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Observations on the Populations of Plankton and Micro-organisms in an old Branch cut off from the River Waal*)

by

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1. INTRODUCTION

In 1954, the Department for Nature Conservation of the State Forest Service started an investigation on the flora and fauna of some old branches of the rivers Rhine, Waal, Maas and IJssel. The purpose was to get an idea of the biocommunities living in old river branches cut off from the river. In this publication, the results are published of an investigation on the microscopical organisms living in one of the nicest branches of the river Waal near Zaltbommel, named *„Kil van Hurwenen"*.

The micro-organisms were caught with a cone-shaped plankton net by vertical hauls. The plankton samples were fixed in a 3% formalin solution and examined by bringing the whole sample in a Petri dish under the microscope. The species were identified and the numbers estimated (see tables).

On August 16, 1955, the horizontal distribution of the plankton in the southern part of the Kil was investigated, as well as the plankton population of the zone near the shore. On August 19, 1955, the micro-organisms of the northern part of the Kil were investigated and on August 23, 1955, the micro-organisms of the shallow parts of the southern Kil.

On August 28, 1941, observations were made on the vertical distribution of the micro-organisms in the deep open water of the same old branch in co-operation with VAN HEUSDEN (VAN HEUSDEN, 1945). These data are also included here.

So, observations have been made on the micro-organisms living in the open water (lake plankton), between the waterplants (pond plankton) and in the transitional zone between these two habitats.

*) Received January 15, 1957.

TABLE 1. Horizontal distribution of plankton in the Kil-south. (August 16, 1955)

Sampling places	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Crustacea :																		
Leptodora kindti	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Diaphanosoma brachyurum	1	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bosmina longirostris	1	1	.	1	1	2	2	2	1	1	1	1	1	1	1	1	1	1
Daphnia longispina	.	1	.	1	1	1	2	2	1	1	1	2	2	1	1	1	1	1
Ceriodaphnia pulchella	1	.	1	1	.	1	1	.	1	1	1	.	1	1	1	1	1	1
Cyclops oithonoides	1	1	1	2	3	3	3	4	2	2	4	3	4	4	3	3	3	2
Diaptomus gracilis	.	1	.	.	1	1	1	1	.	.	1	1	.	1	.	.	.	.
Canthocamptus sp.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Rotifera:																		
Polyarthra trigla	3	3	2	1	2	2	2	2	3	3	2	2	3	3	3	3	2	2
Keratella cochlearis	2	2	1	1	2	1	1	1	2	2	1	2	1	2	2	2	2	2
— quadrata	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Filinia longiseta	2	1	1	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2
Asplanchna priodonta	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gastropus stylifer	.	.	1	1	.	1	.	.	1	.	.	.	.	1	.	.	1	.
Anureopsis hypelasma	.	.	.	.	.	.	1	1	.	1	.	1	.	.	1	1	1	.
Trichocerca capucina	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Brachionus bidens	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pompholyx sulcata	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	1	.
Floscularia mutabilis ?	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Protozoa :																		
Tintinnopsis lacustris	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.
Tintinnidium fluviatile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Difflugia lobostoma	1	1	1	1	1	1	1	1	1	.	2	1	1	1	1	1	1	1
— aculeata	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.
Arcella vulgaris	.	1	.	1	.	1	.	.	1	1	.	1	.	.	1	.	.	.
Euglena sp.	.	1	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1
Phacus longicauda	1	1	.	1	1	.	1	1	1	1	1	1	.	1	1	1	1	1
Flagellatae :																		
Mallomonas caudata	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.
Eudorina elegans	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pandorina morum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Trachelomonas sp.	1	1	1	.	1	1	1	1	1	1	1	1	1	2	1	1	1	1
Ceratium hirundinella	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Peridinium sp.	1	1	1	1	.	1	1	1	.	1	2	1	1	1	1	1	.	.
Dinobryon sertularia	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
— stipitatum	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.
— divergens	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
Desmidiaceae :																		
Staurastrum gracile	1	.	.	1	1	.	.	1	1	1	1	.	.	.	.	.	1	1
Cosmarium botrytis	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Closterium moniliforme	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.
Chlorophyceae:																		
Scenedesmus quadricauda	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	1	.
Pediastrum duplex	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
— boryanum	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
— tetras	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Tetrapedia emarginata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Cyanophyceae :																		
Aphanizomenon flos-aquae	2	1	2	2	2	1	1	2	3	3	3	3	3	2	2	2	2	1
Anabaena spiroides	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Oscillatoria sp.	1	1	2	1	1	1	1	1	1	1	1	1	1	1	.	1	.	.
Actinastrum hantzschii	1	1	.	1	1	.	1	1	.	1	.	1	1	1	1	1	1	1
Richteriella botryoides	1	.	1	.	.	.	.	1	.	1	.	.	.	.	1	.	1	.
Diatomeae :																		
Asterionella formosa	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2
Synedra delicatessima	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2
Diatoma elongatum	1	1	1	.	1	1	.	.	1	.	.	.	.	.	.	.	1	1
Fragilaria crotonensis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Melosira granulata	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cyclotella sp.	1	1	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1	1
Attheya zachariasae	1	1	.	1	1	1	1	1	1	1	1	.	.	.	1	1	1	1
Melosira sp.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Synedra ulna	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Nitzschia sigmoidea	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	1
Total number of species :	34	35	27	35	29	36	33	37	37	38	34	34	30	33	34	38	38	34

