Monitoring of chemistry, macrophytes, and diatoms in acidifying moorland pools

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MONITORING OF CHEMISTRY, MACROPHYTES, AND DIATOMS IN ACIDIFYING MOORLAND POOLS

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RIN report 87/19
Research Institute for Nature Management
Leersum
1987

PREFACE

Acid rain is one of the most important threats to the environment. The first ecological responses were seen in the early seventies in the very sensitive, poorly buffered, lakes of Scandinavia, although the atmospheric deposition in that area is much less than in The Netherlands.

The results of the first investigations of the present author on the impact of acid rain on poorly buffered waters, mainly moorland pools, in The Netherlands, demonstrated that these oligotrophic water bodies, with a highly characteristic flora and fauna, were much more affected by acidification than the Scandinavian lakes.

Therefore, regular monitoring of chemistry and diatoms in some moorland pools started in 1979. Diatoms were chosen as biological indicators because they are very sensitive to changes in acidity and because a unique set of old samples, which could serve as a frame of reference, was available.

The international value of this project was recognized by the European Community, that funded a part of the research activities.

This document is not only a report of the research activities of the author, but summarizes all the available knowledge on management, physiography, chemistry, and botany of the study sites. Therefore, it is a base-line study for forthcoming monitoring and modelling studies on the impact of acid precipitation in shallow freshwater bodies.

The Director

ABSTRACT

Monitoring of chemistry and diatoms at three stations in the moorland pool Achterste Goorven and one station in the pool Gerritsfles was started in August 1979 and continued until February 1985. Monitoring in the pool Kliplo began in May 1981. A similar program was started in the pools Tongbersven-West and Groot Hasselsven in April 1983. Bathymetry was studied in all pools but Groot Hasselsven. Inventories of macrophytes were also carried out.

From the pools Achterste Goorven, Gerritsfles and Kliplo diatom samples, from the periods 1916-29, 1948-53 and 1960-77, were compared with samples obtained in recent years. From these pools also old data on chemistry, mainly pH measurements, and data on the distribution of macrophytes were available.

In Achterste Goorven and Gerritsfles the changes in directly measured pH, diatom-inferred pH and macrophyte distribution indicate acidification. About 1920, 1950 and 1980 the pH in these pools was 5-6, 4.5-5.5 and 3.7-4.7 respectively. In Kliplo, the pH changed from c. 5 in 1924-29 to c. 4.5 in the period 1972-85. Both in Achterste Goorven and Gerritsfles the diversity of macrophytes and diatoms decreased as a consequence of the acidification.

Differences in chemistry and biology of the pools are mainly caused by differences in morphometry. In extremely dry years (e.g. 1921, 1959 and 1976) in Kliplo c. 20% of the bottom was exposed to the atmosphere, of the Achterste Goorven c. 75%, while Gerritsfles was intermediate in this respect. This has a marked influence on the biogeochemical cycles in the pools, especially that of sulphur.

Analysis of the diatoms of Achterse Goorven between 1916 and 1928 revealed that the severe drought of 1921 did not affect the diatom assemblages of this pool. Probably also the effects on chemistry were negligible. Apparently only minor amounts of reduced sulphur compounds were stored in the sediments. In contrast, the drought of 1959 had a marked impact on chemistry and diatoms of Gerritsfles. The sulphur compounds, which were present in the bottom in reduced form and originated from atmospheric deposition in the decades before, were mineralized to sulphuric acid.

The impact of the drought of 1976 could be studied in detail. In Kliplo, a humic pool with a very intensive sulphate reduction, no drought induced changes of chemistry and diatom assemblages could be observed (average c. 100 mmol m^{-3} 1/2 SO_4^{2-}). In Achterste Goorven very high levels (>1400 mmol m^{-3} 1/2 SO_4^{2-}) of sulphate were observed in 1978, which gradually lowered until c. 1982 to a level of c. 500 mmol m^{-3} 1/2 SO_4^{2-}. In Gerritsfles, the sulphate concentration had a similar pattern as in Achterste Goorven and stabilized at a level of c. 250 mmol 1/2 SO_4^{2-} in 1980-81. These differences are related to morphometry and the water renewal time, which is c. 5 years in Achterste Goorven and about 3 years in Gerritsfles.

The deposition of sulphate is roughly balanced by that of ammonium, which is nitrificated and subsequently either taken up by water plants or denitrificated. The net results of this chain of reactions is the production of one mole of protons for each mole of ammonium. This compensates for the consumption of one mole of protons during the reduction of one equivalent mole of sulphate. Nevertheless, an increase of pH in Achterste Goorven and Gerritsfles was observed since c. 1980, probably as a result of the enormous amount of sulphate reduced and released as sulphide after the drought of 1976, leading to net sulphate reduction over ammonium uptake. In Gerritsfles, the decrease of the acidobiontic diatom Eunotia exigua since 1980 indicates some recovery from the disturbance caused by the drought of 1976.

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1 INTRODUCTION

The present report is an account of the project 'Monitoring of chemical characteristics and diatom assemblages in moorland pools', which was started in 1982 as a continuation of the project 'Construction of a frame of reference for the assessment of the biological quality of surface waters in the Netherlands with diatoms from old collections', which ran from 1978 to 1982.

Previous investigations (Van Dam et al. 1981) have shown that isolated moorland pools are seriously affected by acid precipitation. This appeared particularly from the comparison of old (1916-29) and recent (1978) diatom assemblages from plankton tow samples. In the 16 pools which were investigated a wide range of sulphate concentrations (120-1640 equivalent mmol m^{-3}) was found. The differences seemed to be dependent on the concentration of humic matter, the hydrology (perched water table vs. regional groundwater table) and the surrounding vegetation (open heathland vs. pine forest).

The degree of acidification of moorland pools seems to be dependent on morphometry. Especially after dry summers, e.g. 1976, large increases of sulphate concentrations in moorland pools were observed after refilling. Vangenechten et al. (1981) observed a maximal sulphate concentration of 10600 equivalent mmol m^{-3} in Belgian moorland pools. Similar responses to the drought of 1976 were seen by Leentvaar (1984a) in a forest pond and Roijackers (1985) in an oxbow pond. The acidification after dry years is caused by the mineralization of reduced sulphur compounds which were stored in the sediments. It is a question if these sulphur compounds are naturally present or if they have been accumulated by atmospheric deposition in recent times. Analyses of changes caused by dry periods in the past, e.g. 1921. 1947 and 1959 may shed light on this question. The impact of such dry periods will be most severe in those pools were a large fraction of the bottom will be exposed to the atmosphere.

Until about a century ago the majority of the moorland pools in The Netherlands, Belgium and Germany was situated in an open landscape of heathlands and aeolian drift sands. Nowadays most of the pools are situated in forests of Scots pines (Pinus sylvestris). The reafforestation with Scots pines has caused a considerable increase of sulphate and cations in groundwater, because conifers are efficient collectors of gaseous sulphurdioxide (e.g. Nihlgård 1970, Mayer & Ulrich 1978). In groundwater under pine plantations in The Netherlands elevated levels of sulphate, exceeding 3000 equivalent mmol m^{-3}, have been observed by Oosterom & Van Schijndel (1979), Oosterom (1982), Stuyfzand (1984), Oostveen (1985) and Kragt (in prep.). A maximum of 9350 equivalent mmol m^{-3} was measured by Kemmers & Jansen (1980). Percolation of this contaminated groundwater may give a serious contribution to the acidification of moorland pools.

It is difficult or even impossible to detect long-term chemical changes in moorland pools directly, because old data are scarce. In some cases few colorimetric pH measurements are available (e.g. Redeke & De Vos 1932). However, a comparatively large number of old plankton tow samples, taken by the late Prof. Dr. J. Heimans, is present in the collection of the Hugo de Vries-laboratory (University of Amsterdam). The diatoms of these samples are good indicators for past environmental conditions, particularly pH (Hustedt 1939, Meriläinen 1967). By using diatoms as indicators it is possible to trace long term changes in water chemistry (Battarbee 1984).

The research has been concentrated on the pools Achterste Goorven, Gerritsfles and Kliplo, because a comparatively large number of old algal samples were available. Also other features, e.g. chemistry and macrophytic vegetation, of these pools have been relatively well recorded in the past. Additionally some observations have been made in Tongbersven-West and Groot Hasselsven, because they were the subject of hydrological investigations by Oostveen (1985).

The specific questions to be addressed are:

1. What are the changes in measured pH and other chemical characteristics of the investigated pools since 1916?
2. What are the changes in the species composition and diversity of the diatom assemblages in the pools since 1916?
3. What are the changes in diatom-inferred pH of the pools since 1916?
4. What is the relationship between these changes and the morphometry and the hydrology of the pools, the occurrence of extremely dry years (1921, 1959, 1976), changes in atmospheric deposition and land-use patterns in the catchment area of the pools?

As aquatic macrophytes are both important indicators of acidification of freshwater bodies (e.g. Grahn et al. 1974, Roelofs 1983) and important sites of biogeochemical processes in the pools, also changes in the macrophytic vegetation of the pools were studied.

This report is also intended to serve as a base-line document for future studies. Therefore, it summarizes all the data which could be traced in published and unpublished documents on physiography, chemistry, and botany of the study sites. See also Van Dam (1987) for additional notes on historical aspects.

2 METHODS

2.1 LITERATURE RESEARCH

Many of the old data on general situation, vegetation, chemistry and human impact are not published in regular journals. Umpublished reports and diary notes were found in the archives of the Research Institute for Nature Management (Leersum), the Hydrobiological Society (Leersum), the State Forestry Service (Utrecht), the Society for the Promotion of Nature Reserves ('s-Graveland), the Hugo de Vries-laboratory (Amsterdam), the Municipality of Oisterwijk and in the State Archive ('s-Hertogenbosch).

2.2 MORPHOMETRY

Enlargements of aerial photos from the Topographical Service (scale approx. 1:18000) were made to a scale of c. 1:1000 to serve as a base for maps of bathymetry and sediment thickness in the field. However, these maps gave a distorted picture and had to be corrected with a measuring-line in the field.

Depth was measured by lowering a stick with a white disc (diameter 20 cm) from a dinghy to the depth where the disc touched the sediment surface. Thickness of the sediment was estimated by pushing a stick (2 cm square in cross-section) into the sediment upto a depth where it was no longer possible to push the stick deeper by hand force. Substraction of the water depth from this depth gave the sediment thickness. The measurements of water depth and sediment thickness were done in a regular pattern (grid distance 10 or 20 m) in order to construct maps of bathymetry and sediment thickness. Thickness of quivering bog carpets was measured by pushing a calibrated stick through the moss carpet and flapping down two side-sticks at the bottom of the stick and subsequently by drawing back the stick until the side-sticks touched the bottom of the quivering bog.

2.3 HYDROLOGY

The water level was measured each 3 months by measuring the distance from the water level to the top of a stick which was pushed firmly in the bottom. The height of the top of the sticks above mean sea level ("NAP") was measured by comparison with the nearest marks of the official network of "Rijkswaterstaat".

2.4 CHEMISTRY

pH was measured in the field with a Metrohm E488 pH meter, a WTW 91 pH meter or a Gallenkamp pH stick. Conductivity at 25 ^{o}C was measured in the field with a Yellow Springs Instrument 33 conductivity meter or a WTW 91 conductivity meter. When air temperature was below 10 ^{o}C "field" values for pH and conductivity were often measured in the laboratory within a few hours after sampling. Oxygen content was always measured in the field with a Yellow Springs Instrument 54 oxygen meter.

Field measurements at low pH (pH $<$ c. 4.5) often appeared to be inaccurate if the manufacturer's instructions for use were followed. Therefore, electrodes were frequently calibrated not only with buffer solutions pH 4 and pH 7, but also pH 3, after 1981. Electrodes were discarded when the devation from 3 exceeded 0.1 unit after calibration with buffer solutions pH 7 and pH 4.

Samples from Achterste Goorven and Gerritsfles were taken monthly from July 1979 to June 1980 and quarterly from August 1980 to February 1985. Samples from Kliplo were taken quarterly from May 1981 to February 1985. They were transported in polyethylene bottles as cool as possible, left overnight at 4°C and arrived within 48 hours in the laboratory of the "Waterleidingbedrijf Midden-Nederland" and subsequently analysed according to the methods described by Van Dam et al. (1981).

Monthly samples (1983-84) from Gerritsfles, Kliplo, Tongbersven, and Groot Hasselsven were transported in polyethylene bottles as cool as possible, left overnight at 4°C. They arrived within 24 hours in the laboratory of the Department of Soil Science and Geology of the Agricultural University at Wageningen and analysed according to the methods described by Begheijn (1980) and Lubbers (w. y).

Symbols and units for physical and chemical parameters are given in Table 1. Detection limits are for samples analysed by Waterleidingbedrijf Midden-Nederland (see App. 17 for detection limits of Agricultural University). Before data processing values below detection limits were arbitrarily set at half the detection limit.

Before data processing the raw chemical data were checked for errors by calculating ionic balances. For this purpose, Mn, Fe and Al were supposed to be present as Mn^{2+}, Fe^{3+} and Al^{3+} respectively, although the charge of these ions is highly dependent on pH and redox conditions (Stumm & Morgan 1970). Nevertheless, ionic balances were generally correct within a few percents of the anion or cation sum. Only when large concentrations of ion (>100 mmol m^{-3} 1/3 Fe) or dissolved organic carbon (more than c. 1500 mmol m^{-3} C) were present, the cation sum exceeded the anion sum by more than 10%. If the cation sum was more than 10% higher or lower, the apparent erroneous analysis was eliminated from the data set.

For each sample the ionic activity coefficients were calculated, using the Güntelberg equation (Stumm & Morgan 1970). The ionic activities were multiplied with ionic conductivity values (Vogel 1961, see Golterman et al. 1978 for Al^{3+}) and added to give calculated conductivities for each sample. This calculated conductivity (25°C) could not be used as a check for the chemical analysis as the calculated conductivity was usually c. 35% higher than the conductivity as measured in the laboratory (25°C).

2.5 MACROPHYTES

The most prominent macrophyte species which where found while mapping bathymetry (section 2.2) were recorded on maps (original scale 1: 1000) in the pools Achterste Goorven, Gerritsfles, and Kliplo. The most important plants occurring along the shores of these pools were recorded during field trips of a few hours in September 1984. Both aquatic and nearshore plants of Tongbersven and Groot Hasselsven were recorded during short visits in September 1984.

The recent vegetation was compared with records of the former vegetation from excursion reports and publications.

Nomenclature of vascular plants and mosses follows Van der Meijden et al. (1983) and Margadant & During (1982) respectively. For pH classification of the macrophytes the groups of Hustedt (1939) (see next section) were used. Species were classified using the autecological information tabulated by Iversen (1929), Zólyomi (1967), Pietsch (1976, 1982), Landolt (1977) and Ellenberg (1979) as well as personal experience.

Table 1

Symbols, units and detection limits for physical and chemical parameters.

Symbol	Parameter	Unit	Detection limit
AL	1/3 Al^{3+}	mmol m^{-3}	11
ALK	Alkalinity	meq m^{-3}	1.6
CA	1/2 Ca^{2+}	mmol m^{-3}	
CL	Cl^{-}	mmol m^{-3}	
CO2	CO_2	mmol m^{-3}	23
CO3	CO_3^{2-}	mmol m^{-3}	
COLOR	Colour	mg Pt l^{-1}	
DATE	Date	-	
DC	Dissolved carbon	mmol m^{-3}	
DIC	Dissolved inorganic carbon	mmol m^{-3}	
DOC	Dissolved organic carbon	mmol m^{-3}	
EC25f	Electrical conductivity (field) at 25°C	mS m^{-1}	
EC25l	Electrical conductivity (lab) at 25°C	mS m^{-1}	
E_o	Evaporation of open water	m a^{-1}	
FE	1/3 Fe^{3+}	mmol m^{-3}	
H	H^{+}	mmol m^{-3}	
H2PO4	$H_2PO_4^{-}$	mmol m^{-3}	
HCO3	HCO_3^{-}	mmol m^{-3}	
IR	Ionic ratio (CA/(CA+CL))	-	
K	K^{+}	mmol m^{-3}	
KMNO4u	Kaliumpermanganate consumption in unfiltered water	mg l^{-1}	
LEVEL	Water level above NAP (mean sea level) or above mean level of pool	m	
MG	1/2 Mg^{2+}	mmol m^{-3}	
MN	1/2 Mn^{2+}	mmol m^{-3}	
NA	Na^{+}	mmol m^{-3}	
NH4	NH_4^{+}	mmol m^{-3}	
NH4-or	Organic ammonium	mmol m^{-3}	
NO2	NO_2^{-}	mmol m^{-3}	0.2
NO3	NO_3^{-}	mmol m^{-3}	1.6
O2	O_2	mmol m^{-3}	
ORGANION	Organic anions	meq m^{-3}	
SIO2	SiO_2	mmol m^{-3}	17 (before 840301) 1.7 (after 840301)
SO4	SO_4^{2-}	mmol m^{-3}	
TEMP	Temperature	°C	
TIME	Time	h MET	
TOHA	Total hardness	mmol m^{-3}	
Tr	Water renewal time	a	
pHf	pH (field)	-	
pHl	pH (laboratory)	-	
t-PO4f	Total fosfate in filtrated water	mmol m^{-3}	
V	Volume	m^3	
z	Depth	m	
$\bar{z}$	Mean depth	m	
z_{max}	Mean maximal depth	m	
%AL	100xAL/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%ALK	100xALK/(CL+NO3+ALK+SO4)	%	
%CA	100xCA/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%CL	100xCL/(CL+NO3+ALK+SO4)[a]	%	
%FE	100xFE/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%H	100xH/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%HCO3	100xHCO3/(CL+NO3+HCO3+SO4)	%	
%K	100xK/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%MG	100xMG/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%MN	100xMN/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%NA	100xNH4/(H+NA+K+NH4+CA+MG+MN+FE+AL)	%	
%NO3	100xNO3/(CL+NO3+ALK+SO4)[a]	%	
%SO4	100xSO4/(CL+NO3+ALK+SO4)[a]	%	

[a] HCO_3^{-} was used instead of alkalinity in the samples analysed by the Agricultural University.

2.6 DIATOMS

Old samples were obtained from the collections present at the Hugo de Vries-laboratory (University of Amsterdam), the Research Institute for Nature Management, the Limnological Institute (Royal Netherlands Academy of Sciences) and the Zoological Laboratory (University of Ghent). Recent samples were taken at irregular intervals in 1977 and 1978 and quarterly from August 1979 through May 1984.

Sampling, slide preparation, identification, and counting have been described in detail by Van Dam & Kooyman-van Blokland (1978) and Van Dam et al. (1981). The old plankton samples were taken with a net with a mesh width of 60 µm (A. van der Werff, pers. comm.) and the recent ones with a net with a mesh width of 40 µm. Replica slides were deposited in the collection of the Hugo de Vries-laboratory. The references for identification are listed by Van Dam (1984). Nomenclatorial and taxonomical changes, suggested by Krammer & Lange-Bertalot (1985) and Ross in Hartley (1986), were followed.

In each diatom slide 400 valves were identified and counted. Additionally, the slide was searched for the most prominent species outside the count. The relative abundance is reported here as the number of valves of each taxon recorded in the count.

For the pH classification of the diatom taxa the system of Hustedt (1939) was followed:

R	abbreviation	group	pH range
1	acb	acidobiontic	only in acid waters, generally below pH 5.5
2	acph	acidophilic	generally only in acid waters
3	cir	circumneutral	at pH c. 7
4	alph	alkaliphilous	generally only in alkaline waters
5	alb	alkalibiontic	only in alkaline waters
0	noph	unclassified	unknown

The pH-class number R and the abbreviations will be used in the tables in this report.

pH Spectra were calculated with the ecological data from the literature listed by Renberg (1976) and Van Dam et al. (1981). Diatom-inferred pH values were calculated with the formulas of Renberg & Hellberg (1982):

$$B = (cir + 5alph + 40acb)/(cir + 3.5alph + 108alb),$$

where cir etc. represent the relative abundance of each pH group in the count. The pH-RENBE was inferred with the formula:

$$pH\text{-}RENBE = 6.40 - 0.85\,{}^{10}\log B.$$

A second method to estimate the pH from the diatom assemblage composition is by weighted averaging. For this purpose, optimum pH values for the most abundant diatom taxa (U) were calculated by weighted averaging from 99 samples out of 97 almost pristine soft-water lakes and pools in Western Europe with pH values ranging from 3.3-7.3. The pH (pH-wa) for each sample of the present investigations was estimated by weighted averaging, using the U-values of each taxon. The inferred pH (pH-WA) was calculated from the relationship: pH-WA = 1.337(pH-wa) - 1.487, with a standard error of 0.8 units (C.J.F. ter Braak & H. van Dam, unpublished results).

Diversity indices were calculated according to Van Dam (1982):

NRSPCOUN the number of diatom taxa in the count
NRSPTOTA the number of diatom taxa recorded in the slide
DOMINANC the relative abundance of the most abundant taxon in the count.

2.7 DATA PROCESSING

Chemical and physical data were entered in the memory of the VAX750-computer of RIN with the program INPUT of the Section Ecohydrology. Diatom countings were entered in an ORACLE .

All computations were done with the GENSTAT statistical package (Alvey et al. 1977, 1982). Statistical tests were performed according to Sokal & Rohlf (1969).

3 RESULTS AND DISCUSSION

3.1 SITUATION AND ENVIRONMENT

Achterste Goorven

The pool Achterste Goorven (Photos 1-4) is situated 2 km south of the village of Oisterwijk (51°34'N, 5°13'E) at c. 8.3 m above NAP (mean sea water level) at a distance of 143 km from the North Sea (Figs. 1,2). The surface area is c. 2.4 ha.

It is a part of the nature reserve "De Oisterwijkse Bossen en Vennen" which contains numerous moorland pools, with a large variation in chemistry and biota (Van Dam & Kooyman-van Blokland 1979, Coesel et al. 1978, Van Dam 1983). The area was acquired in 1915 by the "Vereniging tot Behoud van Natuurmonumenten in Nederland". Since then the paths around the pool are open to the public.

The pool, with a relatively complex morphometry, was selected for our studies because more than 70 old samples were taken by Prof. Dr. J. Heimans

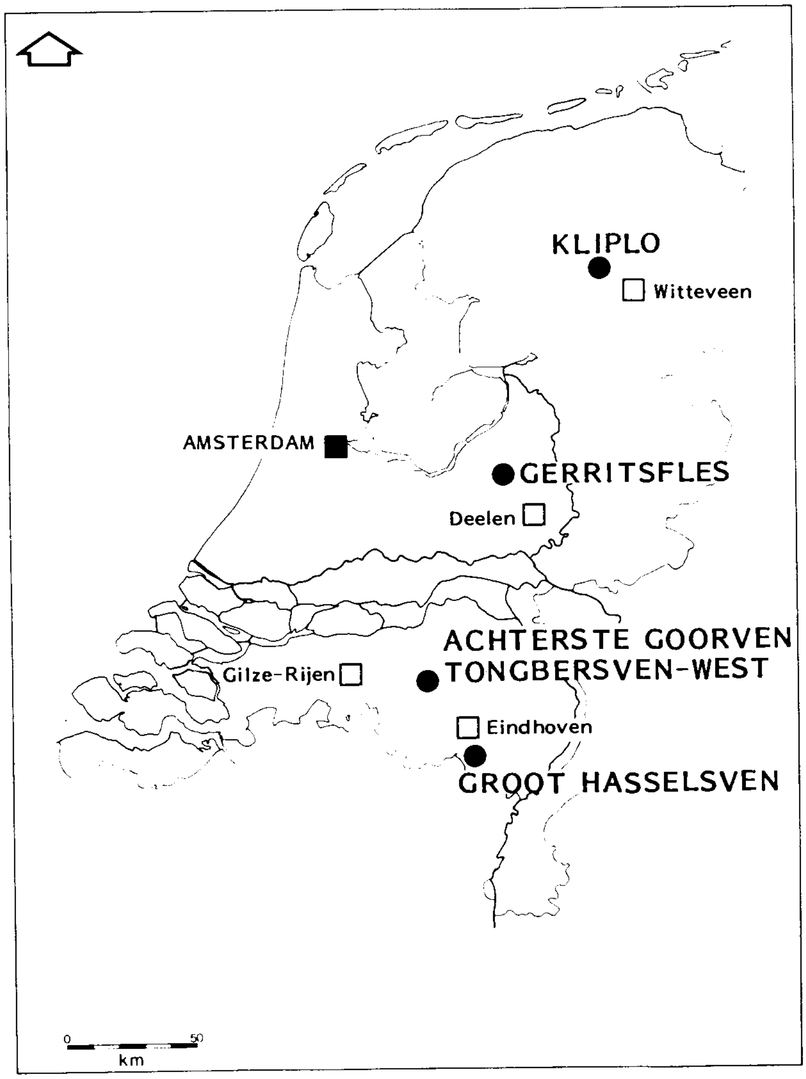


Fig. 1. Location of study areas (dots) and precipitation monitoring stations (open squares) in The Netherlands.

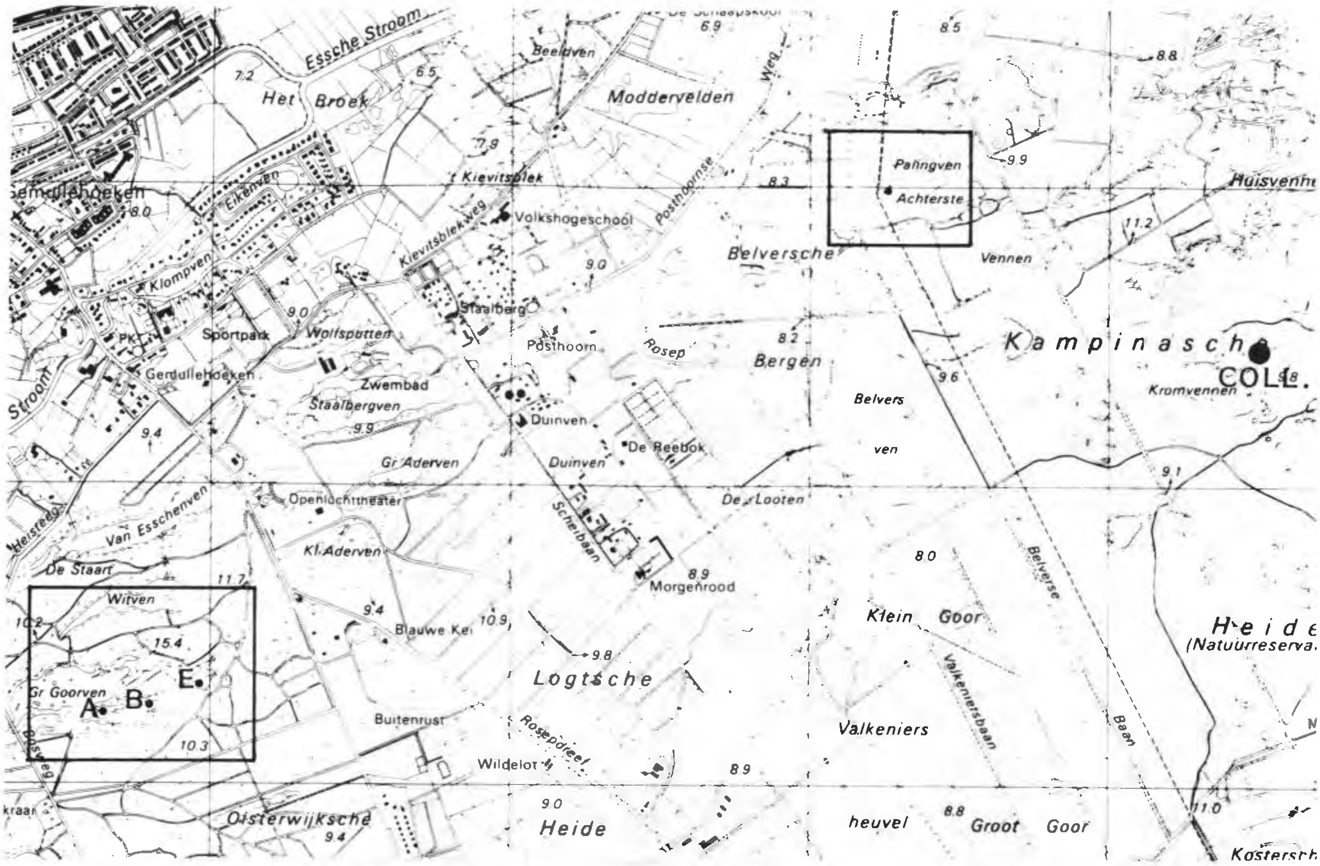


Fig. 2. Location of Achterste Goorven (stations A, B, E) and Tongbersven-West. Sampling stations indicated with dots. Coll. = location of precipitation collector. (Topographical Map of The Netherlands, scale 1: 25 000, sheet 51A).

stations A, B and E (Fig. 9) could be located with certainty.

Heimans (1925, 1960) investigated the desmids. They were reinvestigated by Coesel et al. (1978). Other hydrobiological investigations were carried out by a multidisciplinary team, consisting of members of the Netherlands Hydrobiological Society (Van Dijk et al. 1960). In addition, a long series of papers in naturalist journals and other reports permit a reconstruction of the developments in macrophyte vegetation during the course of this century.

The ample documentation about the pool and its surroundings allows a more reliable interpretation of changes in diatom assemblages and water chemistry than is usually possible.

According to the soil map by Geenen (1977) the pool is situated in a drift sand area. Originally the area was covered with forest, which was transformed into heathland by man. The introduced sheep maintained the heathlands for a long period. Due to overgrazing the heathlands were damaged and a landscape of drifting sand dunes was the result. Although no soil profiles have developed at the surface of the accidented terrain, fragments of overblown podzolic profiles are present as became evident from a few reconnaissance borings (see also Geenen 1977).

The origin of the pool was discussed by Loriè (1918, 1922) and Dubois (1917, 1919). Loriè hypothesizes an aeolian origin, while Dubois supposes the pool to be formed by fluviatile activities. According to the morphometry one would expect that Dubois' theory is most probable. Then the pool can be classified in the category of pools which is a remnant of snow water melting valleys, distinguished by Broertjes (1977).

Photo 1

Achterste Goorven, from the central southern shore of basin I facing north (J. van Osch, Oct. 1984).

Photo 2

Achterste Goorven, from the central southern shore of basin II facing north-east (J. van Osch, Oct. 1984).

Photo 3

Achterste Goorven, from the eastern shore of basin III facing west with J. van Dijk making phytosociological relevès (J. Sloff, Aug. 1948).

Photo 4

Achterste Goorven, from the same place facing southwest (J. van Osch, Oct. 1984).

Photo 5

Gerritsfles, Sparganium angustifolium (Thijsse 1926).

According to Geenen (1977) the pool was formed in the Late Glacial (11.800-11.000 before present) during the Allerød-interstadial as a wind deflated pool, blown out by the prevailing SW-winds. The open water was transformed into a bog as a natural process. The peat was excavated as a fuel by local farmers. As early as 1509, regulations for excavating the peat from the 'Goir', 'Goer' or 'Goor' existed (Posthumus 1911). The 'Goor' comprised not only the Achterste Goorven, but included also the present Voorste Goorven. In the State Archive at 's-Hertogenbosch documents were found, in which private persons were allowed to excavate peat from the 'Goor' in 1724, 1746, and 1823. The peat diggers were allowed to construct dams through the pool, to facilitate the transport of the peat; usually these dams had to be removed after completion of the work (Posthumus 1911).

At the western side, the Achterste Goorven is separated from the Voorste Goorven by a narrow capriciously formed dam, which is only two metres wide at the narrowest point. According to Heimans (1925) this dam has not always been present. Indeed, it is absent on all topographical and cadastral maps between 1835 and 1921. Thijsse (1927) mentions the artificial appearance of the dam. Heimans explicitly mentions the presence of the dam, already since the beginning of his investigations in 1916. As Lorié (1922) omits the dam in his sketch, where the pool has the same outline as on the old topographical and cadastral maps, one may really doubt if the dam has been absent in the past age.

At the northwestern side Achterste Goorven is separated from the small pool Diepven by a curved dam. This dam is clearly man-made. On the old maps upto 1921 and in the sketch of Lorié the Diepven has an open connection with the Achterste Goorven.

Both dams are planted with Scots pines of about the same age. I counted the annual rings on stubs of pines which were apparently logged a few years ago. As c. 92 rings were present both dams are probably more than c. 100 years old. There is palaeolimnological evidence that the dams were constructed about 1880 (Dickman et al. 1987).

The Achterste Goorven is situated in a forest, which was planted in 1840, as can be concluded from old topographical maps (see also Van Hees & Van den Wijngaard 1977). Prior to this time Calluna-heathlands and vegetations of aeolian drift sands surrounded the pool.

Pinus sylvestris is the main tree species, but it is often mixed with Quercus robur and Q. rubra. Picea sp. and Castanea sativa occur very locally. Near the pool, where the water table is close to the surface, Betula pubescens, and to a lesser extent Frangula alnus grow spontaneously. Betula occurs also on some of the islands, which for the rest are overrun with Myrica gale and Molinea caerulea. In the understory Vaccinium myrtillus and Deschampsia flexuosa are the most important species, especially on the tops of the sand dunes. Molinia caerulea is dominating on wet soils nearshore, but intrudes also into the vegetation of dry soils.

The vegetation in the understory of the pine-forest on the spit between the central and eastern basin is slightly different. Because the pines are planted here further apart than elsewhere, the quantity of light permits Calluna vulgaris to be present here, apart from the already mentioned Vaccinium and Molinia. The present state of the surrounding forest and its vegetation does not differ from the earlier one, as described by Thijsse (1912) and Koster (1942).

The majority of the pines on the irregularly formed peninsula northeast of station E was logged in 1950 (Westhoff & Van Dijk 1950) to promote the growth of Narthecium ossifragum which was present luxuriantly in earlier days but declined because of the afforestation, like Gentiana pneumonanthe (Thijsse 1912, 1937). Narthecium was still reported in 1959 (Westhoff & Van Dijk 1950, Van der Voo & Westhoff 1959), but has never been found later on.

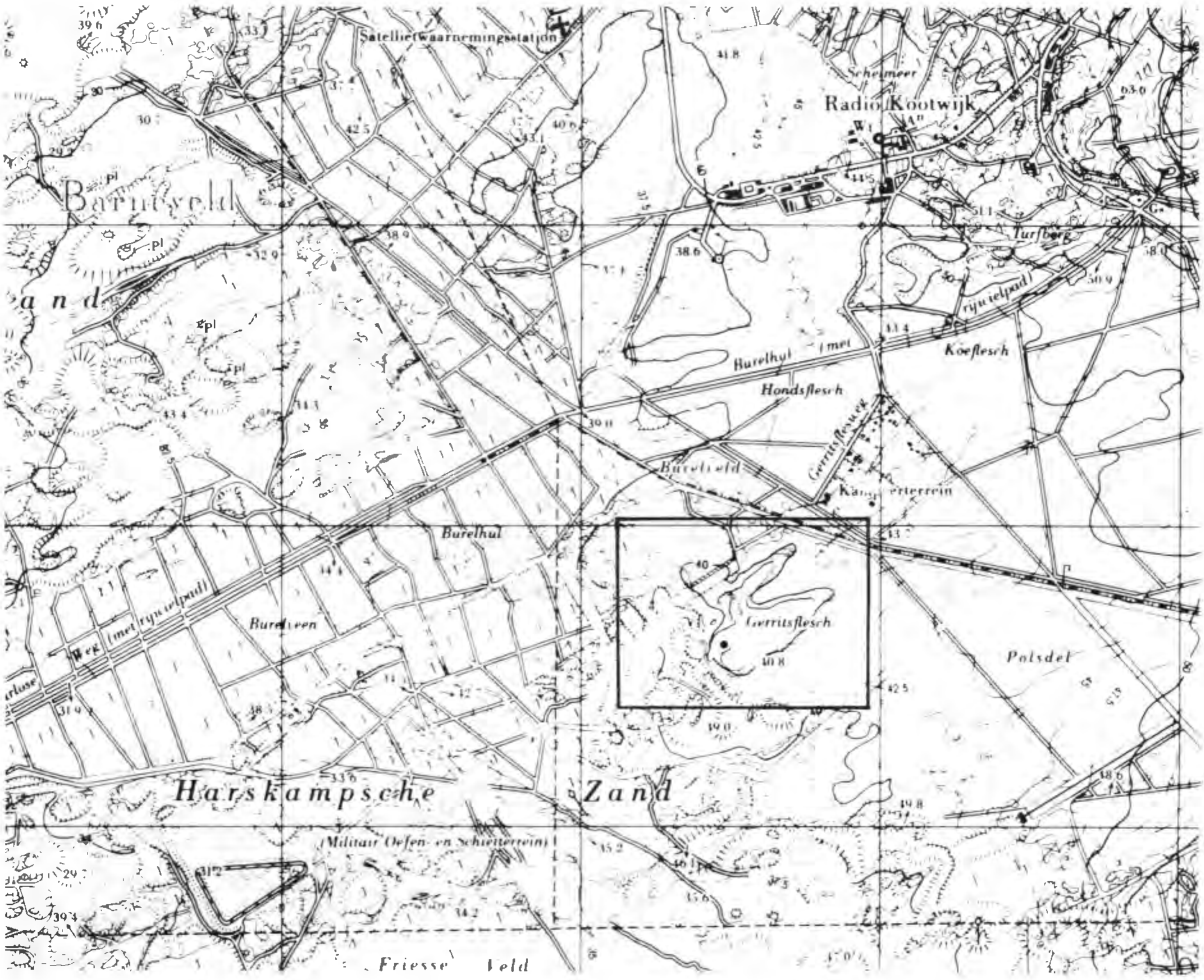


Fig. 3. Location of Gerritsfles. Sampling station indicated with a dot. (Topographical Map of The Netherlands, scale 1: 25 000, sheet 33A).

The vegetation of this peninsula is dominated by *Molinia caerulea*, *Calluna vulgaris* and *Erica tetralix*, while a lot of saplings from *Pinus* and *Betula* are present.

In winter the pool is often used as a skating-rink.

Gerritsfles

The pool Gerritsfles (Photos 5-8) is situated 4.5 km SE from the village of Kootwijk (52°10'N, 5°49'E), at a distance of 102 km from the North Sea (Figs. 1,3). The surface area is c. 6.8 ha. The pool is only 20 km SE of the former shoreline of the Zuiderzee, which was a brackish water area upto 1932, when the enclosure dam cut off the Zuiderzee from the sea. After that year the Zuiderzee (now IJsselmeer) turned into a shallow freshwater lake. This change may have affected the composition of the rain feeding the Gerritsfles.

The pool and its surroundings were acquired as a nature reserve in 1922 by the State Forestry Service.

The Gerritsfles is a classical site for hydrobiological research in The Netherlands. After preliminary studies by De Beaufort (1913) the pool was inventoried by a team under the guidance of Prof. Max Weber and Dr. J. Romijn in 1918. Since then the pool, which is situated in a comparatively

Photo 6

Gerritsfles, at some distance from the western shore looking to the southeast (R. van Beek, March 1975).

Photo 7

Gerritsfles, from the eastern part of the western shore looking to the sampling station (J. van Osch, Oct. 1984).

Photo 8

Gerritsfles, looking about northwest over the southeastern part of the pool (J. van Osch, Oct. 1984).

remote area, was regularly visited by hydrobiologists, particularly Redeke & De Vos (1932), Dresscher et al. (1952) and Van Dam et al. 1983 (see also Higler 1979). The scientists were attracted by the nearly undisturbed habitat, the presence of so-called glacial relict species, e.g. Eurycercus glacialis and Dytiscus lapponicus, and the peculiar hydrology.

Schimmel & Ter Hoeve (1952) investigated the hydrology of the pool in detail. It appeared that the pool is fed by rainwater only. The water does not sink away in the subsoil owing to a practically impermeable ferruginous hard pan, common to poor, podzolised heathsoils overblown by drift sand. The proper groundwater table is found actually about 15 m beneath the bottom of the pool. The fluctuations of the water level in the pool are relatively small, because excess water may leave the pool by periodic underground overflowing via the ore-wall formed by the vertical extension of the iron pan. Thus the composition of the water in the pool is independent of the surroundings, which consist of sand dunes without apparent soil development at the southwestern side of the pool and heathlands, presently mainly covered with Molinia caerulea at the other sides of the pool. The Molinia swards are situated on the podzols of cover sands according to the soil map of The Netherlands (scale 1:50 000).

At the northwestern side a lot of grassland has its border only about 10 metres from the shoreline of the Gerritsfles. As this meadow does not fall within the limits of extension of the iron pan it does not affect the pool by drainage water. According to Schimmel (pers. comm.) the artificial fertilizer, which was applied to the grassland could reach the Gerritsfles, scattered by wind. Fertilizing was finished about 1965. The cows, which were grazing in the meadow, used the pool for drinking water (Wigman 1932).

Until 1940 sheep came to drink about once a week at the southeastern shore of the pool (Moerman 1934, Schimmel pers. comm.). Roedeer and boar visit the pool regularly.

Although the pool and its immediate surroundings were a nature reserve since 1922 the pool was nevertheless used for bathing by tourists. This might have helped to eutrophy its water (Sloff 1928, Thijsse 1928, Wigman 1932, Bijlmer 1938, Boer Leffef 1959), but these bathing activities ceased about 1965 (Bink & Schimmel 1975).

According to the topographical maps (scale 1:25 000) the pool was situated in an entirely open landscape until 1921. This situation was recorded beautifully by the photographs in Tesch et al. (1926). On the maps of 1899 bare sand dunes occurred on the southwestern side, while the rest of the vegetation of the environment was heathland. According to Schimmel & Mörzer Bruyns (1952) the heathland vegetation belonged mainly to the Calluno-Genistetum. The grassland parcel on the northwestern side appears for the first time on the map of 1928. On this map also some spontaneous regrowth of trees at the southwestern side is registrated. The size of this small forest lot increased in later years. Presently the former Calluno-Genistetum is dominated by a Molinietum caeruleae.

The vegetation of the forest belongs to the Frangulo-Salicetum auritae with mainly Betula pubescens and Salix aurita and also Prunus serotina. Polytrichum commune and Molinia caerulea are dominant in the herb layer (Van de Beld 1978).

At the northwestern shore of the pool is a marshy vegetation with Molinia caerulea and Eriophorum angustifolium as dominant species (Schimmel & Ter Hoeve 1952, Van de Beld 1978).

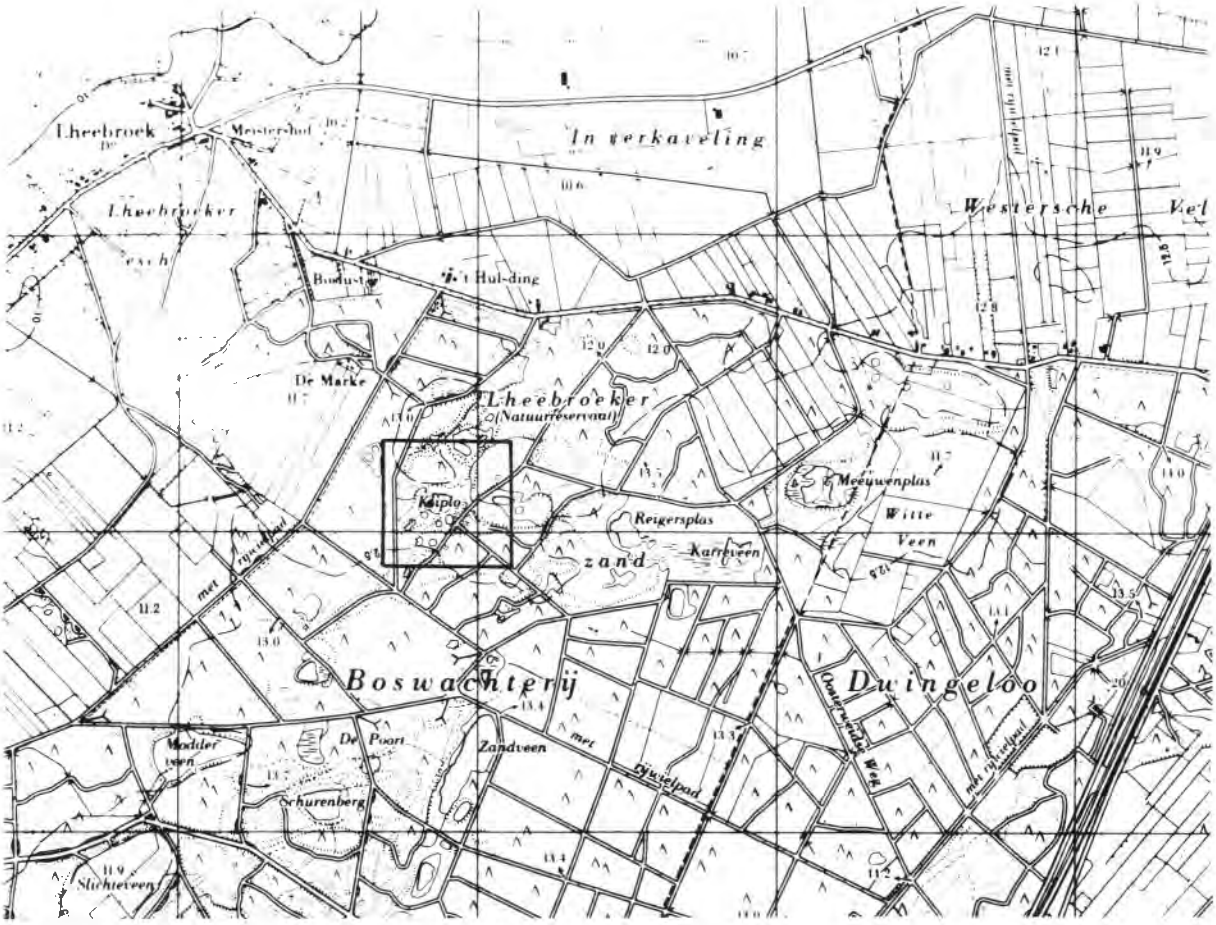


Fig. 4. Location of Kliplo. Sampling station indicated with a dot. (Topographical Map of The Netherlands, scale 1: 25 000, sheet 17A).

Kliplo

The pool Kliplo, also known as Kiplo or Kipelo (Photos 9, 10) is situated 4 km east of the village of Dwingeloo (52°50'N, 6°26'E) at a distance of 117 km from the North Sea (Figs. 1, 4). The surface area is c. 0.6 ha.

It is a nature reserve, founded in the forestry "Dwingeloo" in 1908. The forestry includes a number of moorland pools, differing in chemistry and biota (Coesel & Smit 1977).

Kliplo was studied intensively by Beyerinck (1926) in his classical dissertation on the distribution and periodicity of freshwater algae in the province of Drenthe. Most of the pools in this region harbour only a small number of species of algae. Only a few localities, including Kliplo, appeared to be mines of algae. These findings inspired the members of the Hydrobiological Club to make a more complete inventory of this relatively small pool (see e.g. Redeke & De Vos 1932). Later on, the site was regularly sampled by other investigators, which permits the construction of a time series of plankton samples.

The pool is situated in an area of sand dunes, with a loamy layer in the subsoil. The drift sands were probably formed in mediaeval times, by overgrazing with sheep. The area was reafforested, mainly with Scots pines, between 1910 and 1925. Most sands are dry and poor in humic substances and loam, although the small heathland at the western side of the pool is

Photo 9

Kliplo, looking from the southwestern shore to the north. Between *Potamogeton natans* (foreground) and the belt of *Phragmites australis* (background) *Sparganium angustifolium* is visible (E.E. van der Voo, c. 1960).

Photo 10

Kliplo, seen from the sandy beach at the southwestern side to the northwest (R. van Beek, May 1980).

Photo 11

Tongbersven-West, looking from the permanent sampling station southwest (J. van Osch, Oct. 1984).

situated on a podzol, poor in lime (Vrielink et al. 1976).

Hydrologically, the pool is isolated from its surroundings (Bakker 1984, Bakker et al. 1986), as can be observed in the field directly. Some tens of metres north of the pool the surface of the forest floor is situated beneath the surface of the water in the pool.

At the northwestern side is a remnant of a small ditch, which may have been a pipe of a duck decoy. Probably the pool has been used for catching ducks in the 19th century. This activity certainly introduced nutrients in the pool (foddering etc.).

Brouwer (1968) states that already in 1939 the pool was used for bathing by the local population and tourists. Also in later years conservationists complained about this improper use of a nature reserve (Mörzer Bruyns 1950, Glas 1958), but in 1971 the bathing was finished definitively (Londo 1973, P. Kerssies pers. comm.).

In winter the pool is used as a skating-rink by the local youth.

The bathers entered the pool from the southeastern shore of the pool. The bottom is sandy here, and continues outside the pool as a beach, bordering at sand dunes in the pine forest, which is rather open here.

Also at the western side of the pool the vegetation is open. Directly along the shore is a strip of quivering bog, c. 5-10 m wide and c. 50 m long. The vegetation includes, apart from *Sphagnum* spp., *Polytrichum* and other mosses, *Andromeda polifolia*, *Oxycoccus palustris*, *Carex rostrata* and *Eriophorum angustifolium* (Wartena 1954, Glas 1958). Brouwer (1968) also mentions the presence of three species of *Drosera*. West of this bog strip is an open heathland with *Empetrum nigrum*, *Calluna vulgaris*, *Erica tetralix* and *Juniperus communis* as important species. Spontaneous regrowth of Scots pines, which occurred since 1925, was removed in 1965.

At the remaining sides, Kliplo is enclosed by trees. In the southwestern and northeastern corners even small patches of carr with birch, peat mosses and *Molinia* are present. At the northern side a few metres wide belt of birches separates the pool from a dry pine-forest. At the southern side the pool borders at a dry complex of *Juniperus*-heathland and bare sand dunes, with birches overhanging the pool.

Tongbersven-West

The pool Tongbersven-West (Photos 11, 12) is situated 4 km east of the village of Oisterwijk (51°34'N, 5°14'E) at c. 8.2 m above NAP (mean sea water level) at a distance of 146 km from the North Sea (Figs. 1, 2). The surface is c. 0.46 ha.

It is a part of the nature reserve 'Kampina' which is very rich in moorland pools. Hydrobiological aspects of a number of pools in this area were studied by Van Dam & Kooyman-van Blokland (1978), Coesel et al. (1978) and Van Dam (1983). The area was acquired in 1929 by the "Vereniging tot Behoud van Natuurmonumenten in Nederland". The environment of the pool is not open to the public, although a private person is allowed to use a small cottage at the northern side of the pool as a weekend house.

The nomenclature of the pools in this region is very complex, as pointed out by Van Dam (1973). Other names which are used for this pool include Palingven-West (Glas 1957), Palingvennen and Tongbersvennen (Verschoor 1977).

The pool was selected for our studies because it seemed particularly suitable for the study of the hydrological relations between the pool and its surroundings (Oostveen 1985), because the pool is rather small and the surrounding vegetation and soils are rather homogeneous.

According to the soil map by Geenen (1977) the pool is situated in an

Photo 12

Tongbersven-West, looking southwest over the largest pool (J. van Osch, Oct. 1984).

Photo 13

Groot Hasselsven, looking from the southeastern shore (near the sampling station) to the northwest (J. van Osch, Oct. 1984).

area where the predominant soil type is a dry podzol, which is locally covered with a layer of aeolian drift sand with a maximum thickness of less than 4 dm.

Oostveen (1985) supposes that the pool is a remnant of a meltwater valley. The dating of the origin is still uncertain. He also demonstrated that the pool has an impervious bottom and has no contact with the aquifer.

Tongbersven-West is situated in a pine forest, which was planted after 1900 on the heathlands (Van Hees & Van den Wijngaard 1977). On the topographical map (scale 1:25 000) which was revised in 1930, the northern shore is indicated as a tree plantation, while spontaneous regrowth of trees is indicated south of the pool. On the map which was surveyed in 1949 part of the forest at the northern side of the pool appeared to be cut again. On the maps of 1961 and later the pool is totally surrounded by forest. Pinus

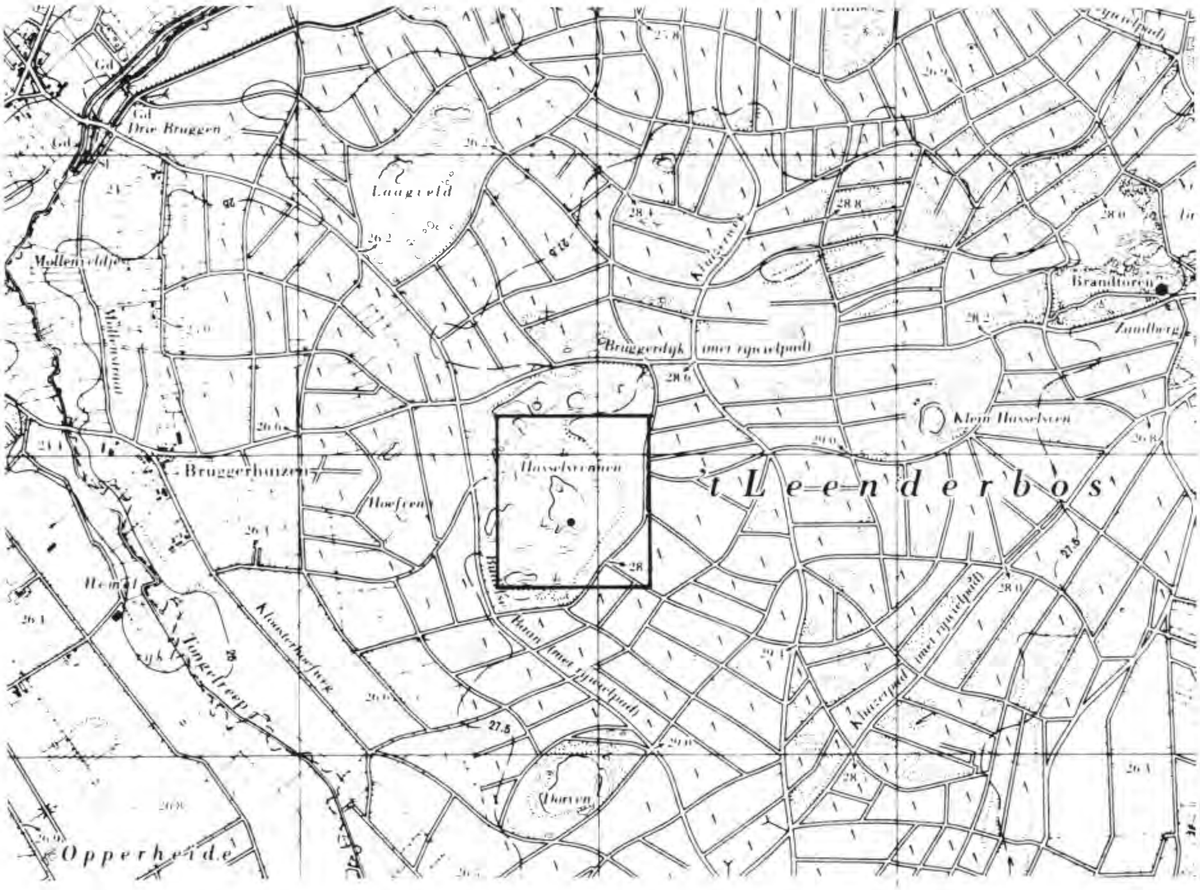


Fig. 5. Location of Groot Hasselsven. Sampling station indicated with a dot. (Topographical Map of The Netherlands, scale 1: 25 000, sheet 57E).

sylvestris is the main tree species. Locally Prunus serotina and Quercus robur occur. Picea abies, Castanea sativa and Rhododendron are present sporadically. Molinia caerulea and Deschampsia flexuosa dominate the understory (see also Hofman & Jansen 1986).

Groot Hasselsven

The pool Groot Hasselsven (Photo 13) is situated in the Leenderbos, 3 km SW of the village of Leende (51°20'N, 5°30'E) at c. 26.3 m above NAP (mean sea water level) at a distance of 161 km from the North Sea (Figs. 1,

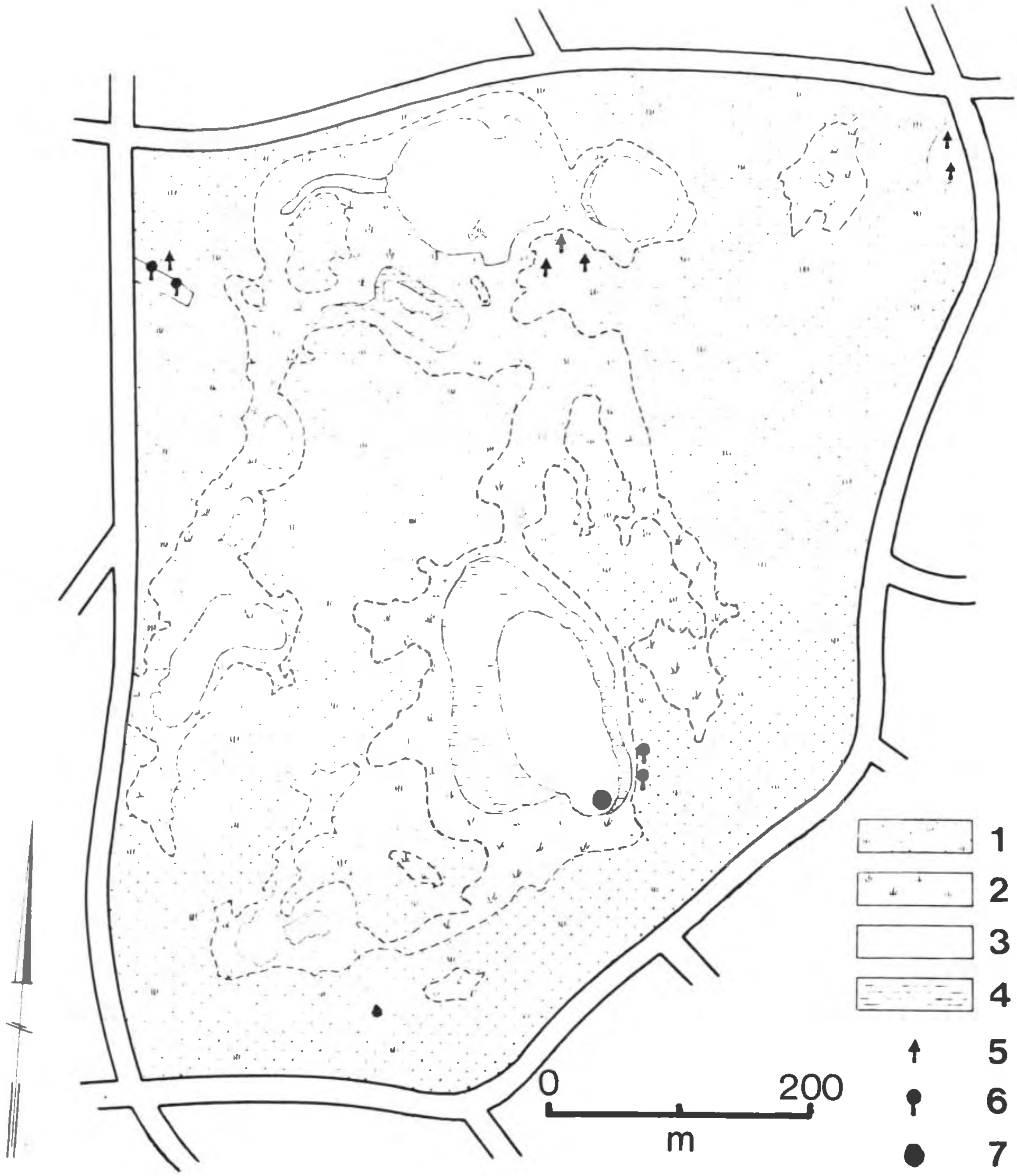


Fig. 6. Nature reserve "Hasselsvennen" in October 1955 (Unpublished Map of State Forestry Service). 1 = dry heath (Genisto pilosae - Callunetum), 2 = wet heath (Ericetum tetralicis), 3 = moorland pool (open water), 4 = marsh, 5 = Scots pine (spontaneous regrowth), 6 = birch or oak, 7 = sampling station.

5). The surface area is c. 1.3 ha.

It is a part of the nature reserve 'Hasselsvennen' (Fig. 6), which belongs to the State of The Netherlands since 1931. The direct surroundings of the pool are not open to the public. The pool was selected for our studies because it appeared especially suitable for the study of hydrological relations between the pool and its surroundings, because of its small area and the rather homogeneous soil and vegetation around the pool. Hydrological studies by Oostveen (1985) demonstrated that the pool has no contact with the aquifer and is fed by precipitation and - to a limited extent - by surface runn-of.

According to the soil map of The Netherlands the pool is situated in an area with wet podzols as the predominant soil type.

Until the 1930s the pools of the nature reserve Hasselsvennen were in a vast area of heath and moorland. Beginning in the late 19th century the largest area of these unproductive soils was reclaimed for agriculture. Also at the northeastern side and the southern and southwestern sides of Groot Hasselsven some parcels were indicated as arable land on the cadastral maps of the late 19th and early 20th centuries. The area surrounding the Hasselsvennen-reserve was planted with trees, mainly Scots pines, from 1932 to 1941 (Iven & Van Gerwen 1974).

On the sketch-map of the vegetation in 1955 (Fig. 6) there is no special signature for associations of *Molinia caerulea*, which is very common now in the moorland around Groot Hasselsven. The former Ericetum at the western and northern side of the pool is now a sward of *Molinia caerulea*. The former Callunetum east of the pool is a stand of *Erica tetralix*, *Calluna vulgaris* and *Molinia caerulea* now. Only in a small area south of the pool, near the sampling station, the Ericetum is still free of *Molinia*.

The belt of marshy vegetation is inundated at high water levels in winter and spring and is united with the pool at that time. The most conspicuous plant species of the marshy zone is *Juncus effusus*, which is present all around the pool. On the outer side it is mixed with *Molinia caerulea*. The common rush is accompanied by the moss *Drepanocladus fluitans* nearly everywhere. *Juncus bulbosus* is also regularly present near the open water. Clumps of *Phragmites australis* are present in the NW area of this zone. Scattered stems of common reed are present in the rush belt at the western side of the pool.

Van Donselaar (1957) recorded essentially the same zonation in the marsh at the western side, although *Phragmites* appeared to be more common at that time. He recorded prolific growth of *Juncus bulbosus* and *Sphagnum cuspidatum* between the reed.

Juncus effusus, *Phragmites australis* and *Drepanocladus fluitans* are indicators of eutrophication. According to Iven & Van Gerwen (1974) the eutrophication was caused by a colony of black-headed gulls (*Larus ridibundus*). In the 1940s numerous gulls were present, in the 1960s only some tens of pairs were breeding in the marsh. Finally the last birds were dislodged in 1970 (Iven & Van Gerwen 1974).

3.2 MORPHOMETRY

Achterste Goorven

The results of the survey of bathymetry and sediment thickness on 11, 12 and 13 September 1984 are presented in Figs. 7-9 and App. 1-3. The water level on these days was 6 cm below the average water level recorded during the period 1979-85 (8.34 m + NAP). Data on area, volume and other morphometric parameters are presented in Tables 2-4 and depth-area (hypsographic) and depth-volume curves are presented in Figs. 10-13.

Achterste Goorven has a complex morphology. It consists of a series of smaller and larger basins interconnected by natural channels and man made ditches. Especially in basin III (Fig. 8) a number of small (natural?) islands occur. Consequently the shore line development is as high as 3.98 (Table 3).

The area and volume at mean water level were calculated by extrapolation from Figs. 10 and 11 respectively. The mean volume is 14.5×10^3 m^3 and the mean area 23.5×10^3 m^2. Consequently the mean depth at mean water level is 0.62 m (Table 3). The mean depth of basin III, where sampling station E is situated, is only 0.54 m.

