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ECOLOGICAL CONDITIONS OF THE WATERCHESTNUT (*TRAPA NATANS* L.) IN THE DANUBE DELTA (ROMANIA)

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ABSTRACT

The diversity of water body types in the Danube Delta offers appropriate ecological niches for the colonisation of frequently large stands of the waterchestnut (*Trapa natans*). Their phytocoenoses were observed in slowly running and standing waters from clear, sediment-poor, to turbid and sediment-rich waters on muddy ground.

Trapa natans occurs in standing, and slowly running, waters and is well adapted to fluctuation of water level changes. The water dynamics is responsible for the composition of accompanying species of the phytocoenoses. The particular zonation, demonstrated by a cross section shows the adaption to the structure and the water flow of certain water bodies. Comparing older and newer research data, a decline of the populations of waterchestnuts became visible.

ZUSAMMENFASSUNG: Ökologische Bedingungen der Gewöhnlichen Wassernuss (*Trapa natans* L.) im Donaudelta (Rumänien).

In der Vielfalt der Gewässertypen des Donaudeltas findet auch die Wassernuss (*Trapa natans* L.) ihre entsprechenden ökologischen Nischen in denen sie sich in größeren Beständen entwickeln kann. Ihre Phytcoenosen wurden sowohl und in langsam fließenden, aber auch in stehenden Gewässern vorgefunden, die von klar und arm an Sedimenten, bis hin zu sehr sedimentreichen, turbiden Gewässern auf stärker schlammigen Grund reichen. Die Wasserstandsdynamik bedingt das Vorkommen bestimmter Begleitarten in der Zusammensetzung der Phythocoenosen. Ein Vergleich älterer und neuerer Aufnahmedaten, zeigt trotz der beachtlichen, vorhandenen Populationen einen deutlichen Rückgang der Wassernussvorkommen.

REZUMAT: Condițiile ecologice ale ciulinilor de baltă/cornaci (*Trapa natans* L.*)* în Delta Dunării (România).

În diversitatea mare a tipurilor de corpuri de apă, ciulinii de baltă, numiți și cornaci (*Trapa natans* L.) își găsesc nișe ecologice corespunzătoare pentru a se dezvolta deseori în grupări foarte mari. Fitocenozele lor au fost găsite atât în ape lin curgătoare, dar și în ape stătătoare, de la relativ limpezi și sărace în sedimente, până la ape turbide bogate în sedimente și cu fundul de lac cu soluri nămoloase. Dinamica apelor Dunării condiționează existența anumitor specii însoțitoare în componența fitocenozelor. Comparând cercetări din trecut cu cele recente, se constată totuși un declin vizibil al suprafețelor populate în trecut de *Trapa natans*.

INTRODUCTION

Waterchestnut (*Trapa natans* L.) an Eurasian continental-Mediterranean species (Ciocârlan, 1994; Oberdorfer, 2001, 2009; Sârbu et al., 2013) occurs as a bottom-rooted species in slowly flowing and standing eutrophic waters. According to Cook (1996) – seen in a global view – it occurs in seasonally summer-warm to tropical waters of the Old World i.e. Eurasia, being naturalized in North America. The distribution map of the waterchestnut shows two distinctly separated areas (Walter and Straka, 1970), one from Central to Eastern Europe reaching to the upper part of the delta of the Volga River (Losev et al., 1998) and the other including South-East Asia and the southern Far East (Walter and Straka, 1970). But in the European part of its large distribution area, the waterchestnut populations are increasingly in decline - in particular in Central and Western Europe - and in danger of extinction. This is a result mainly of change of ecological conditions including water quality and loss of natural habitats. That is the reason why the species was included as a first measure for its conservation in Europe in the "Convention on the Conservation of European Wildlife and Natural Habitats", known as the Bern Convention. It was opened for signature at the 33th Ministrial Conference on September 1979 in Bern, Switzerland, and came into force on 1 June 1982. The Appendix I with the list of strictly protected flora species includes among others the waterchestnut (*Trapa natans*). In Germany this species is not only included in the Red List of species, but also in the Red List of endangered plant communities (Rennwald, 2000). These data correspond to the occurrences of *Trapa natans* in Central Europe, but in the Red Book of vascular plants of Romania this species is not included (Dihoru and Negrean, 2009).

