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ABOUT THE INNER PONDS OF THE FERTŐ-LAKE

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Fertö-lake was ranged by VARGA (1954) among the fertös meaning a special case of permanent standing fresh waters. VARGA translated the word fertö into German as Flachsee.It was defined as a type of lakes: "the fertös are fairly large but very shallow standing waters; presenting a very fluctuating condition in every respect, in physical, chemical and biocoenotical sense; the total layer of water has been producing and decomponing. As a holocoenoid, it is in the progressed stage of ageing of lake, their dessication is frequent." VARGA ranged into the fertö-type also our Velencei lake beside Fertö-lake. The Balaton, the Prespa lake and Iljmen lake came into the 2nd type, among the real lakes. VARGA'S definition of fertö has been more or less acceptable to Fertö-lake for 30 years.
In the south-western and southern areas of the Fertö-lake on the Hungarian territory the basin of the lake can be characterized with an excessive growth of the reed-belt (Fig. 1). To be stressed: The percentage of reed-belt in Hungarian territory is 85. As to the total lake surface 55 per cent is covered with reeds.
Along the frontier the Hungarian area of lake joins with open water to the Austria area mostly. Near Mörbisch and at four other places the frontier runs in the zone of reed-belt.
In the hydrological cycle of 1981/1982 the mean water level of the open water as well as in the reed-belt was 115,54 m in absolute height above Adria.In our sketch this contour lies along the littoral edge of the reed-belt. In this case the measurable depth of water is approximately one m in average in the open water and in the reed-belt it is half or approximately one m. The water body of the reed-belt joins with the water body of the open areas directly, though in the reed-belt the water depth is much lower than that of the open area, because the sedimentation is much thicker in the reed-belt.
As a consequence of the multiplication of reeds a continuously covered area of the water surface has developed, forming the reed-belt. But in the reed-belt in the deeper parts of the basin a few larger parts of the water surface remained open. These are called by us Inner Ponds meaning isolated water bodies inside the lake (Fig. 1). From the edge of the Inner Ponds into the reed-belt the water body continues directly. In the last decade the surface and mass of the Inner Ponds did not alter considerably in dimension.
We treat the Fertö-lake as a single lake from the large open surface of water body across the reed-belt to the Inner Ponds and from here across the reed-belt again to the coastal edge, to the 0 water level, including the part of Austria too. However, inside the single lake we distinguish

-1st the larger open part, it is called Outer Water
or plane or sik in Hungarian,

-2nd the larger reed belt and

-3rd Inner Ponds inside the latter area.

The present situation has been developed in the first six decades of this century, as a consequence of the accretion and the hydrometeorological situations. On the other hand the effects of the lake regulation, the water level control, the lake use has been important for its development. Since 1965 the use of the sluice has been influencing the process of accretion.
Near Mörbisch and Fertörakos an inner pond, named Fertörákosi pond (Frt) is connected with a straight channel to the Outer Water, (width 50 to 150 m). This pond has a dense traffic of ships, and this hinders its total segregation from the outer water. The Püspök (Pt) and the Kládlersarok pond (Klst) are segregating from Fertörákosi pond in a secondary way.

In the fourth decade of this centuary the Herlakni (Hlt) and the Kisherlakni ponds (Khlt) were excluded. The Herlakni pond is the second largest pond. The highest length is 1600 m and its width is as long as 400 m. Its water depth is 1 to 1,2 according to season. From these to south the 3rd series of the Inner Ponds follows, such as Hidegségi- (Hit), Atjáró (Atjt) and Oberlakni (Olt) ponds. We can suppose, that these ponds are much smaller than the former ones. To the South again we can find the Nagy határtisztás (Nhtt) pond. There are other smaller ponds. But these have very small surface and they can be reached only with difficulties. In the Inner Ponds the water depth alters from 0,8 to 1 m according to season. I should be underlined, that the Inner Ponds are not identical with the bare surface of the reed-belt which remained after the destruction of reeds, where the water depth is only 1 or 2 dm or only a few cm according to season and place, where Utricularia vulgaris or Chara species grow. In the Inner Ponds greater or smaller stands of reed occur, and in some places Typha angustifolia, Schoenoplectus litoralis and Najas marina also canbe found in greater and smaller quantities. Other higher plants do not occur in the Inner Ponds.

