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Contributions to the knowledge of the chemistry and crustacean zooplankton of sodic waters: the Seewinkel pans revisited

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Abstract: The Seewinkel, the region between Neusiedlersee and the Hungarian border, has numerous shallow pans. 32 of these were investigated from May 1982 to May 1985. Chemical and zooplankton samples were taken in three month intervals. Results of the analyses revealed, that there were insignificant changes during the last decades. In some cases human activity, created a different chemistry of the water and an altered species composition of the zooplankton. In addition numerous smaller pans have disappeared during that time.

Kurzfassung:Der Seewinkel, die Region zwischen dem Neusiedler See und der Grenze zu Ungarn, beherbergt zahlreiche seichte Wasserkörper ("Lacken"). In der Zeit von Mai 1982 bis Mai 1985 wurden 32 von diesen besucht, und chemische, sowie Zooplanktonproben in dreimonatigem Intervall entnommen. Die Ergebnisse der Untersuchungen zeigten meist nur geringfügige Änderungen während der letzten Dekaden. In einigen Fällen jedoch verursachten menschliche Aktivitäten wesentliche Veränderungen des Chemismus und der Artenzusammensetzung des Zooplanktons. Darüber hinaus sind zahlreiche kleinere Lacken verschwunden.

1. Introduction

The Seewinkel, the region in the east of Austria between the Neusiedler See and the Hungarian border, is characterized by a multitude of shallow pans. Apart from the arid and semiarid zones of North America and East Africa, the Pannonian region - where the Seewinkel is situated - is one of those areas with an accumulation of highly alkaline water bodies. In North America and East Afrrica the soda content is the result of weathering of volcanic rocks, in Europe it originated from salt rich tertiary and quaternary sediments (Löffler, 1969).
An early classification of the Seewinkel pans - called "Lacken" - followed optical criteria. In some cases the names relate to this phenomenon (Schwarzsee-Lacke, Weiss See, etc.). The appearance of the dark water pans ("Schwarze Lacken") is characterized by the abundant development of plants and a humic brown coloration of the clear water. The bottom in many cases is a gravelly sediment. White pans ("Weisse Lacken) show typically poor vegetation. The whitish clay turbidity is partly held in suspension by colloids (Gerabek 1952, Löffler 1957). Increasing eutrophication has enhanced growth of reed, thus white and brown water coexist in the larger pans (Illmitzer Zicksee, Lange Lacke). There appears to be a development from white to dark water pan in the course of aging. On a large scale this intermediate form is represented by the Neusiedler See where there is a distinct border between the light, turbid water of the open lake and the humic brown clear water of the reed belt.

On the basis of the water chemistry a classification is much more complicated. The reason for this is the complex situation of the soils in the Seewinkel. According to Franz (1961) a. o. the development of soda soils is connected to a salt rich layer, continuous in the western part of the Seewinkel, and discontinuous concentrated to depressions, in the eastern part. The salt enrichment, originating during the Riss/Würm iceage, came from influence of mineralized groundwater in arid climatic conditions (Riedl 1965). The process which took place repeatedly (Bernhauser 1962) led to differences in the salt composition of the soils and consequently to variable water chemistry in the pans. In the western part of the Seewinkel (west of the Illmitz - Podersdorf road) the situation of the pans is more or less determined by the course of dams of different age (ancient shorelines of the Neusiedler See, Fig. 6).The pans in the central and eastern part, however, seem to be scattered irregularly on the gravel masses of the Riss and Würm iceage (Bernhauser 1962).

The large pans of the central Seewinkel which have gravelly bottoms (Lange Lacke, Wörthenlacken, Fuchslochlacke, Zicksee at St. Andrä a. o.) have connections with the ground water and accordingly desiccation is a rare event. Smaller pans in the north, south and east have deep mineralized soft sediments and fall dry fairly regularly (Birnbaumlacke, Ochsenbrunnlacke, Weiss-See, Martinhoflacke, Götschlacke, Salzsee a. o.). The pans near the shoreline of Neusiedler See are situated in Solontschak and Solonetz soils, free of gravel, between the oldest and the youngest dam (Nelhiebl 1980) (Oberer and Unterer Stinkersee, Silbersee, Albersee, Illmitzer Zicksee a. o.). In these cases drying up of the pans is a recurring event.

Since the investigation of the pans by Löffler (1957, 1959) little work was done on their limnology. In contrast to Löffler's work, which provides a conspectus of chemistry, Rotatoria and Crustacea, subsequent investigations dealt with specific problems (e.g.Jungwirth 1973, Newrkla 1974, Glatz 1976, Fischer-Nagel,1977, Dietz 1966). The Seewinkel, of interest not only from the point of view of its ecology, is economically also important for the Burgenland (agriculture and tourism developed considerably). It therefore seems to be obvious that changes must have taken place during the last few decades. Predominantly due to the increase of the agricultural areas, changes of the water chemistry, especially as regards the nutrients has occurred. Moreover numerous smaller pans disappeared.

For this reason an investigation programme was carried out by the Biological Station Neusiedler See, Illmitz, during the years from 1982 to 1985. The data on chemistry and crustacean fauna, although full of gaps, should make a comparison with earlier works possible and should show changes more clearly.

2. Sampling stations and methods

In the Seewinkel, an area of about 200 km^2, there are scattered some 50 to 60 pans. 32 of them were visited more or less regularly in order to collect samples for chemical and plankton analysis.The location of the pans investigated is shown in Fig. 1.

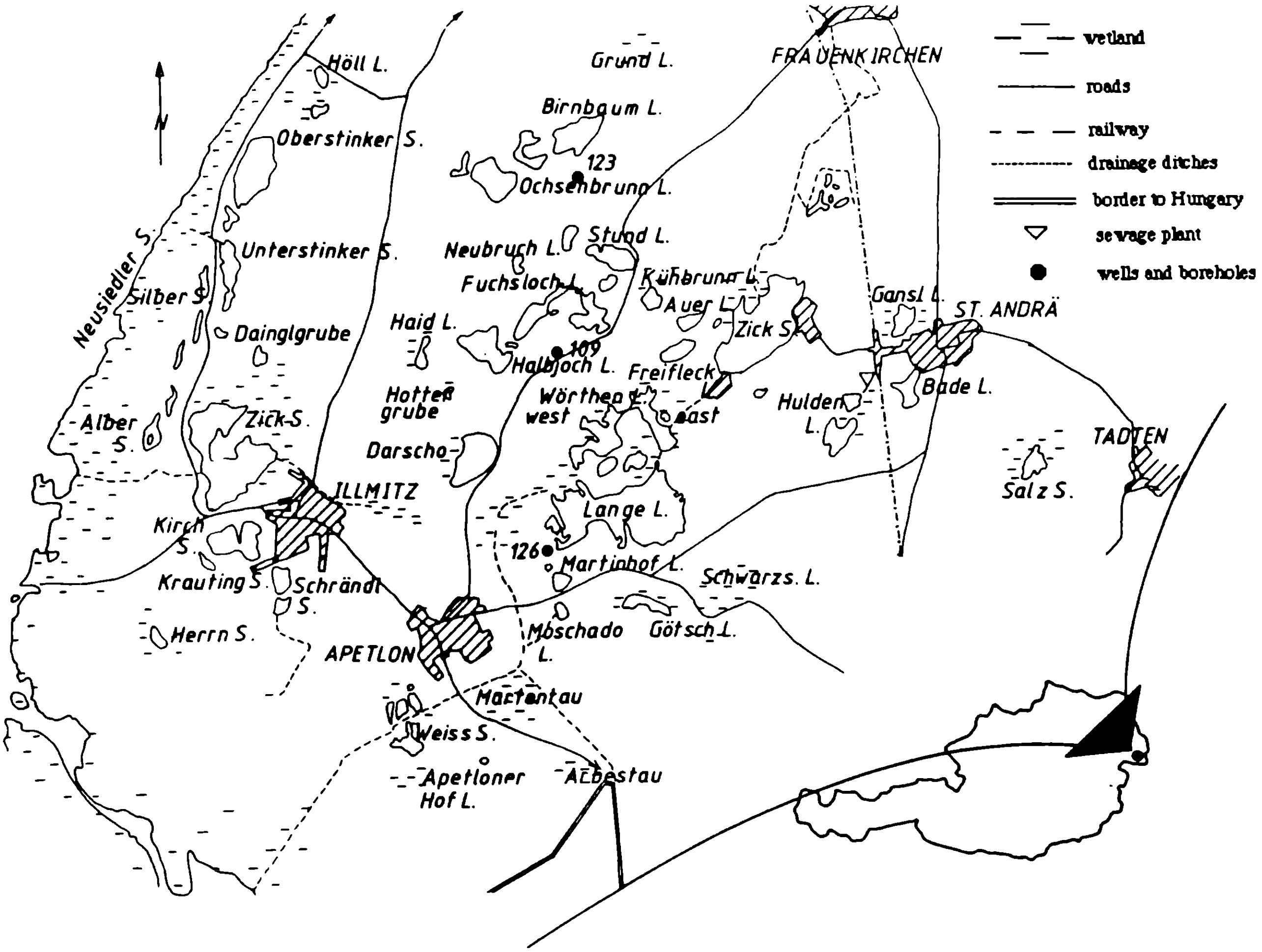


Fig. 1: The Seewinkel; map of the investigation area

From May 1982 to 1985 samples were taken, when possible, from all 32 pans every third month. From Lange Lacke, Huldenlacke, Albersee and Oberer Stinkersee monthly samples were collected from June 1982 to July 1983. Intensified sampling was done during 1984 in the Darscho, Halbjochlacke and Fuchslochlacke.

Apart from temperature, conductivity and pH the following parameters were measured:

- alkalinity (SBV), Ca and Mg: titration with n/10 HCl and EDTA n/40, according to Berger (unpubl.);
- Na, K: flame photometer;
- Cl: according to Mohr;
- SO_4: complexometric titration subsequent to exchange of cations;
- NO_3: sodiumsalicylic method;
- NH_4: indophenolblue method.

Analytical difficulties arose in several respects. High content of exceedingly fine inorganic turbidity (up to 10 $g.l^{-1}$) was a serious impediment to filtration. After filtration through a Whatman GF/F in many cases a colloidal turbidity remained making further treatment with a high speed centrifuge necessary. Alterations as regards the concentrations, especially of Ca and Mg can neither be excluded nor evaluated.

Table 1:List of the pans and sampling dates.

	1982			1983			1984		1985
	19. 05.- 02. 06.	17. & 19. 08.	14. & 21. 12.	15. 03.	26. & 28. 07.	24. & 27. 10.	07. & 09. 05.	13. & 16. 08.	26. 03.
1 Lange Lacke		*	*	*	*	*	*	*	*
2 Albersee	*	*	*	*	*		*		*
3 Huldenlacke	*	*	*	*	*	*	*	*	*
4 Oberer Stinker See	*	*	*	*	*		*		
5 Darscho	*	*	*	*	*	*	*	*	
6 Fuchslochlacke	*	*	*	*	*	*	*	*	*
7 Obere Halbjochlacke	*	*	*	*	*	*	*	*	*
8 Moschado Lacke	*	*	*	*	*	*	*	*	*
9 Zicksee, St. Andrä	*	*	*	*	*	*	*	*	*
10 Freiflecklacke	*	*	*	*	*	*	*	*	*
11 Badelacke	*	*	*	*	*	*	*	*	*
12 Martinhoflacke	*	*	*	*	*	*	*		*
13 Höllacke					*	*	*		
14 Salzsee	*	*	*	*	*	*	*	*	*
15 Kirchsee	*	*	*	*	*	*	*	*	
16 Wörthenlacke	*	*	*	*	*	*	*	*	
17 Birnbaumlacke	*	*	*	*		*	*	*	
18 Schrändlsee	*	*	*	*		*	*	*	
19 Kühbrunnlacke	*	*	*	*	*	*			
20 Unterer Stinker See	*	*	*	*		*	*		
21 Haidlacke	*	*	*	*	*		*	*	
22 Krautingsee	*	*		*	*		*		
23 Auerlacke	*	*	*	*	*	*			
24 Herrnsee		*		*	*	*	*	*	
25 Stundlacke	*	*	*	*	*	*		*	
26 Ochsenbrunnlacke	*	*		*	*	*	*	*	
27 Illmitzer Zicksee	*	*	*	*	*				
28 Neubruchlacke	*	*		*			*		
29 Golser Lacke				*			*		
30 Silbersee				*	*	*			
31 Dainglgrube				*	*	*			
32 Weißsee	*			*					
33 Schwarzseelacke	*								
34 Götschlacke									*

High salt concentrations prior to desiccation during summer enforced heavy dilution furthering the inaccuracy of the analytical results. Since the comparison of the water chemistry of the pans is made difficult by their changing water content, i. e. changes in concentration, the 50^{th} percentile was taken as a basis of comparison. This shows an average regardless of the extreme values, which of course will have to be discussed in context with the crustacean plankton.

Zooplankton samples were collected by a plankton net of 100 μ mesh size from the "open water", i.e. from the part of the pans without vegetation. The material was preserved with formalin immediately after collecting. Quantitative sampling is rather difficult from such shallow pans ("plankton swarms" could be observed by the naked eye), thus a quantitative description of the condition in the zooplankton does not seem to be feasible. Table 1 lists the pans and the sampling dates.

A correlation analysis, using Statview statistical package run on an Apple Macintosh computer, was used for the analysis of the data. In this analysis presence-absence data of all species from each pan and the chemical measurements were included.

3. Results

3.1. Climatic and hydrographic conditions

Measurements of temperature and precipitation were taken at the Biological Station Illmitz. Average air temperatures (weekly means), maxima and minima for the years 1982 to 1984 are shown in Fig. 2. Typical temperature development occured in 1982 when low temperatures during January and February were followed by a rapid increase. After a fall back in May a rapid rise to summer temperatures followed. The fall of high summer temperatures began in August. In spite of the differences from year to year summer maxima in all three years were between 25 and 35 °C. Owing to their shallowness water temperatures in the pans directly reflect the changes in air temperatures also reaching summer values above 30° C.

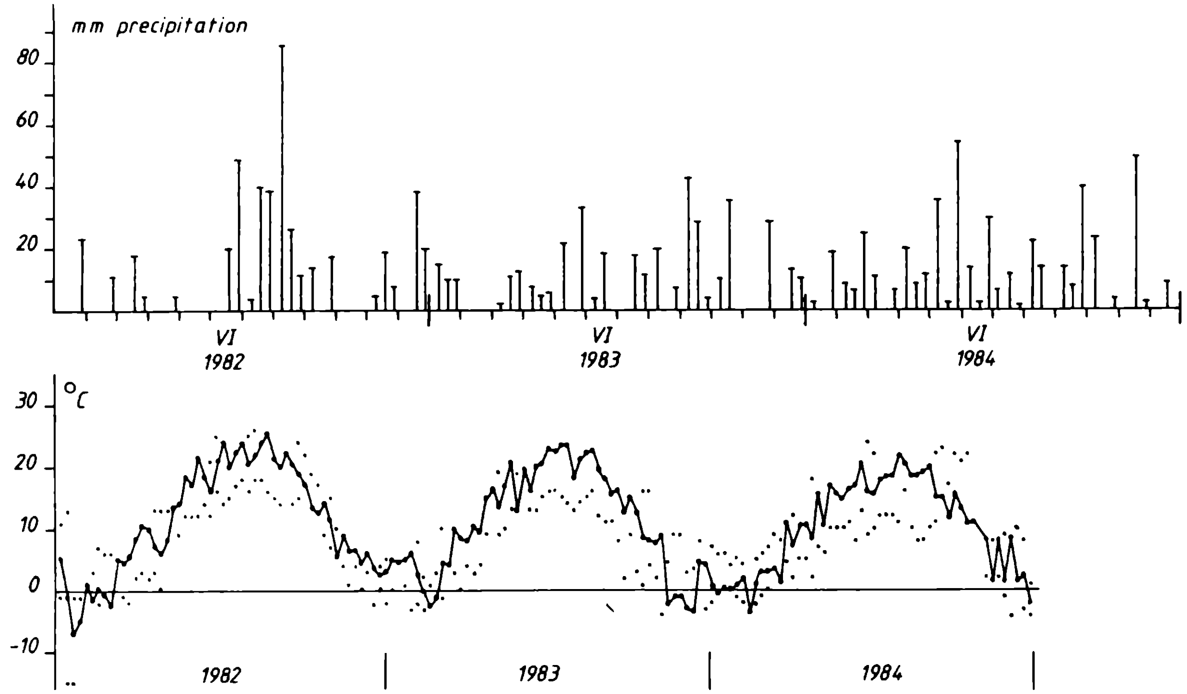


Fig. 2: Precipitation (10-day sums) and weekly mean temperature (maxima and minima are indicated by dots) during the investigation period.

Precipitation in the Seewinkel amounts to some 600 mm p.a. as a long term average. It therefore is one of the dry areas in Austria. Maximum rainfall occurs in spring, early summer and late autumn. Heavy rains, however, fall in the summer related to thunderstorms. This kind of distribution is demonstrated clearly for 1982 (Fig. 2). Total precipitation in 1982, 1983 and 1984 was 458 mm, 379 mm and 472 mm respectively. In 1982 rains occured predominantly during summer, whilst distribution was more even during the subsequent years. All three years can be classed as dry years. Several factors are of influence for the water level of the shallow pans which are naturally without inlet or outlet. Direct precipitation has a relatively low significance, since the water surface and a narrow strip of the surrounding country only can be considered as the catchment area. Accordingly, changes in water level can be registered only in connection with heavy downpours However, such kind of rain takes place during summer and is compensated rapidly by high evaporation. This kind of climatic condition, i.e. dry summers, is a prerequisite for the existence of alkaline lakes (Löffler 1961). Fig. 3 shows the development of water level (Data by Hydrographic Service of the Burgenl. Landesregierung) and precipitaiton (monthly sums) in the Oberer Stinkersee, Unterer Stinkersee and the Illmitzer Zicksee. These three pans were chosen because of their vicinity to the meteorological station although the water levels of Unterer Stinkersee and Illmitzer Zicksee were controlled with an artificial outlet. In contrast to the Oberer Stinkersee, their water level therefore cannot be regarded as natural, especially during spring.

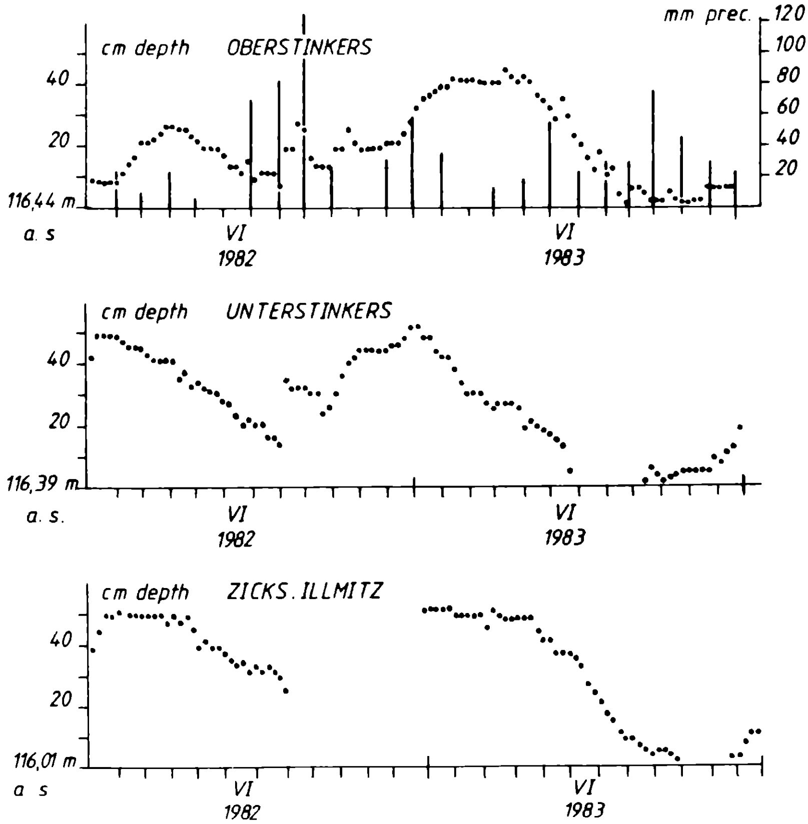


Fig. 3: Water level (dots) and precipitation (vertical bars, monthly sums) for three pans near the Biological Station Neusiedler See, Illmitz.

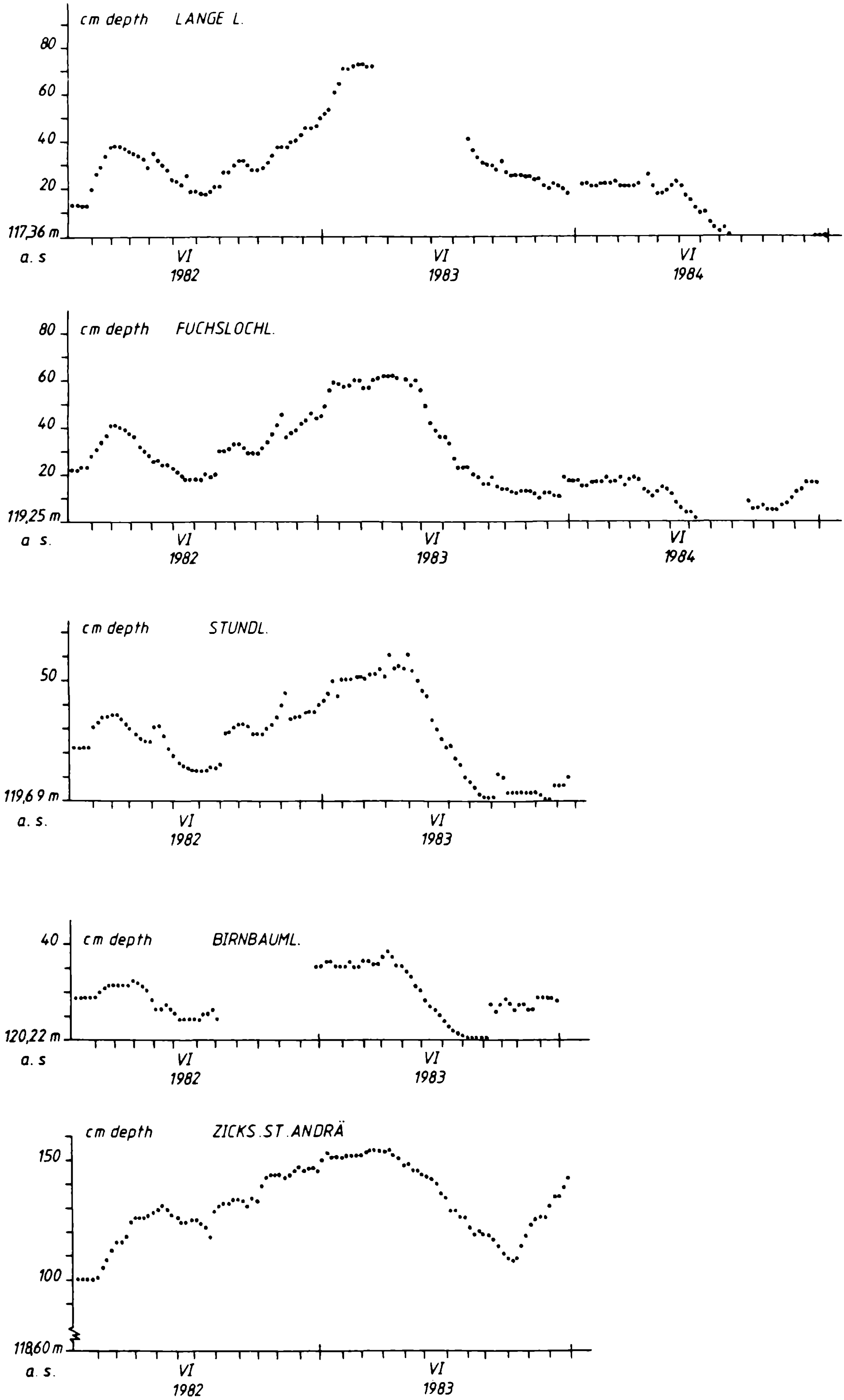


Fig. 4: Development of water level in several pans of the central and northern Seewinkel.

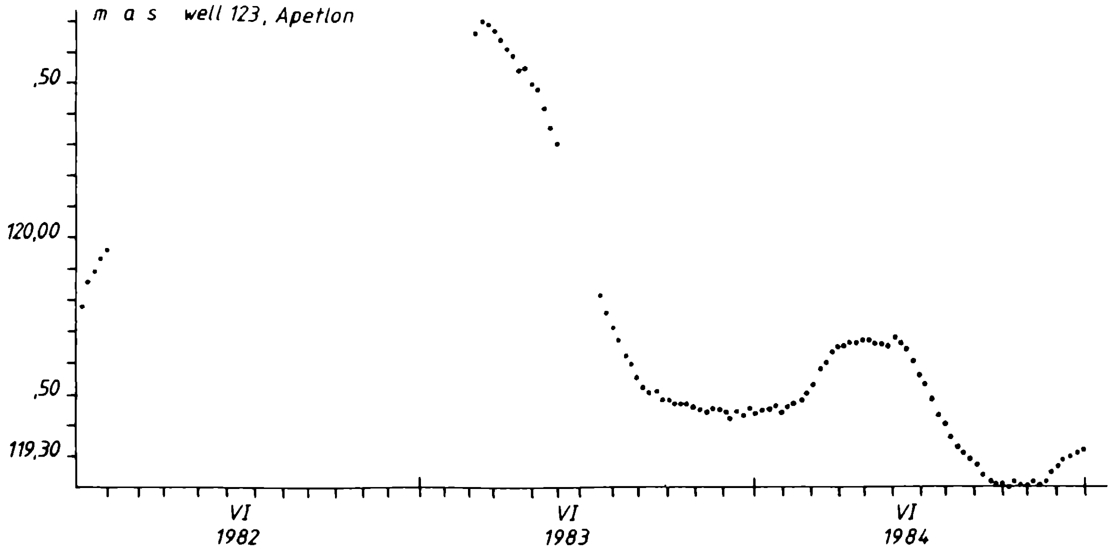


Fig. 5: Water level in well 123 (Paulhof) during the investigation period.

Heavy rains during July and August 1982 increased water levels significantly. This was followed by a subsequent decrease in September. Further direct influences of precipitation could not be stated although not only those three pans underwent pronounced changes in water level. 1983 for instance, during the second half of the year, extreme low water levels could be observed (Unterer Stinkersee and Illmitzer Zicksee fell dry) in spite of appreciable rains.

Responsibility for the water level of the pans primarily seems to rest with the groundwater and its annual oscillation. Some pans of the central (Lange Lacke, Fuchslochlacke), the northern (Stundlacke, Birnbaumlacke) and the eastern Seewinkel (St.Andräer Zicksee) are shown in Fig. 4. It appears that the basic pattern in all pans was similar; high water levels in spring were followed by a decrease from May onwards. Low levels were reached in June and continued till September. The subsequent increase led again to high spring levels. "Individual" differences naturally were present regarding the beginning and duration of high and low water levels as well as their amplitude. Comparison with changes of water level in wells (Data by Hydrographic Service of the Burgenl. Landesregierung) revealed very good agreement with that of the pans (Fig. 5). This can be demonstrated most impressively for well 123 (Paulhof) , the Lange Lacke and Fuchslochlacke. Especially this example shows clearly that the rain induced rise of the water levels during July and August 1982 matches similar changes in the well. Other pans and wells reacted likewise although somewhat less clearly. It can be assumed therefore that heavy rains influence the hydrographic conditions of the pans via their impact on the groundwater level. It is evident that local rains and groundwater level do not have to correspond necessarily, however, since precipitation and groundwater had similar trends in the whole catchment area of the Rabnitz (in which the Seewinkel and the Neusiedler See are situated) (HYDROGRAPH. JHB, 1982) it is possible to relate these two phenomena. There appears to be a lag of 6 to 7 months between precipitation and groundwater changes (see Figs. 3 and 5). A similar connection could be found for Neusiedlersee itself (Forró & Metz 1987). It seems to be important to stress that water level changes in the pans appear to be influenced by the ground water in first place. The impact of local precipitation can be present, however, apparently it is not as important as is usually believed .