The actual decline of the waterchestnut (*Trapa natans*) in Central Europe has been proved by comparing its distribution in the same area (old branches of the Upper Rhine near to Rastatt) as a monitoring place over a longer time period, including the years 1978, 1989/90, 2005 and 2015 (Werling et al., 2017). From the once larger area covered by waterchestnuts the populations decreased to a few individuals and finally disappeared from the area. A local re-introduction was not successful. The decrease was stated in more areas of the Upper Rhine, but apart from the above mentioned causes such as loss of habitats and water quality, no others are mentioned. There are some assumptions stating that increasing populations of muskrats using the nuts as nutrition contributed to their disappearance.

At present, the only larger occurrence exists on the Upper Rhine area in the old Rhine meander "Rußheimer Altrhein" a Nature Reserve north of the town of Karlsruhe (Adler, 2020). The waterchestnut occurred in the Eastern part of Germany (Rothmaler, 1976), for example on the Elbe river and the Elbe Havel and other smaller river systems as can be followed on the distribution map no. 1852 (Benkert et al., 1996). But, in the most mentioned places, the populations of the waterchestnut fell or disappeared completely.

Going back to historical data, including as well pollen analyses, the waterchestnut has a long history in Europe, extending during the warm periods after the last Ice Age (Walter and Straka, 1970; Schloss, in verbis 2021). From a historical-cultural point of view, the species had an important role as it was the first plant used in Europe for production of flour in the Mesolithic /end of Ice age cca. 9600 BC to the Neolithic 5600 BC (Poschlod, 2017).

On the Upper Rhine, natural pollen deposits have been analysed in old meanders by Schloss S. (in manuscript). On the area of the Sewensee, a lake of Southern Vosges below the Ballon d'Alsace (altitude 500 m), the same author reported copious nuts of *Trapa natans* and pollen deposits. These are dated ca 6000 years BC VI and continuously until the postglacial warm time (Firbas, 1949, 1952), Schloss supposing that it was cultivated (letter from 02.04.2021, unpublished data). According to Plinius Gaius Secuwadus in A.D. 23 the Thracian peoples also used *Trapa natans* centuries later for flour production (Drăgulescu, 2008).

Looking at the occurrences of the waterchestnut in South-Eastern Europe, especially in the Danube Delta, the situation differs from that of Western and Central Europe, as the ecological conditions are more appropriate for a larger spread of this species. But, also in this area changes took place, as they can be followed comparing older data from the Lower Danube and maps of the Danube Delta before and after hydrotechnical works (Gâștescu and Știucă, 2008). E. Țopa (1957) mentioned *Trapa natans* L. from the Danube Delta in the Dunavăț area before any hydrotechnical works took place, the Sulina area, at Sf. Gheorghe in the "Turkish canal", near to the „Oleanca" island and in the Letea area. According to Neagu-Godeanu (1973) the waterchestnut association Trapetum natantis Müller and Görs 1960, composed by a species with a large ecological amplitude, having its main distribution area in the upper part of the Delta, i.e. the area of Rusca, Carasuhat, Șontea-Sireasa, Gorgova-Uzlina, Eracle and the Old Danube. Occurrences on the lower part of the delta are not mentioned. A subspecies *muzzanensis* (Jaggi) Schinz of *Trapa natans* is also mentioned in the Danube Delta (Doroftei and Covaliov, 2013). Data, concerning ecological gradients in the Danube Delta with occurrences of aquatic macrophytes in different vegetation types include also the vegetation type *Trapa natans* based on TWINSPAN classification (Coops and Hanganu, 2000).

MATERIAL AND METHODS

Over more than twenty years in the Danube Delta, studies of the water macrophytes and their ecological requirement have been realized. A special focus was given for *Trapa natans* L., which occurs in this area in different type of water bodies with various ecological niches. Samples of 5 x 5 m were taken along chosen stretches according to the method of Braun-Blanquet with the seven degree abundance-dominance scale (Braun-Blanquet, 1964; Borza and Boșcaiu, 1965). Along some channels cross sections where realized. In the Eracle and Lopatna channels with near natural structure of the borders, then cross sections from one to the other border and on a distance from ten to ten meters between the cross sections were realized showing the succession of different plant communities. As well cross sections from ten to ten meters were realized on the Sf. Gheorghe branch with its lateral channel Gârla de Mijloc (middle channel), for studying the succession of vegetation from the open water mirror with waterchestnut (*Trapa natans*) in smaller and larger strips or cover of reeds and forests.

