RESEARCHES CONCERNING THE DISTRIBUTION OF HYDROPHYTES AND HELOHIDATOPHYTES IN AQUATIC ANTHROPOGENE ECOSYSTEMS IN WHICH THERE ARE STOCKED *CTENOPHARINGODON IDELLA*

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Abstract

The aim of this paper consists in identification and determination of some plant groups, from hydrophytes and helohidatophytes groups, which are part of the aquatic anthropogene ecosystems, as a potential source of food for Ctenopharingodon idella (Valenciennes 1844). For a period of 4 consequent years the distribution of taxa has been studied in the Lower Prut Flood Plain, regarding the description of the dominance of plants which cover the water surface and its depth too. The botanical samples harvested from the designated field have been determined on the basis of information from specialty literature and personal researches, using the standards from Flora Europaea. The results have been expressed as average ± standard deviation. (SD). The statistical work of the dates were processed through the "t" test Student unegual variances and the limit of signification of the changes which is considered to be at p=0.05 and therefore differences at p<0.05 significant and p>0.05 insignificant. From the bioforms analysis, results that 40 fitotaxons (22 hydrophytes and 18 helohidatophytes) of which 2 species are signaled with the status of Threatened European Taxons: Salvinia natans (L.) All. and Trapa natans L. The percentage determination of occupation rate with vegetation across the water surface and the nominal distribution (by species) led to identification of the dominant plants. Our researches resulted in the fact that Ctenopharingodon idella acts during its feeding a election towards hydrophytes and helohidatophytes, displaying a preference for plants from the Potamogeton sp. and Najas sp. genus and other types (Carex sp., Phragmites sp. and Typha sp.) but even in their early period of development.

Key words: grass carp, hydrophytes, food election

INTRODUCTION

Over the last 40 years there have been conducted several scientifical studies in regards to the Prut Flood Plain vegetation and flora, elaborated by well reknown romanian researchers [1,9,14,15]. However, approaches that concern flora studies and plant distribution in anthropogenic aquatic ecosystems from our country, like ponds, are limited.

In Romania, development control of aquatic plants in ponds and other types of lakes, where aquaculture activities take place, represents a permanent activity for those who work in this field. Mechanical, biological and chemical methods of disposing from unwanted vegetation, didn't have in all cases positive results, which allowed the ,,problematic" plants to expand not only to the surface but also in submersive environment. We have to take in consideration that the range of technical equipment from our country is extremely limited and manual work conditions require a high level of physical activity and a large number of personnel. It presents working hazards which are an impediment to the finality of the job.

Ctenopharingodon idella (grass carp) from Cyprinidae family proved to be efficient in the initiative of controlling algal and submerged vegetation,being introduced in ponds in many European countries, dating back from the 60s [18] like in the United States under sterile triploid and fertile diploid forms. However, law is different for each state as in Missisipi there are permitted both forms of grass carp whereas in Alabama and Arkansas they are interdicted by law [19].

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The manuscript was received: 18.07.2014
Accepted for publication: 22.10.2014

In the present paper, there have been identified and determined plants from hydrophite and helohydatophite groups from ponds in which there are stocked *Ctenopharingodon idella*. The necessity of this study consists in the determination of plant species which are consumed by the grass carp and a control of the aquatic plants development in ponds.

MATERIAL AND METHOD

All field activities took place in ponds from the Lower Prut Flood Plains, over a period of 4 consecutive years (2008-2012) with the aim of determing the distribution of hydrophites and helahidrophytes across the period of vegetation, from June until September (3 measurements per month). The monitorised ponds are part of The Fishing Sovarca Farm (noted with SH) and Research Development Brates Farm (noted with BH) which is under the patronage of the Institute of Research-Development for Aquatic Ecology, Fishing and Aquaculture Galati.

The identified plants were determined and conserved, being included in the Herbarium of the Botanical Garden of Galati.

Distribution of taxa plants was analysed through procentual measures reported to the water surface, only if the plant coverage exceeded 5%.