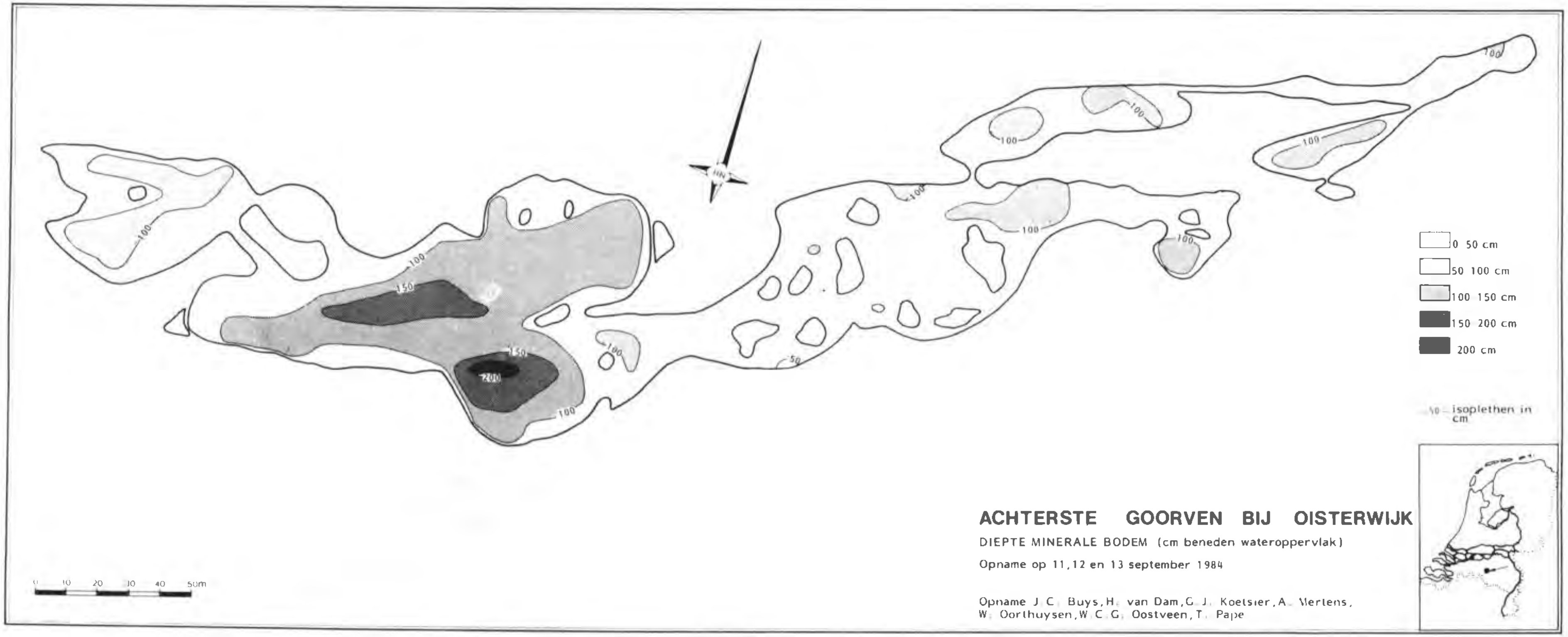


Fig. 7. Achterste Goorven. Generalized depth of mineral soil in cm below water level on September 11-13, 1984 (water level 8.28 m + NAP).

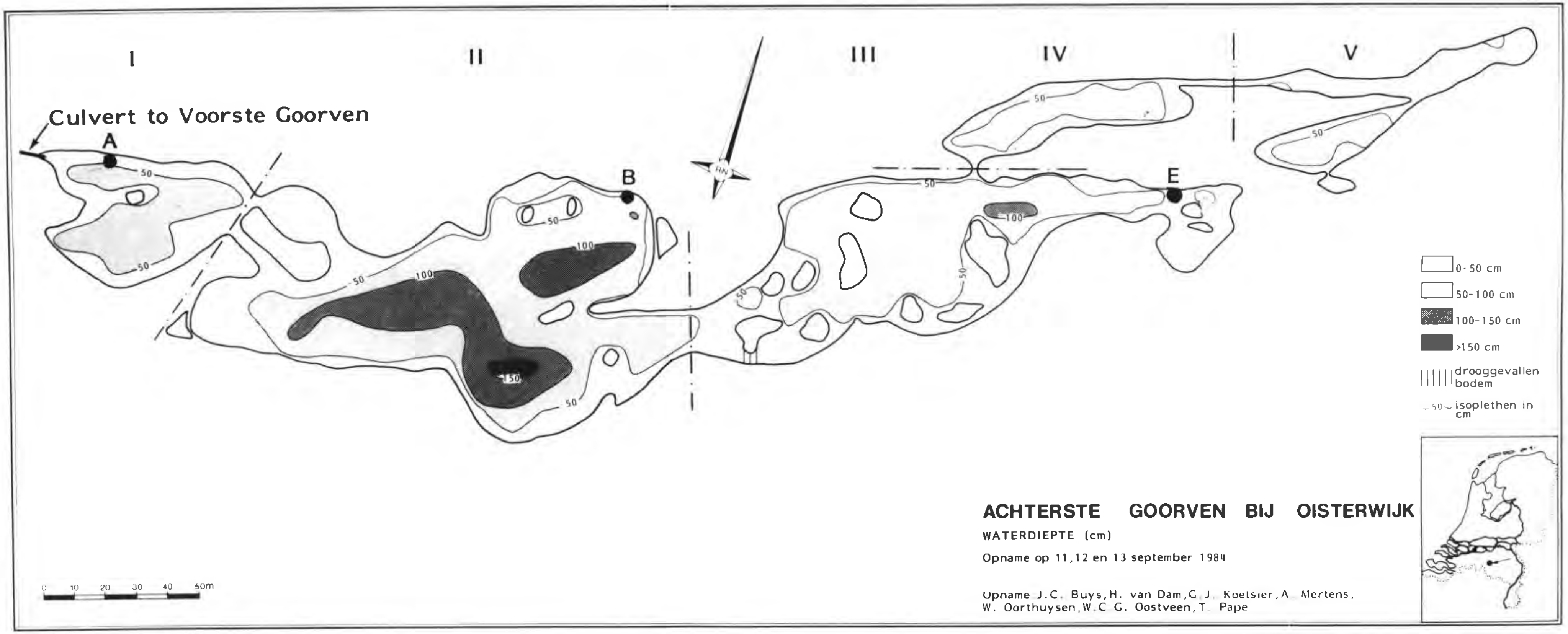


Fig. 8. Achterste Goorven. Generalized bathymetric map (depth in cm) on September 11-13, 1984 (water level 8.28 m + NAP). Hatched area = dry bottom, dots = sampling stations, I-V = basin numbers.

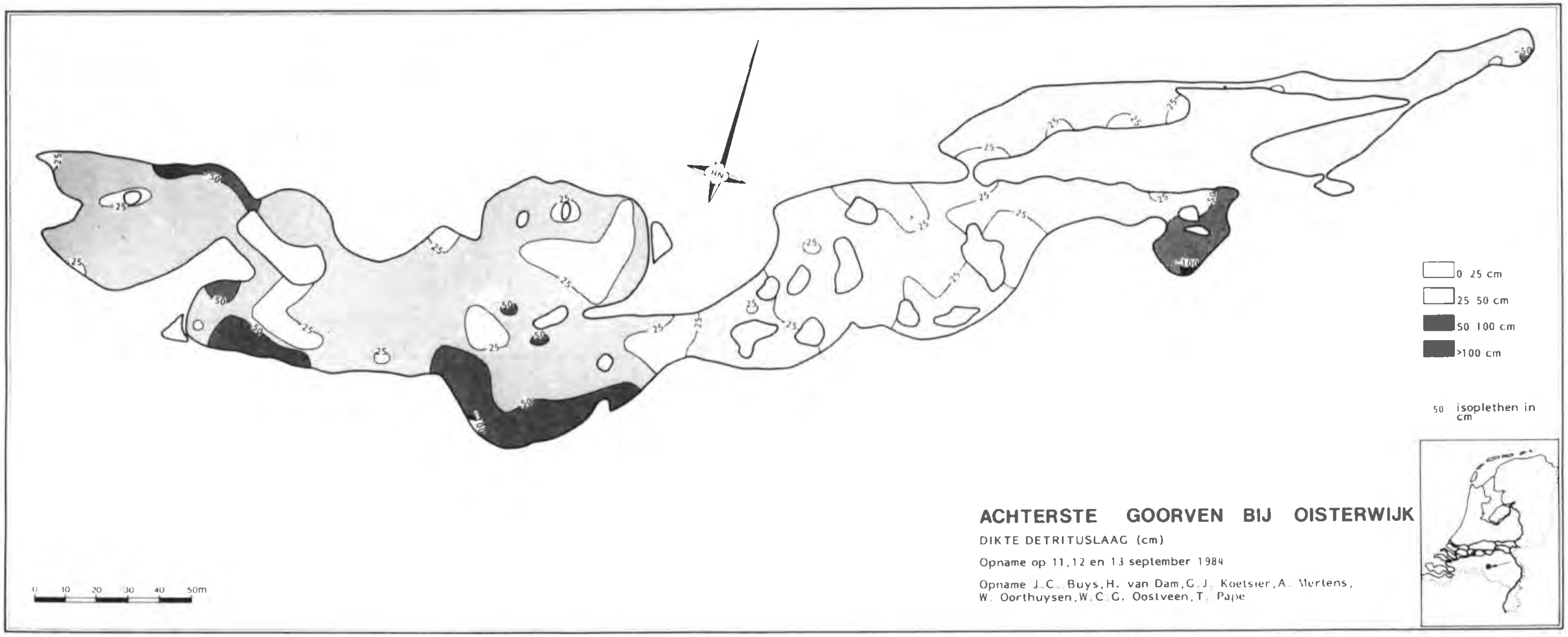
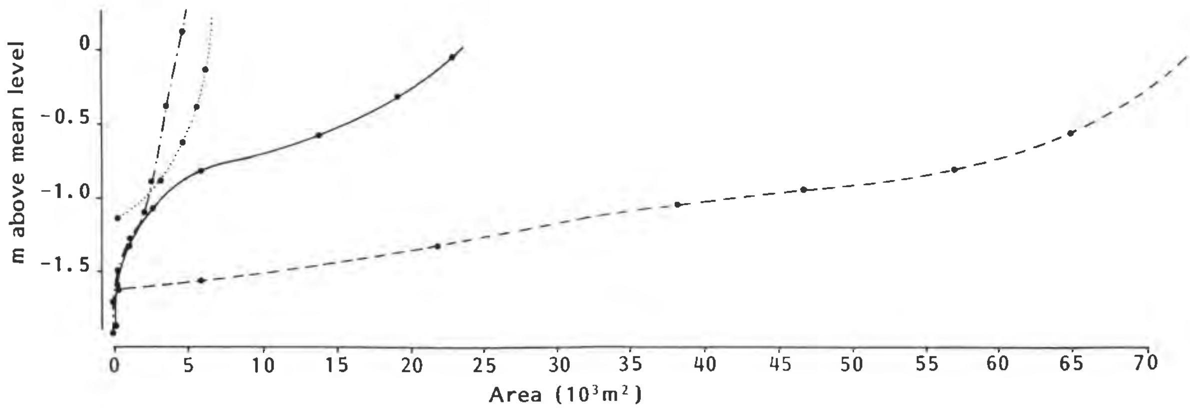


Fig. 9. Achterste Goorven. Generalized thickness of mud layer (cm) on September 11-13, 1984.



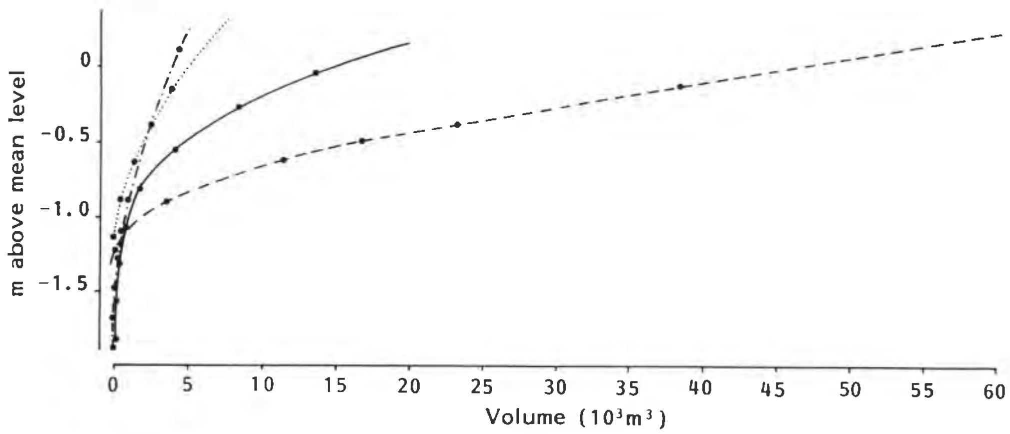
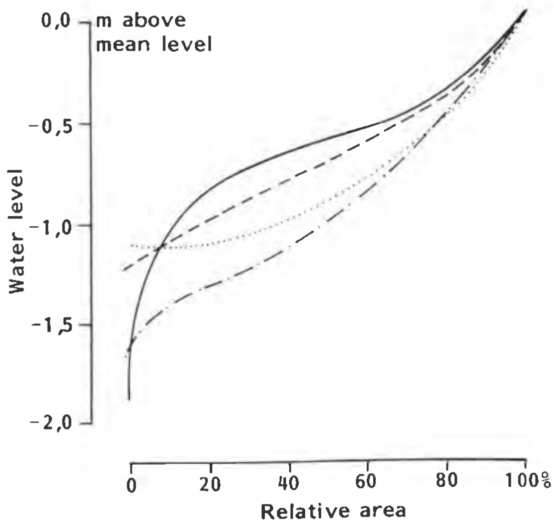


Fig. 10 (top). Achterste Goorven (solid line), Gerritsfles (broken line), Kliplo (dotted line) and Tongbersven-West (dashed-dotted line). Water depth vs. area at mean water level.

Fig. 11 (bottom). Achterste Goorven (solid line), Gerritsfles (broken line), Kliplo (dotted line) and Tongbersven-West (dashed-dotted line). Water depth vs. volume at mean water level.



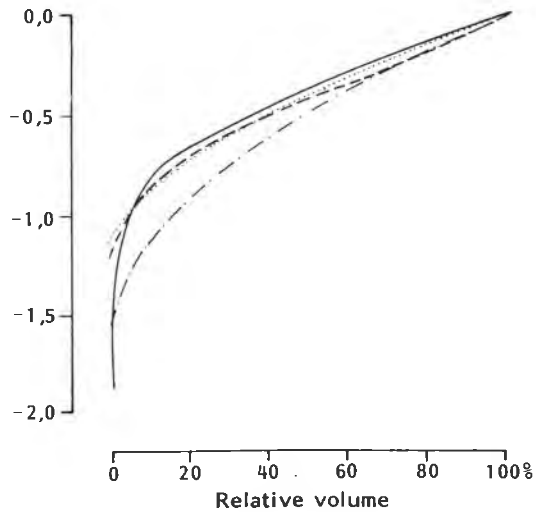


Fig. 12 (left). Achterste Goorven (solid line), Gerritsfles (broken line), Kliplo (dotted line) and Tongbersven-West (dashed-dotted line). Water depth vs. relative area at mean water level.

Fig. 13 (right). Achterste Goorven (solid line), Gerritsfles (broken line), Kliplo (dotted line) and Tongbersven-West (dashed-dotted line). Water depth vs. relative volume at mean water level.

Table 2

Achterste Goorven. Area per basin and total volume (11-13 September 1984).

Level above NAP (m)	Depth z (m)	Area per basin (m^2) I	II	III	IV	V	total pool	Volume (m^3) total pool
8.28	0.00	2544	10364	6384	1710	1846	22847	13314
8.03	0.25	2367	8725	5352	1371	927	18743	8115
7.78	0.50	1380	7407	3590	871	514	13762	4052
7.53	0.75	462	4622	584	134	101	5901	1594
7.28	1.00	0	2421	108	0	0	2530	540
7.03	1.25	0	888	0	0	0	888	113
6.78	1.50	0	108	0	0	0	108	16
6.49	1.79	0	0	0	0	0		0

Table 3

Achterste Goorven. Morphometric data on 11-13 September 1984 (water level 8.28 m + NAP).

Basin		I	II	III	IV	V	total pool
Area (m^2)	A	2544	10364	6384	1710	1846	11847
Volume (m^3)	V	1370	7338	3207	808	616	13314
Max. depth (m)	z_{max}	0.96	1.79	1.11	0.86	0.84	1.79
Mean depth (m)	$\bar{z}$	0.54	0.71	0.50	0.47	0.33	0.58
$\bar{z}/z_{max}$	-	0.56	0.40	0.45	0.55	0.39	0.32
Length of shore line (m)	L	210	625	750	200	350	2135
Shore line development	D_L	1.17	1.73	2.65	1.36	2.30	3.98

Table 4

Achterste Goorven (AGO), Gerritsfles (GER), Kliplo (KLI) and Tongbersven-West (TON)[a]. Morphometric data.

		At bathymetric survey				At mean water level			
		AGE	GER	KLI	TON	AGO	GER	KLI	TON
Area (m^2)	A	22847	65093	5984	4599	23500	67800	6200	4380
Volume (m^3)	V	13314	38346	3909	4563	14500	45800	5100	4100
Max. depth (m)	z_{max}	1.79	1.10	1.00	1.89	1.85	1.24	1.14	1.74
Mean depth (m)	$\bar{z}$	0.58	0.59	0.65	0.99	0.62	0.68	0.82	0.94
Relative depth (%)	z_r	1.05	0.38	1.15	2.47	1.07	0.42	1.25	2.33
$\bar{z}/z_{max}$	-	0.32	0.53	0.65	0.52	0.34	0.54	0.72	0.54
Length of shore line (m)	L	2135	1800	310	430	-	-	-	-
Shore line development	D_L	3.98	1.97	1.13	1.79	-	-	-	-

[a]Depth of Tongbersven-West is measured from water surface to mineral soil, depth of other pools is measured to mud layer.

Table 5

Gerritsfles, Kliplo and Tongbersven-West. Area and volume[a].

Gerritsfles 18 and 19 September 1984				Kliplo 10 September 1984				Tongbersven-West 8 January 1985			
Level (m + NAP)	z (m)	A (m^2)	V (m^3)	Level (m + NAP)	z (m)	A (m^2)	V (m^3)	Level (m + NAP)	z (m)	A (m^2)	V (m^3)
-	-	66469[b]	-	12.84	0	5984	3909	8.28	0.00	4599	4563
39.77	0	65093	38346	12.59	25	5336	2494	7.78	0.50	3620	2513
39.52	0.25	57061	23077	12.34	50	4318	1288	7.28	1.00	2673	950
39.39	0.38	46831	16538	12.09	75	2966	377	7.08	1.20	1963	488
39.27	0.50	38351	11260	11.84	100	51	0	6.88	1.40	1204	176
39.02	0.75	21746	3748					6.68	1.60	318	36
38.77	1.00	5883	294					6.48	1.80	41	2
38.67	1.10	0	0					6.39	1.89	0	0

[a] Depth of Tongbersven-West is measured from water surface to mineral soil, depth of the other pools is measured to the mud layer.

[b] Area including dry bottom (hatched area in fig. 15).

Depth of the mineral soil (Fig. 7) and waterdepth (Fig. 8) have a rather similar distribution. The deepest parts are in basin II, where the maximal water depth is 1.85 m. To the east the depth is generally decreasing (Table 3, Figs. 7 and 8), The thickness of the sediment layer (Fig. 9) is highly unevenly distributed. The thinnest parts are only 1 dm thick, the thickest parts more than 1 m. The thickest sediments are found at wind-sheltered places.

Gerritsfles

The results of the survey of bathymetry and sediment thickness on 18 and 19 September 1984 are presented in Figs. 14-16 and App. 4-6. The water level on these days was 14 cm below the average level recorded during the period 1979-85 (39.91 m + NAP). Data on area, volume and other morphometric parameters are presented in Tables 4 and 5. Depth-area (hypsographic) and depth-volume curves are presented in Figs. 10-13.

The morphology of Gerritsfles is less complex than that of Achterste Goorven. One large and three small islands are present. The shore line development is half that of Achterste Goorven.

The area and volume at mean water level, calculated by extrapolation from Figs. 10 and 11, are 67.8×10^3 m^2 and 45.8×10^3 m^3 respectively. The mean depth at mean water level is 0.68 m (Table 3). Depth of mineral soil and waterdepth (Figs. 14-15) have a rather similar distribution. The deepest part is in the center, east of the largest island, where the maximal water depth is 1.24 m. The shallowest parts are in the NE-branch, where the maximum depth is 0.81 m only. The sediment layer is generally less than one, or only a few decimetres thick. The thickest sediments are at the western (wind sheltered) shores. In the western bay the sediments are locally c. 9 dm thick. This sediment is not uniform, but consists of a series of layers of organic sediments, separated by layers of sand, which was blown into the pool. Only at a few places the mineral bottom is visible between the unconsolidated sediment nearshore.

Kliplo

The results of the survey of bathymetry and sediment thickness on 10 September 1984 are displayed in Fig. 17 and App. 7. The water level on this day was 14 cm below the average level recorded during the period 1982-85

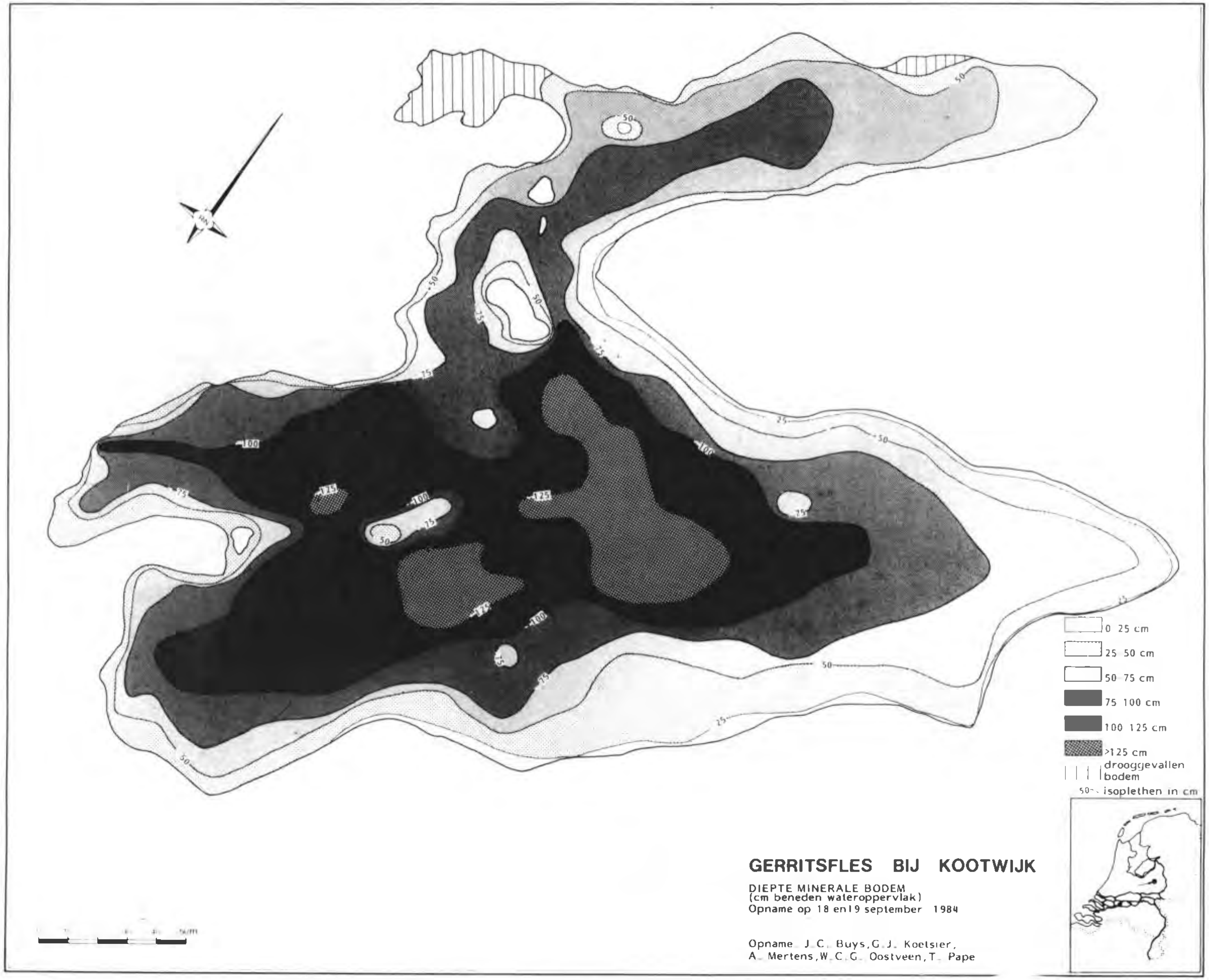


Fig. 14. Gerritsfles. Generalized depth of mineral soil in cm below water level on September 18-19, 1984 (water level 39.77 m + NAP).

Fig. 15. Gerritsfles. Generalized bathymetric map (depth in cm) on September 18-19, 1984 (water level 39.77 m + NAP). Hatched area = dry bottom, dot = permanent sampling station, cross = chemical sampling station LUW.

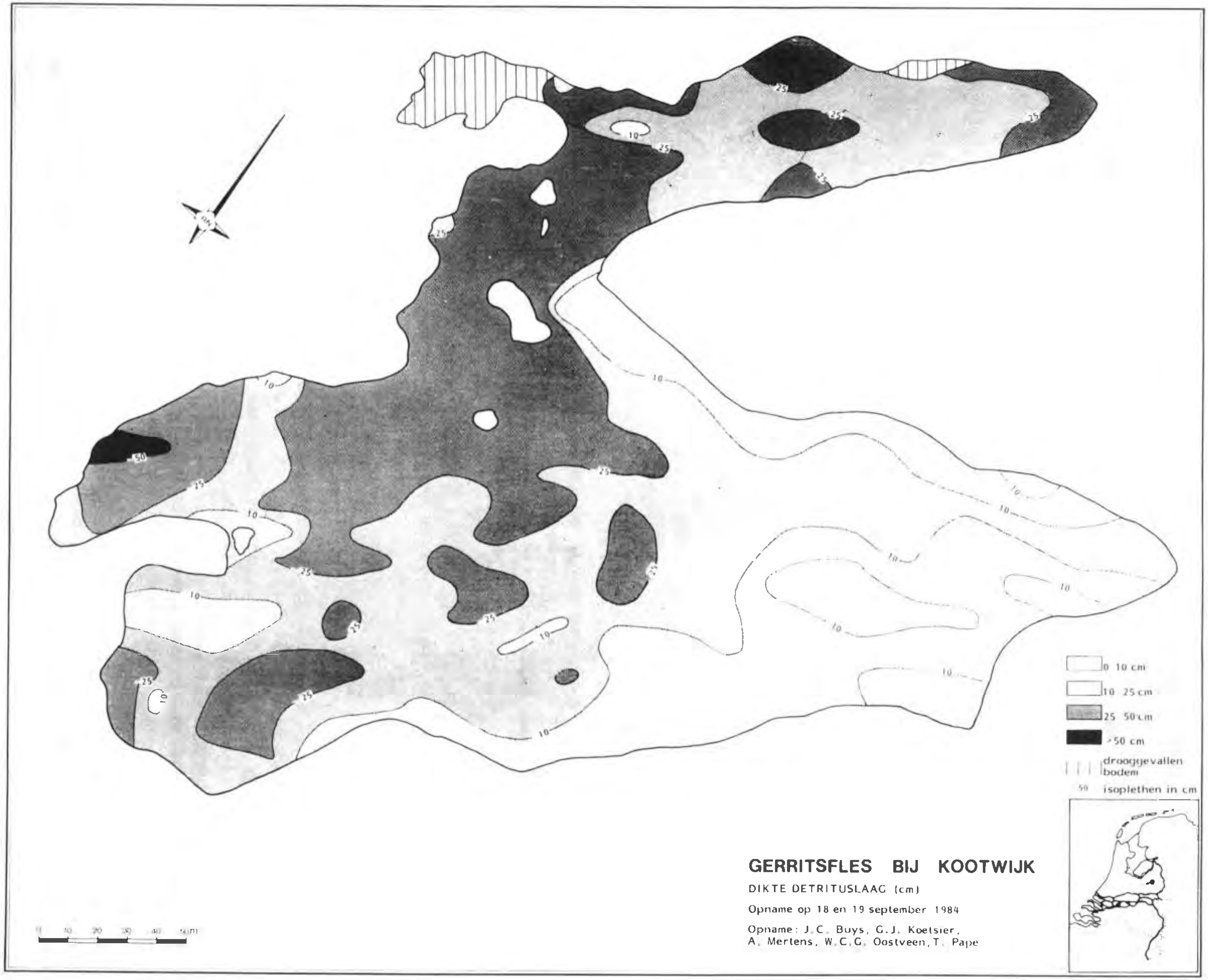


Fig. 16. Gerritsfles. Generalized thickness of mud layer (cm) on September 18-19, 1984.

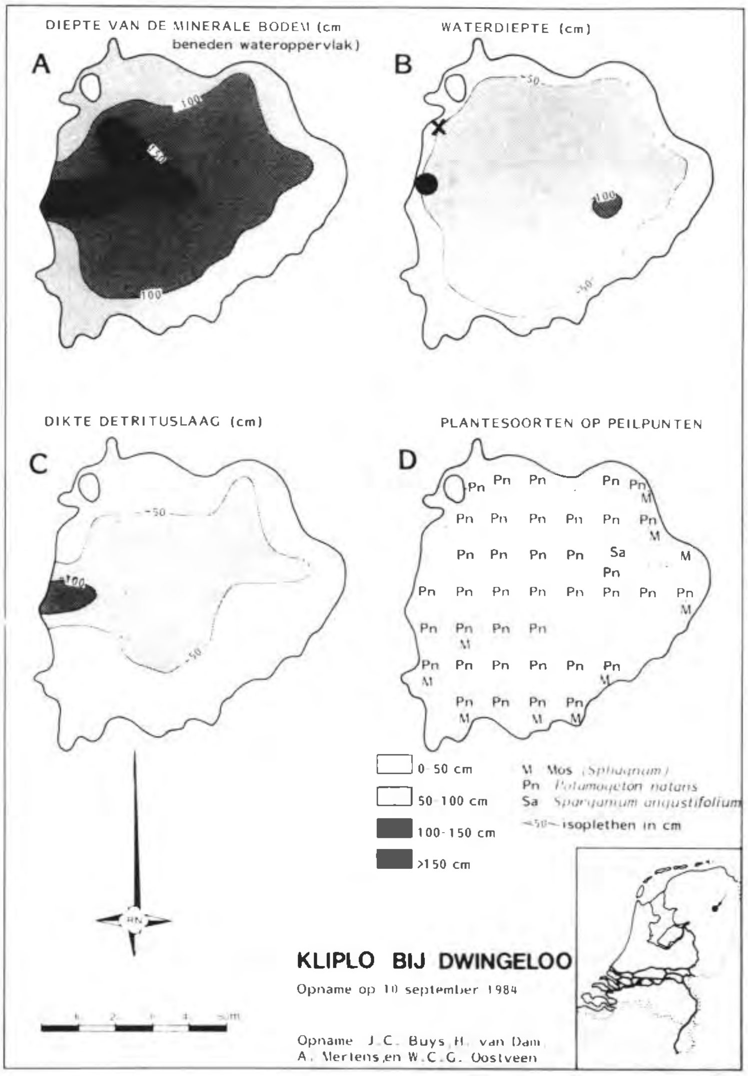


Fig. 17. Kliplo, September 10, 1984. **A.** Generalized depth of mineral soil in cm below water level. **B.** Generalized bathymetric map (depth in cm). **C.** Generalized thickness of mud layer (cm). **D.** Plant species on gauging stations. Water level 12.84 m + NAP. Dot = permanent sampling station, cross = chemical sampling station LUW.

(12.98 m + NAP). Data on volume, area and other morphometric parameters are presented in Tables 4 and 5. Depth-area (hypsographic) and depth-volume curves are presented in Figs. 10-13.

The morphology of Kliplo is simple. Only one small island is present. The shore line development (1.13) is only slightly higher than the theoretical minimum value (1.00).

The area and volume at mean water level, calculated by extrapolation from Figs. 10 and 11 are 6200 m^2 and 5100 m^3 respectively. The mean depth at mean water level is 0.82 m. Consequently Kliplo has the largest mean depth of the investigated pools (the mean depth of Tongbersven-West is 0.94 m, but includes a thick mud layer). Depth of mineral soil and waterdepth (Fig. 17) have a different pattern. The surface of the sediment layer is like a soup plate. The surface of the mineral bottom has a deep depression (maximal 1.96 m below mean water level) near the quaking bog at the western side. Presumably this depression extends under the quaking bog. Here the sediments are up to 1.24 m thick. At the SE-sandy shore the sediment is absent.

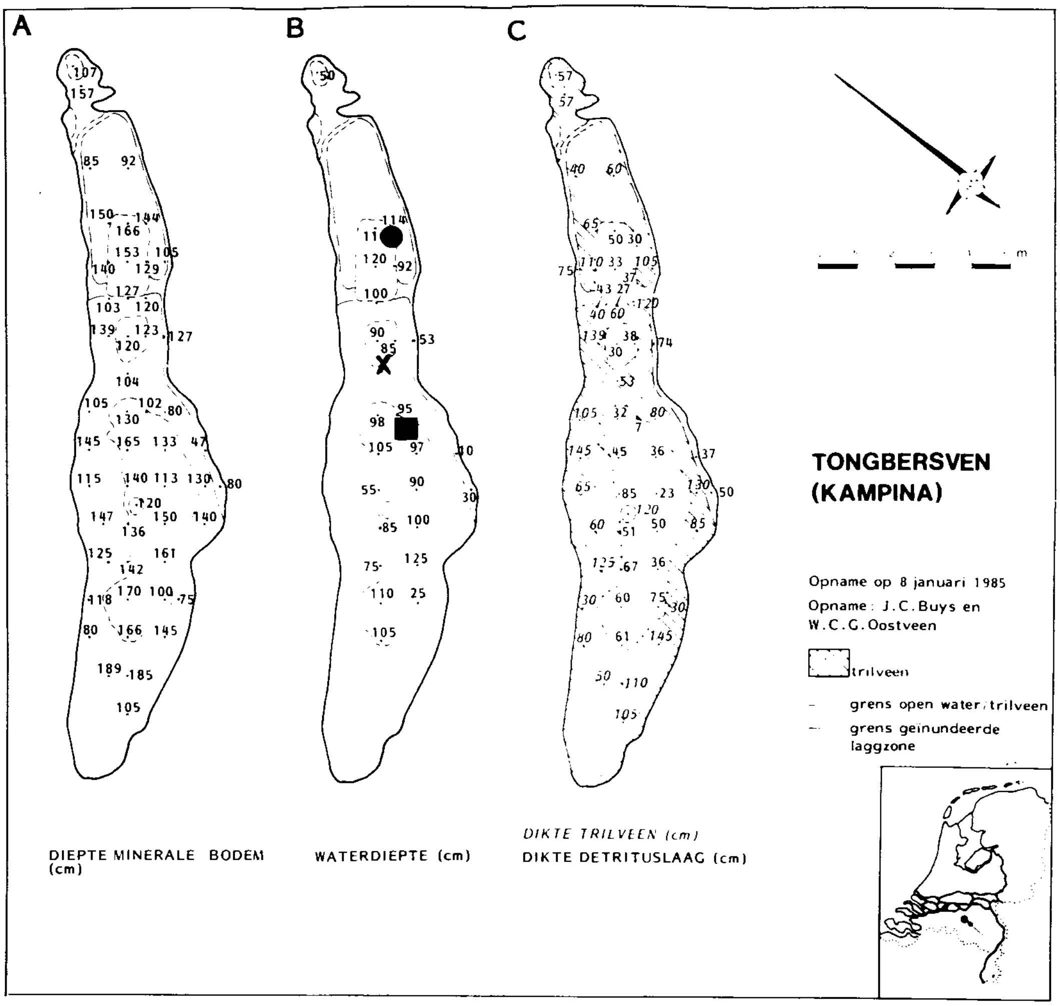


Fig. 18. Tongbersven-West, January 8, 1985. **A.** Depth of mineral soil in cm below water level. **B.** Bathymetric map (depth in cm). **C.** Thickness of quivering-bog layer in cm (italics), thickness of mud layer in cm (normal). Shortly dashed line: borderline between open water and quivering bog. Long-dashed lines: borderline between inundated lagg zone and quivering bog. Water level 8.28 m +NAP. Dot = diatom monitoring station, square = western diatom sampling station, Cross = chemical sampling station LUW.

Tongbersven-West

The results of the survey of bathymetry, sediment thickness and thickness of the quivering bog on 8 January 1985 are presented in Fig. 18. The water level on this day was 9 cm above the mean level recorded over the period 1983-84. Data on volume, area and other morphometric parameters are presented in Tables 4 and 5. Depth-area (hypsographic) and depth-volume curves are presented in Figs. 10-13.

The morphometric parameters of Tongbersven-West cannot be compared directly with those of the other pools. Below the quivering bog in a large area of the pool the thickness of the mud layer could not be measured with the method used. Therefore, all morphometric parameters include the thickness of the mud layer, which can be considerable. The maximum measured thickness of the mud layer was 85 cm, the minimum 7 cm. Oostveen (1985) estimates the mean thickness of the mud layer to be 40 cm, which reduces the mean water depth to 56 cm. The quivering bog has a mean thickness of 54 cm, although the boundary between the bog and the underlying water is difficult to assess. The area of the open water is 1300 m^2 (Oostveen 1985). Consequently the area of the quivering bog (including the relatively narrow lagg zone) is c. 3100 m^2.

The area and volume at mean water level, calculated by interpolation from Table 5 are 4380 m^2 and 400 m^3 respectively. The mean depth at mean water level is 0.94 m (Table 4). The maximum depth of the open water (measured to the top of the sediment at mean water level) is 1.16 m and is found in the largest open water area.

Groot Hasselsven

No bathymetric map of this pool has been made. The bottom of this pool is very flat. During the summers of 1982 and 1983 the depth of the water in the largest part of the pool was estimated to be only 2-4 dm. In winter the depth is c. 5-6 dm.

HYDROLOGY

3.3.1 A simple hydrological model

The pathway of the water before it enters a lake or pool is a key factor in understanding acidification of surface water (e.g. Van Breemen et al. 1983, Stumm et al. 1983, Schnoor & Stumm 1985). The rate of acidification of lakes in a similar geological setting is highly dependent on hydrology (Bache 1984, Likens 1984, Driscoll & Newton 1985, Peters & Murdoch 1985).

Before the present research was started it was already known that Gerritsfles has a perched water table, i.e. the water body is isolated from the regional groundwater and its watershed is hardly larger than the pool itself. Also Kliplo is isolated from the regional groundwater (Bakker 1984, Bakker et al. 1986). The same is true for Tongbersven-West (Oostveen 1985). Achterste Goorven was selected for our studies because it was expected, both from its topographical situation and from earlier chemical measurements (Van Dam et al. 1981), that it might be a groundwater fed pool (see also Ter Hoeve 1949).

No observations of the groundwater table near Achterste Goorven are

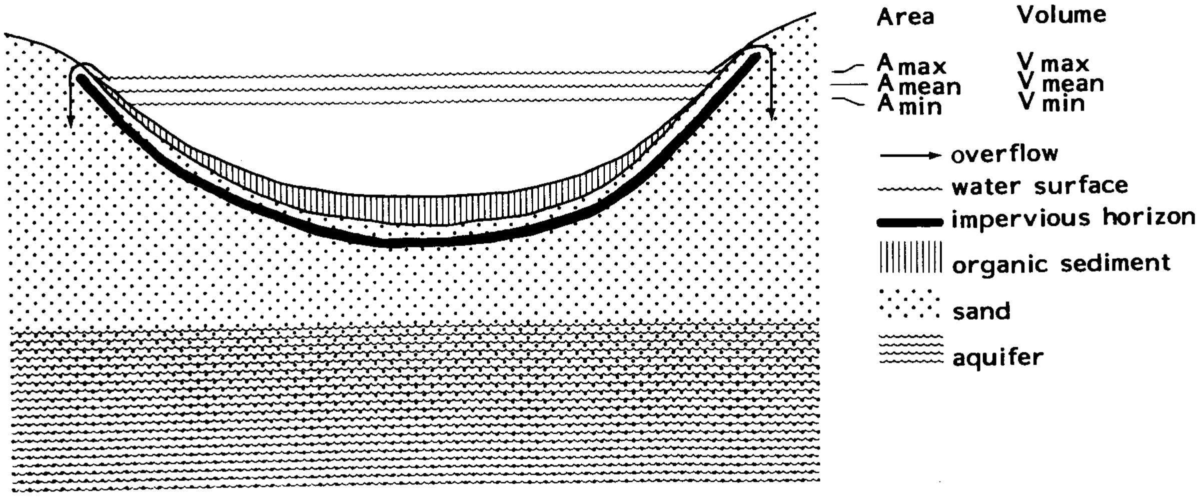


Fig. 19. Schematic cross section of a moorland pool with maximum, mean and minimum water levels.

available. Nevertheless it is possible to get an answer to the question if this pool is isolated from the regional groundwater table or not by the study of its chloride budget, as chloride is considered to be geochemically and biologically inert.

A moorland pool with a perched water table and without visible in - or outlet can be represented as in Fig. 19. The area of the water surface and the volume of the pool at different water levels are defined as in Fig. 19.

The annual input of chloride (F_i) can be approximated by

$$F_i = PA_{max}C_p, \qquad (1)$$

where P is the annual amount of precipitation per square metre and C_p is the concentration of chloride in precipitation. A_{max} (the maximal area of the water surface) is used as a substitute for the catchment area. The annual output of chloride (F_o) can be approximated by

$$F_o = (PA_{max} - EA_{min})C_o, \qquad (2)$$

where E is the annual evaporation of an open water surface per square metre and C_o is the concentration of chloride in the overflowing water. Evaporation is supposed to be most important during summer, when the water level is low. As the overflow takes place at maximum water level, C_o can be approximated by

$$C_o = C_e V_{mean}/V_{max}, \qquad (3)$$

where C_e is the estimated mean chloride concentration of the surface water. In a steady state $F_i = F_o$ and combination of the expressions above gives:

$$C_e = \frac{PA_{max}}{PA_{max}-EA_{min}} \cdot \frac{V_{max}}{V_{mean}} \cdot C_p \qquad (4)$$

The input and output parameters of this model, and also the water renewal time:

$$T_r = V_{max}/(PA_{max}-EA_{min}) \qquad (5)$$

are given in Table 7.

The model can be calibrated on Gerritsfles, Kliplo, and Tongbersven-West, because these pools are known to be isolated from the regional groundwater table. For Tongbersven-West a modification is necessary, because of the uncertainty in the thickness of the sediment and the presence of a

Table 6

Normal amount of precipitation (P) and open water evaporation, according to the Penman formula, (E_o) in mm a^{-1} for nearest climatological stations to the pools over the period 1951-1980 (Anonymus 1982).

Pool	Precipitation station		P	Evaporation station		Eo
Kliplo	Dwingeloo		821	Eelde	632	
				Twente	622	
						627
Gerritsfles	Kootwijk		853	Deelen		662
Achterste Goorven	Tilburg	735		Gilze-Rijen	685	
	Boxtel	743		Eindhoven	690	
			739			688
Tongbersven-West	Boxtel		743	Gilze-Rijen	685	
				Eindhoven	690	
						688
Groot Hasselsven	Leende		753	Eindhoven		690

Table 7

In- and output parameters of the hydrological model.

Parameter	A. Goorven	Gerritsfles	Kliplo	Tongbersven-W.
A_{max} $(m^2)^a$	25000	69900	6300	4599
A_{min} $(m^2)^a$	22200	63800	5800	4070
V_{max} $(m^3)^a$	17170	52300	5900	1816
V_{mean} (m^3)	14500	45800	5100	1365
P (m)	0.739	0.853	0.821	0.743
E $(m)^b$	0.688	0.662	0.627	0.592
C_p $(mol\ m^{-3})^c$	0.069	0.084	0.090	0.069
C_e $(mol\ m^{-3})$	0.47	0.33	0.35	0.31
C_m $(mol\ m^{-3})$	0.44	0.27	0.33	0.25
T_r (a)	5.4	3.0	3.8	1.8

[a] V_{mean} from Table 4. A_{min}, A_{max} and V_{max} calculated from Figs. 10 and 11, using mean lowest and mean highest water levels in the periods 1979-85 (Achterste Goorven, Gerritsfles) and 1982-85 (Kliplo). For Tongbersven-West the lowest and highest water levels over the period 1983-84 were taken from Oostveen (1985). See further text.

[b] $E = E_o$ (Table 6), except for Tongbersven-West, where $E = 0.86E_o$ (see text).

[c] Mean over 1982-84 in precipitation collectors near pools (H.F. van Dobben, pers. comm.).

quaking bog. Oostveen (1985) estimates the volumes of the mud layer and the quaking bog to be 1680 and 1779 m^3 respectively. According to Vegt (1978) the water storage capacity (s) of a peatmoss dominated quaking bog is c. 0.4. Thus the volumina of Tongbersven-West (Table 5) have to be reduced with (1680 + (1-0.4) x 1779) m^3 before the model can be applied. Another correction is for the evaporation of the quaking bog, which differs from an

Table 8

Sensitivity analysis of estimated chloride concentrations (C_e) $(mol\ m^{-3})$ and water renewal times (T_r) against difference between annual precipitation and evaporation of an open water surface (P-E) and storage capacity of quaking bog (s).

			P-E				
		s	0.05	0.10	0.15	0.20	0.25
A. Goorven	C_e	1.0	0.48	0.35	0.28	0.23	0.17
	T_r	1.0	5.4	4.0	3.2	2.6	2.0
Gerritsfles	C_e	1.0	0.68	0.49	0.39	0.32	0.27
	T_r	1.0	6.2	4.5	3.5	2.9	2.4
Kliplo	C_e	1.0	0.77	0.54	0.42	0.34	0.29
	T_r	1.0	8.4	6.0	4.6	3.8	3.2
Tongbersven-W	C_e	0.6	0.30	0.25	0.22	0.19	0.18
	T_r	0.6	2.2	1.8	1.6	1.4	1.3
	C_e	0.4	0.32	0.26	0.23	0.20	0.18
	T_r	0.4	1.8	1.5	1.4	1.2	1.1
	C_e	0.2	0.29	0.24	0.21	0.18	0.17
	T_r	0.2	2.5	2.1	1.9	1.6	1.5

open water surface. A reasonable estimate for the evaporation coefficient of quaking bog surfaces is c. 0.8 (Vegt 1978, Bakker 1984 and literature cited herein). This is similar to the evaporation coefficient of the wet forest plots, which do occur in small patches of the quaking bog. As there is c. 1300 m^2 of open water and c. 3200 m^2 of quaking bog in the pool the mean evaporation coefficient is 0.86. Thus the effective evaporation for Tongbersven-West is 0.86 E_o = 0.86 x 0.688 m = 0.592 m.

The model is sensitive to changes in the values of the input parameters. In Table 8 the sensitivity to changes in the effective precipitation and the storage capacity of the quaking bog (Tongbersven-W. only) is shown. It appears that comparatively small changes in the effective precipitation can have considerable effects on the calculated concentration of chloride. As the evaporation was not measured in situ, but estimated from data from stations some tens of kilometres away, this is a weak point in our calculations. Another weak point is the calculation of volumes at different levels. Three of the four pools were surveyed at a moment when water level was rather low and the volumes at mean and mean maximum level had to be extrapolated. Especially for the large pool Gerritsfles, with its very gently sloping bottom, this is tricky. Furthermore, chloride concentrations from only one station in each pool were used and there may be spatial variation in each pool. Also an infinitesimal model would be more precise than a discrete model.

Nevertheless our observations allow the conclusions that the chloride concentration of Achterste Goorven corresponds well with that of an isolated pool of similar shape and size. It is conceivable that this pool is not fed by groundwater influx. This is not accordance with the conclusions of Ter Hoeve (1949) who studied the regional groundwater pattern in the area of the pools near Oisterwijk. He supposed that the bottom of Achterste Goorven is moderately to strongly permeable.

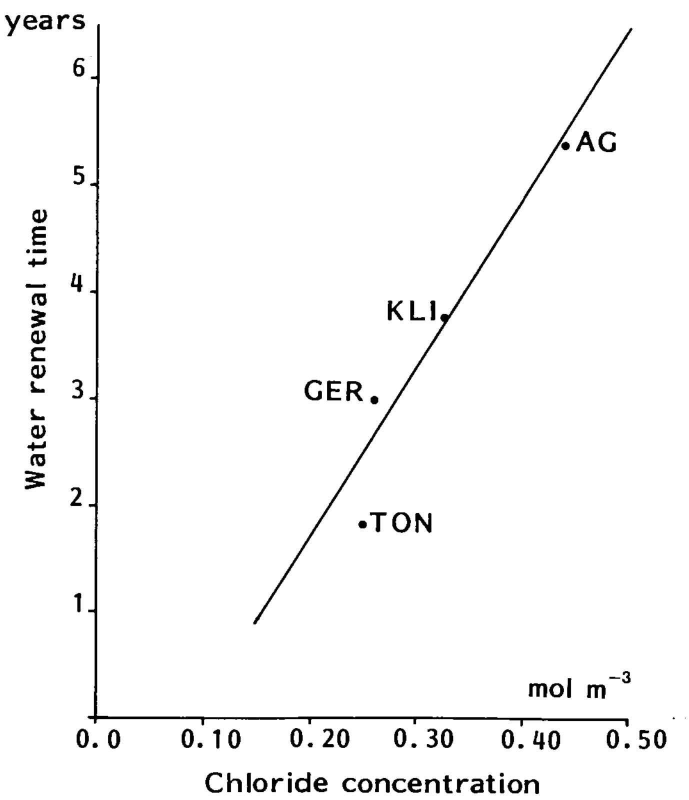


Fig. 20

Relationship between water renewal time and chloride concentration (T_r = 17.1 Cl^- - 2.0, r = 0.97, $p \leq 0.05$).

As no morphological data of Groot Hasselsven are available the water renewal time cannot be calculated with the model. Fig. 20 the relationship between the chloride concentration in 1983-84 and the calculated water renewal time. As the mean chloride concentration of Groot Hasselsven over this period was 0.22 mol m^{-3} the water renewal time is probably c. 1.7 years.

3.3.2 Fluctuations of the water table

Achterste Goorven

Regular observation of the water level at station B was started in October 1979. Records were made each month until June 1980 and quarterly since then. The results are presented in App. 8 and Fig. 21. The mean quarterly level over the period November 1979-February 1985 was 8.34 m + NAP. The annual amplitude (only 4 observations each year) is usually less than 0.3 m. Large fluctuations, especially during periods with a high net precipitation, are softened by the presence of an outlet to Voorste Goorven, which is effective at water levels above 8.28 m + NAP (= 0.06 m below mean water level).

The outlet is a culvert with a diameter of c. 0.2 m through the dam which separates the pool from Voorste Goorven. Formerly the outlet existed either as a culvert or as a small ditch, but did not always function properly (Heimans 1925, Koster 1942, Van Dijk et al. 1948, Glas 1957).

Van Dijk et al. (1948) draw in their map also a small ditch, connecting the Diepven with Achterste Goorven with basin I (Fig. 9) of Achterste Goorven. This connection presently does not exist; no traces are left in the field and its former presence may be wondered, because the water level of Diepven is 8-10 dm higher than that of Achterste Goorven. Apparently Diepven has a perched water table and a ditch to Achterste Goorven would have drained Diepven for the largest part.

The three pools forming basin IV and V (Fig. 8), are interconnected by ditches and drain into basin III of Achterste Goorven by a man-made ditch too.

No exact records exist about water levels in the past. However, Schuiling & Thijsse (1928) mention that during the dry summer of 1911 and more strongly during the extremely dry summer of 1921 (De Bruin 1979) large parts of the pools near Oisterwijk dried up. Still in the summer of 1922 the water level was very low. In pools which were exposed to wind the bottom was blown away partly. On a photo of Achterste Goorven in Zoetmulder (1922), which was very probably taken in the summer of 1921 the water level is c. 0.5 m lower than the present mean water level. According to the unpublished notes of Heimans it was possible to walk right across the pool in August 1921. Thus the water level was probably 0.7-0.8 m lower than the present mean level (Fig. 8).

During the extremely dry summer of 1976 (Schuurmans 1977) I was privileged to follow the footsteps of my highly esteemed predecessor.

From the hypsographic curve (Fig. 12) it appears that in extremely dry years as 1921, 1959 and 1976, when the water level will be c. 0.7 m below the mean water level, the area of the pool is reduced to c. 25% of its area at mean water level. In the eastern basins, the shallowest ones, this proportion will be even lower. The volume will be reduced to only c. 10% of the normal volume (Fig. 11).

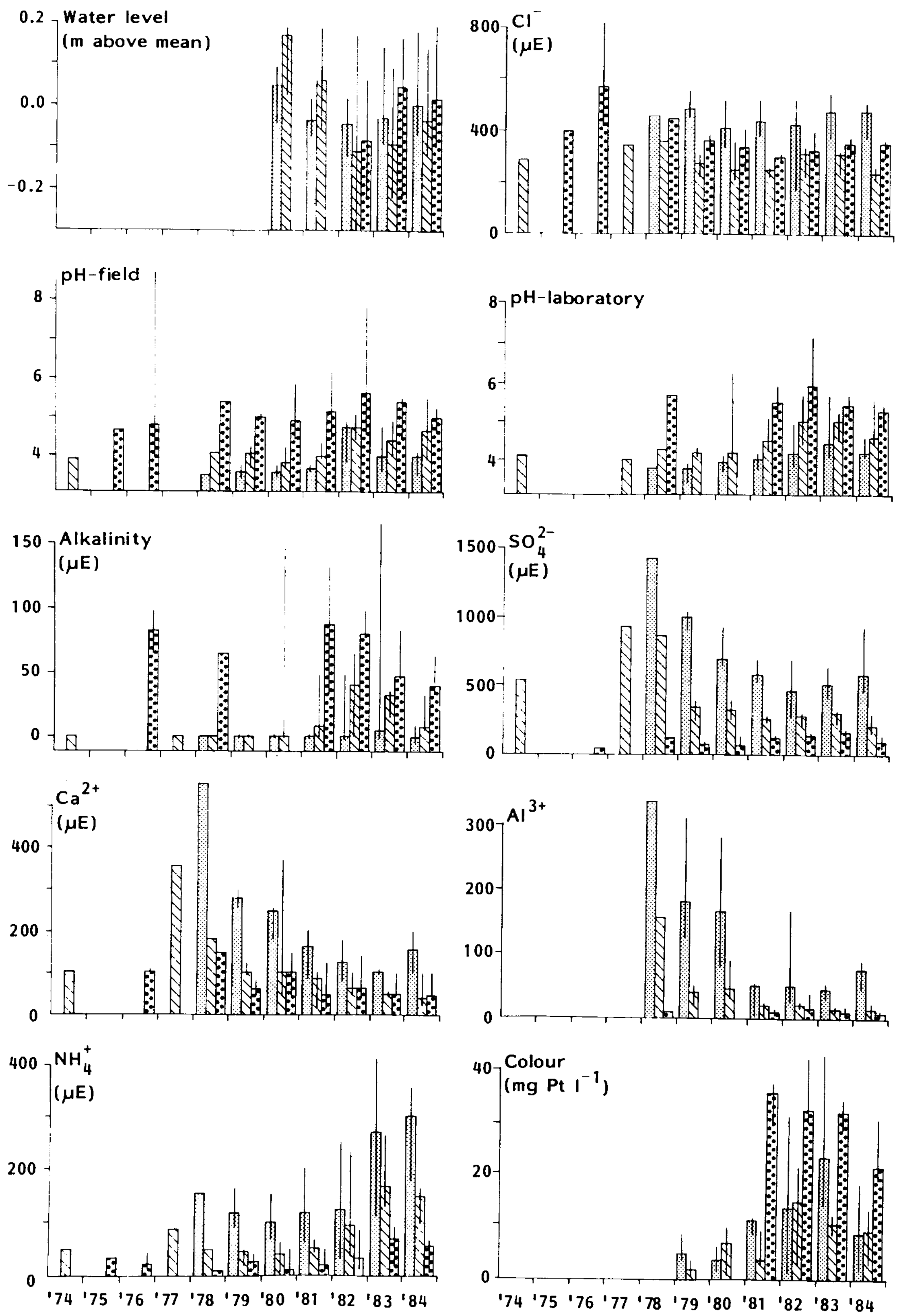


Fig. 21. Changes in median annual values (bars) and intervals (lines) of selected physical and chemical parameters in Achterste Goorven (station E) (finely dotted bars), Gerritsfles (hatched bars) and Kliplo (coarsely dotted bars) from 1974 through 1984.

Gerritsfles

Regular observation of the water level was started in October 1979. Records were made each month until June 1980 and quarterly since. The results are presented in App. 11 and Fig. 21. The mean quarterly level over the period November 1979-February 1985 was 39.91 m + NAP. The annual amplitude in 1980 and 1981 was c. 0.15 m. In the dryer years 1982 and 1983 the amplitude was much larger (nearly 0.5 cm).

Schimmel & Ter Hoeve (1952), who give a thorough description of the hydrology of the pool, which is c. 15 m above the regional groundwater table, recorded the water level at four different occasions between August 1947 and February 1951. In August 1947, during a rather dry summer (De Bruin 1979, Schuurmans 1976) the water level was 39.50 m + NAP. This is 0.30 m lower than the mean August level from 1980 to 1984 and 0.11 m lower than the lowest level which was recorded during our observation period (November 1982). According to Fig. 12 c. 20% of the bottom area of the pool was exposed to the atmosphere at that moment, while the pool had only 45% of its mean volume (Fig. 13). On February 7, 1951 Schimmel & Ter Hoeve recorded 40.35 m + NAP, which is 0.33 m higher than the average February level in our observation period and 0.25 m higher than the maximum level we recorded (February 1980). The mean of these two extreme values from Schimmel & Ter Hoeve is 39.93 m + NAP and close to the mean level of 39.91 m + NAP over the period November 1979-February 1985. On September 1, 1949 the level was 39.71 which is not far from the average August 1979 - 1984 level. Thus on the long run, no serious changes in the water level of Gerritsfles seem to have occurred.

Kliplo

Quarterly observation of the water level started in February 1982. The results are presented in App. 12 and Fig. 21. The mean level over the observation period was 12.98 m + NAP. The mean annual amplitude was 0.34 m.

In the northwestern corner of the pool, 10 m northeast of the small island, the pool has a protuberance, which is the remnant of an old ditch. The treshold of this ditch is at c. 13.33 m + NAP, which is 0.19 m higher than the maximum level that was recorded. It cannot be excluded that occasionally this ditch acts as an overflow.

According to Beijerinck (1926) Kliplo is constantly filled with water. In recent dry years a large part of the bottom was still covered with water. In the extremely dry year 1959 people did still bath when the water attained its lowest level (P. Kerssies, pers. comm.). On August 10, 1976 Mr. H.van der Putten observed that the pool was still deeper than 0.5 m (B. Hoentjer, pers. comm., see also Van Gijsen & Claassen 1978). As the maximum depth at mean water level is 1.14 m (Table 4) the water level during these episodes was approximately 0.5 m below the mean water level. According to Fig. 12 the area at that level is still 80% of the mean area of the pool. The volume is reduced to 40% of the volume at mean water level (Fig. 13). As the mean chloride concentration is 327 mmol m^{-3} (Table 17) the expected concentration at this volume is 818 mmol m^{-3}. The concentrations on 760823 and 761006 were 621 and 818 mmol m^{-3} respectively (App. 12). This corroborates the observation of the water level in August 1976.

Tongbersven-West

Fortnightly observations of the water level were carried out by Oostveen (1985) from July 1983 until July 1984. The mean level was 8.17 m + NAP, the minimum level (8.01 m + NAP) was attained at 830902, the maximum level (8.31 m + NAP) at 830614, before the fortnightly observations started.

No data about water levels in the past are available.

Groot Hasselsven

Fortnightly observations of the water level were carried out by Oostveen (1985) from June 1983 until July 1984. The mean level was 26.27 m + NAP, the minimum level (25.98 m + NAP) was attained at 831111, the maximum level (26.50 m + NAP) at 830615.

On the manuscript of the chromotopographical map scale 1 : 25000 from 1835 (Topographical Survey, Emmen) the surface area of the pool is considerably larger than in recent years. On the topographical maps 1: 25000 from 1898 and 1927 the area of the pool is c. three times as large as the present one, which indicates a higher water table in the past. On the maps surveyed in 1950 and 1961 the area of the pool is c. one fourth of the area on the map from 1970.

The pool desiccated in the dry summer of 1973. The bottom was heavily cracked (Iven & Van Gerwen 1974). It is evident that the pool also dried up in the extremely dry summer of 1976.

3.4 CHEMISTRY

3.4.1 Comparison of methods

As already stated in section 2.4 samples were analysed by two laboratories. Chemical samples for long-term monitoring in the pools Achterste Goorven, Gerritsfles and Kliplo were analysed by the "Waterleidingbedrijf Midden-Nederland" (WMN). Samples for short-term monitoring in Gerritsfles, Kliplo, Tongbersven-West and Groot Hasselsven were analysed by the Department of Soil Science and Geology of the Agricultural University (LUW).

Thus for Gerritsfles and Kliplo parallel series were available for comparison. Sampling stations of LUW were close to the permanent stations of the long-term series (Figs. 15, 17). The samples of both series which are compared in Table 9, were taken about the same days. Moreover, eight parallel samples from other pools are available for comparison. These samples were taken at the same moment from the same bucket.

In Table 9 the average values for the three groups of samples for both laboratories and the grand mean of all samples for each parameter are given. Results of regression analysis for two models are given in Table 10.

No appreciable differences are found for pH1, EC251, sodium, potassium, calcium, magnesium, aluminium, manganese, and chloride in mean values for all pools, although considerable differences are sometimes found between individual samples, especially for aluminium.

As a whole the mean values for iron correspond well, but in Gerritsfles and Kliplo the LUW values are much smaller than the WMN values, while the reverse is true for the other pools.

In the LUW sample from Achterste Goorven E very high values are found for some of the parameters which are not very deviating in other samples

Table 9

Comparison of chemical data from Agricultural University, Department of Soil Science and Geology (L) and "Waterleidingbedrijf Midden-Nederland" (W). ? : apparently erroneous data, excluded from calculation of mean values and regression analysis, ! : outlier, excluded from regression analysis.