3.2. Chemistry

A general feature of the chemistry of the pans is the dominance of Na/K over Ca/Mg. This type of water is also known from the hungarian pans (Woynarovich 1941, Dvihally & Ponyi 1957, Megyeri 1959, 1974, 1975).

A "geographical classification "based on the changing ion rations within the alkaline spectrum was undertaken by Löffler (1959). His investigation revealed the central Seewinkel pans with the highest soda concentration, the western pans being rich in Cl, and the pans in the south west the south and east as rich in Mg and SO_4 but with lower concentrations. This classification is still true today in most cases. The subsequent comparison of the chemistry among the pans in the present investigation uses the 50 th percentile of the measured parameters.

3.2.1. Conductivity ($\mu S \cdot cm^{-1}$) (Fig. 6)

Highest values (> 4000 $\mu S \cdot cm^{-1}$) were measured in the central (Ochsenbrunnlacke , Halbjochlacke and Freiflecklacke) and in the western part of the Seewinkel (Herrnsee, Dainglgrube, Höll-Lacke, Silbersee, Albersee, Oberer Stinkersee and Illmitzer Zicksee) . Extremes rated up to 30 000 $\mu S.cm^{-1}$ and could be found in the Ochsenbrunnlacke, Höll-Lacke, Halbjochlacke and Oberer Stinkersee. Maximum values above 10 000 were present in all others. In the pans with the lowest conductivity the values were less than 2000 $\mu S \cdot cm^{-1}$ (Huldenlacke a special case because of the influence of the sewage plant of St.Andrä, Martinhoflacke, St.Andräer Zicksee, Salzsee, Neubruchlacke, Badelacke , Lange Lacke and the eastern and western Wörthenlacke).

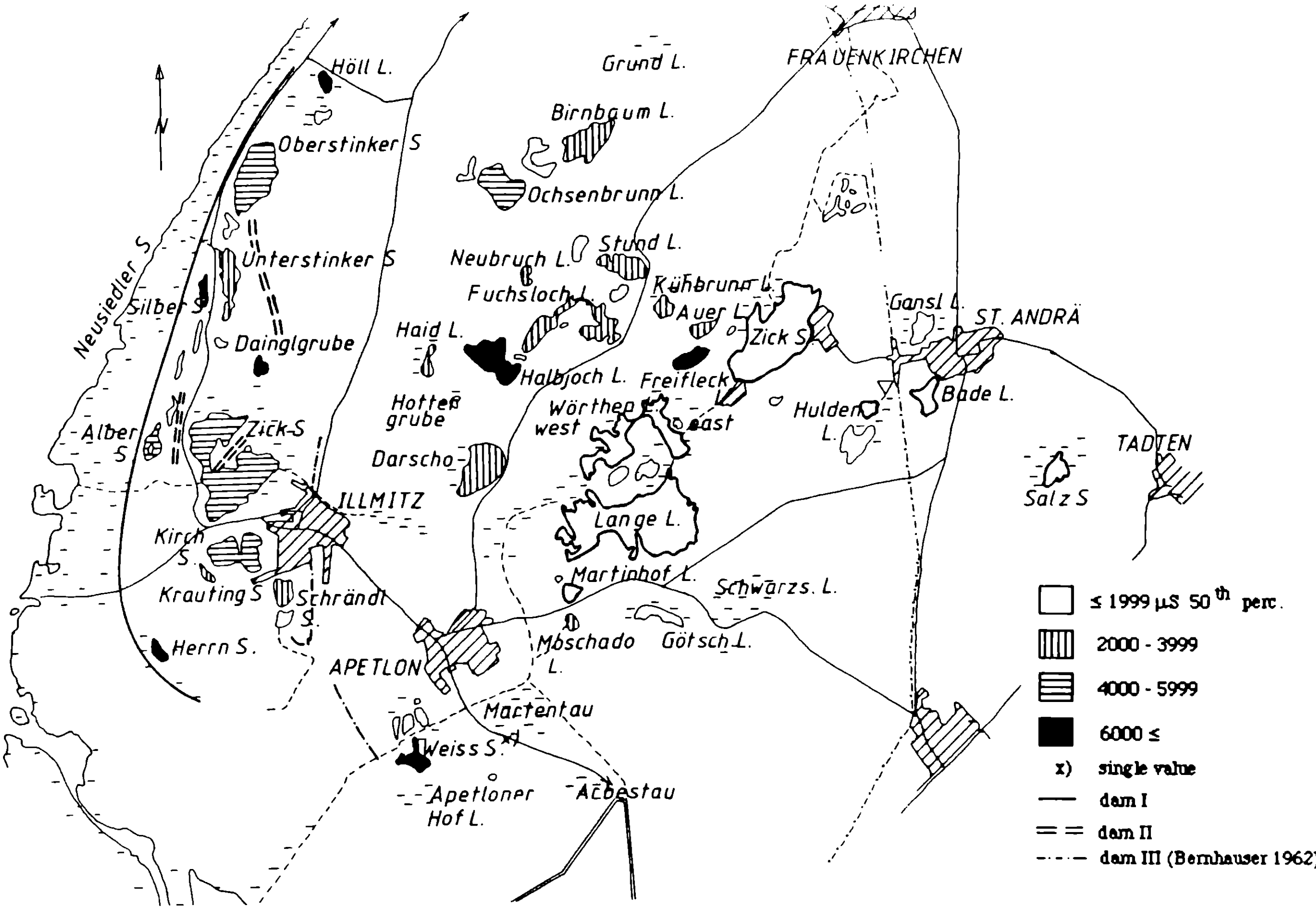


Fig. 6: Conductivity in the various pans (µS cm^{-1}, 50th percentile).

3.2.2.Alkalinity (SBV) (Fig. 7) and soda content (Fig. 8, Table 2)

High alkalinity (SBV) with a dominance of sodium is a significant feature of these waters. When compared to the Wulka, a small river in the catchment area of the Neusiedler See (Ca/Mg hydrogen carbonate, SBV about 5 meq.l^{-1}), the pans with the lowest concentrations already showed an increased alkalinity (St.Andräer Zicksee 6.8 and Huldenlacke 7.4). There was a significant increase towards the west where, especially at times of low water levels and previous to drying out, much higher values could be observed (maximum 299 meq.l^{-1} , Ochsenbrunnlacke in July 1983) . Still higher values are recorded by Herzig (unpubl. data) who found a SBV of 1138 meq.l^{-1} in Fuchslochlacke and of 403 meq.l^{-1} in the Stundlacke just before drying out (16.8.1971).

There were wide variations not only in the 50th percentiles but also in the amplitude within one pan. The Zicksee of St.Andrä which is the largest pan as far as volume is concerned , not only showed the lowest concentrations but also had hardly any change in SBV in spite of water level changes of some 5O cm. (Fig. 9). Annual changes in the Lange Lacke which is more or less perennial were in the range of 11 to 22 meq.l^{-1} , the Oberer Stinkersee, an ephemeral pan, showed SBV-values about 2O to 200 meq.l^{-1} (Fig.9). In both pans mentioned last, SBV trend was reciprocal to water level.

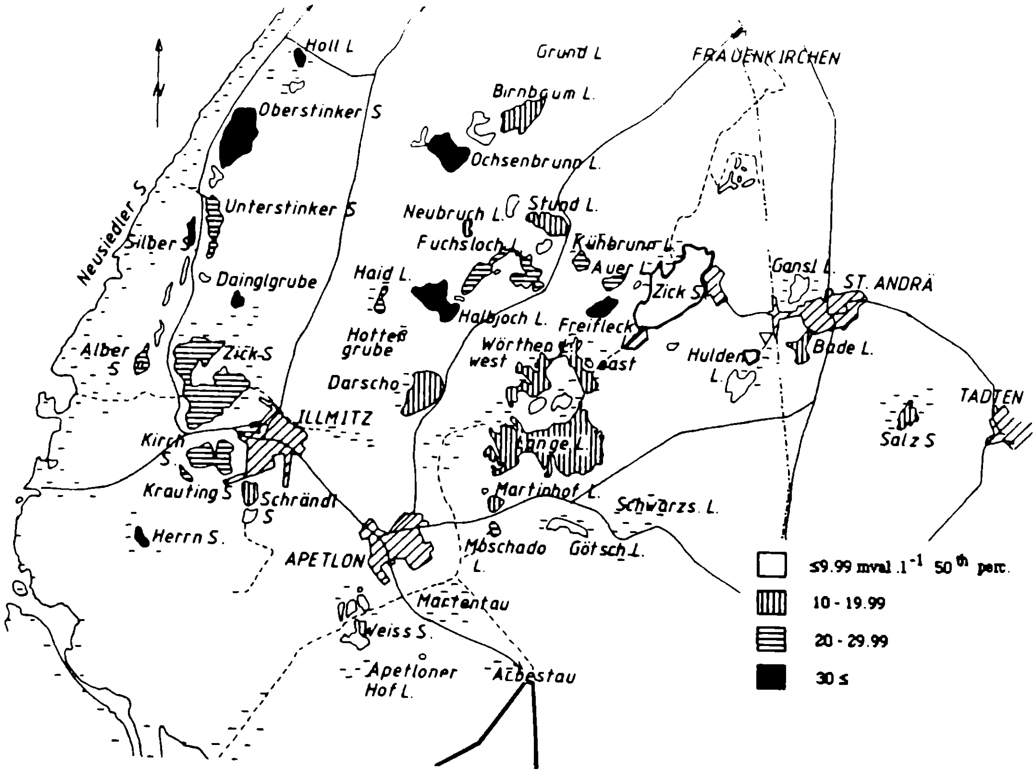


Fig. 7: Alkalinity in the various pans (meq.l^{-1}, 50th percentile).

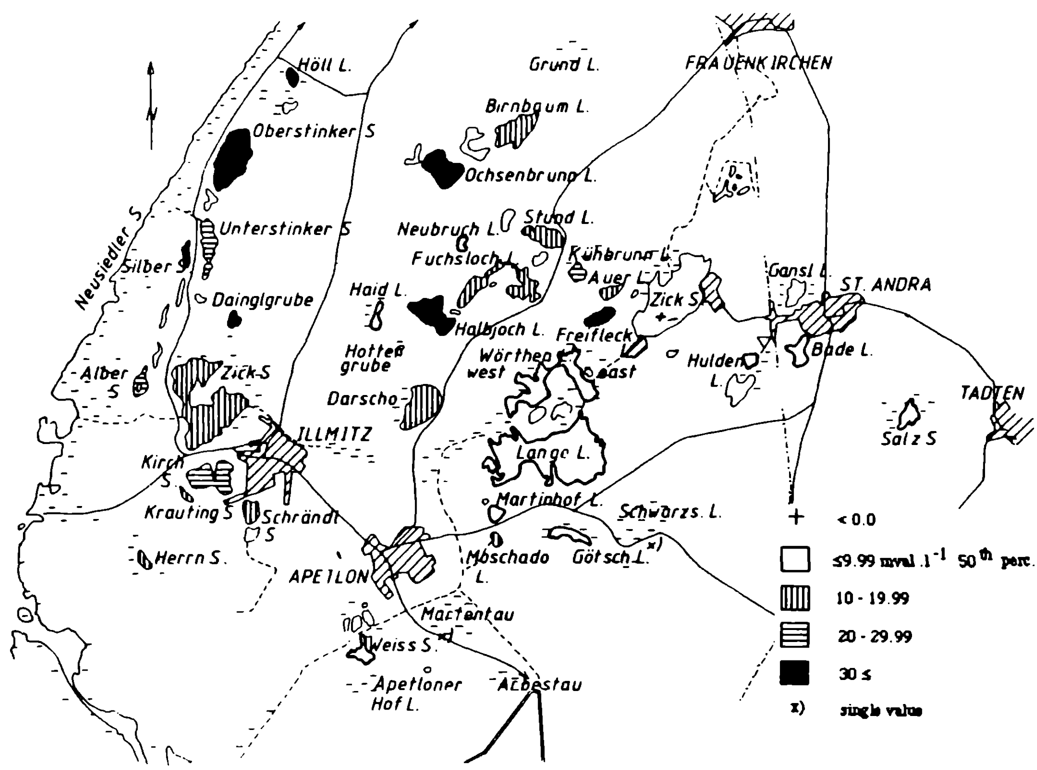


Fig. 8: Soda in the various pans (meq.l^{-1}, 50th percentile).

Table 2: Comparison of alkalinity values (SBV) measured in various Seewinkel pans by various authors (mean, standard deviation (s)).

	Gerabek 1942	Stundl 1949			Löffler 1956		Knie 1958			Löffler 1959			Dietz 1963			Glatz 1976			Fischer-Nagel 1977			present paper		
		SBV	±s	n	SBV	±s	SBV	±s	n	SBV	±s	n	SBV	±s	n	SBV	±s	n	SBV	±s	n	SBV	±s	n
Albersee	10.5				20.2					41.4	12.2	5	31.5	22.0	3				24.0	4.3	5	35.5	27.8	17
Apetloner Hof Lacke																						10.7		
Arbesthaulacke	14.4																					10.2		
Auerlacke	16.6																		13.8			20.7	5.7	6
Badelacke					18.6					25.2	10.8	2							17.0	11.1	2	19.8	21.6	8
Birnbaumlacke	24.5				74.4					96.9	64.9	2				64.6	59.5	55	14.5	9.9	4	12.8	3.6	7
Dainglgrube		43.5	32.1	4						39.2	9.0	5							25.6	4.9	2	25.6	4.9	2
Darscho	14.8				11.1		19.5	3.5	4	18.7	2.0	4							20.2	0.5	3	18.3	6.5	11
Freiflecklacke	18.7									44.5	25.0	3							17.9	5.7	3	43.8	29.2	9
Fuchslochlacke	21.6				46.8		73.6	31.8	4	42.8	11.4	32	10.3						41.8	32.9	11	42.2	38.9	11
Golser Lacke *					9.2					21.2	11.3	2										17.2	4.4	2
Haidlacke	17.7									29.0	3.9	2							9.9	4.1	3	21.5	10.1	7
Obere Halbjochlacke	24.6				69		82.6	27.9	5	70.3	15.6	3										85.6	39.5	12
Hermsee	16.4				17.8					29.7	1.8	3	30.0						30.7	1.8	2	36.1	15.6	6
Huldenlacke	12.4				10.5					20.7	10.6	2							9.0	0.8	3	8.2	5.4	19
Kirchsee	11.8				12.0					21.0	5.5	3	38.5									35.8	23.4	8
Krautingsee										26.3	3.3	2							28.5			33.9	24.9	4
Kühbrunnlacke	18.5				32.4					51.8	26.9	3							19.1	9.8	2	45.4	54.3	6
Lange Lacke	9.8				10.2		11.8	1.8	4	12.1	1.1	4										13.4	4.3	20
Martinhoflacke	10.5				6.8					23.2	9.0	3	12.0						10.4	6.5	3	19.8	21.6	6
Moschadolacke	13.8				17.1					26.9	9.2	4							17.2	16.6	2	24.8	15.4	8
Neubruchlacke																			59.9	28.8	6	18.4	17.8	4
Obere Höllacke	11.4				30.4					46.0	15.5	3							75.5			90.6	74	7
Oberstinkersee	16.4				32.6					39.7	17.0	3							33.3	17.6	3	52.4	43.6	17
Ochsenbrunnlacke	26.2				66.0					66.3	23.3	2							29.7	24.8	6	82.0	99.7	7
Salzsee	13.2				4.3														8.9	5.1	4	16.3	6.7	8
Schrändlsee	9.7				9.6					18.4	5.2	3							24.2	10.2	2	19.0	8.5	7
Schwarzseelacke	9.6				8.5					11.7	4.8	2										4.2		
Silbersee		18.0	12.4	4	14.2					44.3	32.3	3							34.7	18.0	4	71.5	28.7	3
Stundlacke	16.6				52.6					20.3	3.8	3							19.7	8.1	4	28.2	33.6	6
Unterstinkersee	16.3				20.0					30.2	7.7	4							28.1	7.0	2	29.8	11.0	6
Weißsee	12.0				11.4					15.9	1.0	3										14.0	0.6	2
Wörthenlacke east	10.2									13.5	2.7	3							10.3	0.7	2	11.9	1.8	8
Wörthenlacke west										13.1	1.2	2							11.5	0.8	2	12.9	2.0	8
Zicksee St.Andrä	10.1				9.2		9.0	1.4	4	9.5	1.2	2							7.2			6.7	0.6	9
Zicksee Illmitz	8.6				14.4		42.4	31.4	4	27.8	6.9	4										30.9	27.5	5

* Not included in map of Fig. 1.

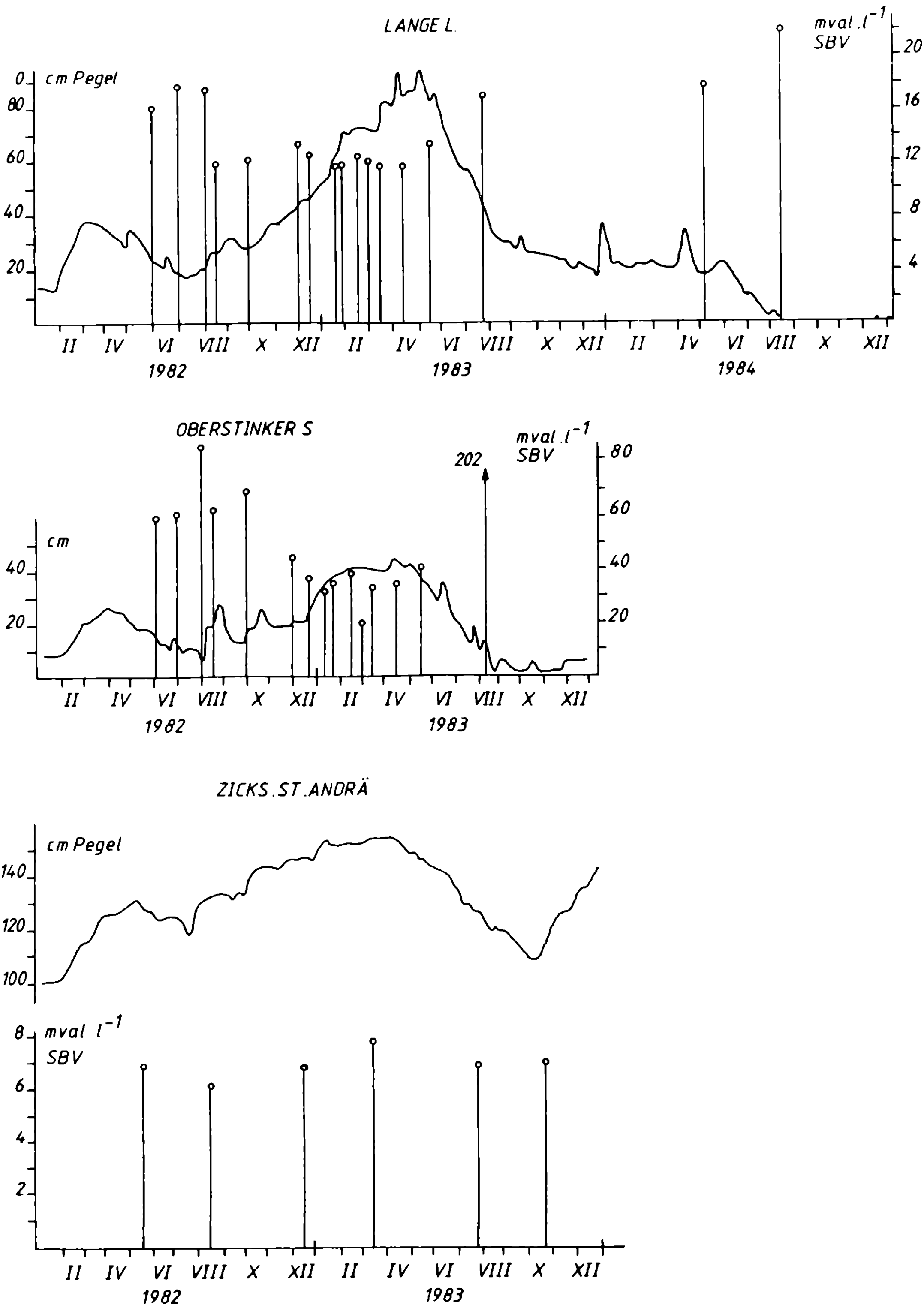


Fig. 9: Phenology of water level and alkalinity of pans (mval.l^{-1} = meq.l^{-1}).

The soda content is defined as the difference of Ca+Mg - SBV (in meq.l^{-1}) (Berger 1971) where a negative result is the estimate for soda. This also changed in the course of the year.Four pans investigated monthly (Huldenlacke, Lange Lacke, Albersee and Oberer Stinkersee) will serve as an example (Table 3). Lange L.: Highest values were reached in the time from May to July 1982 (- 1O meq.l^{-1}). After ice-break soda concentration was about half as much and remained low in spring 1983 (high water level see Fig. 10). Due to its perennial nature (influence of groundwater) oscillations were limited compared with other pans. Albersee and Oberer Stinkersee: These ephemeral pans showed extreme annual changes. Soda contents, shortly before desiccation, were above - 100 meq.l^{-1} (26.7.1983), minima still ranged from -10 to -20 meq.l^{-1} (2.3.1983, ice-break).

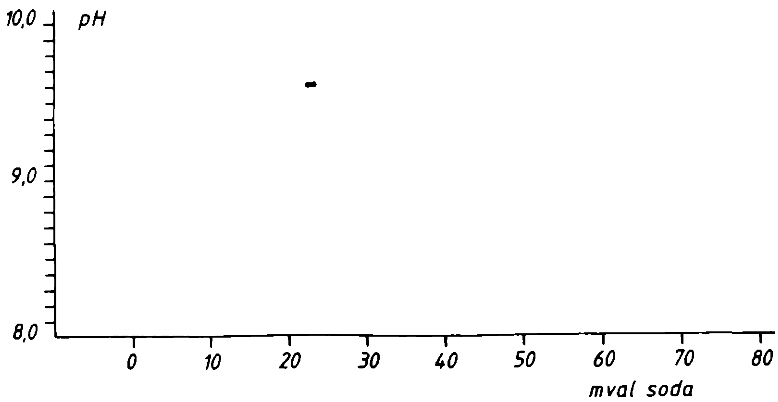


Fig. 10: pH plotted against soda concentrations. Both values are 50^{th} percentiles.

Table 3: Seasonal changes in the soda content (meq.l^{-1}) of some water bodies

	Lange Lacke	Albersee	Oberer Stinkersee	Huldenlacke
19.5.1982				+3,6
8.6.1982	-9.4	-10.9	-57.9	
1.7.1982	-10.6	-44.5	-59.5	-9.6
29.7.1982	-11.5	-39.6	-81.5	-5.3
17.8.1982	-8.1	-30.8	-56.7	-11.1
30.9.1982	-7.1	-44.8	-66.8	+1.8
2.12.1982	-7.5	-26.4	-43.4	+3.0
14.12.1982	-6.7	-31.9	-36.4	+3.6
12.1.1983	-5.8	-16.1	-30.0	-3.4
25.1.(E)	-6.0	-16.8	-33.5	-2.8
17.2.(E)	-6.1	-25.7	-37.4	
2.3. (E)	-5.9	-11.8	-18.1	+1.5
15.3.1983	-5.5	-14.5	-32.0	+0.8
11.4.1983	-5.2		-32.6	+1.0
11.5.1983	-6.2	-20.0	-40.2	+0.3
26.7.1983	-8.7	-101.6 x)	-198.8 x)	+2.4
7.5.1984	-15.3	-26.3	-64.3	-5.2
13.8.1984	-18.9 x)	- x)	- x)	-4.5

Soda content (meq.$^{-1}$) (Ca+Mg) -alkalinity; (E) icecover.It was never observed lower than 8 and only in few occasions it exceeded 10. x) desiccation

In the case of Huldenlacke the effluent of the sewage treatement plant of St.Andrä affected the annual changes. Soda was evident in summer 1982, January 1983 and in 1984. In many cases Ca/Mg dominated the alkali metals demonstrating the effect of mans activity.

Two measurement were made in 1984 (7.5. and 13.8.) when as a rare case the Lange Lacke nearly fell dry . (Fig.4, Table 2). Accordingly high soda concentrations were encountered (-18.9 meq.l^{-1}) . The Huldenlacke had a content of - 4 to - 5 meq soda. In the Albersee and the Oberer Stinkersee in May 1984 values remained lower than the maxima recorded . These two pans were dry in August 1984.

A comparison of the pans revealed a picture very similar to the distribution of the SBV. This was to be expected, especially in cases where other anions (SO_4 and Cl) do not play an important role. It apparently was the case for more or less all the pans with one exception. In the Herrnsee there was a notable discrepancy between SBV and soda. The reason for this will be demonstrated later.

In the Zicksee at St.Andrä no soda was to be found in 1982/83 and low values (-3.4 meq.l^{-1}) were encountered in 1984.

3.2.3. pH (Figs. 10+11)

It can be seen (Fig. 10) that median pH and soda concentrations show quite good correlation, in other words, the "distribution" of the pH generally corresponded to that of the soda.

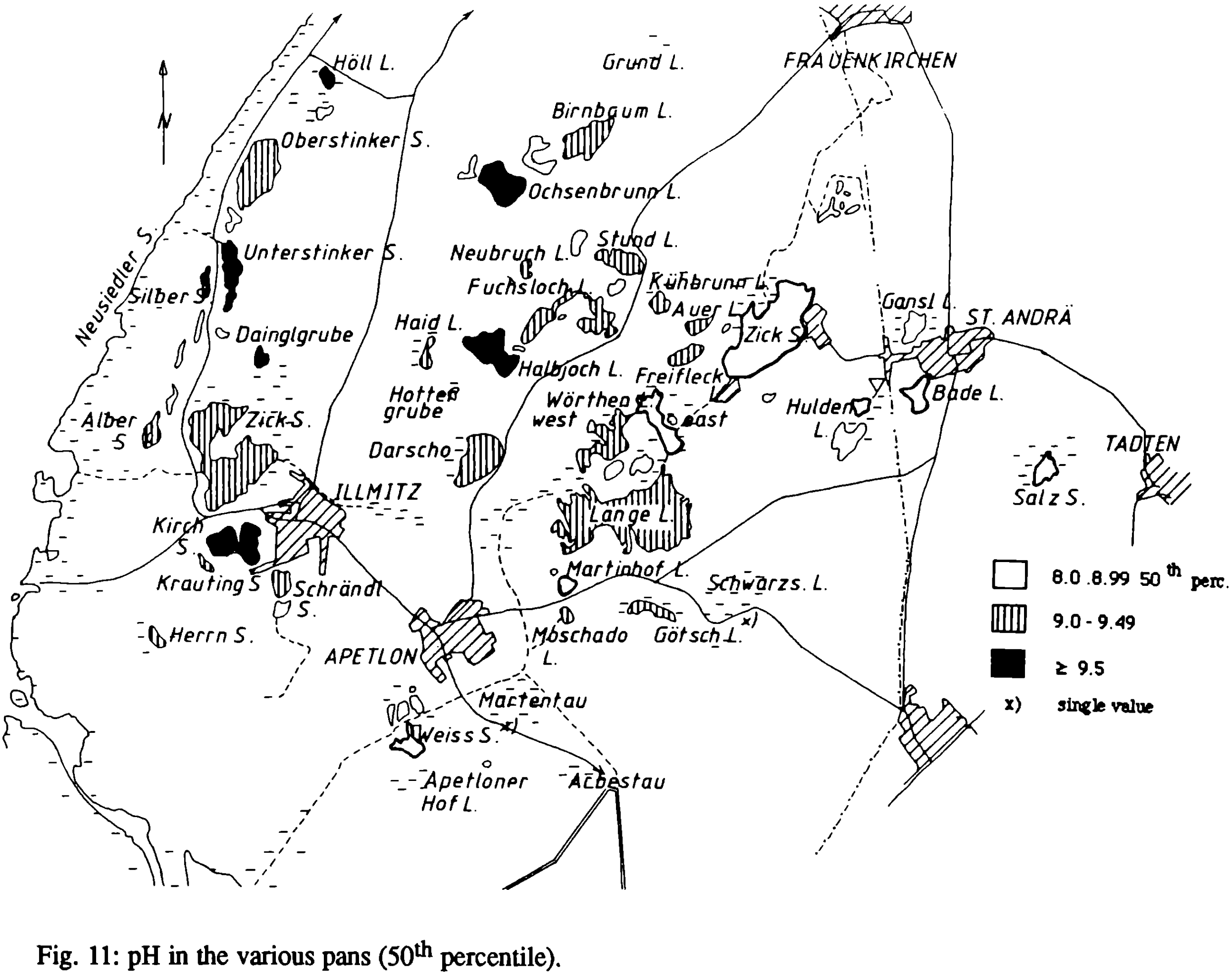


Fig. 11: pH in the various pans (50^{th} percentile).

