. Rev. 8: 87-96.

Feldmann T. 2012. The structuring role of lake conditions for aquatic macrophytes. Ph.D. thesis, Tartu: Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences.

Grime J.P. 1998. Benefits of plant diversity to ecosystems: immediate, filter and founder effects. Journal of Ecology 86: 902-910.

Kraft N.J.B., Adler P.B., Godoy O., James E.C., Fuller S., Levine J.M. 2014. Community assembly, coexistence and the environmental filtering metaphor. Functional Ecology 29: 592-599.

Lodge D.M., 1991. Herbivory on freshwater macrophytes. Aquatic Botany 41: 195-224.

Lodge D.M., Cronin G., van Donk E., Froelich A.J. 1998. Impact of herbivory on plant standing crop: comparisons among biomes, between vascular and nonvascular plants, and among freshwater herbivore taxa. p. 149-174. [In:] Jeppesen E., Søndergaard M., Søndergaard M., Christoffersen K. (eds). The Structuring Role of Submersed Macrophytes in Lakes. New York: Springer.

Madsen J.D. 1993. Biomass techniques for monitoring and assessing control of aquatic vegetation. Lake and Reservoir Management 7: 141-154.

Madsen J.D., Chambers P.A., James W.F., Koch E.W., Westlake D.F. 2001. The interaction between water movement, sediment dynamics and submersed macrophytes. Hydrobiologia 444: 71-84.

Merdalski M., Banaś K. 2005. The effect of allochthonous organic carbon on the hydrochemistry of hardwater lakes. Silesia University, Faculty of Earth Sciences, Polish Limnological Society, Polish Geographical Society - Branch Katowice, Sosnowiec, p. 149-159.

Mitchell S.F., Perrow M.R. 1998. Interactions between grazing birds and macrophytes. p. 175-195. [In:] Jeppesen E., Søndergaard M., Søndergaard M., Christoffersen K. (eds). The Structuring Role of Submerged Macrophytes in Lakes. New York: Springer-Verlag.

Pall, K., & Moser, V. 2009. Austrian index macrophytes (AIM-Module1) for lakes: A Water Framework Directive compliant assessment system for lakes using aquatic macrophytes. Hydrobiologia, 633(1), 83-104.

Robionek A., Banaś K., Chmara R., Szmeja J. 2015. The avoidance strategy of environmental constraints by an aquatic plant *Potamogeton alpinus* in running waters. Ecology and Evolution 5(16): 3327-3337.

Stearns S.C. 1992. The evolution of life histories. Oxford Univ. Press, Oxford.

Szmeja J. 1994. An individual's status in populations of isoetid species. Aquatic Botany 48: 203-224.

Szmeja J. 2006. A guide to the study of aquatic plants. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego (in Polish).

Szmeja J., Banaś K., Chmara R., Ronowski R., The light inside lakes as an environmental factor for macrophytes. Journal of Limnology (in press).