POOL	WDATE	LDATE	WCOLOR	WKMNO4u	LDOC	WSIO2	LSIO2	WEC251	LEC251	WpHf	LpHf	WpH1	LpH1	WCO2	LCO2	WNA	LNA	WK	LK	WNH4	LNH4
-	-	-	mgPt/l	mg/l	.....mmol m^{-3}....			mS/m	mS/m	-	-	-	-	...............mmol m^{-3}............							
G	830517	830527	11	18	412	8	0	8.0	7.9	4.1	4.50	4.8	4.3	91	75	174	176	23	20	133	143
G	830817	830819	12	30	585	22	6	9.7	9.0	4.0	4.55	4.5	4.7	136	0	239	213	33	33	155	172
G	831116	831118	9	29	656	5	1	9.6	8.4	4.9	5.35	5.2	5.3	114	222	261	211	38	31	261	278
G	840216	840217	14	20	357	3	1	5.9	6.3	5.1	4.85	5.6	5.0	136	44	174	183	28	27	161	192
G	840518	840517	10	21	1874	13	1	7.3	5.5	5.5	5.55	4.6	5.4	114	461?	174	170	26	27	155	195
G	840814	840817	9	18	617	13	6	7.6	8.1	3.9	5.15	4.5	4.5	114	82	196	187	26	29	144	146
G	841113	841114	3	8	1169	5	1	6.9	6.1	4.4	4.40	4.4	4.6	114	66	174	161	18	8	94	142
K	830517	830527	34	50	1089	1	0	6.3	5.5	5.3	-	5.4	4.7	136	295	239	241	26	22	47	76
K	830817	830818	41	80	1062	13	7	6.6	7.1	4.4	-	5.2	5.2	204	196	261	243	26	26	19	6
K	831115	831125	32	50	1387	3	1	6.4	6.8	5.5	-	5.7	5.7	159	212	261	317	36	31	94	38
K	840216	840217	31	42	735	2	1	6.5	6.4	4.6	-	5.3	5.8	182	229	261	257	33	41	72	90
K	840518	840517	22	55	1285	30	1	6.4	6.3	5.2	-	4.8	5.8	136	165	261	267	36	41	36	74
K	840814	840817	21	55	1029	25	5	5.7	5.9	4.8	-	5.2	5.3	227	140	261	250	23	23	6	4
K	841113	841114	19	38	649	13	1	5.4	5.9	5.2	-	5.3	5.6	136	86	261	243	28	28	17	33
D	820929	820929	43	50	1540	17	15	8.6	8.3	4.5	-	4.4	4.8	409	107!	304	303	64	65	67	111
P	820929	820929	44	85	1970	1	6	6.4	6.4	4.5	-	4.5	4.7	295	177!	283	302	56	54	4	39
Z	820929	820929	85	70	1540	50	46	8.0	8.0	5.4	-	5.5	5.4	114	100!	326	324	61	67	155	150
H	821001	821001	2	4	190	1	9	12.6	13.0	3.9	-	4.1	3.8	159	59!	304	293	36	41	6	79
M	821001	821001	80	120	1920	83	66	5.2	5.3	4.4	-	4.7	4.9	227	78!	174	217	36	42	14	107
S	821001	821001	4	6	460	17	19	5.3	5.2	4.3	-	4.5	4.1	227	138!	130	156	10	14	3	41
W	830126	830126	4	11	170	1	16	12.6	12.5	4.2	-	4.4	4.0	295	138!	217	200	23	20	25	43
E	830818	830818	43	50	807	47	90	11.0	12.7	3.9	-	4.4	6.8?	204	38!	326	359	38	43	111	80
Mean Gerritsfles (MG)			10	21	810	10	2	7.9	7.3	4.6	4.91	4.8	4.8	117	82	199	186	27	25	158	181
Mean Kliplo (MK)			29	53	1034	12	2	6.2	6.3	5.0	-	5.3	5.4	169	189	258	260	30	30	42	46
Mean other pools (MO)			38	50	1075	27	33	8.7	8.9	4.4	-	4.6	4.5	241	104	258	269	41	43	48	81
Grand mean (GM)			26	41	977	17	13	7.6	7.6	4.6	4.91	4.9	4.9	179	120	239	240	33	33	81	102

Pool	WCA	LCA	WMG	LMG	WAL	LAL	WFE	LFE	WMN	LMN	WALK	LHCO3	WCL	LCL	WSO4	LSO4	WNO3	LNO3	WH2PO4	LH2PO4	Name of pool
-	....................................(equivalent) mmol m^{-3}..																				
G	50	95	49	37	11	15	20	23	2	3	33	1	240	304	250	267	16	0	0.05	0.0	Gerritsfles
G	50	80	58	61	20	35	26	29	2	3	16	1	296	320	291	317	5	0	0.42	0.5	Gerritsfles
G	50	33	58	45	14	13	16	66	2	3	33	17	310	321	291	294	5	1	0.05	0.4	Gerritsflea
G	50	13	41	41	10	2	12	21	1	2	33	10	226	254	167	213	8	15	0.11	0.0	Gerritsfles
G	25	50	41	33	10	16	9	90	1	1	8	45	240	256	312	81?	8	1	0.05	0.5	Gerritsfles
G	15	48	49	49	16	16	20	41	2	2	8	1	254	239	208	263	5	1	0.05	0.4	Gerritsfles
G	100	30	41	49	26	12	3	24	1	2	8	1	212	202	208	229	10	1	0.21	0.5	Gerritsfles
K	50	23	58	57	12	22	46	48	-	4	49	6	310	299	167	133	11	0	0.11	0.0	Kliplo
K	100	70	74	66	12	0	91	54	4	4	49	12	324	307	146	96	1	0	0.11	0.0	Kliplo
K	50	-	74	74	20	24	64	69	4	2	82	41	339	400	83	115	5	1	0.21	0.5	Kliplo
K	50	48	74	70	11	5	19	84	3	4	33	56	339	344	146	97	6	1	0.11	0.0	Kliplo
K	50	88	66	70	7	7	35	89	2	3	66	40	353	324	-	87	3	2	0.05	0.3	Kliplo
K	50	75	66	70	9	4	32	39	4	4	33	11	339	309	42	76	3	1	0.05	0.4	Kliplo
K	100	70	58	66	13	33	18	42	3	6	49	13	296	371	104	57	3	6	0.11	0.5	Kliplo
D	75	65	99	92	26	11	54	38	1	4	1	3	367	372	271	227	3	5	0.32	1.3	Diepveen
P	50	32	74	66	10	16	51	44	1	4	1	3	324	313	187	107	5	5	0.21	2.3	Poort 2
Z	50	39	58	49	19	7	419!	221!	1	4	66	10	381	394	229	171	5	5	1.37	1.5	Echtenerzand
H	200	142	156	152	43	29	8	6	4	4	0	1	353	349	521	475	2	5	0.05	0.8	Groot Huisven
M	125	95	58	51	23	11	91	53	3	4	33	2	240	254	208	100	8	5	0.05	1.5	Mid. Wolfsputven
S	100	104	49	55	10	4	35	6	3	4	1	2	169	186	187	147	2	5	0.05	0.5	Schaapsven
W	299	297	90	93	211!	303!	3	2	8	6	0	2	254	264	708	732	29	45	0.05	0.5	Deelenache Wasch
E	100	340?	90	172?	39	25	150	62	2	1	8	117?	494	523	437	282	3	59?	0.21	0.6	Acht. Goorven E
MG	48	50	48	45	15	16	15	42	2	2	20	11	254	271	247	264	8	2	0.14	0.3	Gerritsfles
MK	64	62	67	68	12	14	44	61	3	4	52	26	328	336	115	95	5	1	0.11	0.2	Kliplo
MO	125	111	84	80	48	51	101	54	3	4	14	18	323	332	346	280	7	11	0.29	1.1	Other pools
GM	81	75	67	64	26	28	56	52	3	3	28	18	303	314	246	214	7	5	0.18	0.6	All pools

e.g. pHl, calcium and magnesium. Presumably this sample was stored too long in the LUW laboratory before the analysis started.

The LUW values for ammonium and phosphate are nearly always higher than the corresponding WMN values. The grand mean of ammonium in the LUW samples is 26% higher than the mean of WMN. The relative difference varies between 10 and 69% for each of the three groups. Phosphate is 2-4 times higher in the LUW- than in the WMN samples. However, this ion is unimportant in ionic balances.

Hydrogen bicarbonate is often higher in the WMN samples than in the LUW samples. This is caused by a difference in methods. The WMN uses an alkalinity titration and supposes all the alkalinity to be present as hydrogen bicarbonate. Sometimes a part of the weak organic acids is also

Table 10

Regression analysis of chemical data from WMN and LUW.

	Model 1[a]			Model 2[b]		r^c
Parameter	Intercept	Slope	%var[d]	Slope	%var[d]	
SIO2	-2.34	0.926	62	0.868	63	0.80
EC251	-2.04	1.019	91	0.994	91	0.96
pH1	0.76	0.853	44	1.008	45	0.68
CO2[e]	29.2	0.760	3	0.949	11	0.34
NA	10.2	0.959	83	1.000	83	0.91
K	-2.05	1.075	91	1.021	91	0.95
NH4	30.9	0.877	79	1.098	71	0.89
CA	8.2	0.815	75	0.877	76	0.88
MG	0.07	0.967	94	0.968	94	0.97
AL	-9.67	1.437	96	1.332	94	0.98
AL[e]	6.08	0.496	19	0.769	14	0.48
FE	28.6	0.423	66	0.573	39	0.82
FE[e]	36.0	0.201	4	0.716	-	0.29
MN	2.22	0.433	25	1.047	19	0.54
ALK/HCO3	4.41	0.309	16	0.399	17	0.45
CL	22.2	0.964	85	1.034	85	0.93
SO4	-12.3	0.957	87	0.921	88	0.94
NO3	-3.07	1.163	52	0.912	52	0.73
H2PO4	0.43	0.902	15	1.618	-	0.43

[a]LUW = Intercept + Slope x WMN.

[b]LUW = Slope x WMN.

[c]Product-moment correlation coefficient.

[d]Percentage variance accounted for (- = residual variance exceeds variance of LUW).

[e]After removal of outliers.

Table 11

Comparison of charge balances from Agricultural University, Department of Soil Science and Geology (L) and "Waterleidingbedrijf Midden-Nederland" (W).

Pool	Gerritsfles		Kliplo		Other pools		All pools	
Laboratory	W	L	W	L	W	L	W	L
H	19	21	7	6	36	56	17	27
NA	199	186	258	260	258	269	239	240
K	27	25	30	30	41	43	33	33
NH4	158	181	42	46	48	81	81	102
CA	48	50	64	62	125	111	81	75
MG	48	45	67	68	84	80	67	40
AL	15	16	12	14	48	51	26	28
FE	15	42	44	61	101	54	56	52
MN	2	2	3	4	3	4	3	3
SUM CATION	531	568	527	551	744	749	603	600
WALK or LCO3	20	11	52	26	14	18	28	18
CL	254	271	328	336	323	332	303	314
SO4	247	264	115	95	346	280	246	214
NO3	8	2	5	1	7	11	7	5
H2PO4	0	0	0	0	0	1	0	1
ORGANION	(40)	40	(54)	54	(53)	53	(49)	49
SUM ANION	569	588	554	512	743	695	633	601
d[a]	-0.03	-0.02	-0.02	0.04	0.00	0.04	-0.02	0.00

[a]d = (SUM CATION - SUM ANION)/(SUM CATION + SUM ANION).

titrated by this method. However, this is not always true, because the highly stained samples from the pools D and P for instance have negligible bicarbonate concentrations. In the LUW samples bicarbonate was calculated from total inorganic carbon determinations.

For CO_2 large differences are found between individual samples, although the average values for Kliplo and Gerritsfles correspond reasonably well. In the other pools, however, LCO_2 is as an average only 43% of WCO_2. This might be caused by the fact that these samples were in a batch that was analyzed immediately after sampling in the WMN laboratory, but had some delay in the LUW laboratory.

In Table 11 ionic balances from samples of both laboratories are compared. The concentration of organic acid (ORGANION) was calculated by the formulas of Oliver et al. (1983) from DOC, assuming a weak acid contribution of organic carbon of 5.5 meq/g C (Henriksen & Seip 1980).

It appears that the analyses of both laboratories generally deviate less than a few percents of the situation where the cation sum is equal to the anion sum, and thus are of good quality.

3.4.2 Long-term changes

The chemical data for the period 1919-85 are presented in App. 8-10 (Achterste Goorven), 11 (Gerritsfles), and 12 (Kliplo). The pH measurements by Glas (1957, 1958) and Moller Pillot (1958) were performed with pH-indicator paper (H.K.M. Moller Pillot, pers. comm.). These are not included in this report, because indicator paper method gives unreliable results in weakly buffered waters.

Only for pH enough data are present for statistical comparison between different periods. The results are given in Table 12.

Median pH values, instead of average values, for each period are calculated for two reasons. Firstly there is controversy in the literature about calculation of average pH values: as arithmetic or as geometric means (Barth 1975, Middleton & Rovers 1976, Sheridan 1976, Eralp & Thomson 1978). In our case, however, all three measures of location give nearly identical results and do not differ more than 0.2 pH unit. Secondly the median is a non-parametric statistic, which allows us to apply non-parametric tests, e.g. the Mann-Whitney-U test or Wilcoxon two-sample test (Sokal & Rohlf 1969) to test the significance of differences between the periods of sampling.

For all stations where pH measurements in the period 1939-30 are available, the pH dropped significantly from this period to 1978-85 (Table 12). Also significant are the differences between the periods 1919-30 and 1950-60 in Gerritsfles and 1919-30 and 1970-76 in Kliplo. The pH drop is largest in Achterste Goorven (2.1 and 1.8 on stations B and E respectively) and smallest in Kliplo (0.8). Gerritsfles is intermediate with a decline of 1.2 units.

The measurements before 1965 were made by colorimetric methods. After 1965, electrometric methods were generally used. Colorimetric measurements can easily give errors in the magnitude of 1 pH unit in weakly-buffered low alkalinity waters (Haines et al. 1983, Blaker & Digernes 1984). But also the electrometric measurements of pH in low alkalinity waters is subject to considerable errors. Although the instructions of the manufacturers were carefully followed and electrodes were calibrated with buffer solutions of pH 7 and pH 4, particularly at pH values below 4 errors were made with the measurement in the field. Sometimes values below 3 were read from the display. A test with a buffer solution of pH 3 gave incorrect values in such cases and the electrode had to be discarded. Also Covington et al. (1985) and Neal & Thomas (1985) report about the inaccuracy of electrometric determination of pH in dilute waters. Errors in the mangnitude of 0.7 pH unit were observed.

It may be concluded that the data indicate acidification of the pools Achterste Goorven, Gerritsfles, and Kliplo over the last sixty years, but

Table 12

Comparison of pH (measured in the field) in four different periods[a].

		A. Goorven A	A. Goorven B	A. Goorven E	Gerritsfles	Kliplo
1919-1930	median	-	6.0	5.7	5.5	6.0
	range	-	5.5-6.6	5.4-6.0	5.5-6.5	6.0-6.5
	n	-	3	2	9	3
1950-1960	median	5.2	-	-	4.1b	5.2
	range	-	-	-	4.0-4.1b	5.2-5.2
	n	1	-	-	2b	1
1970-1976	median	-	3.5	-	3.9	5.6
	range	-	-	-	-	3.9-8.8
	n	-	1	-	1	10
1978-1985	median	4.1	3.9	3.9	4.3	5.2
	range	3.3-5.0	3.3-4.9	3.4-5.6	3.9-5.5	4.1-7.8
	n	18	19	19	17	24

[a]Differences between the first and last period on all but the first sampling stations are significant with $p \leq 0.02$ (Wilcoxon two-sample test, two-tailed). Other significant differences are in Gerritsfles between first and second period ($p \leq 0.02$) and in Kliplo between first and third period ($p \leq 0.02$).

[b]1 measurement (1950) in field, 1 measurement (1960) in laboratory.

the absolute decrease of the pH is still uncertain.

For other chemical parameters fewer data are available, which do not allow statistical analysis. From Achterste Goorven station B (App. 9) a sample is available from November 1919 (taken under a thin layer of ice). Iron, manganese, ammonium and phosphate are present in much lower concentrations in this sample than in any of the recent (1975-78) samples. Especially for the latter two parameters these differences may be a consequence of less sensitive detection methods in the past. Alkalinity was 149 mmol m^{-3} in the old sample and is absent in each of the recent samples. Sulfate was found with a concentration of 208 equivalent mmol m^{-3} in 1919, 458 in 1975 and 729-1645 mmol m^{-3} in 1979-85. The increase is evident.

Table 13 is an extract of App. 11 and summarizes the measurements of some selected parameters from Gerritsfles. The pH, measured in the field, declines significantly over the last 60 years, as was already demonstrated in Table 12. In contrast, the pH, measured in the laboratory, has been fairly stable over the same period. The single measurements of ammonium in 1925 and 1930 were much lower than the average value in 1979-85, but in the latter period single measurements with similar low values as in 1925 and

Table 13

Gerritsfles. Long-term changes in mean values of selected chemical parameters.

	pH-field	pH-lab.	NH_4^+	Cl^-	SO_4^{2-}	n
1925	-	4.4	0	395	354	1
1928	5.5	-	-	-	-	1
1930	5.8[a]	6.5	21	468	396	1
1950	4.0	-	-	395	-	1
1960	-	4.1	111	429	800[c]	1
1974	3.9	4.1	47	282	541	1
1977	-	4.0	89	339	916	1
1978	4.1	4.1	50	353	625	1
1979-85	4.4[b]	4.7	99	267	277	23

[a]n = 8, [b]n = 17, [c]inferred from correlation with Ca^{2+} en Mg^{2+}.

Table 14

Achterste Goorven. Average values of chemical and physical parameters for those data within the period 790710-850211 when simultaneous observations at the stations A, B, and E, were made.

	Station A	Station B	Station E	Number of observations
TEMP	12.8	12.9	12.0	30
O2	295	299	301	30
O2%	86	89	88	30
pHf	4.0	3.9	3.9	19
pHl	4.3	4.1	4.1	23
EC25f	17.4	19.1	17.8	30
EC25l	16.8	17.8	18.0	23
COLOR	4.2	4.3	5.2	9
KMNO4u	15.6	14.8	14.5	9
Cl	458	443	452	23
NO3	3.4	4.8	5.0	9
SO4	927	1041	947	9
ALK	8.2	0.0	0.0	9
CO2	457	520	507	9
CO3	0.0	0.0	0.0	9
H2PO4	0.07	0.09	0.09	9
t-PO4f	0.40	0.49	0.57	9
SIO2	7.4	12.1	13.9	9
NH4	166	167	152	9
NH4-org	16.1	19.6	20.3	9
FE	27	41	37	9
MN	5.2	5.0	3.9	9
AL	159	238	172	9
CA	205	198	206	18
MG	216	234	219	9
NA	361	372	372	9
K	46	53	52	9

1930 occurred regularly. Therefore no change of the concentration of ammonium can be assessed. The chloride concentration declined significantly ($p<0.01$, Wilcoxon two-sample test) between the periods 1925-50 and 1960-85. This is presumably caused by the separation of the Zuiderzee/ IJsselmeer from the Wadden Sea in 1932 and the commensurate decline of the salinity of the water in this area, which probably also affected the chloride content of the precipitation at Gerritsfles. The sulphate concentration in 1979-85 is in the same order of magnitude as in 1925 and 1930. The peaks in 1960 and 1977-78 will be discussed later.

Apart from the changes in field measured pH (Table 12) no long-term changes are apparent in Kliplo (App. 12). The peaks of total phosphate and phosphate are probably caused by differences in analytical methods of different laboratories. The high values of chloride (max. 818 mmol m^{-3}) in the extremely dry summer of 1976 (mean 1981-85 323 mmol m^{-3}) are due to concentration by evaporation (see also section 3.3).

3.4.3 Medium-term changes

Monthly sampling in Gerritsfles and Achterste Goorven (stations A, B and E) started in July 1979. As temporal changes were not extremely large, sampling frequency was reduced to four times a year in July 1980. Because the differences between the three stations in Achterste Goorven were small the full set of analyses was continued only at station E. At the stations A and B only pH, conductivity, oxygen, calcium, and chloride were monitored from August 1980 onwards. In August 1984 complete ionic balances were made on these two stations. Achterste Goorven E is fairly representative for the other stations in Achterste Goorven. Graphical analysis and Friedman two-way analysis of variance by ranks of each of the parameters listed in Table 14 reveal only differences in the concentrations of SiO_2 ($p<0.001$, minimal at station A and maximal at E) and the field measured conductivity ($p<0.02$, maximal at B). Quarterly sampling of Kliplo was started in May 1981. From all pools occasional samples were available from other sources since c. 1975.

The individual results are presented in App. 8-12. Summary statistics for individual pools are given in App. 15-17. The pools are compared with each other in Table 15. Nitrite is left out of the tables, because it was always below the detection limit (0.2 mmol m^{-3}). To assess trends Spearman rank correlatives were calculated over the observation period. The trends were also assessed from visual inspection of the plots of each of the parameters against time, because many of the parameters were not monotonously increasing or decreasing but had a minimum of maximum within

Table 15

Trends in chemical data from Achterste Goorven, Gerritsfles and Kliplo.

Parameter[a]	Achterste Goorven E (E) mean[b]	corr.[c]	trend[d]	Gerritsfles (G) mean[b]	corr.[c]	trend[d]	Kliplo (K) mean[b]	corr.[c]	trend[d]	order of stations
ALK	13	50	I since 82	24	37	I since 81	66	-42	(Max 81)	E<G<K
pHf	4.1	39	I since 82	4.4	10	I since 81	5.3	-18	C	E<G<K
pHl	4.2	77	I since 81	4.7	42	I since 80	5.5	-39	D since 83	E<G<K
(NA+K)/CA+MG)	1.32	55	I	1.9	64	I	2.25	-11	C	E<G<K
H2PO4	0.19	15	C	0.27	-31	D since 81	0.40	-69	D since 81	E≤G<K
t-PO4f	0.87	-3	C	1.0	-29	Max 80-83	1.2	-76	D since 81	E≤G<K
MN	3.0	-72	D	3.1	-72	D	3.8	-43	D since 81	E=G≤K
NO3	4.4	-14	C	7.5	13	(I)	7.1	-33	C	E<K≤G
O2%	87	-36	(D)	102	-21	C	89	-46	(D since 82)	E=K≤G
COLOR	12.8	-35	Max 82-83	8.6	36	Max 83-84	30	-65	D since 81	G<E<K
KMNO4u	32	33	(I)	21	16	(I since 80)	51	-4	C	G<E<K
NH4-org	22.2	-33	C	20.2	-15	C	28.8	-52	Max 82	G<E<K
NA	323	-39	D	210	-26	D	260	14	C	G≤K<E
CL	423	8	C	267	-15	C	323	19	C	G<K<E
FE	53	14	Max 83	17	18	C	51	-53	D	G<K<E
SIO2	31	69	I	8.9	-26	C	10	40	I since 81	G<K<E
CO2	386	-40	D	154	-56	D	163	51	I since 81	G≤K<E
CO3	13	36	C	0	0	C	0	0	C	G=K<E
EC25f	16.9	-51	D	8.7	-9	D	6.4	38	C	K<G<E
EC25l	15.6	-42	D	8.1	-28	D	6.1	11	C	K<G<E
IR	0.26	-61	D	0.22	-60	D	0.17	-9	C	K<G<E
SO4	620	-58	D	277	-45	D	130	-22	C	K<G<E
AL	89	-46	D	24	-57	D until 82	2.7	-32	Max 82	K<G<E
CA	158	-58	D	82	-68	D until 82	70	10	C	K<G<E
K	50	-69	D	41	-17	D	35	-49	Max 80-82	K<G<E
NH4	173	67	I since 82	99	78	I since 82	41	19	C	K<G<E
NH/(NH4+NO3)	0.97	54	I	0.88	56	Min 81	0.97	40	Min 80-82	K>G<E
MG	143	-64	D	67	-85	D	69	-14	C	K=G<E

[a] Classified according to ranking of sampling stations in last column.

[b] Calculated from quarterly observations from 790815-850212 in Achterste Goorven and Gerritsfles and from 810506-850212 in Kliplo.

[c] Spearman rank correlation coefficient (x 100) with time, calculated over the same period as the mean.

[d] Trend since 1979. For Kliplo no measurements of H2PO4, MN, COLOR, SIO2 and CO2 are available from before 1981. I = increase, C = constant, D = decrease, Min = minimum, Max = maximum. Parentheses indicate that trend is not very clear.

the period of observation.

On some of the sampling dates the pools were ice-covered. Depending on the condition of the ice layer the water chemistry was different from the expected one. If the ice was growing, often higher ion concentrations (and lower pH values) were met than were expected; if the ice was melting often lower concentrations (and higher pH values) were found than were expected (App. 10-17, Fig. 21). These interruptions do not seriously disturb the medium-term pattern of changes.

In Kliplo the changes are relatively small. Most striking are the decrease in colour (Fig. 21) and other parameters associated with humus (e.g. Fe^{3+} and $H_2PO_4^-$ since 1981). Also pHl is decreasing since 1983, but it is doubtful wether this drop is persistent. pHf did not change within the same period. Sodium and chloride had a maximum in the summer of 1976, when the water level in Kliplo was extremely low (see section 3.3.2). Sulfate and other parameters associated with acidification (e.g. aluminium and calcium) have been constantly low over the period of observation.

Although differing in some details the changes in Achterste Goorven and Gerritsfles are very similar. In these two pools, and particularly in the first one, highly elevated levels of sulphate, aluminium, calcium, magnesium, carbondioxide, conductivity, and even sodium and potassium were present in 1977-78. All these factors are known to be associated with acidification of moorland pools (e.g. Van Dam et al. 1981). For all these parameters, except sodium, Gerritsfles holds an intermediate position between Achterste Goorven and Kliplo. Since 1978 the values of these parameters have dropped. The decrease was most rapid in the few years after 1977-78 and much slower from c. 1981 onwards. Several parameters, e.g. aluminium and calcium did not decrease anymore after this year, particularly in Gerritsfles. Since c. 1981 pHf, pHl and alkalinity increase in both pools

(Fig. 21, App. 10, 11).

Both colour and potassium permanganate consumption, associated with the presence of organic matter, were very low during the first years after the drought of 1976, but increased after c. 1981 (Fig. 21, App. 10, 11). Ammonium increased in Gerritsfles and Achterste Goorven since 1982 (Fig. 20).

Changes in Kliplo are of minor importance when compared to those in the other two pools. In dry summers only a small fraction of the bottom of Kliplo is exposed to the atmosphere (section 3.3.2). The sediment is not aerated in such years and the reduction of sulphate can continue. As no strong acids are formed by oxydation of iron sulphides and reduced nitrogen compounds, no reduced levels of humic and fulvic acids, which is often seen in acidifying lakes (e.g. Almer et al. 1978, Dillon et al. 1984), occur and the pool is permanently stained brown. The sulphate concentration is kept low by sulphate reduction, which is a common process in the humic moorland pools in the province of Drenthe (Baas Becking & Nicolai 1934).

The chemistry of both Achterste Goorven and Gerritsfles is strongly influenced by the occurrence of extremely dry years like 1976 when respectively c. 75 and 50% of the bottom area of these pools was exposed to the atmosphere. The reduced sulphur compounds, that were accumulated in the bottom because of the high sulphur load in the decades before, oxidized and sulphuric acid was formed, which gave rise to high sulphate concentrations during refilling. Although the sulphate reducing bacteria deploy optimal activity in neutral and alkaline waters, significant activity has been observed in shallow acid natural waters with pH values in the open water down to below 4, and acid peat bogs. However, the pH of the interstitial water of the sediments is often 1-2 units higher than in the overlying water (Baas Becking & Nicolai 1934, Hemond 1980, Kelly & Rudd 1984, Baker et al. 1985, Carignan 1985). Thus after the drought-induced peaks the sulphate concentrations gradually decline by reduction. The sulphur is fixed in the sediments as iron sulphides and organic sulphur compounds. The concentrations in Achterste Goorven may be higher than in Gerritsfles because of the larger proportion of desiccated bottom and because of the much longer water renewal time of Achterste Goorven (Section 3.3.1). After a drop from 1977 onwards the sulphate concentration stabilized in 1980 in Gerritsfles and as late as 1982 in Achterste Goorven. It is important to note that sulphate reduction consumes strong acids and produces alkalinity.

The cations Al^{3+}, Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} have a similar pattern through time as sulphate and are known to be weathered at increasing rates from watersheds exposed to acidification (see Schnoor & Stumm 1985 for a review) and released from sediments of acidifying lakes by cation exchange (Oliver & Kelso 1983, Baker et al. 1985). Vangenechten et al. (1981) observed a similar pattern in the changes of major ion chemistry in Belgian moorland pools during refilling after the drought of 1976. Also in 1960, after the drought of 1959, the calcium and magnesium levels in Gerritsfles were as high as in 1977 (App. 11) and the inferred sulphate concentration was also similar to that of 1977 (Table 13).

The acidification process of lakes has been reported to inhibit breakdown of organic matter. Particularly when the pH falls below 5 the slower working fungi take over the role of the more rapid decomposing bacteria (Grahn et al. 1974, Francis et al. 1984, Rao et al. 1984). This was shown experimentally by Kelly et al. (1984). Indeed many moorland pools in The Netherlands had a bare sandy bottom until three decades ago (e.g. Redeke & De Vos 1932). A layer of organic detritus has developed since then. With the decline of the sulphate concentrations and concomitant increase of the pH since 1981 one would expect an increased decomposition of the organic sediment. This may be indicated by the increased colour and permanganate consumption since 1982 (Fig. 21, App. 10, 11).

The sediments are also the site for nitrogen metabolism. The concentration of inorganic nitrogen (nitrate, nitrite and ammonium) in the pools is considerably lower than would be expected from the composition of the precipitation (Section 3.4.5). Moreover nearly all nitrogen is present as ammonium (97% in Achterste Goorven and 88% in Gerritsfles, Table 15), while in the precipitation c. 65% is present as ammonium. Removal of nitrogen is possible by nitrification of ammonium and subsequent denitrification. Like sulphate reduction nitrification proceeds optimally in neutral or alkaline environments. Nevertheless, nitrification has been reported to occur in very acid (pH < 4) environments (Keeney 1973, Focht & Verstraete 1977, Van Breemen et al. 1982, Schindler 1985). Also denitrification is possible at low pH values when enough organic material is present (Keeney 1973, Focht & Verstraete 1977, Tiedje et al. 1982, Hemond 1983).

Nitrification of one mole of ammonia nitrogen produces two moles of protons, while denitrification of one mole of nitrate nitrogen consumes one mole of protons again and the net result is the production of one mole of protons, or a consumption of alkalinity. As ammonium and sulphate are present in about equivalent amounts in precipitation, the production of protons by ammonium removal matches the consumption of protons by sulphate reduction, at least in the long run. The denitrification of nitrate nitrogen, added by the precipitation will cause an extra consumption of protons.

The aquatic macrophytes probably play an important role in the nitrogen economy of moorland pools. As will be described in the Section 3.5 peat mosses and particularly Juncus bulbosus developed explosively in Achterste Goorven and Gerritsfles after the drought of 1976 and gradually declined again after 1978. This phenomenon is related to the elevated post-drought concentrations of carbondioxide (App. 10, 11). Carbondioxide is a limiting factor for the growth of J. bulbosus in acidified water (Roelofs et al. 1984, Wetzel et al. 1984). J. bulbosus and Sphagnum cuspidatum have a positive photosynthetic response with elevated concentrations of ammonium (> 50 mmol m^{-3}) as was determined experimentally by Roelofs et al. (1984). Both J. bulbosus and Sphagnum flexuosum preferred ammonium above nitrate and seriously affected the ammonium concentrations in the experiments of Schuurkes et al. (1986). Therefore, it is not impossible that the increase of ammonium in Achterste Goorven and Gerritsfles is partly a consequence of the decline of J. bulbosus.

Apart from wet deposition also dry deposition of SO_2 and NH_3 occurs. The dry deposition of sulphur on moorland pools is about twice the wet deposition, as was calculated by Van Dam et al. (1981), but the amount of dry deposition of ammonia is widely unknown. So it is still not possible to calculate an exact balance of proton consumption and production (or alkalinity production and consumption) as has been done by Hemond (1980), Dillon et al. (1982), Kilham 1982 and Schofield et al. (1985) for a bog ecosystem and some lakes.

Schindler (1985) expresses solicitude about depletion of iron when sulphate reduction will continue at accelerated rates. In that case hydrogen sulphide is no longer fixed as iron sulphides and will intoxicate the system. As considerable fractions of the bottoms of Achterste Goorvan and Gerritsfles are exposed to the atmosphere during dry years (about every twenty years) the iron sulphides are oxidized and the process described above will be repeated. In Kliplo, where the bottom is permanently submerged, the iron pool may be exhausted in the long run. The continuous removal of iron by sulphate reduction might uncouple the phosphate and iron cycles, having a fertilizing effect by allowing more phosphorus to remain in solution (Ohle 1954, Stumm & Baccini 1978, Schindler 1985).

Table 16

Seasonal periodicity of physical and chemical parameter in Achterste Goorven E, Gerritsfles (790814-850212), and Kliplo (810506-850212). Min = season of minimum values, max = season of maximum values. W = winter (Nov.-Feb. or Feb.), Sp = spring (Feb.-May or May), Su = summer (May-Aug or Aug.), A = autumn (Aug.-Nov. or Nov.). Parentheses = periodicity not very clear.

	A. Goorven E		Gerritsfles		Kliplo	
Parameter	min	max	min	max	min	max
LEVEL	A	Sp	A	Sp	(A)	(W)
TEMP	W	Su	W	Su	W	Su
O2	Su	W	A	Sp	Su	Sp
O2%	(u)	(Sp)	W	A	A	Sp
pHf	Sp	W	A	Sp	(Su)	(Sp)
pHl	Su	W	A	W	Su	W
EC25f	(Sp)	-	Sp	A	-	-
EC25l	W	Su	Sp	A	Sp	A
COLOR	Su	W	-	-	-	-
KMNO3u	Su	W	-	-	-	-
CL	W	Su	W	A	-	-
NO3	Sp	W	A	Sp	-	-
SO4	u	Sp	-	-	-	-
HCO3	Su	W	Su	W	-	-
CO2	-	-	(Su)	(A)	-	-
CO3	-	-	-	-	-	-
H2PO4	(W)	(Su)	A	Sp-Su	Sp	A
t-PO4f	-	-	Sp	A	-	(Su)
SIO2	(Sp)	W	(u)	(Su)	(Sp)	A
NH4	(A)	W	Su	A	Su	W
NH4-or	Su	W	W	A	-	-
FE	-	-	S	A	W	Su
MN	A	Sp	-	-	W	Su
AL	(A)	(Sp)	Sp	A	Su	W
CA	W	Su	Sp	A	-	Su
MG	W	Su	Sp	A	A	Su
NA	W	Su	Sp	A	-	-
K	(A)	(Sp)	Sp	A	A	Su
%Cl	W	Su	W	Su	-	-
%SO4	A	Sp	W	Su	(A)	(Sp)
%NO3	Su	W	A	Sp	A	Sp
%HCO3	Su	W	Su	W	-	-
%H	W	Su	W	Su	W	Su
%K	(Su)	(W)	(Su)	(W)	-	-
%NA	Sp	A	(A)	(Sp)	-	-
%CA	-	-	(Su)	(u)	(u)	(Su)
%MG	A	Sp	A	Su	A	W
%MN	-	-	-	-	-	-
%FE	-	-	-	-	W	Su
%AL	-	(W)	Su	A	-	-
NH4/(NH4+NO3)	Su	W	(A)	Su	Su	W
(NA+K)/(CA+MG)	-	-	-	-	(Su)	(Sp)
IR	Sp	A	-	-	Sp	A

3.4.4 Short-term changes

Short-term or seasonal trends were assessed by visual inspection of graphs of chemical and physical parameters against time. Because of the rather limited number of measurements no formal analyses (e.g. Fourier transformations) are applicable. A survey of the results is displayed in Table 16.

Kliplo is striking, because of the lack of seasonal differences of many parameters. Even the water level has no consistent time pattern and so is chloride. The pH (laboratory) has a maximum in winter and a minimum in summer or autumn in all pools. Ammonia has its maximum always in the cool seasons (autumn or winter), apparently because of inhibition of nitrification by low temperatures (Focht & Verstraete 1977). There are no other parameters with a similar seasonal pattern in the three pools, apart from temperature.

In Achterste Goorven and Gerritsfles HCO_3^-, $\%HCO_3^-$ and $\%K^+$ are minimal in summer and maximal in winter. $\%Cl^-$ is minimal in winter and maximal in summer in both pools. Cl^-, Ca^{2+}, Mg^{2+} and Na^+ have the lowest concentrations in winter or spring, when the water level is high and the highest concentrations in summer or autumn, when the water level is low.

3.4.5 Differences between pools and precipitation

In Section 3.4.3 the differences of some chemical parameters between Achterste Goorven, Gerritsfles, and Kliplo were already discussed. It is the purpose of this section to describe the differences in ionic composition of all pools and to discuss them in relation to the composition of the incoming precipitation.

Charge balances of the mean composition of all five pools over the period March 1983 - March 1985 are given in Table 17. Standard deviations are given in App. 16. The values for all pools but Achterste Goorven are the averages of monthly measurements by the Department of Soil Science and Geology of the Agricultural University (Wageningen) from March 1983 through March 1985 (Full data are presented in App. 17). For Achterste Goorven the results of eight quarterly measurements from May 1983 through February 1985 by 'Waterleidingbedrijf Midden-Nederland' were used. The comparison of quarterly data of Achterste Goorven of one laboratory with monthly data of another laboratory is warranted, because the results of both laboratories are comparable (Section 3.4.1) and the averages of quarterly values of the LUW samples differ only slightly from averages based on monthly values of the LUW

Table 17

Charge balances for surface water (April 1982-March 1984) and precipitation (January 1982-December 1984)[a].

	Achterste Goorven station E[b]					Gerritsfles[c]				
	Real[d] abs.[g]	Real rel.[h]	Prec.[e] abs.	Prec. rel.	Hypo[f] abs.	Real abs.	Real rel.	Prec. abs.	Prec. rel.	Hypo. abs.
SO4	552	26.0	120	24.1	791	231	20.8	105	21.3	317
CL	455	21.4	69	13.9	455	254	22.8	84	17.0	254
HCO3	15	0.7	3	0.6	20	18	1.6	0	0.0	27
NO3	5	0.2	48	9.6	317	2	0.2	50	10.1	151
ORGANION	48	2.3	7	1.4	46	42	3.8	7	1.4	21
Sum anions	1075	50.6	247	49.6	1629	547	49.2	246	49.9	744
H	44	2.1	37	7.4	244	16	1.4	37	7.5	112
NH4	267	12.6	108	21.7	712	185	16.6	94	19.1	284
K	38	1.8	5	1.0	33	27	2.4	4	0.8	12
NA	310	14.6	55	11.	363	188	16.9	68	13.8	206
MG	120	5.6	13	2.6	86	44	4.0	16	3.2	48
CA	131	6.2	23	4.6	152	41	3.7	20	4.1	60
AL	61	2.9	4	0.8	26	14	1.3	3	0.6	9
FE	78	3.7	6	1.2	40	50	4.5	5	1.0	15
Sum cations	1049	49.4	251	50.4	1655	565	50.8	247	50.1	747

	Kliplo[c]					Tongbersven-West[c]					Groot Hasselsven[c]				
	Real abs.	Real rel.	Prec. abs.	Prec. rel.	Hypo. abs.	Real abs.	Real rel.	Prec. abs.	Prec. rel.	Hypo. abs.	Real abs.	Real rel.	Prec. abs.	Prec. rel.	Hypo. abs.
SO4	96	9.3	98	20.0	353	183	16.2	120	24.1	428	398	31.8	127	25.3	431
CL	324	31.3	90	18.3	324	246	21.8	69	13.9	246	217	17.4	64	12.8	217
HCO3	27	2.6	0	0.0	0	26	2.3	3	0.6	11	0	0.0	2	0.4	7
NO3	1	0.1	49	10.0	176	2	0.2	48	9.6	171	6	0.5	50	10.0	170
ORGANION	58	5.6	11	2.2	40	104	9.2	7	1.4	25	16	1.3	7	1.4	24
Sum anions	506	48.8	248	50.5	893	561	49.7	247	49.6	881	637	51.0	250	49.9	848
H	5	0.5	35	7.1	126	9	0.8	37	7.4	132	116	9.3	29	5.8	98
NH4	45	4.3	87	17.1	313	124	11.0	108	21.7	385	46	3.7	112	22.8	380
K	27	2.6	4	0.8	14	52	4.6	5	1.0	18	62	5.0	5	1.0	17
NA	253	24.4	73	14.9	263	211	18.6	55	11.0	196	173	13.8	55	11.0	186
MG	66	6.4	17	3.5	61	44	3.9	13	2.6	46	64	5.1	14	2.8	47
CA	63	6.1	19	3.9	68	67	5.9	23	4.6	82	108	8.6	26	5.2	88
AL	12	1.2	3	0.6	11	20	1.8	4	0.8	14	26	2.1	4	0.8	14
FE	56	5.4	5	1.0	18	41	3.6	6	1.2	21	18	1.4	6	1.2	20
Sum cations	530	51.2	243	49.5	875	568	50.3	251	50.4	895	613	49.0	251	50.1	851

[a] Precipitation water for all pools but Groot Hasselsven according to H.F. van Dobben (pers. comm.). Organic acids, aluminium and iron at all stations and other ions for Groot Hasselsven according to the nearest stations of the National Precipitation Chemistry Network (Anonymus 1983, 1985 and A.J. Frantzen, pers. comm.).

[b] 8 analyses WMN May 1983-February 1985

[c] 20-22 analyses LUW March/April 1983-March 1985

[d] Real = surface water

[e] Prec. = precipitation water

[f] Hypo. = hypothetical concentration of surface water, assuming an equal concentration of chloride and a proportional concentration of other ions in surface and precipitation water.

[g] abs. = absolute concentration

[h] rel. = relative concentration

samples. At least differences between pools are much larger than differences within pools.

Organic acids were calculated from DOC. The mass action quotient of the fulvic and humic acids can be estimated by the formula of Oliver et al. (1983): $pK = 0.96 + 0.90pH - 0.039(pH)^2$. The concentration of organic acids $[A^-]$ is given by $[A^-] = K[C_T]/(K + [H^+])$, with $K = 10^{-pK}$ and $C_T = C_c DOC$. C_c is taken as 10 ueq/mgC (120 ueq/mmol C) by Oliver et al. (1983), but values between 5 and 10 ueq/mg C have been reported by several, mainly North American authors (Eshleman & Hemond 1985). The value of 5.5 µeq/mg C (66 µeq/mmol C), which was found by Henriksen & Seip (1980) in Scotland and Norway gave the best fit with our results and was used therefore.

In Achterste Goorven DOC was not measured directly. From the measurements of DOC, $KMnO_4$ consumption and color, presented in section 3.4.1, DOC was inferred by simple regression models. The best fit is given by: DOC (mmol m^{-3}) = 423.1 + 13.41$KMnO_4$ (mg 1-1) (r = 0.71). For Achterste Goorven the alkalinity values determined by 'Waterleidingbedrijf Midden-Nederland' are halved, because these concentrations are based on titrations with HCl down to pH = 4.4. It appears from Section 3.4.1 that only half of the alkalinity is due to bicarbonate. The other half consists of weak organic acids.

For precipitation the results of a special network of stations nearshore or close to the pools, running from January 1982 through December 1984 (H.F. van Dobben, pers. comm.), were used. The samples were collected in the same way as in the National Precipitation Chemistry Network and analysed by the National Institute for Public Health (Anonymus 1983). Organic anions were inferred from DOC as described above. For Groot Hasselsven the results of the station Eindhoven of the National Precipitation Chemistry Network were used (Anonymus 1983, 1985, A.J. Frantzen, pers. comm.).

The data from Table 17 are visualized in Fig. 22.

The precipitation at all stations is rather similar, although some differences are apparent. The total concentration of ions is c. 500 equivalent mmol m^{-3}. Sulfate is the most important anion. The minimal concentration is 98 equivalent mmol m^{-3} near Kliplo, while the maximum is 127 near Groot Hasselsven. Chloride is the next important anion, with a minimum of 64 mmol m^{-3} near Groot Hasselsven and a maximum of 90 near Kliplo. Nitrate is present with c. 50 mmol m^{-3} at all stations, while bicarbonate is nearly absent.

Ammonium is the most important cation, encompassing the range of 87 mmol m^{-3} (Kliplo) to 112 mmol m^{-3} (Groot Hasselsven). The next important cation is sodium with a minimum of 55 mmol m^{-3} near Achterste Goorven and Tongbersven-West and a maximum of 73 mmol m^{-3} near Kliplo. The third important cation is hydrogen with a concentration of c. 35 mmol m^{-3} at all stations. All the other cations are of minor importance.

The precipitation near Gerritsfles is intermediate in all respects. In all precipitation samples chloride is roughly balanced by sodium, although there is an excess of c. 15% chloride. Sulfate is roughly balanced by ammonium, although sulphate exceeds ammonium by c. 10%. The excess of chloride and sulphate over sodium and ammonium is about equal to the hydrogen-ion concentration.

The composition of the moorland pool water is much less uniform than that of precipitation water. From the data in Table 17 and Fig. 22 it appears that the chloride concentration varies from 217 mmol m^{-3} in the pool with the shortest water renewal time (Groot Hasselsven) to 455 mmol m^{-3} in the pool with the longest water renewal time (Achterste Goorven). The Achterste Goorven has the highest total ion concentration (2124 equivalent mmol m^{-3}), the total ion concentrations of the other pools are rather

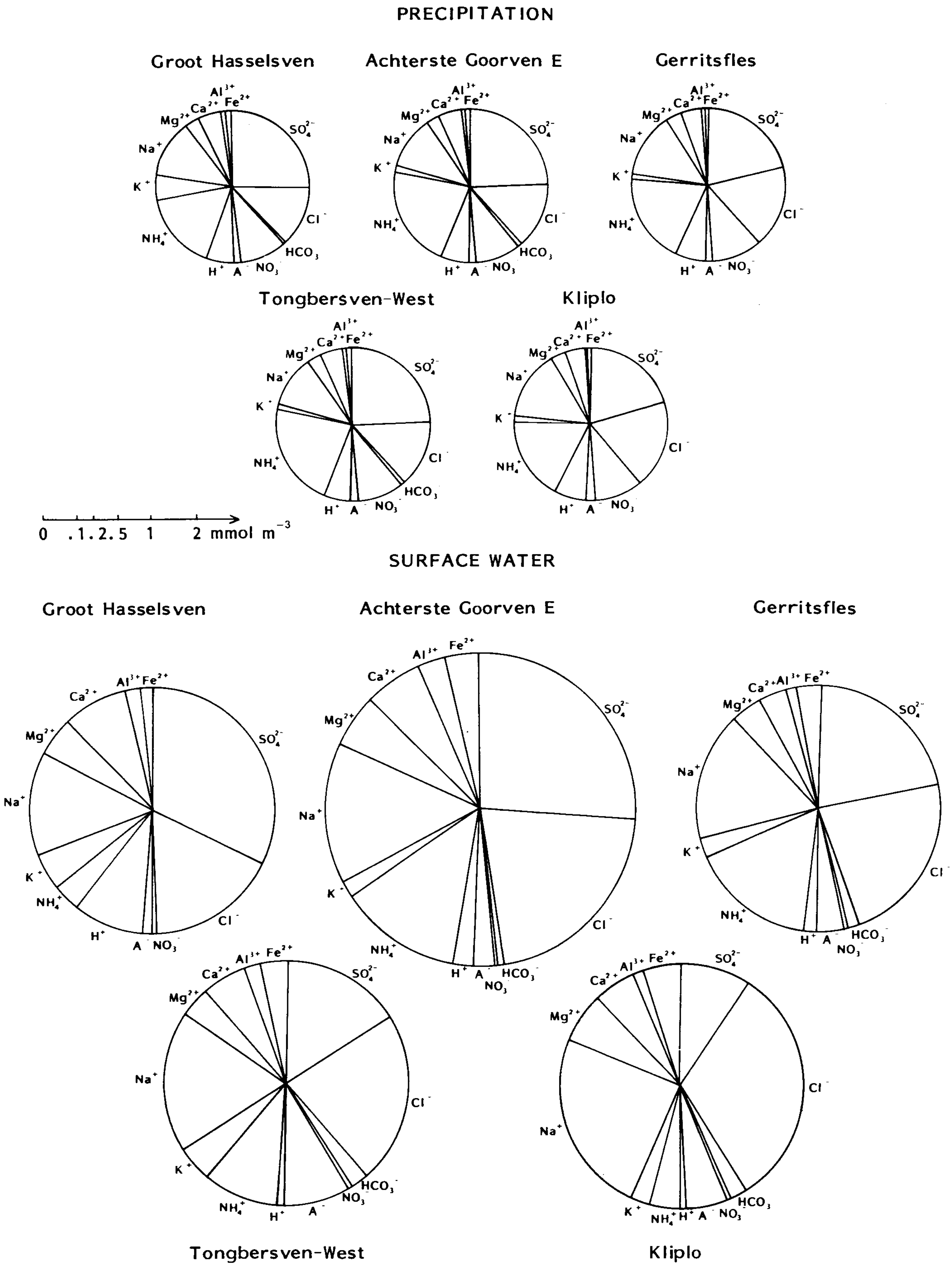


Fig. 22. Comparison of chemical composition of precipitation (top) and surface water (bottom) of all pools. Absolute concentration is proportional to the square root of length of radius of the circles (see scale). Data as in Table 17.

similar with 1036-1250 equivalent mmol m^{-3}.

Although sulphate is the most important anion in precipitation, it is only the most important anion in Achterste Goorven and Groot Hasselsven, where chloride is the next important anion. In the other pools the order of these two anions is reversed. Nitrate is nearly absent in the pools, while bicarbonate is found with some tenths of mmol m^{-3} in all pools but Groot Hasselsven. Organic anions are important in Kliplo and especially Tongbersven-West, but never exceed 20% of the total ion concentration.

Sodium is the most important cation in all five pools, followed by ammonium in all pools but Kliplo and Groot Hasselsven, where magnesium and calcium are more important. The highest ammonium concentrations are in Achterste Goorven. This order is different from that in precipitation. Hydrogen ion is maximal in Groot Hasselsven (116 mmol m^{-3}), also important in Achterste Goorven (44 mmol m^{-3}), but of minor importance ($\leq$ 16 mmol m^{-3}) in the other pools. Aluminium is maximal in Achterste Goorven (6 equivalent mmol m^{-3}). Iron has its maximum (78 equivalent mmol m^{-3}) also in Achterste Goorven, but compared to the other ions it is maximal in Kliplo (5.4%).

In table 17 the hypothetical concentration of the ions in each of the pools is calculated when no chemical and biological processes would take place. The concentration of the inert chloride ion is supposed to be equal in the real and hypothetical case and the concentration of each of the other ions is calculated from precipitation by multiplying the concentration in precipitation by the quotient of the measured chloride concentration in the pool and the concentration of chloride in precipitation.

The processes which are responsible for the differences between the hypothetical and real concentrations, especially sulphate reduction, nitrification, and denitrification, have been discussed at length in Section 3.4.3 for Achterste Goorven, Gerritsfles and Kliplo. Realizing that the dry deposition of SO_2 is about twice as large as that of the wet deposition of sulphate and also the dry deposition of ammonia may be considerable it is evident that even in the most acid pool (Groot Hasselsven, pH c. 3.9) these processes are important.

The concentrations of ammonium in Groot Hasselsven and Kliplo (respectively 47 and 45 mmol m^{-3}) are much lower than in the other pools, where ammonium is higher than 100 mmol m^{-3}. This might be caused by the activity of aquatic macrophytes. In Groot Hasselsven the flat bottom of the shallow pool (in summer only a few decimetres deep) is covered with a thick mat of Drepanocladus fluitans, which assimilates ammonium and affected the ammonium concentrations in the experiments of Schuurkes et al. (1986) considerably. In Kliplo a luxuriant vegetation of Potamogeton natans exists, which is probably responsible for the low concentrations of both ammonium and nitrate. In the literature concerned (Ferguson & Bollard 1969, Toetz 1973, Schwoerbel & Tillmanns 1972, 1974, Kopp et al. 1974, Roelofs et al. 1983, Schuurkes et al. 1986) no information could be found about the form of inorganic nitrogen which is used by this species. In Achterste Goorven, where the biomass per square metre of submerged aquatic macrophytes probably is minimal, the ammonium concentration is maximal.

In all pools the concentrations of aluminium and sodium are elevated for the reasons that have been explained in Section 3.4.3. Iron is elevated in all pools but Groot Hasselsven, probably because it may not only be dissolved from the bottom of acidifying water bodies, but also because it is associated with the presence of humic substances (Gjessing 1976, Wetzel 1983). One would expect elevated concentrations of calcium and magnesium too, because of leaching from the sediment, but this is apparently compensated for by the adsorption of divalent ions by peat mosses (Clymo & Hayward 1982), especially in Gerritsfles and Kliplo.

In Section 3.4.3 it appeared that morphology and hydrology are key

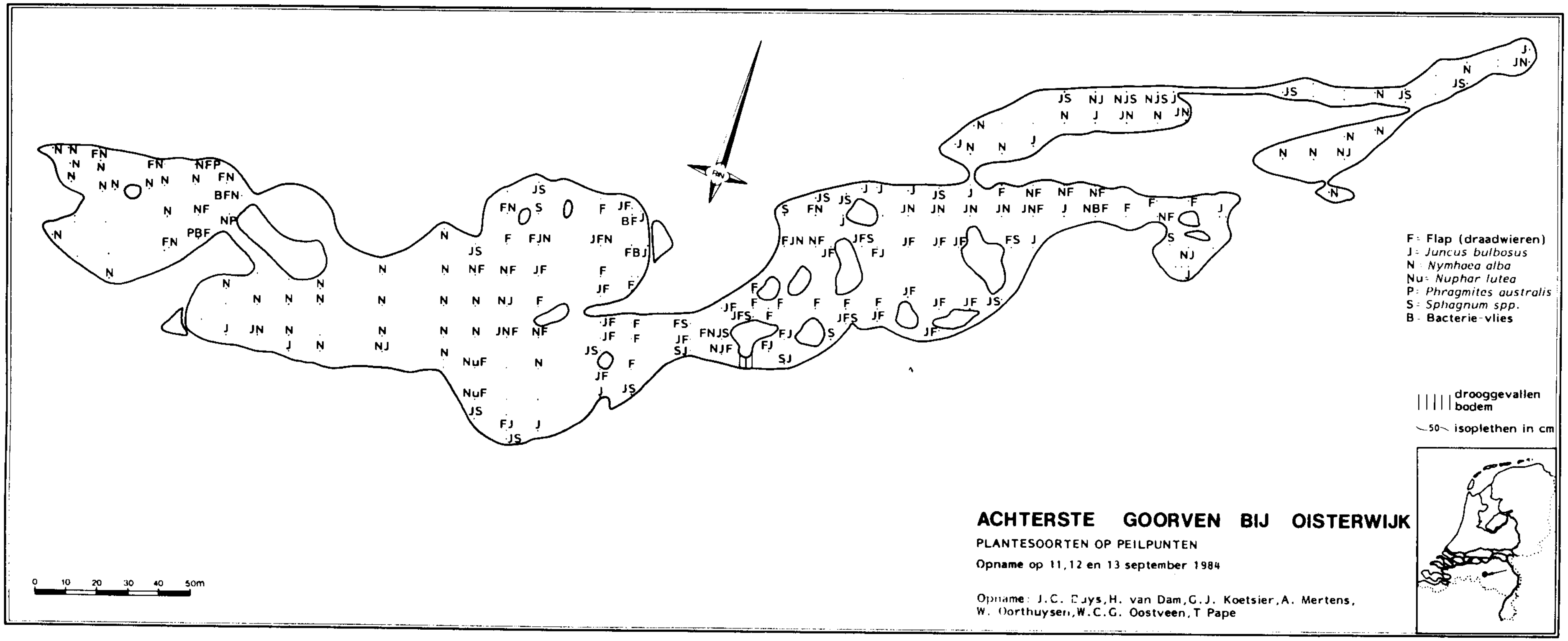


Fig. 23. Achterste Goorven. Plant species on gauging stations on September 11-13, 1984. F = filamentous algae, B = bacterial membrane, hatched area = dry bottom.

factors for understanding chemistry of Achterste Goorven, Gerritsfles, and Kliplo. This is also apparent from the data in Table 17 and Fig. 22. The composition of the precipitation near Groot Hasselsven, Achterste Goorven, and Tongbersven-West is very similar, nevertheless the chemical composition of the water in these pools is widely different. The composition of the water in Groot Hasselsven, with a very shallow bottom and probably a short water renewal time is most similar to that of the precipitation. That of Achterste Goorven, with the longest water renewal time is most different from rain water.

3.5 MACROPHYTES

Achterste Goorven

The present macrophytic vegetation of the interconnected basins, which form together the tarn Achterste Goorven, is quite uniform. A belt of Myrica gale and Molinia caerulea, with a minimum width of about one metre extends to several tens of metres in marshy places and is inundated during periods of high water. This band separates the pool with its boggy margins from the surrounding forests (Goor is a regional name for a mire in which Myrica gale is often one of the co-dominant shrubs). Salix (aurita/cinerea group) is often mixed with Myrica gale. The distribution of aquatic macrophytes which were found in a survey in September 1984 is shown in Fig. 23.

Nymphaea alba is the most conspicuous water plant; although the total coverage is less than one percent of the surface area of the pool. Next important is Juncus bulbosus, which occurs in loose patches throughout the pool, particularly near the shores and in the shallower eastern basins. After the extreme dry year 1976, when the water level was very low in summer, the species grew so luxuriant, that the reddish-green plants covered the water surface like a sward. After 1979 J. bulbosus declined rapidly. The abundance of filamentous algae, which form a mat on the bottom on many places, increases from west to east.

Sphagnum and Molinia caerulea often occur nearshore, the former species never forming floating mats. Eriophorum angustifolium and Carex rostrata locally form patches. Juncus effusus occurs here and there. Rhynchospora alba and Batrachospermum are rare, while Drosera intermedia occurs at one place in the eastern basin. The most western basin is differentiated from the others by the presence of Phragmites australis.

This very simple zonation is only an impoverished stage of former vegetation pattern. Some of the earliest papers about the flora of the pool (e.g. Thijsse 1912, 1916, 1927, 1937, Bergmans 1926, Schuiling & Thijsse 1928, Van de Griendt 1933, Koster 1942) speak in general terms, without allowing spatial differentiation within the pool. The present-day species were already present, apart from a series of other ones. Most striking were a belt of Hypericum elodes, immediately adjacent to the Myrica-zone and dense submerged fields of various species of Utricularia, at least U. minor and U. intermedia. The prolific growth of Sphagnum species, sending their long stems into the open water, caused a rapid terrestrialization of the pool (see also Heimans 1960). A rich mosaic of vegetation belonging to the associations Rhynchosporion and the Eleocharitetum multicaulis was present. Patches of Eriophorum angustifolium and Carex rostrata were present regularly.

The development of the vegetation in the western basin can be reconstructed from descriptions and photos from several reports (Thijsse 1927, Geijskes 1929, Deinum 1936, Koster 1942). The Hypericum elodes-vegetation and the belt of Phragmites australis attained their optimum here, within a luxuriant zone of Sphagnum. In the open water Nymphaea alba, Myriophyllum sp. (M. alterniflorum seeds were found in the sediment according to Dickman et al. 1987), Potamogeton polygonifolius, Hypericum elodes and Carex rostrata were abundant. The studies of Van Dijk et al. (1948), Glas (1957) and Verhoeven & Bastiaanssen (1959) indicate that no major changes had taken place since the interbellum, although they mention more species, because of the greater depth of their investigations. Myriophyllum was not observed, and Juncus bulbosus, Potamogeton natans and Utricularia sp. were recorded as supplementary species in the open water, with Carex lasiocarpa and Eleocharis multicaulis occurring in nearshore habitats. Several mosses, especially Sphagna (sect. subsecundum) were also abundant. In the small recess in the north-west, where the outlet is located, more eutraphentic species like Alisma plantago-aquatica, Mentha aquatica and Lycopus europaeus were met.

Kwakkestein (1977) still noted Utricularia minor (in small quantities), Nymphaea alba, Nuphar lutea and also the red alga Batrachospermum during an excursion in 1975. Eleocharis multicaulis and Hypericum elodes still occurred in 1976, but were not recorded later on (Van Dam 1983). The vegetation at this station is now in a very impoverished condition.

Van Dijk et al. (1948) gave the first account of the vegetation in the central basin (II). Apart from the still presently occurring Nymphaea alba, Juncus bulbosus and Nuphar lutea (sparse), species like Potamogeton natans, P. polygonifolius, Scirpus fluitans and Utricularia intermedia were present in the open water (the last species was already noted by Thijsse (1916) from this and/or the next basin). Molinea caerulea, Hydrocotyle vulgaris, Hypericum elodes, Carex rostrata, Eleocharis multicaulis and Sphagnum were confined to nearshore habitats, forming a transition zone to a more terrestrial area with Sphagna, Rhynchospora alba , Eriophorum angustifolium, Drosera intermedia , D. rotundifolia and Viola palustris among others.

Hypericum elodes, Potamogeton polygonifolius and Utricularia intermedia disappeared already during the next decade (Glas 1957, Van der Voo & Westhoff 1959). Most of the other species drastically declined or disappeared completely during the last 25 years.

Sampling station E is located in basin III (Fig. 8). Thijsse (1916) notes that the eastern part of the pool looks 'rough' owing to Scirpus fluitans and that the flowers of several Utricularia species give a pale yellowish hue to the pool in midsummer. In a paper of 1927 he writes "The farther we come to the east, the more prolificly the Sphagnum grows. On some spots Polytrichum hummocks are dominant. Finally the Sphagnum grows so densely, that it extends from shore to shore and the water-lilies are reaching above the peat mosses with short stalks. During the last twenty years this section has been filled up completely and already thousands of long-leafed sundew plants are growing here. The pool will be transformed into a bog here in time" (see also Schuiling & Thijsse, 1928).

According to the observations of Van Dijk et al. (1948) this process did not develop as predicted. There was still a considerable area of open water (see also Glas 1957 and Verhoeven & Bastiaanssen 1959). In the water Nymphaea alba was widespread, while Potamogeton natans, P. polygonifolius, Carex rostrata, Eleocharis multicaulis and Eriophorum angustifolium were locally important. Juncus bulbosus was found nearshore sites. Sphagneta, with Drosera intermedia, D. rotundifolia and Rhynchospora alba amongst others were well developed, especially in the nearly separated tip, close to station E.

Kwakkestein (1977) still noted both Drosera species and Rhynchospora. Recently, however, the well developed floating bog has been reduced to some tussocks of Sphagnum growing here and there, while Molinia caerulea is very

Table 18

Presence (X) of aquatic and nearshore macrophytes in Achterste Goorven (A,B,E = station A,B,E respectively), Gerritsfles, Kliplo, Tongbersven-West, and Groot Hasselsven. R is indicator value for pH (1 acidobiontic, 2 acidophilous, 3 circumneutral, 4 alkaliphilous, - indifferent).

	Pool	Acht. Goorven					Ger.		Kliplo		Tong.		Hass.	
	From 19..	12	12	12	75	84	16	73	24	65	57	76	57	82
	To 19..	59	59	59	76	84	58	84	58	84	57	84	57	84
R	Station	A	B	E	ABE	ABE								
1	Drepanocladus fluitans	X	X	X	X	X	X	X	X	X	X	X		X
1	Drosera intermedia		X	X	X	X			X	X	X	X		
1	Drosera rotundifolia		X	X	X		X	X	X	X	X	X		
1	Eleocharis multicaulis	X	X	X	X		X	X	X	X	X	X		
1	Juncus bulbosus	X	X	X	X	X	X	X		X	X	X	X	X
1	Rhynchospora alba		X	X	X	X			X	X	X	X		
1	Sphagnum spec.	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Agrostis canina		X	X	X	X	X	X	X	X	X	X		
2	Carex rostrata	X	X	X	X	X	X	X	X	X	X	X	X	
2	Deschampsia setacea						X							
2	Eriophorum angustifolium	X	X	X	X	X	X	X	X	X	X	X		X
2	Hydrocotyle vulgaris	X	X		X	X	X	X	X	X	X	X		
2	Hypericum elodes	X	X		X									
2	Juncus acutiflorus	X	X	X										
2	Juncus effusus		X		X	X	X	X	X	X	X	X	X	X
2	Lobelia dortmanna						X							
2	Luronium natans						X							
2	Molinia caerulea	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Myrica gale	X	X	X	X	X					X	X		
2	Potamogeton polygonifolius	X	X	X										
2	Potentilla palustris	X	X				X	X	X	X	X			
2	Sparganium angustifolium						X	X	X	X				
2	Utricularia minor		X		X		X		X	X	X	X		
2	Viola palustris		X				X		X	X				
3	Carex lasiocarpa	X		X										
3	Menyanthes trifoliata		X						X	X	X			
3	Myriophyllum alterniflorum	X												
3	Potamogeton natans	X	X	X	X		X		X	X				
3	Scirpus fluitans		X	X			X							
3	Utricularia intermedia	X	X											
4	Alisma plantago-aquatica	X												
4	Eupatorium cannabinum	X												
4	Lycopus europaeus	X								X				
4	Lysimachia vulgaris	X	X							X				
4	Mentha aquatica	X												
4	Scirpus lacustris	X												
4	Typha angustifolia	X												
-	Eleocharis palustris		X				X	X		X		X	X	
-	Glyceria fluitans						X	X						
-	Juncus articulatus								X	X				
-	Lemna minor							X						
-	Nuphar lutea		X		X	X						X		
-	Nymphaea alba	X	X	X	X	X					X	X		
-	Phragmites australis	X			X	X			X	X			X	X
	Number of species	25	29	18	20	15	22	16	20	24	18	18	7	7
	Average R	2.5	2.0	1.8	1.6	1.6	1.9	1.6	1.8	2.0	1.6	1.5	1.6	1.5

References:

Achterste Goorven: Thijsse (1916,1927,1929,1937), Bergmans (1926), Schuiling & Thijsse (1928), Koster (1942), Van Dijk, Sloff & Westhoff (1948), Glas (1957), Verhoeven & Bastiaanssen (1959), Van der Voo & Westhoff (1959), Van Dijk & Westhoff (1960), Kwakkestein (1977), Van Dam (1983), Verstegen (1985), G.M. Dirkse (pers. comm.), Hofman & Janssen (1986), own record.

Gerritsfles: Vuyck (1924), Romijn (1925), Thijsse (1926), Sloff (1928), Wigman (1932), Van Oordt (1935,1939), Schimmel & Mörzer Bruijns (1952), Moller Pillot (1958), Van der Voo (1973), Notenboom-Ram (1976), Van de Beld (1978), Higler (1979), Van Dam et al. (1983), J. Heimans (unpubl.), G.M. Dirkse (pers. comm.), S. van der Werf (pers. comm.), own record.

Kliplo: Beijerinck (1924,1926,1931,1950), Van Oordt (1939), Koster (1942), Mörzer Bruijns (1950), Wartena (1954), Ringelberg (1956), Stapelveld (1956), Glas (1958), Van der Voo (1965,1973,1975), Brouwer (1968), Londo (1973), Smit (1976), Coesel & Smit (1977), Van Gijsen & Claassen (1978), Buskens (1983), Goessens (1983), G.J. Baaijens (pers.comm), G.M. Dirkse (pers. comm.), own record.

Tongbersven-West: Glas (1957), Beije (1976), Verschoor (1977), Verstegen (1985), G. M. Dirkse (pers. comm.), Hofman & Janssen (1986), own record.

Groot Hasselsven: Van Donselaar (1957), Iven & Van Gerwen (1974), G.M. Dirkse (pers. comm.), own record.

abundant Rhynchospora alba occurs here and there. A few spots with Drosera intermedia are still present. In the open water the Potamogeton, Scirpus, Utricularia and Eleocharis species have vanished.

Van Dijk et al. (1948) and Glas (1957) also described the vegetation of the small pools (basins IV and V). Those pools are interconnected by man-made ditches and discharge into the eastern basin. The vegetation in earlier days seems to have been very similar to the recent vegetation with Nymphaea alba and Juncus bulbosus as the most prominent species. Along the shores Sphagna were abundant (see also Thijsse 1916).

The floristic records of the aquatic and nearshore macrophytes near the sampling stations A, B, and E (basins I, II, and III respectively) for the periods 1916-59, 1975-76, and 1984 are entered in Table 18. In both last periods the differences between the three stations were so small that no distinction has been made in the table. The species are ordered in groups according to their pH distributions. The groups are similar to those used in diatom ecology (Hustedt 1939). The species were assigned to each of these groups using the references listed in Section 2.5.