The study area at all include parts of the Șontea-Fortuna complex (Fortuna, Crânjală, Lacul Rotund, the Gorgova-Isac-Uzlina complex with Taranova, and Perivolovca), parts of the Matița-Merhei complex (Lopatna, Eracle, Babina, and Lungu lakes), the Litcov Channel area (locally), the Caraorman Channel and Sf. Gheorghe with Gârla de Mijloc and Meleaua Sacalin.

The samples were grouped in tables with indicator values for nitrogen and temperature (Ellenberg et al., 2001), as being important for the development of waterchestnut communities.

The samples taken from the different sites are included in phyto-coenological tables grouped according to the studied stretches of running water in natural channels, the so-called Gârlas, more artificial canals and lakes. From the indicator values according to Ellenberg et al. (2002), Sanda et al. (1983); Sârbu et al. (2013) are included in the table those of temperature (T) and nitrogen (N) as they are of significant importance for the existence and development of waterchestnut communities. The nomenclature of species is given according to Sârbu et al. (2013), Ciocârlan (2009), and Oberdorfer (2001).

The samples were used as well for detailed studies concerning the species composition and structure of the phytocoenoses and their ecological requirements. All the phytocoenoses were considered in strong relation to the hydro-morphological dynamics, the grain size of sediments, the water quality and the succession of the vegetation along ecological gradients.

RESULTS AND DISCUSSION

Over the large area of the Danube Delta, the waterchestnut *Trapa natans* L. phytocoenoses were observed in slowly running and standing waters from clear, sediment-poor, to turbid and sediment-rich waters on muddy ground. Due to the structure of its ramified stems supporting more leaf rosettes the waterchestnut is able – as has been observed – to adapt to changing water levels. It occurs in waters with various sediment loads but also locally in clear waters. The depth of the water is between 20 cm to around 130 cm, but the given data are varying between 20 and 200 cm (Krausch, 1965; Coops and Hanganu, 2000). The study areas presented below demonstrate the large ecological conditions in which *Trapa natans* occurs.

The Șontea – Fortuna complex

In this complex our attention were focused on the area from Crânjală Channel and Lake Fortuna to the polder Fortuna including Lake Rotund, called by the local people „Lake Cruglic" (Lipovan language around the lake). In a part of it the waterchestnut covers a large area. The increasing abundance-dominance by phytocoenoses, with 100% cover and only a few accompanying species is in strong relation with the inflow of sediment-rich Danube water through the open connection with the Sulina main branch of the Danube at Mila 26 (mile 26) flowing further through the channels of the polder Fortuna, so that the river water loaded with silt has access to Lake Rotund. In this sediment-rich water, the waterchestnut finds good conditions for a luxuriant development (Figs. 1 and 2; Tab. 1, column 1-2, 5-6, 9-12).



Figure 1: Rotund Lake 2008.



Figure 2: Rotund Lake 2011.

With its morphological construction, the roots of the water nuts play also a filtering function between clear and turbid water in the lake. Apart from the dominant waterchestnut on the border of this cover, there are also transition stages, where *Trapa natans* is represented only with lower abundance-dominance values, being more or less replaced by the dominant species *Ceratophyllum demersum* and large covers of *Salvinia natans* (Tab. 1). With the continuous inflow of sediment-rich water, the lake will be completely silted up. In the area of Crânjală Channel and Lake Fortuna, *Trapa natans* has been less frequent, but the inflow from the channel with sediment-rich water was as easily visible by the occurrence of strips of flowering rush (*Butomus umbellatus*), also an indicator species for siltation processes.

Table 1: Phytocoenoses of waterchestnut (*Trapa natans*) and accompanying species in the area of Fortuna Lake, polder Fortuna including Rotund Lake.