During our investigations pH usually ranged between 8 and 10. It was never observed lower than 8 and only in few occasions it exceeded 10. This occured in Albersee, Fuchslochlacke, Haidlacke, Halbjochlacke, Oberer Stinkersee and Schrändlsee. There was a clear tendency towards higher values during summer. This fact, also observed by Löffler (1959) and Stundl (1938), is most likely to be attributed to primary production. Unfortunately there are no data on the algal production available. Therefore it is difficult to evaluate the effect in regard to the fluctuation since it is to be remembered that the increase of alkalinity during summer also contributes to this phenomenon. As can be seen from Fig. 23 high pH levels concurred with high nitrogen concentrations especially in the Albersee. Peak values however, coincided with low N (September 1982 and March 1983) suggesting that in these cases primary production led to a decrease in nutrients. No such effect is to be seen in the Lange Lacke. On two occasions pH higher than 1O could be observed during winter. In the Fuchslochlacke and the Halbjochlacke pH was 1O,11 in December 1983.

3.2.4. Ca and Mg (Figs 12+13)

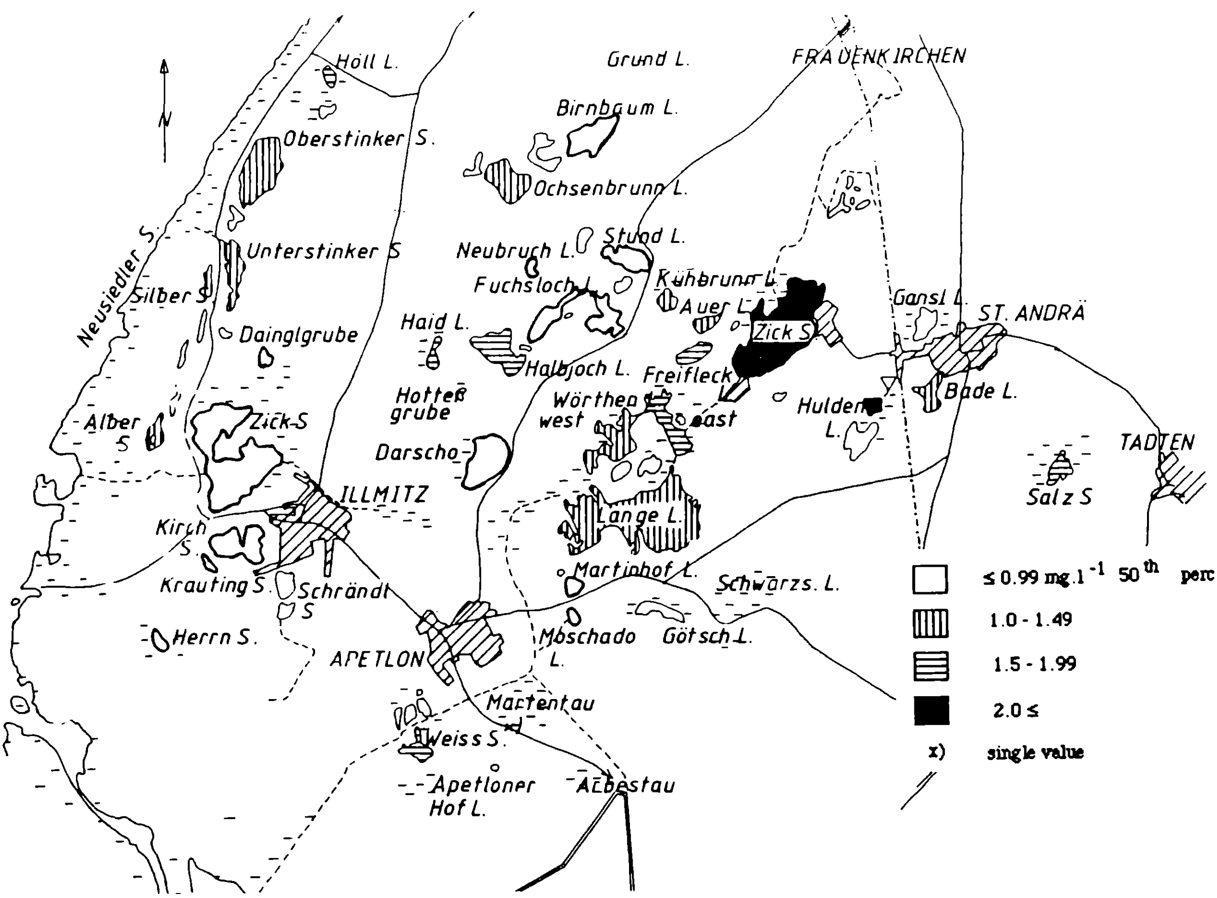


Fig. 12: Ca in various pans (mg.l^{-1}, 50^{th} percentile).

Ca and Mg concentrations remained comparatively low a feature well documented for alkaline lakes all over the world. Somewhat higher values were found in the less concentrated pans, the Zicksee at St.Andrä and the Huldenlacke. A summary of the distribution of Ca is given in Fig. 13. The trend of decreasing concentration with increasing SBV is obvious (compare Fig. 7).

Mg concentrations, which were generally higher than those of Ca, showed very interesting regional distribution which was independent of the trends of concentration (Fig. 13). Apart from the special position of the Zicksee at St.Andrä, increased concentrations were found south of the line Salzsee - Wörthenlacke - Haidlacke- Unterer Stinkersee (Fig. 13). Highest values were reached in the Krautingsee, Herrnsee, Weiss See and the Silbersee. The Schrändlsee Martinhoflacke, and Moschadolacke, also south of that line, in contrast had very low concentrations of Mg. This regional distribution concurs with the results published by Löffler (1959). There is also agreement with the Mg concentrations of groundwater, as was demonstrated by Knie & Gams (1960) in context with their investigation of wells in the Seewinkel. The iso-lines for Mg (<4O $mg.l^{-1}$ and > 5O $mg.l.^{-1}$) , arbitrary boundaries used by these authors, are included in Fig. 13.

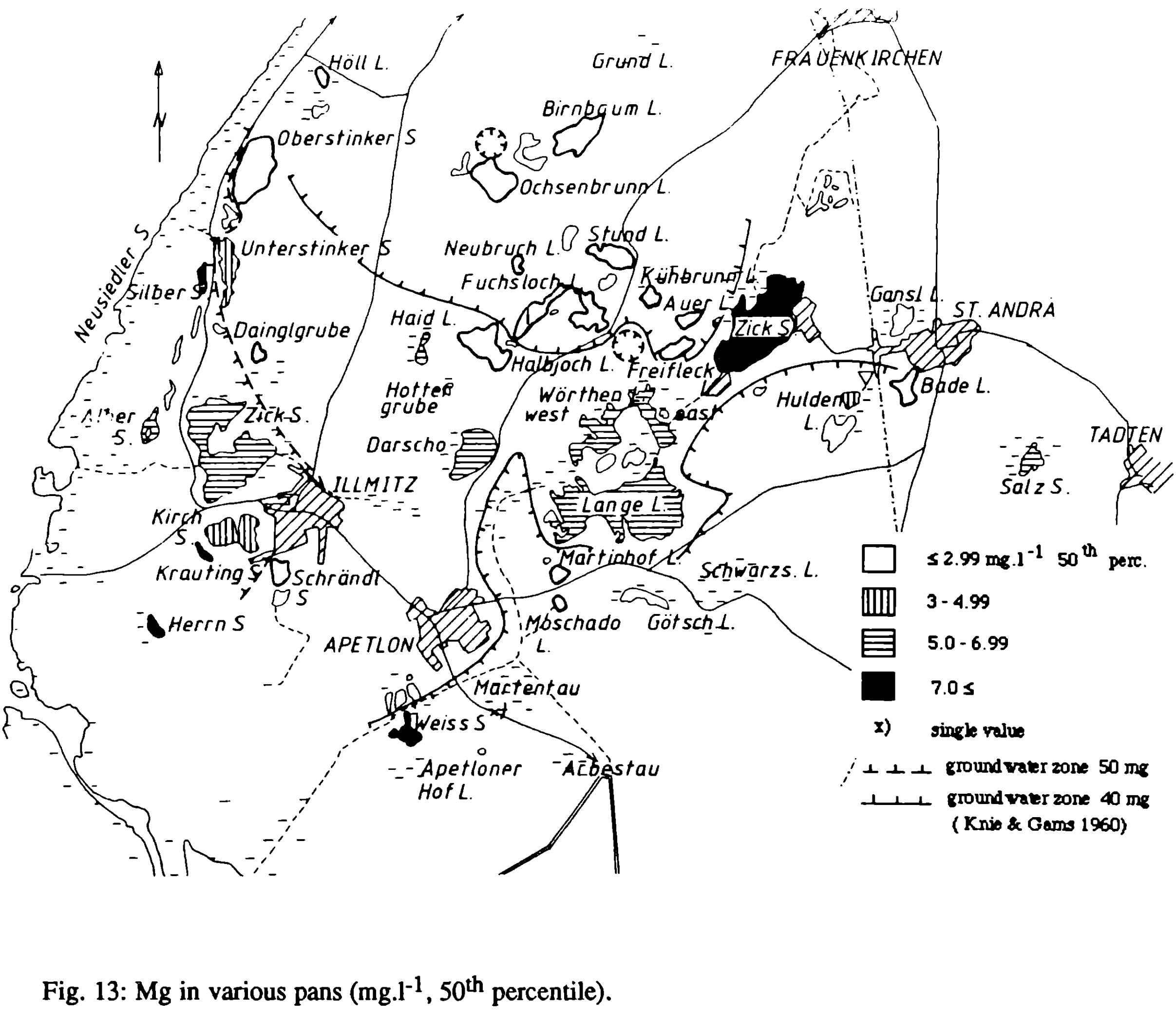


Fig. 13: Mg in various pans ($mg.l^{-1}$, 50^{th} percentile).

3.2.5. Na and K (Figs 14+16)

Na and K concentrations in the majority of the pans agreed with the general concentration (given as SBV), several of them, however, show notable differences. In the Weiss S. (single value) the Krauting S., Albersee and Silbersee sodium concentrations were above, in Unterer Stinkersee, Ochsenbrunnlacke and Herrnsee below expectation (Fig. 15). With K concentrations a different situation occured. There was not only an accumulation of high values in the western part of the Seewinkel (Fig. 16) but also an independence of total concentration (Fig. 15). Generally, concentrations were below 1 meq.l^{-1}. In the western part, however, values nearly always were above 1 meq.l^{-1} . An exception was the Unterer Stinkersee which was notable for its low concentration amongst the highly concentrated pans. Highest values were reached by the Silbersee (3.6 meq.l^{-1}). Because of the low n (3) this 50th percentile is not well established.

The increased presence of potassium has been taken as a hint for pollution by artificial fertilizers and manure (Löffler 1959, Knie & Gams 1960). However there was no striking difference in this regard between the pans in the western Seewinkel and the others. Here high concentrations are not to be seen in this context but probably rather in the common origin of these pans.

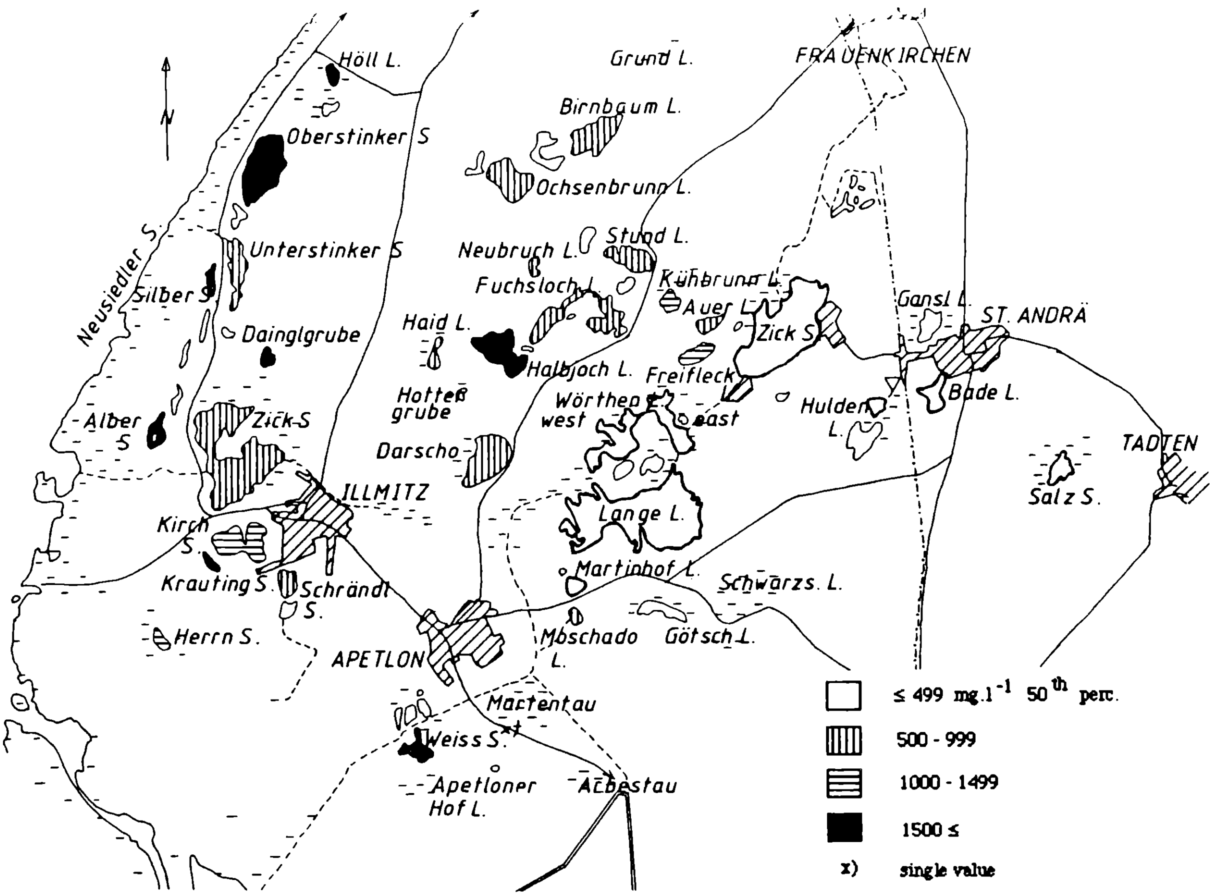


Fig. 14: Na in the various pans (mg.l^{-1}, 50th percentile)

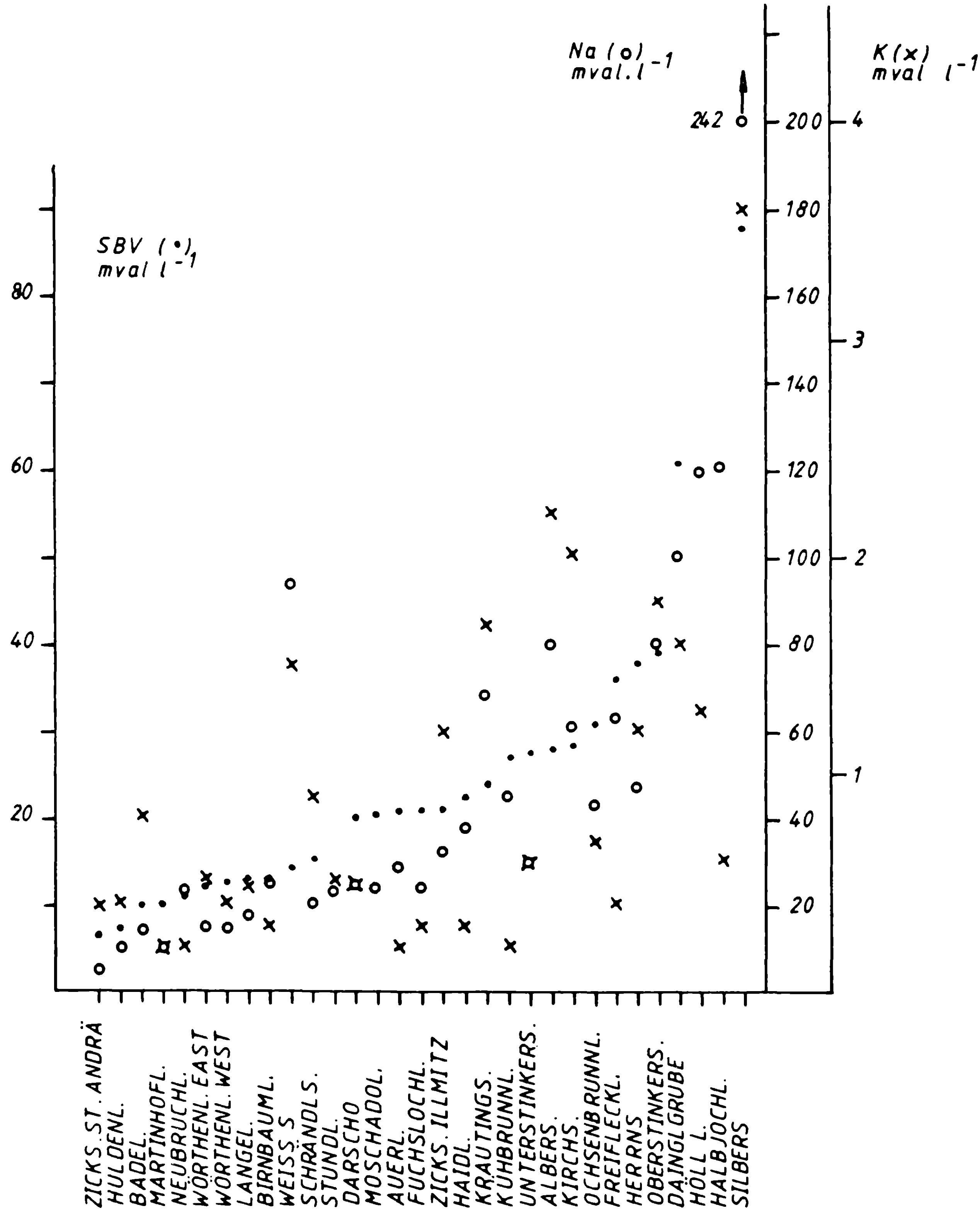


Fig. 15: Alkali metals plotted with alkalinity (SBV) arranged in increasing order (values-50th percentiles) (mval.l^{-1} = meq.l^{-1}).

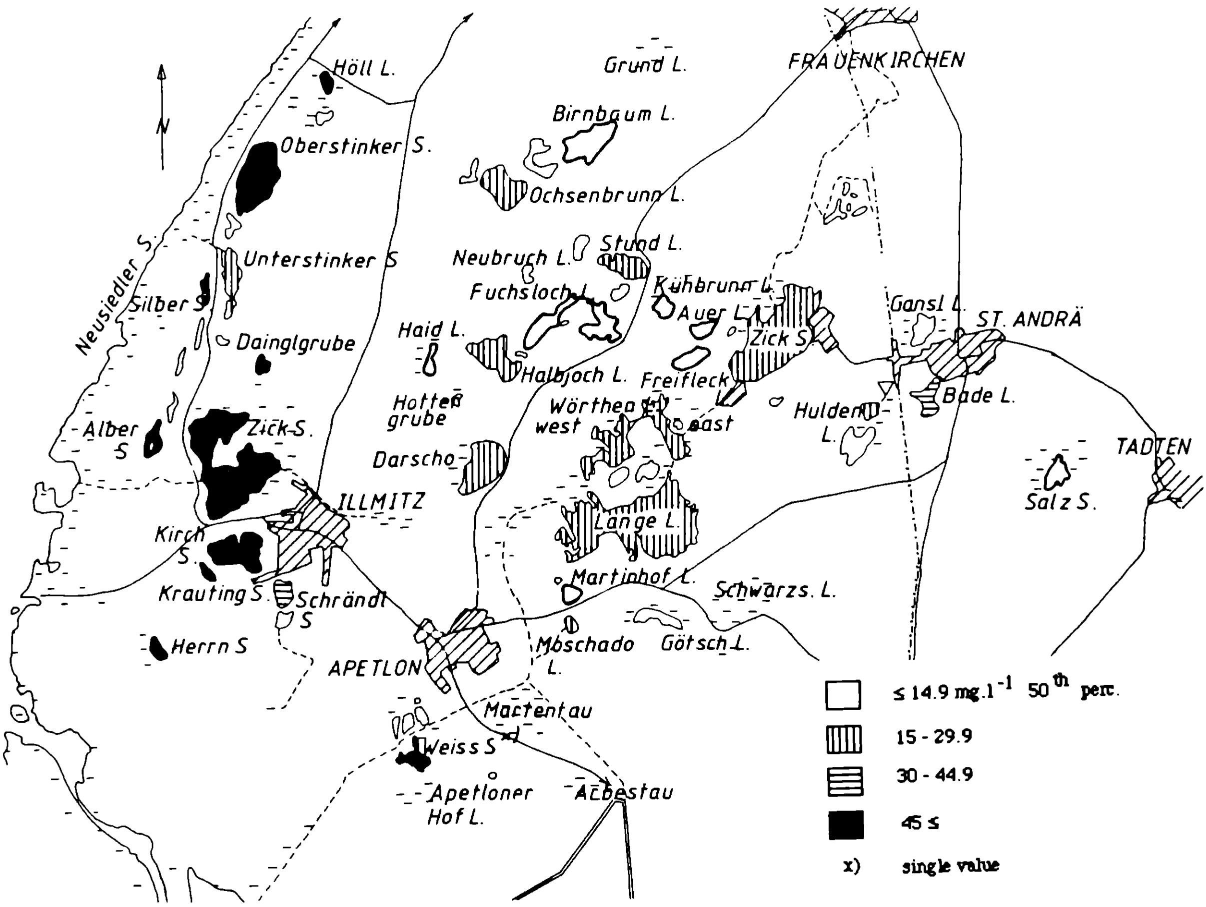


Fig. 16: K in the various pans (mg.l^{-1}, 50th percentile).

3.2.6. SO_4 and Cl (Figs. 17,18,19,20)

SO_4 and Cl are not negligible in spite of the predominance of the SBV. Their sum is plotted together with the SBV for comparison in Fig. 17. It is obvious that they agreed well, i.e. that the concentrations of Höll-Lacke, Silbersee or Halbjochlacke were due to generally high concentrations. Out of line were the Weiss S. (single value), the Albersee and Herrnsee. In the latter two pans the sums for SO_4 and Cl were markedly above those to be expected. In the Albersee the Cl, while in the Herrnsee the SO_4 was principally responsible. This seems to be the only case where SBV did not dominate. Disregarding those two extrems, distribution of Cl and SO_4 agreed well with the results given also by Knie & Gams (1960). The ratio of SBV to (Ca+Mg) higher than 1 did not only apply for the 50th percentile but held true for most of the year. For Oberer Stinkersee, Fuchslochlacke and Albersee individual values are plotted in Fig. 20. From this it can be seen that in the course of the year in the Oberer Stinkersee and the Fuchslochlacke all ratios except one were below, in the Albersee all but two were above 1. This also sheds new light on the single value of the Weiss S. which is extrem out of line. Further investigation in this case is probably indicated.

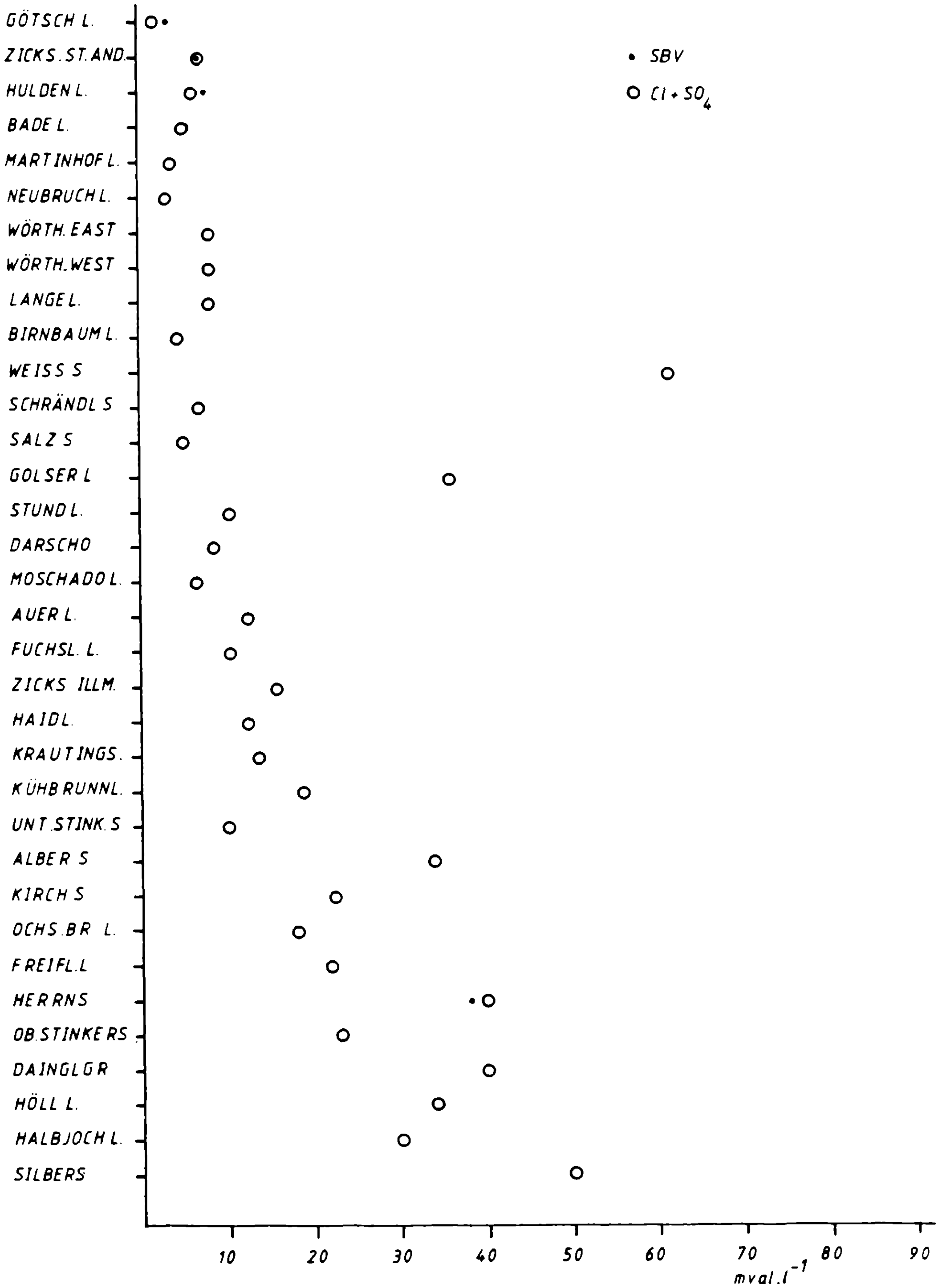


Fig. 17: Sum of Cl and SO_4 plotted with alkalinity (SBV) arranged in increasing order.

All values 50^{th} percentiles.

