Observations in Guanotrophic Environments

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(with 7 figs.)

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INTRODUCTION

Excrements of birds are added to soils and waters wherever birds are present. It results in certain responses of the environment which become visible, especially when birds concentrate on the same spot for a longer time. In the Netherlands the colonies of Cormorants (*Phalacrocorax carbo*) are very spectacular in this respect, as the trees in the colonies die and show up white as a result of thick layers of droppings. The vegetation under the trees is affected and growth of plant species as *Solanum dulcamarum* and *Juncus effusus* indicate changes in the original vegetation. The same is found in colonies of spoonbills (*Platalea leucorhodia*), seagulls (*Larus argentatus*), black headed gulls (*Larus ridibundus*) and grey herons (*Ardea cinerea*). Migratory birds also visibly affect the vegetation by excrements, which in chorology is a subject of distribution studies of plant and animal. In this case the amount of excrements produced by the birds is not essential, but rather the quality. This may be also true for all other birds which live scattered widely over forests, meadows and other landscapes. However, little is known of the quality and quantity of the excrements added to soil and water. In most cases the quantity of excrements added by the birds may be negligible in comparison to the nutrients already present in soil and water. Perhaps the analyses of excrements of geese and ducks resting on ice in winter may help to gain an insight in this relation, and perhaps

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the nuisance of dove flocks in big cities, which spoil the roofs of the buildings, may be of some use in estimating the quantity of excrements. Food relations of the birds are important for the study of the quality of the excrements. Guano is the well known product of fish-eating birds, which live in colonies on the islands near the coast of South America.

In our country cormorants, gulls and herons also live mainly on fish only. The chemical composition of guano is known and it consists for the greater part of P, N and K compounds. The composition will vary with the quality of food of the birds. It is also known that many parasites pass the intestines of birds and fall on land or into water.

When the specificity of an environment is determined by bird excrements, we may speak of guanotrophy (LEENTVAAR 1958). WESTHOFF (1951) recorded the growth of mushrooms (*Agaricus campestris*) near a colony of seagulls on the Isle of Terschelling, which is guanotrophy. RITCHIE (1920) in his book 'The influence of man on animal life in Scotland' describes in a chapter the case of gulls and moorland, which is also a case of guanotrophy. GEELEN c.s. (1961) investigated the changes caused partly by a colony of black headed gulls, partly by sewage pollution on an acid oligotrophic 'ven' near Nijmegen in the Netherlands. STADIE (1929) tried to establish quantitative relations of the effect of a colony of *Larus ridibundus* in Schleswig Holstein, on the vegetation. There are also studies of GESSNER (1932), SANDERSON (1953) and MACKENTHUN (1962) on the effect of birds on vegetation or water. We bring into mind that ponds crowded with duck or geese are coloured green through the fertilizing effect of the excrements. In Poland ducks, geese and waterfowl are considered useful for the fertilization of water and therefore are reared on fish ponds. The study of guanotrophy, however, as a specific environments has not yet been carried out. In this paper I will give some observations on guanotrophic environments in the Netherlands. The first object is an originally acid oligotrophic 'ven' colonized by *Larus ridibundus* since a few years, which shows the initial influences of the excrements on the water. The second gives a picture of a similar biotope with a colony of *Larus ridibundus* already existing 45 years. A few other examples of influences of birdcolonies in eutrophic water are given. In the scope of the research carried out in our institute, I note that the study of guanotrophy is important for the management of the reserves in which bird colonies are present, or in those cases in which a colony of birds intends to settle. The chemical and bacteriological analyses have been carried out by the laboratory of drinking-water 'Midden Nederland' at Bilthoven as routine examinations.

In 1961 and 1962 the bacteriological examinations were carried out by Miss F. C. ROEST, ass. bacteriologist of the State Sanitary Laboratory at Bilthoven. She also helped with the determinations of plankton organisms.

Guanotrophy in acid oligotrophic environments

I. The 'Hilversumse Wasmeer'

The Hilversumse Wasmeer is located south-east of the town of Hilversum. It is a shallow acid-oligotrophic lake ('ven') with a sandy bottom. In order to preserve the original oligotrophic character of the ven and its surroundings, the Foundation 'Het Gooisch Natuurreservaat', which owns the reserve, decided to place a screaned fence around it. This was done in 1957. Next year a colony of *Larus ridibundus* settled to breed in the northern part of the lake as it than remained undisturbed. This was a good opportunity to study the initial influences of a bird colony on water and vegetation.

Hydrobiologically the Hilversumse Wasmeer was known already by the occurrence of rare organisms. REDEKE (1947) mentions the rare crustacean *Eurycercus glacialis* and other oligotrophic species. The vegetation has been described in a report by Dr. M. F. MÖRZER BRUYNS in 1950 which follows here.

The lake is surrounded by pine forest. The length of the nature reserve is about 750 m, its width about 200 m. The lake surface is nearly 350 m long and 100 m wide maximum. The maximum depth is approximately 1 m.

The highest parts of the heath-vegetation around the lake are covered mainly with *Calluna vulgaris. Erica tetralix* and *Molinia coerulea* are less common, together with *Potentilla erecta, Rumex acetosella, Cuscuta epithymum, Festuca ovina, Spergula vernalis, Nardus stricta, Sieglingia decumbens*, and locally seedlings of *Quercus robur, Betula pubescens, Betula verrucosa, Frangula alnus* and *Sorbus aucuparia. Juncus squarrosus* and *Agrostis canina* penetrate from wet parts. Seedlings of *Prunus serotina* are present everywhere. The total surface of this Calluno-Genistetum is not great.

The next lower part is formed by associations of Ericetum tetralicis. *Erica tetralix* is present together with *Molinia coerulea, Juncus squarrosus, Trichophorum caespitosum, Sphagnum compactum*, a few *Calluna vulgaris, Drosera rotundifolia* and *Gentiana pneumonanthe*. On old sodcuts *Rhynchospora fusca* was found and on lower parts *Carex panicea.*

The next zone nearer to the water is formed by *Molinia coerulea*, which presents about 95% of the vegetation. The rest is composed of *Agrostis canina, Carex panicea, Hydrocotyle vulgaris, Luzula campestris* and *Sphagnum spp.* This 'Molinietum' is bordering another zone which is nearly at the same level. Here *Agrostis canina* and *Hydrocotyle* are the most important, whereas *Molinia, Drosera intermedia, Sphagnum* spp. and some *Juncus effusus* are present. In this zone also the first *Eriophorum angustifolium* appears. This community is extended over larger areas near the drier sides with fields of *Heleocharis palustris*. Except for the species already mentioned, the most important plants in this zone are *Juncus bulbosus, Glyceria fluitans, Littorella uniflora* and *Heleocharis palustris*. The submerged vegetation joins this zone closely.

Compared to similar vegetations elsewhere in our country the associations are developed fragmentary only. This may be caused by the cleaning of the lake, but also the frequent visit of people is seriously damaging the vegetation.

After colonization of the gulls in 1958, the vegetation was again mapped by students of the laboratory of Systematic Botany from the University of Utrecht. The results will not be given here as they will be published separately. Essential influences due to the initial guanotrophy were not yet recorded, however.

Developments in the gull colony

After 1957 a colony of black headed gulls settled in the north part of the 'ven' and in 1959, 1961, 1962 and 1963 the number of nests, eggs and the time of hatching of the young were registrated through the kind cooperation of the warden of the reservate.

On 24 April 1959 the first eggs were found in the nests. In the next weeks the numbers ran as follows:

28 April 167 nests with 325 eggs
5 May 303 nests with 758 eggs
12 May 345 nests with 723 eggs.

On 19 May many young were hatched.

In 1960 no gulls were breeding in the lake.

24 April 1961	15 nests	24 eggs
28 April	55	88
6 May	170	353
10 May	247	569
15 May	313	753
19 May	342	843
23 May	357	861

On 19 May the first young were hatched. About 40 nests were present on an island, which brings the total number of nests about 400.

24 April 1962	14 nests	18 eggs
28	79	130
1 May	167	328
5	283	617
8	317	814
12	360	917
15	371	971
18	380	982

On 18 May the first young were observed and 22 nests were present on the island.

22 April 1963	10 nests	11 eggs
25	35	52
29	115	210
2 May	248	511
6	359	864
10	410	1073
13	419	1090
16	445	1170

On 16 May the first young were observed. On the island 102 nests were present with 271 eggs.

The figures show that the total number of adults and young increased during the period of observation. Except for 1963 the first eggs were found on 24 April. The first young gulls appeared around 18 May. In July the gulls left the lake.

During the presence of the gulls on the lake the water is polluted by their excrements. The pollution can be detected by way of Coliform bacteria.

As no pollution by human beings is present, the *Escherichia coli* found must be bird coli. Coli tests were carried out at two stations in the lake. One at the north side near the colony and another in the South of the lake. The results are shown in fig. 1.

In 1959 the numbers of Coli were low. The highest numbers were found near the colony. In 1961 and 1962 very high numbers of Coli were found during a short time after hatching. In 1961 this high number was spread out over a longer period, which may be explained by a more synchronized hatching in 1962, restricting the pollution period. In 1959 the weather was very dry and the nests in the colony were for the greater part not surrounded by water. As a result the excrements and Coli bacteria were deposited on land and few could be detected in water. The year 1959 was abnormal, also in other respects which will be shown later. As in 1959 the highest numbers of Coli were found near the colony. In the southern part of the lake less Coli was found as the birds did not frequent this side and most of the germs sedimented and died before reaching this part. In the figures of 1961 and 1962 slightly lower numbers of Coli are found on 15 May, resp. 24 May. If this is significant it might be due to the fact that the adults are breeding during that time and as a result less excrements reach the water. This shows the relation of the behaviour of the birds and numbers of Coli found in the water. This is more pronounced after the hatching of the young, which deposit their excrements everywhere when walking about. In the same way a slight increase in Coli bacteria during autumn sometimes may indicate the presence of migratory birds, as the gulls are absent at that time. As will be shown this is sustained by the plankton-observations.

In 1959, 1961 and 1962 the numbers of nests were resp. 345, 357 and 380. So there is a slight increase of nests and adults. The number of Coli found could have been about the same, which was not the case in 1959 as we have seen. In 1963 445 nests or even more were counted and we should have expected at least the same amount of Coli or more than during the previous years. Fig. 1 shows, however, that less Coli are found at the northern side. At the southern side also low numbers of Coli are found, but here it is the same as in previous years. In the year 1963 weather conditions were not abnormal and comparable to 1962 and 1961.

An explanation of the very low numbers found near the colony in 1963, after the hatching of the young, is very difficult, as no direct relations with other factors in the environment seem to be present. It will be shown that the environment in the water changed during the years, the pollution increased and different organisms appeared in the water. However, there is no indication that the number of bacteria consumers increased also. It also may be possible that the Coli bacteria die sooner in the changed environment, resulting in lower counts. I will not exclude the possibility of yearly fluctuations, but this seems rather unlikely, as the relation to the presence of birds is too evident. Also the knowledge that the estimations of Coli have been done in 1959 and 1963 by the same Institute and the estimations of 1961 and 1962 by another, seems not to be essential considering the method used for counting. In that case the differences found should have been changed in the same order as at the North side of the lake. Continuation of the observations in later years should have given the answer. In 1965 I found in the period from 9 June until 30 June no higher Coli numbers than 350. This again sustains the conclusion, that the number of Coli is decreasing. The reason for this may be critical changes in the environment after the year 1962. Some other factors confirm this conclusion.

Counts of bacteria, grown at 37° C on agar, were carried out also, but the numbers were low, and as a conclusion only may be said that somewhat higher numbers were found during the breeding season.

Counts of bacteria grown at 22° C on gelatine disks were carried out in 1961, 1962 and 1963. It appears, that at both parts of the lake the same picture was found. As these are common water bacteria, the development is not directly related to the presence of gulls, but they may develop secondarily as a result of the increase of organic matter produced by the birds. In March 1961, January 1962 and January 1963 very high numbers of water bacteria were found. The development in spring and autumn of great numbers of water bacteria is not uncommon in waterbodies. At this time much organic material comes into circulation. This should be the explanation for the sharp rise in March and also for the less important maxima recorded during the breeding season. In January 1962 and January 1963 the water was covered with ice.

The high number of water-bacteria developed during the last part of the previous steep fall in temperature in December and diminished when the water temperature remained above 0° C. Plankton is scarce then and a decreased consumption of bacteria by certain species of plankton may help to augment the total numbers of bacteria. The dead plankters may be a source of organic matter which stimulates the growth of bacteria.

In 1963 the amount of water-bacteria could not be determined, as the gelatine on the disks liquified. This was especially the case in the second half of 1963. I am inclined to think that other species of water bacteria developed, parallel to the changing conditions in the lake. These species of bacteria seem to have the ability to liquify gelatine i.e. they are able to destruct the higher N-compounds which are present in the bird excrements. Naturally I cannot be sure that this is the right explanation without further laboratory experiments.