		Number of sample	1	2	3	4	5	6	7	8	9	10	11	12
		sampling 7.09.2006	*	*	*	*	*	*	*	*				
		sampling 23.06.2007									*	*		
		sampling 10.09.2011											*	*
T	N													
		Species												
7	8	*Trapa natans*	5	5	2	2	4	4	2	3	4	5	5	5
6	6	*Spirodela polyrrhiza*	.	.	.	.	.	+	+	+	+	+	.	+
5	5	*Potamogeton crispus*	1	+	1	.	.	.	+	.	.	.	.	.
7	8	*Ceratophyllum demersum*	+	+	.	3	3	2	4	4	+	.	.	+
6	6	*Hydrocharis morsus-ranae*	+	.	.	+	.	.	.	.	.	.	.	.
6	8	*Typha latifolia*	+	.	.	+	.	.	.	.	.	.	.	.
5	7	*Phragmites australis*	+	.	.	+	.	.	.	.	.	.	.	.
6	6	*Nuphar lutea*	.	3	1	.	.	.	.	.	.	.	.	.
6	7	*Elodea nuttalii*	.	.	.	.	+	.	.	.	.	.	.	.
5	6	*Lemna minor*		+	.	+	+	+	+	.	.	+	+	+
x	8	*Potamogeton pectinatus*	.	.	.	.	.	.	2	+	.	+	4	3
8	7	*Salvinia natans*	+	+	5	3	+	1	2	.	.	.	.	.
6	6	*Lemna trisulca*	+	.	.	.	+	+	.	.	.	.	.	.
6	5	*Nymphaea alba*	.	.	.	.	.	.	.	.	.	.	.	+
8	8	*Azolla filiculoides*	.	.	.	+	+	+	.	.	.	.	.	.
6	7	*Potamogeton lucens*	.	.	.	+	.	+	.	.	.	.	.	.
6	6	*Najas marina*	.	.	.	.	.	.	.	.	.	+	.	.
8	8	*Lemna gibba*	.	.	.	.	.	.	.	.	.	.	+	+

Fortuna samplings: 7.09.2006, 1-4, Crânjală Channel, lake Fortuna and polder Fortuna; 7.09.2006: 5-8: lake Rotund western side; 9 and 10: Fortuna: 23.06.2007, samples 11 and 12: Rotund lake eastern side, 10.09.2011.

The Gorgova, Gorgoștel, and Uzlina complex

The above mentioned lake area presents, in comparison with the area of Fortuna, more diversified phytocoenoses (Schneider-Binder, 2018). In that area, we can find in the Gorgoștel Lake, together with the waterchestnut, the yellow water lily (*Nuphar lutea*), mentioned as characteristic for the subassociation of the ass. Trapetum natantis Müller et Görs 1960 (Philippi, 1969), described as representative from the Upper Rhine in Germany. The same association is large represented in the Danube Delta (Krausch, 1965; Popescu et al., 1997).

Table 2: Phytocoenoses of waterchestnut (*Trapa natans*) and accompanying species in the area of Gorgoștel, Gorgova, and Uzlina; 1 g = mouth of the channel from Gorgoștel Lake to Perivolovca; 2 g = lake Gorgoștel, 12.06.2003 depth 0.80 m, on the border *Phragmites australis*; 3 g = lake Gogorgoștel, moderate water current, 12.06. 2003; 4 g = lake Gorgoștel, depth 1.80 m – 0.30 m, 25.09.2004; 5 g = lake Gorgoștel, 25.09.2004; 6 Gt = lake Gorgovăț, 26.09.2004; 7 G lake Gorgova, 15.06.2003; 8 Gc = Gorgovăț Channel, 15.06. 2003; 9 Gt = lake Gorgovăț, 15.06. 2003; 10 Gt = lake Gorgovăț; 11 T = Taranova Channel, 25.09.2004; 12 and 13 U = lake Uzlina, 16.06.2003; 14 U-P = lake Uzlina near to the Uzlina Channel (moderate flowing water), 16.06.2003. Abbreviations: g = lake Gorgoștel; Gt = lake Gorgovăț; G = lake Gorgova; Gc = Gorgovăț Channel; T = Taranova Channel near to the Taranova Lake; U = Uzlina Lake; U-P = transition from Uzlina Lake to the Uzlina Channel.