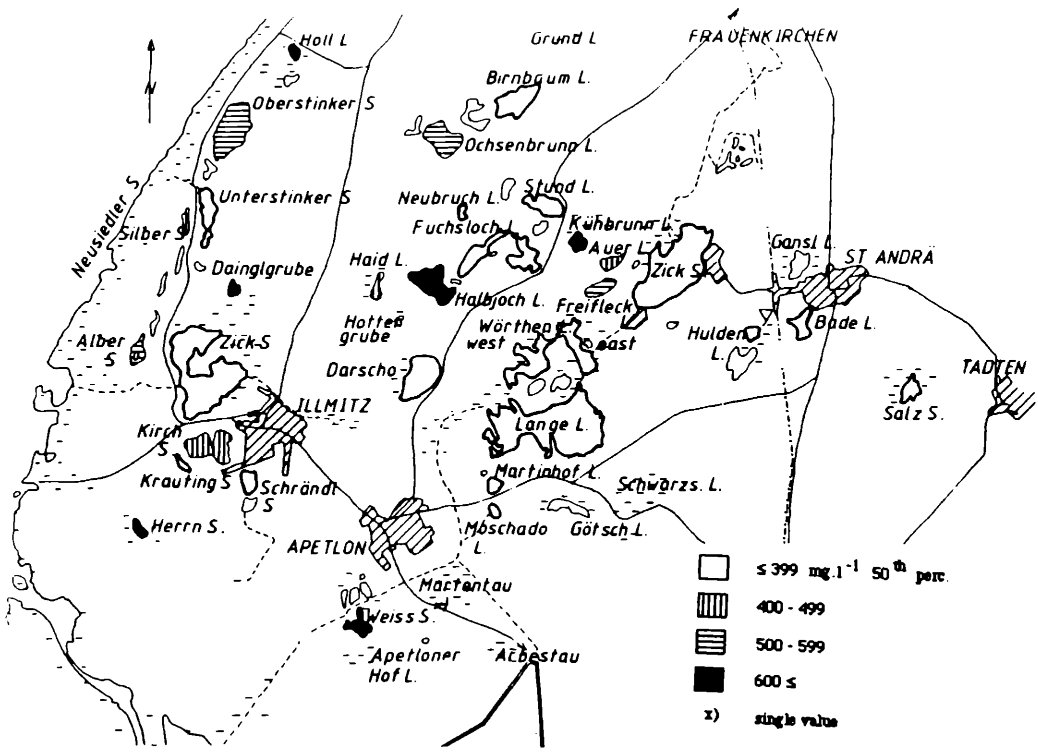


Fig. 18: SO_4 in the various pans ($mg.l^{-1}$, 50^{th} percentiles).

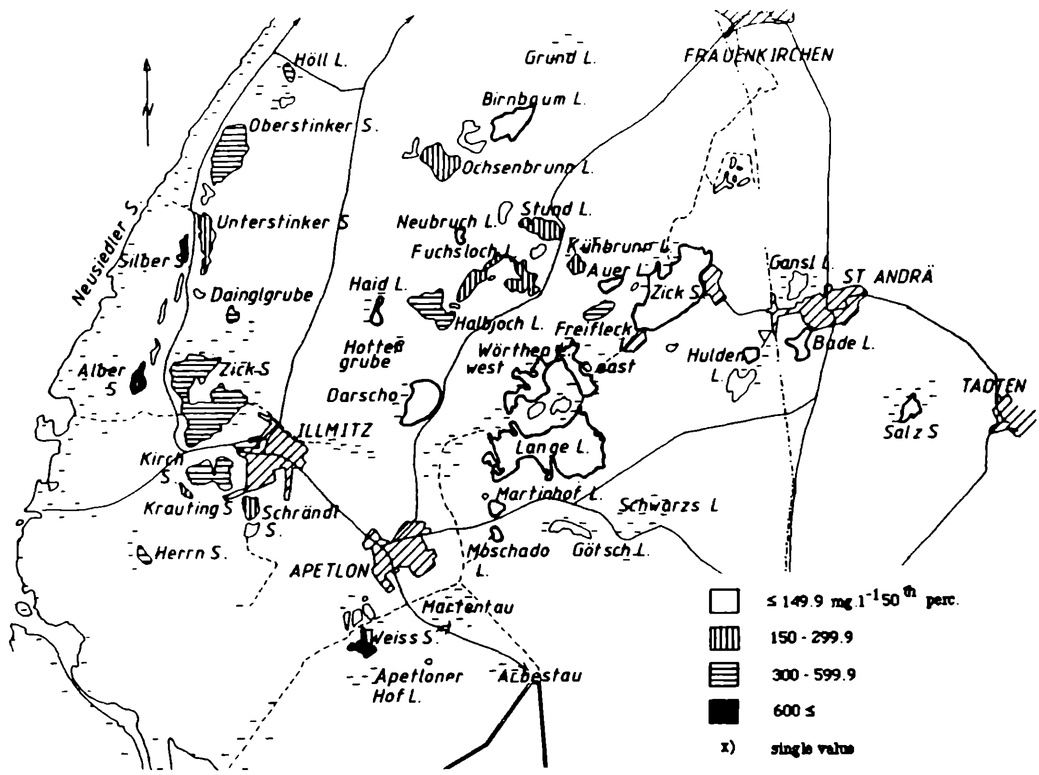


Fig. 19: Cl in various pans ($mg.l^{-1}$, 50^{th} percentiles).

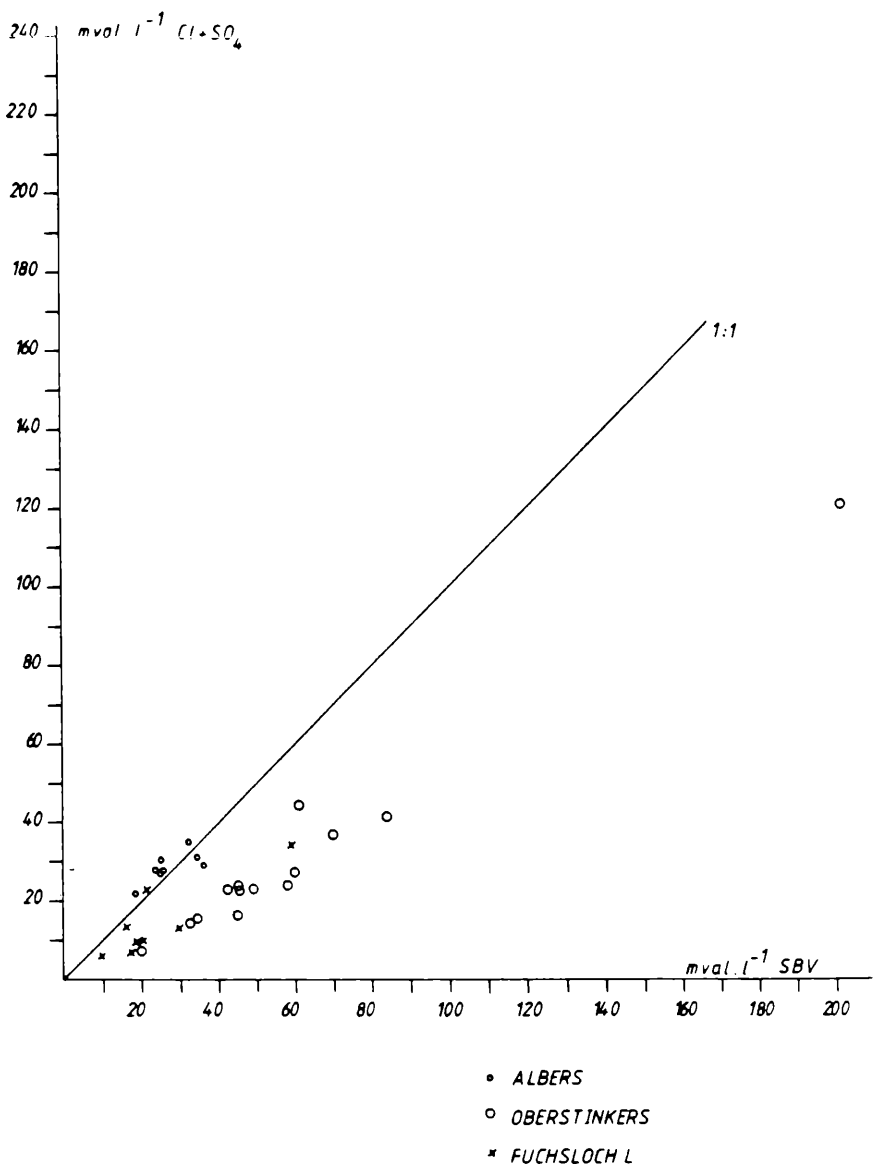


Fig. 20: Sums of Cl and SO_4 plotted against alkalinity (SBV), ($mval.l^{-1} = meq.l^{-1}$).

3.3. Nutrient loading

Investigations regarding the nutrient content of the pans revealed exceedingly variable results, regional and seasonal. Earlier authors (Gerabek 1952, Stundl 1949) generally found low nutrient levels. Their results, however, are not readily comparable due to different methods. Data by Knie (1958) show levels for nitrate and ammonium which were similar to those found today. Extremely high values for nitrate and K were found by Knie & Gams (1962) in wells within villages, expecially in Illmitz. This was put into context with heavy pollution of the soil with manure (cattle was held in stables next to human housing). Spreading of this polluted groundwater very well could cause an increased load of pans in the vicinity. High K values in the Kirchsee near Illmitz were related to anthropogenic influence (Löffler 1959).Nowadays, however, the heavily loaded pans are not in the vicinity of villages. Exceptions are the Huldenlacke (sewage effluent) and the Badelacke which takes the storm water drainage of St.Andrä.

A similar loading (>400 $\mu g.l^{-1}$ of NH_4 + NO_3) was found in the Martinhoflacke, Auerlacke, Neubruchlacke and Birnbaumlacke. Somewhat less (between 200 and 400 $\mu g.l^{-1}$) were loadings of the Lange Lacke, Ochsenbrunnlacke and Stundlacke (Fig. 21). As a source the intensive agriculture (especially the vine culture which showed a pronounced increase in the last decades; Salzl-Lidy 1978) has to be mentioned.

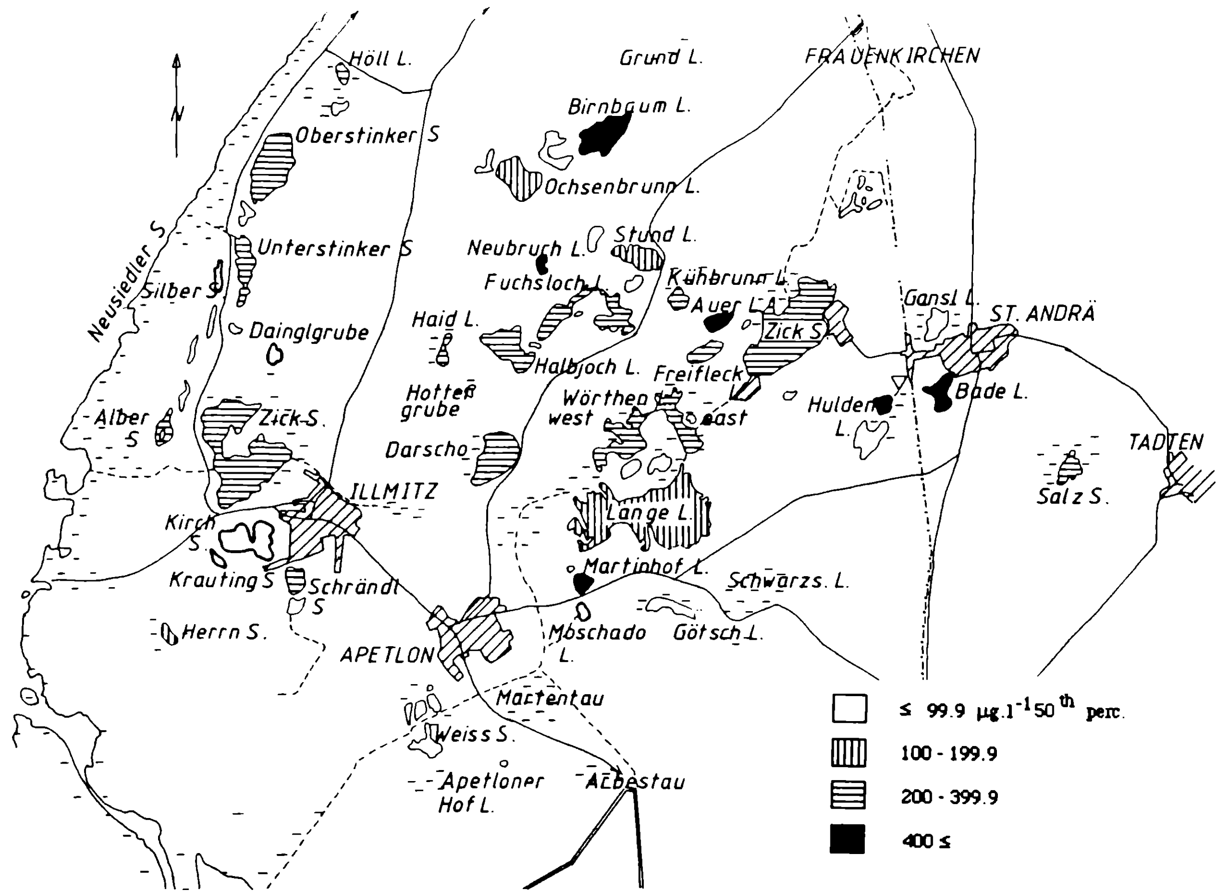


Fig. 21: NH_4-N + NO_3-N in the various pans ($\mu g.l^{-1}$, 50th percentile).

Two pans well suited for comparison in this respect are the Martinhoflacke and the Moschado Lacke. They are situated next to each other and showed highly diverse N loadings. They are shown together with the land use of their surrounding and a diagramm of wind direction (Sauerzopf 1959) in Fig. 22. It appears that in the case of the Moschado Lacke main wind direction is met predominantly by meadows and in addition there is an extensive buffering zone around this pan. In contrast the Martinhoflacke is separated from the nearst vinyards by a dust road only. This example seems to support the interpretation given above.

This, however, becomes less evident again, looking at Kühbrunnlacke, Auerlacke and Freiflecklacke. In these the N loadings were highly different, but with respect to their surrounding there are no discernable differences (Fig. 22). A similar unclear situation is encountered with other pans. Birnbaumlacke, Ochsenbrunnlacke and Neubruchlacke are surrounded by vinyards without any substantial buffering zones and had high N loadings. Pans in the western Seewinkel (Höll-Lacke in the north to Herrnsee in the south) had low to very low loadings. A common feature here is the vicinity to natural and unused areas in the west and northwests, the main wind direction. This pattern, however, does not hold for all of them. The Dainglgrube (very low N) is surrounded by vinyards, the Herrnsee (very high N) lies in the middle of extensive meadows.

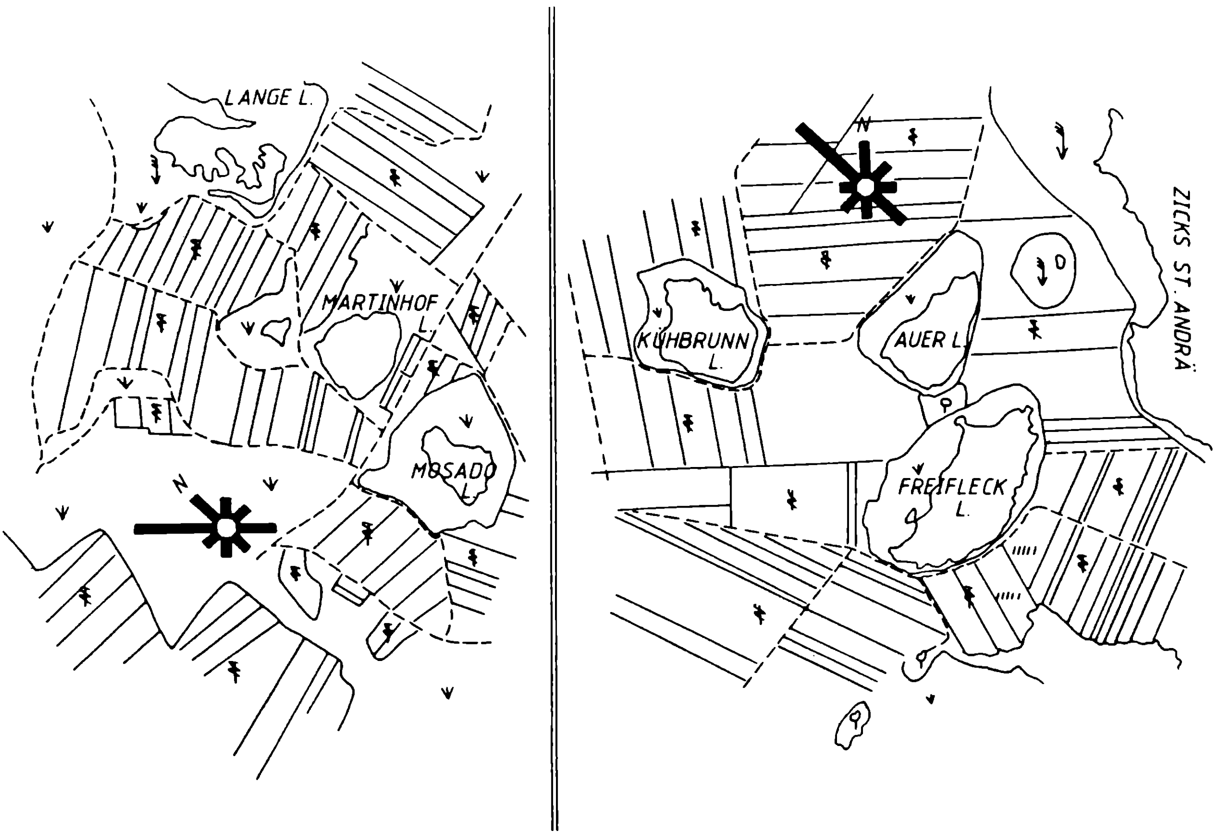


Fig. 22: Land use and wind directions in the vicinity of Martinhoflacke, Moschadolacke, Kühbrunnlacke, Auerlacke and Freiflecklacke.

Further influence could come from pisciculture which takes place in Herrnsee, Darscho, Wörthenlacke, Lange Lacke and Zicksee at St.Andrä. There was (uncorroborated) evidence of fertilization of the Lange Lacke with liquid manure.

As another source the water fowl can be of local importance. In most cases it is a turnover of the internal loading since the birds feed in the pan. This is different in the case of the Lange Lacke where during autumn and winter 20 - 30 000 geese rest. During the day they feed on the surrounding fields and every evening they return to the Lange Lacke. It is estimated (Herzig 1987) that an annual loading of some 1,5 tons of N is caused by ducks and geese of which 90 % can be related to the geese.

Similar to the changes of salt concentration in the course of a year changes of nutrient concentration are to be expected. According to this during low water in late summer and autumn values should be highest. During his investigations, Stundl (1949), could not find free nutrients in the water in August and made primary production responsible. But different analytical methods make it difficult to evaluate the results put forward by Stundl. Above that, the present data are not sufficient to present well documented annual cycles which lend themselve to interpretation.

In the Albersee and Oberer Stinkersee, during summer and autumn 1982, high, during the following winter low N concentrations were found (Fig. 23). The results for Halbjochlacke and Darscho were the other way round. Extremely high values were measured in the Lange Lacke which were interpreted as the result of considerable faecal pollution by the birds.

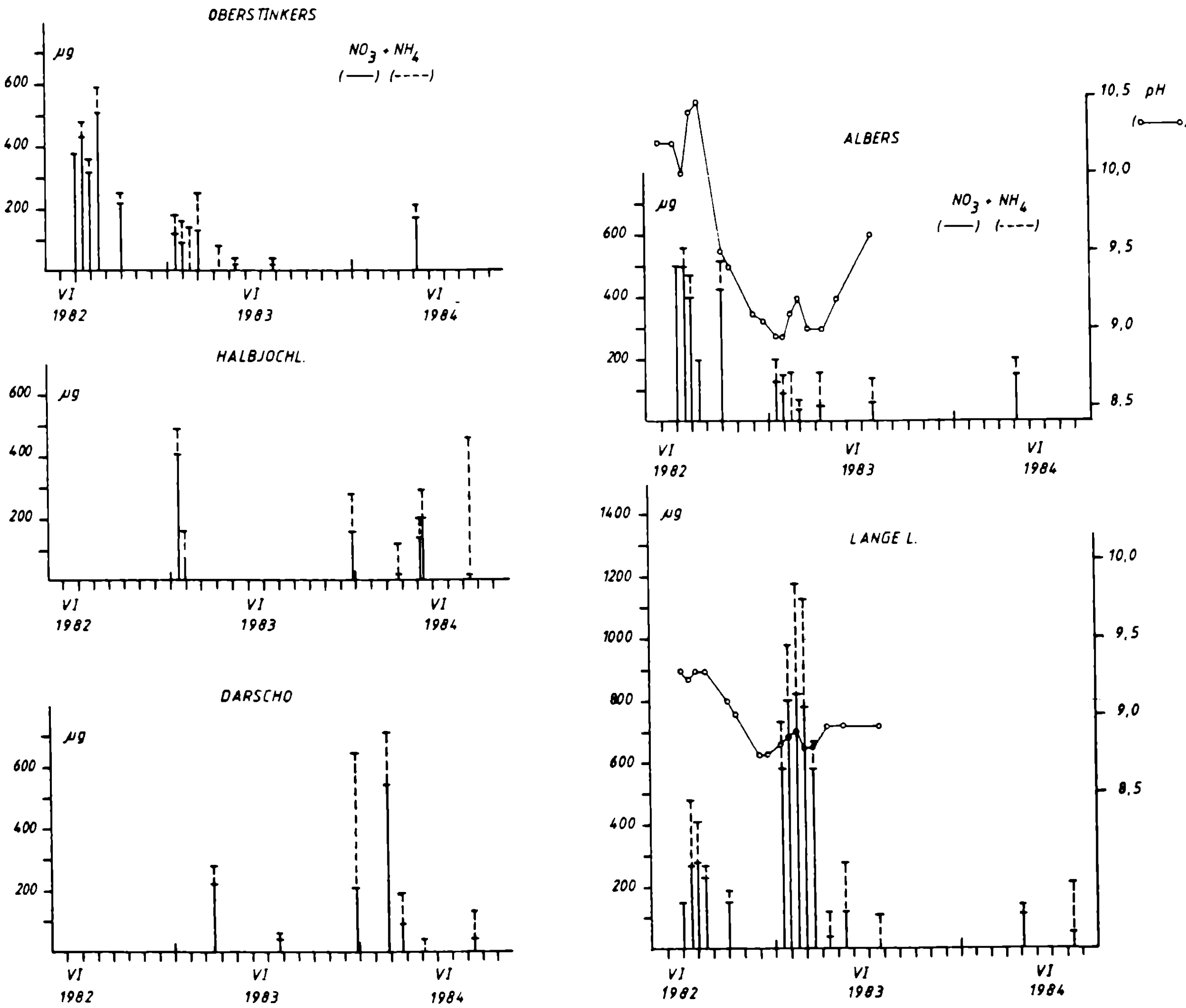


Fig. 23: Concentrations of NO_3 and NH_4 in pans of the central and the western Seewinkel.

In Albersee and Lange Lacke the pH is included.

As a general rule, the NO_3 was predominant, there was, however, a significant increase of NH_4 during winter under the ice. In one exceptional case, in the Halbjochlacke in August 1984, nearly all N was due to NH_4 .

The general conclusion to be drawn from our results is that a more intensive investigation of the nutrient situation will be imperative before clear statements are possible. Even then great care will have to be taken in translating the results from one pan to another.

3.4. Species composition

Within the years 1982 and 1985 a total of 32 pans was investigated, and 35 Branchiopoda and Copepoda species were found. Table 4 summarizes these data, the numbers at each sampling date refer to the individual pans as listed in Table 1. The number of existing pans greatly varied in the three years of investigations. If a year (or season) was rather dry (e.g. in spring 1985) only few pans (less than 50 %) contained water.

Of the 35 species we have encountered *Dunhevedia crassa, Cyclops vicinus, Macrocyclops albidus* and *Acanthocyclops robustus* were previously not known to occur in these waters.

The number of species recorded in a pan varied between 2-18, with numbers more than ten being found in larger permanent pans. However, the maximum number of species occurred in Moschado Lacke, a small pan (area 5.8 ha) with conductivity between 380-6100 μScm^{-1} and alkalinity between 7.76-47.25 $meql^{-1}$. The number of species found in the samples varied between 1-11. The species number was mostly less than ten, with few exceptions (i.e. Moschado Lacke and Salzsee). Generally, species number reached its maximum in spring samples, and in most pans it was minimal in summer (see species lists of individual pans shown in Table 5). The actual species composition of the zooplankton community was less variable in term of the dominant species. In most pans one or two calanoid species (*Arctodiaptomus spinosus* and/or *A. bacillifer*) were dominant in each season, except for Zicksee at St. Andrä where calanoids did not occur (juveniles were found only on one occasion). In addition one or two - rarely three - cladoceran species were abundant. Besides the congeneric occurrence of diaptomids, in some cases co-occurrence of *Daphnia* species was found, too.

Eight species were found only once, these species are littoral and mud-living ones, e.g. *Ceriodaphnia quadrangula* and *Simocephalus vetulus* were encountered in samples from vegetated areas, one of the four rarely found *Cyclops* species is *Eucyclops serrulatus* which was collected in thirteen pans by Löffler (1959) and was frequently found in sodic waters in Hungary, too (Megyeri 1959). Other species, e. g. *Dunhevedia crassa, Microcyclops varicans* are rather rare, however, the observed pattern of their occurrence may also reflect inadequate sampling (i.e. small sample size).

Table 4: List of species collected between May 1982 and May 1985 (numbers refer to the sequential numbers of the pans in Table 1).