The samples were taken from the open water by vertical hauls from 1 meter depth to the surface. The sampling places 5, 8, 11 and 14 are in the midst of the open water and the spots are respectivily 3, 5, 4 and 3 meter above the bottom. See also map, figure 1.

TABLE 2. Vertical distribution of plankton in the Kil-south. (August, 1941)

depth in meters:	0	1	5
Crustacea:			
Cyclops sp.	550	800	800
Daphnia longispina	40	200	100
Bosmina longirostris	700	2100	40
Ceriodaphnia pulchella	—	100	—
Rotifera:			
Keratella cochlearis	11100	11700	3100
Polyarthra trigla	4000	3100	200
Trichocerca capucina	600	500	80
Pompholyx complanata	—	—	1400
Protozoa:			
Tintinnopsis lacustris	2700	6300	200
Zooplankton total:	20540	19200	5990
Flagellatae:			
Ceratium hirundinella	3600	3500	20
Eudorina elegans	1800	8900	40
Diatomea:			
Asterionella formosa	164900	124800	5200
Melosira sp.	641900	298700	151600
Cyclotella sp.	414600	76700	24100
Phytoplankton total:	1226150	518600	180960
Total plankton:	1247000	538000	187000

The figures give the number of plankton organisms per 10 liters of water.

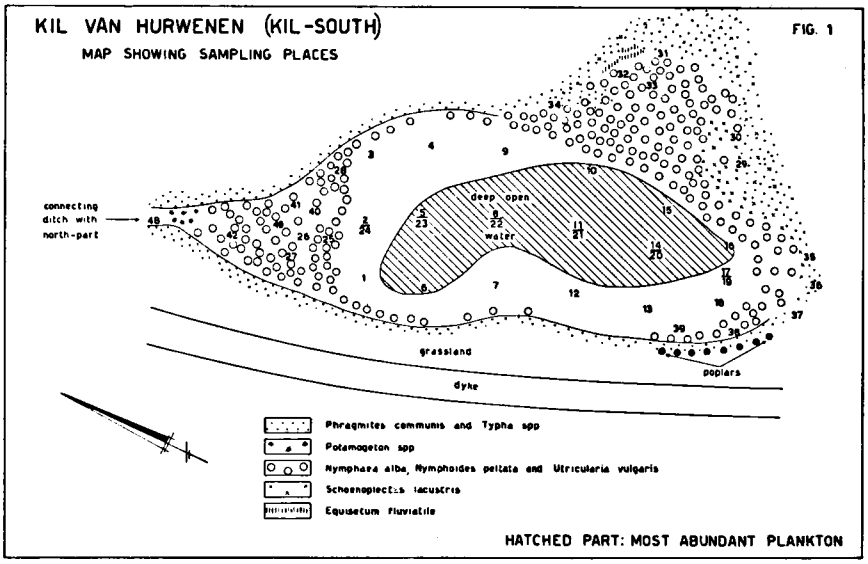
2. DESCRIPTION OF THE OLD RIVER BRANCH

The "Kil van Hurwenen" is an old meander of the river Waal, which was cut off from the river in the year 1639. The western and southern side are protected by a high dike, the eastern part consists of a flat grass- and moorland. The bottom is composed of sand and clay. The vegetation of the shore consists of *Schoenoplectus lacustris* and large fields of *Phragmites communis*. The shallow regions of the water are occupied by communities of *Nuphar luteum, Nymphaea alba, Nymphoides peltata* and *Potamogeton* spp. (see maps).

