Expansion and retreat of aquatic macrophyte communities in south Bohemian fishponds during 35 years (1941–1976)

S. Hejný
Botanical Institute, Czechoslovak Academy of Sciences, 252 43 Průhonice, Czechoslovakia

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Abstract

The aquatic macrophyte communities of southern Bohemian fishponds were analyzed during 35 years (1941–1976). From 61 vegetational units 26 communities may be characterized as being well adapted to modern fishpond management, 4 units are on their way to extinction and 18 units are in regression. Our long-term observations evaluated the following types of destruction: destruction of the community, in which one dominant species retreats and another regenerates (*Potameto natantis–Nymphaeetum candidae* → *Potamogeton natans* comm.); destruction of the community, in which only one stratum regenerates (synusia) (*Glycerietum aquaticae utricularietosum australis* → *Utricularia australis* comm.). The development of the pleustophytic communities followed two pathways: transformation of more complicated forms into simpler ones (*Utricularietum australis* → *Lemno–Spirodeletum*); development of complicated forms from simpler ones (*Lemnetum minoris* → *Lemno–Spirodeletum*).

Introduction

After 35 years, the results of studies on macrophyte communities made in south Bohemia show rather great changes in the distribution of the communities. The components of the synantropization process were the following: (a) removal of the whole littoral zone by bulldozing and scraping; (b) intensive duck-farming; (c) intensive application of fertilizers in ponds. 120 ponds forming 11 groups appear as a sufficiently representative set to describe the evaluation with respect to both the number of objects and their mutual geographical proximity. In total, 61 vegetational units were analyzed; 30 units (21 associations and 9 communities) colonized the inner aquatic parts of the ponds and 31 units (23 associations and 8 communities) colonized their littoral parts. After 35 years 2 associations and one community were in extinction (*Sparganietum minimi, Hottonietum palustris, Nymphoides peltata* comm.); 6 associations and 3 communities were in retreat (*Lemnetum minoris, Lemno–Utricularietum bremii, Hydrocharietum morsus-ranae, Potameto natantis–Nymphaetum candidae, Potametum lucentis, Potametum crispi, Batrachietum aquatile, Potamogeton natans* comm., *Trapa natans* comm.) in the group of water plant units (30), but 16 units (11 ass., 5 comm.) have been found developing (*Riccietum fluitantis, Lemno–Spirodeletum, Lemnetum gibbae, Lemnetum trisulcae, Utricularietum australis, Myriophyllo–Potametum, Elodeetum canadensis, Potamoeto–Zannichellietum, Batrachio trichophylli–Callitrichetum, Polygonum amphibium* comm., *Ceratophyllum demersum* comm., *Zannichellia palustris* comm., *Potamogeton acutifolius, Potamogeton obtusifolius* comm., *Batrachium circinnatum* comm.). The situation was very similar as regards the dynamics of vegetation units in the littoral belts (1 ass. in extinction, 9 in regression, 17 units in progression). In both biotopes, the 26 comm. in progress may be characterized as being well adapted to modern fishpond management.

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The empirical data collected in the past have been summarized in a number of tables covering two periods of intensive observation, i.e. 1941 to 1949, and 1961 to 1976. A synoptic table accompanied by detailed explanations was presented at the first symposium of European hydrobotanists at Illmitz in 1981.

I should like to point out two basic ideas derived from our long-term observations.

1. Evaluation of successive structural changes in vegetation units

In relatively species-poor aquatic communities, the structural change of the units, exposed to powerful anthropogenic factors, develops through the changes of individual structural elements, such as the decline or extinction of the dominant species followed by the decline of the whole stratum and/or synusia. Thus the entire associations do not alter, only after a total destruction they may disappear. In spite the fact that our observations extended over less than half a century, the successive series of vegetation relevés showed that two different types of destruction can take place:

a. Destruction of the community of which only one synusia can but may not regenerate. For example, in the association *Glycerietum aquaticae utricularietosum australis* the destruction by bottom scraping is usually followed by regeneration of a synusia of pleustophytes, which can later develop into the *Utricularietum australis.*

b. Destruction of a community of which one dominant species retreats and another regenerates, which results in the development of a new association. The declining *Potameto natantis–Nymphaeetum candidae* association can serve as an example. *Nymphaea candida* disappears, and over a certain period *Potamogeton natans* (*Potametalia*) persists as a basal cenose.