	1982			1983			1984		1985
	19. 05.- 02. 06.	17. & 19. 08.	14. & 21. 12.	15. 03.	26. & 28. 07.	24. & 27. 10.	07. & 09. 05.	13. & 16. 08.	26. 03.
Branchinecta orientalis Sars, 1901	4,10,23, 24,26			6		11,18, 20,23	6, 20	6,26	6,7,8,10, 11,12,35
Diaphanosoma brachyurum (Lievin, 1848)	1,8,24, 33	1,5,20			1,5,12, 16,24	1,5		18,24	
Daphnia magna Straus, 1820	1,3,6,7, 8,9,10, 14,16,19, 23,25	3,10,14, 17,20, 24,27	1,2,3,5, 6,8,10, 12,14,15, 16,17,18, 19,20,23, 25,27	2,3,6,10, 12,14,15, 18,19,22, 23,24,25, 26,27,29, 30,31	1,3	3,18, 19,23	1,3,4,6, 8,13,14, 15,16,18, 20,21,22, 24,29	8,11	3,6,7,10
Daphnia atkinsoni Baird, 1859	5,6,7, 10,11,12, 23,25	11	17	11,17		11,17	6,8,15, 17		12
Daphnia similis Claus, 1876		28		28					
Daphnia pulex Leydig, 1860		14	16	16,24					
Daphnia longispina O.F.Müller, 1785	22,33	9	9	8,16,32		9	9		
Ceriodaphnia reticulata (Jurine, 1820)		8	9		1,8		14		
Ceriodaphnia quadrangula (O.F.Müller, 1785)	21								
Simocephalus vetulus (O.F.Müller, 1776)	9								
Simocephalus exspinosus (Koch, 1841)	14	14, 20		8,16,22					
Scapholeberis rammneri Dumont & Pensaert, 1983	8,9,11, 14,16	14							
Megafenestra aurita (Fischer, 1849)		14							

Table 4 continued

	1982			1983			1984		1985
	19. 05.- 02. 06.	17. & 19. 08.	14. & 21. 12.	15. 03.	26. & 28. 07.	24. & 27. 10.	07. & 09. 05.	13. & 16. 08.	26. 03.
Moina brachiata (Jurine, 1820)	1,2,4,5, 6,7,8,10, 11,12,13, 14,15,16, 17,18,19, 20,23,25, 26,28,32	1,4,6,7, 10,11,12, 13,14,15, 16,17,18, 19,20,21, 23,24,25, 26,28			1,3,6,7, 10,12,15, 22,24,25, 27,28,31	1,5,6,7, 11,13,15, 17,18,20	1,3,4,6, 8,10,13, 14,15,17, 20,21,22	1,5,6,8, 11,14,15, 16,17,26	
Bosmina longirostris (O.F.Müller, 1785)		9	1,5,9, 16,21	1,9,16	9,16	9		9,16	
Macrothrix rosea (Jurine, 1820)	14, 20	8,14,20					14,2		
Macrothrix hirsuticornis Norman & Brady, 1867	1,2,8, 17,19,23	1,19,24	1,19	1,5,11, 13,17,19, 23,26,28	16	3,17,19	1,6,8, 10,17,22	18	6
Oxyurella tenuicaudis (Sars, 1862)	2,8,9, 14,16,33	8,9			9,16		22	14,18	
Alona rectangula Sars, 1862	1,2,29	20							
Pleuroxus aduncus (Jurine, 1820)				3,9,16		14			
Dunhevedia crassa King, 1853		14							
Chydorus sphaericus s.l. (O.F.Müller, 1785)	1,3,5,8, 9,10,11, 14,16,20, 21,22,27	5,14	1,3,5,8, 9,14,16, 20,21,27	1,3,5,6, 8,9,12, 14,15,16, 20,21,22, 24,27,29, 31,32	8,9	14	9,18,22	18	9

Table 4 continued

	1982			1983			1984		1985
	19. 05.- 02. 06.	17. & 19. 08.	14. & 21. 12.	15. 03.	26. & 28. 07.	24. & 27. 10.	07. & 09. 05.	13. & 16. 08.	26. 03.
Arctodiaptomus bacillifer (Koelbel, 1885)	1,3,8,14, 15,16,22, 27,29,32, 33	8,14,21, 24	3,14,15, 16,21,27	1,3,14, 15,20,21, 22,24,27, 29, 30	3,16,21, 22,24,31	14	1,3,8,14, 15,16,18, 20,21,22 29,34	1,2,5, 8,21	1
Arctodiaptomus spinosus (Daday, 1890)	1,2,4,5, 6,7,8,10, 11,12,13, 15,16,17, 18,19,20, 23,25,26, 28	1,2,4,5, 6,7,8,10, 11,12,13, 15,17,18, 19,20,23, 24,25,26, 28	1,2,4,6, 7,10,12, 13,17,18, 19,20,23, 25,27	1,2,4,6, 7,10,11, 12,13,15, 17,18,19, 20,23,25, 26,27,28, 30,31	1,2,4,5, 6,7,8,10, 11,12,13, 15,16,19, 24,25,26, 27,30,31	1,2,5,6, 7,12,13, 15,17,18, 20,23,24, 26,30,31	1,2,4,5, 6,7,8,10, 13,15,17, 18,20,21, 24,26,28, 34	1,2,15, 18,24,26	1,2,7,12
Macrocyclops albidus (Jurine, 1820)		9							
Eucyclops serrulatus (Fischer, 1851)				22					
Cyclops strenuus s.l. Fischer, 1851			3,23	1,2,3,11, 22,24,29, 30		3,9	3,14,17		2,3,6,11
Cyclops vicinus Ulianine, 1875	5,11,16	9	9,16	9,16		1,16	16		9
Acanthocyclops robustus (Sars, 1863)	1,2,3,8, 9,33	3,5,16			9,16	16	1,3	2,9,16	
Megacyclops viridis (Jurine, 1820)	14	8,14,21, 24	2	8,20,24, 29,30,31	21,22		22		
Diacyclops bicuspidatus (Claus, 1857)	14,29	5	8	11				2,8,9,14	
Metacyclops gracilis (Lilljeborg, 1853)				11					
Metacyclops minutus (Claus, 1863)		11				11	17		
Metacyclops planus (Gurney, 1909)	3					3			
Microcyclops varicans (Sars, 1863)								14	

Table 5: List of species collected in individual pans

LANGE LACKE	1982									1983								1984		1985
	8.	1.	14.	29.	19.	30.	14.	2.	14.	12.	25.	17.	2.	15.	11.	26.	24.	7.	13.	26.
	6.	7.	7.	7.	8.	9.	10.	12.	12.	1.	1.	2.	3.	3.	5.	7.	10.	5.	5.	3.
Diaphanosoma brachyurum																				
Daphnia magna																				
Ceriodaphnia reticulata																				
Moina brachiata																				
Bosmina longirostris																				
Macrothrix hirsuticornis																				
Oxyurella tenuicaudis																				
Alona rectangula																				
Chydorus sphaericus s.l.																				
Arctodiaptomus bacillifer																				
Arctodiaptomus spinosus																				
Cyclops strenuus s.l.																				
Cyclops vicinus																				
Acanthocyclops robustus																				

ALBERSEE	1982									1983								1984	1985
	2.	1.	14.	29.	19.	30.	14.	2.	21.	12.	25.	17.	2.	16.	13.	11.	28.	9.	26.
	6.	7.	7.	7.	8.	9.	10.	12.	12.	1.	1.	2.	3.	3.	4.	5.	7.	5.	3.
Daphnia magna																			
Moina brachiata																			
Macrothrix hirsuticornis																			
Oxyurella tenuicaudis																			
Alona rectangula																			
Arctodiaptomus spinosus																			
Cyclops strenuus s.l.																			
Acanthocyclops robustus																			
Megacyclops viridis																			
Diacyclops bicuspidatus																			
Daphnia juv.																			

HULDENLACKE	1982									1983								1984		1985
	19.	1.	14.	29.	17.	30.	14.	2.	14.	12.	25.	2.	15.	13.	11.	26.	24.	7.	13.	26.
	5.	7.	7.	7.	8.	9.	10.	12.	12.	1.	1.	3.	3.	4.	5.	7.	10.	5.	5.	3.
Branchinecta orientalis																				
Diaphanosoma brachyurum																				
Daphnia magna																				
Moina brachiata																				
Bosmina longirostris																				
Macrothrix hirsuticornis																				
Pleuroxus aduncus																				
Chydorus sphaericus s.l.																				
Arctodiaptomus bacillifer																				
Cyclops strenuus s.l.																				
Acanthocyclops robustus																				
Metacyclops planus																				

Table 5 continued

OBERER STINKERSEE	1982									1983								1984
	2. 6.	1. 7.	14. 7.	29. 7.	19. 8.	30. 9.	14. 10.	2. 12.	21. 12.	12. 1.	25. 1.	17. 2.	2. 3.	16. 3.	19. 4.	11. 5.	28. 7.	9. 5.
Branchinecta orientalis																		
Daphnia magna																		
Moina brachiata																		
Bosmina longirostris																		
Macrothrix hirsuticornis																		
Chydorus sphaericus s.l.																		
Arctodiaptomus spinosus																		

DARSCHO	1982			1983				1984			
	19. 5.	17. 8.	14. 12.	15. 3.	26. 7.	24. 10.	21. 12.	21. 2.	27. 3.	7. 5.	13. 8.
Diaphanosoma brachyurum											
Daphnia magna											
Daphnia atkinsoni											
Moina brachiata											
Bosmina longirostris											
Macrothrix hirsuticornis											
Chydorus sphaericus s.l.											
Arctodiaptomus spinosus											
Cyclops vicinus											
Acanthocyclops robustus											
Diacyclops bicuspidatus											
Cyclops juv.											

FUCHSLOCHLACKE	1982			1983				1984				1985
	19. 5.	17. 8.	14. 12.	15. 3.	26. 7.	24. 10.	21. 12.	21. 2.	27. 3.	7. 5.	13. 8.	26. 3.
Branchinecta orientalis												
Daphnia magna												
Daphnia atkinsoni												
Moina brachiata												
Macrothrix hirsuticornis												
Chydorus sphaericus s.l.												
Arctodiaptomus spinosus		*										
Cyclops strenuus s.l.												

Table 5 continued

HALBJOCHLACKE	1982			1983				1984			1985
	19. 5.	17. 8.	14. 12.	15. 3.	26. 7.	24. 10.	21. 12.	21. 2.	27. 3.	7. 5.	26. 3.
Branchinecta orientalis											
Daphnia magna											
Daphnia atkinsoni											
Moina brachiata											
Arctodiaptomus spinosus											
Cyclops juv.											

MOSCHADO LACKE	1982			1983		1984		1985
	2. 6.	19. 8.	14. 12.	15. 3.	26. 7.	27. 3.	7. 5.	26. 3.
Branchinecta juv.								
Diaphanosoma brachyurum								
Daphnia magna								
Daphnia atkinsoni								
Daphnia longispina								
Ceriodaphnia reticulata								
Simocephalus exspinosus								
Scapholeberis rammneri								
Moina brachiata								
Macrothrix rosea								
Macrothrix hirsuticornis								
Oxyurella tenuicaudis								
Chydorus sphaericus s.l.								
Arctodiaptomus bacillifer								
Arctodiaptomus spinosus								
Acanthocyclops robustus								
Megacyclops viridis								
Diacyclops bicuspidatus								

Table 5 continued

ZICKSEE, ST. ANDRÄ	1982			1983			1984		1985
	19. 5.	17. 8.	14. 12.	15. 3.	26. 7.	24. 10.	7. 5.	13. 8.	26. 3.
Daphnia magna									
Daphnia longispina									
Ceriodaphnia reticulata									
Simocephalus vetulus									
Scapholeberis rammneri									
Bosmina longirostris									
Oxyurella tenuicaudis									
Pleuroxus aduncus									
Chydorus sphaericus s.l.									
Macrocyclops albidus									
Cyclops strenuus s.l.									
Cyclops vicinus									
Acanthocyclops robustus									
Diacyclops bicuspidatus									
Cyclops juv.									
Diaptomus juv.									

FREIFLECKLACKE	1982			1983		1984		1985
	19. 5.	17. 8.	14. 12.	15. 3.	26. 7.	7. 5.	13. 8.	26. 3.
Branchinecta orientalis								
Daphnia magna								
Daphnia atkinsoni								
Moina brachiata								
Macrothrix hirsuticornis								
Chydorus sphaericus s.l.								
Arctodiaptomus spinosus								
Cyclops juv.								

MARTINHOFLACKE	1982			1983			
	2. 6.	19. 8.	14. 12.	15. 3.	26. 7.	24. 10.	26. 3.
Branchinecta orientalis							
Diaphanosoma brachyurum							
Daphnia magna							
Daphnia atkinsoni							
Moina brachiata							
Chydorus sphaericus s.l.							
Daphnia juv.							
Arctodiaptomus spinosus							
Diaptomus juv.							
Cyclops juv.							

Table 5 continued

	1982			1983			1984	1985
BADELACKE	19.5.	17.8.	14.12.	15.3.	26.7.	24.10.	13.8.	26.3.
Branchinecta orientalis								
Daphnia magna								
Daphnia atkinsoni								
Scapholeberis rammneri								
Moina brachiata								
Macrothrix hirsuticornis								
Chydorus sphaericus s.l.								
Arctodiaptomus spinosus								
Cyclops strenuus s.l.								
Cyclops vicinus								
Diacyclops bicuspidatus								
Metacyclops gracilis								
Metacyclops minutus								

	1982			1983			1984
HÖLLACKE	2.6.	19.8.	21.12.	16.3.	28.7.	24.10.	9.5.
Moina brachiata							
Macrothrix hirsuticornis							
Daphnia juv.							
Arctodiaptomus spinosus							

	1982			1983		1984		1985
SALZSEE	19.5.	18.8.	14.12.	15.3.	24.10.	7.5.	13.8.	26.3.
Daphnia magna								
Daphnia pulex								
Ceriodaphnia reticulata								
Simocephalus exspinosus								
Scapholeberis rammneri								
Megafenestra aurita								
Moina brachiata								
Macrothrix rosea								
Oxyurella tenuicaudis								
Pleuroxus aduncus								
Dunhevedia crassa								
Chydorus sphaericus s.l.								
Arctodiaptomus bacillifer								
Cyclops strenuus s.l.								
Megacyclops viridis								
Diacyclops bicuspidatus								
Microcyclops varicans								

Table 5 continued

KIRCHSEE	1982			1983			1984	
	2. 6.	19. 8.	14. 12.	16. 3.	28. 7.	24. 10.	9. 5.	13. 8.
Daphnia magna								
Daphnia atkinsoni								
Moina brachiata								
Chydorus sphaericus s.l.								
Arctodiaptomus bacillifer								
Arctodiaptomus spinosus								

WÖRTHENLACKE	EAST 1982			1983			1984		WEST 1982			1983			1984	
	19. 5.	19. 8.	14. 12.	15. 3.	26. 7.	24. 10.	7. 5.	13. 8.	19. 5.	19. 8.	14. 12.	15. 3.	26. 7.	24. 10.	7. 5.	13. 8.
Diaphanosoma brachyurum													*			
Daphnia magna																
Daphnia pulex																
Daphnia longispina																
Simocephalus exspinosus																
Scapholeberis rammneri																
Moina brachiata																
Bosmina longirostris																
Macrothrix hirsuticornis																
Oxyurella tenuicaudis																
Pleuroxus aduncus																
Chydorus sphaericus s.l.																
Daphnia juv.																
Arctodiaptomus bacillifer																
Arctodiaptomus spinosus																
Cyclops vicinus																
Acanthocyclops robustus																
Cyclops juv.																

BIRNBAUMLACKE	1982			1983		1984	
	2. 6.	19. 8.	21. 12.	16. 3.	24. 10.	9. 5.	13. 8.
Daphnia magna							
Daphnia atkinsoni							
Moina brachiata							
Macrothrix hirsuticornis							
Arctodiaptomus spinosus							
Cyclops strenuus s.l.							
Metacyclops minutus							
Cyclops juv.							

Table 5 continued

KÜHBRUNNLACKE	1982			1983		
	19.	17.	14.	15.	26.	24.
	5.	8.	12.	3.	7.	10.
Daphnia magna						
Moina brachiata						
Macrothrix hirsuticornis						
Arctodiaptomus spinosus						

SCHRÄNDLSEE	1982			1983		1984	
	2.	19.	21.	16.	24.	9.	13.
	6.	8.	12.	3.	10.	5.	8.
Branchinecta orientalis							
Diaphanosoma brachyurum							
Daphnia magna							
Moina brachiata							
Macrothrix hirsuticornis							
Oxyurella tenuicaudis							
Chydorus sphaericus s.l.							
Arctodiaptomus bacillifer							
Arctodiaptomus spinosus							

UNTERER STINKERSEE	1982			1983		1984
	2.	19.	21.	16.	27.	9.
	6.	8.	12.	3.	10.	5.
Branchinecta orientalis						
Diaphanosoma brachyurum						
Daphnia magna						
Simocephalus exspinosus						
Moina brachiata						
Macrothrix rosea						
Alona rectangula						
Chydorus sphaericus s.l.						
Arctodiaptomus bacillifer						
Arctodiaptomus spinosus						
Megacyclops viridis						

Table 5 continued

HAIDLACKE	1982			1983		1984	
	2. 6.	19. 8.	21. 12.	16. 3.	26. 7.	9. 5.	13. 8.
Daphnia magna							
Ceriodaphnia quadrangula							
Moina brachiata							
Bosmina longirostris							
Chydorus sphaericus s.l.							
Arctodiaptomus bacillifer							
Arctodiaptomus spinosus							
Megacyclops viridis							
Cyclops juv.							

KRAUTINGSEE	1982	1983		1984
	2. 6.	16. 3.	28. 7.	9. 5.
Daphnia magna				
Daphnia longispina				
Simocephalus exspinosus				
Moina brachiata				
Macrothrix hirsuticornis				
Oxyurella tenuicaudis				
Chydorus sphaericus s.l.				
Arctodiaptomus bacillifer				
Eucyclops serrulatus				
Cyclops strenuus s.l.				
Megacyclops viridis				

AUERLACKE	1982			1983	
	19. 5.	17. 8.	14. 12.	15. 3.	24. 10.
Branchinecta orientalis					
Daphnia magna					
Daphnia atkinsoni					
Moina brachiata					
Macrothrix hirsuticornis					
Arctodiaptomus spinosus					
Cyclops strenuus s.l.					

Table 5 continued

HERRNSEE	1982	1983			1984	
	19. 8.	16. 3.	28. 7.	24. 10.	9. 5.	13. 8.
Diaphanosoma brachyurum						
Daphnia magna						
Daphnia pulex						
Moina brachiata						
Macrothrix hirsuticornis						
Chydorus sphaericus s.l.						
Arctodiaptomus bacillifer						
Arctodiaptomus spinosus						
Cyclops strenuus s.l.						
Megacyclops viridis						

STUNDLACKE	1982			1983	
	19. 5.	19. 8.	14. 12.	15. 3.	26. 7.
Branchinecta orientalis					
Daphnia magna					
Daphnia atkinsoni					
Moina brachiata					
Arctodiaptomus spinosus					

OCHSENBRUNNLACKE	1982		1983			1984	
	2. 6.	19. 8.	16. 3.	26. 7.	27. 10.	9. 5.	13. 8.
Branchinecta orientalis							
Daphnia magna							
Moina brachiata							
Macrothrix hirsuticornis							
Arctodiaptomus spinosus							
Cyclops juv.							

ILLMITZER ZICKSEE	1982			1983	
	2. 6.	19. 8.	21. 12.	17. 3.	28. 7.
Daphnia magna					
Moina brachiata					
Chydorus sphaericus s.l.					
Arctodiaptomus bacillifer					
Arctodiaptomus spinosus					
Cyclops juv.					

Table 5 continued

NEUBRUCHLACKE	1982 2.6.	1982 19.8.	1983 16.3.	1984 9.5.
Daphnia similis				
Moina brachiata				
Macrothrix hirsuticornis				
Arctodiaptomus spinosus				

GOLSER LACKE	1982 1.7.	1983 16.3.	1984 9.5.
Daphnia magna			
Moina brachiata			
Alona rectangula			
Chydorus sphaericus s.l.			
Arctodiaptomus bacillifer			
Cyclops strenuus s.l.			
Megacyclops viridis			
Diacyclops bicuspidatus			

SILBERSEE	1983 17.3.	1983 28.7.	1983 24.10.
Daphnia magna			
Arctodiaptomus spinosus			

DAINGLGRUBE	1983 17.3.	1983 28.7.	1983 24.10.
Daphnia magna			
Moina brachiata			
Chydorus sphaericus s.l.			
Arctodiaptomus bacillifer			
Arctodiaptomus spinosus			
Cyclops strenuus s.l.			
Megacyclops viridis			

WEISSEE	1982 2.6.	1983 16.3.
Daphnia magna		
Daphnia longispina		
Moina brachiata		
Chydorus sphaericus s.l.		
Arctodiaptomus bacillifer		

SCHWARZSEELACKE	1982 2.6.
Diaphanosoma brachyurum	
Daphnia longispina	
Oxyurella tenuicaudis	
Arctodiaptomus bacillifer	
Acanthocyclops robustus	

GÖTSCHLACKE	1985 26.3.
Branchinecta larva	
nauplius	

3.5. Occurrence of characteristic species

Branchinecta orientalis occurred in fourteen pans, mainly in spring (March and May) and it was found in four pans in October 1983. In March 1985 it was collected in seven pans, which is the greatest number of records of the species at a given date; at this time the other dominant species, e. g. *Daphnia magna, Arctodiaptomus spinosus* were recorded in a few pans only (Table 4). The localities of *B. orientalis* are small and medium sized pans, including permanent and temporary waters. Löffler (1959) collected it from fifteen pans, thus the wide distribution of this species in the Seewinkel seems to be the same as 30 years ago. It should be noted, however, that we did not find *Branchinecta* in the Birnbaumlacke, where Löffler (1959) and Jungwirth (1973) observed it as very abundant.

Diaphanosoma brachyurum was collected between May and October, it occurred in ten pans. It appears in the plankton of less saline waters at temperatures above 10 °C; this relationship was shown also for the Neusiedlersee population (Herzig 1979). *D. brachyurum* is also common in the summer zooplankton of less turbid, moderately saline pans in the Hungarian Plain (Megyeri, 1959). In the Seewinkel we found it in less alkaline, moderately saline pans with conductivity values between 850 μScm^{-1} (Huldenlacke) and 3,500 μScm^{-1} (Moschado Lacke), higher values were measured in Herrnsee (4,500 μScm^{-1}) and Martinhoflacke (7,100 μScm^{-1}). *D. birgei lacustris* was very recently described by Korinek (1981) from Lake Balaton and raised to species level by Korovchinsky (1987). This species was recorded in sodic waters in the Kiskunság National Park (Hollwedel 1984, Forró 1987). A revision of Neusiedlersee and Seewinkel material of *Diaphanosoma* is necessary in order to clarify the distribution of these species in the region.

Daphnia magna was the most common species, it was found in nearly all pans. This species occurred in each season, however, it was more frequently occurring in winter and spring samples. Its occurrence was negatively correlated with temperature, pH, conductivity and alkalinity (Table 6). The appearence of *D. magna* was observed mainly at pH values between 8.5 - 9.5, at conductivities below 5,000 μScm^{-1} and at an alkalinity less than 50 $meql^{-1}$. Its occurrence was positively related to the occurrence of *Bosmina longirostris, Chydorus sphaericus* and *Cyclops strenuus.* Also in Löffler's study was *D. magna* the most common species in the Seewinkel pans, and Megyeri (1959) also listed it among frequent species, collecting it mainly during winter and spring.

Daphnia atkinsoni is another species typical for spring and in some cases for autumn. In the present study we recorded it in eleven pans, while Löffler (1959) found it in twelve. It is typical for temporary waters, occurring in early spring and in autumn, when the pans contain water again after freezing or drying out; this was observed also in Hungarian sodic waters (Megyeri 1959).

Table 6: Correlation matrix, using all species and chemical variables and showing only common species.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	1																										
2	-.017	1																									
3	.252	-.095	1																								
4	.127	-.074	-.123	1																							
5	.071	.18	-.158	.242	1																						
6	-.099	-.124	.234	-.062	-.259	1																					
7	-.119	.269	-.018	.116	-.147	-.004	1																				
8	-.112	-.032	.405	-.07	-.294	.508	.077	1																			
9	-.06	.139	.057	-.084	.209	-.053	-.092	.16	1																		
10	-.016	-.01	.025	-.144	.002	-.022	.078	-.014	-.352	1																	
11	.1	-.141	.486	-.07	-.294	.508	.186	.433	0	.124	1																
12	-.045	-.057	-.095	-.028	-.118	-.047	.089	-.054	-.065	-.11	-.054	1															
13	-.014	.226	.114	-.062	.06	-.004	-.037	-.027	.052	-.268	-.118	-.048	1														
14	-.068	-.086	-.022	-.043	-.006	-.072	-.086	-.081	.269	-.19	-.081	-.033	-.072	1													
15	-.027	-.09	-.417	-.016	.486	-.241	-.267	.326	.224	-.236	-.427	-.12	.087	.103	1												
16	-.029	-.086	-.410	-.073	.053	-.396	-.002	-.248	-.229	.334	-.292	-.072	-.307	-.197	.263	1											
17	-.157	-.139	-.344	-.114	-.018	-.218	-.211	-.248	-.127	.246	-.230	-.086	-.205	-.02	.444	.530	1										
18	-.152	-.165	-.258	-.075	.042	-.175	-.203	-.205	-.136	.298	-.161	-.082	-.175	-.019	.398	.420	.774	1									
19	-.108	-.137	-.289	-.101	-.081	-.201	-.170	-.219	-.164	.377	-.186	-.076	-.189	-.043	.296	.512	.857	.724	1								
20	-.143	-.156	-.294	-.127	-.062	-.225	-.194	-.251	-.19	.225	-.181	-.084	-.205	-.027	.413	.497	.880	.751	.656	1							
21	-.144	-.115	-.283	-.107	-.113	-.168	-.166	-.215	-.078	.269	-.180	-.062	-.171	.011	.369	.405	.796	.504	.740	.763	1						
22	-.118	-.173	-.335	-.122	-.069	-.224	-.195	-.238	-.167	.386	-.220	-.086	-.215	-.045	.329	.579	.883	.64	.945	.710	.858	1					
23	.106	-.122	-.087	.393	-.08	.045	-.141	.017	-.058	-.032	-.032	.017	-.033	-.044	-.004	-.031	.092	.095	.253	.030	.200	.233	1				
24	-.195	.166	-.174	-.135	-.064	.04	-.119	-.072	.208	-.055	-.036	-.025	-.020	.201	.223	-.052	.257	.254	.055	.359	.223	.043	-.162	1			
25	.108	-.081	-.17	.227	-.079	-.108	-.078	-.114	-.138	.105	-.104	-.060	-.101	-.085	.112	.255	.347	.147	.483	.173	.376	.525	.513	-.197	1		
26	-.012	-.082	.146	.186	-.101	.006	-.022	.115	.291	-.291	-.077	.063	.061	-.075	-.139	-.401	-.218	-.197	-.219	-.209	-.215	-.249	.131	-.022	-.034	1	
27	.093	-.042	.186	.16	-.117	.137	-.021	.05	.092	-.23	.146	-.009	-.053	-.09	-.233	-.326	-.237	-.225	-.208	-.248	-.217	-.241	.169	-.174	.055	.610	1

1	*Branchinecta orientalis*	10	*Arctodiaptomus spinosus*	19	Na
2	*Diaphanosoma brachyurum*	11	*Cyclops strenuus*	20	Cl
3	*Daphnia magna*	12	*Cyclops vicinus*	21	SO4
4	*Daphnia atkinsoni*	13	*Acanthocyclops robustus*	22	Alkalinity
5	*Moina brachiata*	14	*Megacyclops viridis*	23	Ca
6	*Bosmina longirostris*	15	Temperature	24	Mg
7	*Macrothrix hirsuticornis*	16	pH	25	PO4
8	*Chydorus sphaericus*	17	Conductivity	26	NH4
9	*Arctodiaptomus bacillifer*	18	K	27	NO3

Moina brachiata is very common in Seewinkel pans. We found it in 28 pans; similarly to *D. brachyurum* this species is confined to warm periods, but *M. brachiata* tolerates more saline waters. Its occurrence was highly positively correlated with temperature (Table 6). It was mainly recorded at pH values between 8.75 – 10.25, and at a conductivity of up to 35,000 μScm^{-1}. Together with *A. spinosus* this species is characteristic for the summer crustacean community in the so called "white–pans" in the Hungarian Plain (Megyeri 1959, 1963, 1975), occurring in great abundance, particularly before desiccation . Hart (1986) found *M. brachiata* in a large silt–laden South African reservoir invariably as the last species in the annual succession; it developed at temperatures above 20°C and reached peak biomass near the annual temperature maximum. In a coastal saline pan Coetzer (1987) recorded it in the warm period, where it showed positive correlation with *D. magna* . *M. brachiata* is typical in not highly saline, sodium–carbonate rich lakes in Spain (Alonso & Comelles 1984, Comin & Alonso 1988).

In eight Seewinkel pans *M. brachiata* co-occurred with *Diaphanosoma brachyurum*. These are less saline waters, e. g. in Huldenlacke both species occurred at 850 μScm^{-1} conductivity and at 7.36 $meql^{-1}$ alkalinity. On the other hand there are three pans (Badelacke, Salzsee, Neubruchlacke) with low salinity and alkalinity values, where of these two cladocerans only *M. brachiata* was found. This may be explained by the relatively high turbidity of these waters.

Bosmina longirostris occurred in six pans; these are – except for Haidlacke – less alkaline and less saline permanent waters (e.g. Zicksee at ST. Andrä, Wörthenlacke, Lange Lacke). It was found in spring and winter samples, except for Zicksee at St. Andrä and Wörthenlacke, where it was encountered also in summer samples. It showed negative correlations with temperature, pH, conductivity and alkalinity; strongest correlation was found with pH (Table 6). It was collected at salinities between 750-2,600 (mostly 1,200-1,700) μScm^{-1}, pH between 8.4-9.2 and alkalinity between 6.1- 13 $meql^{-1}$, minimum values of alkalinity and conductivity were measured in Zicksee at St. Andrä. Löffler (1959)found it in three of the pans we also studied, but only in samples collected in October.