In total 37 species were seen. The species richness declined from 37 to 20 from before 1960 to after 1970. The average R (pH indication value) varied from 2.5 near station A to 1.8 near station E before 1960. In the period 1976-84 $\bar{R}$ was 1.6 throughout the whole pool, which is indicative for acidification and floristic levelling. The vanished species are characteristic for meso-eutrophic, not extremely acid waters (e.g. Myriophyllum alterniflorum, Scirpus fluitans, Carex lasiocarpa, Mentha aquatica). During the last decade five species disappeared (Drosera rotundifolia, Eleocharis multicaulis, Hypericum elodes, Potamogeton natans, Utricularia minor). The latter three cannot thrive well in acidified waters. Many of the declined taxa belong to the rare and endangered species of the northwest-European flora.

Gerritsfles

The present submerged vegetation was surveyed from a dinghy in September 1984 (Fig. 24). The nearshore vegetation was surveyed partially in 1977 by Schroevers (in Higler 1979 and Van Dam et al. 1983) and integrally on a scale of 1: 1000 in 1978 by Van de Beld (1978).

The bottom of the open water is nearly totally covered with a dense layer of Sphagna. In some samples, taken at random we met only Sphagnum denticulatum (syn. S. obesum, det. G.M. Dirkse), but Van de Beld and Schroevers (loc. cit) also recorded S. cuspidatum in small quantities. The latter author also mentions Drepanocladus fluitans.

Going from the zone of the submerged mosses to the shore the zonation follows the general pattern:

1. Submerged mosses, mainly Sphagna.
2. Submerged mosses and Juncus bulbosus.
3. Eleocharis palustris or Carex rostrata and J. bulbosus.
4. Optimal development of J. bulbosus.
5. J. effusus.
6. Eriophorum angustifolium.

This zonation does not always develop completely, depending among other things, on the slope. Therefore, a diverse mosaic of nearshore vegetation, which forms a belt of only a few to about fifty metres width, is present. After the extreme drought of 1976 Juncus bulbosus encroached the pool from the shores during several years, but receded again from about 1978 onwards.

At some places additional species occur, like Potentilla palustris, Eleocharis multicaulis and Sparganium angustifolium. The latter species,

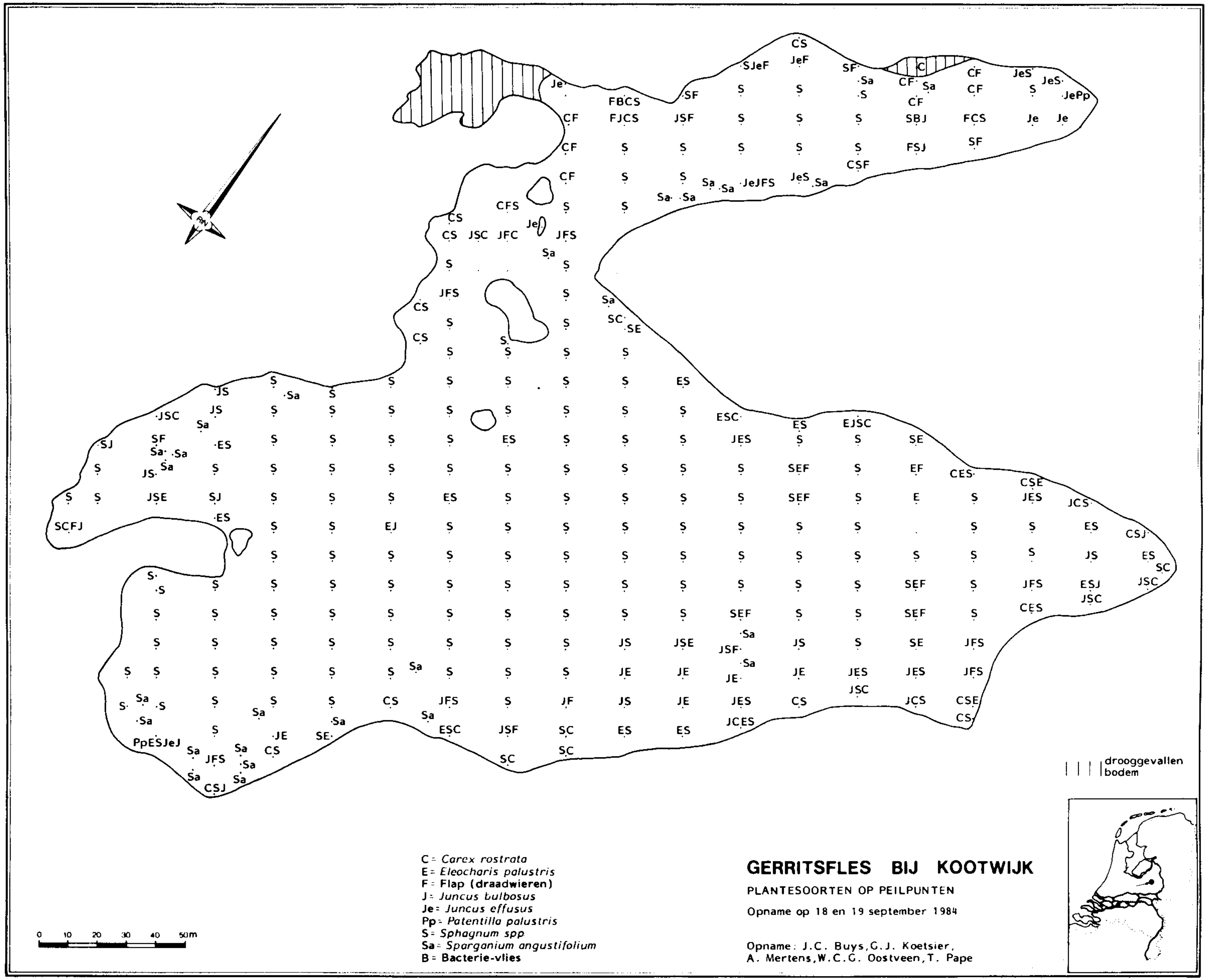


Fig. 24. Gerritsfles. Plant species on gauging stations on September 18-19, 1984. F = filamentous algae, B = bacterial membrane, hatched area = dry bottom.

which is very rare in The Netherlands and other countries in NW Europe, deserves some special attention. Van de Beld (1978), which had no dinghy available, recorded the species from one place nearshore. In our survey we saw the species at several stations with some hundreds of poorly developed infertile plants in 25-50 cm deep water (Fig. 24). The plants were very tiny and slender and difficult to identify. Mr. W.J. Holwerda and Dr. P. Baas identified some of our specimina from morphological and anatomical characteristics respectively. Our plants were very similar to Glyceria fluitans and it is not impossible that the records of G. fluitans by Schroevers (loc. cit.) and Van de Beld (1978) actually refer to S. angustifolium.

Earlier records of plant species are listed in Table 18, together with the recent records. The species mentioned before were already present in earlier days, probably with exception of Juncus effusus, which was present in very small quantities in 1950, but much more frequent in 1958. Today it forms a belt of 1-10 m wide along c. 30% of the length of the shoreline. One gets the impression that the abundance of the submerged Sphagna did increase over the years, as open sandy places, which are hardly present now, occurred in former times.

This impression is strenghtened by the observation that Lobelia dortmanna, a Littorellion species, which grows exclusively on bare sandy bottoms, occurred until ca. 1927 and not in later years. Another Littorellionspecies, Deschampsia setacea, was not seen after 1951. Also Luronium natans was found on several places in 1951, but has not been seen later on. Potamogeton spec. (probably P. natans, because seeds are abundant in the sediment, B. van Geel pers. comm.) was observed in 1951 for the last time. Scirpus fluitans was seen in 1951 only. Glyceria fluitans, which was found in small herds along the shores of the northern offshoot in 1951 and in 1977 seems to have decreased. As mentioned before, it is not impossible that this species has been confused with Sparganium angustifolium by earlier authors. The latter species is decreasing, because before 1960 it occurred much more abundant and also fertile (Photo 5).

The decline of species which are characteristic for low alkalinity waters is typical for acidifying moorland pools (Van Dam & Kooyman 1978, Roelofs 1973).

Kliplo

The present submerged vegetation is dominated by Potamogeton natans. The floating leaves cover only about one or a few percents of the surface area, but the submerged stems with small leaves form a dense underwater network. Only in the northeastern and southeastern corner are some places without this species (Fig. 17). Sphagna are present at some nearshore habitats. The very rare Sparganium angustifolium is present with a few individuals near the northeastern shore.

On the sandy beach in the southeastern corner Juncus bulbosus, Hydrocotyle vulgaris and Eriophorum angustifolium are present. The latter species forms a small stand in the southwestern corner of the pool. The northern shore is set off with a belt of Phragmites australis, which occurs also locally on the southern shore. Potentilla palustris is found everywhere along the western and northern shore and Carex rostrata is also regularly found along the shores. Furthermore, Menyanthes trifoliata is present near the small island.

The species mentioned above were also recorded during earlier investigations and are listed in Table 18. Although few of the old reports include quantitative data, the observations seem to indicate that the

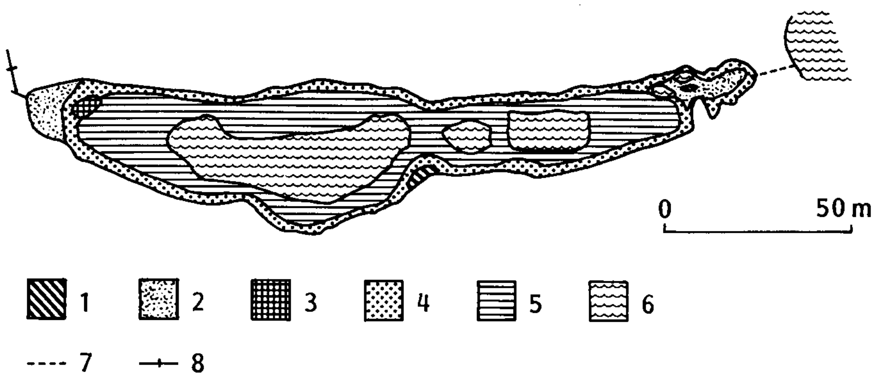


Fig. 25. Tongbersven-West, 20 September 1984. Outline-map of vegetation. 1 = Erica-Molinia, 2 = bog carr, 3 = Myrica, 4 = lagg zone, 5 = quivering bog, 6 = open water, 7 = ditch with dam, 8 = rudimentary ditch.

abundance of Potamogeton natans increased over the last decades, while Sparganium angustifolium decreased (Photo 9, 10). This tendency is in accordance with observations by G.J. Baaijens (pers. comm.). According to Beijerinck (1926) and Wartena (1954) also Utricularia minor was present in larger quantitites. This species is not mentioned by other authors and has been seen only in small quantities in recent years (G.J. Baaijens pers. comm.).

Acidification is not obvious from changes of the vegetation and flora.

Tongbersven-West

A sketch of the vegetation of this small pool is given in Fig. 25. The vegetation is rather different from the other investigated pools, because it is filled up with a quivering bog for a large part.

The open water of the most western (largest basin) is partly colonized by Utricularia minor (Hofman &Janssen 1986). One of the first pioneers of the terrestrial phase is Eleocharis multicaulis. In the quivering bog around and between the three patches of open water Molinia caerulea, Sphagnum spp., Rhynchospora alba, Drosera rotundifolia, Oxycoccus palustris, Eriophorum angustifolium, Erica tetralix and Polytrichum sp. are the most important taxa. Drosera intermedia occurs in small quantities (Hofman &Janssen 1986).

At the transition between the floating bog and mineral soil is a lagg zone with bare mud, Sphagnum species and Molinia caerulea and, more rarely, Utricularia minor. Especially in the western part Juncus effusus occurs. Betula pubescens grows very close to the mineral soils.

In the westernmost part of the bog is a small area with shrubs of Myrica gale. On the mineral soil in the eastern and western tips small lots of carr occur with Betula pubescens as the predominant tree species. Locally Pinus sylvestris occurs. In the understory Molinia and Sphagnum are most abundant. There is also a very small area with a wet heath vegetation of Erica tetralix and Molinia caerulea (Fig. 25).

The flora and vegetation were studied before by Glas (1957), Beije (1976) and Verschoor (1977). The records are listed in Table 18. Changes over the last decades are of minor importance, although Nymphaea alba was seen in 1957 and 1975 and not in 1983. Potentilla palustris and Menyanthes trifoliata occurred only in 1957. Nuphar lutea was recorded in 1976 only.

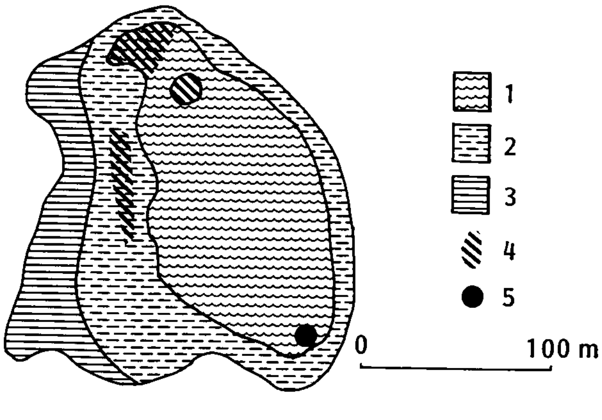


Fig. 26

Groot Hasselsven, 17 September 1984. Outline-map of vegetation. 1 = open water with Drepanocladus fluitans, 2 = D. fluitans + Juncus effusus, 3 = D. fluitans + J. effusus + Molinia caerulea, 4 = Phragmites australis, 5 = sampling station.

Groot Hasselsven

The flat and shallow sandy bottom of the pool is covered with a dense mat of the moss Drepanocladus fluitans with some Juncus effusus (Fig. 33). The vegetation of the open water gradually changes into the belt of marshy vegetation, which was described in section 3.1.

The data collected by Van Donselaar (1957) are given in Table 18. He found Eleocharis palustris and some Juncus bulbosus and Carex rostrata at the southern shore. Drepanocladus fluitans was not recorded in 1957.

3.6 Previous studies on microphytes

Achterste Goorven

As stated in the introduction, the desmids have been thoroughly studied by Heimans (1925, 1960) and Coesel et al. (1978). In the period 1916-25 114 species were found, whereas 79 species were observed in the years between 1950 and 1955. In both periods an assemblage of desmids characterizing the oligo-mesotrophic environment was present and many rare species were well represented. Heimans (1960) did not assess the decrease of the number of species as a significant one, because he studied much more samples in 1916-25 than he did in 1950-55. Coesel et al. (1978), sampling the pool in 1975 found only 28 species, which indicated oligotrophic conditions. Rare species did not occur any longer. They attributed these changes to acidification by acidic atmospheric deposition. Also the decline of the submerged aquatic macrophytes, an important habitat for desmids, may have been attributed to the impoverishment of the desmid flora.

Koster (1960) studied the algae from some plankton tows and moss squeezings, taken near our stations A and B in 1948-53. The dinoflagellate Glenodiniopsis uliginosa, which is characteristic for acid humic waters, poor in lime, peaked occasionally at station B.

Van der Werff (1960) made an inventory of the diatoms in 4 plankton samples, taken in the period 1948-52. As the mean number of species in his samples amounted only 14, his lists are certainly not exhaustive. Moreover, the relative abundance of the diatoms was estimated with a very rough scale. The only conclusion be drawn from this cursory investigation is that the Achterste Goorven was a habitat for diatoms from (not extremely) acid, virtually unpolluted waters.

Van Dam & Kooyman-van Blokland (1978) compared the diatoms in two plankton samples, one towed in 1919, the other one in 1975. They found a serious increase of the relative abundance of acidobiontic species over this period of 56 years, which they attributed to the acidification of wet and dry deposition. Van Dam et al. (1981) studied the diatoms again. They investigated the diatoms at the stations A, B, and E, taking one sample in each of the years around 1920, 1950 and 1978. Their conclusion was that in 1920 a clear pH gradient existed, going from E to A. This gradient persisted until c. 1950 and was largely faded away in 1978. Also the diversity declined over the last 60 years.

Gerritsfles

According to Table 1 in Higler (1979) the microflora of the Gerritsfles has been studied at ten occasions at least between 1916 and 1978. The results have been reported by Heimans and Van der Werff in Dresscher et al. 1952, Higler 1979 and Schroevers and Van Dam & Sinkeldam in Van Dam et al. 1983. The diatoms were treated especially by Van Dam et al. 1981.

Schroevers gives a clear account of the changes in the non-diatomaceous algae over a sixty-years period. Although the diversity of the microphytes declined during this era, the pool is still a habitat for some rare and interesting algae. The relative importance of blue-green and green algae has increased over time. The desmid flora, however, severely impoverished. In 1918, 32 species were present and in 1931, 1950, and 1977 16, 20, and 14 species respectively. The typical Littorellion species disappeared, while species of more acid waters, rich in mosses, increased. Already Heimans (in Dresscher et al. 1952) concluded acidification of the pool from these observations.

In the diatoms a two-fold development was observed. A clear shift from circumneutral and acidophilous species (e.g. *Eunotia bilunaris*, *E. incisa*, *Brachysira vitrea* fo. *lanceolata*) to acidobiontic species, particularly *Eunotia exigua*, could be assessed. On the other hand, a number of species have appeared that are more or less indicative for a higher trophic level (e.g. *Cocconeis placentula*, *Melosira varians*, *Navicula cryptocephala*).

Kliplo

Beijerinck (1924) gives the first account of algae and other microorganisms from Kliplo. This small publication preceded his magnum opus, published in 1926. Cursory reports were published by Quispel (1941), Brantjes (1972), and Roelfs (1981). Diatoms were studied by Van Dam et al. (1981) and De Vries (1982, 1984). Other algae, especially desmids, were studied by Wartena (1954), Smit (1976), Coesel & Smit (1977), and Goessens (1983).

Goessens (1983) compared the numbers of desmids found by the several authors. Beijerinck recorded 70 species in the early twenties. After the first investigation, this number gradually decreases: in 1954, 58 species were met, in 1973 56 and in 1980 still only 48. Also the kinds of species changed. The earliest and latest reports have only 28 species in common. According to Coesel & Smit (1977) the changes in the desmid assemblages indicate a transition from an oligotrophic to an oligo-mesotrophic state of the pool.

Van Dam et al. (1981) studied the diatoms from some samples taken in 1924 and 1978 in order to demonstrate acidification. Both the pH spectra and the floristic composition indicated no apparent acidification. De Vries (1982, 1984) studied the diatoms from plankton tows, taken on two places in the pool with about six-week intervals between August 1979 and August 1980.

Most abundant were Eunotia bilunaris, E. incisa, Frustulia rhomboides var. saxonica, Tabellaria flocculusa, T. quadriseptata, Navicula subtilissima and N. hoefleri. He could not observe important differences between his two stations (one located near the sandy beach, the other near the island) and throughout his period of observation. On the other hand, important differences were found between diatom assemblages from different habitats (e.g. plankton and emersed moss tussocks).

Tongbersven-West

A desmid sample from the westernmost basin was studied by Verschoor (1977) and Coesel et al. (1978). They found Netrium digitus, Cylindrocystis brebisonii and Tetmemorus laevis as dominant species between peat mosses and bladderwort, while Euastrum binale var. gutwinskii, Micrasterias truncata and Cosmarium cucurbita were less common. This assemblage is characteristic for oligo- to slightly mesotrophic moorland pools, which are rich in peat mosses.

Groot Hasselsven

No data on microphyte assemblages in the past are available.

3.7 DIATOMS

All the slides studied are listed in App. 18. All the taxa recorded, with author names and acronyms of the names, which are used in most of the Tables, are listed in App. 19.

As stated in Section 2.6 most diatom taxa were identified with the keys listed by Van Dam (1984). Recent nomenclatorial and taxonomical changes suggested by Krammer & Lange-Bertalot (1985) were followed.

To prevent confusion the taxonomy and the nomenclature of some taxa have to be explained here.

Some species of the genus Anomoeoneis were transferred to Brachysira by Round & Mann (1981). The infraspecific taxa were renamed by Ross in Hartley (1986), excluding B. vitrea fo. lanceolata Van Dam (in Dickman et al. 1987). The correct name for E. lunaris (Ehrenberg) Grunow should be E. bilunaris (Ehrenberg) Nörpel (M. Nörpel, pers. comm.). The infraspecific taxa E. lunaris var. capitata (Grunow) Schoenfelt and var. excisa Grunow are provisionally named E. bilunaris var. capitata and excisa respectively in this report. Eunotia exigua var. meisteri (Hustedt) Nörpel was formerly known as E. meisteri Hustedt (M. Nörpel, pers. comm.). Eunotia glacialis Meister includes both E. gracilis (Ehrenberg) Rabenhorst and E. valida Hustedt (M. Nörpel, pers. comm.). The valves found during the present study were originally identified as E. valida.

The identity of Eunotia rhomboidea has been discussed at length by Van Dam et al. (1981). These authors postulate that this taxon is only an asymmetrical form of the concept of E. tenella, as illustrated and described by Hustedt (1932). However, recent research by M. Nörpel (unpublished) demonstrated that this concept of Eunotia tenella does not cover the original concept of this taxon. Therefore, this complex of both symmetrical and asymmetrical forms should be named E. rhomboidea Hustedt. I have seen the type material of this species in Bremerhaven. It includes both symmetrical and asymmetrical specimina, which intergrade without any discontinuity. The original concept of E. tenella applies to the coarsely striated, E. exigua-formed valves, as depicted by Petersen (1950). In the counts the symmetrical and asymmetrical forms were separated.

Navicula leptostriata was described by Jørgensen (1948) from some acid (pH 5.0-6.8) lakes in Denmark. After studying his type material I concluded that N. heimansii Van Dam et Kooyman (1982) is a synonym of this name.

The material of N. hoefleri Cholnoky was in excellent agreement with Figs. 30 and 31 in Ross & Sims (1978).

The name N. subtilissima Cleve may also have been used for N. pseudosubtilissima Manguin, which is impossible to separate from N. subtilissima without an electron microscope. The ecology of both species is very similar (Germain 1982).

The results of the counts are presented in full in the App. 20 to 26. The serial numbers in these appendices refer to the slides studied, listed in App. 18. The taxa with a relative abundance of at least 4 valves in one slide are listed in the Tables 19 to 25, together with the number of valves belonging to each of the classes of Hustedt's (1939) pH system in each sample (SUM-ACIB, SUM-ACPH etc.) and the diatom-inferred pH according to Renberg & Hellberg (1982) (PH-RENBE) and the weighted averaging method described before. In the following the weighted-average pH (PH-WA) will be discussed, if not especially mentioned. %PH-WA denotes the percentage of valves counted that was used for the calculation of PH-WA. RESTACIB denotes the number of valves of acidobiontic taxa which were present with less than four valves in all samples from a sampling station. RESTACPH etc. are defined similarly. RESTNOPH refers to those taxa that could not be classified in the pH system.

The total number of taxa (NRSPTOTA), number of taxa in the count (NRSPCOUN) and dominance (DOMINANCE) are used as diversity measures (Van Dam 1982). In Table 26 the average relative abundance of the most important diatom taxa in three periods is given, together with data on diatom-inferred pH (PH-RENBE) and diversity measures.

Achterste Goorven

Station E was studied most intensively, because from this station several samples which were taken before and after the extremely dry year 1921 were available. In this way it was possible to study the biological effects of a drought in the past.

The diatom assemblages from the three sample stations (Fig. 8) are rather different, particularly during the years 1919-29. After 1953, the diatom assemblages of the three stations became more similar (Table 26). As a whole the diatom assemblages in the years 1919-53 were typical for oligo- to mesotrophic, weakly to strongly acid pools. Species like Brachysira brebissonii, Cymbella gracilis, Eunotia elegans, Peronia fibula and Navicula leptostriata are rather common in most of the old samples and are rare elsewhere in The Netherlands and adjacent areas of Belgium and Germany. Moreover, a number of other rare taxa of more accidental occurrence, e.g. Amphora veneta var. capitata, Cymbella incerta, C. hebridica, Eunotia praerupta, Pinnularia nobilis and Stauroneis anceps fo. gracilis were found. The following rare taxa were only seen before 1953: Amphora thumensis, A. veneta var. capitata, Cymbella cesatii, C. hebridica, Navicula festiva, N. hassiaca, Pinnularia braunii (incl. var. amphicephala), P. hemiptera and P. legumen. These taxa are characteristic for slightly acid to neutral water with a low conductivity.

The differences between the diatom assemblages from different stations and periods are best seen from Table 26. For the calculation of the values

Table 19

ACHTERSTE GOORVEN station A. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom-inferred pH (PH-RENBE = according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: PE = periphyton, PT = plankton tow. 0 = taxon present outside the count, - = taxon not found.

R	YEAR	19	19	29	52	53	78	79	80	80	81	81	82	82	83	83	84
	MONTH	9	12	7	6	8	11	11	5	11	5	11	5	11	5	11	5
	KND OF SMPLE	PT	PT	PE	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT
R	SPECNAME																
1	ANOMSERI	-	-	-	-	5	4	0	0	-	1	-	0	1	-	-	3
1	EUNOEXIG	-	10	0	6	-	256	149	217	379	136	276	255	250	396	300	153
1	FRUSRvSA	12	3	7	10	57	19	34	25	3	40	15	27	21	1	5	9
1	NAVIHOEF	-	-	-	-	0	-	7	1	-	9	6	0	3	-	1	1
1	NAVISUSB	1	1	5	2	6	12	4	7	-	9	3	2	2	-	0	0
1	PINN363A	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
1	TABEQUAD	0	1	0	2	31	19	15	11	0	10	13	15	17	0	2	8
1	RESTACIB	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
2	ANOMSBfT	-	-	-	11	-	1	-	-	-	-	-	-	-	-	-	-
2	ANOMSvBR	-	-	0	-	12	19	33	13	4	23	16	11	15	0	4	3
2	CYMBGRAC	22	0	12	6	-	0	2	7	-	4	2	1	7	-	-	3
2	EUNOALPI	3	2	-	5	-	-	-	-	-	-	0	-	-	-	-	-
2	EUNODENT	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOELEG	1	0	1	10	2	4	11	5	-	6	3	4	1	-	-	0
2	EUNOPMfI	4	-	3	-	0	-	3	0	0	1	1	3	1	-	0	-
2	EUNOPRAE	4	0	0	2	-	0	0	0	0	1	1	0	1	-	0	0
2	EUNOPvMI	0	-	-	17	-	-	-	-	-	0	-	-	0	-	-	-
2	EUNORHOM	2	-	0	30	78	21	23	7	1	13	7	8	21	0	1	4
2	EUNOTENE	-	1	0	3	-	-	7	-	2	-	4	1	2	-	-	-
2	EUNOVENE	1	0	5	27	149	5	7	6	4	3	5	9	7	-	0	7
2	NAVIHEIM	0	0	10	4	1	0	2	1	-	4	1	-	1	-	-	2
2	NAVIMEDI	-	-	2	-	4	2	5	5	2	7	2	6	1	-	0	0
2	PEROHERI	0	-	0	5	1	-	1	0	1	3	0	-	0	-	-	0
2	PINNSILV	-	-	-	11	-	-	-	-	-	-	-	0	-	-	-	-
2	STENINTE	-	-	-	0	4	0	0	0	-	-	-	-	-	-	-	-
2	RESTACPH	-	1	1	9	4	2	1	3	-	2	1	-	2	-	-	-
3	ACHNMINU	88	189	112	44	1	1	2	2	-	14	1	2	-	-	0	-
3	ANOMEfLA	76	38	87	11	3	7	18	5	1	26	4	8	10	0	2	2
3	EUNOLUNA	0	0	1	132	39	4	1	2	0	3	2	5	2	2	78	199
3	FRAGVIRE	0	-	20	13	0	20	53	49	2	56	13	20	17	0	4	3
3	GOMPGRAC	1	0	-	4	-	-	-	0	-	-	0	-	-	-	-	-
3	NITZGRAC	1	-	0	6	1	-	-	0	-	-	-	0	-	-	-	-
3	PINNINTE	-	0	-	-	0	1	4	7	0	6	6	2	2	0	1	2
3	RESTCIRC	-	1	2	5	-	2	2	-	-	-	-	1	-	-	-	1
4	ACHNHUNG	-	0	-	4	-	-	-	-	-	-	-	-	-	-	-	-
4	ANOMEXIL	-	0	17	0	-	0	-	1	-	-	-	0	-	-	-	-
4	COCCPLAC	-	-	-	4	-	0	-	-	0	-	-	-	-	-	-	-
4	CYMBMICR	183	145	73	4	0	0	5	6	-	4	5	6	6	-	-	0
4	FRAGCvVE	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
4	NITZPERM	0	0	40	1	1	0	7	19	1	19	13	13	10	1	2	0
4	RESTALPH	1	4	2	3	-	1	-	-	-	-	-	1	-	-	-	-
5	RESTALKB	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
0	RESTNOPH	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
1	SUM-ACIB	13	15	12	25	99	310	209	262	382	205	313	299	294	397	308	174
2	SUM-ACPH	37	8	34	140	255	54	95	47	14	67	43	43	59	-	5	19
3	SUM-CIRC	166	228	222	215	44	35	80	65	3	105	26	38	31	2	85	207
4	SUM-ALPH	184	149	132	16	1	1	16	26	1	23	18	20	16	1	2	-
5	SUM-ALKB	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
0	SUM-NOPH	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
	PH-RENBE	6.4	6.3	6.3	5.9	4.7	4.3	4.9	4.8	3.5	5.0	4.6	4.7	4.6	3.5	4.6	5.1
	PH-WA	6.8	7.2	6.8	5.1	4.8	4.3	4.7	4.5	4.1	4.8	4.3	4.3	4.3	4.0	4.1	4.3
	%(PH-WA)	46	62	63	76	96	97	91	90	100	88	92	93	93	100	99	98
	NRSPTOTA	36	53	36	61	34	44	37	40	21	40	34	34	31	11	21	28
	NRSPCOUN	15	15	18	41	20	20	26	23	11	24	23	21	23	4	11	15
	DOMINANC	183	189	112	132	149	256	149	217	379	136	276	255	250	396	300	199

in this table the Sphagnum squeeze samples from Table 21 and App. 22 have not been included.

In the period 1919-29 large differences between the stations existed. Station A was dominated by Achnanthes minutissima, Cymbella microcephala and Brachysira vitrea fo. lanceolata. Nitzschia perminuta and Cymbella gracilis were subdominants. Station B was dominated by Navicula leptostriata and Fragilaria virescens, with Frustulia rhomboides var. saxonica, Brachysira exilis fo. lanceolata and Nitzschia perminuta as other important taxa. At station E Frustulia rhomboides var. saxonica, Tabellaria quadriseptata, Eunotia incisa and Navicula leptostriata were dominant taxa. The latter diatom assemblage is quite similar to the present assemblage of Kliplo

Table 20

ACHTERSTE GOORVEN station B. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom-inferred pH (PH-RENBE according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: PT = plankton tow, SS = Sphagnum squeeze. 0 = taxon present outside the count, - = taxon not found.

	YEAR	25	26	26	28	29	50	52	53	75	78	79	80	80	81	81	82	82	83	83	84
	MONTH	7	4	9	8	7	8	6	8	9	11	11	5	11	5	11	5	11	5	11	5
KND OF SMPLE		PT	PT	PT	PT	PT	PT	PT	SS	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT
R	SPECNAME																				
1	EUNOEXIG	-	-	-	-	-	-	-	9	156	352	340	289	399	322	398	392	389	358	357	255
1	FRUSRvSA	32	58	29	45	25	33	101	30	19	5	3	15	-	11	-	2	1	6	12	4
1	NAVIHOEF	0	0	-	0	0	-	-	-	0	-	1	5	-	2	-	0	0	1	-	0
1	NAVISUSB	3	6	4	4	1	11	-	4	2	0	0	3	-	1	-	0	-	1	1	0
1	TABEQUAD	1	0	1	2	0	21	25	59	56	5	6	9	0	4	0	1	0	4	4	13
1	RESTACIB	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
2	ANOMSvBR	2	4	6	7	9	39	13	8	15	3	1	2	-	5	0	1	1	0	-	1
2	CYMBGRAC	9	17	11	3	4	1	1	8	0	0	0	1	-	0	1	0	-	0	0	0
2	EUNOELEG	7	5	13	15	5	3	6	2	2	0	0	-	-	0	-	C	-	1	-	1
2	EUNOPECT	0	0	-	4	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
2	EUNOPMfI	2	1	-	12	4	-	-	-	-	-	0	-	-	0	-	-	-	-	-	0
2	EUNORHOM	1	0	6	0	3	16	14	20	127	5	14	12	-	11	-	1	1	7	2	4
2	EUNOVENE	11	1	5	9	2	59	135	127	11	3	2	5	1	4	0	0	0	4	3	2
2	NAVIHEIM	83	94	120	58	62	9	6	9	-	2	0	4	-	2	1	-	-	1	-	1
2	NAVIMEDI	4	4	9	7	9	9	6	-	2	1	0	6	-	2	-	0	5	-	3	0
2	PEROHERI	5	5	4	8	3	2	2	6	0	-	-	0	-	2	-	-	-	0	-	0
2	STENARCT	-	-	0	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	STENINTE	0	0	0	0	0	6	0	3	-	0	0	0	-	0	-	0	-	0	0	-
2	TABEFLOC	10	1	6	7	9	5	2	0	1	1	0	0	-	2	-	0	0	0	0	0
2	RESTACPH	1	1	6	3	1	-	3	4	1	2	-	2	-	-	-	-	-	-	-	1
3	ACHNMINU	3	4	2	5	4	6	-	2	-	0	1	3	-	-	-	-	0	1	-	-
3	ANOMEfLA	67	54	53	19	34	44	11	11	3	4	2	8	-	4	0	-	0	0	1	1
3	EUNOLUNA	19	19	4	7	10	22	52	23	1	3	0	1	-	2	-	0	1	5	8	102
3	FRAGVIRE	46	56	64	141	119	74	17	59	2	7	24	30	-	17	-	1	0	11	9	10
3	NITZGRAC	2	3	6	4	0	5	2	1	0	0	-	-	-	-	-	-	-	-	-	0
3	NITZHANT	-	-	0	-	-	4	-	-	-	2	-	-	-	-	-	-	-	-	-	-
3	RESTCIRC	1	-	-	4	1	6	1	1	1	-	4	2	-	1	-	2	-	-	-	-
4	ANOMEXIL	6	9	-	3	9	6	-	-	-	2	-	-	-	-	-	-	-	-	-	-
4	CYMBMICR	7	4	3	6	2	4	2	-	0	1	-	0	-	1	-	-	2	-	-	2
4	NITZPERM	78	54	48	27	84	1	1	11	-	2	2	3	-	5	-	0	0	-	-	0
4	RESTALPH	-	-	-	-	-	2	-	3	1	-	-	-	-	-	-	-	-	-	-	-
0	NAVICBRE	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	SUM-ACIB	36	64	34	51	26	65	126	102	233	362	350	321	399	342	398	395	390	370	374	272
2	SUM-ACPH	135	133	186	133	111	156	188	187	159	17	17	32	1	28	2	2	7	13	8	10
3	SUM-CIRC	138	136	129	180	168	161	83	97	7	16	31	44	-	24	-	3	1	17	18	116
4	SUM-ALPH	91	67	51	36	95	13	3	14	1	5	2	3	-	6	-	-	2	-	-	2
5	SUM-ALKB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	SUM-NOPH	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PH-RENBE	5.8	5.6	5.6	5.6	5.9	5.4	4.9	5.1	3.9	4.2	4.2	4.4	-	4.3	-	3.2	3.6	3.9	3.9	4.7
	PH-WA	5.8	5.7	5.9	5.7	5.8	5.3	4.8	5.1	4.5	4.1	4.2	4.3	4.0	4.2	4.0	4.0	4.0	4.1	4.1	4.2
	%(PH-WA)	71	75	78	78	72	88	97	92	99	98	99	98	100	98	100	100	100	100	100	99
	NRSPTOTA	40	43	52	51	36	48	25	29	28	43	33	34	4	41	10	26	24	29	20	34
	NRSPCOUN	23	20	23	28	21	30	20	24	16	17	13	20	2	19	3	8	7	12	10	15
	DOMINANC	83	94	120	141	119	74	135	127	156	352	340	289	399	322	398	392	389	358	357	255

Table 21

ACHTERSTE GOORVEN station E. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom inferred pH (PH-RENBE = according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: BL = blobs, JB = Juncus bulbosus epiphytes, PT = plankton tow, SQ = squeeze of coarse organic material. 0 = taxon present outside the count, - = taxon not found.

R	YEAR	19	19	20	20	21	22	22	22	24	25	26	28	75	78	79	79	80	80	80	80	80	81	81	81	82	82	83	83	84
	MONTH	6	9	2	8	8	8	10	10	4	5	4	8	9	11	11	12	2	3	4	5	11	5	5	11	5	11	5	11	5
	KND OF SMPLE	PT	PT	PT	PT	BL	BL	PT	PT	PT	PT	PT	PT	JB	PT	PT	SQ	SQ	SQ	SQ	PT	PT	SQ	PT	PT	PT	PT	PT	PT	PT
R	SPECNAME																													
1	ANOMSERI	0	-	-	2	-	-	-	-	-	-	-	-	8	3	0	-	0	-	-	0	2	-	-	0	0	0	4	1	0
1	EUNOEXIG	-	-	2	-	-	-	0	3	0	-	-	-	153	291	398	394	390	393	399	395	381	393	392	399	398	398	377	348	352
1	FRUSRvSA	102	187	46	103	76	182	73	113	114	121	100	55	17	12	-	1	3	0	1	2	1	0	0	0	0	0	5	0	7
1	NAVIHOEF	4	15	2	12	1	-	0	8	18	2	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1	NAVISUSB	57	61	12	41	11	-	2	14	10	25	48	2	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	TABEQUAD	108	55	213	122	16	15	17	70	25	46	30	0	124	12	0	2	3	2	0	1	11	5	0	0	0	1	2	4	4
1	RESTACIB	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-
2	ANOMSvBR	-	-	-	-	-	-	-	-	-	-	-	6	8	13	-	-	0	0	0	-	-	0	-	-	-	-	-	0	0
2	CYMBGRAC	0	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOALPI	2	0	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOELEG	-	0	3	-	0	-	2	1	9	2	2	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2	EUNORHOM	1	2	-	-	-	-	-	-	-	-	-	7	86	17	-	2	0	2	0	0	1	0	-	-	0	-	0	6	7
2	EUNOTENE	-	-	-	-	-	-	-	4	2	-	-	-	-	14	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
2	EUNOVENE	69	27	83	15	10	153	118	41	62	141	111	6	2	12	-	-	-	-	-	-	1	-	-	0	0	0	0	-	0
2	NAVIHEIM	0	22	5	67	277	3	83	92	97	2	22	116	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIMEDI	-	-	-	-	-	-	-	0	-	-	-	5	0	1	-	0	-	-	0	-	-	-	-	-	-	-	0	2	-
2	PEROHERI	-	0	-	-	-	-	8	1	5	4	2	11	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	TABEFLOC	-	-	7	-	-	2	0	1	2	1	-	14	-	1	-	0	-	-	0	-	0	-	-	-	-	-	-	-	0
2	RESTACPH	1	1	-	-	-	2	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-
3	ANOMEfLA	20	-	-	-	-	9	68	19	14	9	-	35	0	4	-	0	-	0	-	-	-	-	-	1	0	0	0	0	0
3	EUNOLUNA	36	28	24	38	9	32	29	14	40	47	83	12	1	2	-	0	4	1	0	1	1	2	-	-	2	0	4	39	27
3	FRAGVIRE	-	-	-	-	-	-	-	-	-	-	-	64	-	0	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-
3	PINNINTE	0	0	-	0	0	-	-	0	0	0	0	0	0	6	-	0	0	0	0	0	0	0	-	0	0	0	0	0	2
3	RESTCIRC	-	2	-	-	-	-	-	2	-	-	-	3	1	3	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-
4	ANOMEXIL	-	-	-	-	-	2	-	0	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
4	NITZPERM	-	-	-	-	-	-	0	-	-	-	-	39	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	0	-
4	RESTALPH	-	-	2	-	-	-	-	-	-	-	-	2	-	-	1	1	-	-	-	-	-	-	6	-	-	-	-	-	-
1	SUM-ACIB	271	318	276	280	104	197	92	208	169	194	180	57	302	322	398	397	396	397	400	398	395	398	392	399	398	399	390	353	363
2	SUM-ACPH	73	52	98	82	287	160	211	157	177	150	137	184	96	63	1	2	-	2	-	-	4	-	-	-	-	1	2	8	8
3	SUM-CIRC	56	30	24	38	9	41	97	35	54	56	83	114	2	15	-	-	4	1	-	2	1	2	2	1	2	-	4	39	29
4	SUM-ALPH	-	-	2	-	-	2	-	-	-	-	-	45	-	-	1	1	-	-	-	-	-	-	6	-	-	-	4	-	-
5	SUM-ALKB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PH-RENBE	4.4	4.2	4.2	4.3	4.0	4.5	5.0	4.3	4.6	4.5	4.7	5.5	3.2	3.9	3.3	3.3	3.3	2.8	-	3.1	2.8	3.1	4.0	2.8	3.1	-	3.9	4.2	4.1
	PH-WA	4.6	4.4	4.7	4.7	5.8	4.6	5.4	5.0	4.6	5.1	4.6	5.7	4.5	4.2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.1	4.1
	%(PH-WA)	99	96	98	97	100	99	98	96	98	92	99	81	98	99	100	100	100	100	100	100	100	100	98	100	100	100	99	100	100
	NRSPTOTA	19	17	13	15	13	10	17	36	20	12	13	43	15	38	7	12	10	10	13	11	11	8	17	7	10	9	16	14	16
	NRSPCOUN	10	10	12	8	7	9	9	16	13	11	9	23	9	20	3	5	4	5	2	5	8	3	8	2	2	3	9	6	7
	DOMINANC	108	187	213	122	277	182	118	113	114	141	111	116	153	291	398	394	390	393	399	395	381	393	392	399	398	398	377	348	352

(Table 26), which is a humic pool. Particularly Frustulia rhomboides var. saxonica is known as an indicator of humic acid waters. Presumably Achterste Goorven was, at least near station E, more humic in the past than it is presently.

In the period 1975-84 the similarity between the three stations is much greater than in 1919-29. Eunotia exigua, an acidobiontic species, is the dominant species on all the stations and its abundance is larger than that of any of the dominant species sixty years ago. The relative abundance of Eunotia exigua increases from station A to E. In contrast circumneutral diatoms like Eunotia bilunaris and Fragilaria virescens decrease from station A to E in the most recent period.

The period in between, 1950-53, was investigated at the stations A and B. The majority of the species of the earliest period was still present, although the relative abundance of alkaliphilous species, like Nitzschia

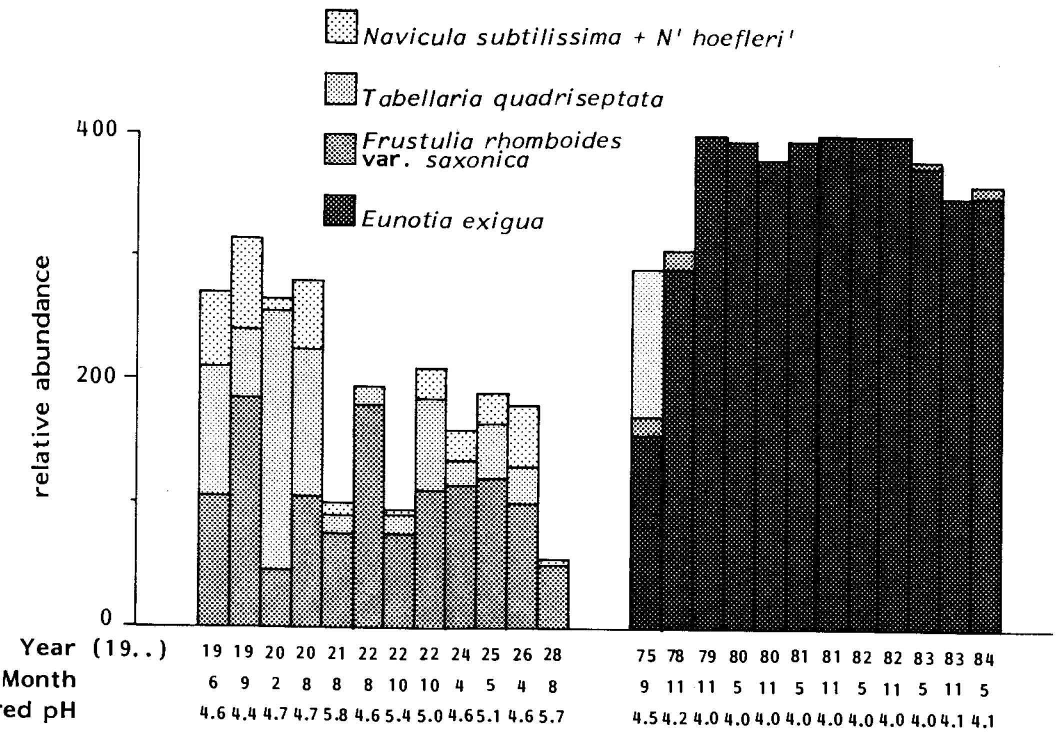


Fig. 27. Changes in the relative abundance of acidobiontic diatoms in Achterste Goorven (station E).

perminuta and Cymbella microcephala, was much lower than in 1919-29. The same is true for circumneutral taxa such as Achnanthes minutissima and Brachysira exilis fo. lanceolata. Species which are characteristic for acid waters, e.g. Tabellaria quadriseptata, Eunotia rhomboidea and especially Eunotia incisa are more abundant in 1950-53 than in 1919-29. Particularly the latter species developed optimally in the intermediate period.

The diatom-inferred pH (Table 26) within the period 1919-29 gradually declines from 6.9 at station A, via 5.8 at station B to 4.9 at station E. In 1975-84 these values are 4.3, 4.1 and 4.1 respectively. The values during the period 1950-53 at stations A and B are in between. Thus the diatom-inferred pH has its largest decline (1.6 units) at station A and its smallest decline at station E (0.8 unit). These changes are statistically significant (Table 27). The pH gradient, which was present sixty years ago, apparently still persists, although the extremes are closer together and the diatom-inferred pH indicates acidification at all sampling stations. The present gradient is not detectable by direct measurement of pH (Section 3.4.3).

The series of samples taken at station E between 1919 and 1928 includes the extremely dry year 1921, when a large proportion of the bottom of the pool was exposed to the atmosphere (Section 3.3.2). In August 1921, and also August 1922, it was apparently impossible for Heimans to collect the usual plankton tow samples, as he collected "klodders" (blobs). The species composition of the diatom assemblages as well as the diatom-inferred pH were not essentially different before and after the dry year. After the dry year 1976 a considerable increase of Eunotia exigua occurred (Table 21, Fig. 27).

The results, presented in the Tables 19, 20, and 21, mainly refer to plankton tow samples, but occasionally epiphytic diatoms from Juncus bulbosus, Sphagnum etc. have been studied. The differences between plankton tow samples and other samples from the same period are negligible, if present at all. Also no indications are found for seasonal changes by inspection of Tables 19, 20, and 21. Both the variation between substrates and the seasonal variation is less than the variation between two plankton tow samples taken at station E on October 21, 1922 (Table 21).

In total 151 diatom taxa were observed at the three stations A, B, and E over the period 1919-84 (Table 28). The species richness lowers from west to east as 109, 99, and 92 taxa were found at these stations respectively.

The number of taxa found at each of the stations during the periods 1919-1929 and 1975-84 seems to be constant (65-76), but taking into account the comparatively small number of samples during the earliest period the number of taxa has declined since (Table 28). This agrees with the average total number of species in the sample and the number of species in the count, which declined significantly between these two periods. The dominance increased significantly over the same range of time (Tables 27, 28).

Thus over the last sixty years both the diversity within the whole pool and the diversity at each sampling station decreased. The dissimilarity between the three sample stations decreased too.

Gerritsfles

The seven diatom samples, taken in 1916 and 1918 by Heimans (Table 22) are from several localities in the pool. Unfortunately the exact position of most of his sample stations is not known. The third sample in the table (from Utricularia minor?) was not taken in the open water, but in the marshy area at the NW side of the pool. Also the localities of the sampling stations from 1950 until 1974 could not be traced. The samples taken in 1964, 1965, and 1977 are from the cove on the SE side of the spit near the permanent sample station (Fig. 15). All samples from 1978 onwards were taken at the permanent sample station.

For the calculation of the mean relative abundances of the most prominent diatom taxa, the diversity indices and diatom-inferred pH (Table 26) the sample from April 1970 (Table 22) was skipped, because it is obviously contaminated with diatoms from eutrophic waters, e.g. Asterionella formosa, Fragilaria crotonensis and F. ulna. This sample was taken during an excursion when different types of water were investigated (Brantjes 1972) and left out of consideration for the calculation of the number of taxa which was found in Gerritsfles. The non-plankton tow samples from 1977 and 1978 and also the first plankton sample of November 1978 in Table 22 were skipped for the calculations of average values.

As a whole the diatom flora of Gerritsfles (Tables 22, 26, App. 23) is typical for strongly to extremely acid waters. Taxa like Brachysira vitrea and Navicula subtilissima are rather common in the eldest samples and are rare elsewhere in The Netherlands and adjacent areas of Belgium and Germany. Besides, a number of other rare taxa were present rather regularly in the eldest samples and gradually declined in later years (Cymbella gracilis, Navicula leptostriata, Neidium affine var. longiceps and Stauroneis anceps fo. gracilis. Eunotia diodon, E. meisterii, Navicula festiva and N. cf. variostriata were present before 1961 with small quantities, but have not been refound.

The differences between the periods 1916-18, 1950-60, and 1964-84 are best seen from Table 26. In the first period Eunotia incisa and E. bilunaris were dominant taxa, while Brachysira vitrea fo. lanceolata, E. rhomboidea (asymmetrical and symmetrical forms), Frustulia rhomboides var. saxonica and Navicula subtilissima where subdominant. In the second period E. rhomboidea (predominantly asymmetrical forms) and F. rhomboides var. saxonica were dominant taxa, while E. incisa was subdominant. In the most recent period E. exigua became dominant with a mean relative abundance of 314 valves. F.

Table 22

GERRITSFLES. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom-inferred pH (PH-RENBE according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: BA = Batrachospermum, BO = bottom marerial, EP = epipsammon, PT = plankton tow, SP = sedimentation plankton, UT = Utricularia minor? 0 = taxon present outside the count, - = taxon not found.

	YEAR	16	16	16	18	18	18	18	50	50	51	60	64	64	65	65	70	73	74	77	77	78	78	78	78	78	79	80	80	81	81	81	82	82	83	83	84
	MONTH	6	6	7	6	7	7	7	9	9	9	7	5	11	4	10	4	6	4	11	11	8	11	11	11	11	11	5	11	2	5	11	5	11	5	11	5
	KND OF SMPLE	BA	PT	UT	PT	BO	PT	PT	PT?	PT?	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	BO	SP	PT	PT	EP	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT
R	SPECNAME																																				
1	CALOLvDE	-	0	-	3	7	5	3	0	0	2	-	-	-	-	-	-	-	-	0	0	-	-	-	1	0	-	-	-	-	-	-	-	0	0	-	0
1	EUNOEXIG	-	6	11	18	18	5	6	16	86	10	24	249	364	328	376	242	268	370	371	272	394	378	400	364	355	383	396	395	374	224	219	273	270	250	263	154
1	EUNOPALU	-	-	4	-	-	-	-	-	-	-	-	5	-	3	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1	FRUSRvSA	66	18	24	33	20	24	25	36	121	198	49	35	10	26	1	4	3	5	7	11	1	3	0	5	8	11	1	5	26	174	180	124	41	60	55	63
1	NAVISUSB	14	3	1	37	61	65	52	6	-	1	2	1	-	-	-	-	-	-	1	6	-	2	-	-	2	-	-	-	-	-	-	-	1	0	-	1
1	TABEBINA	-	-	-	-	-	-	-	-	0	9	0	0	-	-	-	0	-	0	-	1	-	-	-	-	1	-	-	-	0	0	-	-	1	0	1	0
1	TABEQUAD	-	2	-	18	9	-	3	10	10	6	7	37	3	23	15	62	31	5	1	11	0	0	0	5	5	0	0	-	-	0	0	3	67	54	19	155
1	RESTACIB	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	ACHNMARG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	CYMBGRAC	-	-	-	4	-	0	0	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
2	EUNOELEG	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNORHOM	-	6	4	25	15	53	82	139	75	104	130	16	13	4	7	1	81	8	7	46	4	4	-	6	6	3	-	-	0	2	-	0	4	11	55	16
2	EUNOTENE	-	11	101	5	8	19	32	64	38	8	29	2	-	2	-	1	11	0	-	6	-	7	-	13	4	-	-	-	0	-	-	0	5	-	2	2
2	EUNOVENE	9	289	54	161	108	27	76	80	43	12	37	3	4	5	0	-	1	3	-	12	1	2	-	2	6	-	-	-	0	-	-	-	7	4	0	3
2	FRUSRHOM	0	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	0	-	-	-	-	1	-	-
2	NAVIHEIM	-	-	-	2	2	8	3	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIMEDI	-	-	15	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NEIDAvLO	-	0	-	-	8	1	3	8	0	1	2	-	-	-	-	-	-	-	-	2	0	0	-	1	0	-	-	-	-	-	-	-	-	-	-	-
2	PINNAPPE	-	-	90	-	-	-	-	0	-	-	1	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNSILV	-	0	2	-	-	-	-	-	-	-	-	4	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	STAUAfGR	-	-	-	3	5	3	3	0	-	-	0	-	-	-	-	-	-	-	-	1	0	0	-	-	-	-	-	-	-	-	-	-	-	0	-	-
2	TABEFLOC	-	13	0	18	20	23	10	15	17	6	10	3	0	-	-	18	1	1	0	4	0	2	-	2	3	1	-	-	-	-	-	-	0	1	1	1
2	RESTACPH	-	1	1	2	-	1	-	3	1	3	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	ACHNMINU	-	-	-	3	1	8	-	-	1	4	3	-	-	-	-	1	2	-	1	-	-	0	-	-	2	-	-	-	-	-	-	-	-	-	-	-
3	ANOMEfLA	-	-	-	23	33	36	34	6	0	6	3	-	-	-	-	-	-	-	6	11	-	-	-	0	2	-	-	-	-	-	-	-	0	2	-	-
3	EUNOLUNA	310	45	87	31	65	99	60	10	7	-	25	20	-	2	-	-	-	8	3	5	-	0	-	-	1	2	2	-	-	-	-	0	-	-	2	0
3	FRAGVIRE	-	0	-	0	-	1	-	-	-	10	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NEIDAFFI	0	1	1	-	-	-	-	3	0	0	0	-	0	2	-	-	0	0	1	-	-	1	0	1	0	0	-	-	0	-	1	0	2	7	1	1
3	NITZGRAC	-	-	-	-	0	6	4	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NITZHANT	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNINTE	0	1	1	3	9	0	2	1	0	0	3	-	-	-	-	-	0	-	-	5	0	1	-	0	3	-	-	-	0	0	0	0	1	9	-	4
3	PINNMICR	1	0	2	0	-	6	2	1	-	-	73	25	5	5	1	-	-	-	2	1	0	0	0	0	-	-	-	-	-	-	-	-	1	1	-	-
3	RESTCIRC	-	3	2	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ASTEFORM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGULNA	-	-	-	0	-	-	-	0	-	-	0	-	-	-	0	37	-	0	-	-	-	0	0	-	-	0	-	-	-	-	-	-	-	-	-	-
4	NITZPERM	-	-	-	3	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
4	RESTALPH	-	1	-	1	-	1	-	-	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
5	STEPROTG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
5	RESTALKB	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	NITZ199A	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	RESTNOPH	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	SUM-ACIB	80	29	40	110	115	99	89	68	217	227	83	327	377	380	392	309	304	380	380	301	395	383	400	375	371	394	397	400	400	398	399	400	380	364	339	373
2	SUM-ACPH	9	320	267	226	166	135	209	311	174	147	209	28	17	11	7	29	94	12	7	72	5	15	-	24	19	4	-	-	-	2	-	-	16	17	58	22
3	SUM-CIRC	311	50	93	60	109	164	102	21	8	20	108	45	5	9	1	4	2	8	13	24	-	2	-	1	8	2	2	-	-	-	1	-	4	19	3	5
4	SUM-ALPH	-	1	-	4	-	1	-	-	1	6	-	-	-	-	-	52	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-
5	SUM-ALKB	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	SUM-NOPH	-	-	-	-	10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PH-RENBE	5.5	4.9	5.1	4.8	4.9	5.2	5.0	4.4	3.9	4.4	5.0	4.3	4.6	3.7	2.8	5.4	3.2	3.6	3.8	4.1	-	3.1	-	2.8	3.9	3.1	3.5	-	-	-	2.8	-	3.4	3.9	3.3	3.4
	PH-WA	4.3	5.0	4.7	4.9	4.8	4.8	4.9	4.9	4.6	4.6	4.9	4.2	4.1	4.1	4.1	4.2	4.3	4.1	4.1	4.3	4.0	4.1	4.0	4.1	4.1	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.4
	%(PH-WA)	100	99	77	95	94	94	97	97	100	94	99	97	100	94	99	83	100	100	100	96	83	100	100	99	100	100	100	99	100	100	100	100	99	98	100	100
	NRSPTOTA	10	28	18	31	22	28	21	22	23	24	25	18	12	11	8	18	12	13	17	26	10	24	7	20	20	8	5	2	11	6	6	9	19	18	13	14
	NRSPCOUN	5	15	16	22	19	21	17	16	11	22	17	12	7	10	5	16	9	7	10	19	4	9	1	10	14	5	4	2	2	3	3	3	11	11	10	10
	DOMINANC	310	289	101	161	108	99	82	139	121	198	130	249	364	328	376	242	268	370	371	272	394	378	400	364	355	383	396	395	374	224	219	273	270	250	263	155

rhomboides var. saxonica was the only subdominant taxon.

The diatom-inferred pH (Table 26) declines significantly (Table 27) from 4.8 to 4.1 over the last 70 years.

The major break in the long-term development of the diatom assemblages in the pool Gerritsfles is between 1960 and 1964 (Table 22). In that period the constantly low relative abundance of c. 20 valves of Eunotia exigua changed to a constantly high relative abundance of c. 317 valves (Fig. 28). At the same time other taxa (e.g. E. rhomboides, E. incisa, Tabellaria flocculosa) declined all of a sudden. Pinnularia microstauron developed optimally in this period of transition. Rapid inspection of a sample of October 1958 (leg. P. Leentvaar) confirmed these observations. Presumably these changes were induced by the extremely dry summer of 1959 (Schuurmans 1977), when probably a large part of the bottom of the pool fell dry. The concomitant release of sulphate from the sediment after refilling (Vangenechten et al. 1981, Van Dam et al. 1981) may have induced the

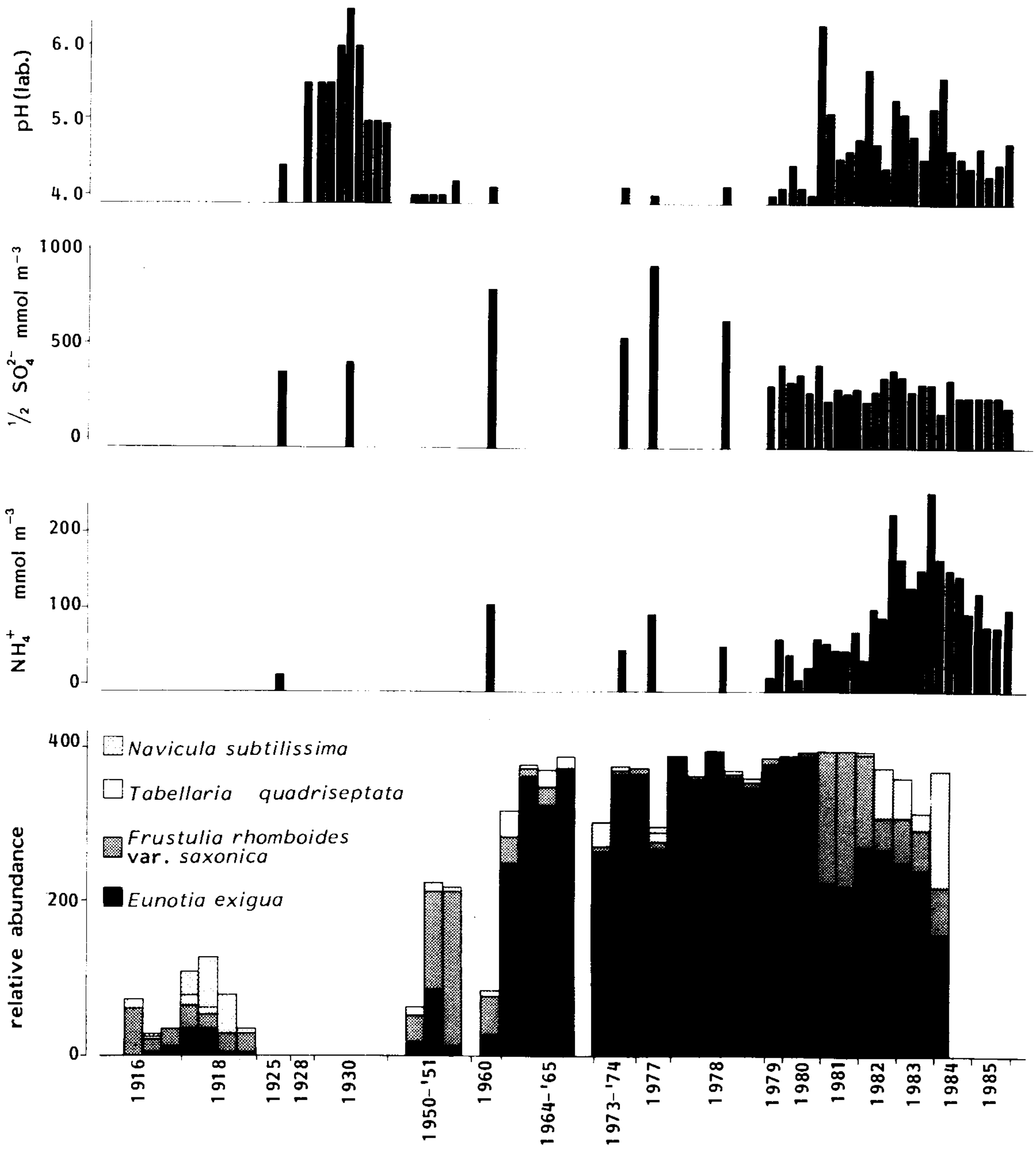


Fig. 28. Changes in some chemical parameters and relative abundance of acidobiontic diatoms in Gerritsfles.

enormous increase of Eunotia exigua and the decrease of other species with a time lag of a few years. As a matter of fact the pool of sulphur compounds in the sediment probably was formed during decades of high wet and by deposition of atmospheric sulphur.

The results, presented in Table 22, mainly refer to plankton tow samples, but occasionally epiphytic or bottom-dwelling diatoms have been studied. The Batrachospermum sample from 1916 differs from other samples in its period by the high relative abundance of Eunotia bilunaris and the Utricularia minor? sample by its high relative abundance of symmetrical forms of E. rhomboidea and Pinnularia appendiculata. This sample was not taken from the open water but from the shallow, marshy area at the NW side, which falls frequently dry in summer. The bottom sample is not different from other samples within this period. The Sphagnum samples of November 1977

Table 23

KLIPLO. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom-inferred pH (PH-RENBE = according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: PT = plankton tow, SP = sedimentation plankton. 0 = taxon present outside the count, - = taxon not found.