		Number of sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Sampling point	g	g	g	g	g	Gt	G	Gc	Gt	Gt	T	U	U	U-P
T	N															
		Species														
7	8	*Trapa natans*	5	3	4	4	3	5	5	3	3	5	5	+	5	1
6	6	*Spirodela polyrrhiza*	+	.	.	.	.	+	.	+	+	+	+	+	+	.
5	5	*Potamogeton crispus*	1	+	1	.	.	.	.	+	.	.	.	.	.	.
7	8	*Ceratophyllum demersum*	2	+	+	+	+	.	.	2	+	+	.	+	.	.
6	6	*Hydrocharis morsus-ranae*	+	.	.	+	.	.	.	.	.	.	.	.	.	+
6	8	*Typha latifolia*	+	.	.	+	.	.	.	.	.	.	.	.	.	.
5	7	*Phragmites australis*	+	.	.	+	.	.	.	.	.	.	.	.	.	.
6	6	*Nuphar lutea*	.	3	1	.	.	.	.	.	.	.	.	.	.	.
6	7	*Elodea nuttalii*	.	.	.	.	.	+	.	.	.	.	.	.	.	.
5	6	*Lemna minor*	.	.	.	.	.	+	.	+	.	+	+	.	+	.
x	8	*Potamogeton pectinatus*	.	.	.	.	.	.	+	3	+	.	+	3	.	2
8	7	*Salvinia natans*	.	.	.	+	+	.	.	+	.	.	.	.	.	.
6	6	*Lemna trisulca*	.	.	.	.	.	.	.	+	.	.	.	.	.	.
6	7	*Myriophyllum spicatum*	.	.	.	.	+	.	.	.	.	.	.	.	.	.
6	5	*Nymphaea alba*	.	.	.	.	.	.	.	.	.	.	.	+	.	+

The presence in the samples 5-7, 9-10, and 12 of the fennel or sago pondweed (*Potamogeton pectinatus*) adapted to running waters of different speed indicate the striking distance of the Uzlina Channel, flowing inside the Uzlina Lake and influencing the species composition of the waterchestnut phytocoenoses. The presence of 15 different aquatic macrophytes is a proof for a more diversiefied variant of *Trapa natans* phytocoenoses, in general represented by a low number of accompanying species.

The Lopatna, Eracle channels, Lungu Lake area, and Babina Lake (of Matița and Merhei area)

The Lopatna and Eracle (partly) channels are part of the old natural channel system in this area of the delta. Without or with small human intervention they are representative for the succession of the vegetation from one to the other border of the channels. Along the bordering reeds we can follow the ribbon-like disposed phytocoenoses in a relatively clear water with only a small sediment load. Seen in cross section, the reed bed of both sides is followed by a belt with dominant yellow water lily (*Nuphar lutea*), with floating watermoss (*Salvinia natans*) between the leaves, and in the middle part with slowly running water the waterchestnut is dominant (Figs. 3 and 4). The Babina Lake north of the channel system is also representative (Fig. 5).

Table 3: Phytocoenoses of *Trapa natans* in the Lopatna-Eracle area; Lo = Lopatna channel; L-E intersection; E= Eracle channel; Lu = lake Lungu. Sample 1, 2, 3 Lopatna channel, 4 = Lopatna Eracle channels intersection, 5 and 6 = Eracle channel, 6 = lake Lungu, all samples from 9.09.2011.

		Number of sample	1	2	3	4	5	6	7
		Sampling point	Lo	Lo	Lo	L-E	E	E	Lu
T	N								
		Species							
7	8	*Trapa natans*	5	5	4	3	5	5	5
8	7	*Salvinia natans*	.	1	1	.	+	+	+
7	8	*Ceratophyllum demersum*	.	.	.	.	.	.	.
6	6	*Stratiotes aloides*	+	+	1	.	.	.	.
6	6	*Hydrocharis morsus-ranae*	.	.	+	.	.	.	.
6	6	*Nuphar lutea*	.	.	.	3	+	+	.
6	5	*Potamogeton nodosus*	.	.	.	.	.	+	.
5	7	*Phragmites australis*	.	.	.	.	+	+	.