Water-chemistry

In 1955 the water of the undisturbed lake was analysed with the following result (27 June 1955):

colour	yellow	
transparency	weak opalescent	
smell	none	
temperature	21°C	
pH	4.3	
oxygen	8.4	mg/l
$KMnO_4$	19	,,
BOD_5	2	,,
NH_4	0.3	,,

NO_2	0	mg/l
NO_3	0	,,
Cl	18	,,

This analyses shows that the water did not differ from other 'vennen'. It is an acid oligotrophic water. Compare also with the undisturbed 'ven' from the Leersumse Veld. In 1959, 1961, 1962 and 1963 the same analysis has been made monthly, more or less complete. The results are given below and in the graphs. The factors will be discussed separately.

Temperature

The temperature did not differ essentially in the northern and the southern part of the lake. In 1963 the summer temperature was higher than in the other years. In the northern part ice was present from 8 January until 6 March 1962. In the southern part this was interrupted on about 6 February, probably because of the more sheltered situation, which allows higher air temperatures. From 11 December 1962 until 6 March 1963 ice covered the water again.

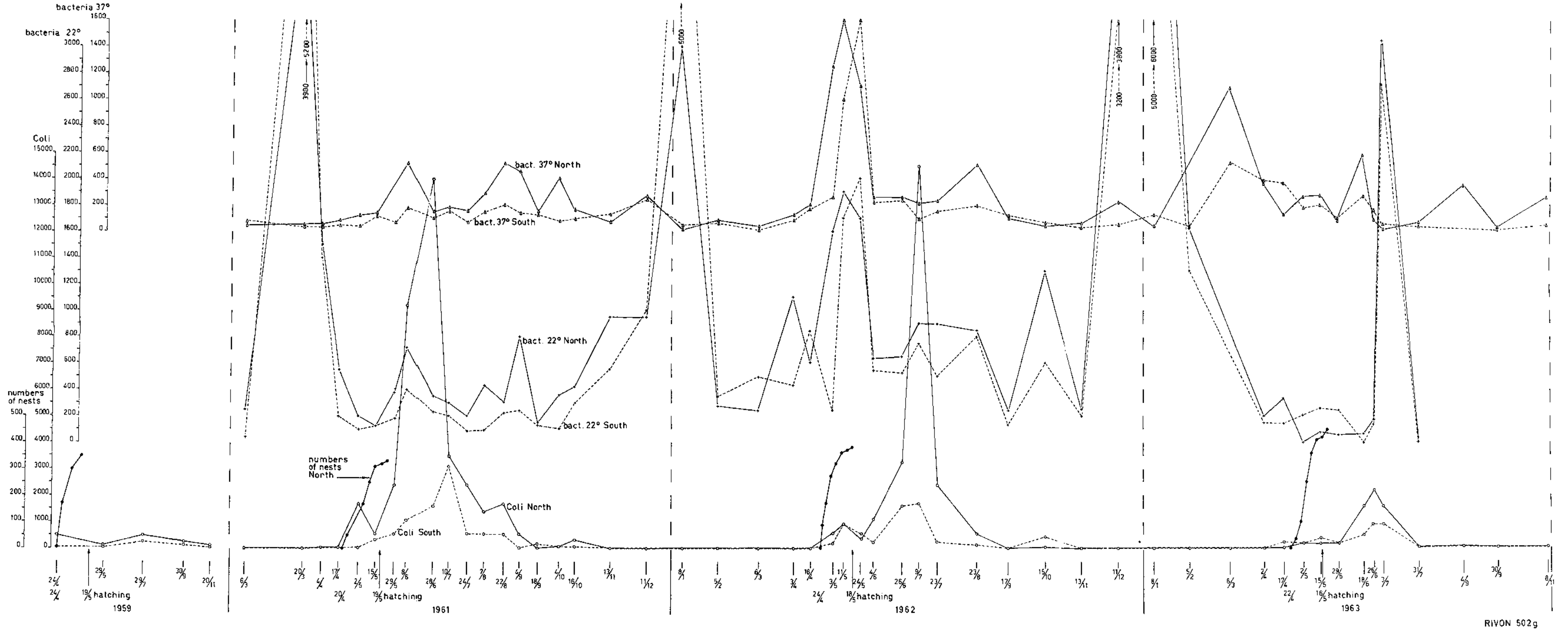
Oxygen

The normal picture of oxygen content in a 'ven' is given in the graph of lake 1 in the Leersumse Veld. This means a high saturation value until August, when a low valve is found. Later in autumn the saturation increases again. In December the saturation value decreases, especially under ice.

In 1961 this picture was found at the northern and southern part of the Hilversumse Wasmeer. In May 1962 oxygen fell to low values, which may be related to the re-circulation of organic matter in the water. After that time the oxygen values from the south and the northern part deviated. The August minimum in the southern part was spread out over a longer period. The normal picture of high saturation values during winter was present in the northern part, but in the southern part a steep fall was noticed until 6 March. The latter is synchronized with large amounts of organic matter and this may be the cause of the low value. The sample was taken under ice and there was much interference of bottom material. In 1963 in both parts low oxygen saturations were found during summer. Saturation values of 30—45% were found. These rather low saturation values seem to exist over a longer time now and also the amount of organic matter is greater. The picture becomes more similar to that of the stabilized guanotrophic lake 2 in the Leersumse Veld (see graph 6), where, also during a longer time in summer, lower saturation values were found. It seems that in the southern part of the Hilversumse Wasmeer more extreme values are found than in the northern part.