The water level in the Inner Ponds reflects the oscillations of the Outer water but amplitudes are smaller. Permanent and strong winds from NW can result in a rise of the water level + 15 cm compared to normal water level at Fertörákosi pond and + 20 to +25 cm at Madárvárta sik)(Mvs), but only + 1 or + 2 cm at Herlakni pond. The maxima at Fertörakosi pond and Madárvárta sik (Mvs) can be abserved after 8 to 9 hours, at Herlakni pond after 13 to 15 hours, but as mentioned above the maxima are only + 1 and + 2 cm in the latter cases.

In the former two places within 48 h oscillations with decreasing maxima and minima can be observed twice. In Herlakni pond only one maximum with + 1 or + 2 cm occur as well as one lesser minimum within 48 hours.In the Herlakni pond one damped developing maximum with only + 1 or + 2 cm and a damped minimum coming back resting water level go on one after the other in a 48 hours period. The presented hydraulical system of the lake is a very important feature of our lake in every aspect,in regards to the mixing of the water bodies between the opfen and covered parts, i.e. the Inner Ponds and the Outer Water. In the Outer Water a total period in the oscillation is accomplished in one day. Only tracks of this dynamics can be observed in Inner Ponds. Two different levels of dynamics exist in the lake. From these the different features of the various water bodies take its origen. The total homogenesis of the water bodies of the outer and inner parts cannot be sured ensue. But the water with different characteristics can mix with restriction by its connected surfaces, the frontier of the reed-belt and along the canals. This mixing is higly influenced by direction, energy, duration of water movements. We have been studying differences among the Outer Water and the Inner Ponds for some years. Without aiming the completeness I should like to compare the waters of the Inner Ponds and the Outer Water presenting some qualitative types.

1 st The transparency of the water with Secchi disc is appr. 20 cm under calm conditions in the Outer Water, in the Inner Ponds the water is generally transparent to the bottom. The water depth is 1 m in the Outer Water and 0,7 to 1 m in the Inner Ponds, where epipelic algae also can develop.In the Outer Water depending on the energy, duration and direction of the wind, or depending on the surge of the lake different amounts of silt can be floating, with highest values of 844,9 mg l^{-1}.The outer water seems to be grey. The water of the Inner Ponds is brown with a high transparency, and it is darker brown in the south.

- 2 nd. The brown colour of the water derives from the organic humus combination. The presence of the humus combinations may moderate the processes of the roots and the development of th typical sapropel in an anaerobic situation. the 2 nd table shows the organic substance of water expressed as the chemical oxygen demand. From 1980 the arithmetic means of the measured data present a very moderately rising tendency in certain years. The dispersions of the data in a data series alter 20 per cent of means and casually it reaches also 40 per cent nearly. The quotients of the chemical oxygen demand with Kaliumbichromat and the chemical oxygen demand with Kaliumpermanganat are higher consistently in the Outer Water then in the Inner Ponds, these are 6,4 and 5,1, respectively in the bare surface of the reed-belt at the measuring station only 3,5. We have established that the organic substance were more in the water of the Inner Ponds than in the Outer Water, but the proportion oxidizable only with Kaliumbichromat always was less than in the Outer Water.

3 rd. Table 3 present the electric conductivity of water (20^{o}) in arithmetic means from 1980 to 83 in Outer and Inner places. For 1980 and 81 years we observed higher values in the Inner Ponds and from 1983 we had lower ones in the Outer Water. The 2 nd half of 1982 was exceptional in precipitation. It had a + 200,4 mm anomaly against 663,3 mm total. This resulted in a higher water level than normally. The surplus water from autumn to spring rediluted the salt concentration of water with a higher rate than the usual one. June, 15^{th}, 1983 in one of 16 places the conductivity of the water reached the 2000 $\mu S\ cm^{-1}$ level. 23 rd of August the arithmetic mean of the data rised to 2300 in the Outer Water and to 2397 $\mu S\ cm^{-1}$ in the Inner Ponds. These levels occupy a position already in the value range of the late summer of the former years. In spring and early summer we measured the lowest values in a tendency to decrease in Atjárō-, Oberlakni ponds and Pitner strand.

Table 4 th represents the arithmetic means, the minima and the maxima of data series of the Chlorophyll-a contents in the Outer Water and the Inner Ponds of 1983 of former years. Largest variations between m and M can be found in the Inner Ponds. The means do not indicate a grand difference between the Outer and Inner objects. In Inner Ponds the water is transparent to the bottom. Here epipelic algal mats can occur too, spliting and floating up to the surface of water. According to BUCZKO's non published infórmation the algae mat are developed by Oscillatoria tenuis and some other Cyanophyta. Every year higher data occur more often in late summer and autumn. Only once namely in 1980 a first maximum in early summer could be rekognized.Moreon at the end of winter some higher values in Chl a content could be observed.