	YEAR	24	29	48	58	62	64	70	72	72	78	79	80	81	81	82	82	83	83	84
	MONTH	8	6	5	5	8	5	4	7	7	11	10	5	5	11	5	11	5	11	5
	KND OF SMPLE	PT	PT	PT	PT	SP	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT
R	SPECNAME																			
1	ANOMSERI	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-
1	EUNOEXIG	0	0	-	3	6	11	19	6	76	1	3	4	3	0	1	0	3	8	0
1	FRUSRvSA	56	25	25	23	29	44	54	271	224	28	198	154	68	96	95	129	21	64	70
1	NAVIHOEF	11	13	4	2	-	1	3	-	79	37	2	7	13	1	24	18	1	4	11
1	NAVISUSB	50	11	1	2	8	39	26	0	2	77	50	42	4	137	46	95	28	99	144
1	TABEQUAD	22	12	12	1	0	1	2	61	0	4	8	4	3	2	18	4	3	4	2
1	RESTACIB	-	-	-	-	1	4	1	-	-	-	-	-	1	-	-	-	-	-	-
2	CYMBGRAC	-	4	27	-	-	-	-	-	1	1	-	0	-	0	0	-	0	0	0
2	EUNOPOLY	-	5	4	0	0	2	2	-	-	8	0	1	1	0	3	0	3	0	0
2	EUNORHOM	25	3	8	4	34	7	50	5	0	21	22	45	83	39	20	42	241	100	51
2	EUNOTENE	8	0	0	-	16	2	2	2	-	10	1	1	4	1	2	6	1	2	0
2	EUNOVENE	96	34	21	8	116	1	6	6	1	20	5	37	16	22	11	20	57	52	33
2	NAVIHEIM	2	88	78	101	1	39	25	18	1	98	5	13	6	22	93	30	7	5	11
2	STAUAfGR	0	0	10	1	0	3	-	-	-	3	0	1	-	1	1	3	0	1	0
2	TABEFLOC	72	116	36	38	50	13	105	22	0	9	51	21	82	9	21	15	15	16	25
2	RESTACPH	-	-	-	-	1	-	4	-	-	5	-	-	1	-	2	2	1	-	-
3	ACHNMINU	10	1	10	-	-	1	1	-	-	-	-	-	-	0	-	1	-	-	-
3	ANOMEfLA	1	3	100	197	28	87	27	2	0	22	5	18	15	8	32	12	7	0	11
3	EUNOLUNA	35	82	3	9	96	47	4	2	1	10	35	26	90	58	12	10	10	41	25
3	FRAGVIRE	-	1	39	1	3	4	-	-	4	30	1	1	1	0	5	2	0	0	4
3	NITZGRAC	-	0	9	7	9	72	3	-	1	1	13	17	2	2	5	2	2	0	10
3	PINNINTE	0	0	2	1	0	3	0	0	-	7	1	4	6	2	8	7	0	3	3
3	RESTCIRC	-	1	6	1	2	8	1	1	1	2	-	4	1	-	-	2	-	1	-
4	ACHNLANC	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ANOMEXIL	1	-	-	-	-	2	-	-	-	5	-	-	-	-	-	0	-	-	-
4	ASTEFORM	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
4	DIATELON	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPACUM	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPPARV	5	-	5	0	-	1	2	-	0	-	-	-	0	0	1	-	-	-	-
4	MELOITGR	-	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-
4	RESTALPH	1	1	-	1	-	4	5	4	1	1	-	-	-	-	-	-	-	-	-
5	STEPROTG	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-
1	SUM-ACIB	139	61	42	31	44	100	105	338	389	147	261	211	92	236	184	246	56	179	227
2	SUM-ACPH	203	250	184	152	218	67	194	53	3	175	84	119	193	94	153	118	325	176	120
3	SUM-CIRC	46	88	169	216	138	222	36	5	7	72	55	70	115	70	62	36	19	45	53
4	SUM-ALPH	12	1	5	1	-	11	52	4	1	6	-	-	-	-	1	-	-	-	-
5	SUM-ALKB	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-
	PH-RENBE	4.8	5.0	5.4	5.5	5.3	5.3	6.0	4.0	3.7	4.8	4.4	4.6	5.0	4.6	4.6	4.3	4.4	4.5	4.5
	PH-WA	4.8	5.2	5.9	6.1	4.9	5.2	5.0	4.5	4.2	5.3	4.4	4.6	4.8	4.4	5.1	4.6	4.9	4.5	4.5
	%(PH-WA)	96	94	85	97	97	77	81	99	78	85	96	93	96	99	92	94	99	99	95
	NRSPTOTA	34	28	27	26	24	38	42	20	24	36	20	25	25	31	33	29	22	24	25
	NRSPCOUN	16	16	22	17	16	30	28	15	13	23	15	19	19	14	20	20	15	14	13
	DOMINANC	96	116	100	197	116	87	105	271	224	98	198	154	90	137	95	129	241	100	144

and August 1978 and the epipsammon material from November 1978 are not essentially different from other samples from the same period, but the bottom sample of November 1977 is differentiated by relatively high proportions of e.g. E. rhomboidea and E. incisa. The plankton tow samples of November 1978 are from different places in the pool, but their composition is very similar.

In total 94 diatom taxa were observed over the period 1916-84 (Table 28). In 1916-18 63 taxa were seen in 7 samples, in 1950-60 43 taxa in 4 samples and in 1964-84 62 taxa in 21 samples. If we take into account the relatively large number of samples from the last 20 years, there seems to be

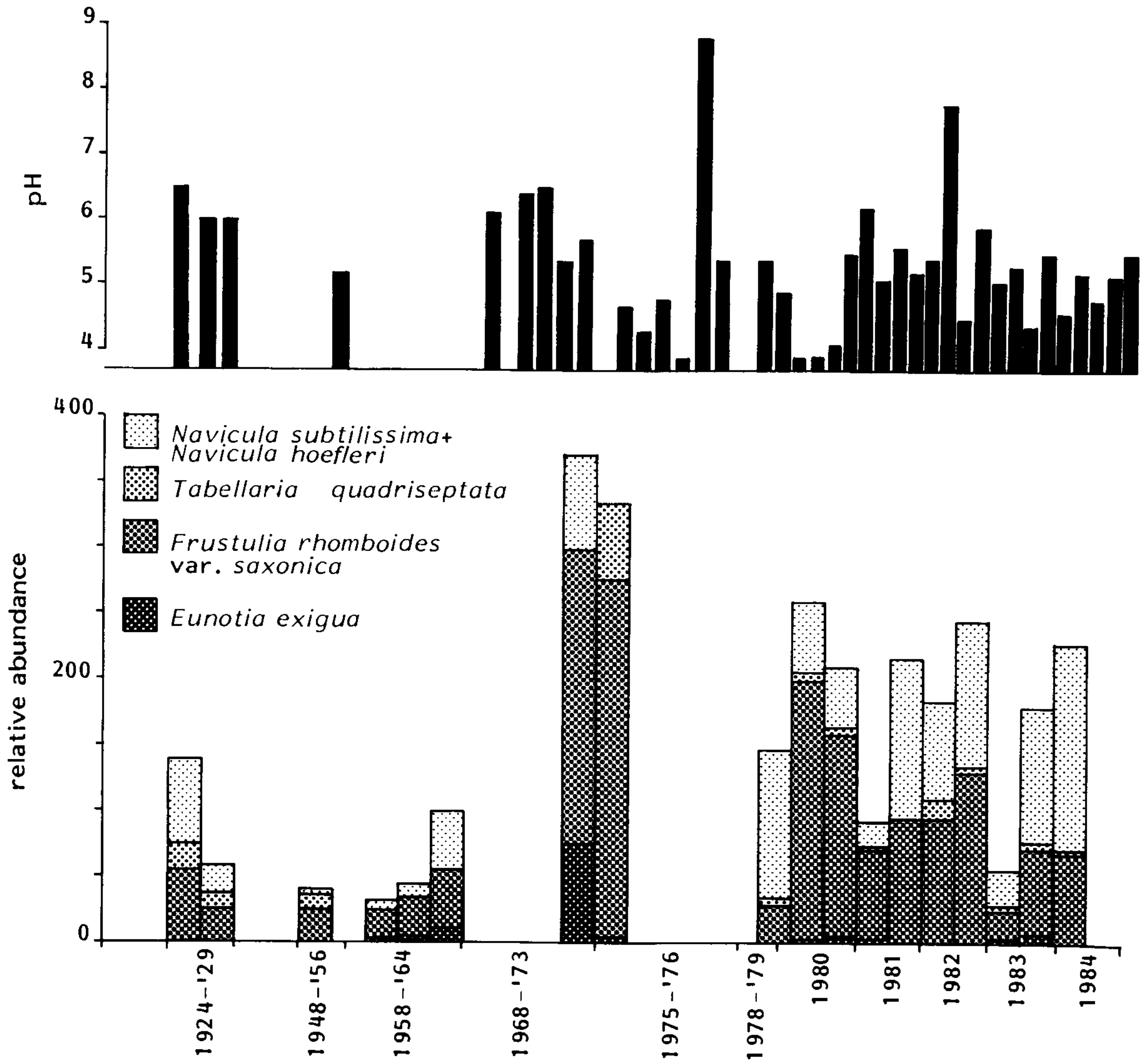


Fig. 29. Changes of pH and relative abundance of acidobiontic diatoms in Kliplo.

a constant decrease of the species richness, at least since 1960. The changes in the mean total number of taxa per sample (Table 26) have the same pattern: constantly 23-24 taxa per sample before 1960 and only 12 in the most recent period. The same is true for the mean number of taxa in the count. The dominance has a reverse pattern. As a whole the diversity of diatom taxa in Gerritsfles in the period 1964-84 is significantly lower than before (Table 27).

Kliplo

The exact location of the samples taken in 1929, 1948, 1964, and 1970 (Table 23) is unknown. The sample from 1924 was taken near the northern shore, the sample from 1958 at the NE shore, the samples from 1962, 1972, and 1978 (serial number 12) at the eastern shore, the sample of 1972 (serial number 11) at the western shore, the samples from 1979 and 1980 at the NW shore (near the small island). All samples from 1981 onwards were taken at the permanent sampling station at the western side of the pool (Fig. 17).

For the calculation of the mean relative abundances of the most prominent diatom taxa, total number of taxa, diversity indices and diatom-inferred pH (Table 26) the sample from April 1970 (Table 23) was skipped, because it is obviously contaminated with diatoms from eutrophic waters, e.g. Asterionella formosa, Diatoma elongatum. Melosira italica-group and Stephanodisus rotula-group. This sample was taken during an excursion when different types of water were sampled (Brantjes 1972). This sample was also left out of consideration for the calculation of the number of taxa which was found in Kliplo. The first sample of July 1972 was skipped for the calculations of average values.

As a whole the diatom flora of Kliplo (Tables 23, 26, App. 24) is typical for moderately acid, oligo-mesotrophic waters. Taxa like Navicula leptostriata, N. hoefleri and N. subtilissima are rather common in most of the samples and are rare elsewhere in The Netherlands and adjacent areas of Belgium and Germany. Besides, a number of other rare taxa were present rather regularly or occasionally over the study period of sixty years: Brachysira serians, Cymbella gracilis, Eunotia polydentula, E. praerupta and Stauroneis anceps fo. gracilis.

The differences between the periods 1924-20, 1948-64 and 1972-84 are best seen from Table 26. These differences are far less obvious than in Achtertse Goorven and Gerritsfles and the period 1948-84 has been split up in a rather arbitrary way. In the first period Tabellaria flocculosa was the dominant species. Other abundant taxa were Frustulia rhomboides var. saxonica, Navicula subtilissima, N. leptostriata, Eunotia incisa and E. bilunaris. In the second period Brachysira vitrea fo. lanceolata, with F. rhomboides var. saxonica, E. incisa, E. bilunaris, T. flocculosa, N. leptostriata and Nitzschia gracilis as other important taxa. In the last period F. rhomboides var. saxonica dominated the assemblages, while N. subtilissima, N. leptostriata, E. rhomboidea (asymmetrical forms), E. incisa, E. bilunaris and T. flocculosa were other abundant species.

The diatom-inferred pH (Table 26) changed significantly (Table 27) from 5.0 via 5.5 to 4.7 over the last 60 years.

In contrast to the pools Gerritsfles and Achterste Goorven no significant changes are found after the extremely dry year 1976 (Table 23, Fig. 29).

Although the sedimentation plankton sample from August 1962 has a fairly high proportion of Eunotia incisa it is otherwise very similar to the plankton tow samples.

Exclusive of the sample of June 1970 (see above) in total 97 diatom taxa were found in Kliplo over the period 1924-84. In 1924-29 45 taxa were seen in 2 samples, in 1948-64 52 taxa in 4 samples and 1972-84 75 taxa in 11 samples (Table 28). However, an increase of species richness cannot be assessed, because of the comparatively large numbers of samples in the most recent period. The mean total number of taxa per sample and the mean number of taxa in the count are relatively constant with c. 29 and 18 taxa respectively (Table 26). In contrast, the dominance did increase from 106, via 125 to 146 over the last 60 years (Table 26), indicating a decrease of the diversity of the diatom assemblages.

Tongbersven-West

From May 1983 until May 1984 diatom samples were taken with intervals of three months at a station in the eastern basin (Fig. 18B). Field chemistry data, collected simultaneously with diatom sampling are given in App. 27. Unfortunately, for technical reasons, it was not possible to sample in the central basin, where samples for chemical analysis in the laboratory were taken. Apart from the series from the eastern basin in February 1984 a

Table 24

TONGBERSVEN-WEST. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom inferred-pH (PH-RENBE = according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: PT = plankton tow, SS = Sphagnum squeeze. First two samples are from western basin, others from eastern basin. 0 = taxon present outside the count, - = taxon not found.

R									
	YEAR	19	84	83	83	83	84	84	84
	MONTH	5	2	5	8	11	2	5	5
	KND OF SMPLE	PT	PT	PT	PT	PT	PT	PT	SS
R	SPECNAME								
1	ANOMSERI	0	0	6	0	1	-	1	-
1	EUNOEXIG	-	4	95	123	74	77	98	72
1	EUNOPALU	1	1	10	3	21	9	5	158
1	FRUSRvSA	79	54	94	62	59	49	36	116
1	NAVIHOEF	22	2	12	3	3	0	1	-
1	NAVISUSB	13	3	0	4	-	2	1	-
1	NITZSCLE	-	4	-	-	-	-	-	-
1	TABEQUAD	63	63	84	113	115	162	198	31
1	RESTACIB	0	0	1	0	1	0	1	0
2	ANOMSvBR	-	4	10	5	1	1	2	0
2	EUNOALPI	129	-	-	-	2	-	-	-
2	EUNODENT	5	1	-	2	-	0	1	-
2	EUNORHOM	8	12	3	6	5	2	1	-
2	EUNOTENE	5	2	0	0	-	1	-	-
2	EUNOVENE	6	2	2	1	3	0	0	0
2	FRUSRHOM	41	-	0	3	1	0	-	4
2	NAVIHEIM	4	-	-	-	-	-	1	-
2	NAVIQUAD	-	31	-	-	-	-	-	-
2	PINNSILV	-	3	-	-	-	-	-	-
2	PINNSUBC	-	-	-	0	8	1	-	-
2	RESTACPH	2	3	0	4	0	2	2	0
3	ACHNPUSI	-	6	-	-	-	-	-	-
3	EUNOLUNA	8	25	76	55	75	88	50	18
3	GOMPGRAC	-	5	0	-	-	-	-	-
3	NAVISEMI	0	80	-	-	2	-	-	-
3	NITZPALE	-	-	-	-	4	-	-	-
3	PINNGIBB	2	45	2	6	0	1	0	0
3	PINNINTE	6	12	4	6	2	1	2	-
3	STAUKRIE	-	4	-	-	-	-	-	-
3	STAUPHOE	-	4	-	-	-	1	-	-
3	RESTCIRC	0	4	1	4	4	3	1	0
4	ANOMEXIL	5	-	0	-	-	-	-	-
4	MELOITGR	-	6	-	-	-	-	-	-
4	RESTALPH	1	3	0	-	14	0	-	1
0	NAVIINDI	-	17	-	-	-	-	-	-
1	SUM-ACIB	178	131	302	308	273	299	340	377
2	SUM-ACPH	200	58	15	21	20	7	7	4
3	SUM-CIRC	16	185	83	71	93	94	53	18
4	SUM-ALPH	6	9	-	-	14	-	-	1
5	SUM-ALKB	-	-	-	-	-	-	-	-
0	SUM-NOPH	-	17	-	-	-	-	-	-
	PH-RENBE	4.4	5.2	4.6	4.5	4.8	4.6	4.4	4.0
	PH-WA	4.4	4.6	4.4	4.5	4.5	4.5	4.5	4.0
	%(PH-WA)	91	57	72	66	73	80	74	82
	NRSPTOTA	27	37	26	23	40	24	22	15
	NRSPCOUN	19	29	14	17	26	17	16	6
	DOMINANC	129	80	95	123	115	162	198	158

sample was taken in the western basin, from which a sample from 1919, taken by Heimans, was available (Fig. 18B).

The sample from the western basin which was taken in 1984 and the Sphagnum squeeze sample from the eastern basin (Table 24) were omitted from the calculation of average values given in Table 26.

As a whole the diatom flora of Tongbersven-West (Tables 24, 26, App. 25) is characteristic for humic acid waters. The most abundant taxa (Eunotia exigua , E. bilunaris and Frustulia rhomboides var. saxonica) are rather common in The Netherlands and adjacent areas of Belgium and Germany, but a number of rare taxa are present rather regularly, e.g. Brachysira brebissonii, Cymbella gracilis, Navicula hoefleri). In the sample from the western basin, taken in 1984, even an extremely rare species (Neidium alpinum) is present.

Table 25

GROOT HASSELSVEN. All diatom taxa with a relative abundance of at least 4 valves in at least one sample, pH indices (R), pH spectra, diatom-inferred pH (PH-RENBE = according to Renberg & Hellberg (1982), PH-WA = by weighted averaging, %(PH-WA) = percentage of valves used for calculation of PH-WA) and diversity indices. Kind of sample: PT = plankton tow, SQ = squeeze of Juncus bulbosus and Sphagnum. 0 = taxon present outside the count, - = taxon not found.

	YEAR	83	83	83	84	84
R	MONTH	5	8	11	2	5
	KND OF SMPLE	PT	PT	SQ	PT	PT
R	SPEC NAME					
1	EUNOEXIG	391	396	346	370	393
1	FRUSRvSA	9	2	20	2	5
1	RESTACIB	0	2	0	2	0
2	RESTACPH	0	0	0	9	0
3	EUNOLUNA	0	0	-	10	1
3	PINNMICR	0	0	34	-	0
3	RESTCIRC	0	0	0	2	2
4	NITZPERM	-	-	-	4	-
1	SUM-ACIB	400	400	366	374	398
2	SUM-ACPH	-	-	-	9	-
3	SUM-CIRC	-	-	34	12	3
4	SUM-ALPH	-	-	-	5	-
5	SUM-ALKB	-	-	-	-	-
	PH-RENB	-	-	4.2	4.1	3.2
	PH-WA	4.0	4.0	4.1	4.1	4.0
	%PH-WA	100	100	100	99	100
	NRSPTOTA	8	8	7	20	10
	NRSPCOUN	2	3	3	13	4
	DOMINANC	391	396	346	370	390

Table 26

Average relative abundance of diatom taxa with a mean relative abundance of at least four valves in at least one sampling period in Achterste Goorven, Gerritsfles, Kliplo, Tongbersven-West and Groot Hasselsven, pH spectra, diatom-inferred pH and diversity indices. From (19..) - to (19..) indicates period of sampling. 0 = taxon present outside the count, - = taxon not found.

POOL	A Goorv. A			A Goorv. B			A Goorv. E		Gerritsfles			Kliplo			Ton.	Has.
FROM 19..	19	52	78	25	50	75	19	75	16	50	64	24	48	72	83	83
TO 19..	29	53	84	29	53	84	28	84	18	60	84	29	64	84	84	84
Number of samples	3	2	11	5	3	12	12	12	7	4	21	2	4	11	5	5
Eunotia exigua	3	3	252	0	3	334	0	357	9	34	317	0	5	9	93	379
E. paludosa	-	-	-	0	-	0	0	0	1	2	0	-	1	0	10	0
Frustulia rhomboides var. saxonica	7	34	18	38	55	7	106	4	30	101	40	41	30	104	60	8
Navicula 'hoefleri'	-	0	3	0	-	1	5	0	0	0	-	12	2	18	4	-
N. subtilissima	2	4	4	4	5	1	24	0	33	2	0	31	13	66	1	1
Tabellaria quadriseptata	0	17	10	1	35	9	60	13	5	8	20	17	4	5	134	-
others	0	6	1	0	0	0	0	2	3	1	1	-	1	1	4	0
Acidobiontic taxa (subtotals)	12	64	288	43	98	52	195	376	81	149	378	101	56	203	304	308
Brachysira brebissonii	-	6	13	6	20	2	1	2	0	0	-	-	-	0	4	1
B. brebissonii f. thermalis	1	6	0	0	-	0	1	0	0	0	-	-	-	-	-	-
Cymbella gracilis	11	3	2	9	3	0	0	-	1	-	-	2	7	0	0	1
Eunotia elegans	1	6	3	9	4	0	2	-	1	-	-	-	-	-	-	-
E. incisa	2	88	5	6	107	3	70	1	103	43	2	65	37	25	1	0
E. pectinalis var. minor	0	9	0	0	0	0	-	-	0	-	-	0	0	-	0	-
E. pect. var. minor f. impressa	2	0	1	4	-	0	0	-	0	-	-	-	-	-	-	-
E. rhomboidea (asymmetrical forms)	1	54	10	2	17	15	1	10	26	112	12	14	13	60	3	0
E. rhomboidea (symmetrical forms)	0	2	1	0	-	0	1	1	25	35	2	4	5	3	0	0
Navicula leptostriata	3	3	1	83	8	1	66	0	2	1	-	45	55	26	0	0
N. mediocris	1	2	3	7	5	2	0	0	2	1	-	-	0	0	-	-
Peronia fibula	0	3	0	5	3	0	3	0	-	0	-	-	-	-	-	-
Pinnularia appendiculata	-	2	-	0	-	-	0	-	13	0	0	0	-	0	-	-
P. irrorata	-	6	0	-	-	-	-	-	0	1	-	-	-	-	0	-
Stauroneis anceps fo. gracilis	0	0	-	0	0	0	0	-	2	0	0	0	4	1	0	-
Tabellaria flocculosa	0	3	1	7	2	0	2	0	12	12	1	94	34	24	0	-
others	4	9	0	1	7	0	1	0	2	6	0	3	2	1	4	0
Acidophilous taxa (subtotals)	25	202	40	139	176	23	148	14	189	210	16	227	157	140	14	2
Achnanthes minutissima	130	23	2	4	3	0	0	0	2	2	0	6	3	0	0	-
Brachysira vitrea fo. lanceolata	67	7	8	45	22	2	15	0	18	4	0	2	103	12	0	-
Eunotia bilunaris	0	86	27	12	32	10	33	6	100	11	2	59	39	29	67	2
Fragilaria virescens	7	7	22	85	50	9	5	0	0	3	0	1	12	4	0	0
Nitzschia gracilis	0	4	0	3	3	0	0	0	1	-	0	0	24	5	-	-
Pinnularia biceps	0	0	3	0	1	0	0	1	2	1	1	0	2	4	3	0
P. microstauron	-	0	0	0	1	0	-	0	2	19	2	-	1	0	0	7
others	1	6	0	0	2	0	0	0	1	1	1	1	4	0	3	0
Circumneutral taxa (subtotals)	205	133	62	149	114	21	53	7	126	39	6	69	188	54	79	10
Brachysira vitrea	6	0	0	5	2	0	1	-	-	-	-	1	1	0	0	-
Cymbella microcephala	134	2	3	4	2	1	0	-	-	-	-	-	-	-	-	0
Nitzschia perminuta	13	1	8	58	4	1	3	0	0	1	0	-	-	0	0	1
others	2	6	0	0	1	0	0	0	0	1	0	8	4	0	3	0
Alkaliphilous taxa (subtotals)	155	9	11	67	9	2	4	0	0	2	0	9	5	0	3	1
Alkalibiontic taxa (subtotals)	-	2	0	0	-	-	-	-	0	0	0	-	-	-	0	0
Unclassified taxa (subtotals)	-	3	0	0	2	0	-	0	1	-	-	-	-	-	0	0
Renberg-inferred pH (mean)	6.3	5.3	4.5	5.7	5.1	4.0	4.5	3.4	5.1	4.4	3.5	4.9	5.4	4.5	4.6	3.8
Renberg-inferred pH (stand. dev.)	.1	.9	.5	.1	.3	.4	.4	.5	.2	.5	.5	.1	.1	.3	.1	.5
Weight. aver. inf. pH (mean)	6.9	5.0	4.3	5.8	5.1	4.1	4.9	4.1	4.8	4.8	4.1	5.0	5.5	4.7	4.4	4.0
Weight. aver. inf. pH (stand. dev)	.2	.2	.2	.1	.3	.2	.5	.1	.2	.2	.1	.3	.6	.3	.2	.1
Average total number of taxa	42	48	31	44	34	27	19	14	23	24	12	31	29	27	27	11
Average number of taxa in count	16	31	18	23	25	12	11	6	16	17	7	16	21	17	18	4
Average dominance	161	141	256	111	112	334	151	357	164	147	317	106	125	146	139	379

Table 27

Achterste Goorven stations A, B, E, Gerritsfles, and Kliplo. Two-tailed significancy levels of Wilcoxon two-sample tests applied to Renberg-inferred pH (pH-RENBE), total number of taxa (NRSPTOTA), number of taxa in count (NRSPCOUN) and dominance (DOMINANC) between different periods; - = to few samples for test, n.s. = not significant.

Period 1 Period 2		1916-29 1948-64	1916-29 1964-84	1948-64 1964-84
Acht. Goorven A	pH-RENBE	-	<0.01	-
	NRSPTOTA	-	0.02	-
	NRSPTOTA	-	n.s.	-
	DOMINANC	-	n.s.	-
Acht. Goorven B	pH-RENBE	<0.05	<0.002	<0.01
	NRSPTOTA	n.s.	<0.01	n.s.
	NRSPCOUN	n.s.	<0.002	<0.01
	DOMINANC	n.s.	<0.002	<0.01
Acht. Goorven E	pH-RENBE	-	<0.002	-
	NRSPTOTA	-	<0.01	-
	NRSPCOUN	-	<0.002	-
	DOMINANC	-	<0.002	-
Gerritsfles	pH-RENBE	n.s.	<0.001	<0.01
	NRSPTOTA	n.s.	<0.01	<0.01
	NRSPCOUN	n.s.	<0.001	<0.001
	DOMINANC	n.s.	<0.01	<0.01
Kliplo	PH-RENBE	-	-	<0.002
	NRSPTOTA	-	-	n.s.
	NRSPCOUN	-	-	n.s.
	DOMINANC	-	-	n.s.

Table 28

Number of taxa and number of samples per period.

Station	Period	Number of taxa	Number of samples	Station	Period	Number of taxa	Number of samples
A. Goorven	1919-29	72	3	Kliplo (KLI)	1924-29	45	2
A (AGA)	1952-53	76	2		1948-64	52	4
	1978-84	70	11		1972-84	75	11
	1919-84	109	16		1919-84	97	16
A. Goorven	1925-29	75	5	Tongbersven-West	1983-84	59	5
B (AGB)	1950-53	54	3				
	1975-84	71	12	Groot Hasselsven	1983-84	34	5
	1925-84	99	20				
A. Goorven	1919-28	65	12	AGA+AGB+AGE	1919-29	109	20
E (AGE)	1975-84	22	17		1950-53	89	5
	1919-84	92	29		1975-84	103	40
					1919-84	151	65
Gerritsfles	1916-18	63	7	AGA+AGB+AGE	1916-29	136	29
(GER)	1950-60	43	4	+GER+KLI	1948-64	111	13
	1964-84	62	21		1964-84	149	73
	1916-84	94	34		1916-84	203	114

The differences between the species composition of the old and the recent sample from the western basin are large. As an example Eunotia naegelii (a rare species in western Europe) was very common in the old sample and was not found again in 1984. Neidium alpinum was absent in 1919, but common in 1984.

The diatom-inferred pH (Table 24) changed from 4.4 to 4.6 at this station. In the eastern basin the mean diatom-inferred pH in 1983-84 was 4.4. The spatial variation of diatom assemblage composition in this pool is unique.

The Sphagnum squeeze sample from the eastern basin is differentiated from the plankton tow samples by the high proportion (158 valves) of Eunotia paludosa, an aerophilous species, although this taxon is also present in lower quantities in the plankton tow samples.

In total 75 diatom taxa were found in Tongbersven-West over the period 1919-84. Only 3 taxa were exclusively found in 1919, 59 taxa were seen at the station in the eastern basin in 1983-84 (Table 28). The total number of taxa and the number of taxa at the western station increased from 27 to 37 and 19 to 29 respectively from 1919 to 1984. The mean total number of taxa (27) and mean number of taxa in the count (18) at the eastern station is about the same as in the humic pool Kliplo (Table 26), as is the dominance.

It may be concluded that the pH in this pool probably increased over the last six decades, with a concomitant increase of diversity.

Groot Hasselsven

All samples were taken at the permanent sampling station at the southern side of this pool in 1983-84. As samples for elaborate chemical analysis (App. 17) were usually taken a few days earlier or later than the diatom samples, field chemical data, gathered simultaneously with diatom sampling are given in App. 27.

The diatom flora of Groot Hasselsven (Tables 25, 26, App. 26) is characteristic for extremely acid waters, with a mean relative abundance of Eunotia exigua of 379 valves. Rare taxa (e.g. Brachysira species, Neidium densestriatum, Navicula leptostriata, Nitzschia perminuta) were found occasionally.

The Sphagnum squeeze sample differs from the plankton tow sample by the relatively high abundance of Frustulia rhomboides var. saxonica and Pinnularia microstauron, although it is possible that these differences are not caused by variation in habitat, but by variation in time.

In total 34 taxa were found in Groot Hasselsven (Table 28), which number must be considered to be very low. Also the mean total number of taxa (11) and mean number of taxa in the count (4) is very low (Table 26). The dominance is very high with 379 valves.

Although no old samples are available for comparison, this pool has probably been acidified strongly during the last decades.

4 SYNOPSIS

In the previous chapter the various aspects of the studied pools were described and briefly discussed. It is attempted in this chapter to give an integrative survey of the results and to answer the questions of the introduction.

In the beginning of the 19th century all pools were situated in an open landscape of heathlands and/or aeolian drift sand dunes. The surroundings of Achterste Goorven were planted with Scots pines around 1840. The surroundings of Kliplo and Tongbersven-West were turned into Scots pine plantations in the first decades of this century. The forest west of Kliplo was cut in c. 1965. Groot Hasselsven and Gerritsfles are still in an open landscape, although spontaneous regrowth of pines, birches and willows occurs along the southwestern shores of the latter pool since 1920.

At the western side the Achterste Goorven is separated from Voorste Goorven by a narrow dam, probably constructed in the second half of the 19th century. Before the dam was constructed, the westernmost pool of Achterste Goorven was influenced by the water of Voorste Goorven, which was enriched with nutrients by human activities. Gerritsfles and Kliplo always have been isolated pools, but were a part of the traditional agricultural system of the heathland areas and were used until the first half of this century for washing of sheep. Also sheep regularly drank from these pools. Both pools were used as bathing places for local people and tourists until the late sixties of this century. As far as is known, Groot Hasselsven and Tongbersven-West were not used by people during the last hundred years. Groot Hasselsven harboured a colony of black headed gulls until 1970.

Bathymetric maps of Achterste Goorven, Gerritsfles, Kliplo and Tongbersven-West are presented in Figs. 8, 15, 17, and 18 respectively. These maps are summarized as depth-area curves in Fig. 12. Other morphological features are tabulated in Table 4. The average depth ($\bar{z}$) of Kliplo is 0.82 m and the maximum depth (z_{max}) 1.14 m. The ratio $\bar{z}/z_{max}$ = 0.72 and indicates that the bottom is very flat. The bottom of the pool has the form of a soup plate. Consequently in extremely dry years like 1921, 1959 and 1976 only c. 20% of the bottom surface is exposed to the atmosphere. In Achterste Goorven $\bar{z}/z_{max}$ = 0.62/1.85 = 0.34 and in extremely dry years c. 75% of the bottom surface is exposed to the atmosphere. Gerritsfles is intermediate with $\bar{z}/z_{max}$ = 0.68/1.24 = 0.54. The water depth of Tongbersven-West could not be assessed properly, because of the preserve of a quivering bog over c. 70% of the pool's area. Probably the depth distribution will be in between those of Gerritsfles and Kliplo. The depth distribution of Groot Hasselsven was not mapped, but the pool is only a few decimetres deep. Consequently already in the not extremely dry summer of 1983 a considerable part of the bottom dried up.

It is known from other investigations that Gerritsfles, Kliplo, Tongbersven-West, and Groot Hasselsven are seepage pools, i.e. they have perched water tables and are isolated by an impervious layer from the main aquifer. The catchment area of these pools is hardly larger than their surface area. A simple hydrological model was developed to predict the concentration of the inert chloride ion from its concentration in the precipitation, the annual water evaporation excess, the fluctuations of the water table and the volume and area distributions of the pool (Table 7). The predictions of the model are in good agreement with the observed chloride concentrations. Also for Achterste Goorven the predicted chloride concentration is in accordance with the measured value, so it is conceivable that this pool has a perched water table too.

Water renewal times, as calculated with the hydrological model are c.

5.4, 3.8, 3.0, and 1.8 years for Achterste Goorven, Kliplo, Gerritsfles and Tongbersven-West respectively. The water renewal time of Groot Hasselsven is probably between one and two years. Therefore, Achterste Goorven will recover most slowly from disturbances like the drought of 1976.

Long-term changes in the measured pH can be read from Table 12. At the four stations where pH measurements were made in the period 1919-30 the pH dropped significantly from this period to 1978-85. Also significant are the differences between the periods 1919-30 and 1950-60 in Gerritsfles and 1919-30 and 1970-76 in Kliplo. The pH drop is largest in Achterste Goorven (2.1 and 1.8 units at stations B and E respectively) and smallest in Kliplo (0.8 unit). Gerritsfles is intermediate with a decline of 1.2 units. The earliest measurements are between 5.4 and 6.5 in the three pools. The recent measurements have a median of 5.2 in Kliplo and c. 4.0 in the other two pools.

Other chemical parameters than pH were measured more rarely in the past. At Achterste Goorven station B sulphate increased from 208 to 458 equivalent mmol m^{-3} from 1919 to 1975, while concentrations in the range of 729 to 1645 equivalent mmol m^{-3} were found at this station from 1979-85. In the early sample ammonium had a lower and alkalinity had a higher value than the more recent samples. Table 13 summarizes the observations of some selected chemical parameters from Gerritsfles. The pH as measured in the field declines significantly from 1928 to 1985, but the pH as measured in the laboratory seems to be fairly stable. The chloride concentration drops significantly from 1925 to 1985. No long-term changes are apparent in ammonium and sulphate. The peaks of sulphate in 1960 and 1977-78 will be discussed below.

Chemistry of Achterste Goorven and Gerritsfles was monitored from August 1979 through February 1985. The program in Kliplo started in May 1981. In Tongbersven-West and Groot Hasselsven observations were done from April 1983 through March 1985. Thus over the last period a parallel program was run in all pools. The average charge balances of pool water and incident rain over this period are given in Table 17 and Fig. 22.

The composition of the precipitation is rather similar at all sites. The total concentration of ions is c. 500 equivalent mmol m^{-3}. Sulphate is the most important anion (c. 98-127 equivalent mmol m^{-3}), roughly balanced by ammonium (87-112 mmol m^{-3}). Chloride ranges from 64-90 mmol m^{-3}, roughly balanced by sodium (55-73 mmol m^{-3}). Nitrate has a concentration of c. 50 mmol m^{-3} at all sites.

The composition of the water in the pools is much less uniform. Sulphate and chloride are the most important anions. The chloride concentration varies from 217 mmol m^{-3} in the pool with the shortest water renewal time (Groot Hasselsven) to 455 mmol m^{-3} in the pool with the longest water renewal time (Achterste Goorven). Nitrate and bicarbonate are nearly absent, while organic anions are important, particularly in Kliplo and Tongbersven-West. Sodium is the most important cation in all pools, followed by ammonium in all pools except Kliplo and Groot Hasselsven, where the divalent cations are more important. Iron and aluminium are elevated, particularly in Achterste Goorven.

The dissimilarities between the composition of precipitation and surface water may be caused by sulphate reduction, sulphide oxidation, nitrification, denitrification and uptake of nutrients by aquatic macrophytes. Ammonium can be taken up by mosses or it can be nitrificated, subsequently nitrate can be denitrified. Both pathways are responsible for the release of one mole of protons for each mole of ammonium (decrease of alkalinity of one mole). Probably the most important processes are those of the sulphur cycle. Large quantities of the total (wet + dry) deposition of sulphate are reduced. The reduction of each mole of sulphate does increase alkalinity by two moles and thus counteracts the acidification. The reduced sulphur compounds are stored in the sediment and reoxidized when the bottom is exposed to the atmosphere in very dry years. Thus the lowest sulphate concentrations are expected in Kliplo, where in extremely dry years only a minor fraction of the bottom falls dry. On the other hand, Achterste Goorven and Groot Hasselsven ought to have the largest sulphate concentrations, because in dry years more than 50 percent of the bottom is aerated. Gerritsfles would be intermediate. This is exactly what was observed (Table 17).

Changes of selected chemical parameters in Achterste Goorven, Gerritsfles and Kliplo between 1975 and 1985 are plotted in Fig. 21. In Kliplo changes are relatively small. Sulphate and other parameters associated with acidification (e.g. aluminium and calcium) have been constantly low throughout the period of observation. No precipitation of humic and fulvic acids is occurring and the pool is permanently coloured, although the colour has been decreasing during the last years. The peak in chloride is caused by strong evaporation during the dry summer of 1976.

Changes in Achterste Goorven and Gerritsfles are very similar. In 1977-78 highly elevated levels of sulphate, aluminium, calcium, magnesium, carbondioxide and conductivity were observed. The decreasing ions and conductivity are typically associated with acidification and induced by the drought of 1976. The peak in calcium, magnesium and sulphate in Gerritsfles in 1960 (Table 13) was caused by the drought of 1959. Gerritsfles has an intermediate position between Kliplo and Achterste Goorven. The decrease of these parameters was faster in Gerritsfles than in Achterste Goorven, which is related to the longer water renewal time of Achterste Goorven. As a consequence of the decrease of sulphate in both pools the pH is increasing since c. 1981. Also fulvic acids were not precipitated any longer and colour and permanganate consumption increased too. Ammonium increases in both pools since c. 1982.

The distribution of the most important macrophytes of the open water in Achterste Goorven, Gerritsfles and Kliplo in September 1984 is given in Figs. 23, 24, and 17 respectively . Outline sketches of the vegetation of Tongbersven-West and Groot Hasselsven are in Figs. 25 and 26. Changes in the floristic composition of the pools from 1916 through 1984 are given in Table 18.

The present macrophytic vegetation of Achterste Goorven is quite uniform. In the open water Nymphaea alba occurs regularly and next important is Juncus bulbosus, especially nearshore. The abundance of J. bulbosus, as well as that of filamentous algae, is increasing from west (station A) to east (station E). In the littoral zone Sphagnum, Drepanocladus fluitans, Carex rostrata etc. are present. In total 15 species were seen in 1984. This is an impoverishment in comparison with the period 1912-59, when 37 species were seen. In addition, the vegetation of the open water was much more diverse and luxuriant in the period 1916-59. In the pool a gradient was visible of vegetation types characteristic for mesotrophic and weakly acid-neutral sites near station A to types which are characteristic for oligotrophic and acid sites near station E. Most conspicuous is the decrease of these species which are characteristic for weakly acid low alkalinity waters, e.g. Potamogeton polygonifolius, Scirpus fluitans, Myriophyllum alterniflorum and Utricularia intermedia.

The present vegetation of Gerritsfles is dominated by dense mats of Sphagnum denticulatum on the bottom. Nearshore Juncus bulbosus, Sparganium angustifolium, Eleocharis palustris, Carex rostrata and Eriophorum angustifolium are present. Juncus effusus settled about 1950 and greatly expanded since. Before 1958 20 species were seen, since 1973 16 species have been observed. Lobelia dortmanna, Deschampsia setacea, Luronium natans and

Potamogeton natans were not present in the recent inventories. These species are characteristic for weakly acid low-alkalinity waters. The abundance of peat mosses, which are typically found in strongly acid waters, probably increased during the last decades.

The present submerged vegetation of Kliplo is dominated by Potamogeton natans. Sphagna are present at some places nearshore. Sparganium angustifolium is very rare. Phragmites australis, Potentilla palustris, Carex rostrata and Eriophorum angustifolium are the most dominant littoral species. Although Sparganium angustifolium declined since 1958, long-term changes in flora and vegetation of this pool are minor in comparison with the previous pools. This might be expected because of the morphometry and chemistry of the pool.

Tongbersven-West is differentitated from the other pools by the presence of a quivering bog, which covers about seventy percent of the basin. In the open water patches of Utricularia minor are present. At some nearshore places Eleocharis multicaulis is floating. The vegetation is rather constant since the first inventory in 1957, although Nymphaea alba was not seen after 1975.

The flat and shallow bottom of Groot Hasselsven is covered with a mat of Drepanocladus fluitans. The open water is surrounded by a belt with Juncus effusus, Drepanocladus fluitans and some J. bulbosus. Phragmites australis is present with some patches. The vegetation is still indicative for the eutrophic conditions in the past, which were caused by the presence of a gull colony until 1970.

The most powerful description of spatial and temporal variation in the diatom assemblages. is the pH, inferred by weighted averaging from the diatoms, given at the bottom of Table 26. The diatom-inferred pH significantly decreases over time at all stations where old and new diatom samples are available (Table 27). Between 1919 and 1929, a gradient existed in Achterste Goorven, with the inferred pH going from 6.9 at the westernmost station A to 4.9 at the most eastern station E, thus the pH encompassed a range of 2.0 units. Between 1975 and 1984, the gradient was from 4.3 at station A to 4.1 at station E, a range of only 0.2 units. Although the gradient still existed after about fifty years the stations have become more similar, which is in accordance with the direct pH measurements and the inventories of macrophytes which were discussed above. Also in Gerritsfles and Kliplo the diatom-inferred pH declined significantly over time (Table 27).

Changes in the species composition over time can be seen from Table 26. Most conspicuous is the enormous increase of the acidobiontic Eunotia exigua at all stations. It is the dominant species in all pools, except the humic ones (Kliplo, Tongbersven-West). Also the asymmetric forms of the acidophilous E. rhomboidea increased at most stations, with the exception of Gerritsfles. These species increased at the expense of a number of other species. The acidophilous Cymbella gracilis and Navicula leptostriata decreased at all stations from which a time series is available. The acidophilous Eunotia pectinalis var. minor fo. impressa, Stauroneis anceps fo. gracilis and the circumneutral Brachysira vitrea fo. lanceolata and Nitzschia gracilis declined at all stations except Kliplo. The circumneutral Achnanthes minutissima and the alkaliphilous Brachysira vitrea, Cymbella microcephala and Nitzschia perminuta declined particularly at stations A and B in Achterste Goorven. The acidobiontic Navicula hoefleri and N. subtilissima, the acidophilous Eunotia elegans, E. incisa and Tabellaria flocculosa, the circumneutral Eunotia bilunaris and a number of additional taxa decreased particularly at the very acidified stations Achterste Goorven E and Gerritsfles. Many of the decreased taxa have a limited distribution in northwestern Europe, while the few increased ones are trivial. This does impair the conservational values of the pools. The significant decrease of the average total number of taxa and the average number of taxa in the count at the stations in Achterste Goorven and Kliplo and the significant increase of the dominance at the same stations (Tables 26 and 27) lead to the same conclusion.

As argued before, the extreme drought periods of 1959 and 1976 severely affected the chemistry of Gerritsfles and Achterste Goorven by the release of sulphuric acid from oxidizing sediment during refilling. Fig. 27 shows (see also Table 21) that the relative abundance of Eunotia exigua greatly increased from the pre-drought year 1975 to the post-drought years 1978-84. The drought in the year 1921 was comparable to that of 1976. After 1921 the acidobiontic diatoms did not increase in comparison with the period before. Eunotia exigua was only found in a few individuals, while Frustulia rhomboides var. saxonica and Tabellaria quadriseptata were the most important acidobiontic diatoms from 1919 through 1928. From the diatoms no changes in chemistry, included by the drought of 1921 can be concluded. Apparently not enough reduced sulphur compounds had been accumulated in the sediment at that time for the release of significant amounts of sulphuric acid during refilling after the drought.

The relative abundance of acidobiontic diatoms in Geritsfles is plotted in Fig. 28. No data are available for the drought of 1921, but the reaction on the extreme dry year 1959 is evident here. Apparently there is some delay, because in 1960 the relative abundance of acidobiontic diatoms was low, even lower than in the period 1950-51, but in 1964 and 1965 the relative abundance of the acidobiontic diatoms, particularly Eunotia exigua, is over 375 of the 400 valves counted in each sample. In 1973 the acidobiontic diatoms accounted for 304 valves, but after the relatively dry summer of that year their relative abundance increased again. Later on, then the acidobiontic diatoms remained dominant, especially after 1976. But from 1981 onwards E. exigua became less dominant. Until May 1982 Frustulia rhomboides var. saxonica became codominant and Tabellaria quadriseptata joined in November 1982. These changes are a reaction on the increase of pH and associated changes in chemistry since then (Fig. 28).

In Gerritsfles it has taken about five years for the first signs of post-drought recovery to appear. In Achterste Goorven no major changes were seen until 1984, although Eunotia bilunaris, a circumneutral species, was present with considerable numbers at station E in May 1984. The longer recovery time of Achterste Goorven is probably associated with the longer water renewal time (5 years) of this pool, in comparison with Gerritsfles (3 years).

In Kliplo no reaction of the diatoms on any drought period was observed (Fig. 29), which is in accordance with its morphological features described above.

As a final conclusion it may be stated that the chemistry and biology of the investigated pools are seriously affected by acid deposition. The long-term changes are most obvious in the pools where a large part of the bottom is exposed to the atmosphere in extremely dry years. Continuation of the monitoring project is necessary for modelling the impact of atmospheric deposition on chemistry and biology of acid sensitive shallow water bodies in northwestern Europe.

5 ACKNOWLEDGEMENTS

The Society for the Preservation of Nature Reserves in The Netherlands and the State Forestry Service gave permission to visit their properties.

Mrs. A. Mertens and Messrs. C.N. Beljaars, J.C. Buys, H.H. Hoekstra, G.J. Koetsier, W. Oorthuysen, C.G. Oostveen and T. Pape assisted with field work. Mr. Buys also assisted with the preparation of diatom slides and data processing. Mr. Beljaars analysed the majority of the diatom slides. Mrs. N. Heusinkveld typed the manuscript and Messrs. J. van der Grift and R. Wegman made the drawings.

Chemical data from Groot Hasselsven, Tongbersven-West, Gerritsfles and Kliplo (1983-85) were provided by Prof. Dr. Ir. N. van Breemen, Ir. J. Mulder and Mr. E. Velthorst (Agricultural University, Wageningen). Dr. H.F.R. Reijnders (National Institute for Health and Environmental Hygiene, Bilthoven) and Drs. H.F. van Dobben provided data on the chemical composition of precipitation. Historical data on Achterste Goorven were searched by Mr. W. de Bakker (Oisterwijk).

Old plankton samples were put at disposal by Dr. P.F.M. Coesel and Mrs. H. Kooyman-van Blokland (University of Amsterdam) and Drs. B.Z. Salomé (Limnological Institute, Royal Netherlands Academy of Sciences).

Mr. G.M. Dirkse identified some mosses. Mr. W.J. Holwerda and Dr. P. Baas (Leiden) identified vegetative material of Sparganium angustifolium. Prof. Dr. H. Lange-Bertalot and Dipl.-Biol. M. Nörpel (Frankfurt am Main) checked some identifications of diatom taxa. Prof. Dr. E.G. Jørgensen (Lyngby) lent type slides of diatoms. Ir. H. Houweling and Drs. M.J.H.A. van der Linden assisted with interpretation of hydrological and chemical data respectively.

The research was supported in part by the Beijerinck-Popping foundation of the Royal Netherlands Academy of Sciences and the European Community (Contract nr. ENN-650-N(N)).

6 REFERENCES

Almer, B., Dickson, W., Ekström, C. & Hörnström, E. 1978. Sulfur pollution and the aquatic ecosystem. In: J.O. Nriagu (ed.), Sulfur in the environment. II. Ecological impact. Wiley, New York, 271-311.

Alvey, N.G., C.F. Banfield, R.I. Baxter, J.C. Gower, W.J. Krzanowski, P.W. Lane, P.K. Leech, J.A. Nelder, R.W. Payne, K.M. Phelps, C.E. Rogers, G.J.S. Ross, H.R. Simpson, A.D. Todd, R.W.M. Wedderburn & G.N. Wilkinson 1977. Genstat, a general statistical program. Rothamsted Experimental Station, Harpenden.

Alvey, N., N. Galwey & P.W. Lane 1982. An introduction to Genstat. Academic Press, London. 152 p.

Anonymous, 1982. Normalen en standaardafwijkingen voor het tijdvak 1951-1980. Klimatologische gegevens van Nederlandse stations **10**: 1-118. Koninklijk Nederlands Meteorologisch Instituut, De Bilt.

Anonymus 1983. Chemical composition of precipitation over the Netherlands. Annual Report 1982. Koninklijk Nederlands Meteorologisch Instituut, De Bilt/Rijksinstituut voor de Volksgezondheid, Bilthoven. 16 p. + ann.

Anonymus 1985. Chemical composition of precipitation over the Netherlands. Annual Report 1983. Koninklijk Nederlands Meteorologisch Instituut, De Bilt/Rijksinstituut voor de Volksgezondheid, Bilthoven. 119 p. + ann.

Baaijens, G.J. 1969. Verslag van het waterchemisch onderzoek aan voedselarme vennen en venen in het Drentse District. Unpublished manuscript, Leiden. 64 p. + ann.

Baas Becking, L.G.M. & Nicolai, E. 1934. On the ecology of a Sphagnum bog. Blumea **1**: 10-45.

Bache, B.W. 1984. Soil-water interactions. Philosophical Transactions of the Royal Society **B305**: 393-407.

Baker, L.A., Brezonik, P.L., Edgerton, E.S. & Ogburn, R.W. 1985. Sediment acid neutralization in softwater lakes. Water, Air, and Soil Pollution **25**: 215-230.

Bakker, T.W.M. 1984. Het Dwingelderveld, geohydrologie. Rapport SBB 1984-29, Staatsbosbeheer, Utrecht. 175 p. + ann.

Bakker, T.W.M., Castel, I.I.Y., Everts, F.H. & De Vries, N.P.J. 1986. Het Dwingelderveld, een Drents heidelandschap. Pudoc, Wageningen. 198p.

Barth, E.F. 1975. Average pH. Journal of the Water Pollution Control Federation **47**: 2191-2192.

Battarbee, R.W. 1984. Diatom analysis and the acidification of lakes. Philosophical Transactions of the Royal Society **B 305**: 451-477.

Beaufort, L.F. de 1913. Wetenschappelijke vergadering 30 September 1911. Tijdschrift van de Nederlandsche Dierkundige Vereeniging Ser. **2**, **12**: (48).

Begheijn, L.T. 1980. Methods of chemical analysis for soils and waters. Department of Soil Science and Geology, Agricultural University, Wageningen.

Beld, A. van de 1978. Natuurreservaat de 'Gerritsflesch'. Vegetatiekartering mei-juli 1978. Stageverslag, Rijksinstituut voor Natuurbeheer, Leersum/Vervolgkursus Groenvoorzieningen, Landschapsverzorging en Rekreatie, Zeist. 35 p. + ann.

Beije, H.M. 1976. Vennen op Kampina en hun beheer. Rapport no. 316, Vakgroep Natuurbeheer, Landbouwhogeschool, Wageningen. 119 p.

Beijerinck, W. 1924. Het Lheebroeker Zand (een nieuw natuurmonument in 't Drentsch Staatsdomein). De Levende Natuur **29**: 97-102.

Beijerinck, W. 1926. Over verspreiding en periodiciteit van de zoetwaterwieren in Drentsche heideplassen. Verhandelingen der Koninklijke Akademie van Wetenschappen, Afdeeling Natuurkunde (Tweede Sectie) **25**(2): 1-211.

Beijerinck, W. 1931. Over Eurycercus glacialis Lillj. en andere arctische levensvormen in de plassen der "Dwingeloo'sche Heide". De Levende Natuur **36**: 238-248.

Beijerinck, W. 1950. Letter to dr. M.F. Mörzer Bruyns d.d. 2.12. 1950. (Archive RIN, Leersum), 2 p.

Bergmans, J. 1926. Schoon Oisterwijk, Oisterwijk, Oisterwijk. 128 p.

Bijlmer, L. 1938. Gerritsflesch bij Kootwijk. De Levende Natuur **42**: 344.

Bink, F. & H. Schimmel 1975. Excursierapport Staatsnatuurreservaat "Gerritsflesch", gemeente Barneveld. Rijksinstituut voor Natuurbeheer, Leersum. 4 p.

Blakar, I.A. & Digernes, T. 1984. Evaluation of acidification based on former colorimetric determination of pH: the effect of indicators on pH in poorly buffered water. Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie **22**: 679-685.

Boer Leffef, W.J. 1959. Excursierapport entomologisch onderzoek Gerritsfles. Rijksinstituut voor Veldbiologisch Onderzoek ten behoeve van het Natuurbehoud, Zeist. 2 p.

Brantjes, N.B.M. 1972. Methodiek voor waterbeoordeling. Met fytoplanktonwaarnemingen verkregen evaluatiekriteria voor natuurgebieden. Afdeling Geobotanie, Katholieke Universiteit, Nijmegen/Rijksinstituut voor Natuurbeheer, Leersum. 65 p.

Breemen, N. van, Burrough, P.A., Velthorst, E.J., Dobben, H.F. van, Wit, T. de, Ridder, T.B. & Reijnders, H.F.R. 1982. Soil acidification from atmospheric ammonium sulphate in forest canopy throughfall. Nature **299**: 548-550.

Breemen, N. van, J. Mulder & C.T. Driscoll 1983. Acidification and alkalinization of soils. Plant and Soil **75**: 283-308.

Broertjes, J.P. 1977. Het ontstaan van de Brabantse vennen. Bijdragen tot de Studie van het Brabantse Heem **16**: 19-25.

Brouwer, G.A. 1968. Over natuurbehoud in Drente. Kroniek van een halve eeuw. Mededelingen van de Botanische Tuinen en het Belmonte-Arboretum **11**: 32-119.

Bruin, H.A.R. de 1979. Neerslag, openwaterverdamping en potentieel neerslagoverschot in Nederland. Frequentieverdelingen in het groeiseizoen. Wetenschappelijk Rapport 79-4, Koninklijk Meteorologisch Instituut, De Bilt. 90 p.

Buskens, R. 1983. De makrofauna, in het bijzonder de Chironomiden, en de vegetatie van een vijftigtal geëutrofieerde, zure of laag-alkaliene stilstaande wateren op de Nederlandse zandgronden. Rapport nr. 159, Laboratorium voor Aquatische Oecologie, Katholieke Universiteit, Nijmegen. 75 p. + ann.

Carignan, R. 1985. Quantitative importance of alkalinity flux from the sediments of acid lakes. Nature **317**: 158-160.

Clymo, R.S. & P.M. Hayward 1982. The ecology of Sphagnum. In A.J.E. Smith (ed.), Bryophyte ecology. Chapman & Hall, London. p. 229-289.

Coesel, P.F.M., R. Kwakkestein & A. Verschoor 1978. Oligotrophication and eutrophication tendencies in some Dutch moorland pools, as reflected in their Desmid flora. Hydrobiologia **61**: 21-31.

Coesel, P.F.M. & H.D.W. Smit 1977. Jukwieren in Drenthe, vroeger en nu. Veranderingen in de Desmidiaceeënflora van enige Drentse vennen gedurende de laatste 50 jaar. De Levende Natuur **80**: 34-44.

Covington, A.K., Whalley, P.D. & Davison, W. 1985. Recommendations for the determination of pH in low ionic strength fresh waters. Pure and Applied Chemistry **57**: 877-886.

Dam, H. van 1982. On the use of measures of structure and diversity in applied diatom ecology. Nova Hedwigia/

Beih. 73: 97-115.
Dam, H. van 1983. Vennen in Midden-Brabant. RIN-rapport 83/23, Rijksinstituut voor Natuurbeheer, Leersum. 125 p. + ann..
Dam, H. van 1984. A guide to the literature for the identification of freshwater diatoms in The Netherlands. Hydrobiological Bulletin 18: 11-16.
Dam, H. van 1987. Verzuring van vennen: een tijdsverschijnsel. Proefschrift, Landbouwuniversiteit, Wageningen. 175 p.
Dam, H. van, C. van Dijk, L.W.G. Higler, H.H. Hoekstra, K. Kersting, P. Leentvaar, F. Repko, P. Schroevers & J.A. Sinkeldam 1983. Verslag van de hydrobiologische waarnemingen in de Gerritsfles en Kempesfles op 2 en 3 november 1977. Rapport Rijksinstituut voor Natuurbeheer, Leersum. 59 p.
Dam, H. van & H. Kooyman-van Blokland 1978. Man-made changes in some Dutch moorland pools as reflected by historical and recent data about diatoms and macrophytes. Internationale Revue der gesamten Hydrobiologie 63: 587-607.
Dam, H. van & H. Kooyman 1982. A new diatom from Dutch moorland pools: Navicula heimansii (Bacillariophyceae). Acta Botanica Neerlandica 31: 1-4.
Dam, H. van, G. Suurmond & C.J.F. ter Braak 1981. Impact of acidification on diatoms and chemistry of Dutch moorland pools. Hydrobiologia 83: 425-459.
Deinum, D. 1936. De Brabantsche vennen. De Wandelaar 8: 308-313.
Dickman, M.D., H. van Dam, B. van Geel, A.G. Klink & A. van der Wijk 1987. Acidification of a Dutch moorland pool, a palaeolimnological study. Archiv für Hydrobiologie 109: 377-408.
Dijk, J. van, F. de Graaf, W. Graafland, A.A. de Groot, J. Heimans, J.T. Koster, A.P.C. de Vos, H.F. de Vries, A. van der Werff & V. Westhoff 1960. Hydrobiologie van de Oisterwijkse vennen. Publicatie van de Hydrobiologische Vereniging Amsterdam 5: 1-90.
Dijk, J. van, J.G. Sloff & V. Westhoff 1948. Rapport over het Goorven, deel uitmakende van het Oisterwijksche vennengebied, geïnventariseerd: 24 tot 29 Augustus 1948. Unpublished report, Vereniging tot Behoud van Natuurmonumenten in Nederland, Amsterdam. 49 p.
Dijk, J. van & V. Westhoff 1960. De veranderingen in de vegetatie van het Choorven van 1948 tot en met 1955. Publicatie van de Hydrobiologische Vereniging Amsterdam 5: 13-24.
Dillon, P.J., O.S. Jeffries & W.A. Scheider 1982. The use of calibrated lakes and watersheds for estimating atmospheric deposition near a large point source. Water, Air and Soil Pollution 18: 241-258.
Dillon, P.J., Yan, N.D. & Harvey, H.H. 1984. Acidic deposition: effects on aquatic ecosystems. CRC Critical Reviews in Environmental Control, 13: 167-194.
Donselaar, J. van 1957. Excursieverslag Laagveld, Hasselsvennen, Biesven, Dorven, Klotvennen, Kraanvennen. Stichting Onderzoek Levensgemeenschappen, Bilthoven. 5 p.
Dresscher, T.G.N., F. de Graaf, A.A. de Groot, J. Heimans, G.P.H. van Heusden, J.T.H. Koster, W. Meyer, M.F. Mörzer Bruyns, H.J.W. Schimmel, A.P.C. de Vos, H.F. de Vries & A. van der Werff 1952. De Gerritsflesch bij Kootwijk. Publicatie van de Hydrobiologische Vereniging Amsterdam 4: 22.
Driscoll, C.T. & Newton, R.M. 1985. Chemical characteristics of Adirondack lakes. Environmental Science and Technology 19: 1018-1024.
Dubois, E. 1917. Hoe ontstonden de vennen van Oisterwijk? Verslagen der algemene vergaderingen van 28 Mei 1913, 2 Mei 1914, 8 Mei 1915, 6 Mei 1916 en 12 Mei 1917 en bijdragen over enkele terreinen der Vereeniging. Vereeniging tot Behoud van Natuurmonumenten in Nederland, Amsterdam. p. 81-91.
Dubois, E. 1919. Over het ontstaan en de geologische geschiedenis van vennen, venen en zeeduinen. Archives du Musee Teyler, Sèr. III, 4: 266-293.
Ellenberg, H. 1979. Zeigerwerte der Gefässpflanzen Mitteleuropas (2nd ed.). Scripta Geobotanica 9: 1-22.
Eralp, A.E. & M.B. Thomson 1978. pH Averaging. Journal of the Water Pollution Control Federation 50: 389-392.
Eshleman, K.N. & H.F. Hemond 1985. The role of organic acids in the acid-base status of surface waters at Bickford Watershed, Massachusetts. Water Resources Research 21: 1503-1510.
Ferguson, A.R. & E.G. Bollard 1969. Nitrogen metabolism of Spirodela oligorrhiza. Planta 88: 344-352.
Focht, D.D. & Verstraete, W. 1977. Biochemical ecology of nitrification and denitrification. Advances in Microbial Ecology 1: 135-214.
Francis, A.J., Quinby, H.L. & Hendrey, G.R. 1984. Effect of lake pH on microbial decomposition of allochthonous litter. In: G.R. Hendrey (ed.) Early biotic responses to advancing lake acidification. Acid Precipitation Series 6. Butterworth, Woburn, 1-21.
Geenen, H.G.M. 1977. Bodemgesteldheid van Midden-Brabant. Toelichting bij de bodem- en grondwatertrappenkaart, schaal 1:25 000. Rapport nr. 1359, Stichting voor Bodemkartering, Wageningen. 81 p.
Germain, H. 1982. Quatre Navicules du groupe des Subtilissimae (Diatomophyceae). Cryptogamie: Algologie 3: 105-111.
Geijskes, D.C. 1929. Een juffertje uit Oisterwijk. De Levende Natuur 34: 139-143, 179-187.
Gijsen, M.E.A. van & T.H.L. Claassen 1978. Biologisch wateronderzoek; macrofyten en macrofauna. Een onderzoek in het kader van het milieuonderzoek ten behoeve van het Integraal Struktuurplan voor het Noorden des Lands. Deelrapport 2. Rijksinstituut voor Natuurbeheer, Leersum. 121 p. + ann.
Gjessing, E.T. 1976. Physical and chemical characteristics of aquatic humus. Ann Arbor, Ann Arbor. 120 p.
Glas, P. 1957. Excursierapport vennen Campina en Oisterwijk. Stichting Onderzoek Levensgemeenschappen, Bilthoven. 53 p.
Glas, P. 1958. Excursierapport Kliplo-ven (Plassenverordening voor Drenthe 1956 nr. 104). Stichting Onderzoek Levensgemeenschappen, Bilthoven. 3 p.
Goessens, F. 1983. Samenstelling en oecologie van mikrofytencoenosen (exl. Diatomeeën) in een achttal vennen en veentjes in Z.W.-Drenthe. Intern Rapport nr. 156, Hugo de Vrieslaboratorium, Amsterdam. 165 p. + ann.
Golterman, H.L., R.S. Clymo & M.A.M. Ohnstad 1978. Methods for physical and chemical analysis of fresh waters. IBP Handbook No. 8, Blackwell, Oxford. 213 p.
Grahn, O., Hultberg, H. & Landner, L. 1974. Oligotrophication - a self-accelerating process in lakes subjected to excessive supply of acid substances. Ambio 3: 93-94.
Griendt, N. van de 1933. De plantengroei van de Oisterwijksche vennen in verband met de theorieën over haar ontstaan. Summary, Heimans archive (P.F.M. Coesel), Amsterdam.
Haines, T.A., Akielaszek, J.J., Norton, S.A. & Davis, R.B. 1983. Errors in pH measurement with colorimetric indicators in low alkalinity waters. Hydrobiologia 107: 57-61.
Hartley, B. 1986. A check-list of the freshwater, brackish and marine diatoms of the British Isles and adjoining coastal waters. Journal of the Marine Biological Association U.K. 66: 531-610.
Hees, A.F.M. van & J.H.R. van den Wijngaard 1977. Bosgeschiedenis en bostypen van Midden-Brabant, deelrapport 5. Projectstudie Landinrichting Midden-Brabant, 'De Dorschkamp', Wageningen. 26 p. + ann.
Heimans, J. 1925. De Desmidiaceeënflora van de Oisterwijksche vennen. Nederlandsch Kruidkundig Archief

34:245-268.

Heimans, J. 1960. Desmidiaceeën in de vennen van het natuurreservaat Oisterwijk. Publicatie van de Hydrobiologische Vereniging Amsterdam 5: 25-42.

Hemond, H.F. 1980. Biogeochemistry of Thoreau's Bog, Concord, Massachusetts. Ecological Monographs 50: 507-526.

Hemond, H.F. 1983. The nitrogen budget of Thoreau's bog. Ecology 64: 59-109.

Henriksen, A. & Seip, H.M. 1980. Strong and weak acids in surface waters of southern Norway and southwestern Scotland. Water Research 14: 809-813.

Higler, L.W.G. 1979. Limnological data on a Dutch moorland pool through sixty years. Hydrobiological Bulletin 13: 138-143.

Hoeve, J. ter 1949. De waterhuishouding in het gebied der Oisterwijkse vennen. Unpublished Report, Staatsbosbeheer, Utrecht. 5 p.

Hofman, K. & M. Janssen 1986. Historische ontwikkelingen van vennen in Midden-Brabant, qua vegetatie en waterchemie en een beschrijving van de huidige toestand. Rapport 210, Laboratorium voor Aquatische Oecologie, Katholieke Universiteit, Nijmegen/Rijksinstituut voor Natuurbeheer, Leersum. 233 p.