HILVERSUMSE WASMEER BIRD-COLI, WATERBACTERIA AND NUMBERS OF NESTS 1959-1963

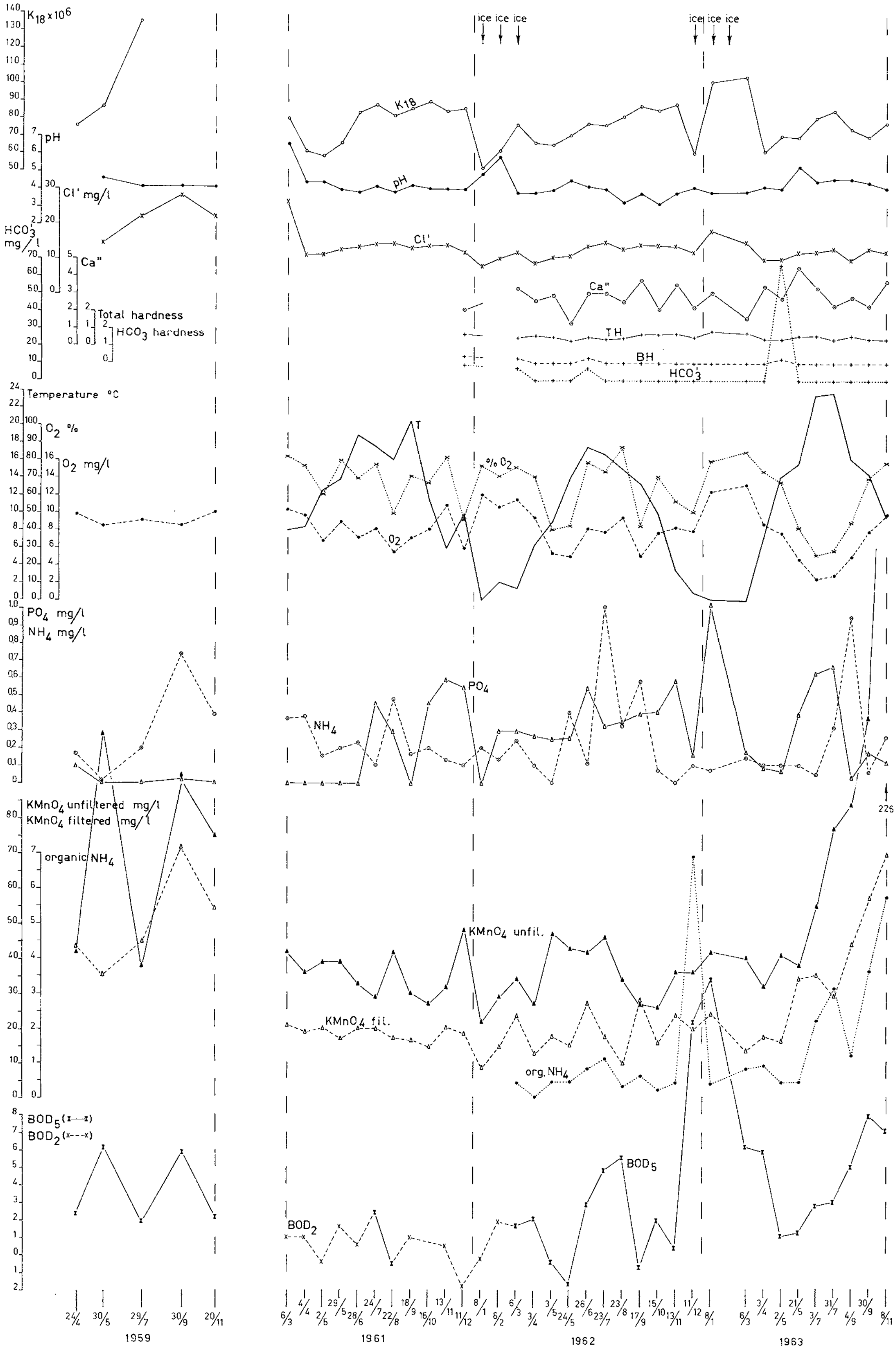
FIG. 1



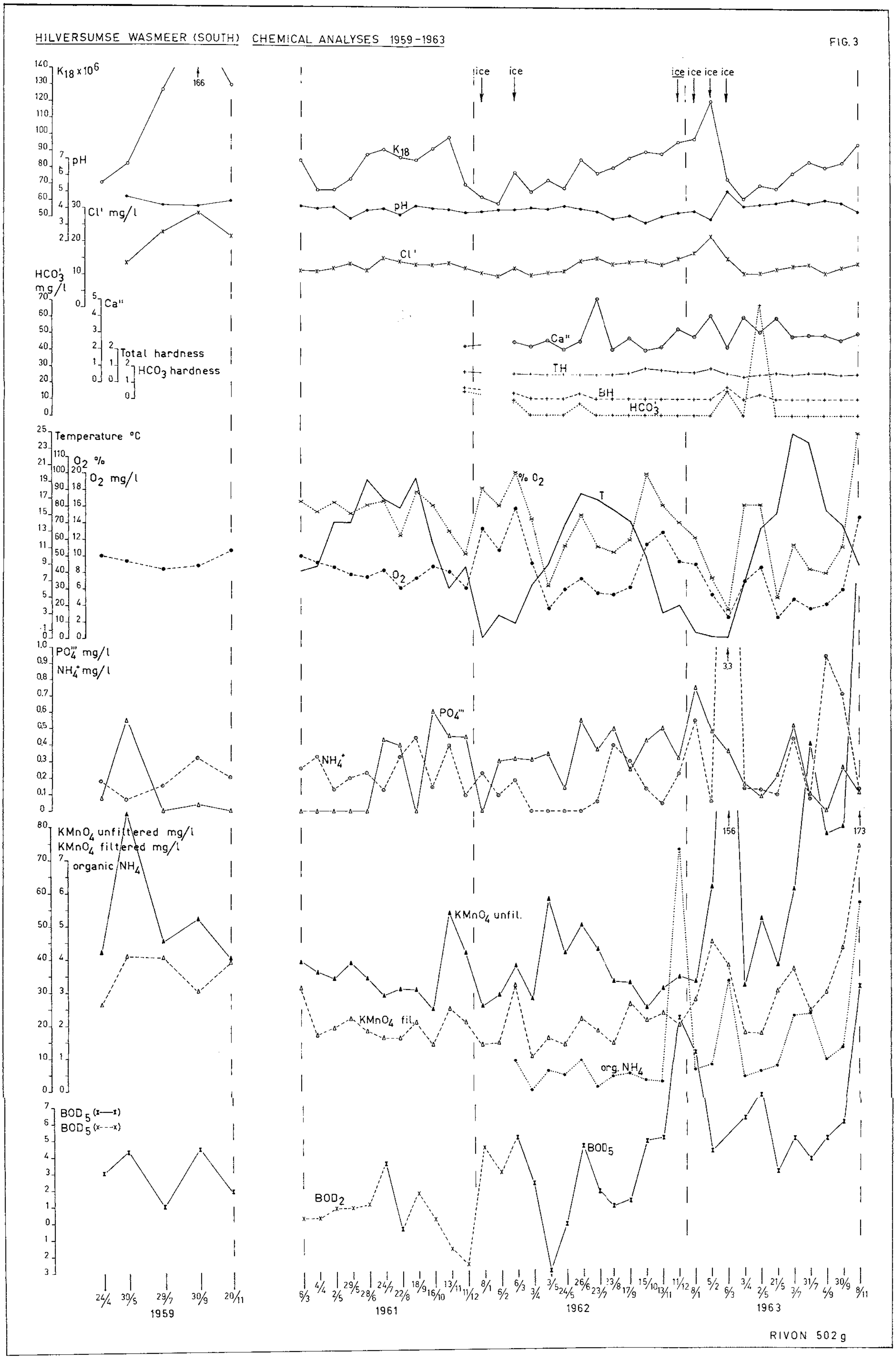
RIVON 502g

HILVERSUMSE WASMEER (NORTH) CHEMICAL ANALYSES 1959-1963

FIG. 2

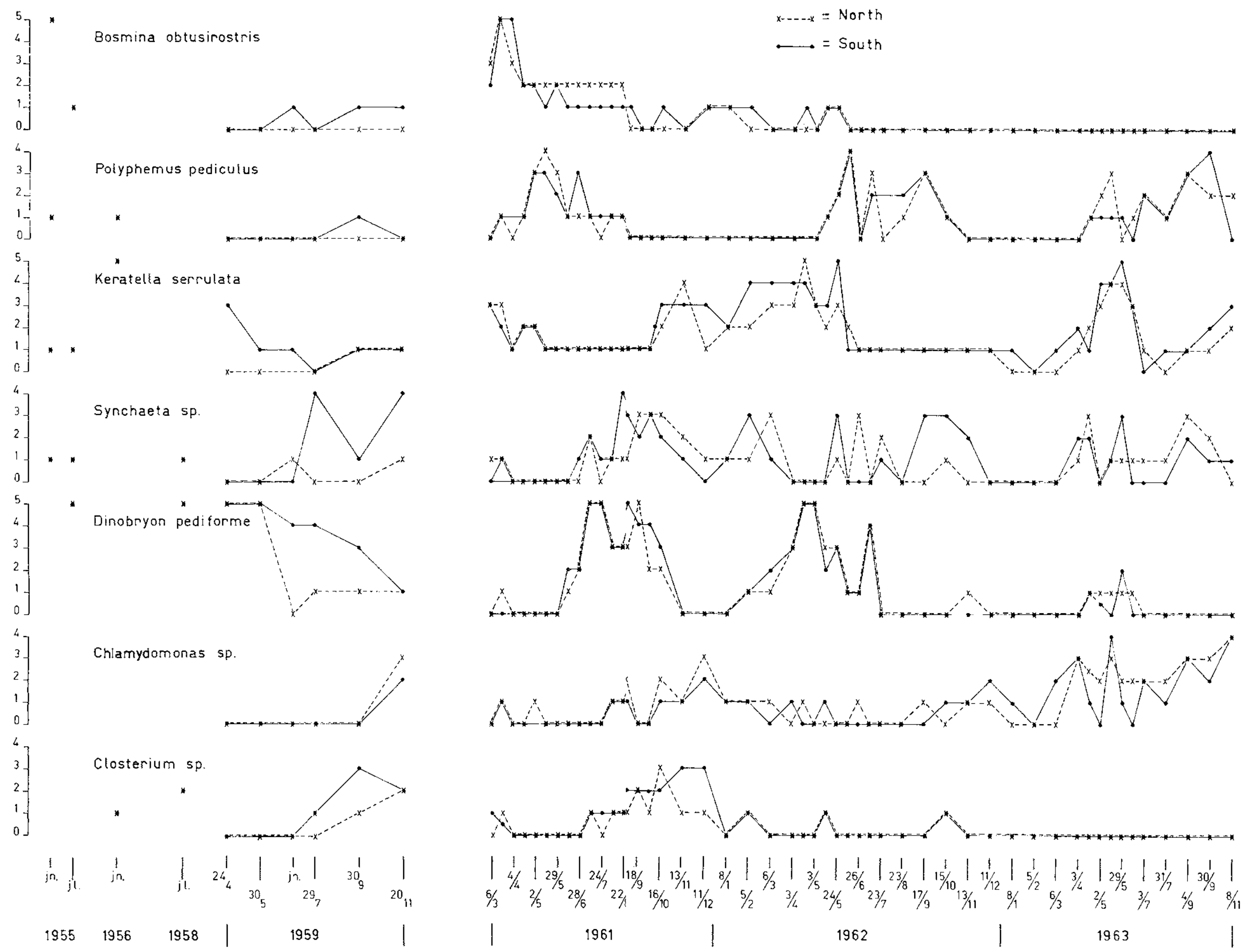


RIVON 502 g

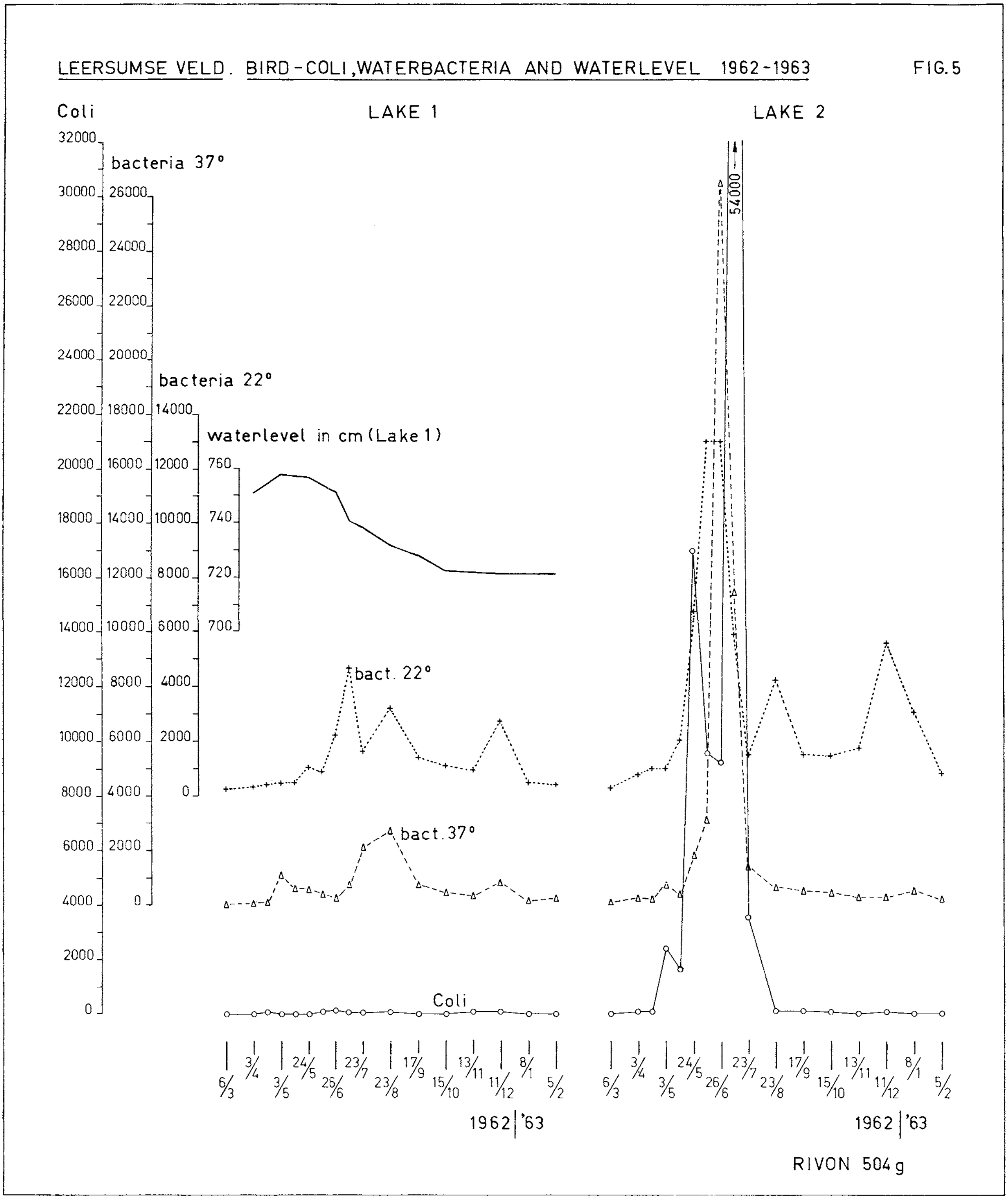

HILVERSUMSE WASMEER (SOUTH) CHEMICAL ANALYSES 1959-1963
FIG. 3
$K_{18} \times 10^6$
pH
Cl' mg/l
HCO_3' mg/l
Ca''
Total hardness
HCO_3 hardness
ice
166
TH
BH
HCO_3
Temperature °C
O_2 %
O_2 mg/l
% O_2
T
PO_4''' mg/l
NH_4^+ mg/l
PO_4'''
NH_4^+
3,3
$KMnO_4$ unfiltered mg/l
$KMnO_4$ filtered mg/l
organic NH_4
$KMnO_4$ unfil.
$KMnO_4$ fil.
org. NH_4
156
173
BOD_5
BOD_2
1959
1961
1962
1963
RIVON 502 g

HILVERSUMSE WASMEER DEVELOPMENT OF SOME PLANKTON ORGANISMS 1955-1963

FIG. 4



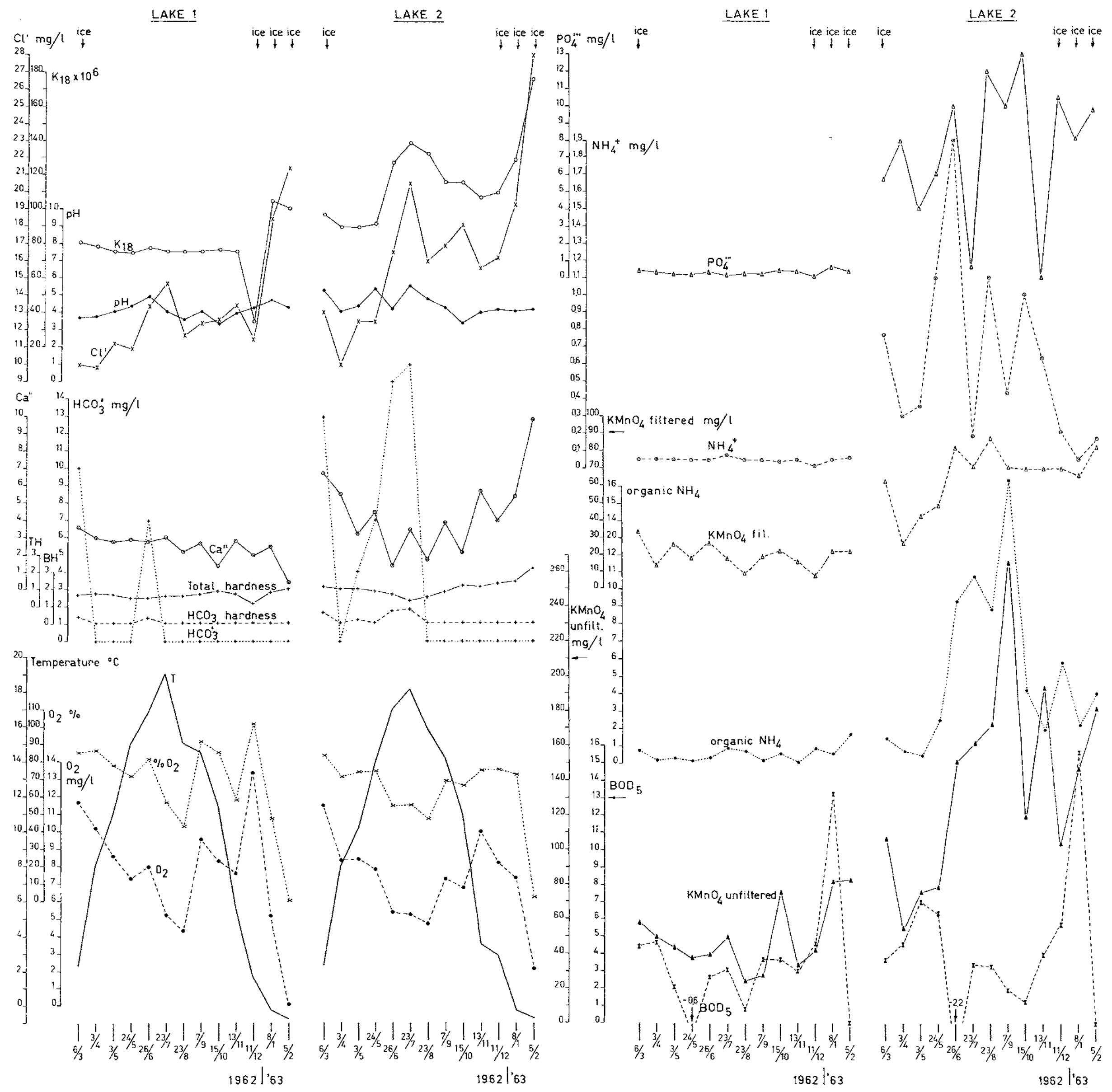
RIVON 502g



LEERSUMSE VELD. BIRD-COLI, WATERBACTERIA AND WATERLEVEL 1962-1963
FIG. 5
Coli
LAKE 1
LAKE 2
bacteria 37°
bacteria 22°
waterlevel in cm (Lake 1)
54000
bact. 22°
bact. 37°
Coli
1962 | '63
1962 | '63
RIVON 504 g