Macrothrix hirsuticornis was one of the most common cladocerans, encountered in eighteen pans. It occurred in most localities in spring, but could be found in all seasons. Löffler (1959) also collected it in eighteen pans. In Hungarian sodic waters it is quite common, and Megyeri (1959) considered it as characteristic for sodic water. Because of its wide distribution in temperate, but also in arctic regions, and its ability to adapt to a great variety of environments (Usai & Margaritora, 1987), the latter statement of taking *M . hirsuticornis* as a character species in sodic waters remains questionable.

Chydorus sphaericus is quite widely distributed in the Seewinkel pans, we found it in 21 waters, Löffler (1959) in 30 ones. Its occurrence was confined to cold seasons (winter and spring). It showed strong negative correlations with temperature, conductivity, pH and alkalinity (Table 6). Its occurrence is restricted to pH values between 8.5-9.5, conductivity less than 5,000 $\mu S\ cm^{-1}$ and alkalinity less than 50 $meql^{-1}$. Löffler (1959) in the Seewinkel and Megyeri (1959) in Hungarian sodic waters frequently, recorded two other chydorid species: *Oxyurella tenuicaudis* and *Alona rectangula*. They were rather rare in our material which may be related to our sampling strategy (i.e. our collections were limited to the "open water" parts of the pans). Of the above mentioned chydorids, *C. sphaericus* is the only one which is known to live also in the open water of various water bodies.

Of the four diaptomid species Löffler (1959) collected in the region only *Arctodiaptomus bacillifer* and *A. spinosus* occurred in our samples. *A. bacillifer* was found in twenty pans, Löffler (1959) recorded it from 31. Most frequently this species occurred in spring, however, in those pans, where it was the only diaptomid (e. g. in Huldenlacke), it could be collected throughout the year. Its occurrence was positively correlated with temperature and Mg concentrations, and was not strongly, but negatively related to pH, conductivity and alkalinity (Table 6). It was found at salinities between 480-14,000 μScm^{-1} (mean=2870), at alkalinities between 1.88-76.16 $meql^{-1}$ (mean=18.5).

We collected *A. spinosus* in 26 pans; in fifteen pans it was the only diaptomid, while in eleven ones it co-occurred with *A. bacillifer*. This species shows positive correlations with the measured environmental variables, with the exception of temperature (Table 6). Its occurrence was highly positively related to pH, conductivity and alkalinity. It occurred at high pH values (above 10), and at extreme values of conductivity, between 500 μScm^{-1} (Martinhoflacke) and 38,000 μScm^{-1} (Ochsenbrunnlacke) (mean = 5724), and at an alkalinity between 1.88 and 300 $meql^{-1}$ (mean=39.3) . *A. spinosus* was collected in sodic waters only (Kiefer 1971). Our data concerning this species are in good agreement with previous data (Löffler 1959, 1961; Newrkla 1975; Megyeri, 1958, 1959, 1963, 1973, 1974, 1975), also confirming that this is a natronobiont species.

Four cyclopoid species were found in our material. *Cyclops strenuus* occurred in twelve, mostly permanent, less saline pans; its occurrence was limited to winter and spring. It showed strong negative correlation with temperature, pH, conductivity and alkalinity (Table 6). *Acanthcyclops robustus* was encountered in eight - with two exceptions - permanent pans, most frequently in summer samples. Löffler (1959) recorded *A. vernalis* in the Seewinkel, *A. robustus* was not mentioned. However, the localities of the two species overlap almost completely Thus, it is possible, that the same taxon was found in both studies. Another explanation is, that *A. robustus* did not live in these pans earlier, its occurrence nowadays may be related to increasing eutrophication in the 70´s. *Megacyclops viridis* was recorded only in ten pans in the present study, while Löffler (1959) found it in 37 waters. It occurred mainly in spring and summer samples. *Diacyclops bicuspidatus* was encountered in seven pans, Löffler (1959) found it in 19 . Last not least *Metacyclops planus*, should be mentioned which was first found in Seewinkel pans in the Carpathian Basin by Löffler (1959). He recorded it in four pans, while we could collect it only in Huldenlacke, where the species was abundant in numerous samples.

3.6. Seasonal changes

Four different pans (Lange Lacke, Huldenlacke, Albersee and Oberer Stinkersee) were bimonthly or monthly sampled between May 1982 and April 1983.

Lange Lacke, the greatest permanent pan in the Seewinkel (area= 187 ha; Sauerzopf 1959a), is moderately alkaline and saline as compared with other pans in the region. Fig. 24 shows the seasonal variation of some environmental features in this water. Temperature showed the greatest fluctuation, while chemical parameters (pH, alkalinity and conductivity) did not show marked variation.

14 species occurred in this water, species number varied between 4 and 9 in 1982-1983 (Table 5). The relative abundance of species occurring in the plankton is shown in Fig. 25. Diaptomids, mainly *A. spinosus*, are dominant throughout the whole period, *A. bacillifer* occurred only in March, and later also in May 1983. A rather clear seasonal succession is shown by cladocerans. In summer *Diaphanosoma brachyurum* and *Moina brachiata* appeared, and remained in the plankton until October. Late September - early October *Daphnia magna* and *Bosmina longirostris* occurred, the latter species being dominant. The dominance of *B. longirostris* may be explained by the rather high fish stock. In winter, *Chydorus sphaericus* was present in low numbers.

Huldenlacke is also a permanent water body, though of smaller size than Lange Lacke (about 30 ha). Variations in environmental variables are shown in Fig. 26. Again, water temperature was most variable, but pH varied here to a greater extent than in Lange Lacke. Conductivity and alkalinity had similar values as in the previous pan, and varied inconsiderably. Some years ago the limnological conditions of Huldenlacke were altered by the additional water supply from the sewage treatment plant of St. Andrä. This certainly influences the chemical features of the pan and may provide an explanation for the observed insignificant changes of alkalinity and conductivity.

Twelve species were collected in this pan, the number of species in the samples varied between 2 - 6 (Table 5). Fig. 27 shows the seasonal occurrence of crustacean species. *Arctodiaptomus bacillifer* occurred frequently; in addition three *Cyclops* species were abundant: *Cyclops strenuus* dominated (up to 47 %) in winter, *Acanthocyclops robustus* in summer and spring, while *Metacyclops planus* was abundant in summer and autumn, it also occurred in December and in April. Similarly to Lange Lacke, five cladocerans were found, their occurrence and relative abundance were rather different. *Diaphanosoma brachyurum, Moina brachiata* and *Bosmina longirostris* were of lesser significance, while *Daphnia magna and Chydorus sphaericus* were collected more frequently. Surprisingly, *D. magna* was dominant not only in winter and spring samples, but also in summer.

Albersee is a small temporary pan, (area = 9.2 ha Sauerzopf 1959a). Pronounced seasonal changes in the environmental features were detected (Fig. 28). Beside temperature, alkalinity and conductivity revealed high fluctuations.

Ten crustacean species were encountered in the pan, the number of species in the samples changed between 1-6, most frequently three species were found (Table 5). Fig. 29 presents the seasonal changes in relative abundance of individual species. *Arctodiaptomus spinosus* was dominant throughout the year, *Cyclops strenuus* prevailled throughout winter; *Megacyclops viridis* occurred in spring, rarely in winter. Two cladocerans were found in the plankton: *Moina brachiata* was dominant in summer (occasionally more abundant than *A. spinosus*), with records also in autumn and in December. *Daphnia magna* occurred in December and was found until May, but never reached a higher relative abundance than 20 %.

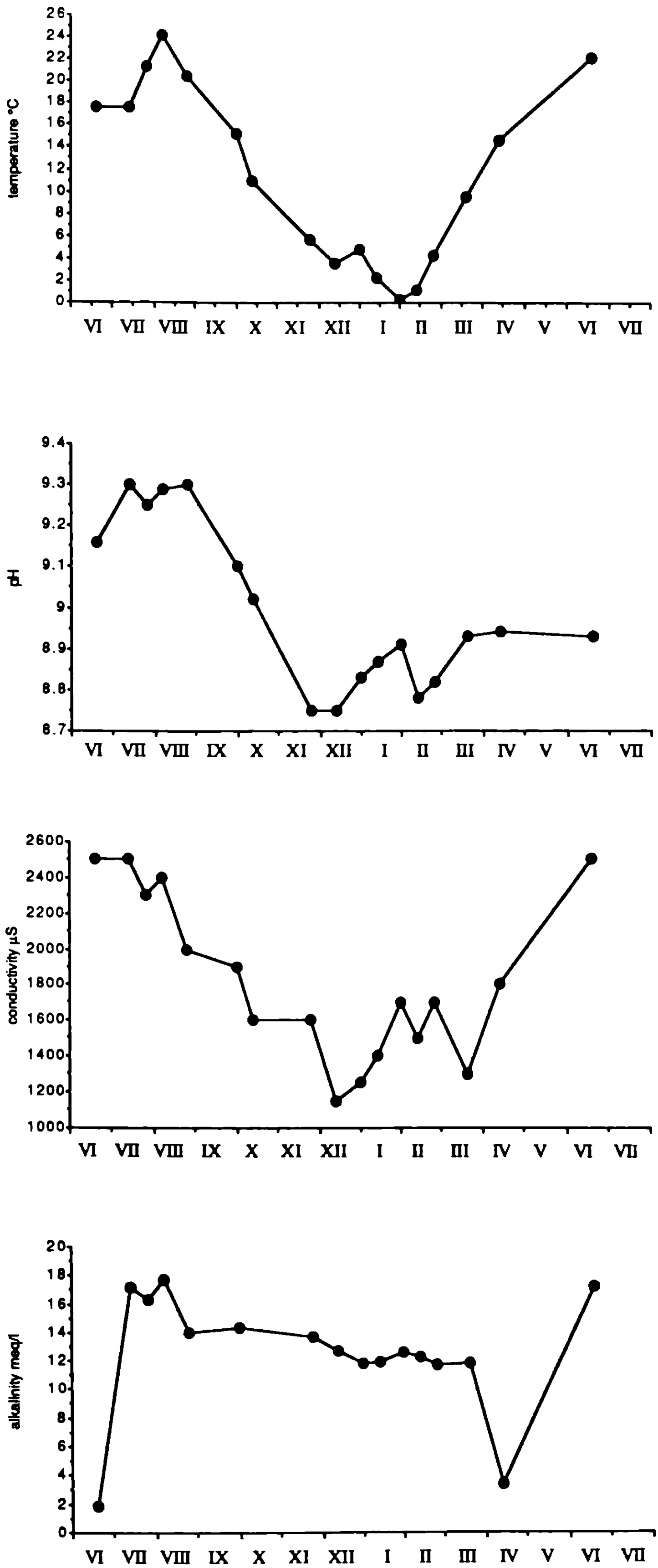


Fig. 24: Seasonal changes of environmental features in Lange Lacke (1982-1983)

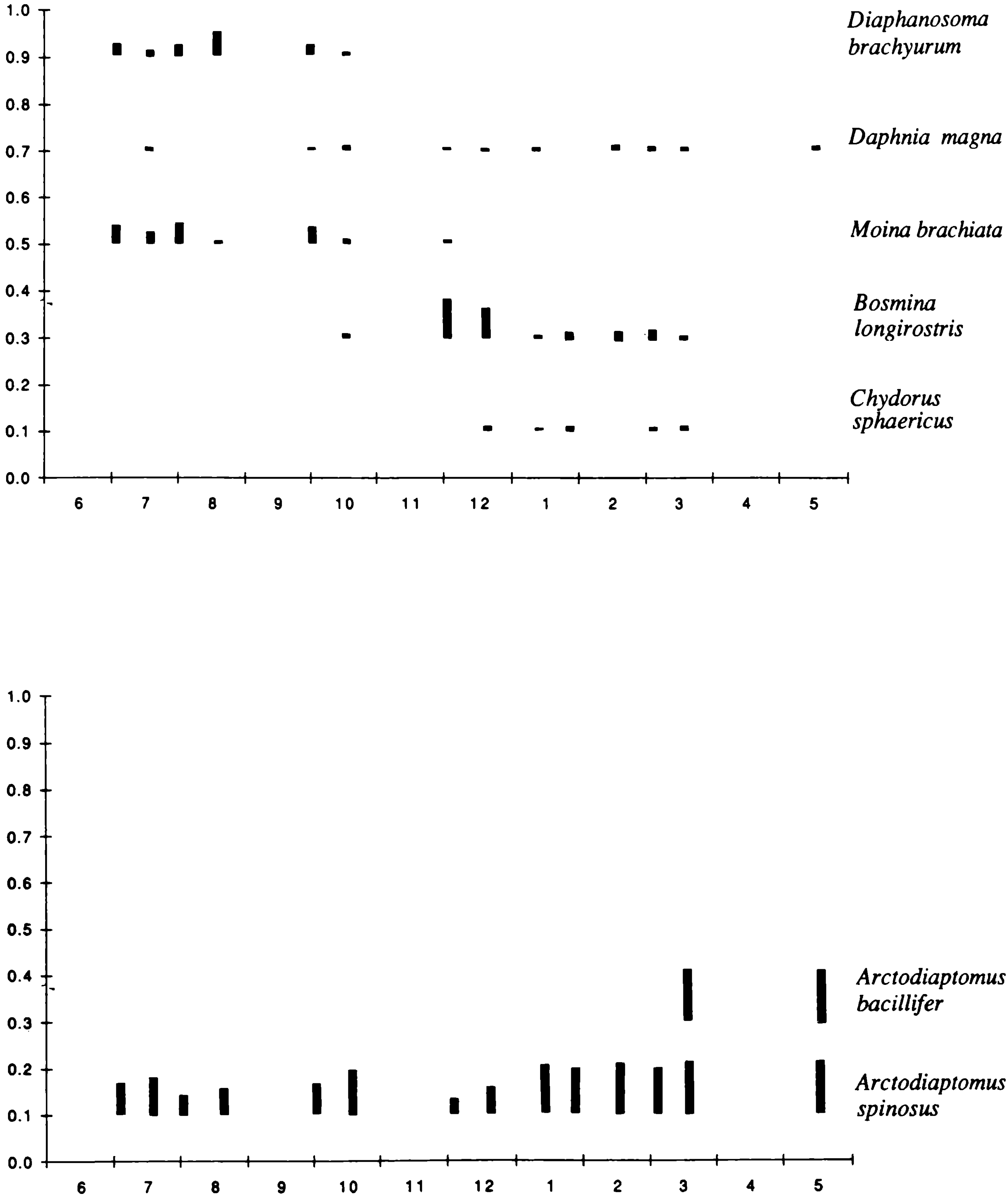


Fig. 25: Seasonal succession of crustacean zooplankton in Lange Lacke (relative abundance) (1982-1983).

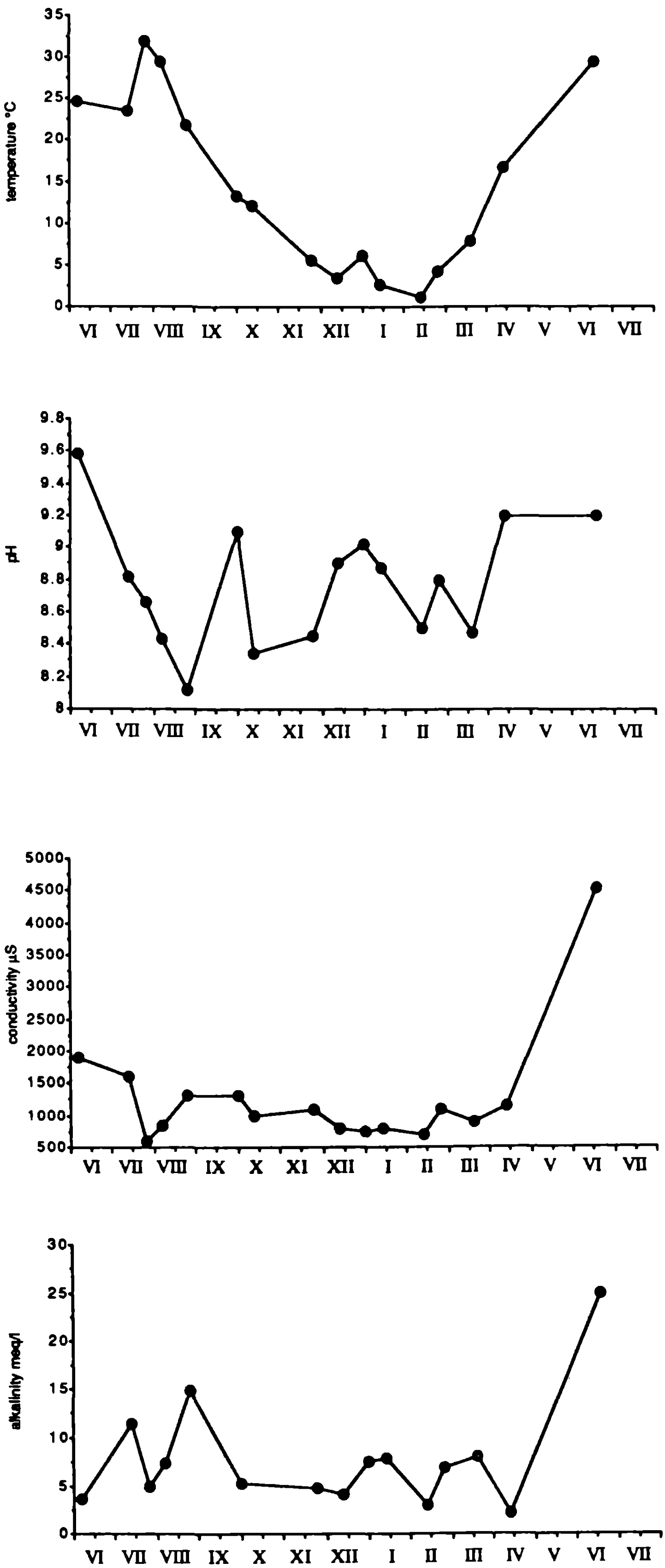


Fig. 26: Seasonal changes of environmental features in Huldenlacke (1982-1983).

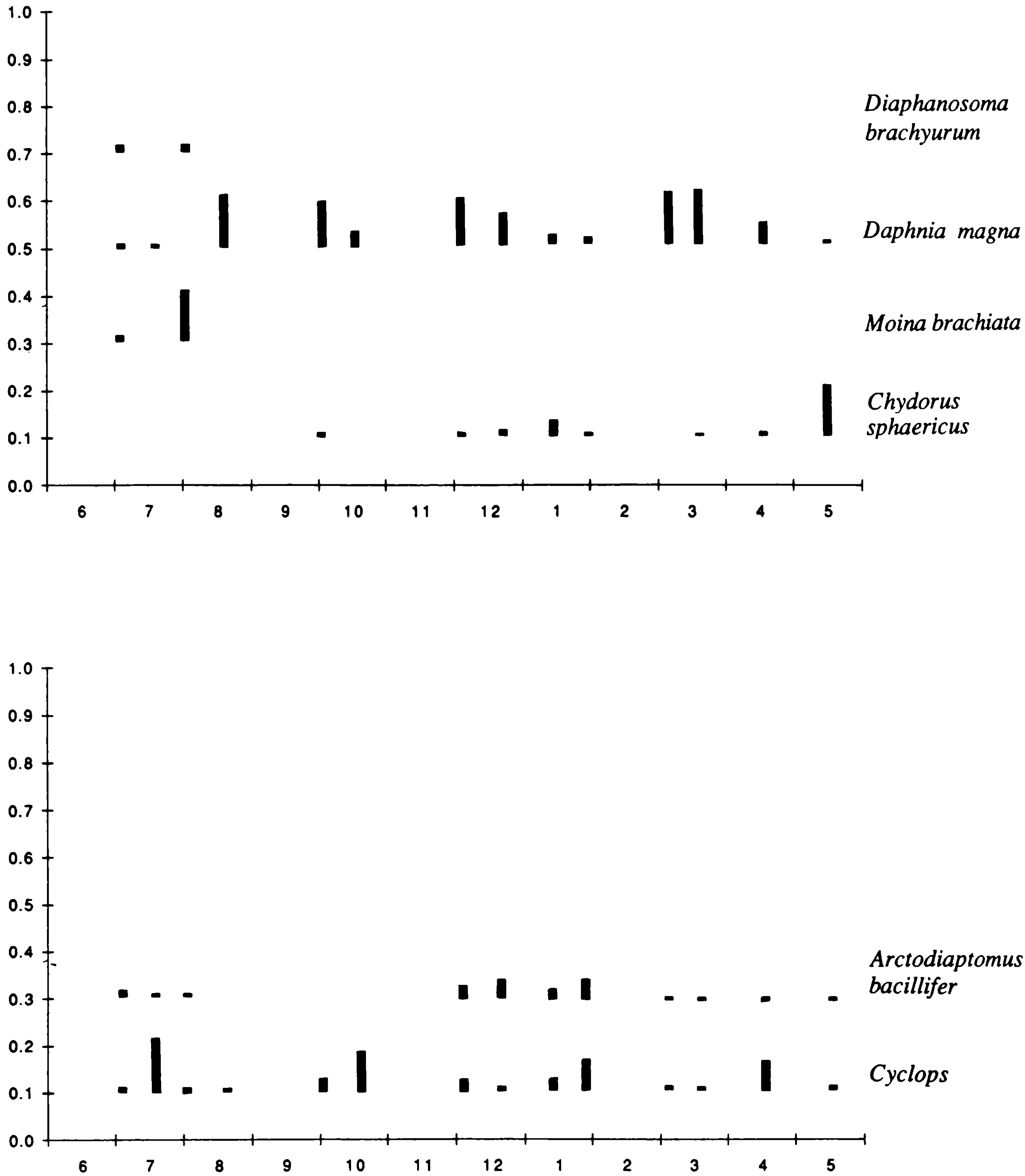


Fig. 27: Seasonal succession of crustacean zooplankton in Huldenlacke (relative abundance) (1982-1983).

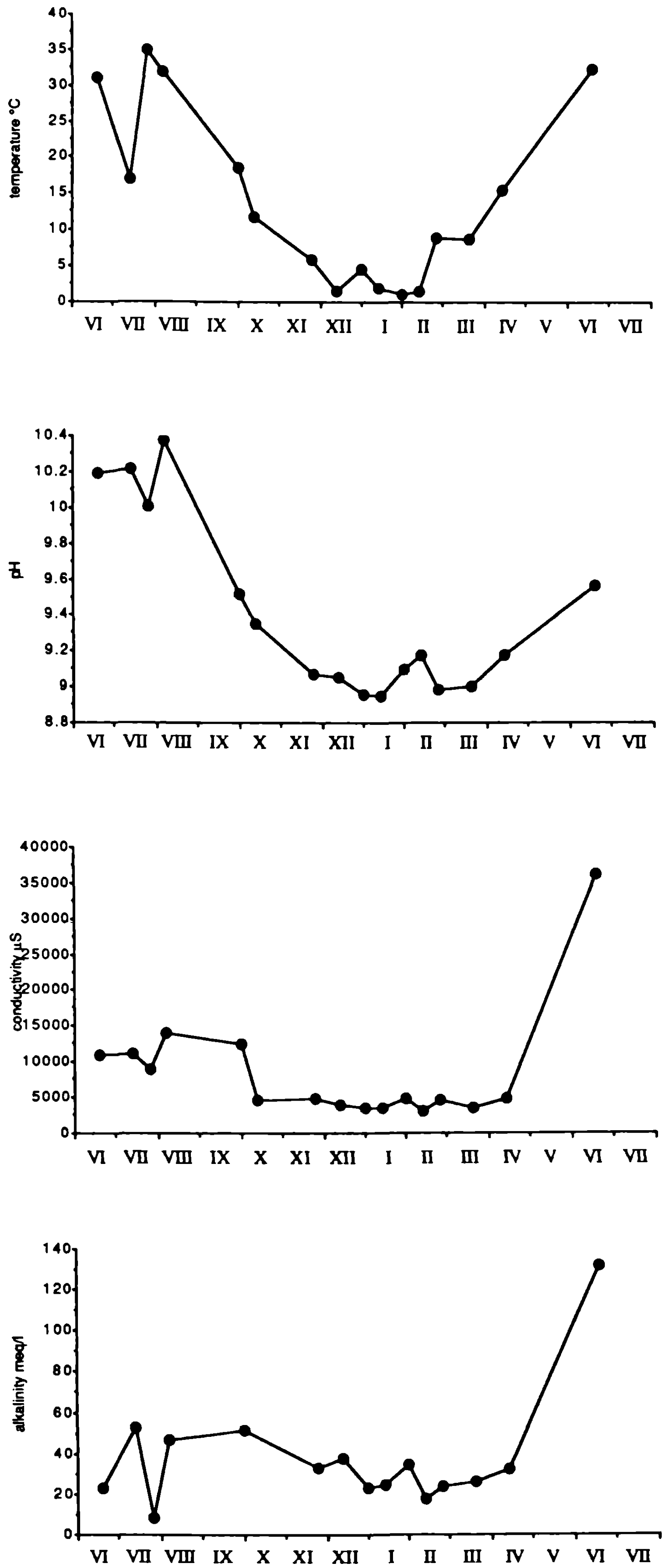


Fig. 28: Seasonal changes of environmental features in Albersee (1982-1983).

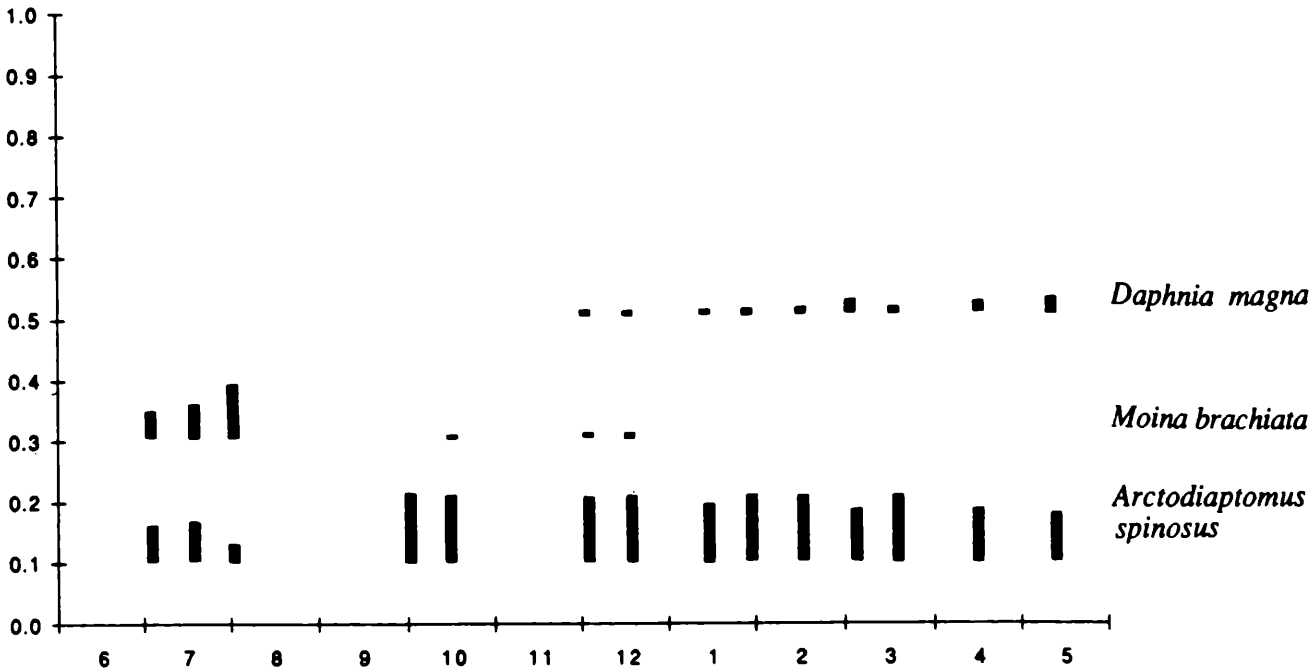


Fig. 29: Seasonal succession of crustacean zooplankton in Albersee (relative abundance) (1982-1983).