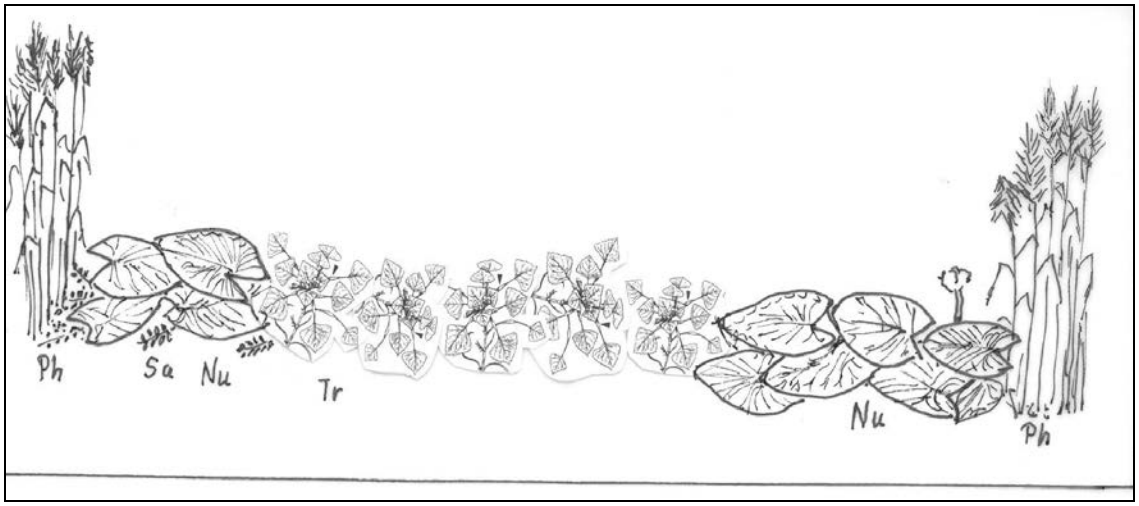


Figure 3: Cross-section through the macrophyte vegetation of Lopatna channel (Ph = *Phragmites australis*, Sa = *Salvinia natans*, N = *Nuphar lutea*, Tr = *Trapa natans*).