LEERSUMSE VELD CHEMICAL ANALYSES 1962-1963

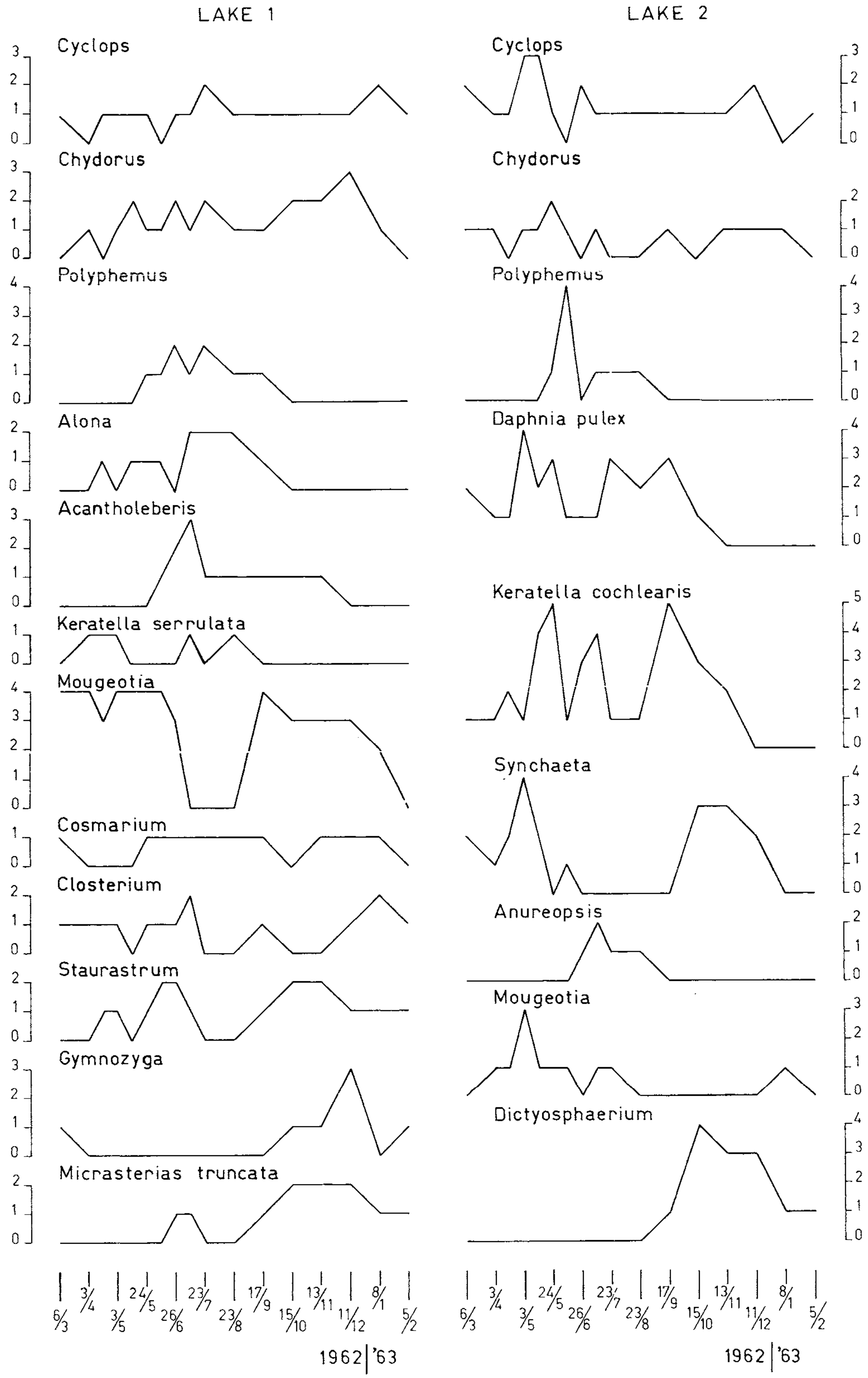
FIG.6



LEERSUMSE VELD

DEVELOPMENT OF SOME PLANKTON ORGANISMS 1962-1963

FIG. 7



RIVON 504 g

On the other hand the highest saturation values are found in the southern part including even super-saturations.

In conclusion it seems that after a normal picture of oxygen content in 1961, more and more fluctuations appear in the lake which in 1963 become similar to the situation in a normal guanotrophic lake from acid oligotrophic origin.

Chloride

The Cl content in the lake is very low and fluctuates between 10 and 15 mg/l. The drought in 1959 was the cause of a gradual increase to the extreme values of 28 and 29 mg/l. In 1961, 1962 and 1963 the Cl content did not change very much except during ice-cover. A very slight increase in Cl content during the summer may be detectable. The stable situation in Cl content in the three last year shows that comparable circumstances have been present in relation to evaporation, rain and waterlevel. No increase in Cl content is recorded as an influence of the birds. This has been also found in the stable and long existing guanotrophic lake 2 from the Leersumse Veld. Practically no Cl is added to the water by the excrements of the birds.

Electric conductivity

In the year 1959 abnormal high values were found, caused by the low waterlevel. In the next years the electric conductivity is lowest in spring and gradually increases during summer and autumn. The waterlevel is highest in spring by greater rainfall, which causes dilution. Before and after ice-cover abrupt fluctuations are present as a result of melting snow and ice. Compared to the guanotrophic lake 2 in the Leersumse Veld, the curve of electric conductivity is similar, but the value is lower. Compared to the oligotrophic lake 1 in the Leersumse Veld the value of the electric conductivity is about the same (80 μ S). In lake 1 the value is very constant. In conclusion it may be said that no increase in electric conductivity is found yet, but a significant difference in spring and summer is present. Only the latter may correspond with the increase in guanotrophic character.

pH

The pH is about 4. This low value is mainly due to dissolved humic substances. The water has a brown colour.

Submerged Sphagneta were originally abundant in the lake, but under the influence of gulls they disappeared and only a species of moss (*Drepanocladus*) remained. These Sphagneta therefore could not have been the cause of the low pH. As the pH did not change much in the events, it is clear that the low value is determined by humic acids. Fluctuations in pH are found during or after ice cover. Influence of rain(melt)water may give a temporary rise in pH. In the late summer and autumn of 1962 a lowering in pH was found with values of 3.2, synchronized with low oxygen values. CO_2 produced in decomposition and respiration may be the cause. In 1963 the pH rose during summer to the value of 4.5. This value is similar to what is found in the guanotrophic lake 2 in the Leersumse Veld. In conclusion it may be said that the pH in 1963 became similar to the stable guanotrophic character, as in present in lake 2 from the Leersumse Veld.

Calcium and bicarbonate

The calcium content is very low and does not exceed 4 mg/l. As it is a soft water the total hardness is very low. HCO_3 is seldom present, but higher amounts appeared sometimes in 1963. The amount of Ca has not increased by guanotrophy. The amount of CO_2 might have increased, but this has not been determined. There is no distinct influence of the guanotrophy apparent in the calcium-bicarbonate-CO_2 equilibrium.

Organic matter

Organic matter was determined in filtered and unfiltered water as $KMnO_4$-oxydation. The value for the dissolved organic matter is abnormally high in 1959. In 1961 it is fairly constant after which year more fluctuations appear with finally in 1963 very high values, comparable to what is found in the Leersumse Veld lake 2. In the southern part a very high value was found on 5 February 1963, probably due to bottom-effect under the ice. Compare also 1955.

The same may be said of the total amount of organic matter present. The fluctuations are greater, due to action of the wind on occasions. In the southern part the amount of total organic matter is greater. The reason for this is not clear.

BOD

The value of BOD depends on the presence of easily oxydizable organic matter, and the respiration of micro-organisms. In 1959 values of about 5 were found in spring and autumn. This is not abnormally high compared to the values found in lake 1 from the Leersumse Veld. In 1961 only a 2 days BOD was determined, except for the August and July values. In the graph this is therefore marked with a dotted line. We may conclude from the figures that a general tendency is present to higher BOD values, as could be expected. It is worth mentioning that in 1963 no negative values of BOD were found, i.e. no oxygen production is found in the bottles 5 days in the dark. The fact that in BOD tests oxygen increase is found instead of oxygen comsumption is difficult to explain. In other investigations I found that this often occurs in clean oligotrophic water, where the amount of reductive substances is low. Oxygen production in dark may be possible by the activity of certain unicellular flagellates, such as *Chlamydomonas*, which were indeed present.

Organic ammonia

Organic ammonia has been only determined in 1962 and 1963. In 1962 the value was similar to that from the lake 1 in the Leersumse Veld. On 11 December 1962 a very high value was found under ice. In 1963 the values increase.

Ammonia

Ammonia is always present in acid oligotrophic waters. The amount is no more than 0.5 mg/l. There is a rough parallel with the curve of dissolved oxygen. The fluctuations are greater and it may be concluded, that higher maxima occur more frequently in the course of the years.

NO_3 and NO_2

NO_3 and NO_2 were always absent. Only on 30 September 1963 an amount of 0.5 mg/l NO_3 was found. It is known, that in acid oligotrophic waters nitrification is very slow. The decomposition of organic matter ends with the forming of detectable amounts of ammonia or perhaps also of gaseous N.

PO_4

In the southern part an amount of 0.55 mg/l PO_4 was found in 1959. In the northern part it was lower. In acid undisturbed oligotrophic 'vennen' PO_4 is very low or absent. In the years 1961, 1962 and 1963 we observe that total absence of PO_4 was only found in 1961. In 1962 a fairly constant amount was found. In 1963 a tendency is noticeable towards lower concentrations compared to the previous year, except during the summermonths. In this year other organisms developed, and I suppose that these use PO_4; a conclusion derived at from the increasing amount of excrements. If we consider the yearly averages, we find in 1961 0.20 mg/l, 1962 0.34 mg/l and 1963 0.27 mg/l PO_4. The total volume of the lake is about 10,000m^3. If we put the amount of PO_4 as 0.3 mg/l, the gulls brought about 300 kg PO_4 with their excrements into the water since the beginning of the settlement in 1958. The total number of gulls breeding every year is about 1000, if we do not count the young and errant birds. A rough estimation is that one gull produces 0.3 kg PO_4 with the excrements in the water in 6 years or 50 g per annum. In this respect it is interesting to compare with other data. MACKENTHUN (1962) mentions that domestic duck contribute 180 g soluble P pro year to the waste water and wild duck contribute 1170 g soluble P per acre.

TABLE I

Planktonorganisms Hilversumse Wasmeer in 1955, 1956, 1958 and 1959.

	1955		1956	1958				north —		1959	— south					
	Apr.	Jl.	June	July	Apr.	May	Jn.	Jl.	S.	N.	Apr.	May	Jn.	Jl.	S.	N.
Crustaceae:																
Cyclops sp.	1	1	1		3	3		1	1	1	1	2	1	1	1	1
Chydorus sphaericus		1	1		1	3						2	2			1
Diaphanosoma brach.			1	1									1	1		
Alona guttata									1				1	1		
Rhynchotalona falcata		1							1						1	
Acantholeberis curv.		1	1										1		1	
Alonella sp.				1											1	
Ceriodaphnia sp.				1											1	
Polyphemus pediculus	1		1												1	
Scapholeberis mucron.	1		1													
Bosmina obtusirostris	5	1											1		1	1
Eurycercus glacialis	1															
Rotifers:																
Keratella serrulata	1	1	5		4				1	1	3	1	1		1	1
Synchaeta pectinata	1	1		1	1			1		1				4	1	4
Trichocerca longiseta					1											
Dinocharis pocillum	1															
Lecane sp.						1										
Lecane lunaris	1							1					1	1		1
Monommata longiseta										1						1
Protozoa:																
Arcella sp.								1					1		1	

Planktonorganisms Hilversumse Wasmeer in 1955, 1956, 1958 *and* 1959.