According to the investigations of PADISAK (1983) the differences in algal composition between Inner Ponds and the Lake are caused rather by species diversity than by Phytobiomasses. While in the Outer water Chlorococcales are dominant, in the Inner ponds Crytomonades prevail.

5 th: Generally the content of dissolved oxygen was higher in the Outer Water than in the Inner places during 1980, 1981 und 1982. In 1983 average values of the content of oxygen of the Outer water was higher from april to july, while the Inner ponds had higher means from september to october. Years agoe this change could not be observed.

6 th: When relating quantitative data to other limnological parameters, as they are i.e. pH, turnover of Nitrogen and Phosphorus, plankton and benthos the differences are shown between the Outer water and the Inner ponds. For certain aspects the differences can be defined well, while for some characteristics no differentiation is possible.

These results indicated a bigger dilution in this area. The bigger dilution could issue from the greater than usual influent of subterrenian and surface runoff. I think this is an effect of the anomalia to the water quality. These results suggest to put more attention to the subterranian influent for the regime of our lake.

Now I should like to mention that we have made a very simple experiment. I liter lake was evaporated indulgently to 400 ml. During evaporation the conductivity of water was measured seven cases showing the process of the salt concentration. The conductivity of the remaining water varied according to $y' = 2316,5 - 4,48\ x + 0,519\ x^2$ $\mu S\ cm^{-1}$ relation as a function of volume decrease, r= 0,9935. Extending the experiment the concentrated water was diluted back to the original volume indulgently, while the conductivity of water was measured six times showing the process of the dilution. The conductivity of the diluted water varied according to $y' = 2828,9 - 25,85\ x + 0,44$ relation as a function of the wanting volume, r=0,8085. The two processes were qualitatively similar, but they were dissimilar quantitatively. During concentration a part of the dissolved ions fixed irreversibly and they linked to the insoluble components. During backdiluation the water did never reach levels of conductivity measured in the former process.

Nevertheless,also the Lake-System evolved in one basin,for its creation particular parameter joined.

In our days Fertö Lake combines 3 larger ecosystems,namely the open great water body,which is surounded almost entirely by its huge reed belt.Due to the special patch -growth of Phragmites australis within this second system an enumerous amount of different sized pools is found in between.

As third type within the littoral zone larger ponds exist as they were described.

Disregarding the manifold differences as they are shown partly in this paper one should not be aware that all 3 subsystems are constituting one water body.It is the task of the present work to show some of the common as well as of the different features in the 3 ecosystems still far away from completness.

R e f e r e n c e s

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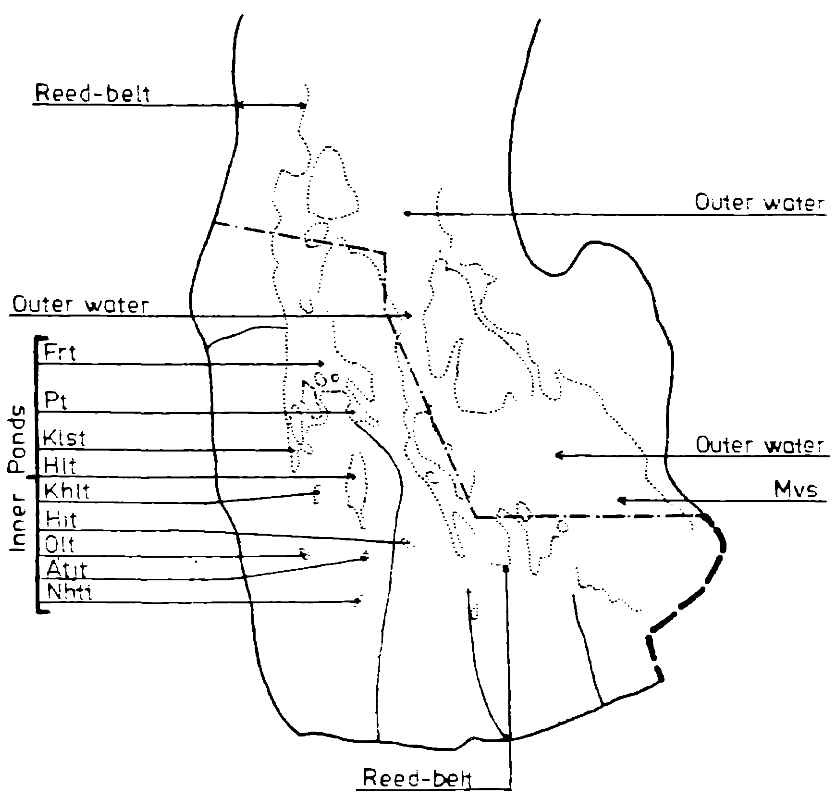
1st figure

A sketch for the southern area of the Fertő-lake.
On the basis of Kováts's map /A/.