The total surface of moorland and water is ± 100 acres. The northern part has a length of about 1000 meters and a width of 250 meters, the southern part of respectively 600 and 300 meters. The two parts communicate by a small ditch completely filled with waterplants. The two small ditches in the northern part of the branch unite and contain a pumping-engine with which the waterlevel is regulated especially in dry times. So in summer, riverwater will enter the Kil. In wintertime the whole area is flooded by the river. The depth of the northern part is up to 2 meters, the depth of the southern part is 6 meters.

3. THE HORIZONTAL DISTRIBUTION OF THE PLANKTON IN THE KIL-SOUTH

In large deep lakes, the horizontal distribution of plankton organisms is rather regular. Irregularities only occur through the inflow of river-water, etc. Usually there will be some irregularities in the plankton near the shore, caused by micro-organisms living normally at and near the bottom of the shallow water. Bottom dwellers are found everywhere in the surface layers of the open water of the Kil, however they decrease in numbers as one approaches the centre. The same applies to micro-



organisms living in the zone of floating plants. These species can be recognized easily. Another problem arises from certain species concentrating at certain points of the waterbody, also causing an inhomogeneous distribution. This is a very important question in plankton sampling. It appears, that inhomogeneousness must be taken into account when taking random plankton samples. Therefore during the investigation in the Kil, 18 plankton samples were taken at regular distances in the open water region. The hauls were taken from one meter depth to the surface. The numbers of organisms were estimated and recorded in table 1, which shows, that the majority consists of the Diatomea, *Melosira granulata, Asterionella formosa,* the Cyanophyca *Aphanizomenon flos-aquae,* the Rotifers, *Polyarthra trigla, Keratella cochlearis* and *Filinia longiseta* and the Crustacean, *Cyclops oithonoides.* The distribution of these species is rather regular. The motile plankters, such as the Crustacea and the Rotifers, are more unevenly distributed then the non-motile. It is a well-known fact that the motile plankters form swarms, and it is quite possible that this is principally caused by social behaviour. However, external factors such as light intensity, local currents and local food concentrations may also be of importance. This matter will not be further treated here. Among the plankters summed up in table 1 the following are bottom- or shallow-water species: *Ceriodaphnia pulchella, Canthocamptus* sp.; *Difflugia aculeata, Arcella vulgaris, Nitzschia sigmoidea.*

4. The vertical distribution of plankton in the open water of the Kil-south

On August 28, 1941, the vertical distribution of the plankton in the Kil was studied in a series of investigations in deep pools situated behind the dikes, called „wielen". These are remainders of former breaches in the dikes near the river. The result of this plankton research

has not been published yet, but the data on the Kil are given here for a better understanding of the biocommunity. 25 Liters of water from a certain depth were sieved, and the number of individuals of each species was counted. The samples were taken from 0, 1 and 5 meters depth. The results are shown in table 2 and figure 2.

In figure 2 the vertical distribution of some organisms, occuring in sufficient large numbers, is given. As is shown by VAN HEUSDEN (1945) we can distinguish in most „wielen" an upper water layer saturated with oxygen and with a higher temperature, a deep layer without oxygen and with a low temperature and a transitional zone (thermocline) between them, where oxygen and temperature decrease rather suddenly.