Results are presented as average ± standard deviation (SD). The statistical work of the dates were processed through the "t" test Student unegual variances and the limit of signification of the changes which is considered to be at $p=0.05$ and therefore differences at $p<0.05$ significant and $p>0.05$ insignificant.

Density stocking in ponds was about 250 grass carps per hectare, at the age of 2 years, weighing about 400g.

RESULTS

The flora analysis emphasises the determination of 40 species (from 19 families) from which 22 species are hydrophytes and 18 are helohidatophytes.

From the taxa plant total, phytogeographic spectrum shows us that: 38% are cosmopolitan, 35% euroasians, 20% circumpolar and only 7% european plants (table 1, table 2). Distribution in ponds (noted with H1,H2,...H8) of the plant species is presented in figures 1-8. It was established the means of distribution of hydrophytes and helohidatophytes that are part of the analysed ponds but also the assessment of preferred species for the grass carp.

DISCUSSIONS

The present flora list was analysed bearing in mind the Red List of Romanian Plants [10], list of threatened taxa plants and endemic species at global level including Europe [13].

The conducted analysis emphasises the fact that from 40 identified plants in monitorised ponds, just 2 species have a special status: *Salvinia natans* (L.) All. and *Trapa natans* L. From a sozologic point of view these 2 species are endangered in Europe. However, in the studied areas- *Salvinia natans* and *Trapa natans* – we could meet them in abudance, especially in alimentation channels and evacuation of water but also in ponds.We can mention that in our area of research, there couldn't be identified some species highlighted by other researchers [14]. We could list the following: *Stratiotes aloides, Elodea canadensis, Valisneria spiralis, Nymphaea alba, Nuphar luteum, Sagitaria sagitifolia, Sparganium emersum.* Most probably, the seasonal technological activity of the ponds cannot ensure optimum conditions of vegetation for these taxa plants.

The stocking density of the grass carp in anthropogene aquatic systems was longly studied [12]. The recommendations given by some authors referr to environment conditions as well as the present aquatic macrophyte community. In this way, some authors [4] use 25-30 fish ha^{-1} of grass carps in ponds in which aquatic „problematic" plants are from *Hydrilla* genus. Other authors experimented on a 90-150-250-300 kg ha^{-1} stocking density with a 2 year old grass carp [5,6]. In the same way, the stocking density can influence the water chemistry with an impact on the concentration raise of nutrients (especially nitrogen, phosphorus) in the water which can determine the growth of a large range of

plants. As a result, the recommendation are extremely different, reason why biology and aquatic plant distribution have to be known.

In this paper, we chose a 100 kg ha^{-1} stocking density of grass carp (2 years old) keeping in mynd the present tough vegetation (rush, cattail) but also the submerged vegetation and the floating one (*Potamogeton* sp., *Najas* sp., *Hydrocharis* sp.).

Table 1 List of hydrophytes

No	Scientific name of plants/author	Botanical family	Common name	Phytogeographic spectrum
1	*Ceratophyllum demersum* L.	Ceratophyllaceae	coontail	cosmopolitan
2	*Ceratophyllum submersum* L.			european
3	*Hydrocharis morsus-ranae* L.	Hydrocharitaceae	grass frogs	euroasian
4	*Lemna minor* L.	Lemnaceae	duckweeds	cosmopolitan
5	*Lemna trisulca* L.			
6	*Myriophyllum verticillatum* L.	Haloragaceae	watermilfoil	circumpolar
7	*Najas marina* L.	Najadaceae	slender naiad	cosmopolitan
8	*Najas minor* All.			euroasian
9	*Nymphoides peltata* (S. G. Gmelin) O.Kuntze	Menyanthaceae	yellow floatingheart	euroasian
10	*Oenanthe aquatica* (L.) Poiret	Apiaceae	-	euroasian
11	*Potamogeton crispus* L.	Potamogetonaceae	curly-leaf pondweed	cosmopolitan
12	*Potamogeton gramineus* L.		fennel pondweed	circumpolar
13	*Potamogeton nodosus* Poiret			
14	*Potamogeton pectinatus* L.			cosmopolitan
15	*Potamogeton perfoliatus* L.			
16	*Potamogeton pusillus* L.		small pondweed	circumpolar
17	*Ranunculus aquatilis* L.	Ranunculaceae	-	cosmopolitan
18	*Ranunculus trichophyllus* (Chaix) Bosch		bubbles	european
19	*Ranunculus rionii* Lagger		-	euroasian
20	***Salvinia natans* (L.) All.**	Salviniaceae	floating fern	euroasian
21	*Spirodela polyrhiza* (L.) Schleichen	Lemnaceae	duckweeds	cosmopolitan
22	***Trapa natans* L.**	Trapaceae	water nut	euroasian