Inner Ponds: Frt= Fertőrákosi pond /p/; Pt= Püspök p; Klst= Kládlersarok p; Hlt= Herlakni p; Khlt= Kisherlakni p; Hit= Hidegségi p; Átjt= Átjáró p; Olt= Óberlakni p; Nhtt= Nagy határtisztás p.



1st table. Some stressed data of morphometry of Fertő-lake, from 116,00 m in absolute height altitude to Adria

Parts	territory					
	Austrian		Hungarian		total	
	surface					
	10^6 m^2	%	10^6 m^2	%	10^6 m^2	%
open water	127	54	11	15	138	45
reed-belt	107	46	64	85	171	55
total lake	234	76	75	24	309	100

On the basis of Kováts's data /1/.

2nd table. The chemical oxigen demand /COD/ of waters with Kaliumpermanganat /sMn/ and Kaliumbichromat /Cr/ in the Inner Ponds and Outer Water

Years	COD-sMn				COD-Cr				quotiens	
	Outer Water		Inner Ponds		Outer Water		Inner Ponds		$\frac{\text{COD-Cr}}{\text{COD-sMn}}$	
	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	Outer Water	Inner Ponds
	O_2 mg/l									
1980	15,71	2,454	23,09	2,802	97,92	9,31	117,89	12,751	6,233	5,106
1981	14,64	2,25	19,29	2,885	91,92	11,556	100,01	19,719	6,279	5,185
1982	17,0*	2,441	24,2	9,69	108,6	21,84	136,7	14,85	6,368*	5,648
1983**	16,7	2,62	24,7	4,003	100,98	17,489	105,14	20,865	6,047	4,368
$\bar{x}$	15,68		22,66		99,85		114,93		6,368	5,072
s_x	0,841		1,994		6,009		14,152			

* supplyed data, ** from January to October

x = measured data,

n = number of data,

$\bar{x}$ = arithmetic mean of data in a year = $\frac{\sum x}{n}$

s_x = dispersion of data = $\sqrt{\frac{/x_i - \bar{x}/^2}{n}}$

3th table. The conductivity of waters by 20°C /FVK_{20}/ in the arithmetic means from 1980 to 1983 in the Outer Water and Inner Ponds

Year	FVK_{20}					
	Outer Water		Inner Ponds		Hungarian port of lake	
	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
	S cm^{-1}					
1980	2075	110,1	2139	147,9	2110	132,4
1981	2199	170,2	2207	192,6	2192	180,6
1982*			2190	265,9		
1983**	2094	280,7	1865	261,4	1882	353,2
$\bar{x}$	2123		2100		2062	
s_x	54,7		138,1		131,0	

* wanting data;
** from January to October,

x = measured data;

n = number of data,

$\bar{x}$ = arithmetic mean of data in a year = $\frac{\sum x}{n}$

s_x = dispersion of data = $\sqrt{\frac{/x_i - \bar{x}/^2}{n}}$

4th table. The arithmetic means /$\bar{x}$/, minimums /m/ and maximums /M/ of data series of the Chlorophyll-a contents in Outer Water and Inner Ponds

Year	Outer Water			Inner Ponds		
	m	$\bar{x}$	M	m	$\bar{x}$	M
	mg m^{-3}					
1980	3,3	8,37	16,28	1,95	8,39	34,2
1981	0,56	5,22	17,79	0,30	4,35	12,22
1982*	2,26		13,53	0,37		15,50
1983**	2,00	8,96	15,59	2,98	9,84	40,12
$\bar{x}$	2,03	7,52	15,80	1,40	7,53	25,51
s_x	0,986	1,642	1,532	1,126	2,323	11,893

* wainting data,
** from January to October,

x = measured data,

n = number of data,

$\bar{x}$ = $\frac{\sum x}{n}$

s_x = dispersion of data = $\sqrt{\frac{/x_i - \bar{x}/^2}{n}}$