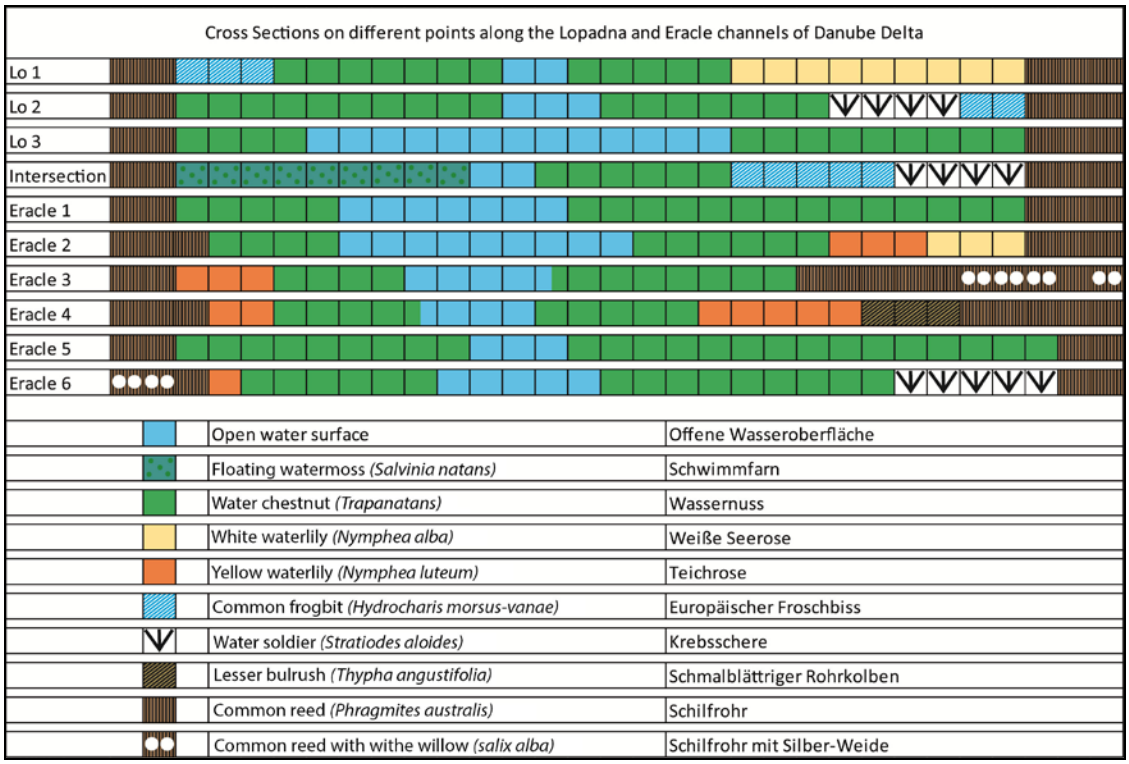


Figure 4: Cross sections (10) from one to the other border, showing the succession of different plant communities.



Figure 5: Babina Lake with common reed stands bordered by large carpets of *Trapa natans* (covering degree 80-100) north of the Lopatna-Eracle channel system, July 2021; photo and sampling Becker I. (KIT).

Old Danube (M), channel Crișan, channel Litcov (eastern part), lake Iacob (Iacub), channel Caraorman.

The *Trapa*-type vegetation is well represented in this old stream and canal system, including the Old Danube, the Crișan channel, Litcov and Caraorman channels (Fig. 6). In that area is mentioned as well a large occurence of Trapa-type vegetation in the Obretinu lake (Coops and Hanganu, 2000). The number of accompanying species is low (Tab. 4) and beside the dominant *Trapa natans*, only *Salvinia natans* is more frequent.

Table 4: Phytocoenoses of *Trapa natans* in the area of the old Danube (Dunărea Veche), channel Crișan, channel Litcov, lake Iacub and channel Caraorman; DV = Dunărea Veche/Old Danube, on the „M" the cutted former Meanders of the Sulina branch; Iac (= lake Iacob); Cri = channel Crișan; Lit = Litcov Channel eastern part, sample 4, 25.09.2004; Car = channel Caraorman; Date of sampling: 1-4 = 9.09.2011); 5-7 = (12.09.2018).

		Number of sample	1	2	3	4	5	6	7
		Sampling point	DV	Lo	Lo	L-E	E	E	Lu
T	N								
		Species							
7	8	*Trapa natans*	2	5	5	5	5	4	3
5	7	*Butomus umbellatus*	2	.	.	.	.	.	.
8	7	*Salvinia natans*	1	5	1	.	+	2	.
6	6	*Sagittaria sagittifolia*	.	.	.	+	1	.	.
6	5	*Spirodela polyrrhiza*	.	.	+	+	.	.	2
5	7	*Phragmites australis*	.	.	.	1	.	.	.



Figure 6: Caraorman Channel with carpets of waterchestnuts (*Trapa natans*) in summer aspect, with interloking carpets of fringed water lily (*Nymphoides peltata*), 12.08.2021 (Photo Isabell Becker KIT, institute for wetlands ecology).

Danube branch Sf. Gheorghe, Gârla de mijloc, Gârla Turcească, Meleaua Sacalin

A particular occurrence of *Trapa natans* can be observed on the Sf. Gheorghe branch with its ramifications Gârla de Mijloc, Gârla Turcească and finally the Meleaua Sacalin with its part named Sacalinu Mic. In that area the water flow broadens out on a large surface with low water level fluctuation, so that a special succession (seen as cross-section) of vegetation is developed downstream the fluvial-km 5. It is represented by *Trapa natans* on the open water side followed by common reed (*Phragmites australis*), locally with lesser bulrush (*Typha angustifolia*) and black alder (*Alnus glutinosa*) on a small river bank, being an indicator for the small fluctuation of the water level in that area. Downstream of km 5 the small fringe of *Trapa natans* and reeds broaden out more and more (Fig. 7) being visibly a large siltation process. In that area the waterchestnut grows in some abundance with overlapping of the rosettes in very low waters and finally it covers the muddy soil. Characteristic for these siltation areas, near to the waterchestnut is also the locally dominant flowering rush (*Butomus umbellatus*) (Fig. 7).