	1955		1956	1958				north —		1959	— south					
	Apr.	Jl.	June	July	Apr.	May	Jn.	Jl.	S.	N.	Apr.	May	Jn.	Jl.	S.	N.
Flagellatae:	1															
Rhipidodendron huxleyi												1	1	1	1	
Dinobryon pediforme		5		5	5	5		1	1	1	5	5	4	4	3	1
Chlamydomonas sp.										3						2
Euglena polymorpha											1					
Peridinium sp.															1	
Chlorophyceae:																
Dictyosphaerium sp.										2						
Pediastrum sp.					1						1					
Mougeotia sp.				1										3	1	
Botryococcus brauni						1									1	
Desmidiaceae:																
Docidium baculum			2		1	1				1	1	1	1	1	2	
Staurastrum sp.	1				4	2		1		1	3	2	2	1	1	1
Xanthidium sp.					2						1	1	1		1	
Closterium gracile			1	2				1	1	2				1	3	2
Gymnozyga brebissoni			5		1			1			1					1
Staurastrum sp.				1									1	1		
Diatomeae:																
Diatoma sp.					1						1					

TABLE II

Planktonorganisms Hilversumse Wasmeer in 1961 (north).

	March		April		May			June		July		August.		Sept.		Oct		Nov.	Dec.
	6	20	4	17	2	15	29	8	28	10	24	7	22	4	18	4	16	13	11
Crustacea:																			
Cyclops sp.	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Bosmina obtusirostris	3	5	3	2	2	1	1	1	1	1	1	1	1						1
Eurycercus glacialis		1		1			1	1	1		1	1					1		
Chydorus sp.	1		1	1	1	1	1	1	1	1	1	1	1				1	1	2
Polyphemus pediculus		1		1	3	4	3	1	1	1		1	1						
Diaphanosoma brachyurum									1			1		1					
Scapholeberis mucronata						1	1	1				1							
Alona sp.											1	1	1	1					
Alonella sp.						1	1				1								
Ceriodaphnia sp.						1					1	1	1	1					
Acantholeberis curvirostris				1	1						1	1						1	2
Rhynchotalona falcata											1	1	1						1
Canthocamptus sp.					1													1	2
Pleuroxus sp.														1					
Rotatoria:																			
Keratella serrulata	3	3	1	2	2	1	1	1	1	1	1	1	1	1	1	1	2	4	1
Asplancha sp.	1	1																	
Synchaeta sp.	1	1								2		1	1	1	3	3	3	2	1
Rotaria sp.	1		1	1	1	1		1	1	1	1			1	1	1	1	1	1
Lecane sp.			1					1	1	1		1	1	1	1	1	1		1
Lecane lunaris	1							1	1	1				1					
Lecane ligona																			
Euchlanis sp.			1	1	1	1							1						

Planktonorganisms Hilversumse Wasmeer in 1961 (north).

	March		April		May			June		July		August		Sept.		Oct.		Nov.	Dec.
	6	20	4	17	2	15	29	8	28	10	24	7	22	4	18	4	16	13	11
Cephalodella sp.			1										1		1	1			
Trichocerca sp.															1		1		
Habrotrocha sp.			1																
Protozoa:																			
Arcella sp.	1	1	1	1	1			1	1	1	1	2	1	1	1	1	1	1	1
Difflugia sp.											1				1				
Actinosphaerium									1										
Centropyxis sp.											1								
Flagellatae:																			
Rhipidodendron huxleyi		1	1	1	1			1		1	1	1	1	1		1	1	1	1
Synura sp.																1	1	4	1
Chlamydomonas sp.		1			1							1	1	2			2	1	3
Dinobryon pediforme		1						1	2	5	5	3	3	3	5	2	2	1	1
undet.						1													
Lepocinclis sp.														1	1				
Peridinium sp.															1				
Euglena sp.															1		1		
Mallomonas sp.																			
Chlorophyceae:																			
Mougeotia sp.	1	1	1	3	3	1		1	1	1			1	1		1	1	1	1
Binuclearia?	1	1	1	1	3	1		1	1	1									
Tribonema sp.			1		3														

Planktonorganisms Hilversumse Wasmeer in 1961 (north).

	March		April			May		June		July		August		Sept.		Oct.		Nov.	Dec.
	6	20	4	17	2	15	29	8	28	10	24	7	22	4	18	4	16	13	11
Spirogyra sp.				1															
Ulothrix sp.				1			1							1			1		
Botryococcus brauni											1	1	1						1
Dictyosphaerium sp.																			1
Desmidiaceae:																			
Closterium sp.		1								1		1	1	1	2	1	3	1	1
Euastrum sp.										1									
Staurastrum sp.								1				1		1		1	1	1	
Pleurentaenium sp.														1					
Cosmarium sp.																	1		
Sphaerozosma sp.																	1		
Diatomeae:																			
Navicula sp.		1							1		1	1	1						
Pinnularia virides				1															
pennatae		1																	
Cyanophyceae:																			
Merismopedia sp.								1	1	3	2			1		3	1	1	

TABLE III

Planktonorganisms Hilversumse Wasmeer in 1961 (south).

	March 6	March 20	April 4	April 17	May 2	May 15	May 29	June 8	June 28	July 10	July 24	August 7	August 22	Sept. 4	Sept. 18	Oct. 4	Oct. 16	Nov. 13	Dec. 11
Crustacea:																			
Cyclops sp.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Bosmina obtusir.	1	5	5	2	2	1	2	1	1	1	1	1	1				1		1
Eurycercus glacialis				1															
Chydorus sp.	2		1	1	2	1	1		1				1					1	1
Polyphemus pediculus		1	1	1	3	3	2	1	3	1	1	1	1						
Diaphanosoma brachyurum								1	1				1	1				1	
Scapholeberis mucronata						1	1	1					1						
Alona sp.					1						1			1					
Alonella sp.						1	1								1	1	1	1	
Acantholeberis curvirostris																			1
Rhynchotalona falcata														1					
Canthocamptus sp.	1							1						1				1	1
Rotatoria:																			
Keratella serr.	3	2	1	2	2	1	1	1	1	1	1	1	1	1	1	1	3	3	3
Asplanchna sp.	1	2		1															
Synchaeta sp.		1							1	2	1	1	4	3	2	3	2	1	
Rotaria sp.	1								1	1	1			1	1	1	1	1	
Lecane sp.	1									1	1	1			1	1		1	1
Lecane lunaris		1	1		1					1									
Lecane ligona		1	1																
Euchlanis sp.			1		1		1						1						
Cephalodella sp.					1														

Planktonorganisms Hilversumse Wasmeer in 1961 (south).

	March		April		May			June		July		August		Sept		Oct.		Nov.	Dec.
	6	20	4	17	2	15	29	8	28	10	24	7	22	4	18	4	16	13	11
Trichocerca longiseta					1										1				
Habrotrocha sp.																		1	
Protozoa:																			
Arcella sp.	1	1		1	1		1		1	1	1	1	2	1	1	2	1	1	1
Difflugia sp.	1																		
Euglypha ciliata																		1	
Flagellatae:																			
Rhipidodendron h.	1	1		1	1			1						1	1	1	1	1	1
Synura sp.										1						2	1	3	1
Chlamydomonas sp.		1										1	1	1			1	1	2
Dinobryon pediforme								2	2	5	5	3	3	5	4	4	3	1	1
undet.													1						
Lepocinclis sp.														2					
Peridinium sp.															1				
Euglena sp.															1				
Chlorophyceae:																			
Mougeotia sp.	3	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1	1
Binuclearia ?	2	1	1	1	1	1		1	1	1		1					1		
Tribonema sp.			1																
Spirogyra sp.		1			1	1		1											
Ulothrix sp.								1											
Botryococcus brauni													1						1

Planktonorganisms Hilversumse Wasmeer in 1961 (south).

	March		April		May			June		July		August		Sept.		Oct.		Nov.	Dec.
	6	20	4	17	2	15	29	8	28	10	24	7	22	4	18	4	16	13	11
Dictyosphaerium sp.																			1
Pediastrum boryanum			1														1		
Pediastrum duplex													1						
Desmidiaceae:																			
Closterium sp.	1									1	1	1	1	2	2	2	2	3	3
Euastrum sp.										1									
Staurastrum sp.				1	1			1									1	1	1
St. dejectum													1						
Cosmarium sp.																			1
Diatomeae:																			
Navicula		1							1										1
Pinnularia viridis																			
Cyanophyceae:																			
Merismopedia sp.	1							1	1	3	2	2		1	1			1	

TABLE IV

Planktonorganisms Hilversumse Wasmeer 1962 (north).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	April 3	April 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11
Crustacea:																	
Cyclops sp.	1	1	1	1	2	1		1	1	1	1	1	1	1	1	1	2
Bosmina obt.	1						1	1									
Eurycercus glac.									1		1	1	1		1	1	1
Chydorus sp.	1	1	1	2	2	1	2	2	2	1	1		1	1	2	2	2
Polyphemus ped.							1	2	4		3		1	3	1		
Diaphanosoma br.													1	2			
Scapholeberis m.										1			1	1			
Alona sp.		1								1	1	1	1	1	1	1	1
Alonella sp.									1				1	1			
Acantholeberis c.				1							1						1
Canthocamptus sp.		1	1				1								1		1
Graptoleberis t.									1			1			1		
Ceriodaphnia sp.				1													
Daphnia sp.								1									
Rotatoria:																	
Keratella serrulata	2	2	3	3	5	3	2	3	2	1	1	1	1	1	1	1	1
Synchaeta sp.	1	1	3					1		3		2			1		
Rotaria sp.	1						1			1	1		1		1		
Lecane sp.						1				1					1	1	
Lecane lunaris							1			1							1
Lecane stichea										1							
Euchlanis sp.								1	1								

Planktonorganisms Hilversumse Wasmeer 1962 (north).

	ice Jan. 8	ice Feb 5	ice Mar. 6	April 3	16	3	May 11	24	June 4	26	July 9	23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11
Trichocerca longiseta						1		1									
Trichotria sp.										1							
Protozoa:																	
Arcella sp.		1	1		1			1		1	1		1	1	2	1	2
Centropyxis							1										
Flagellatae:																	
Rhipidodendron h.		1		1	1					1	1			1		1	1
Synura sp.	1	3	1	1	1												1
Chlamydomonas sp.	1	1	1		1					1				1		3	3
Dinobryon pediforme		1	1	3	5	5	3	3	1	1	4					1	
undet.														2	2	2	
Peridinium sp.										1							
Chlorophyceae:																	
Mougeotia sp.		1	1	3	3	1	1	1		1	1	1		1	1	1	1
Binuclearia ?						1		1									
Tribonema sp.				1				1									
Ulothrix sp.				1	1	1	1			1		1					
Desmidiaceae:																	
Closterium sp.		1		1													
Cosmarium sp.												1					
Docidium sp.										1							

Planktonorganisms Hilversumse Wasmeer 1962 (north).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	April 3	April 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11
Gymnozyga brebissoni																1	
Diatomeae:																	
pennatae	1																
Actinocyclus normanni									1				1				
Cyanophyceae:																	
Merismopedia sp.								1		1		1		1			
Vermos:																	
Vejdovskyella comata																	1

TABLE V

Planktonorganisms Hilversumse Wasmeer 1962 (south).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	April 3	April 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Okt. 15	Nov. 13	Dec. 11
Crustacea:																	
Cyclops sp.		1	1	1	1	1		1		1	1	1	2	1	1	2	2
Bosmina obt.	1	1			1		1	1									
Eurycercus glac.											1	1	1	1	1		1
Chydorus sp.	1	2	1	2	2	1	1	1		1	1	1	1	1	1	1	1
Polyphemus ped.							1	2	4		2	2	2	3	1		
Diaphanosoma br.												1	1	1			
Scapholeberis m.								1	1		1	1					
Alona sp.					1		1	1	1	1	1	1	1	3	2	1	1
Acantholeberis c.		1		1						1		1	1	1		1	
Canthocamptus sp.													1				
Monospilus dispar										1		1			2		1
Ceriodaphnia sp.													1	1			
Daphnia sp.								1									
Rhynchotalona falcata														1	1		
Rotatoria:																	
Keratella serrulata	2	4	4	4	4	3	3	5	1	1	1	1	1	1	1	1	1
Synchaeta sp.	1	3	1					3						3	3	2	
Rotaria sp.											1	1	1				
Lecane sp.				1						1		1		1	1		
Lecane lunaris			1						1		1						
Euchlanis sp.								1									

Planktonorganisms Hilversumse Wasmeer 1962 (south).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	April 3	April 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Okt. 15	Nov. 13	Dec. 11
Trichocerca longiseta						1	1	1									
Protozoa:																	
Arcella sp.	1									1	1	1	1	1	1	1	2
Flagellatae:																	
Rhipidodendron h.				1	1					1	1	1			1	1	2
Synura sp.	4	3	1	1													1
Chlamydomonas sp.	1	1		1			1								2	2	3
Dinobryon pediforme		1	2	3	5	5	2	3	1	1	4						
undet.												2		2	2	3	
Peridinium sp.				1													
Chlorophyceae:																	
Mougeotia sp.		1		3	3	1	1	1			1				1		
Binuclearia ?								1									
Tribonema sp.				1		1		1									
Ulothrix sp.				1			2										
Botryococcus brauni												1				1	
Desmidiaceae:																	
Closterium sp.		1					1								1		
Staurastrum dej.				1													
Euastrum sp.				1											1		
Docidium sp.				1													