Notă: * european threatened taxa plants

As to hydrophyte and helohidatophytes distribution in BH1 (fig. 1) we can observe that, throughout the 4 monitorised years, *Phragmites australis*, *Polygonum lapathifolium* and *P. hydropiper* don't present significant differences of growth or procentual decrease. However, during the first 2 years, there have been noticed significant decrease ($p<0.5$) in *Typha angustifolia* and *T. laxmanii* group and significant growth ($p<0.5$) at *Nymphoides peltata* and *Najas marina*.To a certain extent, the desequilibrum in plant distribution was determined by the plant which the grass carp consumed, aspects which were noticed by other authors [11]. We can observe a slight procentual growth of the *Polygonum lapatifolium* and *P. hydropiper* group. In accordance with these results are other studies [7] which show us that some plants, consumed or avoided by the grass carp can develop in these conditions [2].The plant distribution is different in BH2 (fig. 2) where the dominant species is *Nymphoides peltata* which does not present significant growths or decreases but we could observe the surface coverage of the water with of over 60%.

It seems that this plant is not consumed by the grass carp, not even in it's early stages but not even when the plant has flowers. A similar situation was signaled by other authors, in the case of *Nuphar lutea* in the same pond with *Hydrilla* sp. [17]. In the plant group *Salvinia*

natans and *Lemna trisulca* (fig. 3) there can be observed significant decreases ($p<0.5$) between the first 2 years and the last ones. It is certain that, *L. trisulca* was preferred by the grass carp resulting in the rate of water surface coverage having modified in favour of other species. In support to this information, there are the researches of some authors who introduced exclusively in grass carp's food *Lemna* sp. [3]. *S. natans* is not preferred by the grass carp and the removal of the plants has to be conducted before the sporocarps reach maturity (August).

Table 2 List of helohidatophytes

No	Scientific name of plants/author	Botanical family	Common name	Phytogeographic spectrum
1	*Alisma lanceolatum* With.	Alismataceae	water plantain	eurasiatica
2	*Alisma plantago-aquatica* L.			circumpolar
3	*Butomus umbellatus* L..	Butomaceae	flowering rush	euroasian
4	*Carex riparia* Curtis.	Cyperaceae	sedge	euroasian
5	*Carex vulpina* L.			
6	*Cicuta virosa* L.	Apiaceae	water hemlock	euroasian
7	*Cyperus glomeratus* L.	Cyperaceae	-	euroasian
8	*Equisetum fluviatile* L.	Equesetaceae	horsetail	circumpolar
9	*Eleocharis palustris* (L.) Roemer et. Schultes	Cyperaceae	spikerushes	cosmopolitan
10	*Mentha aquatica* L.	Lamiaceae	water mint	european
11	*Phragmites australis* (Cav.) Trin. et Steudel	Poaceae	rush	cosmopolitan
12	*Polygonum amphibium* L. f. *aquaticum* Leiss.	Polygonaceae	smartweed	cosmopolitan
13	*Polygonum hydropiper* L.			circumpolar
14	*Polygonum lapathifolium* L.			cosmopolitan
15	*Schoenoplectus lacustris* (L.) Palla	Cyperaceae	bulrushes	cosmopolitan
16	*Typha angustifolia* L.	Typhaceae	cattails	circumpolar
17	*Typha latifolia* L.			cosmopolitan
18	*Typha laxmanii* Lepechin			euroasian

From the plant category which do not exceed in distribution 5% (like *Potamogeton)* we observe significant diferences in pond BH4 (fig. 4). Most probably, the've been consumed by the grass carp and in their absence *Typha latifolia*, in it's early stages, completed the daily basis of alimentation. We have to notice the abundent development in all the ponds of *Nymphoides peltata* species, which covered the water surface at it's highest rates (30-75%).