Figure 7: Small fringe of *T. natans* and ribbon-like small stands of common reed (*Phragmites communis*) and black alder (*Alnus glutinosa*) on fluvial-km 5 of the Sf. Gheorghe branch.

Table 5: *Trapa natans* Phytocoenoses on Sf. Gheorghe branch, Gârla de Mijloc.

		Number of sample	1	2	3	4	5	6	7	8	9	10
T	N											
		Species										
7	8	*Trapa natans*	5	5	5	5	5	4	3	2	1	2
6	7	*Butomus umbellatus*	.	.	+	+	.	2	3	3	3	2
6	7	*Typha angustifolia*	1	.	+	1	.	.	.	.	.	.
5	7	*Phragmites australis*	+	.	.	.	1	.	.	.	2	.
6	7	*Salix alba*	.	.	.	.	.	.	.	.	1	.

All samples 1-10 are from the Sf. Gheorghe branch downstream km 5, Gârla de Mijloc from ten to ten m distance; Date: 06.09.2011.



Figure 8: Carpets of *Trapa natans*, lesser *Typha angustifolia* and *Salix alba* stands.



Figure 9: Ribbon- like stands of *Trapa natans* (first front), *Butomus umbellatus*, lesser *Typha angustifolia*, *Phragmites australis* and *Salix alba* on the left back.



Figure 10: *Trapa natans* covering as large carpets with high abundance-dominance the remained water surfaces in the siltation area (06.09.2011).

CONCLUSIONS

The waterchestnut, a thermophilous species, is widely spread in the Danube Delta, populating different sites mostly as a monodominant species. The number of accompanying species is low, and accounts for 3-7 species, all with small cover degree. Temperature and nitrogen are very important for the waterchestnut, which requires in its flowering time and the growing of fruits temperatures which exceed +20°C. The water is mostly turbid, but the species occurs as well in moderate turbid and also in clear waters. On the bottom of the most sites where the species occurs the mud is rich in humus, but poor in calcium carbonate.

Trapa natans occurs in standing and slowly running waters and is well adapted to fluctuation of water level changes. The water dynamics is responsible for the composition of accompanying species as it was stated be the inflow of the Uzlina Channel into the Uzlina Lake and as well by the phytocoenoses in the Lopatna Channel. The particular zonation, demonstrated by a cross section of the vegetation in the Lopatna area, shows the adaption to the structure and the water flow of a certain water body. Primarily the populations of waterchestnut (*Trapa natans*) are bound to the inflow area of a water stream into a lake, as has been observed by the inflow in Lakes Rotund, Obretinu Mic and Uzlina. In this case the waterchestnuts have a large cover degree and develop a high biomass.

From a historical view it is possible to state some changes in the whole water macrophyte vegetation, including also the waterchestnuts populations. This fact became mostly visible when considering older data (Țopa, 1957; Neagu-Godeanu, 1973, 1975; Munteanu and Curelariu, 1996; Gâștescu and Știucă, 2008), and also newer data according to our recent researches. By comparing these data, the long term trends are coming out indicating a decline of the populations. This is caused by different hydrotechnical works such as dyking, drainage and transformation of wetlands into agricultural lands and fishpolders as it shows for example the data of the former Dunavăț and Holbina area, but also the area of Fortuna, as well of Babinia and Cernovca (Schneider et al., 2008).

Apart from the above mentioned facts, a reduction of *Trapa natans* populations on their typical sites is caused by very low water levels, high temperatures, evaporation and the drying out of lakes, consequences also of the climate changes.

Considering the occurrences of *Trapa natans* in South-eastern Europe, even if at some sites a decline is visible in comparison with those in Central and Western Europe, it emerges clearly that site conditions in South-eastern Europe such as continentality, higher temperatures in summer time and other site conditions in general, all together assure a larger ecological amplitude and more diverse site conditions than for populations of the species in Central and Western Europe.

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