Planktonorganisms Hilversumse Wasmeer 1962 (south).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	April 3	 16	 3	May 11	 24	June 4	 26	July 9	 23	Aug. 23	Sept. 17	Okt. 15	Nov. 13	Dec. 11
Sphaerozosma sp.												1					
Pleurentaenium sp.															1		1
Gymnozyga sr.b.																	
Diatomeae:																	
Actinocyclus normanni							2							1			
Cyanophyceae:																	
Merismopedia sp.	1				1			1		1	1	1	1	1	1		
Oscillatoria sp.					1												
Vermes:																	
Vejdovskyella comata																	1

Table VI

Planktonorganisms Hilversumse Wasmeer 1963 (north).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	Apr. 3	Apr. 17	May 2	May 15	May 29	June 19	July 3	July 31	Sept. 4	Sept. 30	Nov. 8
Crustacea:														
Cyclops sp.				1	1	3	3	3	4	1	2	3	2	2
Bosmina obt.														
Eurycercus glac.					1	1	1	2						
Chydorus sp.				1	2	1	1	3	3	3	3	3	4	4
Polyphemus ped.					1	2	3		1	2	1	3	2	2
Diaphanosoma br.							1		1	1				
Scapholeberis m.							1		1					
Alona sp.				1	1		2	3	1	1	2	1	2	1
Alonella sp.				1		1	1		1	2	1	1	1	1
Acantholeberis c.										1				
Rotatoria:														
Keratella serrulata				1	2	3	4	4	3	1		1	1	2
Synchaeta sp.				1	3		1	1	1	1	1	3	2	
Rotaria sp.				1	1	1	1		1	1	1	1		1
Lecane sp.						1			1		1	1		1
Lecane lunaris						1	1	1			1			
Euchlanis sp.				1	1	1	1	1	1					
Lecane ligona						1								
Brachionus sericus												1		
Keratella cochlearis											1			
Protozoa:														
Arcella sp.					3	2	3	1	1	1	2	1		1

Planktonorganisms Hilversumse Wasmeer 1963 (north).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	Apr. 3	Apr. 17	May 2	May 15	May 29	June 19	July 3	July 31	Sept. 4	Sept. 30	Nov. 8
Flagellatae:														
Rhipidodendron h.					1									3
Chlamydomonas sp.	2			3	1	2	3	2	2	2	2	3	3	4
undet.				2	3	2	1			4	5			
Euglena sp.												2		
Gymnodinium sp.								1						
Chlorophyceae:														
Mougeotia sp.	1	1	1	1		1	1	2	2					1
Binuclearia?									1	1				
Tribonema sp.				1	1			1	1					
Ulothrix sp.				1		1		1	1				1	1
Dictyosphaerium sp.					1									
Botryococcus brauni														1
Desmidiaceae:														
Euastrum sp.														1
Docidium sp.					1				1					
Diatomeae:														
pennatae												1	1	1
Cyanophyceae:														
Merismopedia sp.									1					

TABLE VII

Planktonorganisms Hilversumse Wasmeer 1963 (south).

	ice Jan. 8	ice Feb. 5	ice Mar. 6	Apr. 3	Apr. 17	May 2	May 15	May 29	June 19	July 3	July 31	Sept. 4	Sept. 30	Nov. 8
Crustacea:														
Cyclops sp.	1		1	1	1	4	2	2	1	2	2	2	2	1
Bosmina obt.														
Eurycercus glac.								1				1		
Chydorus sp.	1		1	1	1	1	1	1	2	3	2	2	4	3
Polyphemus ped.					1	1	1	1		2	1	3	4	
Diaphanosoma br.						1	1			2				
Scapholeberis m.								1		1				
Alona sp.				1	1	1	1	1	1	2	1	2	3	1
Alonella sp.				1	1					1	1	1	1	1
Acantholeberis c.										2				1
Ceriodaphnia sp.												1		
Canthocamptus sp.									1				1	
Eurytemora ?										1	1			
Iliocryptus sp.														1
Rotatoria:														
Keratella serrulata	1	1	1	2	1	4	4	5	3		1	1	2	3
Synchaeta sp.				2	2		1	3				2	1	1
Rotaria sp.	1		1	1	1	1	1	1	1			2		
Lecane sp.	1			1		1						1	1	
Lecane ligona									1			2		
Euchlanis sp.				1	1									
Brachionus sericus												1		
Notholca foliacea														1

Planktonorganisms Hilversumse Wasmeer 1963 (south).

	ice Jan. 8	ice Feb 5	ice Mar. 6	Apr. 3	Apr. 17	May 2	May 15	May 29	June 19	July 3	July 31	Sept. 4	Sept. 30	Nov. 8
Protozoa:														
Arcella sp.	2	1	1	1	2	1	1		2		1	1		1
Flagellatae:														
Rhipidodendron h.	1		1	1	1				1			1		2
Chlamydomonas sp.	2	1	2	3	1		4	1		2	1	3	2	4
Dinobryon pediforme					1	1		2						
undet.		1	2	2	2	1			4	4	2	1		
Euglena sp.												2		
Chlorophyceae:														
Mougeotia sp.					1	1						1		1
Tribonema sp.						1		1						
Ulothrix sp.								1	1					
Dictyosphaerium sp.					1									
Botryococcus brauni										1				
Pediastrum boryanum														1
Desmidiaceae:														
Staurastrum dej.							1							
Pleurentaenium sp.	1													
Gymnozyga	1													
Euastrum sp.			1						1			2		1
Docidium sp.									1					
Diatomeae:														
pennatae	1		1	1							1	2	1	
Cyanophyceae:														
Merismopedia sp.	1		1	1					1				1	1
Vermes:														
Vejdovskyella comata												1		

Plankton (Tables I—VII, graph 4)

The plankton community found in the Hilversumse Wasmeer is a typical acid oligotrophic community. The samples were taken in the north and the south by pouring 4 buckets of water through a planktonnet. The organisms present are crustaceans with *Bosmina obtusirostris*, *Polyphemus pediculus*, *Acantholeberis curvirostris*, *Eurycercus glacialis*, *Cyclops* sp.; rotifers *Keratella serrulata*, *Synchaeta pectinata*, *Lecane ligona*; protozoa *Arcella* sp.; flagellates *Dinobryon pediforme*, *Rhipidodendron huxleyi*; Chlorophyceae *Mougeotia* threads; Desmids *Staurastrum* sp., *Docidium* sp. and several others; diatoms and blue algae were very scarce.

The developments in the plankton under influence of the guanotrophy is given in graph 4 for the most important species. Before 1959 *Dinobryon pediforme* was dominant, and appeared sometimes in very large numbers. Desmids also were present in fairly large numbers. *Bosmina obtusirostris* could always be found and also *Keratella serrulata* and *Synchaeta pectinata.*

Most of these organisms are typical for acid oligotrophic environments. Comparing the plankton tables in the different years, we observe that *Bosmina obtusirostris* disappears after 1962; *Dinobryon* disappears practically also after the autumn of 1962; *Polyphemus pediculis* as a spring or autumn organism did not change in numbers or if the few observations before 1959 allow conclusions, is increasing; desmids disappear after summer 1962; *Keratella serrulata* is sometimes present in larger numbers; *Synchaeta* did not change in numbers; *Chlamydomonas* is increasing in numbers. This organism showed greater numbers only in spring and autumn, which is probably related to the recirculation of organic matter in the water at that time. In 1963, however, this flagellate could be found in significant numbers nearly the whole year round. It is a good indicator of an increase in the amount of organic matter or derivates in the changing environment.

In conclusion we observe that the plankton community was changed by the disappearence of most of the desmids, *Dinobryon pediforme*, *Bosmina obtusirostris* and the appearence of *Chlamydomonas.* The organisms first mentioned seem to be susceptible to the excrements of the birds. As the pH did not change much, this is probably just not an essential factor, but rather the increasing amount of ammonia and phosphate, the decreasing oxygen content, and other factors in their totality or their increasing fluctuations. It is to be expected that first the nannoplankters react to the changes in environment, as they multiply rapidly and the contact with the environment is intensive. *Chlamydomonas* has been given as an example, as it was easily recognizable, but there was also an increase of undeterminable unicellular flagellates and of *Euglena*, *Lepocinclis*, *Mallomonas*. Species like *Pediastrum boryanum* and *Pediastrum duplex* as examples of eutrophic Chlorophyceae were found sporadically. In this respect it must be mentioned that micro-organisms may be introduced from elsewhere by the gulls. A good example is the diatom *Actinocyclus normanni*, which was found in the plankton during the breeding season of 1962, and in the autumn. This was also the case in lake 2 of the Leersumse Veld. *Actinocyclus* is an eutrophic diatom, which occurs in great numbers in the Brabantse Biesbosch, located at a distance of 80 kilometers in the tidal zone of the Rhine and Meuse. The gulls breeding in the Hilversumse Wasmeer and the Leersumse Veld frequent the Biesbosch in the breeding season, and migratory birds do so in the autumn. The diatom could have been transported to the lakes by the birds. Of *Pediastrum* spp., *Eurytemora*, *Keratella cochlearis* the same may be said.

II. The 'Leersumse Veld'.

The Leersumse Veld is a State Nature Reserve located near the village of Leersum. It is composed of forest and heather, which enclose these 'vennen'. Previously the lakes were dystroph-oligotroph, and comparable to the Hilversumse Wasmeer. Since 1919 a colony of black headed gulls is present in one of the lakes and changed the character of the vegetation and the water. In 1961 a 2000 nests or couples of gulls were present in lake 2 (HIGLER 1961). Lake 1, which is separated by a small strip of land from lake 2, is undisturbed and the character of the ven is acid-oligotrophic. For comparison the two lakes are excellent, as one is an example of a stable guanotrophic water and the other represents the original undisturbed situation.

Several studies have been carried out in this interesting nature reserve The vegetation has been mapped by REIJNDERS (1960), in order to study the guanotrophic influences on the vegetation. In a diary of TJITTES (1957) the developments of *Larus ridibundus* and other birds are recorded since 1915. MOLLER PILLOT (1961) studied the Hemiptera and other waterinsects of the lakes, and SCHOUTEN (1964) made a survey of the filamentous algae. In 1958 hydrobiological research was done on plankton and waterchemistry (LEENTVAAR 1959). This research was done as a part of a (comparative) survey of 'vennen' in the Netherlands.

For comparison with the beginning guantrophy in the Hilversumse Wasmeer, lake 2 in the Leersumse Veld, as a stable guanotrophic environment, has been chosen for monthly sampling in 1962/63. At the same time lake 1 has been sampled as an example of an undisturbed acid oligotrophic ven. The data below will be considered in the same way as has been done in the case of the

Hilversumse Wasmeer.

Coli-numbers

During the breeding season about 4,000 gulls are present in lake 2 in the Leersumse Veld. The maximum number of Coli recorded is 54,000, and the time during which high numbers are present is about two months. Both levels are higher than in the Hilversumse Wasmeer, as was expected. Just as in the Hilversumse Wasmeer a slight decrease may be observed in Colinumbers when the birds are breeding on the nests (11 May).

In lake 1 no Coli were found during the whole year, except for a few during the nesting time of the birds from lake 2. It shows that birds from the colony also frequented lake 1.

In relation to what has been said about the Coli-number in the Hilversumse Wasmeer (p. 6), it must be mentioned that lake 2 in the Leersumse Veld may be considered as a stable guanotrophic environment, as it exists already about 45 years. In this water also high numbers of Coli can be recorded after the hatching of the young gulls. This makes the observations of 1963 and 1965 in the Hilversumse Wasmeer, and the related conclusions on the unexpectedly low numbers of Coli more doubtful. I am inclined to consider the picture of Coli-numbers as found in 1961 and 1962 in the Hilversumse Wasmeer, and lake 2 from the Leersumse Veld as the normal picture.

Counts of bacteria grown at 37°C give high numbers during the breeding season in lake 2, which shows an obvious relation to the bird concentration. In lake 1 the numbers are low. The higher counts in August may result from a greater survival during the higher water temperatures in summer.

Counts of bacteria grown at 22°C show great numbers during the breading season, shortly afterwards, and in December. About the same picture is found with lower numbers in lake 1. The low numbers here are of the same order as found in the Hilversumse Wasmeer. The spring maximum is absent in both lakes. The development at 22°C seems to be more dependant on the addition of nutrients from excrements. In conclusion it seems that in the stable guanotrophic-dystrophic environment the 22°C bacteria develop well during bird concentrations, i.e. when the excrements add nutrients to the water, which are used for or stimulate the growth of 22°C bacteria. At other times the nutrients needed are for the greater part absent or scarce.