Hustedt, F. 1932. Die Kieselalgen Deutschlands, Osterreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie die angrenzenden Meeresgebiete. In: Dr. L. Rabenhorsts Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz, VII, 2(2): 177-320. Geest & Portig, Leipzig.

Hustedt, F. 1939. Systematische und ökologische Untersuchungen über die Diatomeeënflora von Java, Bali und Samatra. Archiv für Hydrobiologie/ Suppl. 16: 274-394.

Iven, W. & T. van Gerwen 1974. Lind dè is de sgonste plats, natuur en landschap van Leende, een Oost-Brabants dorp. Willem Iven, Teo van Gerwen, Leende. 183 p.

Iversen, J. 1929. Studien über die pH-Verhältnisse dänischer Gewässer und ihren Einfluss auf die Hydrophyten-Vegetation. Botanisk Tidsskrift 40: 277-333.

Jørgensen, E.G. 1948. Diatom communities in some Danish lakes and ponds. Det Kongelige Danske Videnskabernes Selskab, Biologiske Skrifter 5(2): 1-40.

Keeney, R.R. 1973. The nitrogen cycle in sediment-water systems. Journal of Environmental Quality 3: 15-29.

Kelly, C.A. & Rudd, J.W.M. 1984. Epilimnetic sulphate reduction and its relationship to lake acidification. Biogeochemistry 1: 63-77.

Kelly, C.A., Rudd, J.W.M., Furutani, A. & Schindler, D.W. 1984. Effects of acidification on rates of organic matter decomposition in sediments. Limnology and Oceanography 29: 687-694.

Kemmers, R.H. & P.C. Jansen 1980. De invloed van chemische factoren in grondwater en bodem op enkele vegetatietypen in het CRM-reservaat 'Groot Zandbrink'. Nota 1181, Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen. 37 p.

Kilham, P. 1982. Acid precipitation: its role in the alkalinization of a lake in Michigan. Limnology and Oceanography 27: 856-867.

Kopp, A., U. Feller & K.H. Erismann 1974. Untersuchungen zur Regulation der Stickstoff-assimilation von Lemna minor im Übergang von Ammonium- auf Nitrat- bzw. Nitrat- auf Ammoniumernährung unter Photosynthesebedingungen. Zeitschrift für Pflanzenphysiologie 73: 456-460.

Koster, F. 1942. Natuurmonumenten van Nederland, II. Scheltema & Holkema, Amsterdam. 211 p.

Koster, J.T. 1960. Gegevens over de wierflora van Voorste en Achterste Goorven. Publicatie van de Hydrobiologische Vereniging Amsterdam 5: 43-47.

Kragt, F.J. (in prep). De hydrologie van het Strijper Aa-gebied. Rapport Rijksinstituut voor Natuurbeheer, Leersum.

Krammer, K. & Lange-Bertalot, H. 1985. Naviculaceae. Neue und wenig bekannte Taxa, neue Kombinationen und Synonyme sowie Bemerkungen zu einigen Gattungen. Bibliotheca Diatomologica 9: 1-230.

Kwakkestein, R. 1977. Onderzoek naar de Desmidiaceeënflora van de vennen in het gebied rond Oisterwijk. I. De vennen in het westelijke gedeelte. Intern Rapport No. 38, Hugo de Vrieslaboratorium, Amsterdam. 122 p. + ann.

Landolt, E. 1977. Okologische Zeigerwerte zur Schweizer Flora. Veröffentlichungen des Geobotanischen Institutes der Eidgenössischen Technischen Hochschule, Stiftung Rübel 64: 1-208.

Leentvaar, P. 1984a. Hydrobiologische waarnemingen in een bosvijver. Unpublished Report, Rijksinstituut voor Natuurbeheer, Leersum. 22 p. + ann.

Leentvaar, P. 1984b. Vennenonderzoek in 1960. Unpublished Report, Rijksinstituut voor Natuurbeheer, Leersum. 7 p.

Likens, G.E. 1984. Beyond the shoreline. Verhandlungen der internationalen Vereinigung für theoretische und angewandte Limnologie 22:1-22.

Londo, G. 1973. Excursierapport Kliplo-ven. Natuurreservaat in boswachterij Dwingelo. Rijksinstituut voor Natuurbeheer, Leersum. 1 p.

Loriè, J. 1918. De vennen van Oisterwijk in Noord-Brabant, III. Verhandelingen van het Geologisch-Mijnbouwkundig Genootschap voor Nederland en Koloniën. Geologische Serie 2: 281-292.

Loriè, J. 1922. Hoe ontstonden de vennen van Oisterwijk? Jaarboekje der Vereeniging tot Behoud van Natuurmonumenten in Nederland met verslagen der algemeene vergaderingen van 10 Juli 1918, 10 Mei 1919, 8 Mei 1920, 14 Mei 1921 en 29 April 1922, benevens bijdragen over terreinen der Vereeniging en over natuurbescherming. p. 73-81.

Lubbers, M.T.M.H. (without year). Methods for chemical analysis Techicon Auto-Analyzer II. Department of Soil Science and Geology, Agricultural University, Wageningen. 14 p.

Margadant, W.D. & H. During 1982. Beknopte flora van Nederlandse blad- en levermossen. Thieme, Zutphen. 517 p.

Mayer, R. & Ulrich, B. 1978. Input of atmospheric sulfur by dry and wet deposition to two central European forest ecosystems. Atmospheric Environment 12: 375-377.

Meriläinen, J. 1967. The diatom flora and the hydrogen concentration of the water. Annales Botanici Fennici 4: 51-58.

Meijden, R. van der, E.J. Weeda, F.A.C.B. Adema & G.J. de Joncheere. Flora van Nederland (20th ed.). Wolters-Noordhoff, Groningen. 583 p.

Middleton, A.C. & F.A. Rovers 1976. Average pH. Journal of the Water Pollution Control Federation 48: 395-396.

Moerman, J.D. 1934. Veluwsche beken en daling van het grondwaterpeil. Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap 51: 495-520, 676-697.

Moller Pillot, H. 1958. Excursierapport Gerritsflesch. Stichting Onderzoek Levensgemeenschappen, Bilthoven. 4 p.

Mörzer Bruyns, M.F. 1950. Excursierapport van een bezoek aan de reservaten in de Boschwachterij 'Dwingeloo' op 14 November 1950. Afdeling Natuurbescherming en Landschap. Staatsbosbeheer, Utrecht. 3 p.

Neal, C. & Thomas, A.G. 1985. Field and laboratory measurement of pH in low-conductivity natural waters.

Journal of Hydrology 79: 319-322.

Nihlgård, B. 1970. Precipitation, its chemical composition and its effect on soil water in a beech and a spruce forest in south Sweden. Oikos 21: 208-217.

Notenboom-Ram, E. 1976. Hydrobiologisch onderzoek in een aantal stilstaande wateren op de Veluwe. Rapport Rijksinstituut voor Natuurbeheer, Leersum. 62 p. + ann.

Ohle, W. 1954. Sulfat als 'Katalysator' des limnischen Stoffkreislaufes. Vom Wasser 21: 13-32.

Oliver, B.G. & Kelso, J.R.M. 1983. A role for the sediments in retarding the acidification of headwater lakes. Water, Air and Soil Pollution 20: 379-389.

Oliver, B.G., E.M. Thurman & R.L. Malcolm 1983. The contribution of humic substances to the acidity of colored natural waters. Geochimica et Cosmochimica Acta 47: 2031-2035.

Oordt, G.J. van 1935. De Staatsnatuurreservaten. Verslagen en Mededelingen van de Directie van den Landbouw 5. 8 p.

Oordt, G.J. van 1939. Overzicht van de natuurreservaten van het Staatsboschbeheer. In: Gedenkboek ter gelegenheid van het 40-jarig bestaan van het Staatsboschbeheer. Algemeene Landsdrukkerij, 's-Gravenhage. p. 158-170.

Oosterom, H.P. 1982. Samenstelling van het bovenste grondwater onder landbouwpercelen en enkele bospercelen. Projectgroep zuidelijk Peelgebied, no. 15. Nota 1385, Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen. 22 p.

Oosterom, H.P. & J.H.W.M. van Schijndel 1979. De chemische samenstelling van het bovenste grondwater bij natuurlijke begroeiingen op kalkarme zandgrond. Nota 1075, Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen. 27 p.

Oostveen, W.C.G. 1985. Tongbersven en Groot-Hasselsven, een hydrologisch onderzoek. Intern rapport Rijksinstituut voor Natuurbeheer, Leersum. 55 p.

Peters, N.E. & P.S. Murdoch 1985. Hydrogeologic comparison of an acidic-lake basin with a neutral-lake basin in the west-central Adirondack mountains, New York. Water, Air and Soil Pollution 26: 387-402.

Petersen, J.B. 1950. Observations on some small species of Eunotia. Dansk Botanisk Arkiv 14(1): 1-19.

Pietsch, W. 1976. Vegetationsentwicklung und wasserchemische Faktoren in Moorgewässern verschiedener Naturschutzgebiete der DDR. Archiv für Naturschutz und Landschaftsforschung 16: 1-43

Pietsch, W. 1982. Makrophytische Indikatoren für die ökochemische Beschaffenheit der Gewässer. In: G. Breitig & W. von Tümpling (eds). Ausgewählte Methoden der Wasseruntersuchung. II. Biologische, mikrobiologische und toxicologische Methoden (2nd ed.). Fischer, Jena, 67-86.

Posthumus, N.W. 1911. Keurboek van Oisterwijk. Verslagen en Mededelingen van de Vereeniging tot Uitgave der Bronnen van het Oud-Vaderlandsche Recht 6: 174-202.

Quispel, A. 1941. Het plankton uit Dwingeloo. Kameleon 5(2): 3-5.

Rao, S.S., Jurkovic, A.A. & Nriagu, J.O. 1984. Bacterial activity in sediments of lakes receiving acid precipitation. Environmental Pollution A 36: 195-205.

Redeke, H.C. 1948. Hydrobiologie van Nederland, de zoete wateren. De Boer, Amsterdam. 580 p.

Redeke, H.C. & A.P.C. de Vos 1932. Beiträge zur Kenntnis der Fauna niederländischer oligotropher Gewässer. Internationale Revue der gesamten Hydrobiologie 28: 1-45.

Renberg, I. 1976. Palaeo-ecological investigations in coastal Västerbotten, N. Sweden. Early Norrland 9: 115-159.

Renberg, I. & T. Hellberg 1982. The pH history of lakes in southwestern Sweden, as calculated from the subfossil diatom flora of the sediments. Ambio 11: 30-33.

Ringelberg, J. 1956. Overzicht van Rotatoren van enkele plassen in ZO-Drenthe. Letter with annexes to Dr. W. Beijerinck. Rijksarchief, Assen.

Roelfs, G. 1981. Indeling van enkele Drentse vennen op basis van diatomeeëncombinaties. Stageverslag Rijks Hogere Landbouwschool, Groningen/Provinciale Planologische Dienst van Drenthe, Assen. 43 p.

Roelofs, J.G.M. 1983. Impact of acidification and eutrophication on macrophyte communities in soft waters in The Netherlands. I. Field observations. Aquatic Botany 17: 139-155.

Roelofs, J.G.M., Schuurkes, J.A.A.R. & Smits, A.J.M. 1984. Impact of acidification and eutrophication on macrophyte communities in soft waters. II. Experimental studies. Aquatic Botany 18: 389-411.

Roijackers, R.M.M. 1985. Phytoplankton studies in a nymphaeid-dominated system. Doctoral thesis, Katholieke Universiteit, Nijmegen. 172 p.

Romijn, G. 1925. Onderzoek Gerritsflesch op 26 september 1925. Unpublished report. 2 p.

Ross, R. & A. Sims 1978. Notes on some diatoms from the Isle of Mull, and other Scottish localities. Bacillaria 1: 151-168.

Round, F. & D.G. Mann 1981. The diatom genus Brachysira. I. Typification and separation from Anomoeoneis. Archiv für Protistenkunde 124: 221-231.

Schimmel, H.J.W. & J. ter Hoeve 1952. Bodemgesteldheid en waterhuishouding van de 'Gerritsflesch' bij Kootwijk. Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap 69: 16-28.

Schimmel, H.J.W. & M.F. Mörzer Bruyns 1952. De vegetatie van de Gerritsflesch en van de naaste omgeving. Publicatie van de Hydrobiologische Vereniging Amsterdam 4: 7-12.

Schindler, D.W. 1985. The coupling of elemental cycles by organisms: evidence from whole-lake chemical perturbations. In: W. Stumm (ed.). Chemical processes in lakes. Wiley, New York, 225-250.

Schnoor, J.L. & Stumm, W. 1985. Acidification of aquatic and terrestrial systems. In: W. Stumm (ed.). Chemical processes in lakes. Wiley, New York, 311-338.

Schofield, C.L., Galloway, J.N. & Hendrey, G.R. 1985. Surface water chemistry in the ILWAS basins. Water, Air, and Soil Pollution 26: 403-423.

Schuiling, R. & J.P. Thijsse 1928. Een ven bij Oisterwijk. Nederlandsche Landschappen 31. Noordhoff, Groningen. 23 p.

Schuurkes, J.A.A.R., Kok, C.J. & Den Hartog, C. 1986. Ammonium and nitrate uptake of aquatic plants from poorly buffered and acidified waters. Aquatic Botany 24: 131-146.

Schuurmans, C.J.E. 1977. Meteorologische aspecten van de droge zomer van 1976. H_2O 10: 178-180.

Schwoerbel, J. & G.C. Tillmanns 1972. Ammonium-Adaptation bei submersen Phanerogamen in situ. Archiv für Hydrobiologie/Suppl. 42: 139-141.

Schwoerbel, J. & G.C. Tillmanns 1974. Stickstoffaufnahme aus dem Wasser und Nitratreduktase-Aktivität bei submersen Wasserpflanzen: Fontinalis antipyretica L. Archiv für Hydrobiologie 47: 282-294.

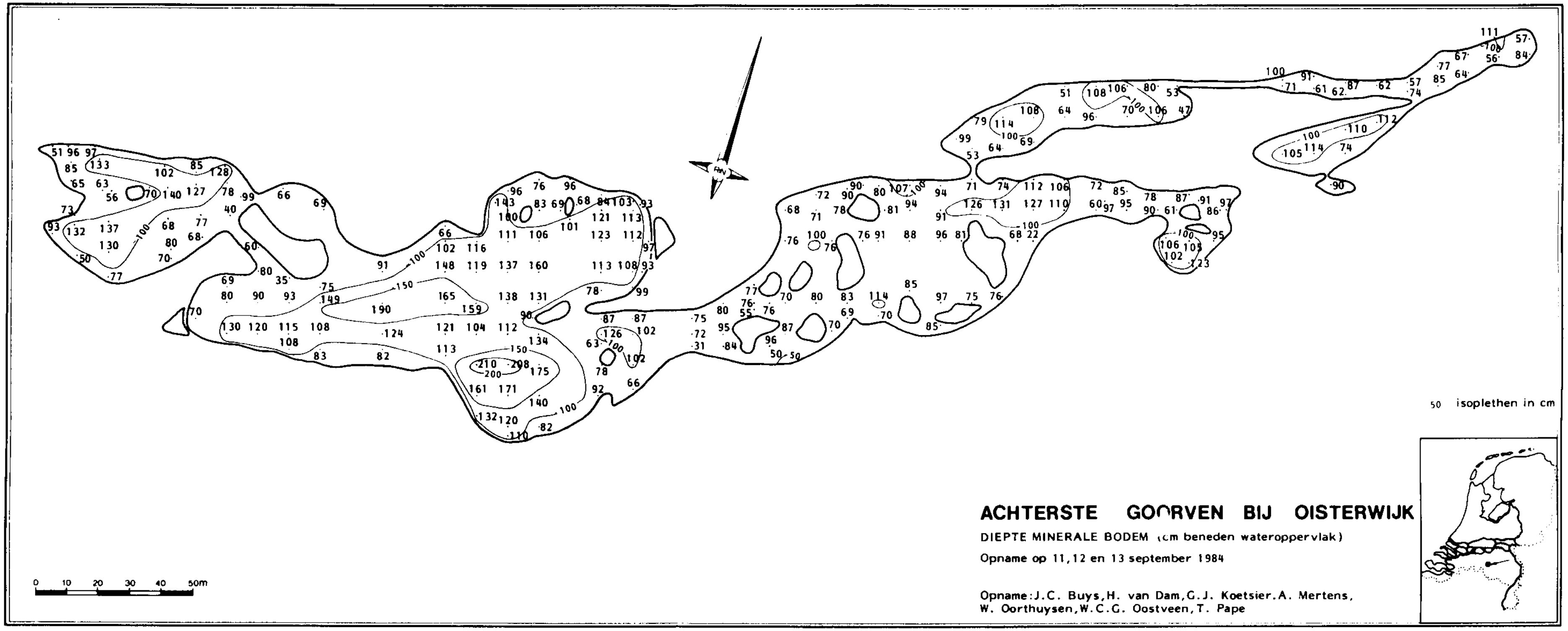
Sheridan, R.P. 1976. Average pH. Journal of the Water Pollution Control Federation 48: 2217.

Sloff, J.G. 1928. Rapport in zake het natuurmonument "De Gerritsflesch". Commissie voor de bescherming van de wilde flora, Nederlandsche Botanische Vereniging, Bergen op Zoom. 4 p.

Smit, H.D.W. 1976. Desmidiaceeën in Zuid-West Drente. Veranderingen in de Desmidiaceeënflora van een aantal Drentse vennen gedurende de laatste vijftig jaar. Intern Rapport nr. 35, Hugo de Vrieslaboratorium,

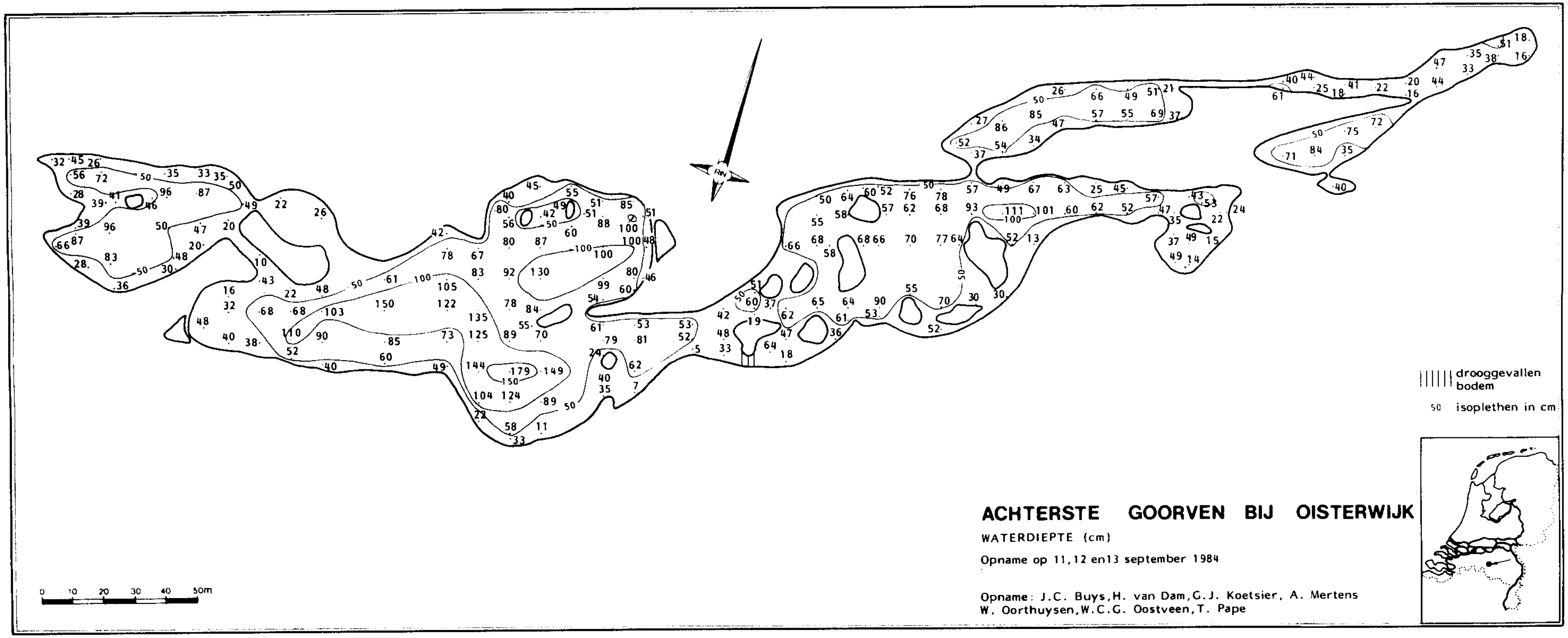
Amsterdam. 106 p. + ann.
Sokal, R.R. & Rohlf, F.J. 1969. Biometry. Freeman, San Francisco. 776 p.
Stapelveld, E. 1956. De bryologische najaarsexcursie naar Drenthe. Brexbaumia 10(1/2): 5-14.
Stumm, W. & Baccini, P. 1978. Man-made chemical perturbations of lakes. In: E. Lerman (ed.). Lakes, chemistry, geology, physics. Springer, Heidelberg, 91-126.
Stumm, W. & J.J. Morgan 1970. Aquatic chemistry, an introduction emphasizing chemical equilibria in natural waters. Wiley-Interscience, New York. 583 p.
Stumm, W., J.J. Morgan & J.L. Schnoor 1983. Saurer Regen, eine Folge der Störung hydrogeochemischer Kreisläufe. Naturwissenschaften **70**: 216-223.
Stuyfzand, P.J. 1984. Effecten van vegetatie en luchtverontreiniging op de grondwaterkwaliteit in kalkrijke duinen bij Castricum: lysimeterwaarnemingen. H_2O 17: 152-159.
Tesch, P., E. Hesselink & J. Valckenier Suringar 1926. De zandverstuivingen bij Kootwijk. Staatsbosbeheer, Utrecht. 70 p. + 41 taf.
Thijsse, J.P. 1912. Oisterwijk. De Levende Natuur 17: 361-363.
Thijsse, J.P. 1916. Een vennentoer. De Levende Natuur **21**: 147-150, 173-177, 207-210, 232-235.
Thijsse, J.P. 1926. De flora en fauna. In: J. van Baren, L.C.T. Bigot, H. Blink, H.P.J. Bloemers & F.A. Hoefer (eds.), Gelderland. Van Loghum Slaterus, Arnhem. p. 75-117.
Thijsse, J.P. 1927. In Oisterwijk. De Levende Natuur **32**: 69-72.
Thijsse, J.P. 1928. Gerrits Flesch. De Levende Natuur **33**: 265.
Thijsse, J.P. 1937. Oisterwijk. De Levende Natuur 41: 166-172.
Tiedje, J.M., A.J. Sextone, D.D. Myrold & J.A. Robinson 1982. Denitrification: ecological niches, competition and survival. Antonie van Leeuwenhoek **48**: 569-583.
Toetz, D.W. 1973. The kinetics of NH_4 uptake by Ceratophyllum. Hydrobiologia **41**: 275-290.
Vangenechten, J.H.D., F. Bosmans & H. Deckers 1981. Effects of short-term changes in rain water supply on the ionic composition of acid moorland pools in the Campine of Antwerp (Belgium). Hydrobiologia **76**: 149-159.
Vegt, J.J. 1978. Verdamping, berging en indringing van boezemwater in het moerasgebied 'De Weerribben'. Studentenverslag, Landbouwhogeschool, Vakgroep Cultuurtechniek, Wageningen/Rijksinstituut voor Natuurbeheer, Leersum. 51 p. + ann.
Verhoeven, H.J. & C.A. Bastiaanssen 1959. Excursierapport Vennen van Oisterwijk. Stichting Onderzoek Levensgemeenschappen, Bilthoven. 8 p.
Verschoor, A. 1977. Onderzoek naar de Desmidiaceeënflora van de vennen in het gebied rond Oisterwijk. II. De vennen in het oostelijk gedeelte. Intern Rapport 42, Hugo de Vrieslaboratorium, Amsterdam. 100 p. + ann.
Verstegen, M. 1985. De macrofauna - met name de Chironomidelarven - van een twaalftal vennen in de gemeenten Boxtel, Oisterwijk en Moergestel. Doctoraalverslag. Vakgroep Zoölogische Oecologie en Taxonomie, Rijksuniversiteit, Utrecht / Vereniging tot Behoud van Natuurmonumenten, 's-Graveland. 65 p. + ann.
Vogel, A.I. 1961. A textbook of quantitative inorganic analysis including elementary instrumental analysis (third edition). Longman, London. 1216 p.
Voo, E.E. van der 1965. De Drijvende egelskop. De Levende Natuur **68**: 2-10.
Voo, E.E. van der 1973. Areaal, milieu en sociologie van Sparganium angustifolium Michaux. Rapport Rijksinstituut voor Natuurbeheer, Leersum. 62 p.
Voo, E.E. van der 1975. Excursierapport Kliploven. Rijksinstituut voor Natuurbeheer, Leersum. 1 p.
Voo, E.E. van der & V. Westhoff 1959. Rapport over de toestand van het Choorven op 28 september 1959. Excursieverslag, Rijksinstituut voor Veldbiologisch Onderzoek ten behoeve van het Natuurbehoud, Bilthoven.
Vrielink, J.G., J.A. van den Hurk & A.W. Waenink 1976. Boswachterij Dwingeloo. Bodemgesteldheid en bodemgeschiktheid. Rapport nr. 1164, Stichting voor Bodemkartering, Wageningen. 71 p. + ann.
Vries, B.J. de 1982. Diatomeeëngemeenschappen in Drentse vennen. Intern Rapport nr. 117, Hugo de Vrieslaboratorium, Amsterdam. 136 p. + ann.
Vries, B.J. de 1984. Diatom assemblies in some moorland pools in the Drenthian district (The Netherlands). Hydrobiological Bulletin **18**: 3-10.
Vuyck, L. 1924. De Gerrits-Flesch. Nederlandsch Kruidkundig Archief **33**: 60-67.
Wartena, A.J. 1954. Desmidiaceae. Unpublished report. 44 p.
Werff, A. van der 1960. De Diatomeeën uit de westelijke vennen te Oisterwijk, vóór en na het schoonmaken. Publicatie van de Hydrobiologische Vereniging, Amsterdam. **5**: 48-56.
Westhoff, V. & J. van Dijk 1950. Aanvullend rapport betreffende het "schoonmaken" van de Oisterwijkse vennen. Vereniging tot Behoud van Natuurmonumenten in Nederland, Amsterdam. 3 p.
Westhoff, V. & A.J. den Held 1969. Plantengemeenschappen in Nederland. Thieme, Zutphen. 324 p.
Wetzel, R.G. 1983. Limnology. Saunders, Philadelphia. 767 p.
Wigman, A.B. 1932. Bruine verten en blinkend zand, een boek van de Veluwsche hei. Schoonderbeek, Laren. 320 p.
Zoetmulder, A.J. 1922. Geïllustreerde gids 'Mooi Oisterwijk'. Oisterwijk, Oisterwijk. 58 p.
Zólyomi, B. 1967. Einreihung von 1400 Arten der ungarischen Flora in ökologische Gruppen nach TWR-zahlen. Fragmenta Botanica Museum Historico-Naturalis Hungaricum **4**: 101-142.

Appendix 1



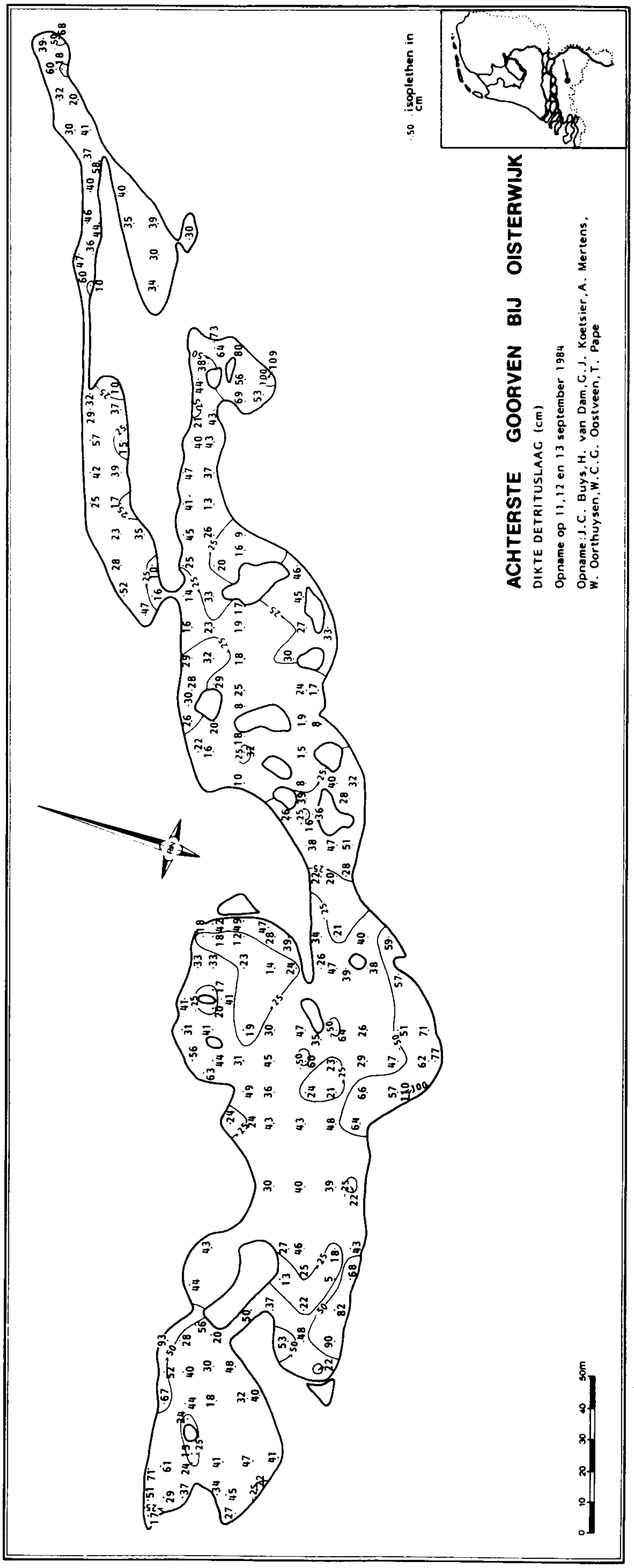
Achterste Goorven. Depth of mineral soil in cm below water level on September 11-13, 1984 (water level 8.28 m + NAP).

Appendix 2



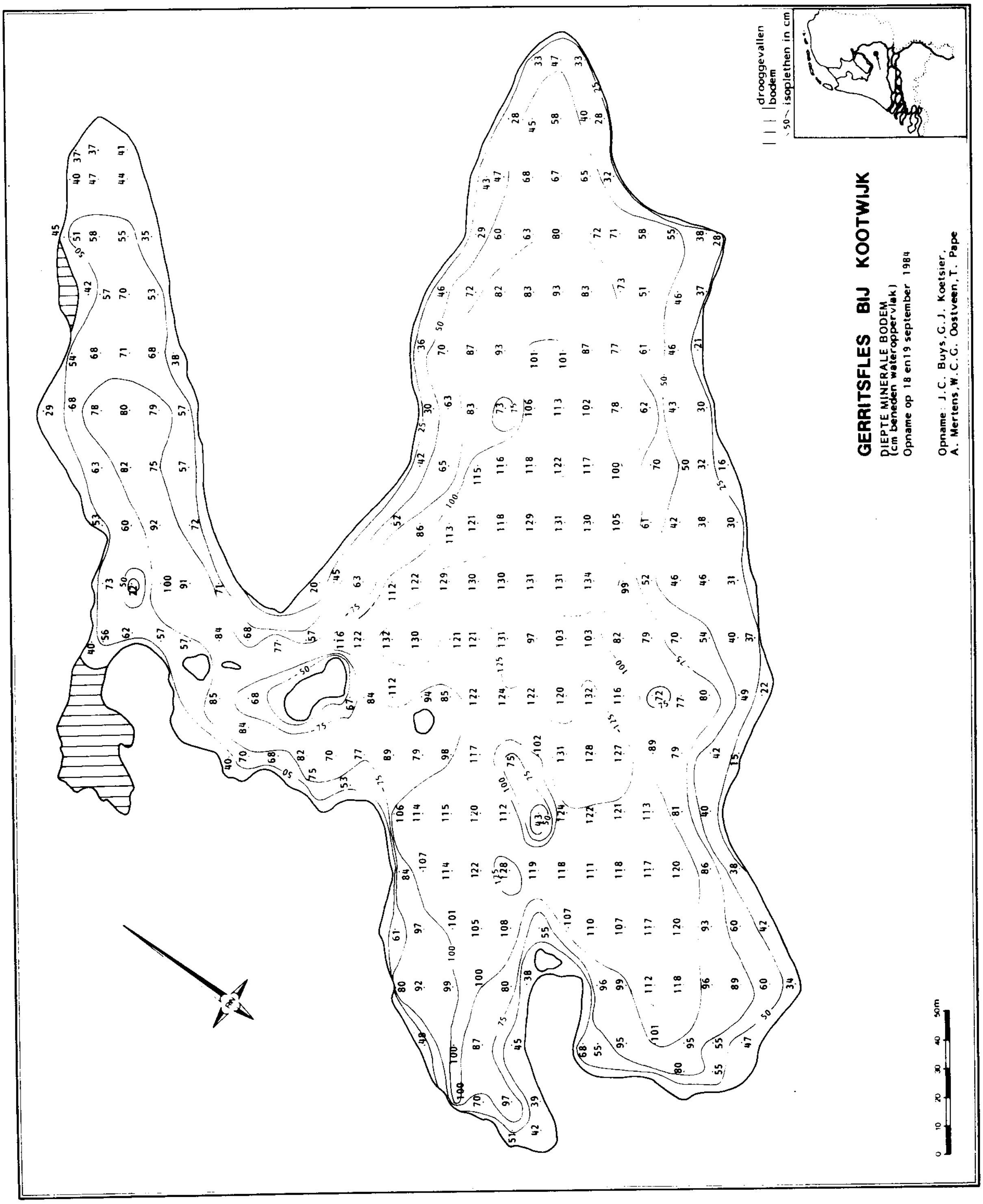
Achterste Goorven. Bathymetric map (depth in cm) on September 11-13, 1984 (water level 8.28 m + NAP). Hatched area = dry bottom.

Appendix 3



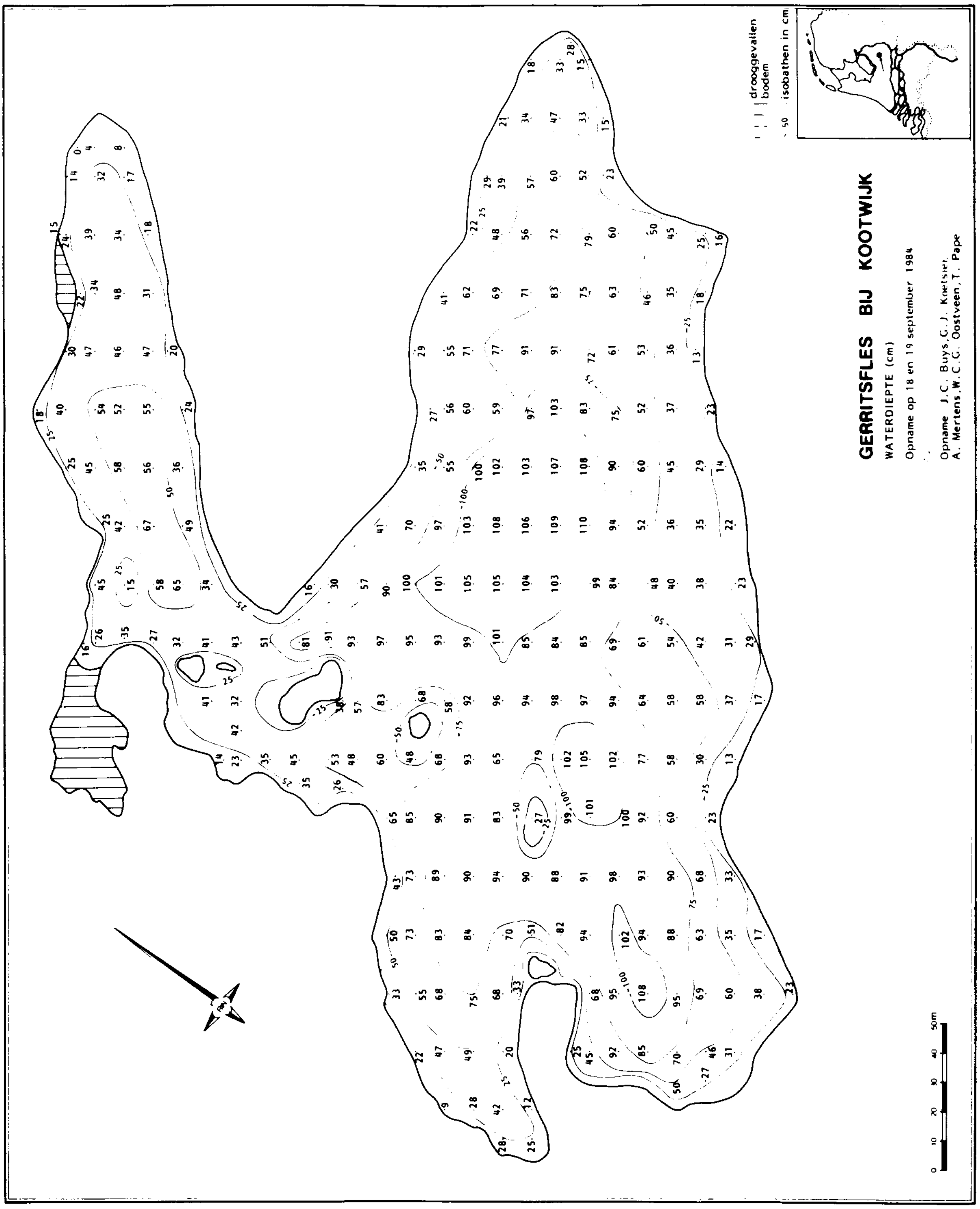
Achterste Goorven. Thickness of mud layer (cm) on September 11-13, 1984.

Appendix 4



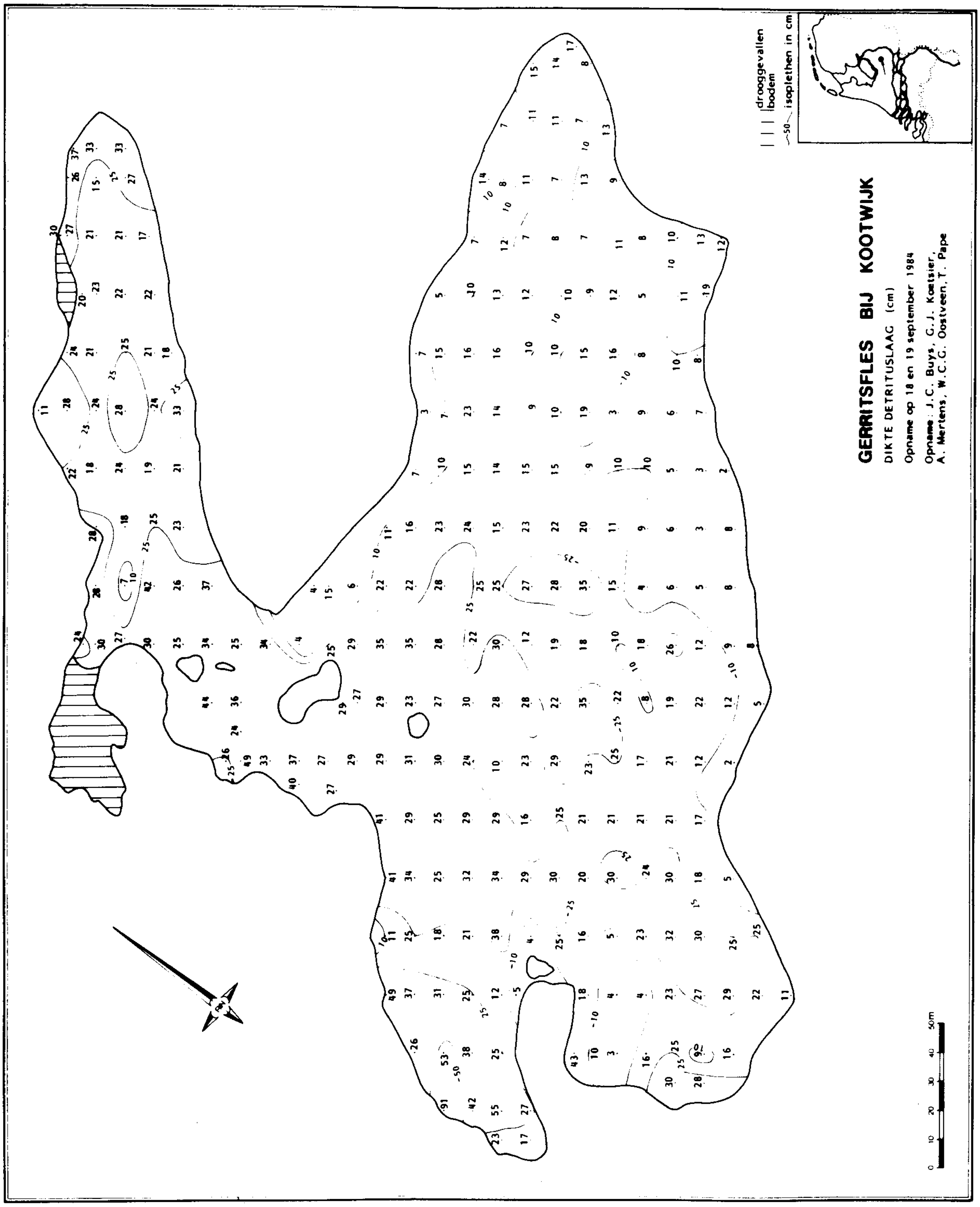
Gerritsfles. Depth of mineral soil in cm below water level on September 18-19, 1984 (water level 39.77 m + NAP).

Appendix 5



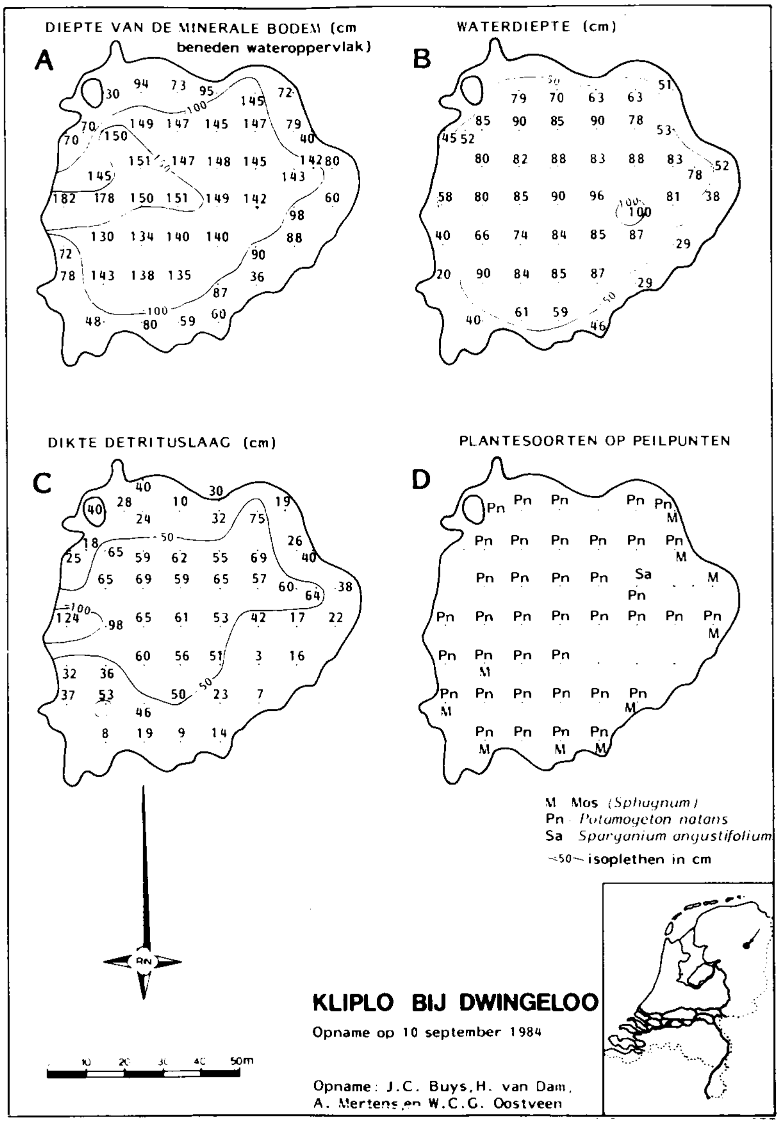
Gerritsfles. Bathymetric map (depth in cm) on September 18-19, 1984 (water level 39.77 m + NAP). Hatched area = dry bottom.

Appendix 6



Gerritsfles. Thickness of mud layer (cm) on September 18-19, 1984.

Appendix 7



Kliplo, September 10, 1984. A. Depth of mineral soil in cm below water level. B. Bathymetric map (depth in cm). C. Thickness of mud layer (cm). D. Plant species on gauging stations. Water level 12.84 m + NAP.

Appendix 8

ACHTERSTE GOORVEN station A, 520613-850211, chemical and physical data

DATE	TIME	LABOR	LEVEL	ICE	TEMP	pHf	pHl	EC25f	EC25l	KMNO4u	KMNO4f	COD	COLOR	O2	O2%	NR
	hMET	-	m+NAP	-	°C	-	-	mS/m	mS/m	mg/l	mg/l	mgO2/l	mgPt/l	mmol/m^3	%	-
520613	-	VANOYE	-	0	-	5.2	-	-	-	-	-	-	-	-	-	1
571018	-	RZIHIL	-	0	-	-	-	-	-	-	-	-	-	-	-	2
750904	-	HVRIES	-	0	-	3.9	-	17.5	-	-	-	-	-	-	-	3
781109	16	WMN	-	0	7.0	3.7	4.9	25.3	25.3	6	2	-	-	-	-	4
790710	15	WMN	-	0	22.0	3.3	3.5	25.4	22.6	7	2	12	6	159	58	5
790815	14	WMN	-	0	23.5	3.7	3.4	24.2	23.6	7	3	8	4	241	90	6
790911	-	WMN	-	0	18.0	3.4	3.5	24.5	20.4	6	2	10	4	256	86	7
791010	-	WMN	8.16	0	17.0	3.3	3.8	22.0	21.5	7	4	20	3	241	79	8
791112	-	WMN	8.25	0	18.5	-	3.9	15.8	19.3	7	4	3	3	344	116	9
791210	-	WMN	8.28	0	8.5	3.7	4.0	19.8	18.1	8	5	7	3	316	86	10
800108	-	WMN	8.39	0	2.0	3.7	3.9	16.5	16.5	15	5	11	2	294	68	11
800212	-	WMN	-	0	7.0	3.6	3.7	17.5	15.4	18	6	15	8	394	104	12
800311	-	WMN	8.45	0	9.5	3.6	4.1	18.5	18.7	-	-	-	-	369	103	13
800414	-	WMN	8.43	0	15.5	-	3.9	18.0	18.1	-	-	-	-	391	126	14
800513	-	WMN	8.40	0	19.0	-	3.8	19.5	19.3	-	-	-	-	291	101	15
800610	-	WMN	8.30	0	20.0	3.5	3.6	21.5	21.5	-	-	-	-	247	87	16
800813	-	WMN	8.32	0	20.0	-	-	18.7	-	-	-	-	-	231	85	17
801111	-	WMN	8.36	0	2.0	-	-	16.7	-	-	-	-	-	400	85	18
810210	-	WMN	8.43	0	5.0	-	-	21.6	-	-	-	-	-	325	82	19
810510	-	WMN	-	0	21.0	4.5	-	17.3	-	-	-	-	-	-	-	20
810812	-	WMN	8.26	0	21.0	3.5	-	19.4	-	-	-	-	-	228	84	21
811112	11	WMN	8.30	0	10.5	4.6	4.7	12.6	12.7	-	-	-	-	119	31	22
820211	-	WMN	8.43	0	5.0	3.8	-	10.0	-	-	-	-	-	338	84	23
820507	-	WMN	8.37	0	11.5	4.0	-	13.6	-	-	-	-	-	419	121	24
820805	-	WMN	8.22	0	22.5	-	-	13.7	-	-	-	-	-	78	29	25
821110	15	WMN	8.23	0	10.5	4.5	4.8	13.8	10.3	-	-	-	-	300	85	26
830216	12	WMN	8.35	1	3.0	4.1	4.6	17.0	14.9	-	-	-	-	500	116	27
830527	13	WMN	8.48	0	11.5	4.0	4.4	13.4	11.6	-	-	-	-	219	64	28
830818	15	WMN	8.25	0	26.5	3.7	4.3	15.4	11.0	-	-	-	-	294	116	29
831115	-	WMN	8.27	0	1.5	4.2	5.8	13.6	12.1	-	-	-	-	350	76	30
840215	14	WMN	8.52	1	1.0	5.0	5.8	13.2	12.1	-	-	-	-	266	58	31
840516	13	WMN	8.32	0	18.0	3.9	4.3	15.0	16.5	-	-	-	-	344	115	32
840815	12	WMN	8.27	0	23.0	4.2	4.5	17.0	14.9	75	-	-	5	156	58	33
841114	13	WMN	8.35	0	8.0	4.3	4.4	14.0	15.4	-	-	-	-	284	76	34
850211	13	WMN	8.39	1	0.0	4.9	4.9	12.1	12.1	-	-	-	-	438	96	35

DATE	CO2	SIO2	TOHA	t-PO4f	NH4-or	NH4	K	NA	CA	MG	MN	AL	FE	CL	NO3	ALK	H2PO4	SO4	CO3	IR	NR
-	....	(equivalent) mmol/m^3	....																	-	-
520613	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
571018	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
750904	-	-	-	-	-	227	26	304	100	165	-	-	-	480	35	0	0.63	208	-	0.17	3
781109	-	-	450	-	10	216	41	370	549	346	7	334	17	494	2	66	0.21	1437	0	0.53	4
790710	613	17	230	0.42	11	133	33	370	250	214	5	133	64	437	3	0	0.05	999	0	0.36	5
790815	454	1	240	0.05	3	127	41	391	250	214	5	145	38	451	3	0	0.05	1020	0	0.36	6
790911	591	1	270	0.53	16	177	41	370	299	230	7	334	27	480	2	0	0.05	1124	0	0.38	7
791010	477	1	280	0.32	14	105	49	391	324	230	6	167	23	494	3	0	0.05	916	0	0.40	8
791112	364	17	280	0.53	9	155	59	348	324	222	6	111	16	465	5	0	0.05	895	0	0.41	9
791210	318	1	250	0.05	33	177	51	370	299	197	5	111	17	437	3	0	0.05	937	0	-	10
800108	364	-	220	0.74	6	133	49	304	250	181	4	44	13	367	6	0	0.05	708	0	-	11
800212	568	1	230	0.84	14	133	61	391	250	214	4	167	40	423	5	0	0.05	750	0	-	12
800311	-	-	-	-	-	-	-	-	-	-	-	-	-	451	-	-	-	-	-	-	13
800414	-	-	-	-	-	-	-	-	-	-	-	-	-	437	-	-	-	-	-	-	14
800513	-	-	-	-	-	-	-	-	-	-	-	-	-	480	-	-	-	-	-	-	15
800610	-	-	-	-	-	-	-	-	-	-	-	-	-	494	-	-	-	-	-	-	16
800813	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
801111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
810210	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
810510	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
810812	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
811112	-	-	-	-	-	-	-	-	-	-	-	-	-	437	-	-	-	-	-	-	22
820211	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23
820507	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24
820805	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
821110	-	-	-	-	-	-	-	-	100	-	-	-	-	409	-	-	-	-	-	0.20	26
830216	-	-	-	-	-	-	-	-	150	-	-	-	-	465	-	-	-	-	-	0.24	27
830527	-	-	-	-	-	-	-	-	100	-	-	-	-	451	-	-	-	-	-	0.18	28
830818	-	-	-	-	-	-	-	-	100	-	-	-	-	451	-	-	-	-	-	0.18	29
831115	-	-	-	-	-	-	-	-	100	-	-	-	-	508	-	-	-	-	-	0.16	30
840215	-	-	-	-	-	-	-	-	100	-	-	-	-	508	-	-	-	-	-	0.16	31
840516	-	-	120	-	-	-	-	-	100	-	-	-	-	451	-	-	-	-	-	0.18	32
840815	364	22	100	0.11	44	305	33	304	75	115	3	44	15	480	2	16	0.05	479	0	0.14	33
841114	-	-	-	-	-	-	-	-	125	-	-	-	-	508	-	-	-	-	-	0.20	34
850211	-	-	130	-	-	-	-	-	150	-	-	-	-	409	-	-	-	-	-	0.27	35

References: nr.1 P. van Oije (unpubl.); 2 P. Leentvaar (unpubl.); 3 Kwakkestein 1977; 4 Van Dam et al. 1981; 5-35 own record.

Appendix 9

ACHTERSTE GOORVEN station B, 191103-850211, chemical and physical data

DATE	TIME	LABOR	LEVEL	ICE	TEMP	pHf	pHl	EC25f	EC25l	KMNO4u	KMNO4f	COD	COLOR	O2	O2%	NR
	hMET	-	m+NAP	-	°C	-	-	mS/m	mS/m	mg/l	mg/l	mgO2/l	mgPt/l	$mmol/m^3$	%	-
191103	-	RDRINK	-	1	-	5.5	-	-	9.7	-	14	-	7	-	-	1
250729	-	HEIMAN	-	0	-	6.6	-	-	-	-	-	-	-	-	-	2
260410	-	HEIMAN	-	0	-	6.0	-	-	-	-	-	-	-	-	-	3
750904	-	HVRIES	-	0	-	3.5	-	13.0	-	-	-	-	-	-	-	4
781109	15	WMN	-	0	8.0	3.7	3.9	28.5	27.5	15	8	-	-	-	-	5
790710	15	WMN	-	0	24.0	3.5	3.5	26.5	23.6	16	1	35	8	272	103	6
790815	14	WMN	-	0	25.0	3.6	3.4	27.5	24.8	6	4	10	2	297	114	7
790911	-	WMN	-	0	18.0	3.4	3.5	24.0	22.6	30	4	30	4	288	97	8
791010	-	WMN	8.16	0	16.0	-	3.8	24.5	22.6	15	4	20	4	238	77	9
791112	-	WMN	8.25	0	19.0	-	3.8	23.0	20.4	6	4	4	3	381	131	10
791210	-	WMN	8.28	0	9.0	3.4	3.9	21.5	20.9	7	5	6	4	209	57	11
800108	-	WMN	8.39	0	1.5	3.8	3.9	27.0	17.1	13	4	15	3	272	58	12
800212	-	WMN	-	0	7.5	3.5	3.9	18.0	17.6	35	8	36	9	366	92	13
800311	-	WMN	8.45	0	10.0	-	3.9	19.0	18.7	-	-	-	-	309	89	14
800414	-	WMN	8.43	0	17.0	-	3.9	21.0	19.3	-	-	-	-	441	147	15
800513	-	WMN	8.40	0	19.0	-	3.8	20.0	20.4	-	-	-	-	291	101	16
800610	-	WMN	8.30	0	20.0	3.5	3.6	22.5	22.6	-	-	-	-	231	82	17
800813	-	WMN	8.32	0	19.5	-	-	20.0	-	-	-	-	-	225	78	18
801111	-	WMN	8.36	0	1.5	-	-	18.8	-	-	-	-	-	400	93	19
810210	-	WMN	8.43	0	5.0	-	-	22.9	-	-	-	-	-	331	86	20
810510	-	WMN	-	0	20.5	4.9	-	18.0	-	-	-	-	-	247	87	21
810812	-	WMN	8.26	0	23.0	3.5	-	18.7	-	-	-	-	-	234	88	22
811112	11	WMN	8.30	0	6.0	4.3	4.3	14.3	14.3	-	-	-	-	275	71	23
820211	-	WMN	8.43	0	5.0	3.8	-	12.3	-	-	-	-	-	328	82	24
820507	-	WMN	8.37	0	11.0	3.9	-	15.3	-	-	-	-	-	388	110	25
820805	-	WMN	8.22	0	23.5	3.3	-	15.9	-	-	-	-	-	103	39	26
821110	16	WMN	8.23	0	10.0	4.2	4.5	16.2	11.6	-	-	-	-	338	95	27
830216	13	WMN	8.35	1	3.0	4.1	4.5	17.0	13.2	-	-	-	-	475	112	28
830526	13	WMN	8.48	0	12.5	3.8	4.3	15.2	12.7	-	-	-	-	247	74	29
830818	16	WMN	8.25	0	26.0	3.9	4.5	13.1	10.8	-	-	-	-	281	110	30
831115	-	WMN	8.27	1	1.5	4.8	5.6	13.6	12.7	-	-	-	-	191	44	31
840215	-	WMN	8.52	0	2.5	4.1	4.7	14.8	13.8	-	-	-	-	363	85	32
840516	13	WMN	8.32	0	17.5	3.8	4.2	18.0	18.7	-	-	-	-	338	112	33
840815	13	WMN	8.27	0	23.0	3.9	4.3	21.9	18.1	5	-	-	2	222	83	34
841114	13	WMN	8.35	0	7.5	4.4	4.5	11.0	12.1	-	-	-	-	338	96	35
850211	13	WMN	8.39	1	0.0	4.9	5.1	11.6	11.6	-	-	-	-	344	75	36

DATE	CO2	SIO2	TOHA	t-PO4f	NH4-or	NH4	K	NA	CA	MG	MN	AL	FE	CL	NO3	ALK	H2PO4	SO4	CO3	IR	NR
-	............................(equivalent) $mmol/m^3$....................................																				-
191103	50	10	170	-	16	0	-	-	165	165	0	-	3	536	0	149	0.00	208	0	0.24	1
250729	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
260410	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
750904	-	-	-	-	-	272	26	348	250	165	-	-	-	508	2	0	0.21	458	-	0.33	4
781109	-	-	480	-	22	205	43	370	549	378	7	556	23	494	3	0	0.21	1645	0	0.53	5
790710	523	17	250	0.32	19	139	33	391	250	239	5	145	86	437	5	0	0.05	1041	0	0.36	6
790815	477	8	240	0.21	9	116	43	391	250	230	5	167	25	465	3	0	0.11	999	0	0.35	7
790911	659	8	280	0.53	42	144	43	370	299	255	6	234	81	494	6	0	0.11	1124	0	0.38	8
791010	591	8	280	0.32	19	94	59	435	299	255	5	389	46	494	3	0	0.05	1145	0	0.38	9
791112	523	17	260	0.63	8	127	84	370	299	222	5	278	15	480	5	0	0.11	999	0	0.38	10
791210	568	8	270	0.11	6	200	74	391	299	230	6	211	27	451	6	0	0.11	1103	0	0.40	11
800108	432	-	210	0.63	25	133	56	304	225	189	4	145	17	381	10	0	0.11	791	0	0.37	12
800212	591	17	200	1.47	36	94	59	370	200	197	4	178	18	423	5	0	0.05	833	0	0.32	13
800311	-	-	-	-	-	-	-	-	-	-	-	-	-	451	-	-	-	-	-	-	14
800414	-	-	-	-	-	-	-	-	-	-	-	-	-	451	-	-	-	-	-	-	15
800513	-	-	-	-	-	-	-	-	-	-	-	-	-	480	-	-	-	-	-	-	16
800610	-	-	-	-	-	-	-	-	-	-	-	-	-	494	-	-	-	-	-	-	17
800813	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
801111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
810210	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
810510	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
810812	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
811112	-	-	-	-	-	-	-	-	-	-	-	-	-	409	-	-	-	-	-	-	23
820211	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24
820507	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
820805	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26
821110	-	-	-	-	-	-	-	-	100	-	-	-	-	395	-	-	-	-	-	0.20	27
830216	-	-	-	-	-	-	-	-	100	-	-	-	-	395	-	-	-	-	-	0.20	28
830526	-	-	-	-	-	-	-	-	100	-	-	-	-	367	-	-	-	-	-	0.21	29
830818	-	-	-	-	-	-	-	-	100	-	-	-	-	451	-	-	-	-	-	0.18	30
831115	-	-	-	-	-	-	-	-	100	-	-	-	-	480	-	-	-	-	-	0.17	31
840215	-	-	110	-	-	-	-	-	100	-	-	-	-	409	-	-	-	-	-	0.20	32
840516	-	-	150	-	-	-	-	-	150	-	-	-	-	465	-	-	-	-	-	0.24	33
840815	318	13	140	0.21	10	416	31	326	125	140	3	78	70	494	1	0	0.05	729	0	0.20	34
841114	-	-	-	-	-	-	-	-	100	-	-	-	-	381	-	-	-	-	-	0.21	35
850211	-	-	120	-	-	-	-	-	125	-	-	-	-	395	-	-	-	-	-	0.24	36

References: nr. 1-3 J. Heimans (pers. comm.); 4 Kwakkestein (1977); 5 Van Dam et al. (1981); 6-36 own record.

Appendix 10

ACHTERSTE GOORVEN station E, 250729-850211, chemical and physical data.