Oberer Stinkersee is larger than Albersee (area = 65 ha; Sauerzopf 1959a), but it is also a temporary pan. Abiotic parameters were highly variable (Fig. 30). Temperature varied greatly, pH did not fluctuate much. Conductivity and alkalinity values revealed the highest measurements taken throughout the investigation period and showed pronounced seasonal changes.

Seven crustacean species were encountered in this pan, the number of species in the samples varied between 1-4, on most occasions two species were found. *Arctodiaptomus spinosus* was abundant throughout the year, it dominated in most cases (≥ 90 % of total abundance) (Fig. 31). A clear succession of cladoceran species became obvious: in summer and autumn *Moina brachiata* occurred, in winter and autumn *Daphnia magna* replaced it, they co-occurred in May. In most cases these cladocerans were not numerous, *M. brachiata* reached a higher relative abundance in August (>50 %) and in May (~30 %). The other cladocerans, *Macrothrix hirsuticornis, Bosmina longirostris* and *Chydorus sphaericus* occurred only on one or two occasions in winter and spring samples.

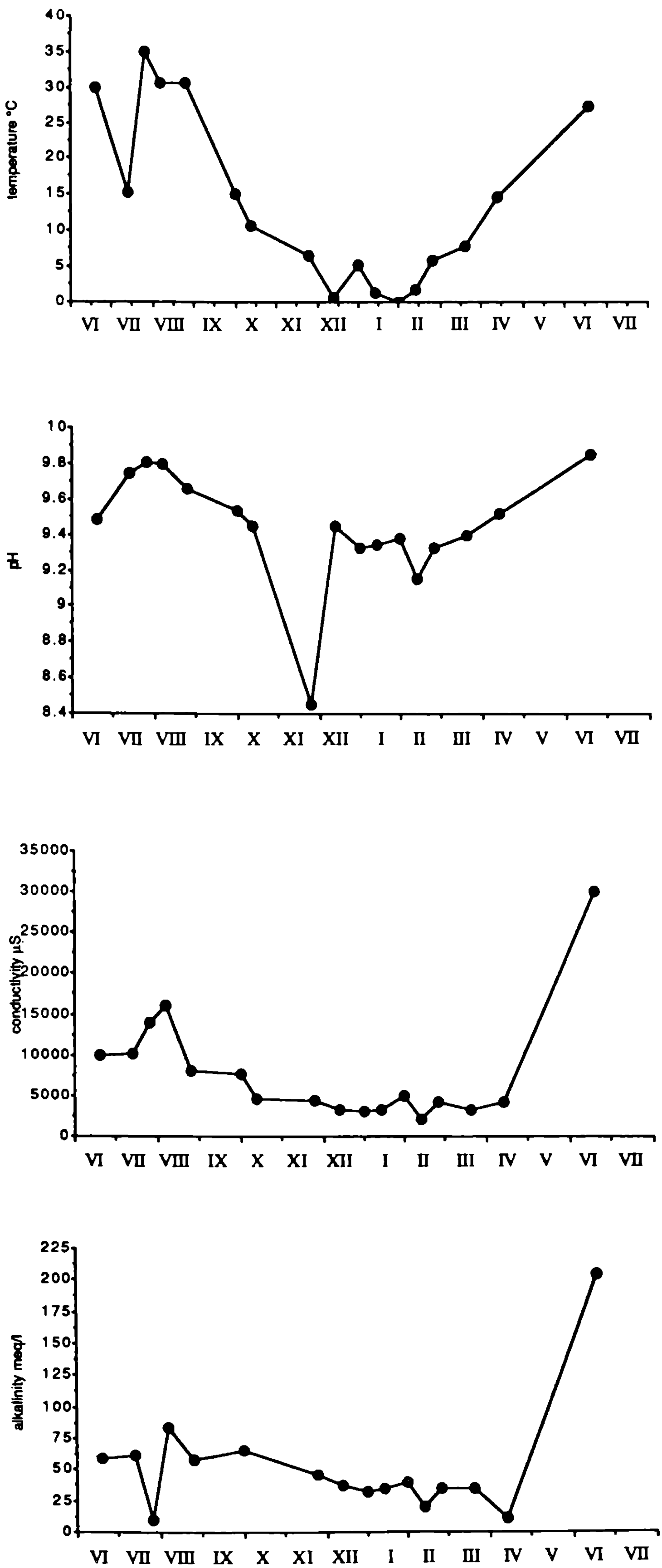


Fig. 30: Seasonal changes of environmental features in Oberer Stinkersee (1982-1983)

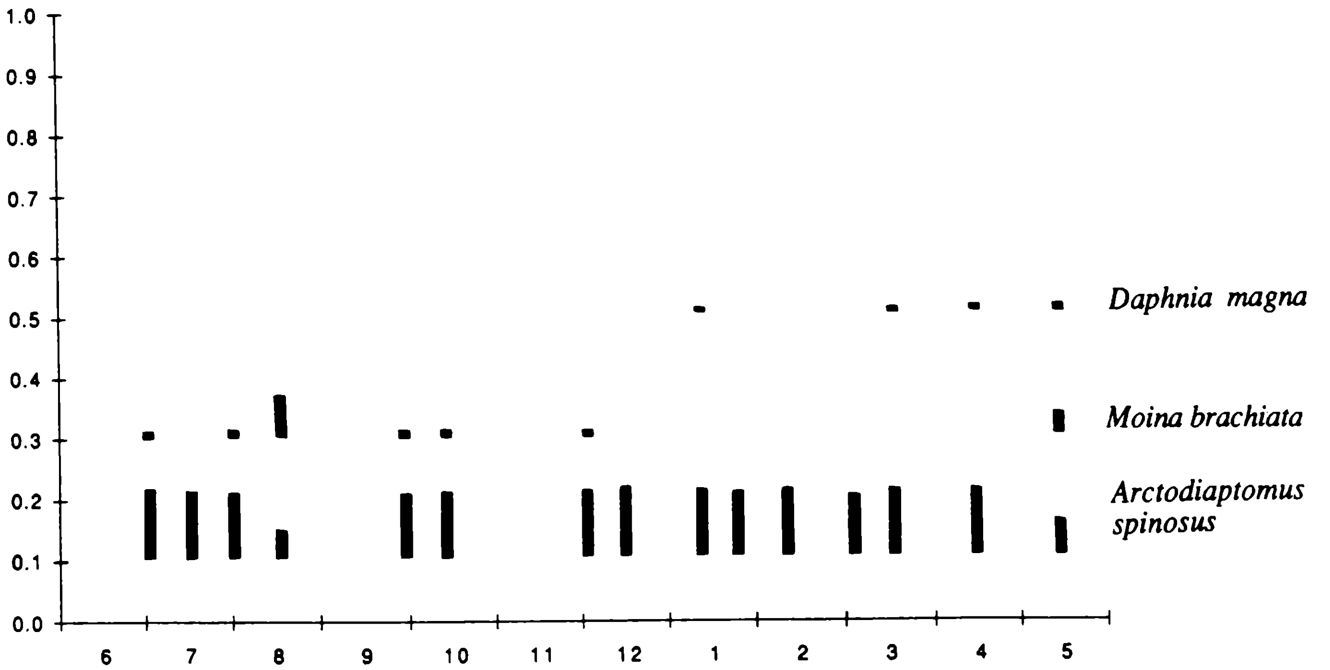


Fig. 31: Seasonal succession of crustacean zooplankton in Oberer Stinkersee (relative abundance) (1982-1983).

4. Discussion

This study revealed the occurrence of 35 crustacean species. Altogether more than two hundred samples were collected, and in more than10 % of them the following species were recorded: *Branchinecta orientalis, Diaphanosoma brachyurum, Daphnia magna, D. atkinsoni, Moina brachiata, Macrothrix hirsuticornis, Chydorus sphaericus, Arctodiaptomus bacillifer, A. spinosus, Cyclops strenuus, Acanthocyclops robustus* and *Megacyclops viridis.* Five species of these (3 Cladocera, 2 Copepoda) occurred more frequently in the plankton, their associations are presented in Table 7.

In northern hemisphere saline waters *Diaptomus* and *Moina* species are characteristic: *D. nevadensis, D. sicilis, M. hutchinsoni* in North America (Cole 1968, Cooper & Koch 1984), *Arctodiaptomus salinus, M. salina* in the Mediterraneum (Alonso & Comelles 1984; Comin & Alonso 1988) and also in Iran (Löffler 1961). In the sodic waters of the Carpathian Basin the *Arctodiaptomus spinosus - Moina brachiata* association is characteristic in summer, including also extreme conditions (Megyeri 1959, 1973). However, *A. bacillifer* is also quite frequently found in these waters; Megyeri (1958) considered it as typical of less turbid and less sodic waters. In the Seewinkel, *A. bacillifer - M. brachiata* associations are rather rare, they are more frequent with the co-occurrence of *D. magna* and/or *D. brachyurum* (Table7).

Table 7: Associations of the five most frequent species.

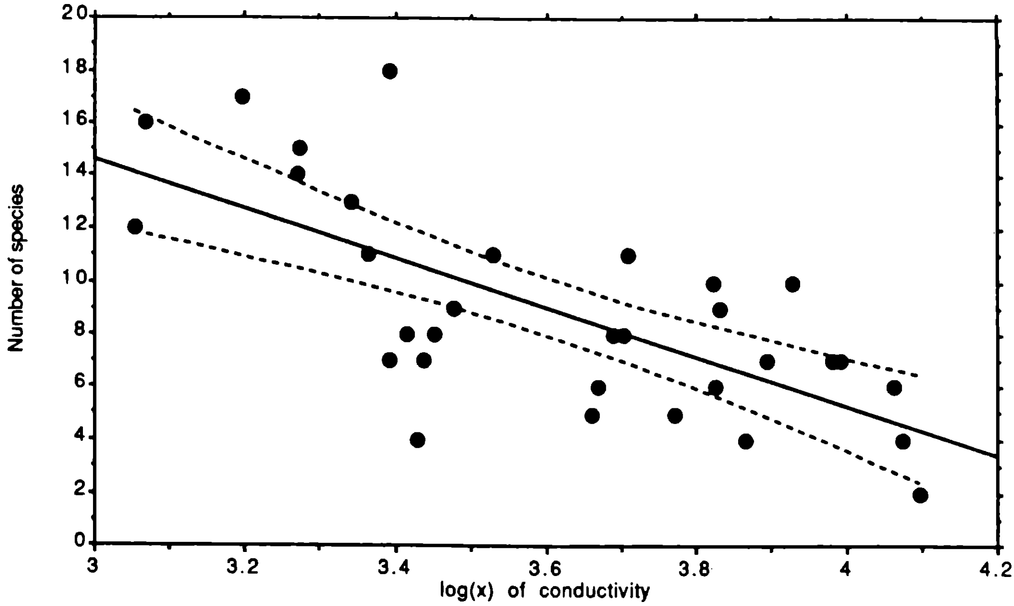
	Moina brachiata	*Daphnia magna*	*Diaphanosoma*	*Moina+Daphnia*	*Moina+Diaphanosoma*	*Moina+Daphnia+Diaph.*
A. spinosus	50	38	4	24	6	6
A. bacillifer	4	24	2	7	2	1
A. spinosus+ A. bacillifer	4	4	1	4	3	3

It has long been recognized that the species number is inversely related to salinity. However, several authors emphasized the role of other factors, such as dominant cation (Scudder 1969), anionic proportions (Bayly 1969), dynamics of ionic composition (Blinn 1971), temporal pattern of interaction between salinity, temperature and the presence of water (Williams 1984).

In Figure 32 species number of the pans are plotted against conductivity and alkalinity; the values used here are log transformed arithmetic means. Numbers refer to the sequential numbers in Table 1. The figure seems to confirm that alkalinity is more effective in determining species numbers than salinity, as it was pointed out by Löffler (1961).

In shallow saline waters temperature is the least conservative factor (Cole 1968), and this is true for all the four pans we examined in more detail. Water temperature in each pan closely followed dial air temperatures, which in the continental climate of the region displays pronounced variation. The size of the water body is in this context of some significance too; e. g. maximum water temperature in Lange Lacke was 24.2 °C, while the maximum value in Oberer Stinkersee was 35 °C.

The variation of chemical factors was different in the four pans. Albersee and Oberer Stinkersee are temporary waters, but did not dry out during this year. Williams (1978) and Hammer (1978) found that the higher the absolute value of salinity the more pronounced its annual fluctuation. Our experience in this case is very similar, since the changes were greatest in Albersee and Oberer Stinkersee, where the spring minimum values were rather high. The changes in the year were 2-3 fold in Lange Lacke and in Huldenlacke, while 5-7 fold in the other two pans. This is also valid for changes in alkalinity, which varied markedly in Albersee and Oberer Stinkersee.



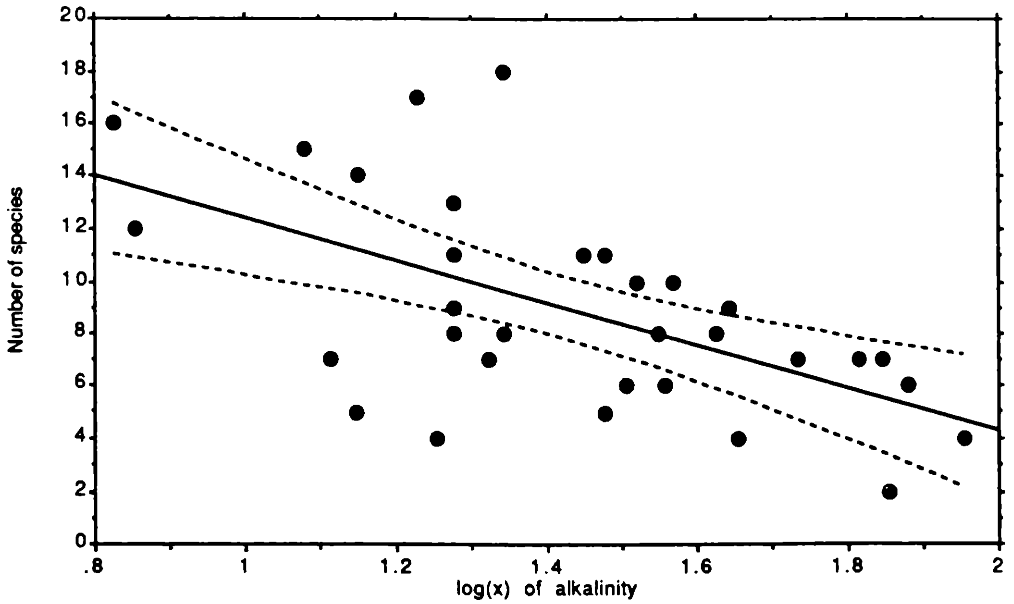


Fig. 32: Plot of species numbers against conductivity (a) and alkalinity (b).

Already the first student of the microfauna of sodic waters, Daday (1893) noted, that the summer zooplankton is composed of few species in great densities. Later, based on the results of several years of investigations, Megyeri (1959) outlined typical species composition and seasonality of the zooplankton of Hungarian sodic waters. Relative abundance and seasonal changes observed in Albersee and Oberer Stinkersee (few species, dominance of *A. spinosus* in almost all cases, clear succession of cladoceran species) indicate that they are still in, or close to, natural conditions. However, the composition and seasonal changes both in Lange Lacke (dominance of *B. longirostris*) and in Huldenlacke (e. g. the occurrence of *D. magna* in each season) very likely reflect human influence.

The first information on chemistry, rotatorian and crustacean zooplankton of the sodic pans of the Seewinkel has been given by Löffler (1957, 1959). At that time the pans were less influenced by human activities. Since then conditions have changed, the number of pans decreased. Table 8 provides a comparison between Löffler's and our faunistical data. A decrease in species numbers, both of Cladocera and Copepoda, becomes obvious. Actually, each species, except *Diaphanosoma brachyurum* and *Bosmina longirostris* was recorded at a smaller number of localities in this study. The number of *Cyclops* species sharply decreased, the reason for it is very likely the disappearence of Szerdahelyer Lacke, where Löffler (1959) found many species. Two species of *Cyclops* were not recorded previously. *C. vicinus* occurred in permanent pans only, *A. robustus* was recorded in several samples. The occurrence of both species may be an indication of eutrophication. Very recently *C. vicinus* was recorded in Neusiedlersee too (Forró & Metz 1987). Löffler (1959) found four diaptomids, while in our material *Arctodiaptomus wierzejski* and *Mixodiaptomus kupelwieseri* did not occur. The latter species is typical for diluted waters in spring. It was recorded from six pans (Löffler, 1959), but, though we collected on more occasions in spring, it was not detected, nowadays.

5. Summary

A comparison of the data presented here with the results of other authors reveals many changes. Most seriously is the disappearence of all those pans which already Löffler (1959) mentioned as impaired by massive growth of reeds. The pans east and southeast of Apetlon and St. Andrä were affected most. In some cases today a vanished pan is replaced by a secondary water surface, created by opening the groundwater horizon. This is the case in the Arbesthau Lacke, Martental Lacke (both used as fishponds) or the Schwarzsee Lacke (Szerdahelyer Lacke in Löffler, 1959). Their present chemistry has no relation whatsoever to the one found by Löffler (1959).

The Xixsee and the Hallabern Lacke, both north of Apetlon, as well as some smaller pans in the vicinity of Illmitz, the Einsetzlacke, the Grund Lacke and small pans south of Podersdorf disappeared. As a basis for comparison of chemical changes in the still intact pans the alkalinity is well suited since this parameter was measured by nearly all authors (Table 2). In spite of this, comparison is not always possible, because single values are likely to differ greatly due to influence of varying climatic conditions. As it was mentioned by Löffler (1959) this already applies especially to the data of Gerabek (1952). In his data solely the pans with a natural low variability (Darscho, Lange Lacke, Wörthenlacke and Zicksee at St. Andrä) agree well with the data of other authors.

Using Löffler's(1959) data serious changes are apparent in three cases: Zicksee at St. Andrä, Birnbaumlacke and Huldenlacke. In the case of the first one the changes seem to be less pronounced than

Table 8: Comparison of species occurrence with the data of Löffler (1959) (numbers in parenthesis indicate frequency of species occurrence).

Löffler (1959) n=58		This study (1982-85) n=32	
BRANCHIOPODA			
Branchinecta orientalis	(15)	*Branchinecta orientalis*	(14)
Diaphanosoma brachyurum	(9)	*Diaphanosoma brachyurum*	(10)
Daphnia similis	(4)	*Daphnia similis*	(1)
Daphnia atkinsoni	(23)	*Daphnia atkinsoni*	(11)
Daphnia magna	(42)	*Daphnia magna*	(32)
Daphnia pulex	(11)	*Daphnia pulex*	(3)
Daphnia longispina	(20)	*Daphnia longispina*	(6)
Scapholeberis mucronata	(15)	*Scapholeberis rammneri*	(5)
Scapholeberis aurita	(2)	*Megafenestra aurita*	(1)
Ceriodaphnia quadrangula	(5)	*Ceriodaphnia quadrangula*	(1)
Ceriodaphnia dubia	(9)	*Ceriodaphnia reticulata*	(5)
Ceriodaphnia reticulata	(16)	*Simocephalus vetulus*	(1)
Ceriodaphnia setosa	(2)	*Simocephalus exspinosus*	(5)
Simocephalus vetulus	(10)	*Moina brachiata*	(28)
Simocephalus exspinosus	(15)	*Bosmina longirostris*	(5)
Bosmina longirostris	(5)	*Macrothrix hirsuticornis*	(18)
Moina rectirostris	(36)	*Macrothrix rosea*	(3)
Macrothrix hirsuticornis	(18)	*Oxyurella tenuicaudis*	(8)
Macrothrix rosea	(7)	*Alona rectangula*	(4)
Macrothrix laticornis	(2)	*Pleuroxus aduncus*	(4)
Leydigia acanthocercoides	(2)	*Dunhevedia crassa*	(1)
Pleuroxus aduncus	(3)	*Chydorus sphaericus*	(21)
Pleuroxus trigonellus	(9)		
Alona tenuicaudis	(25)		
Alona rectangula	(30)		
Alonella excisa	(8)		
Chydorus sphaericus	(30)		
COPEPODA Calanoida & Cyclopoida			
Diaptomus wierzejski	(1)	*Arctodiaptomus bacillifer*	(20)
Diaptomus kupelwieseri	(6)	*Arctodiaptomus spinosus*	(26)
Diaptomus bacillifer	(31)	*Macrocyclops albidus*	(1)
Diaptomus spinosus	(36)	*Eucyclops serrulatus*	(1)
Eucyclops speratus	(1)	*Cyclops strenuus*	(12)
Eucyclops serrulatus	(13)	*Cyclops vicinus*	(5)
Eucyclops macruroides	(1)	*Acanthocyclops robustus*	(8)
Eucyclops phaleratus	(2)	*Megacyclops viridis*	(10)
Paracyclops fimbriatus	(1)	*Diacyclops bicuspidatus*	(7)
Paracyclops affinis	(1)	*Metacyclops gracilis*	(1)
Tropocyclops prasinus	(1)	*Metacyclops minutus*	(2)
Cyclops viridis	(37)	*Metacyclops planus*	(1)
Cyclops strenuus	(18)	*Microcyclops varicans*	(1)
Cyclops furcifer	(1)		
Acanthocyclops vernalis	(8)		
Diacyclops bicuspidatus	(19)		
Diacyclops bisetosus	(10)		
Metacyclops minutus	(5)		
Metacyclops gracilis	(4)		
Metacyclops planus	(4)		
Microcyclops bicolor	(1)		
Microcyclops rubellus	(1)		
Mesocyclops leuckarti	(2)		

in the other two, since it is a relatively large, permanent water body and was moderately saline and alkaline also in the fifties. For example, Löffler (1959) measured an alkalinity about 9 $meq.l^{-1}$, while it varied between 6.1-7.9 $meq.l^{-1}$ (mean=6.7) in 1982-85. However, it is of particular interest that we did not record any diaptomids from Zicksee at St. Andrä, while previously *Arctodiaptomus bacillifer* and *A. spinosus* were reported from this pan (Löffler 1959, Pescheck 1961).

With an average SBV of 97 $meq.l^{-1}$ the Birnbaumlacke was described as one of the most alkaline pans (Löffler 1959); it contained *Branchinecta orientalis* and *A. spinosus*. Jungwirth (1973) measured 390 $meq.l^{-1}$ as maximum alkalinity, and the conductivity varied between 806-18771 μScm^{-1}. Investigations by Glatz (1976) revealed an average alkalinity of still 65 $meq.l^{-1}$. Results published by Fischer-Nagel (1977) show a dramatic drop of the concentration; he measured 14.5 $meq.l^{-1}$. We found this pan to be moderately saline (900-6500 μScm^{-1}; mean=2471) and less alkaline (9.04-16.6 $meq.l^{-1}$; mean=12.7). *Branchinecta* was not recorded here, the total number of species was much greater than that encountered by Löffler (1959). We found seven species (Table 5) and Löffler (1959) only *B. orientalis* and *A. spinosus*. It seems that excavations into the groundwater are largely responsible for it.

Table 9 presents a comparison of the results of the two studies for Huldenlacke. We recorded eleven species, Löffler(1959) only seven; the number of Cladocera species did increase, but *Daphnia atkinsoni* was not found. *A. spinosus* was replaced by *A. bacillifer* , and beside *Metacyclops planus*, which still existed in the pan, *C. strenuus* and *A. robustus* occurred here as new species. A further indication of severe changes is the dominance of cyclopoids over *A. bacillifer*. As mentioned earlier, Huldenlacke accepts the effluent of the sewage plant of St. Andrä, which results in the observed changes.

Table 9: Comparison of species occurenrce in Huldenlacke.

	Löffler (1959)	This study (1982-85)
Diaphanosoma brachyurum		+
Daphnia atkinsoni	+	
Daphnia magna	+	+
Moina brachiata	+	+
Bosmina longirostris		+
Macrothrix hirsuticornis	+	+
Pleuroxus aduncus		+
Chydorus sphaericus		+
Arctodiaptomus bacillifer		+
Arctodiaptomus spinosus	+	
Cyclops strenuus		+
Megacyclops viridis	+	
Acanthocyclops robustus		+
Metacyclops planus	+	+

Frequently, changes in salinity are accompanied with rapid changes in species composition (e. g. Edmondson 1969, Scudder 1969, Herzig 1979 etc.). The Seewinkel pans represent unique habitats because of their chemical characteristics and invertebrate fauna. Impacts which lead to a change in their sodic character result in changes of the corresponding biological features. Accordingly these small water bodies are highly endangered and should be protected more effectively.