2. Evaluation of transformation of vegetation units

In this case, the changes are caused by anthropogenic factors, and they are manifest in the alteration of a relatively simple community into a new association that is structurally organized at the same or a slightly higher or lower level. Transformation develops by 'transposition' or exchange of some species. We can illustrate this type of change on the structurally simple communities of the *Lemnion minoris, Utricularion vulgaris*, and *Hydrocharition morsus-ranae* alliances.

The development of the pleustophyte communities followed two pathways during the second period of our observations between 1961 and 1976.

a. Transformation of more complicated forms into simpler ones, e.g.,

Hydrocharietum morsus-ranae / *Lemno–Spirodeletum*
from (*Hydrocharietum morsus-ranae* or *Utricularietum australis*) into *Lemnetum trisulcae*
Utricularietum australis / *Riccietum fluitantis*

b. Development of complicated forms from simpler ones, e.g.

from *Lemnetum minoris* — into *Lemno–Spirodeletum* / *Lemnetum gibbae*

These cases have been taken from a hydrosere which can provide many other examples of this kind. These examples illustrate the necessity of careful observations of changes in vegetation units, and, also, the necessity of an adequate theoretical explanation of these changes. At this point, I should like to mention the concepts of 'decumbency' and 'incumbency' used by Soviet geobotanists.

Our long-term observations allow us to evaluate the decline and expansion of communities, a prominent chorological phenomenon. Generally, the decline of a plant association proceeds through two stages:

a. A stage, lasting about 10 to 20 yr, in which the surviving stands or communities are clustered, and, if illustrated on a phytocartogram, resemble a disjunctive area of distribution of a plant species.

b. A stage, lasting about 30 yr, manifested in a very scattered occurrence of the surviving stands or communities which resembles, if illustrated in a phytocartogram, a diffusive area of distribution.

Ultimately, the plant association may become extinct within the territory under study.

In spite of the fact that our detailed observations cover a comparatively small territory, we have verified a similar process of decline or expansion of a plant association over a larger region, such as the whole of southern Bohemia.

The decline of an association can be illustrated by the example of the *Potameto natantis–Nymphaeetum candidae*. In this case, the vanishing plant association is strongly affected by the gradual loss of adaptability of the dominant species to the environmental changes. High amounts of fertilizers and the winter drainage of the fishponds cause a rapid disappearance of *Nymphaea candida* and *Potamogeton acutifolius*, while *Potamogeton natans* declines in a much slower way.

The expansion of communities shows the following three stages:

a. The constituent species gradually attain a higher adaptability to the altered environment.

b. A species or several species invade the declining association, and gradually establish themselves as new dominant or co-dominant species.

c. A species or several species attain a high vitality following their improved adaptation, and the remains of the declining association are successively pushed back.

Progressive development can be demonstrated for three types of communities:

(A) The *Utricularietum australis*, arising through a kind of 'liberation' of the pleustophytes (*Utricularia australis* after the destruction of communities of the alliance *Phragmition*. The number of its stands increased from 17 to 28.

(B) *Potameto–Zanichellietum*, arising by a successive increase in adaptability of the populations of *Potamogeton pectinatus* and *Zanichellia palustris* following the application of nitrogen, phosphorus and potassium fertilizers to fishponds. This association spreads widely, replacing all declining vegetation types such as *Potameto natantis –Nymphaeetum candidae* or *Potametum lucentis*. Starting from 24 occurrences, the number of stands recorded in the period under study reached a total of 60. The occurrence of this association cannot be considered as a temporary phenomenon. The stabilization is affected by a richer species composition and higher net production.

(C) *Elodeetum canadensis* is a newly establishing association which continuously encounters favourable conditions for its further spreading in ponds. This association has four specialized developmental stages; namely, the initial, the invasion, the explosive and the degradation stages. It can pass through all four stages within less than 15 to 20 years.

A sudden fall in the water level gives the impulse to the transition from the initial stage to the invasion and explosive stages. The *Elodeetum* retreats and may be suppressed in years following combined summer and winter drainage. As a neophytic type, it shows a periodic development in the ponds where it is clearly a reversible type of plant community. Extinction of the association has been observed in 19.8% (probably only transient disappearance), stabilization in 27.3%, and progressive increase in 54.6% of the instances of its occurrence.

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