DATE	TIME	LABOR	LEVEL	ICE	TEMP	pHf	pHl	EC25f	EC25l	KMNO4u	KMNO4f	COD	COLOR	O2	O2%	NR
	hMET	-	m+NAP	-	°C	-	-	mS/m	mS/m	mg/l	mg/l	mgO2/l	mgPt/l	mmol/m^3	%	-
250729	-	HEIMAN	-	0	-	6.0	-	-	-	-	-	-	-	-	-	1
260410	-	HEIMAN	-	0	-	5.4	-	-	-	-	-	-	-	-	-	2
781109	15	WMN	-	0	6.0	3.4	3.7	13.5	26.4	11	5	-	-	-	-	3
790710	14	WMN	-	0	22.0	3.5	3.6	19.6	26.3	15	6	24	9	244	89	4
790815	14	WMN	-	0	24.0	3.7	3.5	24.5	24.8	40	9	50	9	225	85	5
790911	-	WMN	-	0	17.5	3.4	3.6	27.0	25.9	7	3	8	4	244	82	6
791010	-	WMN	8.16	0	14.5	3.4	3.8	22.5	22.0	9	4	24	4	222	70	7
791112	-	WMN	8.25	0	18.0	3.7	3.9	23.0	18.7	10	5	3	4	378	128	8
791210	-	WMN	8.28	0	9.5	3.7	3.9	21.4	19.3	13	5	11	5	313	88	9
800108	-	WMN	8.39	0	1.5	3.7	3.9	16.8	15.4	15	8	13	3	247	56	10
800212	-	WMN	-	0	6.0	3.5	3.9	15.0	14.3	17	5	13	7	394	101	11
800311	-	WMN	8.45	0	7.5	3.4	3.8	18.0	18.1	15	7	16	7	322	85	12
800414	-	WMN	8.43	0	16.0	-	3.9	19.0	20.4	8	5	8	2	484	159	13
800513	-	WMN	8.40	0	18.5	-	3.8	20.3	22.0	10	3	16	4	256	88	14
800610	-	WMN	8.30	0	19.0	3.6	3.6	24.0	24.2	30	10	33	2	303	104	15
800813	-	WMN	8.32	0	19.0	-	3.7	20.0	19.8	16	8	-	3	303	105	16
801111	-	WMN	8.36	1	1.5	-	4.0	16.6	12.1	17	5	-	4	400	90	17
810210	-	WMN	8.43	0	5.0	3.7	4.0	21.5	15.4	30	10	-	9	341	85	18
810510	-	WMN	-	0	20.0	-	3.8	18.5	17.1	22	4	-	12	263	93	19
810812	-	WMN	8.26	0	21.0	3.6	4.0	23.8	24.2	19	7	-	11	231	83	20
811112	12	WMN	8.30	0	6.0	3.6	4.2	15.0	13.2	19	8	-	10	325	84	21
820211	-	WMN	8.43	1	4.0	-	4.3	7.6	7.2	50	3	-	23	366	89	22
820507	-	WMN	8.37	0	11.0	3.8	4.1	14.8	15.4	16	5	-	5	381	110	23
820805	-	WMN	8.22	0	22.5	5.6	3.8	10.8	14.9	4	3	-	2	88	32	24
821110	14	WMN	8.23	0	10.0	4.8	4.9	13.7	10.2	45	14	-	32	238	68	25
830216	13	WMN	8.35	1	2.0	4.0	4.4	18.5	14.9	45	8	-	24	494	113	26
830526	11	WMN	8.48	0	11.0	3.6	4.1	16.4	13.8	22	-	-	14	278	81	27
830818	13	WMN	8.25	0	24.5	3.9	4.4	13.7	11.0	50	-	-	43	313	120	28
831115	13	WMN	8.27	1	0.5	4.8	5.7	15.5	14.9	140	-	-	24	250	54	29
840215	12	WMN	8.52	0	3.0	3.9	4.6	16.9	13.2	36	-	-	16	378	90	30
840516	12	WMN	8.32	0	16.5	3.5	4.2	19.9	19.8	7	-	-	2	284	93	31
840815	12	WMN	8.27	0	22.0	3.9	4.2	18.2	18.1	8	-	-	2	209	77	32
841114	13	WMN	8.35	0	7.0	4.1	4.2	11.0	12.7	49	-	-	19	319	85	33
850211	14	WMN	8.39	1	0.0	5.2	4.9	12.9	12.1	55	-	-	15	203	43	34

DATE	CO2	SIO2	TOHA	t-PO4f	NH4-or	NH4	K	NA	CA	MG	MN	AL	FE	CL	NO3	ALK	H2PO4	SO4	CO3	IR	NR
-	....							(equivalent) mmol/m^3												-	-
250729	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
260410	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
781109	-	-	450	-	22	155	46	348	549	354	-	334	27	451	2	0	0.21	1416	0	0.55	3
790710	682	17	250	0.32	19	122	36	413	274	222	5	122	81	465	3	0	0.05	1041	0	0.37	4
790815	568	8	240	0.32	36	111	54	413	250	214	4	178	64	480	6	0	0.05	1020	0	0.34	5
790911	773	33	310	0.53	13	166	49	435	299	304	5	311	46	550	2	0	0.05	1249	0	0.35	6
791010	568	8	270	0.42	19	94	54	435	299	239	5	189	23	522	3	0	0.05	958	0	0.36	7
791112	432	17	270	0.63	13	100	84	370	299	239	4	167	20	480	8	0	0.21	916	0	0.38	8
791210	432	8	230	0.11	6	155	72	391	274	197	4	222	27	451	8	0	0.05	895	0	0.38	9
800108	364	-	200	0.74	39	100	43	283	250	140	3	78	43	381	10	0	0.11	687	0	0.40	10
800212	409	8	170	1.90	25	155	51	283	175	156	3	78	16	339	6	0	0.05	645	0	0.34	11
800311	500	17	200	0.53	17	100	59	348	200	189	3	167	22	395	1	0	0.11	729	0	0.34	12
800414	613	8	240	0.11	17	116	92	478	250	222	4	167	26	465	13	0	0.11	1020	0	0.35	13
800513	636	8	240	0.63	19	111	82	435	250	230	4	278	30	508	3	0	0.11	916	0	0.33	14
800610	568	8	240	3.05	33	67	59	435	250	230	4	189	32	522	8	0	0.42	1020	0	0.32	15
800813	432	8	220	0.53	17	67	51	348	250	189	4	167	40	451	6	0	0.11	729	0	0.36	16
801111	341	8	190	0.63	30	72	54	348	200	173	4	133	25	367	3	0	0.21	708	0	0.35	17
810210	295	50	170	0.84	25	105	59	283	200	140	3	122	32	381	6	0	0.11	604	0	0.34	18
810510	386	8	160	1.16	28	72	72	391	150	173	3	6	70	465	1	0	0.32	687	0	0.24	19
810812	409	8	170	0.74	17	61	66	413	175	156	3	42	38	508	1	0	0.32	541	0	0.26	20
811112	341	8	90	1.26	14	144	49	304	50	132	4	53	16	395	6	0	0.05	521	0	0.11	21
820211	364	17	80	1.16	25	30	31	152	75	66	3	50	21	169	3	0	0.11	291	0	0.31	22
820507	273	8	170	1.05	8	172	59	304	175	156	4	167	30	451	1	0	0.21	687	0	0.28	23
820805	295	17	130	0.84	8	78	43	326	150	115	3	50	40	508	1	0	0.42	521	0	0.23	24
821110	341	67	90	0.63	33	255	49	261	100	82	3	24	91	381	3	49	0.21	416	0	0.21	25
830216	318	33	110	0.32	25	316	56	326	100	115	3	50	75	423	10	0	0.05	645	0	0.19	26
830526	273	83	110	2.32	25	216	31	283	100	107	2	56	59	367	10	0	0.42	604	0	0.21	27
830818	204	47	100	1.37	78	111	38	326	100	90	2	39	150	494	3	8	0.21	437	0	0.17	28
831115	318	37	110	1.26	11	416	33	239	100	115	2	37	258	536	2	164	0.32	416	0	0.16	29
840215	318	30	140	0.21	19	294	49	326	150	123	3	89	15	437	5	8	0.11	521	0	0.26	30
840516	364	38	190	0.21	13	316	51	391	200	181	3	86	12	508	3	0	0.05	874	0	0.28	31
840815	341	12	110	0.21	11	360	31	348	100	123	3	44	27	508	2	0	0.05	645	0	0.16	32
841114	341	73	120	0.74	16	177	31	283	150	90	2	67	30	367	3	0	0.53	458	0	0.29	33
850211	886	112	140	1.05	15	244	36	283	150	132	2	72	70	423	8	66	0.11	458	300	0.26	34

References: nr. 1,2 J. Heimans (pers. comm.); 3 Van Dam et al. (1981); 4-34 own record.

Appendix 11

GERRITSFLES, 250926-850211, chemical and physical data.

DATE	TIME	LABOR	LEVEL	ICE	TEMP	pHf	pHl	EC25f	EC25l	KMNO4u	KMNO4f	COD	COLOR	O2	O2%	CO2	SIO2	TOHA	t-PO4f	NH4-or	NH4	K	NA	CA	MG	MN	AL	FE	CL	NO3	ALK	H2PO4	SO4	CO3	IR	NR
	hMET	-	m+NAP	-	°C	-	-	mS/m	mS/m	mg/l	mg/l	mgO2/l	mgPt/l	$mmol/m^3$	%	.............................(equivalent) $mmol/m^3$...................................																			-	-
250926	-	CLVGEZ	-	0	-	-	4.4	-	-	10	-	-	-	-	-	-	-	140	-	-	0	-	-	-	-	-	-	-	395	0	98	-	354	-	-	1
280812	-	REDVOS	-	0	-	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
300308	12	REDVOS	-	0	6.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
300322	12	REDVOS	-	0	5.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
300405	12	REDVOS	-	0	8.0	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
300430	16	RDRINK	-	0	15.5	6.5	6.5	-	10.0	16	13	-	8	-	-	114	17	200	-	13	21	-	-	195	197	7	-	8	468	-	98	0.00	396	-	0.29	6
300511	12	REDVOS	-	0	11.5	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
300823	15	REDVOS	-	0	21.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8
300927	15	REDVOS	-	0	15.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
301101	12	REDVOS	-	0	9.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
500930	-	GGD	-	0	-	4.0	-	-	-	7	-	-	9	-	-	-	0	-	-	-	-	-	-	240	140	-	-	2	395	2	59	1.47	-	-	0.38	11
600727	-	WMN	-	0	-	-	4.1	-	15.8	18	26	-	-	-	-	-	-	290	-	67	111	-	-	329	239	-	-	40	429	0	98	2.74	-	-	0.43	12
740423	-	WMN	-	0	-	3.9	4.1	-	11.0	10	9	-	-	372	-	-	-	130	-	14	47	28	304	100	148	-	-	1	282	0	0	0.21	541	0	0.26	13
771104	-	WMN	-	0	-	-	4.0	-	18.1	5	4	-	-	-	-	-	-	290	-	19	89	31	348	349	222	-	-	15	339	1	0	0.32	916	0	0.51	14
781116	18	WMN	-	0	8.0	4.1	4.1	13.1	12.7	7	4	-	-	-	-	-	-	180	-	10	50	28	261	175	189	4	11	4	353	5	0	0.21	625	0	0.33	15
790710	10	WMN	-	0	20.0	3.7	4.0	9.0	9.8	10	4	12	2	272	96	227	17	90	0.42	16	16	31	217	100	82	4	50	12	226	3	0	0.05	333	0	0.31	16
790814	14	WMN	-	0	25.0	4.2	4.0	9.5	10.1	14	6	60	4	356	138	182	8	100	0.05	25	16	51	239	100	90	4	22	5	268	6	0	0.05	291	0	0.27	17
790911	-	WMN	-	0	18.5	4.0	4.1	9.6	9.7	6	5	8	2	341	115	182	17	100	0.84	10	47	46	217	100	90	3	33	6	282	6	0	0.05	250	0	0.26	18
791010	-	WMN	39.81	0	17.0	-	4.2	10.4	10.0	10	4	10	1	316	105	182	8	100	0.32	3	42	46	239	100	99	5	56	7	268	3	0	0.05	354	0	0.27	19
791112	-	WMN	39.90	0	16.0	-	4.1	13.0	11.0	3	2	5	1	372	120	409	17	120	0.42	7	61	43	217	125	107	3	33	1	310	8	0	1.05	396	0	0.29	20
791210	-	WMN	39.93	0	9.0	4.1	4.2	9.0	9.7	4	2	0	2	359	100	204	8	90	0.63	8	53	51	217	100	82	4	56	1	240	8	0	0.05	354	0	0.29	21
800108	-	WMN	40.07	0	2.0	3.8	4.3	8.4	8.8	8	4	9	1	300	69	204	-	60	0.74	9	61	61	196	50	66	3	67	2	254	5	0	0.11	312	0	0.16	22
800212	-	WMN	40.10	0	5.0	4.3	4.4	7.7	7.3	9	2	8	2	388	97	159	8	90	0.74	12	44	38	217	100	82	3	33	4	226	6	0	0.11	312	0	0.31	23
800311	-	WMN	40.05	0	6.0	3.8	4.1	9.0	8.7	12	4	12	2	341	89	227	8	90	0.32	13	44	43	217	100	90	3	56	4	212	1	0	0.11	312	0	0.32	24
800414	-	WMN	40.04	0	12.5	-	4.2	6.5	7.8	17	8	21	14	434	130	295	8	90	1.47	17	10	43	217	100	82	3	33	7	240	10	0	0.42	333	0	0.29	25
800513	-	WMN	39.95	0	16.0	-	4.1	8.3	9.9	45	6	70	10	306	99	432	8	130	2.63	19	4	49	239	150	99	5	44	27	282	16	0	0.53	354	0	0.35	26
800610	-	WMN	39.85	0	18.0	3.7	4.0	9.7	10.1	12	6	16	5	275	93	227	8	100	1.58	16	33	46	239	100	90	4	44	30	282	5	0	0.21	396	0	0.26	27
800813	-	WMN	39.93	0	21.0	-	4.0	8.6	8.5	22	6	-	8	309	120	182	8	90	1.37	17	22	43	174	100	74	3	33	11	240	5	0	0.11	250	0	0.29	28
801111	-	WMN	40.08	1	1.5	-	6.3	8.4	9.4	50	17	-	11	431	97	136	8	210	2.11	116	61	113	326	299	107	13	89	107	353	6	147	1.58	396	0	0.46	29
810210	-	WMN	40.09	0	6.0	-	5.1	7.5	6.5	10	4	-	5	372	95	114	8	90	0.74	7	55	36	174	100	74	2	22	9	226	6	49	0.05	208	0	0.31	30
810506	14	WMN	40.02	0	11.0	4.3	4.5	6.7	7.0	7	3	-	3	200	58	182	8	80	1.16	9	47	46	152	75	66	3	24	4	226	5	8	0.11	271	0	0.25	31
810811	-	WMN	39.85	0	20.0	4.0	4.3	8.8	7.4	16	4	-	10	425	151	114	8	90	1.05	19	47	43	196	100	66	9	13	21	254	5	0	0.32	250	0	0.28	32
811111	17	WMN	39.92	0	4.0	3.9	4.5	7.9	7.4	13	3	-	3	381	93	159	8	40	1.90	14	72	31	196	15	66	3	14	6	254	8	8	0.05	271	0	0.06	33
820210	16	WMN	40.08	0	4.5	-	5.7	6.2	5.8	11	5	-	9	416	102	91	8	60	0.84	13	33	41	196	50	58	4	17	11	226	2	49	0.11	208	0	0.18	34
820506	-	WMN	39.93	0	10.5	4.4	4.7	7.1	6.7	11	5	-	3	463	134	91	8	60	1.05	9	100	46	196	50	66	2	19	2	268	3	33	0.11	250	0	0.16	35
820804	-	WMN	39.69	0	27.5	-	4.4	8.6	8.9	30	8	-	20	266	107	136	8	90	2.95	17	89	56	261	100	74	3	24	27	353	3	0	0.84	312	0	0.22	36
821109	15	WMN	39.61	0	11.0	5.1	5.3	10.6	9.7	60	10	-	22	322	94	114	8	70	1.37	55	233	46	239	75	58	1	24	30	339	2	66	0.21	354	0	0.18	37
830217	14	WMN	39.92	1	4.0	4.6	5.1	11.4	9.1	19	8	-	10	322	78	91	8	60	0.95	11	172	36	239	50	58	2	14	12	310	11	33	0.11	312	0	0.14	38
830517	9	WMN	40.00	0	14.0	4.1	4.8	8.7	8.0	18	-	-	11	309	96	91	8	50	0.53	16	133	23	174	50	49	2	11	20	240	16	33	0.05	250	0	0.17	39
830817	15	WMN	39.69	0	20.0	4.0	4.5	11.3	9.7	30	-	-	12	250	88	136	22	60	1.26	25	155	33	239	50	58	2	20	26	296	5	16	0.42	291	0	0.14	40
831116	11	WMN	39.74	1	2.0	4.9	5.2	10.9	9.6	29	-	-	9	453	104	114	5	60	0.32	14	261	38	261	50	58	2	14	16	310	5	33	0.05	291	0	0.14	41
840216	14	WMN	40.05	1	0.5	5.1	5.6	7.5	5.9	20	-	-	14	331	74	136	3	50	0.32	11	161	28	174	50	41	1	10	12	226	8	33	0.11	167	0	0.18	42
840518	14	WMN	39.85	0	13.5	5.5	4.6	7.2	7.3	21	-	-	10	356	108	114	13	40	0.42	17	155	26	174	25	41	1	10	9	240	8	8	0.05	312	0	0.09	43
840814	14	WMN	39.79	0	22.0	3.9	4.5	8.8	7.6	18	-	-	9	291	105	114	13	30	0.42	12	144	26	196	15	49	2	16	20	254	5	8	0.05	208	0	0.06	44
841113	15	WMN	39.88	0	8.5	4.4	4.4	7.0	6.9	8	-	-	3	363	100	114	5	70	0.53	8	94	18	174	100	41	1	26	3	212	10	8	0.21	208	0	0.32	45
850212	11	WMN	39.94	1	0.0	3.7	4.6	8.2	7.6	13	-	-	8	450	98	136	2	60	0.53	11	122	23	174	50	66	2	20	11	240	23	16	0.05	208	0	0.17	46

References: nr. 1 Romijn (1925); 2-5,7-10 H.C. Redeke & A.P.C. de Vos (archive Hydrobiological Society); 6 Redeke & De Vos (1932), Redeke (1948); 11 Dresscher et al. (1952); 12 Leentvaar (1984b); 13 Notenboom-Ram (1976); 14 Van Dam et al. (1983); 15 Van Dam et al. (1981); 16-46 own record.

Appendix 12

KLIPLO, 240822-850212, chemical and physical data

DATE	TIME	LABOR	LEVEL	ICE	TEMP	pHf	pH1	EC25f	EC251	KMNO4u	KMNO4f	COD	COLOR	O2	O2%	CO2	SIO2	TOHA	t-PO4f	NH4-or	NH4	K	NA	CA	MG	MN	AL	FE	CL	NO3	ALK	H2PO4	SO4	CO3	IR	NR
	hMET	-	m+NAP	-	°C	-	-	mS/m	mS/m	mg/l	mg/l	mgO2/l	mgPt/l	mmol/m^3	%	....(equivalent) mmol/m^3....																			-	-
240822	-	HEIMAN	-	0	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
260000	-	BEYERI	-	0	-	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
290608	-	REDEKE	-	0	-	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
560810	-	RINGEL	-	0	-	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
580530	-	LEENTV	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	395	-	-	-	-	-	-	5
680726	-	HVRIES	-	0	-	-	6.1	4.4	-	-	-	-	-	-	-	-	-	-	-	-	7	36	217	130	-	-	-	-	480	2	-	-	-	-	0.21	6
700408	-	BRANTJ	-	0	-	6.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
700604	-	BRANTJ	-	0	-	6.5	-	5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	367	-	-	-	-	-	-	8
720705	-	HVRIES	-	0	-	5.4	-	5.8	-	-	-	64	-	-	-	-	-	70	3.58	-	3	26	174	50	82	-	-	-	282	4	98	3.58	125	-	0.15	9
730331	-	HVRIES	-	0	-	5.7	-	4.5	-	-	-	40	-	-	-	-	-	60	1.58	-	3	26	217	50	66	-	-	-	310	3	49	0.74	42	-	0.14	10
751202	16	WMO	-	0	3.0	4.7	-	-	6.7	-	-	61	-	344	81	-	-	-	0.84	-	33	-	-	-	-	-	-	-	395	2	-	-	-	-	-	11
760225	14	WMO	-	0	3.0	4.3	-	-	16.6	-	-	40	-	341	81	-	-	-	0.32	-	33	-	-	-	-	-	-	-	-	2	-	-	-	-	-	12
760407	11	WMO	-	0	-	4.8	-	10.0	-	-	-	80	-	391	100	-	-	100	0.32	-	21	51	304	100	82	-	-	39	423	1	98	0.05	-	-	0.19	13
760610	13	WMO	-	0	23.0	3.9	-	-	8.8	-	-	85	-	313	115	-	-	-	0.63	-	19	-	-	-	-	-	-	-	508	3	-	-	-	-	-	14
760823	14	WMO	-	0	-	8.8	-	9.0	-	-	-	80	-	303	105	-	-	100	0.63	-	17	51	565	100	82	-	-	193	621	1	66	0.05	42	-	0.14	15
761006	14	WMO	-	0	13.0	5.4	-	-	9.9	-	-	255	-	303	92	-	-	-	0.84	-	42	-	-	-	-	-	-	-	818	1	-	-	-	-	-	16
781114	11	WMN	-	0	8.5	5.4	5.6	7.0	7.6	35	7	-	-	-	-	-	-	140	-	30	8	23	326	150	115	-	11	40	451	6	66	0.32	125	0	0.25	17
790829	-	HVRIES	-	0	-	4.9	-	6.4	-	-	-	-	-	-	-	-	-	80	0.95	-	13	26	261	80	82	-	-	-	367	1	0	0.95	21	-	0.18	18
791023	-	HVRIES	-	0	-	5.0	-	7.0	-	-	-	-	-	-	-	-	-	60	1.90	-	43	26	261	45	82	-	-	-	339	4	0	1.26	83	-	0.12	19
800116	-	HVRIES	-	1	-	4.8	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
800314	-	HVRIES	-	0	-	3.9	-	5.5	-	-	-	-	-	-	-	-	-	60	3.26	-	8	51	217	50	66	-	-	-	310	4	0	1.58	104	-	0.14	21
800422	-	HVRIES	-	0	-	4.3	-	8.2	-	-	-	-	-	-	-	-	-	70	5.16	-	7	26	261	50	82	-	-	-	339	0	0	2.95	146	-	0.13	22
800506	-	PPDDRE	-	0	12.0	5.1	-	-	6.1	-	-	-	-	-	103	-	-	-	0.21	-	0	-	-	-	-	-	-	-	395	2	-	0.21	-	-	-	23
800522	-	HVRIES	-	0	-	3.9	-	13.0	-	-	-	-	-	-	-	-	-	170	7.79	-	0	43	261	-	82	-	-	-	395	0	0	6.42	62	-	-	24
800604	-	PPDDRE	-	0	-	5.7	-	5.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	254	-	-	-	-	-	-	25
800622	-	HVRIES	-	0	-	4.0	-	5.5	-	-	-	-	-	-	-	-	-	140	16.11	-	52	33	304	-	82	-	-	-	339	1	0	13.90	83	-	-	26
800805	-	HVRIES	-	0	-	4.1	-	5.0	-	-	-	-	-	-	-	-	-	140	14.53	-	10	26	261	-	82	-	-	-	310	0	0	4.84	42	-	-	27
800825	-	PPDDRE	-	0	15.5	5.0	-	4.3	-	-	-	-	-	206	65	-	-	110	4.53	-	3	41	400	140	74	-	-	-	339	3	180	1.47	104	-	0.29	28
800911	-	HVRIES	-	0	-	4.1	-	5.0	-	-	-	-	-	-	-	-	-	120	4.84	-	6	26	261	150	82	-	-	-	339	0	0	2.63	-	-	0.31	29
801014	-	HVRIES	-	0	-	5.5	-	5.5	-	-	-	-	-	-	-	-	-	90	3.26	-	37	26	261	100	82	-	-	-	339	4	98	1.90	42	-	0.23	30
801103	-	PPDDRE	-	0	1.5	5.9	-	-	-	-	-	-	-	378	84	-	-	-	0.53	-	28	-	-	-	-	-	-	-	339	1	-	0.53	-	-	-	31
810309	-	PPDDRE	-	0	8.0	6.2	-	3.8	-	-	-	-	-	-	-	-	-	50	-	-	50	33	231	50	58	-	-	-	310	7	98	2.63	125	-	0.14	32
810506	10	WMN	-	0	9.0	5.1	5.1	6.2	5.6	45	30	-	30	-	-	91	8	60	1.90	42	19	33	196	50	74	4	17	35	296	10	33	1.47	125	0	0.14	33
810811	-	WMN	-	0	21.0	5.6	5.5	5.4	6.5	50	15	-	38	400	144	136	8	100	1.58	39	7	36	239	125	74	7	7	81	310	8	131	0.42	146	0	0.29	34
810817	-	PPDDRE	-	0	18.0	4.4	-	4.5	-	-	-	41	-	225	75	-	-	70	-	-	14	31	248	80	58	-	-	-	282	0	49	3.26	167	-	0.22	35
811111	12	WMN	-	0	4.5	5.2	5.9	5.5	5.4	30	23	-	36	319	79	114	8	40	1.79	28	25	33	261	15	66	3	11	38	296	19	82	0.53	125	0	0.05	36
820210	-	WMN	12.94	0	5.0	5.4	5.9	5.4	5.6	45	18	-	43	309	78	204	8	80	1.16	33	53	41	239	75	66	11	22	81	282	6	82	0.11	146	0	0.21	37
820506	-	WMN	12.85	0	12.0	7.8	7.2	5.7	5.5	65	8	-	33	422	126	11	8	60	2.00	12	9	51	283	50	66	3	14	43	310	5	82	1.16	104	0	0.14	38
820804	12	WMN	12.77	0	27.5	4.5	5.2	5.6	7.3	75	20	-	30	272	110	227	8	120	3.69	78	13	61	348	150	90	4	36	124	395	6	82	1.47	146	0	0.27	39
821109	12	WMN	13.04	0	10.0	5.9	6.1	7.9	5.8	55	17	-	32	338	96	114	8	60	1.37	42	89	31	261	50	58	3	19	59	324	2	98	0.32	146	0	0.13	40
830217	12	WMN	13.10	1	2.5	5.1	5.6	7.9	6.6	40	8	-	23	313	73	91	8	60	0.53	17	94	31	283	50	74	2	16	30	367	11	49	0.05	187	0	0.12	41
830517	10	WMN	13.14	0	13.5	5.3	5.4	6.3	6.3	50	-	-	34	338	104	136	1	60	0.53	11	47	26	239	50	58	-	12	46	310	11	49	0.11	167	0	0.14	42
830817	11	WMN	12.95	0	20.5	4.4	5.2	6.5	6.6	80	-	-	41	269	96	204	13	90	0.95	33	19	26	261	100	74	4	12	91	324	1	49	0.11	146	0	0.24	43
830921	-	WMN	-	0	-	-	5.1	-	5.8	-	-	-	-	-	-	-	-	70	-	-	-	26	261	50	82	-	-	-	339	3	-	0.32	-	-	0.13	44
831115	10	WMN	12.75	1	2.0	5.5	5.7	5.9	6.4	50	-	-	32	250	57	159	3	60	0.63	25	94	36	261	50	74	4	20	64	339	5	82	0.21	83	0	0.13	45
840216	11	WMN	13.17	1	2.0	4.6	5.3	8.2	6.5	42	-	-	31	313	72	182	2	60	0.42	19	72	33	261	50	74	3	11	19	339	6	33	0.11	146	0	0.13	46
840518	11	WMN	13.00	0	14.0	5.2	4.8	6.3	6.4	55	-	-	22	338	104	136	30	60	0.53	33	36	36	261	50	66	2	7	35	353	3	66	0.05	-	0	0.12	47
840814	10	WMN	12.88	0	20.5	4.8	5.2	7.9	5.7	55	-	-	21	184	65	227	25	60	0.53	22	6	23	261	50	66	4	9	32	339	3	33	0.05	42	0	0.13	48
841113	12	WMN	12.98	0	8.0	5.2	5.3	5.0	5.4	38	-	-	19	325	88	136	13	80	0.42	14	17	28	261	100	58	3	13	18	296	3	49	0.11	104	0	0.25	49
850212	14	WMN	13.11	1	3.0	5.5	5.2	6.3	6.3	44	-	-	19	166	39	432	10	90	0.84	12	61	31	239	100	74	3	11	20	282	13	66	0.11	146	0	0.26	50

References: nr. 1 J. Heimans (unpubl.); 2 Beijerinck (1926); 3 Redeke & De Vos (1932); 4 Ringelberg (1956); 5 P. Leentvaar (unpubl.); 6 Baaijens (1969); 7,8 Brantjes (1972); 9,10 Smit (1976); 11-16 W.P.C. Bots (pers. comm.); 17 Van Dam et al. (1981); 18-22,24,26,27,29,30 De Vries (1982); 23,25,28,31,32,35 M.E.A. van Gijsen (pers. comm.); 33,34,36-43,45-50 own record; 44 Bakker (1984).

Appendix 13

Summary of chemistry of ACHTERSTE GOORVEN station E.

Mean values, ranges and Spearman rank correlation coefficients with time (x100, column corr.), calculated from quarterly observations from 790815-850211. In the columns min. and max. the seasons of minimum and maximum values during the annual cycle are indicated respectively. W = winter (Nov.-Feb. or Feb.), Sp = spring (Feb.-May or May), Su = summer (May-Aug. or Aug.), A = autumn (Aug.- Nov., or Nov.). Statements between parentheses: seasonal periodicity or trend not very clear.

Parameter	Mean	Range	Min.	Max.	Corr.	Trend
SO4	620	(291-1020)	W	Sp	-58	decreasing
O2%	87	(32-128)	(W)	(Sp)	-36	(decreasing)
%H	8.2	(0.2-19.6)	W	Su	-75	decreasing
MG	143	(66-239)	W	Su	-64	decreasing
CA	158	(50-299)	W	Su	-58	decreasing
EC251	15.6	(7.2-24.8)	W	Su	-42	decreasing
NA	323	(152-435)	W	Su	-39	decreasing
IR	0.26	(0.11-0.38)	Sp	A	-61	decreasing
EC251	16.9	(7.6-24.5)	(Sp)	-	-51	decreasing
MN	3.0	(1.8-4.4)	A	Sp	-72	decreasing
K	50	(31-84)	(A)	(Sp)	-69	decreasing
%SO4	57.5	(37.2-67.7)	A	Sp	-68	decreasing
%MG	13.1	(9.4-17.0)	A	Sp	-68	decreasing
AL	89	(5.6-278)	(A)	(Sp)	-46	decreasing
%AL	7.8	(0.5-17.6)	-	(W)	-45	decreasing
%CA	14.3	(6.1-21.3)	-	-	-56	decreasing
%MN	0.3	(0.2-0.6)	-	-	-53	decr. (max. 1982-1983)
CO2	386	(205-886)	-	-	-40	decreasing
CL	432	(169-536)	W	Su	8	constant
H2PO4	0.19	(0.05-0.53)	(W)	(Su)	15	constant
NO3	4.4	(0.81-9.7)	Sp	W	-14	constant
NH4-or	22.2	(7.8-77.6)	Su	W	-33	constant
O2	301	(88-494)	Su	W	-24	constant
%NO3	0.4	(0.1-1.0)	Su	W	1	constant
CO3	13	(0-300)	-	-	36	constant
t-PO4f	0.87	(0.21-2.3)	-	-	-3	constant
%K	4.7	(2.8-6.6)	(Su)	(W)	-47	max. 1980-1981
COLOR	12.8	(2-43)	Su	W	-35	max. 1982-1983
LEVEL	8.34	(8.22-8.52)	A	Sp	30	max. 1983-1984
%FE	5.1	(1.0-21.4)	-	-	29	max. 1982-1983
FE	53	(12.4-258)	-	-	14	max. 1983
%CL	40.8	(31.8-52.4)	W	Su	83	increasing
%NA	30.2	(19.9-39.2)	Sp	A	30	increasing
pHf	4.1	(3.5-5.6)	Sp	W	39	increasing since 1982
SIO2	31	(8.3-112)	(Sp)	W	69	increasing
KMnO4u	32	(4-140)	Su	W	33	(increasing)
%ALK	1.3	(0.0-14.7)	Su	W	49	increasing since 1982
ALK	13	(0-164)	Su	W	50	increasing since 1982
NH4/(NH4+NO3)	0.97	(0.90-1.00)	Su	W	54	increasing
pH1	4.2	(3.5-5.7)	Su	W	77	increasing since 1981
NH4	173	(30.5-416)	(A)	(W)	67	increasing since 1982
(NA+K)/(CA+MG)	1.32	(0.84-1.94)	-	-	55	increasing

Appendix 14

Summary of chemistry of GERRITSFLES

Mean values, ranges and Spearman rank correlation coeffients with time (x100, column corr.), calculated from quarterly observations from 790814-850212. In the columns min. and max. the seasons of minimum and maximum values during the annual cycle are indicated respectively. W = winter (Nov.-Feb. or Feb.), Sp = spring (Feb.-May or May), Su = summer (May-Aug. or Aug.), A = autumn (Aug.-Nov. or Nov.) Trend assessed from observations back to 1978. Statements between parentheses: seasonal periodicity or trend not very clear.

Parameter	Mean	Range	Min.	Max.	Corr.	Trend
%SO4	48.0	(38.5-57.4)	W	Su	-50	decr. from 1978 until 1982
%H	5.9	(0.0-17.7)	W	Su	-42	decr. from 1978 until 1982
MG	67	(14-107)	Sp	A	-85	decreasing since 1978
K	41	(18-113)	Sp	A	-71	decreasing since 1978
CA	82	(15-299)	Sp	A	-68	decr. from 1978 until 1982
AL	24	(10-89)	Sp	A	-57	decr. from 1978 until 1982
EC251	8.1	(5.8-11.0)	Sp	A	-28	decreasing since 1978
NA	210	(152-326)	Sp	A	-26	decreasing since 1978
EC25f	8.7	(6.2-13.0)	Sp	A	-9	decreasing since 1978
%AL	4.0	(2.0-8.0)	Su	A	-57	decr. from 1978 until 1982
CO2	154	(91-432)	(Su)	A	-56	decreasing since 1979
%CA	13.4	(3.0-26.8)	(Su)	(Su)	-68	decreasing since 1978
H2PO4	0.27	(0.05-1.6)	A	Sp-Su	-31	decreasing since 1981
%MG	11.8	(8.1-16.0)	A	Su	-59	decreasing since 1978
MN	3.1	(1.1-13.1)	-	-	-72	decr. since 1978 (max. 1981-82)
%MN	0.5	(0.2-1.6)	-	-	-65	decr. since 1978 (max. 1981-82)
IR	0.22	(0.06-0.46)	-	-	-60	decreasing since 1978
SO4	277	(167-396)	-	-	-45	decreasing since 1978
SIO2	8.9	(1.7-22)	(W)	(Su)	-26	constant
O2%	102	(58-151)	W	A	-21	constant
CL	267	(212-353)	W	A	-15	constant
NH4-or	20.2	(6.7-116)	W	A	-15	constant
FE	17	(0.54-107)	(S)	(A)	18	constant
O2	354	(220-463)	A	Sp	-4	constant
%FE	2.6	(0.1-9.6)	-	-	27	constant
CO3	0.0	(0.0-0.0)	-	-	0	constant
t-PO4f	1.0	(0.05-3.0)	Sp	A	-29	maximum 1980-1983
%K	6.9	(3.6-10.3)	(Su)	(W)	-70	maximum 1980-1982
LEVEL	39.91	(36.61-40.10)	A	Sp	-43	maximum 1982-1983
NH4/(NH4+ NO3)	0.88	(0.19-0.99)	(A)	Su	56	minimum 1981
COLOR	8.6	(1-22)	-	-	36	maximum 1983-1984
%CL	46.8	(39.1-53.4)	W	Su	48	increasing since 1978
ALK	24	(0.0-147)	Su	W	37	increasing since 1981
%ALK	3.9	(0.0-16.4)	Su	W	38	increasing since 1981
NH4	99	(3.9-261)	Su	A	78	increasing since 1982
pH1	4.7	(4.0-6.3)	A	W	42	increasing since 1980
pHf	4.4	(3.7-5.5)	A	Sp	10	increasing since 1981
NO3	7.5	(1.6-23)	A	Sp	13	(increasing since 1978)
%NA	37.0	(29.2-47.5)	(A)	(Sp)	25	increasing since 1982
%NO3	1.4	(0.2-4.6)	A	Sp	35	increasing since 1978
KMNO4u	21	(3-60)	-	-	16	(increasing since 1980)
(NA+K)/(CA+MG)	1.93	(1.08-3.44)	-	-	64	increasing since 1978

Appendix 15

Summary of chemistry of KLIPLO

Mean values, ranges and Spearman rank correlation coefficients with time (x100, column corr.), calculated from quarterly observations from 810506-850212. In the column min. and max. the seasons of minimum and maximum values during the annual cycle are indicated respectively. W = winter (Nov.-Feb. or Feb.), Sp = spring (Feb.-May or May), Su = summer (May-Aug. or Aug.), A = autumn (Aug.-Nov. or Nov.). For those parameters not marked with * some observations were available between 1972 and 1981. Trend has been assessed using these date too. Statements between parentheses: seasonal periodicity or trend not very clear.

Parameter	Mean	Range	Min.	Max.	Corr.	Trend
%FE	8.9	(3.6-15.4)	(W)	(Su)	-54	*decreasing since 1982
FE	51	(18.2-123)	W	Su	-53	decreasing
MN	3.8	(1.8-10.9)	W	Su	-43	*decreasing since 1981
H2PO4	0.40	(0.05-1.5)	Sp	A	-69	*decreasing since 1981
pH1	5.5	(4.8-7.2)	Su	Sp	-39	decreasing since 1983
O2	306	(166-422)	Su	Sp	-40	(decreasing since 1982)
O2%	89	(39-144)	A	Sp	-46	decreasing since 1983
t-PO4f	1.2	(0.42-3.7)	-	(Su)	-76	*(decreasing since 1981)
COLOR	30	(19-43)	-	-	-65	*decreasing since 1981
%K	6.4	(4.3-9.8)	-	-	-52	*decreasing since 1981
%MN	0.7	(0.3-1.9)	-	-	-44	*decreasing since 1983
%AL	2.7	(1.2-4.3)	-	-	-43	*decreasing since 1981
%ALK	12.5	(6.3-22.0)	-	-	-35	*decreasing since 1981
%CA	12.5	(3.3-21.6)	(W)	(Su)	10	*constant
IR	0.17	(0.05-0.29)	Sp	A	-9	constant
EC251	6.1	(5.4-7.3)	Sp	A	11	constant (max. in 1976)
NH4	41	(6.1-94)	Su	W	19	constant
pHf	5.3	(4.4-7.8)	(Su)	(Sp)	-18	constant
(NA+K)/(CA+MG)	2.25	(1.38-3.64)	(Su)	(Sp)	-11	constant
MG	69	(58-91)	A	Su	-14	constant
CA	70	(15-150)	-	Su	10	constant
NO3	7.1	(0.81-19.4)	-	-	-33	constant
SO4	130	(42-187)	-	-	-22	constant
KMNO4u	51	(30-80)	-	-	-4	constant
CO3	0.0	(0.0-0.0)	-	-	0	constant
%NA	47.7	(40.7-57.6)	-	-	26	*constant
EC25f	6.4	(5.0-8.2)	-	-	38	constant
%CL	61.5	(52.1-81.3)	-	-	19	minimum 1981-83
AL	2.7	(1.1-4.3)	Su	W	-32	maximum 1982
NH4/(NH4+NO3)	0.79	(0.49-0.98)	Su	W	40	minimum 1980-82
%MG	12.9	(10.1-17.0)	A	W	-1	*minimum 1982-83
LEVEL	13.77	(13.54-13.96)	(A)	(W)	31	*minimum 1982-83
K	35	(23-61)	A	Su	-49	maximum 1976, 1980, 1982
NH4-or	28.8	(11.1-78)	-	-	-52	maximum 1982
ALK	66	(33-131)	-	-	-42	maximum 1981
NA	260	(196-348)	-	-	14	maximum 1976
CL	323	(282-395)	-	-	19	maximum 1976
%H	0.9	(0.0-3.1)	W	Su	49	*(increasing since 1981)
SIO2	10	(0.8-30)	(Sp)	A	40	*increasing since 1981
%NO3	1.4	(0.2-3.7)	A	Sp	-29	(increasing since 1976)
%SO4	24,6	(10.0-31.0)	(A)	(Sp)	-14	increasing since 1976
CO2	163	(11.4-432)	-	-	51	*(increasing since 1981)

Appendix 16

Survey of chemical and physical data over the period 8303-8503 (analysis of A. Goorven E by WMN, other pools by LUW)

PARAMETER	A. GOORVEN E mean st.dev.	GERRITSFLES mean st.dev.	KLIPLO mean st.dev.	TONGBERSVEN-W mean st.dev.	GR. HASSELSVEN mean st.dev.
LEVEL	8.30 (0.11)	39.86 (0.13)	12.98 (0.14)	8.18 (0.08)[a]	26.27 (0.14)[b]
O2	279 (59)	336 (65)	288 (7)	284 (93)	330 (53)
O2%	80 (24)	96 (12)	84 (19)	86 (35)	103 (24)
pHf[c]	4.1 (0.6)	5.1 (0.5)	5.1 (0.4)	4.9 (0.3)	3.9 (0.1)
pHr[c]	4.1 (0.6)	4.6 (0.6)	4.9 (0.4)	4.5 (0.5)	3.6 (0.3)
pH1	4.53 (0.54)	4.97 (0.44)	5.49 (0.40)	5.22 (0.38)	3.97 (0.18)
EC25r	15.6 (2.9)	8.8 (1.7)	6.6 (1.1)	6.4 (0.9)	14.0 (2.2)
EC251	14.5 (3.0)	7.2 (1.1)	6.1 (0.6)	6.6 (1.3)	10.8 (2.4)
TDC	1435 (643)	987 (635)	1223 (248)	2159 (431)	570 (253)
DOC	1038 (568)[d]	812 (506)	1043 (227)	1976 (371)	466 (254)
DIC	396 (219)	192 (178)	179 (64)	196 (137)	88 (41)
CO2	381 (210)	186 (151)	152 (56)	170 (126)	88 (42)
COLOR	17 (14)	10 (3)[e]	29 (8)[e]	- (-)	- (-)
KMNO4u	46 (42)	20 (7)[e]	53 (14)[e]	- (-)	- (-)
SI	46 (25)	5 (7)	2 (2)	27 (18)	6 (7)
CL	455 (66)	254 (39)	324 (28)	246 (52)	217 (70)
NO3	5 (3)	2 (4)	1 (2)	2 (4)	6 (9)
SO4	552 (154)	231 (55)	96 (26)	183 (48)	398 (136)
HCO3	15 (29)	18 (39)	27 (21)	26 (53)	0 (1)
H2PO4	0.23 (0.18)	0.3 (0.3)	0.2 (0.4)	0.3 (0.4)	0.1 (0.2)
ORG-ANION	48 (37)	42 (30)	58 (14)	104 (20)	16 (8)
NH4	267 (100)	185 (59)	45 (33)	124 (67)	46 (63)
FE	78 (86)	49 (39)	56 (21)	41 (13)	19 (11)
MN	2 (1)	2 (1)	4 (1)	1 (1)	5 (2)
AL	61 (20)	14 (10)	12 (9)	20 (12)	26 (13)
CA	131 (37)	41 (21)	63 (25)	67 (27)	108 (48)
MG	120 (29)	44 (10)	66 (4)	44 (9)	64 (26)
NA	310 (47)	188 (32)	253 (21)	211 (61)	173 (69)
K	38 (8)	27 (7)	27 (8)	52 (16)	62 (24)
H	44 (28)	16 (14)	5 (6)	9 (8)	116 (44)
%H	5 (3)	4 (4)	1 (1)	2 (2)	21 (8)
%K	4 (1)	5 (1)	5 (1)	9 (2)	10 (2)
%NA	30 (5)	34 (4)	48 (5)	36 (7)	27 (4)
%NH4	25 (8)	31 (8)	8 (6)	21 (10)	6 (6)
%CA	12 (3)	8 (4)	11 (3)	11 (4)	17 (3)
%MG	11 (1)	8 (2)	13 (1)	8 (1)	10 (1)
%MN	0 (0)	0 (0)	1 (0)	0 (0)	1 (0)
%AL	6 (2)	3 (3)	2 (2)	5 (4)	4 (2)
%FE	8 (8)	8 (5)	10 (3)	8 (4)	3 (2)
%HCO3	2 (5)	3 (7)	6 (4)	4 (7)	0 (0)
%CL	44 (6)	51 (6)	72 (6)	56 (7)	35 (3)
%NO3	0 (0)	0 (1)	0 (0)	0 (1)	1 (1)
%SO4	53 (9)	45 (8)	22 (5)	41 (6)	64 (3)
M-D	1.46 (0.27)	2.67 (0.64)	2.22 (0.36)	2.42 (0.43)	1.40 (0.29)
IR	0.22 (0.06)	0.14 (0.05)	0.16 (0.04)	0.20 (0.05)	0.32 (0.05)
NH4-Ni	0.98 (0.01)	0.99 (0.02)	0.98 (0.04)	0.97 (0.06)	0.91 (0.11)

[a] 28 observations 830520-840706 (Oostveen 1985)

[b] 21 observations 830615-840716 (Oostveen 1985)

[c] pHf is pH-field as measured simultanously with collection of chemical samples for analysis in laboratory, pHr is pH-field measured simultaneous with collection of diatom samples.

[e] analysis WMN

[d] estimated by regression with KMNO4u

Appendix 17

Chemical data, collected by Department of Soil Science and Geology, Agricultural University, Wageningen (LUW).

GERRITSFLES, 830312-850413

DATE	pHf	pH1	EC251	DC	DIC	SIO2	K	NA	CA	MG	AL	FE	MN	NH4	F	CL	NO3	SO4	H2PO4	HCO3
-	-	-	mS/m	........................(equivalent) mmol/m^3																
830302	-	4.95	8.5	800	200	<3	36	191	40	51	<1	9	2	193	7	271	8	284	<1	8
830415	-	4.41	8.5	499	60	-	27	196	30	53	19	9	2	185	0	251	12	275	0	1
830527	4.50	4.25	7.9	488	76	0	20	176	95	37	15	22	3	143	0	304	0	267	0	1
830617	4.40	4.47	7.3	191	104	0	19	152	33	49	18	11	2	109	0	219	7	239	0	1
830715	4.60	4.62	7.9	949	172	5	31	196	33	49	12	70	2	99	0	244	0	277	0	0
830819	4.55	4.73	9.0	585	0	6	33	213	80	61	35	29	3	172	0	320	0	317	0.5	1
830913	5.55	5.40	8.4	800	134	13	33	200	45	49	2	44	1	241	<1	267	<1	270	<0.5	12
831014	5.60	5.12	8.2	-	99	<1	29	235	35	45	13	-	-	265	16	-	3	294	<1	5
831118	-	5.30	8.4	895	239	<1	31	211	33	45	13	66	3	278	<1	321	<1	294	0.4	17
831216	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
840120	6.05	5.77	6.6	2310	157	7	29	178	20	33	14	123	1	267	<1	280	<1	159	0.7	31
840217	4.85	5.00	6.3	411	54	<1	27	183	13	41	2	21	2	192	<1	254	15	213	<0.1	10
840314	5.55	5.09	6.4	880	209	<1	27	172	25	37	<1	78	1	183	<1	234	<1	215	0.3	10
840420	5.50	5.12	5.9	859	201	<1	22	154	23	33	7	38	1	185	3	219	<1	194	0.6	9
840517	5.55	5.40	5.5	2380	506	<1	27	170	50	33	16	90	1	195	6	256	<1	81	0.5	45
840614	5.40	5.22	6.1	1590	473	8	27	163	45	33	10	74	1	208	<1	235	<1	185	0.5	27
840719	5.85	5.88	8.0	2120	741	32	37	193	50	45	26	149	2	314	<1	233	<1	170	0.9	170
840817	5.15	4.46	8.1	700	83	6	29	187	48	49	16	41	2	146	<1	239	<1	263	0.4	1
840914	-	4.61	6.8	1130	227	11	33	239	60	49	15	27	3	170	4	256	0	220	0.5	4
841019	4.85	5.28	6.8	591	80	2	26	274	80	66	13	21	<1	140	9	327	6	240	<1	6
841114	4.40	4.59	6.1	1236	67	<1	8	161	30	49	12	24	2	142	4	202	<1	229	<1	1
841214	4.70	4.87	6.0	743	144	<1	15	143	20	33	38	22	1	83	3	210	<1	187	1	11
850117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
851402	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
851403	-	4.74	6.0	528	-	5	32	159	24	32	22	29	<1	155	10	186	<1	212	<1	-

TONGBERSVEN-WEST, 830414-841214

DATE	pHf	pH1	EC251	DC	DIC	SIO2	K	NA	CA	MG	AL	FE	MN	NH4	F	CL	NO3	SO4	H2PO4	HCO3
-	-	-	mS/m	........................(equivalent) mmol/m^3																
830414	5.05	5.95	6.4	1900	136	35	51	157	38	44	8	32	1	176	0	194	5	224	0	34
830526	4.65	4.66	5.2	1610	114	1	46	157	23	33	37	36	2	107	66	199	0	188	0	2
830616	4.65	4.75	5.3	2050	231	12	40	122	33	41	34	60	1	30	12	176	0	138	0	6
830714	4.65	4.67	4.9	2170	130	3	33	163	38	37	50	39	1	40	0	193	0	86	0	3
830818	4.80	4.61	5.6	2640	0	12	47	163	83	49	0	74	3	31	0	202	0	152	0.7	0
830914	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
831013	4.65	5.21	7.8	-	118	51	70	313	118	66	30	-	-	51	30	-	10	210	<1	7
831117	4.95	5.48	6.4	1930	288	53	61	222	73	45	12	39	1	98	<1	270	12	178	0.4	31
831215	5.15	5.32	10.6	3540	662	38	102	274	85	49	30	36	1	290	<1	319	<1	311	0.6	48
840119	5.15	5.44	7.6	2180	66	47	61	244	75	53	6	62	2	169	<1	296	<1	260	0.5	6
840216	4.85	5.02	6.3	2020	331	40	55	183	40	41	9	29	3	184	<1	237	<1	192	0.3	12
840315	-	5.38	7.7	1850	190	34	63	252	78	53	8	36	1	158	<1	303	6	213	0.2	17
840420	5.05	5.47	7.1	1999	193	24	65	-	68	45	18	30	1	178	3	278	<1	211	-	21
840517	5.00	5.35	7.1	2070	115	<1	60	270	103	49	10	24	1	123	5	296	<1	183	<0.1	10
840614	4.55	5.23	6.9	2135	198	3	51	254	95	49	20	36	1	105	<1	299	3	181	0.4	11
840719	4.40	4.72	6.2	2130	141	10	38	241	80	45	22	44	<1	71	<1	267	<1	148	0.8	3
840817	4.55	5.32	7.1	1980	81	10	36	293	100	53	22	36	1	21	<1	320	3	145	0.7	6
840913	4.75	5.33	7.7	2660	339	36	38	287	80	49	23	29	<1	171	6	281	0	157	<1	26
841019	4.90	5.07	6.1	2165	200	31	51	152	70	33	17	44	<1	129	7	213	<1	168	1	9
841114	5.50	5.37	5.5	2092	130	42	36	139	30	33	29	66	2	148	8	185	<1	131	<1	11
841214	5.10	5.31	6.0	2520	141	47	46	130	40	33	95	39	2	162	4	185	<1	173	1	10
850117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
850214	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
850314	-	5.97	6.1	1540	175	29	50	201	60	34	12	14	<1	157	4	200	<1	190	<1	44

KLIPLO, 830415-811214

DATE	pH1	EC251	DC	DIC	SIO2	K	NA	CA	MG	AL	FE	MN	NH4	F	CL	NO3	SO4	H2PO4	HCO3
-	-	mS/m	........................(equivalent) mmol/m^3																
830415	5.02	6.3	1460	194	0	26	246	43	67	9	68	2	109	0	305	5	153	1	7
830527	4.68	5.5	1390	301	0	22	241	23	57	22	48	4	76	66	299	0	133	0	6
830617	4.78	5.8	1150	214	5	22	243	45	66	18	38	5	7	0	293	0	102	0	60
830722	4.79	5.8	1020	125	3	22	228	63	66	25	39	4	0	0	317	0	117	0	3
830818	5.24	7.1	1270	208	7	26	243	70	66	0	54	4	6	0	307	0	96	0	12
830913	5.44	5.1	1120	65	4	29	255	60	71	8	39	4	7	<1	335	<1	128	0.2	6
831014	5.66	5.8	-	155	2	31	276	68	66	10	-	-	40	39	-	-	74	1	25
831125	5.66	6.8	1640	253	<1	31	317	-	74	24	69	2	38	<1	400	<1	115	0.5	41
831216	6.02	6.2	1260	201	5	31	261	68	70	15	96	3	69	<1	294	<1	92	<1	56
840120	5.81	5.9	1010	129	2	27	248	43	61	2	47	3	81	<1	321	<1	109	0.1	25
840217	5.76	6.4	1020	285	1	41	257	48	70	5	84	4	90	<1	344	<1	97	<0.1	56
840320	6.00	6.2	1080	245	2	29	254	53	66	<1	77	4	83	<1	312	3	96	0.2	68
840420	5.52	5.9	990	176	<1	24	235	60	57	6	45	2	64	3	319	2	96	0.2	19
840517	5.84	6.3	1490	205	<1	41	267	88	70	7	89	3	74	5	324	2	87	0.3	40
840614	5.62	7.4	1410	199	4	28	239	80	70	3	83	3	25	5	328	<1	104	<0.1	27
840719	5.32	6.8	1220	175	3	29	248	65	64	21	69	4	34	<1	289	<1	93	0.3	13
840817	5.33	5.9	1180	151	5	23	250	75	70	4	39	4	4	<1	309	<1	76	0.4	11
840913	5.75	5.2	1290	144	0	3	287	60	66	9	35	3	17	3	326	0	35	<0.5	26
841019	5.44	5.9	958	56	2	26	248	50	66	12	21	7	21	4	362	<1	79	1	5
841114	5.57	5.9	748	99	<1	28	243	70	66	33	42	6	33	3	371	6	57	<1	13
841214	6.00	6.2	1753	176	2	26	222	50	66	13	41	4	57	2	315	<1	82	<1	49

GROOT HASSELSVEN, 830414-841214

DATE	pHf	pH1	EC251	DC	DIC	SIO2	K	NA	CA	MG	AL	FE	MN	NH4	F	CL	NO3	SO4	H2PO4	HCO3
-	-	-	mS/m	........................(equivalent) mmol/m^3																
830414	3.80	4.05	9.2	1220	79	0	50	157	108	62	39	12	4	52	0	168	10	394	0	1
830526	3.90	3.60	9.1	937	76	0	38	124	73	41	30	38	4	16	66	183	0	335	0	0
830616	3.90	3.91	9.5	574	91	0	43	96	73	53	37	32	4	0	10	144	0	310	0	0
830714	3.85	3.92	10.2	337	116	7	63	122	63	49	28	17	4	2	0	181	0	336	0	0
830818	3.80	3.91	11.4	181	0	15	68	137	113	61	52	13	6	1	0	216	0	376	0.3	0
830914	3.85	3.91	12.5	400	50	9	69	148	133	74	13	8	5	23	<1	225	<1	419	<0.5	0
831013	3.85	3.98	13.5	-	54	<1	78	298	185	98	28	-	-	76	31	-	21	566	<1	0
831117	4.00	4.24	12.8	369	150	9	69	252	178	98	34	9	7	157	<1	350	33	518	0.2	0
831215	3.90	4.20	18.0	573	154	28	151	374	258	156	58	12	9	263	<1	444	2	890	<1	0
840119	3.95	4.23	10.7	520	93	12	70	252	130	82	10	11	5	115	<1	275	10	482	<0.1	0
840216	3.85	3.95	10.2	531	60	12	59	172	75	61	9	11	6	67	<1	220	13	392	0.1	0
840315	3.85	3.95	10.9	760	77	8	63	180	95	61	8	13	4	56	<1	223	13	392	<0.1	-
840420	3.90	3.93	10.1	693	87	2	52	152	90	57	18	11	4	41	5	199	10	-	0.4	0
840517	3.70	3.83	12.0	702	149	<1	47	172	125	61	15	17	4	19	6	194	7	419	<0.01	0
840614	3.60	3.86	11.5	870	156	4	45	137	105	53	19	38	4	15	4	180	1	383	0.6	0
840719	3.95	3.92	11.1	257	96	2	51	150	70	45	27	21	2	6	<1	197	<1	348	0.3	1
840817	3.70	3.87	12.8	424	95	2	65	163	78	49	12	27	4	1	<1	233	<1	381	0.5	0
840913	3.90	3.89	10.9	442	94	5	82	209	90	49	20	11	4	43	6	251	0	361	<0.5	1
841019	3.90	4.03	6.8	538	56	0	51	122	100	49	23	39	7	18	5	171	<1	289	<1	5
841114	3.70	3.86	9.2	236	36	<1	28	104	60	49	29	27	4	6	4	149	<1	311	<1	<1
841214	3.85	4.08	7.9	672	-	2	47	96	70	49	26	12	4	17	3	146	<1	247	<1	-
850117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
850214	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
850314	-	4.42	71	744	-	5	70	187	94	49	36	7	<1	16	<1	205	10	220	<1	-

Appendix 18

Specification of the slides studied.

Abbreviations: LOC = Locality, NR = serial number, DATE = date of sampling, OB = observer of slide, CR = collector, ANAL = date of analysis, INS = institute where original sample is stored, CO = collection, COLL-NR = collection number, SLIDE = slide number at RIN (Loan = no slide present at RIN).
Localities: AGA = Achterste Goorven station A, AGB = Achterste Goorven station B, AGE = Achterste Goorven station E, GER = Gerritsfles, HAS = Groot Hasselsven, KLI = Kliplo, TOH = Tongbersven (western basin), TON = Tongbersven (central basin).
Names of observers, collectors and collections: BE = C.N. Beljaars, BR = N.B.M. Brantjes, BU = J.C. Buys, DA = H. van Dam, HE = J. Heimans, HH= H.H. Hoekstra, KO = G.J. Koetsier, KW = R. Kwakkestein, LE = P. Leentvaar, NA = E. Nat, NI = N. Niesser, NO = E. Notenboom-Ram, OO = W.C. Oostveen, RO = M. Romanesco, SA = B.Z. Salomé, SC = P.J. Schroevers, SI = J.A. Sinkeldam, SM = H. D.W. Smit, SU = G. Suurmond, WB = M. Weber, WE = A. van der Werff, VR = B.J. de Vries.
Names of institutes: AMS = Hugo de Vries-laboratorium, Universiteit van Amsterdam, Amsterdam, LIN = Limnologisch Instituut, Nieuwersluis, RIN = Rijksinstituut voor Natuurbeheer, Leersum.

LOC	NR	DATE	OB	CR	ANAL	INS	CO	COLL-NR	SLIDE	KIND OF SAMPLE
AGA	2	190901	BE	HE	840704	AMS	HE	HO 155	1428	Plankton tow
AGA	1	192112	SU	RO	840823	AMS	HE	HO 179	347	Plankton tow
AGA	3	290715	BE	HE	840703	AMS	HE	HO 461	1424	Periphyton
AGA	4	520613	SU	WE	840823	AMS	WE	W 1300	367	Plankton tow
AGA	5	530806	BE	HE	840703	AMS	HE	HO 510	1422	Plankton tow
AGA	10	781109	SU	SU	840823	RIN	DA	D 384	333	Plankton tow
AGA	11	791112	BE	KO	840809	RIN	DA	D 545	1544	Plankton tow with fine detritus
AGA	17	800513	BE	HH	840702	RIN	DA	D 617	1410	Plankton tow with detritus
AGA	20	801111	BE	HH	840809	RIN	DA	D 698	1548	Plankton tow with fine detritus
AGA	22	810510	BE	HH	840810	RIN	DA	D 710	1552	Plankton tow with fine detritus
AGA	24	811112	BE	DA	840810	RIN	DA	D 734	1554	Plankton tow with fine detritus
AGA	26	820507	BE	BE	840705	RIN	DA	D 1707	1473	Plankton tow with detritus
AGA	28	821110	BE	BE	840814	RIN	DA	D 1447	1558	Plankton tow
AGA	30	830526	BE	BE	840815	RIN	DA	D 1989	1562	Plankton tow
AGA	32	831115	BE	BE	840816	RIN	DA	D 2152	1566	Plankton tow
AGA	34	840516	BE	BU	840703	RIN	DA	D 2198	1418	Plankton tow
AGB	1	250729	BE	HE	840622	AMS	HE	HO 365	1391	Plankton tow
AGB	2	260410	BE	HE	840625	AMS	HE	HO 380	1397	Plankton tow
AGB	3	260925	SU	HE	840823	AMS	HE	HO 392	351	Plankton tow
AGB	4	280825	BE	HE	840625	AMS	HE	HO 408	1399	Plankton tow
AGB	5	290731	BE	HE	840626	AMS	HE	HO 455	1403	Plankton tow
AGB	6	500826	SU	HE	840823	AMS	HE	HO 468	353	Plankton tow
AGB	7	520613	BE	HE	840707	AMS	HE	HO 486	1426	Plankton tow
AGB	8	530806	BE	HE	840705	AMS	HE	HO 511A	1430	_Sphagnum_ squeeze
AGB	9	750915	BE	KW	840807	AMS	KW	75.169	1531	Plankton tow
AGB	10	781109	SU	SU	840823	RIN	DA	D 382	331	Plankton tow
AGB	15	791112	BE	KO	840808	RIN	DA	D 542	1542	Plankton tow with fine detritus
AGB	21	800515	BE	HH	840629	RIN	DA	D 614	1408	Plankton tow with detritus
AGB	24	801111	BE	HH	840809	RIN	DA	D 695	1546	Plankton tow with fine detritus
AGB	26	810505	BE	HH	840809	RIN	DA	D 707	1550	Plankton tow with fine detritus
AGB	28	811112	BE	DA	840810	RIN	DA	D 739	1556	Plankton tow with fine detritus
AGB	30	820507	BE	HH	840705	RIN	DA	D 1704	1471	Plankton tow with detritus
AGB	32	821110	BE	BE	840815	RIN	DA	D 1451	1560	Plankton tow over bottom
AGB	34	830526	BE	BE	840815	RIN	DA	D 1993	1564	Plankton tow over bottom
AGB	36	831115	BE	BE	840816	RIN	DA	D 2155	1568	Plankton tow
AGB	38	840516	BE	BU	840703	RIN	DA	D 2195	1416	Plankton tow
AGE	1	190602	BE	HE	840618	AMS	HE	HO 111	1375	Plankton tow
AGE	2	190901	BE	HE	840618	AMS	HE	HO 157	1377	Plankton tow
AGE	4	200201	BE	RO	840619	AMS	HE	HO 181	1379	Plankton tow
AGE	5	200822	BE	HE	840620	AMS	HE	HO 207	1389	Plankton tow
AGE	6	210804	BE	HE	840620	AMS	HE	HO 255	1387	Blobs
AGE	7	220821	BE	HE	840620	AMS	HE	HO 284	1385	Blobs
AGE	8	221021	BE	HE	840620	AMS	HE	HO 308	1383	Plankton tow
AGE	9	221021	SU	HE	840330	AMS	HE	HO 307	349	Plankton tow
AGE	11	240419	BE	HE	840619	AMS	HE	HO 324	1381	Plankton tow
AGE	10	250527	BE	HE	840622	AMS	HE	HO 368	1393	Plankton tow
AGE	12	260410	BE	HE	840622	AMS	HE	HO 379	1395	Plankton tow
AGE	13	280825	BE	HE	840625	AMS	HE	HO 410	1401	Plankton tow
AGE	14	750915	BE	KW	840626	AMS	KW	75.171	1405	_Juncus bulbosus_ (submerse)
AGE	15	781109	SU	SU	840330	RIN	DA	D 381	329	Plankton tow
AGE	20	791112	BE	HH	830412	RIN	DA	D 539	718	Plankton tow
AGE	21	791210	BE	SI	821228	RIN	DA	D 552	679	Squeeze coarse org. material
AGE	23	800212	BE	HH	821229	RIN	DA	D 576	681	Squeeze coarse org. material
AGE	24	800311	BE	HH	821230	RIN	DA	D 588	683	Squeeze coarse org. material
AGE	25	800414	BE	HH	821231	RIN	DA	D 600	685	Squeeze coarse org. material
AGE	26	800513	BE	HH	830420	RIN	DA	D 611	737	Plankton tow
AGE	29	801111	BE	HH	800412	RIN	DA	D 692	720	Plankton tow
AGE	31	810510	BE	HH	830104	RIN	DA	D 705	689	Squeeze coarse org. material
AGE	32	810510	BE	HH	830415	RIN	DA	D 704	730	Plankton tow
AGE	34	811112	BE	DA	810412	RIN	DA	D 742	722	Plankton tow
AGE	36	820506	BE	HH	830413	RIN	DA	D 1701	726	Plankton tow
AGE	38	821110	BE	BE	830412	RIN	DA	D 1444	724	Plankton tow
AGE	40	830526	BE	BE	831010	RIN	DA	D 1987	899	Plankton tow
AGE	42	831115	BE	BE	840817	RIN	DA	D 2150	1056	Plankton tow
AGE	44	840516	BE	BU	840702	RIN	DA	D 2190	1414	Plankton tow
GER	70	160626	DA	HE	790313	AMS	HE	HR 135	376	_Batrachospermum_ squeeze
GER	1	160629	SU	HE	790315	AMS	HE	HR 137	377	Plankton tow
GER	71	160729	DA	HE	790415	AMS	HE	HR 138	399	_Utricularia minor_ squeeze
GER	2	180619	BE	HE	840710	AMS	HE	HR 493	1438	Plankton tow
GER	3	180723	SI	HE	840823	AMS	HE	HR 497	199	Bottom material
GER	4	180723	SU	HE	840823	AMS	HE	HR 494	195	Plankton tow
GER	5	180723	SI	WB	780131	AMS	HE	HR 496	197	Plankton tow?
GER	7	500930	BE	HE	840823	AMS	HE	HR 950	404	Plankton tow?
GER	8	500930	SU	HE	840823	AMS	HE	HR 948	401	Plankton tow?
GER	9	510930	BE	HE	840706	AMS	HE	HR 953	1432	Plankton tow?
GER	10	600729	DA	LE	780130	RIN	LE		174	Plankton tow
GER	11	640511	BE	SA	840817	LIN	SA	G11564N	1337	Plankton tow
GER	12	641125	BE	SA	840817	LIN	SA	G251164N	1329	Plankton tow
GER	13	650420	BE	SA	840820	LIN	SA	G20465N	1341	Plankton tow
GER	14	651013	DA	LE	790316	RIN	LE		177	Plankton tow
GER	15	700417	BE	BR	840820	RIN	BR	G17470N	1327	Plankton tow
GER	16	730616	BE	NO	831028	RIN	NO	150/24 N		Plankton tow
GER	17	740417	BE	NO	831028	RIN	NO	152/24 N		Plankton tow
GER	18	771102	SI	SI	840823	RIN	DA	D 242	183	Plankton tow
GER	19	771102	DA	DA	780309	RIN	DA	D 244	186	Bottom material
GER	22	780803	DA	HH	790413	RIN	DA	D 428	397	Sedimentation plankton
GER	20	781121	SU	SU	840823	RIN	DA	D 415	383	Plankton tow
GER	72	781121	DA	SU	790413	RIN	DA	D 422	388	Plankton tow
GER	23	781121	DA	SU	790316	RIN	DA	D 424	389	Epipsammon
GER	21	781124	DA	SU	790316	RIN	DA	D 417	385	Plankton tow
GER	28	791112	BE	HH	830411	RIN	DA	D 537	716	Pl. tow with filamentous algae
GER	34	800513	BE	HH	830420	RIN	DA	D 609	735	Pl. tow with filamentous algae
GER	37	801111	BE	HH	830420	RIN	DA	D 690	738	Pl. tow with filamentous algae
GER	38	810210	BE	HH	840710	RIN	DA	D 1684	1469	Pl. tow with filamentous algae
GER	39	810506	BE	HH	830415	RIN	DA	D 702	728	Pl. tow with filamentous algae
GER	41	811111	BE	DA	830419	RIN	DA	D 731	731	Pl. tow with filamentous algae
GER	43	820506	BE	HH	830420	RIN	DA	D 1699	733	Pl. tow with filamentous algae
GER	45	821109	BE	BE	830421	RIN	DA	D 1441	739	Plankton tow over bottom
GER	47	830517	BE	BE	831011	RIN	DA	D 1976	893	Pl.tow over bottom a. _Sphagnum_
GER	57	831116	BE	BE	840820	RIN	DA	D 2157	1060	Plankton tow
GER	65	840517	BE	BU	840806	RIN	DA	D 2208	1529	Plankton tow over bottom
HAS	2	830531	BE	NA	831024	RIN	DA	D 1996	937	Plankton tow over bottom
HAS	5	830818	BE	BE	840710	RIN	DA	D 1861	1475	Plankton tow over bottom
HAS	8	831115	BE	BE	840328	RIN	DA	D 2156	1058	Squeeze _J. bulb._ a. _Drepanocl._
HAS	11	840215	BE	BE	840711	RIN	DA	D 2179	1481	Plankton tow over bottom
HAS	14	840516	BE	BU	840814	RIN	DA	D 2200	1527	Plankton tow over bottom
KLI	1	240821	SU	HE	840330	AMS	HE	HR 687	360	Plankton tow
KLI	3	290608	BE	WE	830425	AMS	WE	W 1075	757	Plankton tow
KLI	4	480520	BE	HE	830426	AMS	HE	HR 923	759	Plankton tow
KLI	6	580530	BE	LE	830427	RIN	LE	36-6/5	761	Plankton tow
KLI	7	620815	BE	SC	830427	RIN	SC	35-987	763	Sedimentation plankton
KLI	8	640507	BE	NI	840821	RIN	NI	K 7564	1333	Plankton tow
KLI	9	700408	BE	BR	840821	RIN	BR	K 8470 N	1331	Plankton tow
KLI	11	720705	BE	SM	840709	AMS	SM	72.208	1436	Plankton tow
KLI	12	720705	BE	SM	840709	AMS	SM	72.204	1434	Plankton tow
KLI	20	781114	SU	SU	840330	RIN	DA	D 399	339	Plankton tow
KLI	22	791024	BE	VR	840822	AMS	VR	79.122.3	Loan	Plankton tow
KLI	25	800522	BE	VR	840822	AMS	VR	80.245.2	Loan	Plankton tow
KLI	31	810506	BE	HH	830428	RIN	DA	D 713	765	Plankton tow over bottom
KLI	33	811111	BE	HH	830429	RIN	DA	D 1696	769	Plankton tow with detritus
KLI	35	820506	BE	HH	830502	RIN	DA	D 1711	771	Plankton tow with detritus
KLI	37	821109	BE	BE	830429	RIN	DA	D 1438	767	Plankton tow over bottom
KLI	40	830517	BE	BE	831011	RIN	DA	D 1979	895	Pl.tow over bottom a. _Sphagnum_
KLI	49	831115	BE	BE	840821	RIN	DA	D 2160	1067	Plankton tow over bottom
KLI	57	840517	BE	BU	840705	RIN	DA	D 2204	1420	Plankton tow over bottom
TOH	1	190526	BE	HE	840320	AMS	HE	HO 141	1171	Plankton tow
TOH	2	840215	BE	BE	840321	RIN	DA	D 2165	1165	Plankton tow over bottom
TON	2	830526	BE	BE	831013	RIN	DA	D 1985	897	Pl.tow over bottom a. _Sphagnum_
TON	5	830823	BE	OO	840710	RIN	DA	D 2007	1477	Plankton tow over bottom
TON	8	831115	BE	BE	831220	RIN	DA	D 2148	1054	Plankton tow
TON	11	840215	BE	BE	840711	RIN	DA	D 2163	1479	Plankton tow over bottom
TON	14	840516	BE	BU	840828	RIN	DA	D 2187	1576	Plankton tow over bottom
TON	15	840516	BE	BU	840711	RIN	DA	D 2188	1483	_Sphagnum_ aqueeze

Appendix 19

List of all diatom taxa.