A irregular distribution of hydrophytes and helahidatophytes is recorded in pond SH5 (fig. 5) in which *Typha angustifolia* and *T. latifolia* has significant modifications between 8-10% and *Nymphoides peltata* don't go higher than 11% of the water surface coverage.

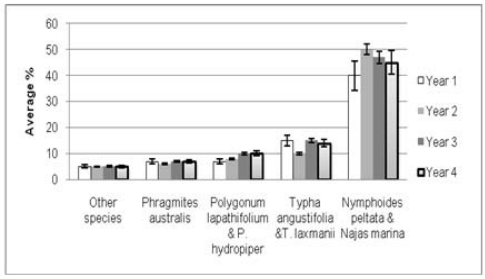

Figure 1 The distribution of plants in pond BH1 (growth juvenile fish)

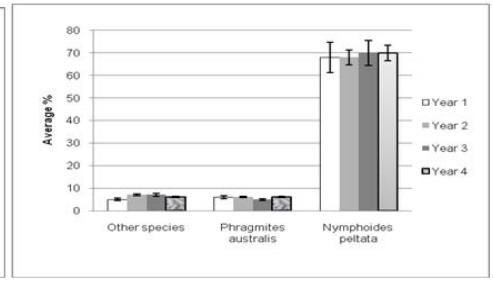

Figure 2 The distribution of plants in pond BH2 (growth juvenile fish)

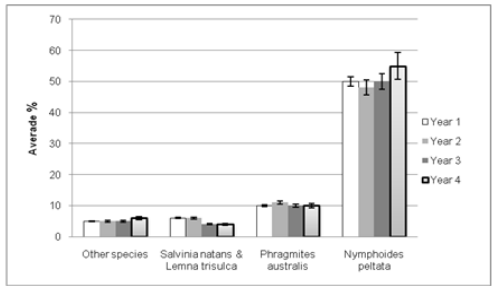

Figure 3 The distribution of plants in pond BH3 (growth fish)

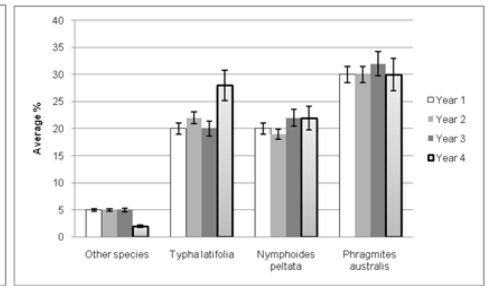

Figure 4 The distribution of plants in pond BH4 (growth fish)

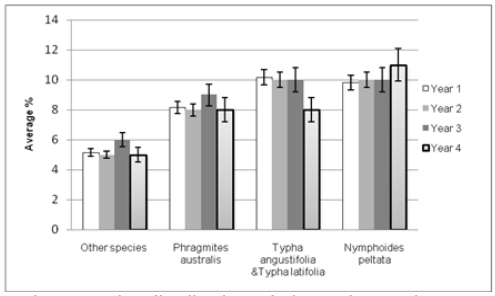

Figure 5 The distribution of plants in pond SH5 (growth fish)

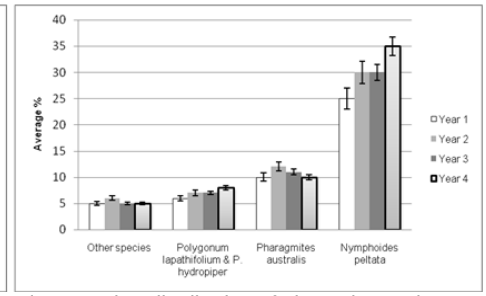

Figure 6 The distribution of plants in pond SH6 (growth juvenile fish)