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APPENDIX: Date of the chemical analyses

LANGE LACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	17,6	2500	9,16	1,88	14,03	94,00	505,4	26,94	65,58	308,04		
01. 07. 82	17,6	2500	9,30	17,16	25,65	79,77	486,0	21,40	132,57	362,00	150	
14. 07. 82	21,3	2300	9,25	16,26	0,00	251,35	446,0	22,48	131,40	672,00	266	206
29. 07. 82	24,2	2400	9,29	17,72	13,63	67,24	436,5	24,20	142,00	479,20	283	130
19. 08. 82	20,4	2000	9,30	14,00	17,64	60,56	391,8	20,26	105,66		228	36
30. 09. 82	15,2	1900	9,10	14,30	11,62	8,76	406,6	19,70	105,35	256,03	258	41
14. 10. 82	11,0	1600	9,02									
02. 12. 82	5,7	1600	8,75	13,68	22,04	61,53	367,2	19,70	79,52	194,00		
14. 12. 82	3,5	1150	8,75	12,65	28,46	55,45	327,6	16,92	95,10			
12. 01. 83	4,8	1250	8,83	11,76	27,25	55,94	319,3	16,25	80,73	169,23	580	149
25. 01. 83	2,3	1400	8,87	11,92	28,06	54,72	312,8	18,02	74,75	207,35	798	176
17. 02. 83	0,3	1700	8,91	12,56	36,67	62,87	339,6	18,24	88,62	222,45	818	351
02. 03. 83	1,1	1500	8,78	12,20	31,66	57,88	217,8	15,80	83,66	195,84	779	348
15. 03. 83	4,3	1700	8,82	11,68	28,46	58,12			87,91	157,82	581	86
13. 04. 83	9,5	1300	8,93	11,80	36,87	58,12			79,08	176,83	40	78
11. 05. 83	14,7	1800	8,94	3,40	35,67	68,58			63,80	306,08	120	156
26. 07. 83	22,2	2500	8,93	17,20	25,05	86,94			115,00	530,00	0	114
24. 10. 83	6,1	1950	9,18	18,84	6,81	37,33	535,0	23,60	149,60	75,84	901	68
07. 05. 84	18,3	2500	9,45	17,96	14,43	91,32	546,8	23,80	137,60		105	34
13. 08. 84	18,0	3200	9,45	22,00	12,83	109,44	713,7		196,00	564,48	46	162
26. 03. 85	8,1	1400	9,19	8,80	24,85	0,00			77,40	309,08	174	88

ALBERSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	31,0	11000	10,19	22,70		143,49	1984,0	115,20	1107,60	1027,90	0	164
01. 07. 82	17,1	11100	10,22	52,52	4,81	95,82	2324,5	111,85	1585,30	1436,00	500	
14. 07. 82	35,0	9000	10,01	8,64		92,42	2127,0	109,25	1358,00	979,20	500	57
29. 07. 82	32,0	14000	10,37	46,80	300,60	70,41	2004,0	110,50	1578,00	555,30	400	67
30. 09. 82	18,5	12500	9,52	51,40	20,04	68,10	2428,0	73,40	1630,70	1338,60	27	432
14. 10. 82	11,8	4500	9,35									
02. 12. 82	6,0	4900	9,07	32,72	21,64	63,72	1830,4	89,48	942,80	787,00		
14. 12. 82	1,6	3900	9,05	37,12	10,22	57,15	1158,8	46,08	800,60			
12. 01. 83	4,6	3600	8,96	23,32	24,05	73,45	1158,8	44,58	599,96	526,58	131	71
25. 01. 83	2,0	3400	8,95	24,80	14,63	88,40	1050,4	63,88	644,46	558,89	87	58
17. 02. 83	1,1	4900	9,10	34,48	16,03	97,28	1158,8	68,36	658,72	570,29	0	164
02. 03. 83	1,5	3050	9,18	17,88	13,63	65,30	816,4	41,40	457,46	420,13	40	29
15. 03. 83	9,0	4550	8,98	23,68	22,44	97,77			599,86	539,88	0	86
13. 04. 83	8,7	3600	9,00	25,88	28,86				587,00	564,60	53	109
11. 05. 83	15,5	4750	9,18	32,04	21,24	133,03			786,28	576,00	11	148
26. 07. 83	32,4	36000	9,56	131,47	0,00	238,34	2698,3	111,43	4040,00	5834,00	59	75
07. 05. 84	18,0	5900	10,06	28,08	0,00	64,93	1562,0	86,45	946,00		147	50
26. 03. 85	17,7	1500	9,50	9,16	20,84	0,00			172,00	208,03	0	84

HULDENLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	24,7	1900	9,58	3,68	55,31	55,45	252,7	26,00	213,30	262,44		
01. 07. 82	23,6	1600	8,82	11,40	12,22	14,11	301,0	14,45	51,15	228,00	333	270
14. 07. 82	32,0	610	8,66	4,96	2,00	9,12	144,1	7,90	26,60		183	258
29. 07. 82	29,4	850	8,43	7,36	17,64	14,11	239,5	15,85	46,00	105,20	550	247
19. 08. 82	21,8	1300	8,12	14,88	6,41	41,83	283,2	19,14	34,64	124,22	140	
30. 09. 82	13,2	1300	9,10	5,30	47,09	58,00	204,2	20,26	157,33	223,06	141	173
14. 10. 82	12,0	1000	8,34									
02. 12. 82	5,5	1100	8,45	4,76	72,14	51,07	164,8	19,14	98,35	197,80		
14. 12. 82	3,5	800	8,90	4,05	71,74	49,61	109,0	15,90	80,55		1117	85
12. 01. 83	6,2	750	9,02	7,52	43,69	23,10	158,9	9,85	42,32	71,15	1117	85
25. 01. 83	2,7	800	8,88	7,80	44,09	33,08	263,6	30,40	53,12	89,40	450	74
02. 03. 83	1,1	700	8,50	2,94	54,91	21,16	79,9	7,60	60,57	97,00	6613	1955
15. 03. 83	4,3	1100	8,80	6,88	68,94	51,80			92,17	89,39	1122	65
13. 04. 83	7,9	900	8,47	8,10	76,15	53,99			85,00	107,00	1650	108
11. 05. 83	16,6	1150	9,20	2,15	49,70	57,88			85,00	247,00	90	100
26. 07. 83	24,9	4500	9,20	25,00	43,69	121,60			410,00	900,00	46	300
24. 10. 83	7,5	1600	9,35	8,50	25,05	24,08	412,0	15,50	210,00	260,00	800	60
07. 05. 84	19,6	2300	9,85	15,00	17,23	68,34	458,0	18,00	170,00		85	52
13. 08. 84	18,5	1700	8,35	6,76	68,14	57,15	199,4	25,82	168,50	334,08	176	1170
26. 03. 85	9,9	450	9,78	8,10	35,07	25,29			46,00	60,00	2700	1200

OBERER STINKERSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	10000	9,48	59,60	32,06	1,22	2033,0	73,40	525,45	608,83		
01. 07. 82	15,3	10200	9,75	61,12	2,00	18,60	2337,0	75,70	748,45	1113,00	383	
14. 07. 82	35,0	14000	9,81	9,92		14,59	2946,0	92,90	848,00	883,20	433	45
29. 07. 82	30,5	16000	9,80	84,00	84,17	6,08	2640,0	85,45	1028,00	556,80	316	35
19. 08. 82	30,5	8000	9,66	57,60	3,61	3,16	1454,0	47,20	424,70	558,60	505	78
30. 09. 82	15,1	7700	9,54	64,60	56,11	0,00	2280,0	67,90	591,33	984,50	216	28
14. 10. 82	10,8	4600	9,45									
02. 12. 82	6,5	4400	8,45	44,80	12,83	10,46	1642,4	51,64	394,62	570,40		
14. 12. 82	0,6	3300	9,45	36,57	16,23	2,55	1208,0	87,16	327,36			
12. 01. 83	5,3	3100	9,33	31,74	13,63	12,89	972,9	34,56	259,58	347,90	116	60
25. 01. 83	1,3	3200	9,34	34,96	24,25	3,53	1060,0	41,96	299,29	471,46	87	74
17. 02. 83	0,1	4950	9,38	39,28	30,46	4,13	1218,0	44,96	316,46	435,50	0	143
02. 03. 83	1,7	2100	9,15	20,20	32,06	6,57	604,0	16,36	151,49	138,82	132	117
15. 03. 83	5,8	4250	9,33	34,00	28,46	6,57			289,10	309,88	40	52
13. 04. 83	7,9	3200	9,40	34,84	16,03	17,02			301,50	357,40	0	75
11. 05. 83	14,7	4200	9,52	10,59	14,43	17,75			358,80	568,40	15	21
26. 07. 83	27,4	30000	9,85	202,40	38,08	20,67	7441,5	175,56	1570,00	3683,00	17	16
07. 05. 84	11,1	10000	10,04	65,20	9,02	31,86	2107,0	92,90	646,70		168	36

DARSCHO

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,6	2300	9,00	16,48	12,42	52,53	503,0	28,40	113,29	190,20		
19. 08. 82	25,3	2350	9,20	6,28	57,72	53,50	159,6	23,60	77,73	126,60		
14. 12. 82	3,8	1300	9,10	14,60	14,23	43,90	391,8	13,20	116,17			
15. 03. 83	6,2	1800	8,96	13,44	26,45	44,14			87,70	211,04	224	57
26. 07. 83	28,6	2900	9,09	19,85	10,82	62,62			140,00	493,00	42	23
24. 10. 83	9,6	2400	9,30	14,00	50,10	114,79	767,0	19,14	168,92	244,70	139	42
21. 12. 83	0,7	2350	9,40	21,00	8,62	63,84	580,0	14,95	136,00	407,00	175	800
21. 02. 84	0,4	2000	9,33	23,70	10,82	81,72	729,5	18,05	191,20	255,00	564	171
27. 03. 84	7,8	2000	9,33	18,90	15,03	65,42	555,0	14,68	136,90		96	103
07. 05. 84	23,5	3000	9,52	21,96	7,21	70,53	665,2	17,12	172,00		0	36
13. 08. 84	21,0	3800	9,45	30,96	14,43	77,82	793,6	21,60	223,60	138,24	42	90

FUCHSLOCHLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,5	4200	9,27	21,06	19,84	8,03	9,7	25,80	212,39			
19. 08. 82	27,9	2900	9,37	16,64	12,42	3,40	549,8	9,12	104,98	194,04		
14. 12. 82	3,9	1700	9,10	20,25	41,68	5,59	639,2	10,90	166,62			
15. 03. 83	5,7	2600	9,15	19,28	26,05	20,43			134,71	304,18	53	68
26. 07. 83	31,3	16000	9,64	94,60		86,94			660,00	2051,00	120	65
24. 10. 83	12,0	13000	9,76	109,52	25,05	47,18	4353,0	26,10	754,50	1587,00	71	5
21. 12. 83	0,7	1800	9,90		12,42	3,89	435,0	8,54	81,15	254,00	242	127
21. 02. 84	0,2	3500	9,50	45,20	7,01	28,82	1645,0	13,00	421,50	645,00	150	85
27. 03. 84	7,3	2300	9,60	23,20	15,43	19,70	745,0	13,30	175,00		17	142
07. 05. 85	28,0	6800	9,98	97,60	20,04	26,75	423,8	4,10	436,80		32	36
13. 08. 84	23,8	1300	9,20	9,32	8,02	4,86	263,6	7,46	92,80	144,00	92	192
26. 03. 85	16,0	450	8,70	7,04	24,45	4,62			25,80	36,44	235	157

OBERE HALBJOCHLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,6	11000	9,61	71,00	40,08	14,59	267,5	36,82	482,09	970,00		
19. 08. 82	27,0	12000	9,87	78,60	40,08	14,59	2428,0	20,60	61,66	128,10		
14. 12. 82	4,0	5500	9,75	61,05	14,23	18,73	1886,4	13,84	288,40	520,87		
15. 03. 83	6,3	5800	9,52	28,36	20,84	17,51			167,07	454,35	409	81
26. 07. 83	32,5	16500	9,72	99,00	30,06	40,13			603,00	2552,00	76	75
24. 10. 83	10,9	16000	9,74	147,52	80,16	45,60	6714,0	31,70	865,90	2123,00	210	29
21. 12. 83	0,7	8000	10,11	66,60	46,09	8,88	2157,0	15,00	354,50	1663,50	164	120
21. 02. 84	0,2	8300	9,90	124,30	35,07	33,44	4378,0	22,00	815,30	2151,00	103	79
27. 03. 84	7,1	6500	10,00	86,80	21,04	31,01	2774,0	20,60	539,40		15	96
07. 05. 85	25,1	20000	10,02	136,80	64,13	38,91	4806,0	27,40	860,00		137	58
13. 08. 84	24,5	17000	9,95	105,50	16,03	21,89	3672,0	30,00	801,50	495,36	21	437
26. 03. 85	16,6	2300	9,67	21,40	8,42	0,00			137,60	429,19	80	471

MOSCHADO LACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	26,1	3500	9,74	30,20	20,04	50,22			79,89	285,40		
19. 08. 82	21,8	900	8,95	8,12	13,63	10,70	224,0	9,68	24,32	50,52		
14. 12. 82	3,5	1200	8,80	18,00	17,03	37,09	424,8	16,20	52,65			
15. 03. 83	3,1	2500	8,90	18,88	21,64	35,51			59,11	205,34	40	47
26. 07. 83	20,9	6100	9,71	47,25	27,45	25,54			170,00	1216,00	34	42
07. 05. 85	18,8	5000	9,70	46,32	8,02	46,94	1412,0	43,70	182,30		126	34
13. 08. 84	18,8	2700	9,28	21,84	14,43	32,59	684,0	22,96	96,30	472,32	40	95
26. 03. 85	7,7	380	8,90	7,76	22,04	0,00			8,60	17,38	61	120

ZICKSEE ST. ANDRÄ

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,8	1300	8,61	6,94	46,29	98,50	126,8	16,53	72,19	235,75		
19. 08. 82	25,0	1250	8,80	6,11	39,28	90,71	115,4	17,48	34,86	116,46		
14. 12. 82	3,7	750	8,43	6,83	53,71	90,47	109,6	15,69	80,55			
15. 03. 83	4,7	1200	8,72	7,92	52,50	87,31			68,32	176,83	106	125
26. 07. 83	26,2	1500	8,81	6,92	41,68	96,67			92,00	326,00	11	70
24. 10. 83	6,8	1100	8,63	9,96	48,10	105,67	121,9	19,03	88,95	221,80	2692	104
07. 05. 85	21,4	1300	8,81	6,40	52,71	91,56	104,6	17,64	92,80		36	89
13. 08. 84	20,2	1300	8,43	6,16	54,11	80,26	115,4	15,80	86,00	324,48	36	115
26. 03. 85	10,5	850	8,70	6,04	42,48	0,00			68,80	274,76	130	101

FREIFLECKLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,7	7500	9,29	33,90	16,03	20,06	1811,0	16,90	362,97	1530,40		
19. 08. 82	26,9	6000	9,40	13,10	44,09	58,37	172,8	14,45	36,14	68,15		
14. 12. 82	3,5	2800	9,10	36,32	13,23	19,82	1141,6	6,90	237,41	365,40		
15. 03. 83	4,6	3400	9,02	17,76	32,06	18,48			173,11	537,98	79	68
26. 07. 83	30,0	20000	9,74	86,92	92,58	16,42			800,00	4499,00	0	16
24. 10. 83	11,4	8800	9,80	60,00	38,08	31,62	1049,2	14,92	780,80	2273,40	218	23
07. 05. 85	28,5	22000	9,79	86,00	114,23	40,13	6830,0	25,40	1062,90		0	19
13. 08. 84	23,0	6300	9,75	49,60	20,04	18,24	1733,0	9,50	502,20	558,72	126	56
26. 03. 85	13,3	1900	9,20	10,60	14,03	0,00			111,80	505,46	105	115

BADELACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,0	3750	9,37	24,81	30,66	10,58	1154,0	33,00	144,95	478,59		
19. 08. 82	21,7	1200	8,85	7,84	15,23	1,46	253,6	11,34	33,82	46,60		
14. 12. 82	3,6	850	8,50	10,40	35,07	3,53	288,2	13,02	32,11			
15. 03. 83	3,3	1150	8,77	8,80	26,45	13,13			31,47	96,99	317	135
26. 07. 83	27,5	9700	9,74	71,50	63,13	9,73			388,00	2277,00	0	28
24. 10. 83	10,3	2000	9,08	15,80	316,63	9,24	564,4	39,18	116,06	259,96	1686	494
13. 08. 84	19,5	1700	9,35	9,68	11,22	10,21	312,8	33,62	68,80	167,04	1090	689
26. 03. 85	10,5	520	8,66	9,40	14,83	15,32			34,40	74,57	683	533

MARTINHOFLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 08. 82	19,8	1000	8,64	7,20	14,03	1,22	229,0	6,90		97,08		
14. 12. 82	3,0	700	8,70	9,55	25,65	3,53	263,6	10,24	89,46			
15. 03. 83	2,8	1300	8,84	10,72	26,05	9,73			18,07	98,90	13	109
26. 07. 83	21,4	7100	9,55	61,70	38,08	13,98			180,00	864,00	174	114
24. 10. 83	7,7	2550	9,45	24,28	10,62	13,13	9,2	9,12	49,84	354,00	1033	47
26. 03. 85	7,8	500	8,63	5,52	12,42	0,00			34,40	72,67	794	489

HÖLLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	29,3	11000	9,59	74,20	28,06	49,86	2033,0	20,33	568,19	875,00		
19. 08. 82	29,5	2000	9,85	44,60	32,06	0,00	1515,0	32,00	343,00	621,10		
14. 12. 82	1,5	3500	8,30	36,33	10,22	21,40	1267,2	30,50	343,67			
15. 03. 83	6,0	4400	9,17	35,76	18,44	37,45			320,60	388,20	172	73
26. 07. 83	26,2	34500	9,76	246,69	71,94	70,41	12246,0	197,12	1780,00	5556,00	0	10
24. 10. 83	13,8	14000	9,84	99,00	40,08	9,12	3588,0	67,90	972,50	1931,50	21	52
07. 05. 84	9,7	14000	9,95	97,60	54,11	23,10	3531,0	76,80	928,80		105	34

SALZSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	20,7	2400	9,43	26,60	11,22	134,25	411,0	26,50	77,99	127,56		
19. 08. 82	24,1	1400	8,43	23,24	8,22	9,24	956,5	6,43	260,34	492,67		
14. 12. 82	3,8	800	8,40	11,90	38,08	70,28	209,2	11,90	59,13			
15. 03. 83	3,8	1500	8,57	17,40	40,08	75,39			52,98	72,28	0	68
24. 10. 83	10,3	1400	8,70	19,24	31,26	84,03	287,2	13,47	76,40	219,95	403	1128
07. 05. 84	20,6	2200	9,55	15,32	39,68	97,52	387,0	18,32	116,90		147	34
13. 08. 84	18,5	1300	8,50	9,92	37,27	45,24	199,4	11,34	68,80	178,65	42	80
26. 03. 85	11,0	400	9,10	6,84	44,09	23,59			17,20	28,82	23	84

KIRCHSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	6500	9,63	28,80	16,03	75,39		112,30	519,85	485,00		
19. 08. 82	32,5	4200	10,07	17,00	34,07	9,73	645,5	59,00	226,60	329,95		
14. 12. 82	1,8	1550	8,88	13,78	35,87	35,39	431,4	39,18	230,48			
15. 03. 83	9,2	2200	9,03	13,52	35,07	45,11			178,83	150,22	13	65
26. 07. 83	31,4	13000	9,38	48,50	8,02	86,09	1461,3	79,20	1010,00	1550,00	15	29
24. 10. 83	16,5	4500	9,76	28,32	2,40	48,40	1336,0	104,80	619,40	581,20	0	60
07. 05. 84	12,5	2600	9,55	76,16	4,01	34,53	2172,0	80,31	643,20		84	41
13. 08. 84	20,8	7800	9,82	60,40	20,04	98,50	1608,0	151,30	856,50	330,24	2	65

WÖRTHENLACKE EAST

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	22,3	1800	8,81	12,04	26,05	76,36	287,8	25,20	92,22	281,44		
19. 08. 82	22,0	1400	8,80	9,60	22,04	57,15	253,6	10,80	71,54	194,40		
14. 12. 82	3,5	950		11,08	43,09	63,35	238,8	9,68	74,18			
15. 03. 83	5,7	1400	8,66	9,60	58,12	65,66			61,34	167,33	40	81
26. 07. 83	31,0	2600	9,13	12,52	0,00	117,95			148,00	567,00	305	57
24. 10. 83	10,3	2100	8,99	14,00	50,10	40,86	490,6	20,82	189,20	348,00	452	47
07. 05. 84	23,5	2100	9,20	12,16	32,06	97,04	382,0	15,24	144,40		21	67
13. 08. 84	24,0	2600	9,23	14,48	28,06	111,87	447,0	22,02	168,50	560,64	15	143

WÖRTHENLACKE WEST

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,3	2100	8,89	14,24	26,05	87,07	347,5	33,20	111,21	247,20		
19. 08. 82	22,5	1600	8,81	11,60	24,05	61,29	293,2	14,68	65,20	143,60		
14. 12. 82	3,5	1000		12,05	35,87	65,18	253,6	12,46	28,96			
15. 03. 83	5,7	1500	8,46	10,60	46,09	62,02			75,36	129,31	92	75
26. 07. 83	29,0	2100	9,45	10,92	17,23	91,32			135,00	512,00	0	57
24. 10. 83	8,9	1600	9,07	13,84	22,85	32,83	456,0	15,24	136,50	214,00	273	23
07. 05. 84	22,6	2300	9,25	13,48	25,45	108,35	406,6	16,92	147,90		42	67
13. 08. 84	23,0	2800	9,28	16,56	20,04	112,84	513,6	22,86	182,30	213,12	8	158

BIRNBAUMLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	28,4	6500	9,45	13,40	32,06	7,90			215,88	694,10		
19. 08. 82	28,0	1100	8,80	9,04	9,62	2,43			47,80	139,74		
14. 12. 82	1,7	900	8,85	9,06	11,62	7,05	302,0	15,42	39,13			
15. 03. 83	5,0	1750	8,90	9,12	8,62	4,99			46,33	116,00	1703	213
24. 10. 83	13,7	2550	9,09	15,56	9,62	6,08	584,4	6,90	147,80	176,50	578	177
07. 05. 84	8,0	2200	9,86	16,60	7,01	3,65	614,0	7,46	123,80		998	55
13. 08. 84	27,5	2300	9,20	16,64	8,02	11,19	573,0	31,23	127,20	51,84	1617	407

SCHRÄNDLSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	8000	9,77	37,60	40,08	38,91	1589,0	109,80	589,83	817,92		
19. 08. 82	32,6	3000	9,41	13,80	29,06	9,12	473,5	35,35	170,88	184,50		
14. 12. 82	2,0	1800	9,00	14,68	13,03	24,32	560,2	35,90	243,99			
15. 03. 83	7,6	2700	9,05	16,84	23,65	33,80			247,12	260,46	13	81
24. 10. 83	16,5	1800	9,12	15,20	13,63	17,75	377,0	34,18	160,20	18,76	0	42
07. 05. 84	10,4	1600	9,24	14,40	22,04	37,94	342,4	23,60	137,60		189	91
13. 08. 84	20,5	2100	10,25	20,16	13,63	27,72	506,4	27,45	172,00	96,00	42	65

KÜHBRUNNLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,5	6000	9,39	38,70	22,04	12,16	1564,0	28,45	269,42	960,15		
19. 08. 82	28,7	2100	9,00	11,20	12,02	1,46	382,0	5,50	55,14	174,14		
14. 12. 82	4,0	1400	9,00	14,34	26,05	2,19	490,6	5,80	109,30	320,00		
15. 03. 83	5,0	2000	8,97	17,44	28,46	16,54	400,0	4,80	88,63	230,05	158	78
26. 07. 83	34,3	2800	9,73	153,60	144,29	18,24	4364,4	39,18	1070,00	5289,00	0	39
24. 10. 83	12,2	4800	9,60	37,00	16,03	6,08	1753,5	11,19	393,33	1015,90	710	34

UNTERER STINKERSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	4800	9,96	37,90	12,02	124,64			219,60	237,40		
19. 08. 82	29,5	3200	9,62	24,40	48,10	17,63	535,5	18,65	87,80	223,30		
14. 12. 82	1,4	1400	8,80	18,83	30,26	22,98	426,4	15,24	117,57			
15. 03. 83	7,0	2350	9,08	19,96	27,66	53,75			163,32	91,30	132	60
24. 10. 83	16,3	5500	9,56	46,80	21,64	6,32	1521,0	42,90	478,00	395,70	168	42
07. 05. 84	10,5	3100	9,60	31,00	6,41	57,03	833,2	27,60	227,00		21	60

HAIDLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	3900	10,11	23,00	12,02	78,43			121,20	466,00		
19. 08. 82	24,0	2150	8,68	10,62	30,06	26,75	447,0	10,35	68,01	29,28		
14. 12. 82	1,5	1300	8,73	15,25	22,85	56,06	377,0	7,20	85,08			
15. 03. 83	5,5	2000	8,71	15,00	33,47	60,92			63,08	214,85	92	47
26. 07. 83	24,1	5700	9,04	41,60	34,47	123,30	1294,2	14,68	240,00	1254,00	38	88
07. 05. 84	6,2	3100	9,53	22,40	10,42	102,39	912,0	12,68	182,30		68	60
13. 08. 84	27,3	3800	9,11	22,50	34,07	133,76	882,4	16,00	165,10	441,60	8	284

KRAUTINGSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	3700	8,92	29,50	37,07	120,99			302,87	294,90		
15. 03. 83	8,8	2500	8,66	17,80	31,06	86,46			192,03	252,86	0	49
26. 07. 83	33,0	14000	9,35	70,45	0,00	271,29	2407,5	93,69	880,00	1884,00	53	86
07. 05. 84	13,0	3000	9,69	18,40	8,42	77,70	764,0	42,72	288,90		0	29

AUERLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	21,6	4300	9,32	23,46	25,85	6,20	1170,0	19,20	144,41	387,94		
19. 08. 82	29,0	2300	9,02	12,96	12,83	3,16	426,4	4,12	53,29	124,32		
14. 12. 82	3,9	1300	9,00	16,40	30,06	11,55	485,6	8,00	63,81	250,00		
15. 03. 83	5,2	1600	8,92	29,20	30,06	11,92			141,80	458,15	396	78
26. 07. 83	32,2	3300	9,13	19,17	15,83	0,97			174,00	493,00	36	390
24. 10. 83	11,7	2700	9,28	22,84	13,03	3,65	826,2	6,34	147,34	416,92	2667	55

HERRNSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	25,8	4500	8,86	15,66	20,04	118,56	671,0	21,40	282,64	554,95		
15. 03. 83	8,5	3500	8,66	22,40	47,09	143,85			310,30	564,60	0	195
26. 07. 83	28,6	7700	9,14	40,56	14,43	271,05	817,2	22,02	530,00	1892,00	57	88
24. 10. 83	10,6	6400	9,26	42,40	0,00	295,49	1069,0	46,08	736,10	1078,90	0	135
07. 05. 84	10,0	6100	9,50	36,08	16,03	302,05	1665,0	47,53	653,60		235	377
13. 08. 84	20,7	16000	9,55	59,60	28,06	445,06	6574,0	91,20	1138,60	1140,50	57	218

STUNDLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
19. 05. 82	22,3	3900	9,35	18,66	9,02	14,59	1120,0	23,30	215,03	302,40		
19. 08. 82	25,0	2250	9,13	14,16	22,04	3,89	475,8	18,36	119,18	159,12		
14. 12. 82	4,0	1500	9,00	17,40	27,66	14,96	525,2	16,92	131,28			
15. 03. 83	5,3	2300	8,99	4,60	28,06	26,75			116,03	161,62	79	75
26. 07. 83	31,2	15000	9,67	96,00	9,02	48,64			660,00	1803,00	128	117
13. 08. 84	23,0	2500	9,60	18,24	8,02	6,32	536,1	17,85	172,00	330,24	609	143

OCHSENBRUNNLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	27,4	9000	9,58	60,00	70,14	3,04			414,27	741,90		
19. 08. 82	32,0	4150	9,45	26,40	24,05	1,22	708,0	18,75	158,45	281,50		
15. 03. 83	5,2	3250	9,28	24,96	18,44				165,08	285,17	911	169
26. 07. 83	25,1	38000	9,82	299,17	101,40	20,06	12817,0	148,17	1773,00	5445,00	206	23
24. 10. 83	14,7	13000	9,90	101,52	60,12	39,52	3267,0	59,50	750,00	1127,50	202	70
07. 05. 84	6,2	3100	10,18	30,48	10,02	8,76	990,8	20,48	247,60		202	52
13. 08. 84	27,7	3300	9,57	31,28	8,02	11,67	941,6	26,04	237,30	55,68	754	224

ILLMITZER ZICKSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	4500	9,91	23,60	6,01	94,85	807,0	54,80	345,70	313,92		
19. 08. 82	31,8	4600	9,53	21,10	22,04	58,37	708,0	42,30	265,14	359,00		
14. 12. 82	2,0	2100	8,95	14,68	13,03	24,32	599,2	35,84	300,74			
15. 03. 83	7,6	2100	9,05	15,40	25,65	62,62			194,46	233,85	26	60
26. 07. 83	29,5	20000	9,30	79,55	7,62	203,44	2915,0	142,01	1650,00	3238,00	46	122

NEUBRUCHLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	30,0	7000	9,38	44,50	30,06				123,69	741,60		
19. 08. 82	28,0	1050	8,78	6,88	10,42	2,43			17,74	89,36		
15. 03. 83	4,8	900	8,75	7,28	12,42	1,22			11,17	62,02	317	109
07. 05. 84	6,3	1800	9,82	14,84	7,21	2,68	520,2	3,56	75,60		483	156

GOLSER LACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
15. 03. 83	6,0	4600	8,70	14,08	45,09	138,14			603,64	575,62	317	135
07. 05. 84	8,3	7400	9,15	20,40	46,09	245,63	2009,0	34,50	1059,50		189	194

SILBERSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
15. 03. 83	8,0	4000	9,21	38,40	25,65	71,01			564,40	479,06	13	55
26. 07. 83	26,7	20500	9,54	88,35	60,32	92,78	8094,9	266,75	1846,00	24,78	252	112
24. 10. 83	12,6	13000	9,88	87,80	0,00	106,76	3020,0	123,50	1406,00	1357,20	0	44

DAINGLGRUBE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
15. 03. 83	7,6	3200	8,95	29,84	5,61	14,35			234,48	365,09	317	55
26. 07. 83	26,7	12500	9,37	65,74	22,24	12,77	2301,0	62,46	500,00	1421,00	0	42
24. 10. 83	14,6	13000	9,69	101,00	22,44	6,81	2996,0	81,80	853,60	1242,40	0	36
07. 05. 84	9,5	5500	9,70	56,56	4,81	16,42	1829,0	53,40	509,10		32	101

WEISSEE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	23,9	9500	9,09	14,40	30,06	86,34	2157,0	56,70	709,00	1996,40		
15. 03. 83	8,0	2300	8,52	13,60	35,27	69,43			163,16	262,37	13	75

SCHWARZSEELACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
08. 06. 82	24,1	480	10,06	4,20	16,03	33,20			12,89	47,58		

GÖTSCHLACKE

Date	Temp. °C	LF µS/cm	pH	SBV mval	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO4 mg/l	NO3 µg/l	NH4 µg/l
26. 03. 85	9,3	320	9,20	3,72	28,86	16,29			17,20	42,16	0	97

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

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