Opt. denotes pH-optimum. R is pH-group (1 = acidobiontic, 2 = acidophilous, 3 = circumneutral, 4 = alkaliphilous, 5 = alkalibiontic).

Opt.	R	Acronym	Name
-	2	ACHNALTA	Achnanthes altaica (Poretzky) Cleve-Euler
-	4	ACHNEvHE	Achnanthes exigua var. heterovalvata (Grunow) Krasske
-	3	ACHNFLEX	Achnanthes flexella (Kützing) Brun
-	4	ACHNHUNG	Achnanthes hungarica Grunow
-	4	ACHNLANC	Achnanthes lanceolata (De Brébisson) Grunow
-	4	ACHNLvEL	Achnanthes lanceolata var. elliptica (De Brébisson) Grunow
6.83	3	ACHNMINU	Achnanthes minutissima Kützing
-	2	ACHNMARG	Achnanthes marginulata Grunow
-	3	ACHNPERA	Achnanthes peragalli Brun & Héribaud
-	3	ACHNPUSI	Achnanthes pusilla (Grunow) De Toni
-	4	ACHNROST	Achnanthes rostrata Østrup
-	3	ACTINfSU	Actinocyclus normanii fo. subsalsa (Juhlin-Dannfelt) Hustedt
-	5	ACTIUNDU	Actinoptychus undulatus (J.W. Bailey) Ralfs
-	4	AMPHLYBI	Amphora lybica Ehrenberg
-	4	AMPHOVAL	Amphora ovalis Kützing
-	4	AMPHPEDI	Amphora pediculus (Kützing) Grunow
-	5	AMPHTHUM	Amphora thumensis (Mayer) Cleve-Euler
-	5	AMPHVENE	Amphora veneta Kützing
-	0	AMPHVvCA	Amphora veneta var. capitata Haworth
-	4	AMPIPELL	Amphipleura pellucida Kützing
-	4	ANOMEXIL	Brachysira vitrea (Grunow) Ross
5.94	3	ANOMEfLA	Brachysira vitrea fo. lanceolata (A. Mayer) Van Dam
-	0	ANOMINTE	Brachysira styriaca (Grunow) Ross
-	2	ANOMSBfT	Brachysira brebissonii fo. thermalis (Grunow) Ross
-	1	ANOMSERI	Brachysira serians (De Brébisson) Round & Mannn
4.81	2	ANOMSvBR	Brachysira brebissonii Ross
-	4	ASTEFORM	Asterionella formosa Hassall
-	5	BACIPAXI	Bacillaria paxillifer (O.F. Müller) Hendey
-	1	CALOLvDE	Neidium densestriatum (Østrup) Krammer
-	4	COCCPLAC	Cocconeis placentula Ehrenberg
-	0	COSC0329	Coscinodiscus spec. 329.1
-	4	CYCLCOMT	Cyclotella comta (Ehrenberg) Kützing
-	4	CYCLMENE	Cyclotella meneghiniana Kützing
-	5	CYCSDUBI	Cyclostephanos dubius (Fricke) Round
-	4	CYMAELLI	Cymatopleura elliptica (De Brébisson) W. Smith
-	3	CYMBAEQU	Cymbella subaequalis Grunow
-	3	CYMBCESA	Cymbella cesatii (Rabenhorst) Grunow
-	4	CYMBCIST	Cymbella cistula (Hemprich) Kirchner
-	3	CYMBCYMB	Cymbella cymbiformis (Kützing) De Brébisson
-	4	CYMBEHRE	Cymbella ehrenbergii Kützing
-	2	CYMBGRAC	Cymbella gracilis (Rabenhorst) Cleve
-	2	CYMBHEBR	Cymbella hebridica (Grunow) Cleve
-	2	CYMBINCE	Cymbella incerta Grunow
-	4	CYMBMICR	Cymbella microcephala Grunow
-	3	CYMBMINU	Cymbella minuta Hilse ex Rabenhorst
-	3	CYMBMvSE	Cymbella minuta var. semicircularis (Lagerstedt) Foged
-	3	CYMBNAVI	Cymbella naviculiformis Auerswald
-	3	CYMBPARV	Cymbella parva (W. Smith) Wolle
-	4	CYMBPROS	Cymbella prostrata (Berkeley) Cleve
-	4	DIATELON	Diatoma elongatum (Lyngbye) Agardh
-	4	DIATEvTE	Diatoma elongatum var. tenuis (Agardh) Van Heurck
-	5	DIPLINTE	Diploneis interrupta (Kützing) Cleve
-	5	DIPLLITO	Diploneis litoralis (Donkin) Cleve
-	5	EPITZEBR	Epithemia adnata (Kützing) De Brébisson
-	2	EUNMvMfB	Eunotia monodon var. bidens (Gregory) Hustedt

Opt.	R	Acronym	Name
4.16	2	EUNOALPI	Eunotia naegelii Migula
-	3	EUNOARCU	Eunotia arcus Ehrenberg
-	2	EUNODENT	Eunotia denticulata (De Brébisson) Rabenhorst
-	2	EUNODIOD	Eunotia diodon Ehrenberg
-	2	EUNOELEG	Eunotia elegans Østrup
4.11	1	EUNOEXIG	Eunotia exigua (De Brébisson) Rabenhorst
-	1	EUNOEvBI	Eunotia exigua var. bidens Hustedt
-	2	EUNOFABA	Eunotia vanheurckii Patrick
-	2	EUNOFALL	Eunotia fallax
-	2	EUNOFLEX	Eunotia flexuosa (De Brébisson) Kützing
-	2	EUNOFORM	Eunotia formica Ehrenberg
-	2	EUNOFfRH	Eunotia vanheurckii fo. rhomboidea (Foged) nom. prov.
-	2	EUNOFvGR	Eunotia fallax var. gracillima Krasske
4.32	3	EUNOLUNA	Eunotia bilunaris (Ehrenberg) Nörpel
-	3	EUNOLvCA	Eunotia bilunaris var. capitata (Grunow) nom. prov.
3.76	2	EUNOLvEX	Eunotia bilunaris var. excisa (Grunow) nom. prov.
-	2	EUNOMEIS	Eunotia exigua var. meisteri (Hustedt) Nörpel
-	2	EUNOMICR	Eunotia microcephala Krasske
-	2	EUNOMvBI	Eunotia monodon var. bidens (Gregory) Hustedt
3.84	1	EUNOPALU	Eunotia paludosa Grunow
-	2	EUNOPECT	Eunotia pectinalis (Dillwyn? Kützing) Rabenhorst
-	2	EUNOPMfI	Eunotia pect. var. minor fo. impressa (Ehrenberg) Hustedt
-	2	EUNOPOLY	Eunotia polydentula (Brun) Hustedt
-	2	EUNOPRAE	Eunotia praerupta Ehrenberg
-	2	EUNOPvBI	Eunotia praerupta var. bidens (Ehrenberg? W. Smith) Grunow
-	2	EUNOPvMI	Eunotia pectinalis var. minor (Kützing) Rabenhorst
-	2	EUNOPvUN	Eunotia pectinalis var. undulata (Ralfs) Rabenhorst
-	2	EUNOPvVE	Eunotia pectinalis var. ventralis (Ehrenberg) Hustedt
4.85	2	EUNORHOM	Eunotia rhomboidea Hustedt (asymmetrical form)
-	2	EUNORvTE	Eunotia robusta var. tetraodon (Ehrenberg) Ralfs
-	2	EUNOSUDE	Eunotia sudetica O. Müller
5.01	2	EUNOTENE	Eunotia rhomboidea Hustedt (symmetrical form)
-	2	EUNOVALI	Eunotia glacialis Meister
4.95	2	EUNOVENE	Eunotia incisa Ehrenberg
-	4	FRAGBREV	Fragilaria brevistriata Grunow
-	4	FRAGCAPU	Fragilaria capucina Desmazieres
-	2	FRAGCONS	Fragilaria constricta Ehrenberg
-	4	FRAGCONU	Fragilaria construens (Ehrenberg) Grunow
-	4	FRAGCROT	Fragilaria crotonensis Kitton
-	4	FRAGCvBI	Fragilaria construens var. binodis (Ehrenberg) Grunow
-	4	FRAGCvVA	Fragilaria capucina var. vaucheriae Desmazières
5.63	4	FRAGCvVE	Fragilaria construens var. venter (Ehrenberg) Grunow
-	4	FRAGPULC	Fragilaria pulchella (Ralfs ex Kützing) Lange-Bertalot
-	2	FRAGTENE	Fragilaria tenera (W. Smith) Lange-Bertalot
-	4	FRAGULNA	Fragilaria ulna (Nitzsch) Lange-Bertalot
-	4	FRAGUvAC	Fragilaria ulna var. acus (Kützing) Lange-Bertalot
5.63	3	FRAGVIRE	Fragilaria virescens Ralfs
4.67	2	FRUSRHOM	Frustulia rhomboides (Ehrenberg) De Toni
4.23	1	FRUSRvSA	Frustulia rhomboides var. saxonica (Rabenhorst) De Toni
-	4	GOMPACUM	Gomphonema acuminatum Ehrenberg
-	4	GOMPANGU	Gomphonema angustatum (Kützing) Rabenhorst
-	4	GOMPAvCO	Gomphonema acuminatum var. coronatum (Ehrenberg) W. Smith
-	4	GOMPAvSA	Gomphonema angustatum var. sarcophagus (Gregory) Grunow
-	4	GOMPCONS	Gomphonema constrictum Ehrenberg
-	3	GOMPGRAC	Gomphonema gracile Ehrenberg
-	4	GOMPINTR	Gomphonema intricatum Kützing
-	4	GOMPOLIV	Gomphonema olivaceoides Hustedt
5.11	3	GOMPPARV	Gomphonema parvulum Kützing

Appendix 19 (continued)

Opt.	R	Acronym	Name
-	4	GYROATTE	Gyrosigma attenuatum (Kützing) Cleve
-	3	HANTAMPH	Hantzschia amphioxys (Ehrenberg) Grunow
-	4	MELOITGR	Melosira italica-group
-	4	MELOVARI	Melosira varians Agardh
-	4	MERICIRC	Meridion circulare (Greville) Agardh
-	0	NAVI351A	Navicula spec. 351.1
-	0	NAVI965B	Navicula spec. 965.2
-	0	NAVICBRE	Navicula cf. brevissima
-	4	NAVICLEM	Navicula clementis Grunow
-	4	NAVICOHN	Navicula cohnii (Hilse) Grunow
-	4	NAVICRYP	Navicula cryptocephala Kützing
-	4	NAVICUSP	Navicula cuspidata Kützing
-	0	NAVICVAR	Navicula cf. variostriata
-	4	NAVIEXIL	Navicula exilis Kützing
-	1	NAVIFEST	Navicula festiva Krasske
-	3	NAVIFOSS	Navicula fossalis Krasske
-	4	NAVIGRAC	Navicula tripunctata (O.F. Müller) Bory
-	4	NAVIGREG	Navicula gregaria Donkin
-	2	NAVIHASS	Navicula hassiaca Krasske
5.93	2	NAVIHEIM	Navicula leptostriata E.G. Jørgensen
-	1	NAVIHOEF	Navicula hoefleri Cholnoky (sensu Ross & Sims)
-	4	NAVIHUNG	Navicula hungarica Grunow
-	0	NAVIINDI	Navicula indifferens Hustedt
-	4	NAVILANC	Navicula lanceolata (Agardh) Ehrenberg
4.23	2	NAVIMEDI	Navicula mediocris Krasske
-	4	NAVIMENI	Navicula menisculus Schumann
-	4	NAVIMINI	Navicula minima Grunow
-	4	NAVIMODI	Navicula modica Hustedt
-	3	NAVIMUTI	Navicula mutica Kützing
-	2	NAVIMvAT	Navicula mediocris var. atomus Hustedt
-	3	NAVINEOV	Navicula neoventricosa Hustedt
-	3	NAVIPROT	Navicula protracta (Grunow) Cleve
-	4	NAVIPSET	Navicula pseudotuscula Hustedt
-	4	NAVIPSEU	Navicula halophila (Grunow) Cleve
-	3	NAVIPUPU	Navicula pupula Kützing
-	2	NAVIQUAD	Neidium alpinum Hustedt
-	3	NAVIRADI	Navicula radiosa Kützing
-	4	NAVIRHYN	Navicula rhynchocephala Kützing
-	3	NAVIROTA	Achnanthes bioretii Germain
-	3	NAVISEMI	Navicula seminulum Grunow
-	4	NAVISLES	Navicula slesvicensis Grunow
-	2	NAVISUBA	Achnanthes subatomoides (Hustedt) Lange-Bertalot & Archibald
4.02	1	NAVISUSB	Navicula subtilissima Cleve
-	2	NAVITANT	Navicula tantula Hustedt
-	4	NAVIVIRI	Navicula viridula (Kützing) Ehrenberg
-	4	NAVIVvRO	Navicula viridula var. rostellata (Kützing) Cleve
-	3	NEIDAFFI	Neidium affine (Ehrenberg) Pfitzer
-	4	NEIDAvAM	Neidium affine var. amphirhynchus (Ehrenberg) Cleve
-	2	NEIDAvLO	Neidium affine var. longiceps (Gregory) Cleve
-	3	NEIDDUBI	Neidium dubium (Ehrenberg) Cleve
-	3	NEIDIfVE	Neidium iridis fo. vernalis Reichelt ex Hustedt
-	0	NITZ199A	Nitzschia lanceolatae spec.
-	0	NITZ739A	Nitzschia spec. 739.1
-	0	NITZ897A	Nitzschia spec. 897.1
-	4	NITZDISS	Nitzschia dissipata (Kützing) Grunow
-	4	NITZFRUS	Nitzschia frustulum (Kützing) Grunow
-	3	NITZGRAC	Nitzschia gracilis Hantzsch
-	3	NITZHANT	Nitzschia hantzschiana Rabenhorst
-	4	NITZHUNG	Nitzschia hungarica Grunow
-	4	NITZOBTU	Nitzschia obtusa W. Smith
-	3	NITZPALE	Nitzschia palea (Kützing) W. Smith
-	4	NITZPERM	Nitzschia perminuta Grunow
-	1	NITZSCLE	Nitzschia paleaeformis Hustedt
-	4	NITZSIGM	Nitzschia sigma (Kützing) W. Smith
-	3	NITZTENU	Nitzschia tenuis W. Smith
-	3	NITZUMBO	Nitzschia umbonata (Ehrenberg) Lange-Bertalot
-	2	PEROHERI	Peronia fibula (De Brébisson & Arnott) Ross
-	1	PINN363A	Pinnularia spec. 363.1
-	2	PINNAPPE	Pinnularia appendiculata (Agardh) Cleve
-	3	PINNBORE	Pinnularia borealis Ehrenberg
-	2	PINNBRAU	Pinnularia braunii (Grunow) Cleve
-	2	PINNBvAM	Pinnularia braunii var. amphicephala (Mayer) Hustedt
-	3	PINNDACT	Pinnularia dactylus Ehrenberg
-	3	PINNGENT	Pinnularia gentilis (Donkin) Cleve
4.68	3	PINNGIBB	Pinnularia abaujensis (Pantocsek) Ross
-	3	PINNHEMI	Pinnularia hemiptera (Kützing) Rabenhorst
4.57	3	PINNINTE	Pinnularia biceps Gregory
-	2	PINNLATA	Pinnularia lata (De Brébisson) W. Smith
-	3	PINNLEGU	Pinnularia legumen Ehrenberg
-	3	PINNMAJO	Pinnularia maior (Kützing) Cleve
-	3	PINNMESO	Pinnularia interrupta W. Smith
5.00	3	PINNMICR	Pinnularia microstauron (Ehrenberg) Cleve
-	3	PINNMfAN	Pinnularia pulchra var. angusta (Cleve) Krammer
-	2	PINNNOBI	Pinnularia nobilis Ehrenberg
-	3	PINNOBSC	Pinnularia obscura Krasske
4.85	2	PINNSILV	Pinnularia irrorata (Grunow) Hustedt
-	2	PINNSTRE	Pinnularia streptoraphe Cleve
3.51	2	PINNSUBC	Pinnularia subcapitata Gregory
-	1	PINNSvHI	Pinnularia subcapitata var. hilseana (Janisch) O. Müller
-	2	PINNUNDU	Caloneis undulata (Gregory) Krammer
-	3	PINNVIRI	Pinnularia viridis (Nitzsch) Ehrenberg
-	3	PINNVvSU	Pinnularia viridis var. sudetica (Hilse) Hustedt
-	5	PODOSTEL	Podosira stelliger (J.W. Bailey) Mann
-	5	RAPHAMPH	Raphoneis amphiceros Ehrenberg
-	4	RHOIABBR	Rhoicosphenia abbreviata (Agardh) Lange-Bertalot
-	5	RHOPGIBB	Rhopalodia gibba (Ehrenberg) O. Mueller
-	0	STAU199A	Stauroneis spec. 199
-	3	STAUANCE	Stauroneis anceps Ehrenberg
-	2	STAUAfGR	Stauroneis anceps fo. gracilis Rabenhorst
-	3	STAUKRIE	Stauroneis kriegeri Patrick
-	3	STAULEGU	Stauroneis legumen (Ehrenberg) Kützing
-	3	STAUPHOE	Stauroneis phoenicenteron (Nitzsch) Ehrenberg
-	2	STENARCT	Stenopterobia arctica Cleve-Euler
-	2	STENINTE	Stenopterobia intermedia (Lewis) Van Heurck
-	5	STEPROTG	Stephanodiscus rotula-group
-	2	SURIARCT	Surirella arctissima W. Smith
-	3	SURILINE	Surirella linearis W. Smith
-	3	SURILvCO	Surirella linearis var. constricta Grunow
-	4	SURIOVAT	Surirella ovata Kützing
-	4	SURIOvAN	Surirella ovalis var. angusta Kützing
-	4	SYNEAFFI	Fragilaria tabulata Kützing
-	1	TABEBINA	Tabellaria binalis (Ehrenberg) Grunow
-	2	TABEFLOC	Tabellaria flocculosa (Roth) Kützing
-	1	TABEQUAD	Tabellaria quadriseptata Knudson

Appendix 20

ACHTERSTE GOORVEN station A. All diatom taxa, with pH-indices (R). 0 = taxon present outside the count, - = taxon not found.

R	YEAR	19	19	29	52	53	78	79	80	80	81	81	82	82	83	83	84
R	MONTH	9	12	7	6	8	11	11	5	11	5	11	5	11	5	11	5
	SERIAL NR	2	1	3	4	5	10	11	17	20	22	24	26	28	30	32	34
3	ACHNFLEX	-	-	-	-	-	0	-	-	0	0	-	-	-	-	-	-
4	ACHNHUNG	-	0	-	4	-	-	-	-	-	-	-	-	-	-	-	-
4	ACHNLANC	-	0	-	0	-	0	-	-	-	-	-	-	-	-	-	-
3	ACHNMINU	88	189	112	44	1	1	2	2	-	14	1	2	-	-	0	-
3	ACHNPUSI	-	-	-	1	0	-	-	-	-	-	-	-	-	-	-	-
4	AMPHLYBI	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	AMPHPEDI	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
0	AMPHVvCA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
4	ANOMEXIL	-	0	17	0	-	0	-	1	-	-	-	0	-	-	-	-
3	ANOMEfLA	76	38	87	11	3	7	18	5	1	26	4	8	10	0	2	2
0	ANOMINTE	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
2	ANOMSBfT	-	-	-	11	-	1	-	-	-	-	-	-	-	-	-	-
1	ANOMSERI	-	-	-	-	5	4	0	0	-	1	-	0	1	-	-	3
2	ANOMSvBR	-	-	0	-	12	19	33	13	4	23	16	11	15	0	4	3
4	COCCPLAC	-	-	-	4	-	0	-	-	0	-	-	-	-	-	-	-
4	CYCLCOMT	-	0	-	0	-	0	0	-	-	-	-	-	-	-	-	-
5	CYCSDUBI	-	-	-	1	-	-	-	0	-	-	-	-	-	-	-	-
3	CYMBAEQU	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
4	CYMBCIST	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	CYMBGRAC	22	0	12	6	-	0	2	7	-	4	2	1	7	-	-	3
2	CYMBINCE	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
4	CYMBMICR	183	145	73	4	0	0	5	6	-	4	5	6	6	-	-	0
3	CYMBMINU	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	CYMBNAVI	-	-	2	0	-	0	0	0	-	0	0	-	-	-	-	-
3	CYMBPARV	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
5	EPITZEBR	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNMvMfB	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOELEG	-	0	-	10	-	4	-	-	-	-	-	-	-	-	-	-
2	EUNOALPI	3	2	-	5	-	-	-	-	-	-	0	-	-	-	-	-
2	EUNOELEG	1	-	1	-	2	-	11	5	-	6	3	4	1	-	-	0
2	EUNODENT	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	EUNOEXIG	-	10	0	6	-	256	149	217	379	136	276	255	250	396	300	153
2	EUNOFABA	-	0	0	-	-	0	0	0	-	0	-	-	-	-	0	0
2	EUNOFLEX	0	-	0	-	0	-	-	-	-	0	-	0	-	-	-	-
2	EUNOFfRH	0	-	0	-	-	-	-	0	-	0	-	0	0	-	-	0
3	EUNOLUNA	0	0	1	132	39	4	1	2	0	3	2	5	2	2	78	199
2	EUNOMvBI	0	0	0	2	-	-	-	-	-	0	-	0	0	-	-	-
2	EUNOPECT	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	-
2	EUNOPMfI	4	-	3	-	0	-	3	0	0	1	1	3	1	-	0	-
2	EUNOPRAE	4	0	0	2	-	0	0	0	0	1	1	0	1	-	0	0
2	EUNOPvMI	0	-	-	17	-	-	-	-	-	0	-	-	0	-	-	-
2	EUNOPvUN	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPvVE	0	0	-	-	0	-	-	-	-	-	-	-	-	-	-	-
2	EUNORHOM	2	-	0	30	78	21	23	7	1	13	7	8	21	0	1	4
2	EUNOSUDE	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
2	EUNOTENE	-	1	0	3	-	-	7	-	2	-	4	1	2	-	-	-
2	EUNOVALI	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
2	EUNOVENE	1	0	5	27	149	5	7	6	4	3	5	9	7	-	0	7
4	FRAGCAPU	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvVA	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvVE	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
2	FRAGTENE	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGULNA	-	0	-	0	-	0	-	-	-	-	-	-	-	-	-	-
4	FRAGUvAC	1	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-
3	FRAGVIRE	0	-	20	13	0	20	53	49	2	56	13	20	17	0	4	3
2	FRUSRHOM	0	-	1	-	1	-	-	1	-	-	-	-	0	-	-	-
1	FRUSRvSA	12	3	7	10	57	19	34	25	3	40	15	27	21	1	5	9
4	GOMPACUM	0	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPCONS	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	GOMPGRAC	1	0	-	4	-	-	-	0	-	-	0	-	-	-	-	-
4	GOMPOLIV	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPPARV	-	1	-	2	-	0	-	-	-	-	-	-	-	-	-	-
3	HANTAMPH	-	0	-	-	0	-	-	-	-	-	-	0	-	-	-	-
4	MELOVARI	-	0	-	0	-	0	-	-	-	-	-	-	-	-	-	-
4	MERICIRC	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
0	NAVI965B	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
0	NAVICBRE	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
1	NAVIFEST	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIGREG	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIHEIM	0	0	10	4	1	0	2	1	-	4	1	-	1	-	-	2
1	NAVIHOEF	-	-	-	-	0	-	7	1	-	9	6	0	3	-	1	1
4	NAVIHUNG	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIMEDI	-	-	2	-	4	2	5	5	2	7	2	6	1	-	0	0
4	NAVIMINI	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
3	NAVIMUTI	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
4	NAVIPSEU	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NAVIPUPU	-	-	-	-	0	0	0	0	-	0	-	-	-	-	-	-
3	NAVIRADI	-	-	-	0	-	-	-	0	-	0	0	-	-	-	-	-
4	NAVIRHYN	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NAVISEMI	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVISUSB	1	1	5	2	6	12	4	7	-	9	3	2	2	-	0	0
4	NAVIVIRI	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NEIDAFFI	-	0	-	0	-	0	-	-	-	-	-	-	-	-	-	-
2	NEIDAvLO	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NITZGRAC	1	-	0	6	1	-	-	0	-	-	-	0	-	-	-	-
3	NITZHANT	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
4	NITZHUNG	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NITZOBTU	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NITZPALE	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
4	NITZPERM	0	0	40	1	1	0	7	19	1	19	13	13	10	1	2	0
1	NITZSCLE	0	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3	NITZTENU	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PEROHERI	0	-	0	5	1	-	1	0	1	3	0	-	0	-	-	0
1	PINN363A	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNAPPE	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNDACT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	PINNGENT	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
3	PINNGIBB	0	0	0	-	0	1	1	0	0	0	0	1	0	0	0	1
3	PINNINTE	-	0	-	-	0	1	4	7	0	6	6	2	2	0	1	2
3	PINNMICR	-	-	-	0	-	-	1	-	-	0	0	-	-	-	-	-
2	PINNSILV	-	-	-	11	-	-	-	-	-	-	-	0	-	-	-	-
2	PINNUNDU	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNVIRI	0	0	-	0	0	-	0	0	-	0	0	0	0	-	0	0
3	PINNVvSU	0	-	0	-	0	-	-	-	-	0	-	-	-	-	-	-
3	STAUANCE	-	-	-	-	-	-	0	-	0	0	0	-	-	-	-	-
2	STAUAfGR	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	STAUPHOE	0	-	0	1	0	0	-	0	0	0	-	0	0	-	-	0
2	STENINTE	-	-	-	0	4	0	0	0	-	-	-	-	-	-	-	-
5	STEPROTG	-	-	-	1	-	0	-	-	-	-	0	-	-	-	-	-
4	SURIOVAT	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	TABEFLOC	0	1	0	3	3	2	1	2	-	2	1	0	2	-	0	0
1	TABEQUAD	0	1	0	2	31	19	15	11	0	10	13	15	17	0	2	8

Appendix 21

ACHTERSTE GOORVEN station B. All diatom taxa, with pH-indices (R). 0 = taxon present outside the count, - = taxon not found.

R	YEAR	25	26	26	28	29	50	52	53	75	78	79	80	80	81	81	82	82	83	83	84
	MONTH	7	4	9	8	7	8	6	8	9	11	11	5	11	5	11	5	11	5	11	5
	SERIAL NR	1	2	3	4	5	6	7	8	9	10	15	21	24	26	28	30	32	34	36	38
2	ACHNALTA	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ACHNLANC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	ACHNMINU	3	4	2	5	4	6	-	2	-	0	1	3	-	-	-	-	0	1	-	-
4	ANOMEXIL	6	9	-	3	9	6	-	-	-	2	-	-	-	-	-	-	-	-	-	-
3	ANOMEfLA	67	54	53	19	34	44	11	11	3	4	2	8	-	4	0	-	0	0	1	1
2	ANOMSBfT	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ANOMSERI	-	-	-	-	-	-	0	0	-	0	0	0	-	0	0	-	0	0	-	0
2	ANOMSvBR	2	4	6	7	9	39	13	8	15	3	1	2	-	5	0	1	1	0	-	1
1	CALOLvDE	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	COCCPLAC	-	-	0	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
0	COSC0329	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
4	CYCLMENE	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
3	CYMBAEQU	-	-	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-
3	CYMBCESA	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	CYMBGRAC	9	17	11	3	4	1	1	8	0	0	0	1	-	0	1	0	-	0	0	0
2	CYMBHEBR	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	CYMBMICR	7	4	3	6	2	4	2	-	0	1	-	0	-	1	-	-	2	-	-	2
3	CYMBMINU	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
3	CYMBNAVI	0	-	0	0	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-
5	EPITZEBR	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOALPI	0	0	2	-	0	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNODENT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2	EUNOELEG	7	5	13	15	5	3	6	2	2	0	0	-	-	0	-	0	-	1	-	1
1	EUNOEXIG	-	-	-	-	-	-	-	9	156	352	340	289	399	322	398	392	389	358	357	255
2	EUNOFABA	0	0	1	0	0	0	-	-	-	0	0	0	-	0	0	0	-	0	0	0
2	EUNOFLEX	0	0	0	1	0	0	-	-	-	0	0	0	-	0	-	0	0	-	-	-
2	EUNOFfRH	-	0	-	1	-	-	0	0	-	-	0	-	-	0	-	0	0	0	-	0
3	EUNOLUNA	19	19	4	7	10	22	52	23	1	3	0	1	-	2	-	0	1	5	8	102
2	EUNOMvBI	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0
1	EUNOPALU	-	0	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
2	EUNOPECT	0	0	-	4	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
2	EUNOPMfI	2	1	-	12	4	-	-	-	-	-	0	-	-	0	-	-	-	-	-	0
2	EUNOPOLY	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPRAE	0	0	0	0	1	0	-	-	-	0	0	0	-	0	-	0	-	0	-	-
2	EUNOPvMI	-	-	0	-	-	0	-	-	-	-	0	-	-	-	-	-	-	-	0	-
2	EUNOPvUN	-	-	2	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
2	EUNOPvVE	0	-	-	1	0	-	-	-	-	0	-	-	-	-	-	-	-	-	0	-
2	EUNORHOM	1	0	6	0	3	16	14	20	127	5	14	12	-	11	-	1	1	7	2	4
2	EUNORvTE	-	-	0	0	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
2	EUNOTENE	0	0	-	-	-	-	-	-	1	-	-	1	-	-	-	0	0	-	-	-
2	EUNOVALI	-	-	-	-	-	0	0	-	-	-	-	-	-	0	-	-	-	-	-	-
2	EUNOVENE	11	1	5	9	2	59	135	127	11	3	2	5	1	4	0	0	0	4	3	2
4	FRAGCAPU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
4	FRAGCONU	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvVA	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
4	FRAGCvVE	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
4	FRAGULNA	-	-	0	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	FRAGVIRE	46	56	64	141	119	74	17	59	2	7	24	30	-	17	-	1	0	11	9	10
2	FRUSRHOM	0	0	-	0	0	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-
1	FRUSRvSA	32	58	29	45	25	33	101	30	19	5	3	15	-	11	-	2	1	6	12	4
4	GOMPACUM	-	-	-	0	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	0
3	GOMPGRAC	-	-	-	1	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPPARV	-	-	-	-	-	0	-	2	0	-	-	-	-	-	-	-	0	-	-	-
3	HANTAMPH	0	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	MELOITGR	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
0	NAVI351A	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	NAVICBRE	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVIFEST	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIHASS	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIHEIM	83	94	120	58	62	9	6	9	-	2	0	4	-	2	1	-	-	1	-	1
1	NAVIHOEF	0	0	-	0	0	-	-	-	0	-	1	5	-	2	-	0	0	1	-	0
2	NAVIMEDI	4	4	9	7	9	9	6	-	2	1	0	6	-	2	-	0	5	-	3	0
4	NAVIMINI	-	-	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-
4	NAVIMODI	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NAVIPUPU	0	-	0	0	0	-	-	-	-	0	-	0	-	0	-	-	-	0	-	-
3	NAVIRADI	-	0	0	-	-	1	-	-	-	0	0	-	-	-	-	-	-	-	-	0
4	NAVIRHYN	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVISUSB	3	6	4	4	1	11	-	4	2	0	0	3	-	1	-	0	-	1	1	0
3	NEIDAFFI	0	-	0	0	0	0	-	-	-	0	-	0	-	0	-	-	-	-	-	-
3	NITZGRAC	2	3	6	4	0	5	2	1	0	0	-	-	-	-	-	-	-	-	-	0
3	NITZHANT	-	-	0	-	-	4	-	-	-	2	-	-	-	-	-	-	-	-	-	-
4	NITZPERM	78	54	48	27	84	1	1	11	-	2	2	3	-	5	-	0	0	-	-	0
1	NITZSCLE	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PEROHERI	5	5	4	8	3	2	2	6	0	-	-	0	-	2	-	-	-	0	-	0
2	PINNAFPE	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNBRAU	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNBvAM	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNDACT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
3	PINNGENT	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNGIBB	0	0	0	0	0	0	1	1	0	0	2	1	-	0	-	0	0	0	0	2
3	PINNHEMI	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNINTE	1	0	0	1	0	2	-	0	0	0	2	1	-	1	0	1	0	0	0	0
3	PINNLEGU	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNMAJO	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNMESO	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
3	PINNMICR	-	-	0	-	-	2	-	-	1	0	-	-	-	0	-	0	-	-	-	1
2	PINNNOBI	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	0
2	PINNSILV	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNSUBC	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNVIRI	0	0	0	1	-	1	-	-	0	0	0	0	-	0	-	-	0	0	-	0
4	RHOIABBR	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	STAUANCE	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-	-	-	-	0	-
2	STAUAfGR	1	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	0	0	-	-
3	STAUPHOE	0	0	0	0	1	0	0	0	-	0	0	0	-	0	-	1	-	0	-	0
2	STENARCT	-	-	0	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	STENINTE	0	0	0	0	0	6	0	3	-	0	0	0	-	0	-	0	-	0	0	-
4	SURIOVAT	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	TABEFLOC	10	1	6	7	9	5	2	0	1	1	0	0	-	2	-	0	0	0	0	0
1	TABEQUAD	1	0	1	2	0	21	25	59	56	5	6	9	0	4	0	1	0	4	4	13

Appendix 22

ACHTERSTE GOORVEN station E. All diatom taxa, with pH-indices (R). 0 = taxon present outside the count, - = taxon not found.

	YEAR	19	19	20	20	21	22	22	22	24	25	26	28	75	78	79	79	80	80	80	80	80	81	81	81	82	82	83	83	84
R	MONTH	6	9	2	8	8	8	10	10	4	5	4	8	9	11	11	12	2	3	4	5	11	5	5	11	5	11	5	11	5
R	SERIAL NR	1	2	4	5	6	7	8	9	11	10	12	13	14	15	20	21	23	24	25	26	29	31	32	34	36	38	40	42	44
2	ACHNALTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
4	ACHNLANC	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
3	ACHNMINU	0	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-
3	ACHNPERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	ACTINFSU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	1	-	-	-	-	-	-
4	AMPHOVAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	AMPHPEDI	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ANOMEXIL	-	-	-	-	-	2	-	0	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	ANOMEfLA	20	-	-	-	-	9	68	19	14	9	-	35	1	4	-	0	-	0	-	-	-	-	-	1	0	0	0	0	0
2	ANOMSBfT	-	-	-	-	-	-	-	6	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ANOMSERI	0	-	-	2	-	-	-	-	-	-	-	-	8	3	0	-	0	-	-	0	2	-	-	0	0	0	4	1	0
2	ANOMSvBR	-	-	-	-	-	-	-	-	-	-	-	6	8	13	-	-	0	0	0	-	-	0	-	-	-	-	-	0	0
4	COCCPLAC	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
0	COSCO329	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	CYMAELLI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
2	CYMBGRAC	0	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	CYMBHEBR	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	CYMBMICR	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOALPI	2	0	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNODENT	0	-	-	-	-	2	-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOELEG	-	0	3	-	0	-	2	1	9	2	2	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1	EUNOEXIG	-	-	2	-	-	-	-	3	0	-	-	-	153	291	398	394	390	393	399	395	381	393	392	399	398	398	377	348	352
1	EUNOEvBI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
2	EUNOFABA	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOFLEX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOFfRH	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	EUNOLUNA	36	28	24	38	9	32	29	14	40	47	83	12	1	2	-	0	4	1	0	1	1	2	-	-	2	0	4	39	27
3	EUNOLvCA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
2	EUNOMvBI	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	EUNOPALU	-	-	-	-	-	0	-	-	2	-	-	-	-	-	-	0	-	2	-	-	-	-	-	-	-	-	2	-	-
2	EUNOPECT	-	-	-	-	-	-	-	-	-	-	-	2	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPMfI	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPOLY	-	-	-	-	-	-	0	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPRAE	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPvVE	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNORHOM	1	2	-	-	-	-	-	-	-	-	-	7	86	17	-	2	0	2	0	0	1	0	-	-	0	-	0	6	7
2	EUNORvTE	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOTENE	-	-	-	-	-	-	-	4	2	-	-	-	-	14	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
2	EUNOVALI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-
2	EUNOVENE	69	27	83	15	10	153	118	41	62	141	111	6	2	12	-	-	-	-	-	-	1	-	-	0	0	0	0	-	0
4	FRAGCAPU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	2	-	-	-	-	-	-
4	FRAGCvVA	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
4	FRAGULNA	-	-	-	-	-	-	-	0	-	-	-	-	-	-	1	1	-	-	-	0	-	-	0	-	-	-	-	-	-
3	FRAGVIRE	-	-	-	-	-	-	-	-	-	-	-	64	-	0	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-
2	FRUSRHOM	1	1	-	0	-	-	-	0	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	FRUSRvSA	102	187	46	103	76	182	73	113	114	121	100	55	17	12	-	1	3	0	1	2	1	0	0	0	0	0	5	0	7
4	GOMPANGU	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPCONS	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	GOMPGRAC	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPFARV	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
3	HANTAMPH	-	0	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	MELOVARI	-	-	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	NAVICBRE	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVICLEM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1	NAVIFEST	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIGRAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
2	NAVIHEIM	0	22	5	67	277	3	83	92	97	2	22	116	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVIHOEF	4	15	2	12	1	-	0	8	18	2	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4	NAVIHUNG	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIMEDI	-	-	-	-	-	-	-	0	-	-	-	5	0	1	-	0	-	-	0	-	-	-	-	-	-	-	0	2	-
3	NAVIMUTI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
2	NAVIMvAT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3	NAVIPROT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
4	NAVIPSET	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
3	NAVIPUPU	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NAVIROTA	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVISUSB	57	61	12	41	11	-	2	14	10	25	48	2	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NEIDAFFI	-	-	-	-	-	-	-	0	0	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NEIDDUBI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
3	NITZGRAC	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	NITZHANT	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NITZPALE	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NITZPERM	-	-	-	-	-	-	0	-	-	-	-	39	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	0	-
1	NITZSCLE	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NITZSIGM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
2	PEROHERI	-	0	-	-	-	-	8	1	5	4	2	11	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNAPPE	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNBORE	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNGIBB	0	2	-	0	0	-	0	0	0	-	0	0	1	1	-	-	-	-	-	0	-	-	-	-	-	-	-	0	0
3	PINNINTE	0	0	-	0	0	-	-	0	0	0	0	0	0	6	-	0	0	0	0	0	0	0	-	0	0	0	0	0	2
3	PINNMICR	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	0	0	0	0	-	-	0	-	-	-	-	-	-	0
2	PINNNOBI	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
2	PINNSTRE	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNVIRI	0	-	-	0	0	-	0	0	0	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNVvSU	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	STAUANCE	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	STAUAfGR	-	0	-	-	-	-	-	0	0	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	STAUPHOE	-	-	-	0	0	-	0	0	0	-	0	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
2	STENINTE	-	-	-	-	0	-	-	-	-	-	-	2	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	TABEFLOC	-	-	7	-	-	2	0	1	2	1	-	14	-	1	-	0	-	-	0	-	0	-	-	-	-	-	-	-	0
1	TABEQUAD	108	55	213	122	16	15	17	70	25	46	30	0	124	12	0	2	3	2	0	1	11	5	0	0	0	1	2	4	4

Appendix 23

GERRITSFLES . All diatom taxa, with pH-indices (R). 0 = taxon present outside the count, - = taxon not found.

R	YEAR	16	16	16	18	18	18	18	50	50	51	60	64	64	65	65	70	73	74	77	77	78	78	78	78	78	79	80	80	81	81	81	82	82	83	83	84
R	MONTH	6	6	7	6	7	7	7	9	9	9	7	5	11	4	10	4	6	4	11	11	8	11	11	11	11	11	5	11	2	5	11	5	11	5	11	5
	SERIAL NR	70	1	71	2	3	4	5	7	8	9	10	11	12	13	14	15	16	17	18	19	22	20	72	23	21	28	34	37	38	39	41	43	45	47	57	65
2	ACHNALTA	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ACHNLANC	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3	ACHNMINU	-	-	-	3	1	8	-	-	1	4	3	-	-	-	-	1	2	-	1	-	-	0	-	-	2	-	-	-	-	-	-	-	-	-	-	-
2	ACHNMARG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	ACTIUNDU	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	AMPHTHUM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	AMPHVENE	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	AMPIPELL	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	ANOMEfLA	-	-	-	23	33	36	34	6	0	6	3	-	-	-	-	-	-	-	6	11	-	-	-	0	2	-	-	-	-	-	-	-	0	2	-	-
2	ANOMSvBR	-	-	-	1	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ASTEFORM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	BACIPAXI	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	CALOLvDE	-	0	-	3	7	5	3	0	0	2	-	-	-	-	-	-	-	-	0	0	-	-	-	1	0	-	-	-	-	-	-	-	0	0	-	0
4	COCCPLAC	-	-	-	-	-	-	-	0	0	-	-	-	0	-	-	0	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	COSCO329	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	CYCLMENE	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	CYCSDUBI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	CYMBAEQU	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	CYMBGRAC	-	-	-	4	-	0	0	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
4	CYMBPROS	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	DIPLINTE	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOALPI	-	0	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNODENT	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNODIOD	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOELEG	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	EUNOEXIG	-	6	11	18	18	5	6	16	86	10	24	249	364	328	376	242	268	370	371	272	394	378	400	364	355	383	396	395	374	224	219	273	270	250	263	154
2	EUNOFALL	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	EUNOLUNA	310	45	87	31	65	99	60	10	7	-	25	20	-	2	-	-	-	8	3	5	-	0	-	-	1	2	2	-	-	-	-	0	-	-	2	0
2	EUNOLvEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2	EUNOMEIS	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOMvBI	-	-	-	1	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	EUNOPALU	-	-	4	-	-	-	-	-	-	-	-	5	-	3	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
2	EUNOPECT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPMfI	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPOLY	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
2	EUNOPvBI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPvMI	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNORHOM	-	6	4	25	15	53	82	139	75	104	130	16	13	4	7	1	81	8	7	46	4	4	-	6	6	3	-	-	0	2	-	0	4	11	55	16
2	EUNOTENE	-	11	101	5	8	19	32	64	38	8	29	2	-	2	-	1	11	0	-	6	-	7	-	13	4	-	-	-	0	-	-	0	5	-	2	2
2	EUNOVALI	-	0	-	-	-	0	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	0	-	0	0	-	-	-	-	-	-	-	-	-	-	-
2	EUNOVENE	9	289	54	161	108	27	76	80	43	12	37	3	4	5	0	-	1	3	-	12	1	2	-	2	6	-	-	-	0	-	-	-	7	4	0	3
4	FRAGCAPU	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCROT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvBI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
4	FRAGULNA	-	-	-	0	-	-	-	0	-	-	0	-	-	-	0	37	-	0	-	-	-	0	0	-	-	0	-	-	-	-	-	-	-	-	-	-
4	FRAGUvAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	FRAGVIRE	-	0	-	0	-	1	-	-	-	10	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	FRUSRHOM	0	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	0	-	-	-	-	1	-	-
1	FRUSRvSA	66	18	24	33	20	24	25	36	121	198	49	35	10	26	1	4	3	5	7	11	1	3	0	5	8	11	1	5	26	174	180	124	41	60	55	63
4	GOMPCONS	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	GOMPGRAC	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPPARV	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
3	HANTAMPH	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
4	MERICIRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVICOHN	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	NAVICVAR	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVIFEST	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIHEIM	-	-	-	2	2	8	3	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVIHOEF	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIHUNG	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVILANC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVIMEDI	-	-	15	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIMENI	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIMINI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NAVIMUTI	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
3	NAVIPUPU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIRHYN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVISLES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVISUSB	14	3	1	37	61	65	52	6	-	1	2	1	-	-	-	-	-	-	1	6	-	2	-	-	2	-	-	-	-	-	-	-	1	0	-	1
4	NAVIVvRO	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NEIDAPFI	0	1	1	-	-	-	-	3	0	0	0	-	0	2	-	-	0	0	1	-	-	1	0	1	0	0	-	-	0	-	1	0	2	7	1	1
4	NEIDAvAM	-	-	-	-	-	0	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
2	NEIDAvLO	-	0	-	-	8	1	3	8	0	1	2	-	-	-	-	-	-	-	-	2	0	0	-	1	0	-	-	-	-	-	-	-	-	-	-	-
3	NEIDIfVE	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	NITZ199A	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	NITZ739A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
3	NITZGRAC	-	-	-	-	0	6	4	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NITZHANT	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NITZPERM	-	-	-	3	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
3	NITZUMBO	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PEROHERI	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNAPPE	-	-	90	-	-	-	-	0	-	-	1	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNBORE	-	1	-	-	-	-	-	-	0	-	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNGIBB	0	2	-	0	0	-	0	0	-	-	0	-	-	-	-	-	-	-	-	0	-	0	-	0	0	-	-	-	0	-	-	0	0	0	-	-
3	PINNINTE	0	1	1	3	9	0	2	1	0	0	3	-	-	-	-	-	0	-	-	5	0	1	-	0	3	-	-	-	0	0	0	0	1	9	-	4
2	PINNLATA	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNMICR	1	0	2	0	-	6	2	1	-	-	73	25	5	5	1	-	-	-	2	1	0	0	0	0	-	-	-	-	-	-	-	-	1	1	-	-
3	PINNOBSC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
2	PINNSILV	-	0	2	-	-	-	-	-	-	-	-	4	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	PINNVIRI	0	-	0	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	RHOIABBR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	STAU199A	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	STAUAfGR	-	-	-	3	5	3	3	0	-	-	0	-	-	-	-	-	-	-	-	1	0	0	-	-	-	-	-	-	-	-	-	-	-	0	-	-
5	STEPROTG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
3	SURILINE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	SURILvCO	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	TABEBINA	-	-	-	-	-	-	-	-	0	9	0	0	-	-	-	0	-	0	-	1	-	-	-	-	1	-	-	-	0	0	-	-	1	0	1	0
2	TABEFLOC	-	13	0	18	20	23	10	15	17	6	10	3	0	-	-	18	1	1	0	4	0	2	-	2	3	1	-	-	-	-	-	-	0	1	1	1
1	TABEQUAD	-	2	-	18	9	-	3	10	10	6	7	37	3	23	15	62	31	5	1	11	0	0	0	5	5	0	0	-	-	0	0	3	67	54	19	155

Appendix 24

KLIPLO. All diatom taxa, with pH-indices (R). 0 = taxon present outside the count, - = taxon not found.

R	YEAR	24	29	48	58	62	64	70	72	72	78	79	80	81	81	82	82	83	83	84
R	MONTH	8	6	5	5	8	5	4	7	7	11	10	5	5	11	5	11	5	11	5
	SERIAL NR	1	3	4	6	7	8	9	11	12	20	22	25	31	33	35	37	40	49	57
2	ACHNALTA	-	-	-	0	-	-	-	-	-	2	-	-	-	0	0	1	-	-	-
4	ACHNEvHE	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ACHNLANC	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	ACHNLvEL	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-
3	ACHNMINU	10	1	10	-	-	1	1	-	-	-	-	-	-	0	-	1	-	-	-
4	ACHNROST	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	ACTINfSU	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	AMPHPEDI	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
4	ANOMEXIL	1	-	-	-	-	2	-	-	-	5	-	-	-	-	-	0	-	-	-
3	ANOMEfLA	1	3	100	197	28	87	27	2	0	22	5	18	15	8	32	12	7	0	11
1	ANOMSERI	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-
2	ANOMSvBR	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
4	ASTEFORM	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
1	CALOLvDE	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
4	COCCPLAC	-	-	-	-	-	0	0	1	0	0	-	-	-	-	-	-	-	-	-
4	CYCLMENE	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
4	CYMBEHRE	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	CYMBGRAC	-	4	27	-	-	-	-	-	1	1	-	0	-	0	0	-	0	0	0
3	CYMBMINU	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3	CYMBMvSE	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
4	CYMBPROS	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	DIATELON	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
4	DIATEvTE	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
5	EPITZEBR	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
2	EUNMvMfB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	-	-
2	EUNOALPI	-	-	-	-	-	0	-	-	-	-	0	-	-	-	-	-	-	-	-
3	EUNOARCU	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
1	EUNOEXIG	0	0	-	3	6	11	19	6	76	1	3	4	3	0	1	0	3	8	0
2	EUNOFORM	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
2	EUNOFvGR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3	EUNOLUNA	35	82	3	9	96	47	4	2	1	10	35	26	90	58	12	10	10	41	25
2	EUNOLvEX	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-
1	EUNOPALU	-	-	-	-	1	1	-	-	-	-	-	-	1	0	-	-	-	-	-
2	EUNOPECT	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	0	-
2	EUNOPMfI	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
2	EUNOPOLY	-	5	4	0	0	2	2	-	-	8	0	1	1	0	3	0	3	0	0
2	EUNOPRAE	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNOPvMI	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EUNORHOM	25	3	8	4	34	7	50	5	0	21	22	45	83	39	20	42	241	100	51
2	EUNOTENE	8	0	0	-	16	2	2	2	-	10	1	1	4	1	2	6	1	2	0
2	EUNOVENE	96	34	21	8	116	1	6	6	1	20	5	37	16	22	11	20	57	52	33
4	FRAGBREV	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
4	FRAGCAPU	0	-	-	1	-	0	1	-	-	-	-	-	-	-	-	-	-	-	-
2	FRAGCONS	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGCvBI	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
4	FRAGCvVA	0	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-
4	FRAGCvVE	-	-	-	-	-	1	-	-	-	-	-	-	-	-	0	-	-	-	-
4	FRAGPULC	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
4	FRAGULNA	0	-	0	-	0	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	FRAGVIRE	-	1	39	1	3	4	-	-	4	30	1	1	1	0	5	2	0	0	4
2	FRUSRHOM	-	-	-	-	-	-	-	-	-	-	0	0	-	-	0	1	-	-	-
1	FRUSRvSA	56	25	25	23	29	44	54	271	224	28	198	154	68	96	95	129	21	64	70
4	GOMPACUM	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPANGU	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPAvGO	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPAvSA	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	GOMPGRAC	-	-	2	-	1	-	-	-	-	0	-	-	-	-	0	-	-	-	0
4	GOMPINTR	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
4	GOMPOLIV	-	-	-	-	-	0	1	-	-	-	-	-	-	-	-	-	-	-	-
4	GOMPPARV	5	-	5	0	-	1	2	-	0	-	-	-	0	0	1	-	-	-	-
4	GYROATTE	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
3	HANTAMPH	-	0	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
4	MELOITGR	-	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-
4	MELOVARI	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	MERICIRC	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVICRYP	-	1	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
4	NAVICUSP	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	NAVIEXIL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
3	NAVIFOSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
4	NAVIGRAC	0	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
4	NAVIGREG	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
2	NAVIHEIM	2	88	78	101	1	39	25	18	1	98	5	13	6	22	93	30	7	5	11
1	NAVIHOEF	11	13	4	2	-	1	3	-	79	37	2	7	13	1	24	18	1	4	11
2	NAVIMEDI	-	-	-	0	0	-	2	-	0	3	-	-	0	-	1	-	1	-	0
4	NAVIMINI	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
3	NAVIMUTI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
3	NAVINEOV	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NAVIPUPU	-	-	-	-	-	0	-	-	-	0	-	2	-	-	-	-	-	-	0
4	NAVIRHYN	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	NAVISUBA	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	NAVISUSB	50	11	1	2	8	39	26	0	2	77	50	42	4	137	46	95	28	99	144
2	NAVITANT	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-
3	NEIDAFFI	-	0	1	1	0	3	0	-	-	0	-	-	-	-	-	1	-	0	-
4	NITZDISS	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	NITZFRUS	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NITZGRAC	-	0	9	7	9	72	3	-	1	1	13	17	2	2	5	2	2	0	10
3	NITZHANT	-	-	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
4	NITZPERM	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	NITZSCLE	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	0
4	NITZSIGM	-	0	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
2	PINNAPPE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
3	PINNBORE	-	-	1	-	1	0	-	-	-	-	-	2	-	-	0	-	-	0	-
3	PINNGIBB	0	0	0	0	-	1	-	-	1	0	-	0	-	0	0	1	0	0	0
3	PINNINTE	0	0	2	1	0	3	0	0	-	7	1	4	6	2	8	7	0	3	3
3	PINNMICR	-	-	-	-	-	3	-	1	-	0	0	0	1	-	0	0	-	-	0
3	PINNMfAN	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
2	PINNNOBI	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
3	PINNOBSC	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
2	PINNSUBC	-	0	-	0	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-
3	PINNVIRI	-	-	-	-	0	-	-	-	-	0	-	-	0	0	0	0	-	-	-
5	RAPHAMPH	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
4	RHOIABBR	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
3	STAUANCE	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
2	STAUAfGR	0	0	10	1	0	3	-	-	-	3	0	1	-	1	1	3	0	1	0
3	STAUPHOE	-	1	-	-	-	-	0	-	-	0	-	-	-	-	0	0	-	-	0
5	STEPROTG	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-
4	SURIOvAN	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	SYNEAFFI	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	TABEFLOC	72	116	36	38	50	13	105	22	0	9	51	21	82	9	21	15	15	16	25
1	TABEQUAD	22	12	12	1	0	1	2	61	0	4	8	4	3	2	18	4	3	4	2

Appendix 25

TONGBERSVEN-WEST. All diatom taxa, with pH indices (R). 0 = taxon present outside the count, - = taxon not found. First two samples are from western basin, others from eastern basin.

R	YEAR	19	84	83	83	83	84	84	84
R	MONTH	5	2	5	8	11	2	5	5
	SERIAL NR	1	2	2	5	8	11	14	15
2	ACHNALTA	-	0	-	-	-	-	-	-
4	ACHNEvHE	-	-	-	-	2	-	-	-
3	ACHNMINU	-	-	1	-	3	-	-	-
3	ACHNPUSI	-	6	-	-	-	-	-	-
4	ACHNROST	1	-	-	-	2	-	-	-
4	ANOMEXIL	5	-	0	-	-	-	-	-
3	ANOMEfLA	-	-	-	-	0	2	-	-
1	ANOMSERI	0	0	6	0	1	-	1	-
2	ANOMSvBR	-	4	10	5	1	1	2	0
4	COCCPLAC	0	0	-	-	-	-	-	0
4	CYCLMENE	-	-	-	-	0	-	-	-
2	CYMBGRAC	-	2	-	3	-	1	1	-
2	EUNOALPI	129	-	-	-	2	-	-	-
2	EUNODENT	5	1	-	2	-	0	1	-
1	EUNOEXIG	-	4	95	123	74	77	98	72
3	EUNOLUNA	8	25	76	55	75	88	50	18
2	EUNOLvEX	-	-	-	-	0	-	-	-
2	EUNOMICR	-	0	-	-	-	-	-	-
1	EUNOPALU	1	1	10	3	21	9	5	158
2	EUNOPMfI	-	0	-	-	-	-	-	-
2	EUNOPvMI	-	-	-	-	0	-	-	-
2	EUNORHOM	8	12	3	6	5	2	1	-
2	EUNOTENE	5	2	0	0	-	1	-	-
2	EUNOVALI	0	0	0	1	0	-	0	-
2	EUNOVENE	6	2	2	1	3	0	0	0
4	FRAGCvVE	-	2	0	-	-	0	-	-
4	FRAGCvVA	-	-	-	-	1	-	-	-
4	FRAGULNA	-	-	0	-	2	-	-	-
3	FRAGVIRE	-	2	-	0	0	-	-	0
2	FRUSRHOM	41	-	0	3	1	0	-	4
1	FRUSRvSA	79	54	94	62	59	49	36	116
3	GOMPGRAC	-	5	0	-	-	-	-	-
3	GOMPPARV	-	0	-	-	6	-	-	-
3	HANTAMPH	-	-	-	-	0	0	-	-
4	MELOITGR	-	6	-	-	-	-	-	-
4	MERICIRC	-	-	-	-	1	-	-	-
4	NAVICOHN	-	-	-	-	-	-	-	1
4	NAVICRYP	-	-	-	-	3	-	-	-
2	NAVIHEIM	4	-	-	-	-	-	1	-
1	NAVIHOEF	22	2	12	3	3	0	1	-
0	NAVIINDI	-	17	-	-	-	-	-	-
4	NAVIMINI	-	1	-	-	-	-	-	-
2	NAVIQUAD	-	31	-	-	-	-	-	-
3	NAVISEMI	0	80	-	-	2	-	-	-
1	NAVISUSB	13	3	0	4	-	2	1	-
2	NAVITANT	-	-	-	-	0	-	-	-
0	NITZ897A	-	-	0	-	-	-	-	-
3	NITZGRAC	-	1	-	-	-	-	-	-
3	NITZPALE	-	-	-	-	4	-	-	-
4	NITZPERM	-	-	-	-	2	-	-	-
1	NITZSCLE	-	4	-	-	-	-	-	-
3	PINNBORE	-	-	-	0	-	-	-	0
3	PINNGIBB	2	45	2	6	0	1	0	0
3	PINNHEMI	-	-	-	-	0	-	-	-
3	PINNINTE	6	12	4	6	2	1	2	-
3	PINNMAJO	-	-	-	-	1	-	-	-
3	PINNMICR	-	1	0	1	0	1	0	0
3	PINNOBSC	-	-	-	-	-	-	-	0
2	PINNSILV	-	3	-	-	-	-	-	-
2	PINNSUBC	-	-	-	0	8	1	-	-
1	PINNSvHI	-	-	1	-	-	-	0	-
3	PINNVIRI	0	0	0	3	-	0	1	0
5	PODOSTEL	-	-	-	0	-	-	-	-
4	RHOIABBR	-	-	-	-	1	-	-	-
5	RHOPGIBB	-	-	-	-	0	-	-	-
3	STAUANCE	-	-	-	-	-	-	0	-
2	STAUAfGR	0	-	-	-	-	1	-	-
3	STAUKRIE	-	4	-	-	-	-	-	-
3	STAULEGU	-	-	-	-	0	-	-	-
3	STAUPHOE	-	4	-	-	-	1	-	-
2	STENINTE	1	-	-	-	-	-	-	-
2	SURIARCT	1	-	-	-	-	-	-	-
1	TABEBINA	0	-	-	-	-	-	-	-
2	TABEFLOC	0	1	0	-	0	-	1	-
1	TABEQUAD	63	63	84	113	115	162	198	31

Appendix 26

GROOT HASSELSVEN. All diatom taxa, with pH indices (R). 0 = taxon present outside the count, - = taxon not found.

R	YEAR	83	83	83	84	84
R	MONTH	5	8	11	2	5
	SERIAL NR	2	5	8	11	14
4	AMPHLYBI	-	-	0	-	-
1	ANOMSERI	-	-	-	0	-
2	ANOMSvBR	-	-	-	3	-
1	CALOLvDE	-	-	0	-	-
3	CYMBCYMB	-	-	-	-	0
4	CYMBMICR	-	-	-	1	-
5	DIPLLITO	-	-	-	-	0
3	EUNOARCU	-	-	-	0	-
1	EUNOEXIG	391	396	346	370	393
2	EUNOFABA	-	-	-	0	-
2	EUNOFLEX	-	-	-	-	0
3	EUNOLUNA	0	0	-	10	1
1	EUNOPALU	0	-	-	-	-
2	EUNORHOM	-	-	-	2	-
2	EUNOTENE	0	-	-	1	-
2	EUNOVENE	-	0	-	2	-
3	FRAGVIRE	-	-	-	2	-
2	FRUSRHOM	-	0	-	-	-
1	FRUSRvSA	9	2	20	2	5
4	GOMPACUM	-	-	-	-	0
3	HANTAMPH	-	-	0	-	-
2	NAVIHEIM	-	-	-	1	-
2	NAVIMEDI	-	-	-	0	-
3	NAVIPUPU	-	-	-	0	-
3	NAVISEMI	-	-	-	-	1
1	NAVISUSB	-	2	-	1	-
3	NEIDAFFI	0	-	-	-	-
4	NITZPERM	-	-	-	4	-
3	PINNGIBB	-	-	0	-	-
3	PINNINTE	-	0	-	0	-
3	PINNMICR	0	0	34	-	0
2	STAUAfGR	-	-	-	0	-
3	STAUPHOE	0	-	-	-	-
1	TABEQUAD	-	-	-	1	0

Appendix 27

Field chemistry at diatom sampling in Tongbersven-West (T) and Groot Hasselsven (H).

Pool	DATE	pHf	EC25f	TEMP	O_2	O2%
-	-	-	mS/m	°C	mmol/m^3	%
T	830518	4.1	7.7	16.5	353	115
T	830823	3.8	6.9	24.0	269	102
T	831115	4.4	6.7	1.0	275	62
T	840215	4.9	7.0	3.0	259	62
T	840516	4.9	6.2	14.0	406	125
T	840815	4.4	5.6	18.0	316	106
T	841114	5.1	5.0	7.0	109	29
H	830518	3.4	12.5	16.0	325	105
H	830818	3.3	15.8	22.0	293	108
H	831115	3.6	17.5	0.0	272	59
H	840215	3.5	12.9	2.0	416	97
H	840516	3.9	11.9	19.0	369	128
H	840815	4.0	13.2	26.0	306	122

De volgende RIN-rapporten kunnen besteld worden door overschrijving van het verschuldigde bedrag op giro 516 06 48 van het RIN te Leersum onder vermelding van het rapportnummer. Uw giro-overschrijving geldt als bestelformulier. Toezending geschiedt franco.

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