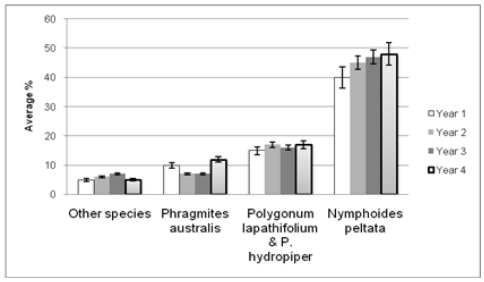

Figure 7 The distribution of plants in pond SH7 (growth remonts and breeding fish)

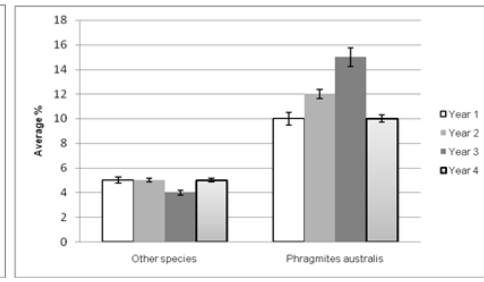

Figure 8 The distribution of plants in pond SH8 (growth fish)

The same situation doesn't go the same for pond SH6 (fig. 6) in which the same species has a significant growth ($p<0.5$) with a difference between the first and the fourth year, of 10 percent. A priority in grass carp's feeding hadn't been observed but most probably abundent development was related to breeding through seeds of the plant (annual abundant seeds). The same argument can be brought in pond SH7 (fig. 7) where the expansion of the species *Nymphoides peltata* is progressive from one year to another.

On the same pond, significant differences are noticed at *other species* group as well as in the case of *Phragmites australis.* This fact makes us state that the preferred food of the grass carp was composed of the 2 reminded cathegories. As an example we have: *Ceratophyllum demersum, Potamogeton crispus, Ranunculus rionii, Myriophyllum verticillatum.* Similar results were obtained by other authors [16] where the coverage rate of the water surface was 45%. Noticeable is the size of *Polygonum lapathifolium* species which adapted in pond conditions, measuring about 180 cm and abundend seeds that cover 15-17% of the water surface. *P. lapathifolium* and *P. hydropiper* are not in the range of grass carp's food preferences.

Significant differnces of species distribution *Phragmites australis* (fig. 7, fig. 8) lead to the thought that this species can be

consumed by the grass carp while lacking the abundancy of other species. Results are in accordance with other authors [8] who fed the grass carp with tough vegetation (*Phragmites* sp. si *Typha* sp.).

Another range of authors [4] believe that submerged macrophytes were completely eliminated by the grass carp. Our researches prove the contrary. Most probably, vegetal structure, pedoclimatic conditions and even phytoplancton are decisive factors in keeping the native hydrophyte and helahidatophyte diversity.

CONCLUSIONS

From our research, we could emphasise some conclusions with aquaculture practice:

1.The adaptation of hydrophyte *Nymphoides peltata* at terestrial environment, in partially drained ponds and the annual seed abundence ensures the extremely fast breeding of the species;

2. *Nymphoides peltata, Polygonum lapathifolium* si *P. hydropiper* species are not consumed by the grass carp;

3. The grass carp displays preferences in choosing plants, from which the following species are: *Potamogeton crispus, P. perfoliatus, P. pusillus, Lemna trisulca, Najas marina, Ceratophyllum demersum, Ranunculus rionii, Myriophyllum verticillatum, Typha angustifolia* si *T. latifolia, Phragmites australis;*

4. The knowledge about the vegetal preferances of the grass carp, of the hydrophytes and helohidatophytes biology from anthropogene aquatic systems and the application of some biological and mechanical measures (agrotechnics) can ensure an optimum control of the vegetal development.

ACKNOWLEDGEMENTS

The authors are grateful for the financial support granted through the POSDRU/159/1.5/S/138963-,,Sustainable performance in doctoral and post doctoral research-PERFORM" and thank the specialists of the Botanic Garden of the Natural Sciences Complex Museum of Galati.

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