Waterchemistry

In 1932 a chemical analysis of the water in lake 2 was made by REDEKE. In 1958 the same was done by DRESSCHER from the Municipal

Sanitary Service in Amsterdam. The results are given below.

		9 April 1932	22 November 1958
Cl	mg/l	9.2	15
CaO	„	—	0.010
Ca	„	4.0	—
NH_4	„	0.08	0.12
organic ammonia		1.50	3.50
NO_3	„	traces	3.98
PO_4	„	traces	0.882
$KMnO_4$	„	138.1	73

As far as these data are comparable, it shows, that the mineral content is increasing according to expectation. The colour of the water in lake 2 is dark brown as a result of dissolved humic acids. The original character is dystrophic-oligotrophic. Lake 1 has clear water, but there is less open water as a result of a dense growth of submerged plants as *Sphagnum* together with many filamentous algae.

Temperature

The temperature shows the same picture as in the Hilversumse Wasmeer in 1962. On 6 March 1962 ice covered the surface. This was also the case on 11 December (with rain) and in January and February 1963.

Oxygen

The saturation values in the two lakes did not differ much. In lake 2 saturation values of about 50% were observed during a longer period (July, August). Under ice cover the oxygen saturation dropped to nearly O. The oxygen content in the guanotrophic lake is fairly good, though one is apt to expect oxygen contents as found under saprobic circumstances. The oxygen consumption is relativily low (see BOD), plankton is scarce, the numbers of bacteria are lower than in saprobic waters. The amount of dissolved organic matter is relatively high, but the substance present seems not easily oxydizable as is shown in the relativily low BOD values. This may indicate that the excrements are composed of substances, which are difficult to reduce. A further chemical analysis of the excrements should be enlightening.

Chloride

In springtime the Cl content is somewhat lower than during the summer, due to the higher waterlevel (rain) in spring. In lake 1 it was lower than in lake 2, but the difference was not very great. Under ice the values were considerably higher.

pH

In lake 1 the pH was about 4. The increase in May and June may be related to the assimilatory activity of masses of filamentous algae, which were present at the time (see plankton table).

In lake 2 the pH reaches higher values and the fluctuations are greater. CO_2 production in decomposition may lower the pH in November. It is, however, difficult to find correlations with other factors in the environment.

Electric conductivity

In lake 1 the electric conductivity is very constant. The great fluctuation in December is a result of the rain (on ice), while in January and February a higher value was found under ice. In lake 2 the electric conductivity is much higher. More minerals are in the water. After the breeding season of the gulls the electric conductivity increases rapidly in the same order as the amount of organic matter, ammonia and organic ammonia. It decreases again in autumn. The lower values in spring are partly due to dilution as the result of a higher waterlevel. The swift rise in June may indicate that minerals are added to the water as an important part of the excrements. After 23 July the mineral content decreases. This is not due to dilution by rain, the amount of rainfall did not differ from the previous months. The minerals must have been precipitated or consumed by organisms. In the plankton table it can be seen that after September green algae developed in greater numbers (*Dictyosphaerium*) and also undeterminable unicellular algae. These organisms must be responsible for the decrease in mineral content resp. electric conductivity in the water. We note that at the same time *Daphnia pulex* decreased in numbers. The decrease in electric conductivity in late summer is not recorded in the Hilversumse Wasmeer with the beginning guanotrophy. Only in 1963 there might be some indication and then *Chlamydomonas* were present in greater numbers. In conclusion it may be said that in the stabilized guanotrophic lake 2, green algae can diminish the content in minerals in late summer, and this may cause the decrease in electric conductivity.

Calcium and bicarbonate

In lake 1 the calcium content is very low and has a constant value until August. At the time the waterlevel drops and the fluctuations in Ca increases. In spring and at the end of June HCO_3 was present for a short time. In lake 2 Ca also is low especially during the summer. The curve shows regular fluctuations. If these are caused by errors in the determination there remains a curve which is rather fluent with a minimum in summer, just the reverse of the temperature curve.

I do not know if there is any relation to the temperature, neither do I know if there have been chemical processes by which Ca was precipitated. In this respect I think of phosphates as phosphate is present in very large amounts, compare also NH_4.

Bicarbonate is present in appreciable amounts only in spring and during the breeding season. This may be related to the presence of greater amounts of CO_2 during that time, which was not determined.

Organic matter

In lake 1 not much filtered organic matter was found. The total amount was higher with maxima in July and November. In January and February, when a thick layer of ice covered the water, much bottom-material was stirred up, which gave large amounts of organic matter. In lake 2 the amount of filtered (dissolved) organic matter was large, especially after the breeding season. The low values in spring are certainly related to dilution by rain. The amount of unfiltered (total) organic matter is much greater, and is also larger in summer than in spring for the same reason. Two sharp declines are found in October and December.

BOD

The values of biochemical oxygen demand are not very high, except in January under ice. In lake 1, BOD_5 did not exceed 5 mg/l. On 24 May there was even oxygen production in the bottles. In general the values are comparable to what is found in the Hilversumse Wasmeer in 1961. In lake 2 the BOD values are more fluctuating. It is surprising that the BOD values are highest in spring, when organic matter in low. The reason is not clear. The same is true for the record on 26 June, when a considerable oxygen production was measured. At this time the number of bacteria, organic ammonia, ammonia and phosphate are very high and BOD values recorded in the guanotrophic lake are low. Compared to the Hilversumse Wasmeer in 1962 and 1963 the values are lower. This must be considered in relation to the unbalanced situation which it presented during 1962 and 1963 in the Hilversumse Wasmeer.

Organic ammonia

Organic ammonia is present in low concentrations in lake 1. Great amounts are found in lake 2 after the breeding season, which diminish in autumn. If greater mineralization activity of bacteria is present then, it could not be established.

NH_4

In lake 2 the amount of ammonia is very high and the fluctuations are very sharp. It is not possible to find correlations with other factors recorded, though PO_4 shows similar sharp fluctuations. This may indicate that both compounds are involved in the same process. The great amount on 26 June of NH_4 is synchronized with high counts of bacteria in the breeding season. It is difficult to say what part is derived directly from NH_4 of the excrements, and what part is the result of decomposition of organic matter by bacterial activity.

NO_2 and NO_3

NO_2 and NO_3 are always absent. It has been stated already that nitrification in this acid environment is very slow. In lake 2 resp. 9 and 6 mg/l NO_3 were recorded under ice in January and February.In February NO_2 (0.17 mg/l) was determined also. I suppose that at other times NO_2 and NO_3 are produced as well under the existing aerobic circumstances, but they are taken up at once by micro-organisms. With the low temperatures in January and February nitrification is perhaps not inhibited. NO_2 and NO_3 remain in solution. The concentrations, however, are very great and I doubt whether this can be the only explanation. It must be mentioned that oxygen content is low, and even absent at the time. Nevertheless denitrification seems to play no role, as NO_2 and NO_3 are present. As NH_4 concentrations at the same time are very low, it seems more evident that oxygen is consumed in nitrification and NO_2 and NO_3 are formed in spite of the low pH (and temperature). Perhaps it is not the pH, but other factors which inhibit the nitrification in an acid oligotrophic environment.

PO_4

The amount of PO_4 in lake 2 is very large. In lake 1 it is little. The amounts in lake 2 fluctuate strongly between 1 and 13 mg/l. This high concentration is found also in saprobic environments, but it has been mentioned already that several factors typical for saprobic environments are not present here.

The annual average of PO_4 is about 7 mg/l. The total volume of lake 2 lies in the same order as the Hilversumse Wasmeer, 10.000 m^3. Since the beginning of the settlement about 45 years ago, the gulls must have brought 7000 kg PO_4 into the lake. At present there are about 4000 gulls. In the course of the years the number increased, and many other birds were present at the lake. So I will not try to speculate on the amount of PO_4 supplied by one gull per annum.

Plankton

Originally the two lakes in the Leersumse Veld were not separated.

As lake 1 remained undisturbed by gulls, the original situation may be represented by this lake. Moreover, as an acid oligotrophic 'ven' the bio-community present is comparable to what is found in the Hilversumse Wasmeer, before its colonisation by gulls. In table VIII the development of micro-organisms throughout the year is given. The vegetation in the lake is more dense than in the Hilversumse Wasmeer. Therefore more filaments of algae are present (*Mougeotia*) in the plankton samples, more desmids and bottom organisms (*Acantholeberis*, *Chydorus*) and less organisms of open water (*Keratella serrulata*, *Dinobryon*). Until July the development of *Mougeotia*, growing between the submerged *Sphagnum*, was vigorous. In autumn it was less so. The community of micro-organisms found is typical for acid oligotrophic water. Errand forms from a more eutrophicated environment are found sporadically. These forms have been transported by the birds from lake 2, in which they occur also, but in greater numbers. Examples of these species are *Keratella cochlearis* and *Pediastrum* spp.. Most of these species occur in small numbers. Therefore no attempt has been made to plot the amounts in curves.

In lake 2 a total different bio-community has developed under the influence of the bird excrements. The total amount of plankton is small. Species of acid oligotrophic environment are rare. They may be considered as errands introduced from yet undisturbed oligotrophic parts of the lake. These are *Acantholeberis*, *Keratella serrulata*, *Vejdovkyella*, *Rhipidodendron*. Some of the species present are more or less indifferent in ecological sensitiveness and a few do prefer more eutrophic circumstances. The latter species develop in lake 2 as dominant elements in the bio-community. They are *Daphnia pulex*, *Keratella cochlearis*, *Brachionus calyciflorus*, *Mallomonas* sp., *Scenedesmus quadricauda* and *Dictyosphaerium*. They also occur in saprobic environments, especially *Brachionus calyciflorus*. Desmids are rare. Diatoms and Cyanophyceae did not develop, in spite of the large amount of PO_4 and other nutrients in the water. This was also recorded for the Hatertse vennen (GEELEN c.s., 1961). Unicellulair flagellates were not so abundant as might be expected. We may expect that the eutrophic species have been introduced by the gulls, just as has been mentioned for *Actinocyclus normanni* in the Hilversumse Wasmeer. The species occurs here also. As there are many more eutrophic species in eutrophic bio-communities, which could have been introduced also from adjacent eutrophic waters in the neighbourhood, it is most evident that the guanotrophic circumstances in lake 2 are not favourable for quite a number of eutrophic forms except the species developing and multiplying here. It is difficult to pin down what are the special factors of importance here, without further analyses of the water.

TABLE VIII

1962/1963 *Leersumse Veld Lake 1.*

	Mar. 6	April 3	April 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11	ice Jan. 8	ice Feb. 5
Crustaceae:																	
Cyclops sp.	1		1	1	1	1		1	1	2	1	1	1	1	1	2	1
Alona sp.			1		1	1	1		2	2	2	1					
Alonella sp.								2	1	1	1						
Polyphemus pediculus						1	1	2	1	2	1	1					
Acantholeberis curvirostris							1	2	3	1	1	1	1	1			
Chydorus sphaericus		1		1	2	1	1	2	1	2	1	1	2	2	3	1	
Scapholeberis mucronata					1	1	1	2	1	1	1						
Monospilus dispar													1				
Graptoleberis testudinaria								2	1		1						
Rotifers:																	
Keratella serrulata		1	1	1					1		1						
K. cochlearis						1											
Lecane sp.			1			1	1	1	1	1	1	1	1		1		
Lecane lunaris						1		1									
Lecane stichea						1											
Lecane ligona								1							1		
Trichocerca sp.						1											
Trichocerca longiseta								1									
Trichotria pocillum						1	1	1		1					1		
Euchlanis sp.						1		1	1								
Monostyla bulla											1						

1962/1963 *Leersumse Veld Lake 1.*

	Mar. 6	Apr. 3	Apr. 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11	ice Jan. 8	ice Feb. 5
Rotaria sp.								1	1	1					1	1	1
Monommata longiseta														1			
undet.											1						
Protozoa:																	
Arcella vulgaris	1		1	1		1	1	1	1	1	1	1		2	3	2	1
Difflugia sp.	1																
Heliozoa												1					
Centropyxis aculeata													1				
Euglypha ciliata															1		1
Flagellatae:																	
Synura uvella	1	1														1	
Chlamydomonas sp.	3			1		1									2		
Dinobryon sp.	2	1	1	1		2	1										
Mallomonas sp.	1					1	2										
Euglena sp.	1																
Eudorina elegans				1					1								
Peridinium sp.						1											1
Gymnodinium sp.			1														
undet.		1								1			3	1	1	1	1
Chlorophyceae:																	
Mougeotia sp.	5	5	4	5	5	5	5	4	1	1	1	5	4	4	4	3	1
Pediastrum duplex							1										

1962/1963 *Leersumse Veld Lake 1*

	Mar. 6	April 3	16	May 3	11	24	June 4	26	July 9	23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11	ice Jan. 8	ice Feb. 5
P. biradiatum							1										
Botryococcus brauni								1									
Stigeoclonium sp.											1						
Gloeiocystis gigas												1					
Desmidiaceae:																	
Cosmarium sp.	1					1	1	1	1	1	1	1		1	1	1	
Closterium sp.	1	1	1	1		1	1	1	2			1			1	2	1
Euastrum sp.							1			1		1	1			1	1
Staurastrum sp.			1	1		1	2	2	1			1	2	2	1	1	1
St. dejectum	1	1	1								1					1	
Gymnozyga sp.	1												1	1	3		1
Micrasterias truncata								1	1			1	2	2	2	1	1
Xanthidium sp.											1	1			1	2	1
Diatomeae:																	
Pennatae								1	1	1	1	1	1		1	1	1
Midgelarvae						1	1	1		1	1						
nematods	1								1								
Sphagnum				1				1	1	1	1				4	4	4

TABLE IX

1962/1963 *Leersumse Veld Lake* 2.

														ice	ice	ice
	Mar.	April			May		June		July		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
	6	3	16	3	11	24	4	26	9	23	23	17	15	13	11	8	5
Crustacea:																	
Cyclops sp.	2	1	1	3	3	1		2	1	1	1	1	1	1	2		1
Alona sp.	1			1		1			1		1			1			
Alona rectangula														1			
Alona costata															1		
Alonella sp.							1			1	1						
Diaphanosoma brachyurum										1							
Daphnia pulex	2	1	1	4	2	3	1	1	1	3	2	3	1				
Polyphemus pediculus						1	4		1	1	1						
Acantholeberis curvirostris									1								
Chydorus sphaericus	1	1		1	1	2	1		1			1		1	1	1	
Scapholeberis mucronata													1				
Harpacticidae						1											
Rotifers:																	
Keratella cochlearis	1	1	2	1	4	5	1	3	4	1	1	5	3	2			
K. serrulata	1		1	1	1												
Lecane sp.		1		1					1						1		
Lecane lunaris								1					1		1		
Trichotria pocillum	1		1												1		
Trichocerca sp.				1		1		1	1				1	1			
Rotaria sp.	1			1		1			1				1		1		
Rotifer neptuneus	1																

1962/1963 Leersumse Veld Lake 2.

														ice	ice	ice
	Mar.	April		May			June		July		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
	6	3	16	3	11	24	4	26	9	23	23	17	15	13	11	8	5
Synchaeta sp.	2	1	2	4	2		1						3	3	2		
Asplanchna sp.			1							2							
Polyarthra sp.								1	1	1	1						
Anureopsis fissa								1	2	1	1						
Brachionus sericus			1											1			
Br. calyciflorus									1	2							
Lepadella sp.									1								
undet.											1						
Protozoa:																	
Arcella vulgaris		1	1		1	1	1	1	1		1	1	1		1		
Euglypha sp.						1											
Difflugia sp.													1				
undet.																	3
Vermes:																	
Vejdovskyella comata													1				
Flagellatae:																	
Synura uvella	1	1	3														
Chlamydomonas sp.	1	2	1														
Dinobryon divergens						1											
Mallomonas sp.	4	1	3														
Phacus longicauda								1	1	1							
Pandorina morum						1											
Volvox aureus											1						

1962/1963 Leersumse Veld Lake 2.

	Mar. 6	April 3	April 16	May 3	May 11	May 24	June 4	June 26	July 9	July 23	Aug. 23	Sept. 17	Oct. 15	Nov. 13	ice Dec. 11	ice Jan. 8	ice Feb. 5
Rhipidodendron huxleyi				1		1											
Gymnodinium sp.	1																
undet.		3										1	2	1		2	2
Chlorophyceae:																	
Mougeotia sp.		1	1	3	1	1	1		1	1						1	
Tribonema sp. ?					1												
undet. threads	1			1		1		1	1		1	1	1	2	2		
Ulothrix sp.						1				1			1		1		
Scenedesmus quadricauda								1	1					1	1		1
Botryococcus brauni												1					
Dictyosphaerium sp.												1	4	3	3	1	1
Desmidiaceae:																	
Gymnozyga sp.														1	1		
Staurastrum sp.			1														
Closterium sp.												1					
Closteriopsis ?													2				
Diatomeae:																	
Diatoma sp.	1																
Actinocyclus normanni						1					1		1				
Cyanophyceae:																	
Oscillatoria sp.									1								
Chaoborus sp.											3	1					
Midgelarvae								1							1		
Stylaria lacustris	1						1										
Nematods		1							1	1							

Guanotrophy in an eutrophic environment

III. The Bakkerskooi

The Bakkerskooi is a nature reserve of the private Society of Nature Reserves at Amsterdam. It is located in the northwest of the province of Overijssel near the community of Wanneperveen. In the trees of the reserve exists a colony of cormorants and blue herons. The young cormorants, after leaving the nests, frequent an isolated pond. The water of this pond is very turbid, and coloured green by the development of many green algae. In 1960 this pond and several other peatpits and broads in the neighbourhood were simultaneously investigated on chemistry and plankton .The results of this comparison were published. (LEENTVAAR 1965). It appeared that chemistry and plankton here were different from other waters in this region. The pond is isolated from the surrounding waters and no water from canals enters. Chloride, electric conductivity and hardness are lower than the surrounding waters, but NO_2, NO_3, NH_4 and PO_4 are very high. The influence of excrements of the cormorants and other birds is noticeable. Bacteriological counts were not carried out. The results of the analyses, carried out in May, July and October 1960 are given below.

		2 May	18 July	19 October
electric conductivity		318	366	300
Cl	mg/l	43	50	37
$KMnO_4$ filtered	,,	93	85	91
$KMnO_4$ unfiltered	,,	153	189	125
organic ammonia	,,	3	3	3
NH_4	,,	0.5	4	1
NO_2	,,	0.6	0.4	—
NO_3	,,	22	8	—
Fe	,,	0.6	0.8	0.6
HCO_3	,,	107	142	123
Ca	,,	39	42	34
Total hardness		8	8	7
HCO_3 hardness		5	6.5	6
PO_4	,,	4	0.5	20
pH		8	8	7
temperature C		11.5	21	10.9
O_2	,,	11	9.6	9.7
O_2 after 2 days illumination		12	13.5	13.5
O_2 after 5 days illumination		21.4	14.7	14.4
O_2 after 1 day darkness		3.1	1.9	4.7
O_2 after 5 days darkness		0	0	0

This analysis shows that the water is an eutrophic hard water. The amount of Cl is relatively low, compared to the surrounding waters. Because of its isolated situation, dilution by rainwater lowers the Cl content. If we compare this analysis with the figures found in the guanotrophic lake 2 in the Leersumse Veld, we observe several differences.

Though the amounts of dissolved and total organic matter are about equal, the values for organic ammonia and saline ammonia are much lower. NO_2 and NO_3 on the other hand are high except in November. This is an indication that nitrification activity is strong, which must be combined with the high pH and the presence of a large amount of dissolved oxygen. The high pH is caused partly by the assimilation activity of the large numbers of green micro-organisms present, but without this, the pH would still be at least neutral, due to the hardness of the water. HCO_3 always is present in large amounts, which is in sharp contrast with the soft water of the Leersumse Veld. In the latter CO_2 is the main source of carbon for assimilation, which excludes the presence of many organisms in the biocommunity which are only able to assimilate HCO_3. PO_4 is also present in large amounts, compared to similar hard surface waters in the surroundings. The values found are comparable to those of the guanotrophic Leersumse Veld lake 2. In October there are very large amounts of PO_4, probably caused by increased decomposition and decreased consumption by algae. The absence of NO_2 and NO_3 at the time is not in accordance with this, however. The interrelations are more complicated than can be explained by the few observations made. Oxygen saturations are high. This is caused by the high assimilation activity of the numerous green algae. Oxygen production in bottles exposed to light was always positive. At the same time oxygen consumption in dark bottles was high i.e. the BOD was high. The BOD values are also higher than those of the surrounding waters (see LEENTVAAR 1963, 1965). The oxygen balance in the pond is determined by intensive oxygen production on one side, and intensive oxygen consumption on the other. In October a bottle was filled with pond water, which was filtered through a plankton net, in order to remove coarse material, and exposed to light. The oxygen production after 5 days was now much higher (18.8 mg/l) than in a bottle with unfiltered water. It indicates that oxygen production depends not only on green netplankters, but perhaps even more on nannoplankters. It may indicate also that the removal of coarse oxygen absorbing suspended organic matter is important. These relations will be the subject of further study.

Plankton (see table X).

The plankton community present in the Bakkerskooi is typical for eutrophic environments with mesosaprobic tendencies. The development of many unicellular flagellates, the Chlorophyceae present, *Brachionus calyciflorus* and numbers of *Daphnia pulex* are representing the mesosaprobic character. As in the Leersumse Veld, Cyanophyceae and Diatomeae are very scarce. The absence of Cyanophyceae is rather remarkable, as they are normally present in this environment. Perhaps the paucity of diatoms and blue algae may be a characteristic of guanotrophy as well under eutrophic as under oligotrophic conditions. Compared to the guanotrophic lake in the Leersumse Veld, the *Pediastrum* spp. and *Scenedesmus* spp. have developed well. N (ammonia) and P nutrients show high values in both cases. The development of these green algae, as an example, seems to be determined mainly by the bicarbonate-carbonate equilibrium.

Other observations on guanotrophy in eutrophic environments are not available, except for the influence of a colony of cormorants on the ditches and the broads in the Naardermeer (LEENTVAAR 1958). In this water guanotrophy was more difficult to determine, because of interference with water movements by surrounding ditches and broads.

TABLE X

Planktonorganisms in the Bakkerskooi in 1960

	2 May	*18 July*	*19 October*
Crustaceae:			
Cyclops sp.	2	3	3
Daphnia pulex	2	2	3
Rotifers:			
Keratella cochlearis	1	1	
K. quadrata		1	
Polyarthra sp.			1
Rotaria neptuneus	1		
Brachionus bidens	1		
Br. angularis			1
Br. calyciflorus	2		
Br. rubens	2		2
Testudinella patina	1		
Asplanchna sp.	1		
Protozoa:			
Arcella sp.		2	
Centropyxis sp.	1		
Tintinnopsis sp.	1		

	2 May	18 July	19 October
Flagellatae:			
Euglena sp.	1		
Eu. oxyuris		2	2
Lepocinclis sp.	1	1	
Phacus longicauda	1		
Trachelomonas sp.		2	1
undet.	3	3	3
Chlorophyceae:			
Spirogyra sp.		1	
Pediastrum boryanum	1	3	1
P. duplex	2	3	1
P. clathratum		1	
Scenedesmus quadricauda	1	3	3
Sc. opoliensis			1
Sc. acuminatus		1	1
Crucigenia rectangularis			1
Tetraedron sp.		1	
T. muticum		1	
T. raphioides		1	
Kirchneriella obesa		1	
Actinastrum hantzschii			1
Ankistrodesmus falcatus			2
undet. threads		2	
Cyanophyceae:			
Merismopedium sp.		1	
Diatomeae:			
Surirella sp.		1	
Nitzschia sigmoidea	1		
Gyrosigma sp.	1		
Melosira sp.		2	
Desmidiaceae:			
Staurastrum sp.		1	
Hyalotheca sp.		1	

SUMMARY

Examples are given of initial guanotrophy in acid oligotrophic environment and of stabilized guanotrophy of long standing, both in acid oligotrophic and eutrophic environment.

Characteristic of a guanotrophic environment is the accumalation of phosphate. In hard waters phosphate is accompanied by large amounts of saline nitrogen compounds. In soft waters the saline nitrogen production seems to be inhibited through low bacteriological

activity. In eutrophic guanotrophic environments oxygen production and biochemical oxygen demand are both high. In oligotrophic guanotrophic environments the oxygen content as a rule does not reach saturation and biochemical oxygen demand is fairly low.
The amounts of chloride and calcium do not change significantly by the addition of excrements of birds.

Diatoms, blue green algae and desmids are very scarce in guanotrophic environments. In hard waters mesosaprobic forms are present in the plankton community. In soft waters no strong saprobic tendencies could be found.

During the initial stage of guanotrophy in an acid oligotrophic environment, the desmids disappear together with other sensitive species as *Dinobryon pediforme* and *Bosmina obtusirostris*. Unicellular flagellates as *Chlamydomonas* appear in increasing numbers. Several factors in the environment respond to the changes by increasing fluctuations of the values recorded.

There was evidence of transport and introduction of microorganisms by waterfowl.

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