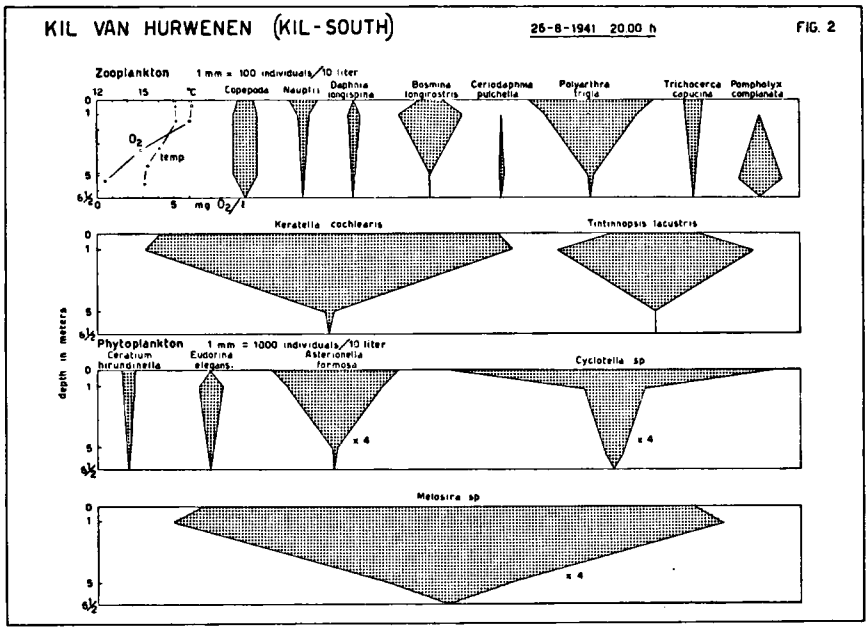


Figure 2 shows that the Rotifer *Pompholyx complatana,* prefers the transitional layer. This species is a thermocline dweller. Very few plankters prefer the deeper water layers: *Ceratium hirundinella,* which is not abundant enough in the Kil for certain conclusions, also prefers the deeper water near the thermocline. The depth of most "wielen" is greater than that of the Kil and therefore allows for a division in epi-, meta- and hypolimnion. In our Kil this is not possible.

The numbers of individuals of each species at different depth is given in table 2. The counts show that the total amount of plankton decreases from the surface to the bottom. It is very difficult, almost impossible, to give a figure of the total "standing crop". In comparison with the "wielen", investigated in the same year, the Kil has a relative large amount of plankton. The chemical composition of all these waters is almost the same (for data see VAN HEUSDEN, 1945). So the phenomenon must be caused by other factors. The difference of depth between the old river branch and the "wiel" causes a difference of circulation of the water layers. In an old river branch, all water layers are mixed during

the summer months, which does not happen in a "wiel". Therefore the plankton productivity of an old riverbranch is better.

5. Comparison of the plankton in the Kil-south in different years

In August 1941, 1954 and 1955 the plankters inhabiting the surface layers of the Kil-south were studied. Table 3 gives a review of the species occuring in sufficiently large numbers. Most species of 1941 are found again in 1954 and 1955. *Dinobryon spp., Mallomonas caudata, Asterionella formosa,* and *Diatoma elongatum* have been secured in the last two years only, in rather large quantities. Of course we may expect changes in the plankton after some years, the character of the total plankton community, however, does not change to any extend. The plankton remains characteristic for eutrophic and oligosaprobic water. The chemical data point to the same. For 1941 the following chemical analysis was made by van Heusden. In 1955 another analysis was made.

Table 3. Planktonorganisms in the surface layers of the Kil-south secured in August of the years 1941, 1954 and 1955.

	1941	1954	1955
Crustacea :			
Cyclops oithonoides	550 (1)	1	3
Daphnia longispina	40 (1)	1	1
Bosmina longirostris	700 (1)	.	1
Ceriodaphnia pulchella	1	.	1
Rotifera:			
Keratella cochlearis	11100 (3)	1	2
— quadrata	1	1	.
Polyarthra trigla	4000 (2)	1	2
Trichocerca capucina	600 (1)	.	1
Notholca longispina	1	1	.
Pompholyx complanata	1	4	1
Pterodina patina	1	.	.
Protozoa :			
Tintinnopsis lacustris	2700 (2)	.	1
Phacus sp.	1	.	1
Flagellatae:			
Ceratium hirundinella	3600 (2)	1	1
Trachelomonas hispida	1	1	1
Eudorina elegans	1800 (2)	1	1
Dinobryon divergens	.	4	1
— sertularia	.	4	1
Mallomonas sp.	.	4	1
Chlorophyceae:			
Pediastrum duplex	1	1	1
Scenedesmus quadricauda	164900 (3)	1	1
Diatomeae:			
Fragilaria sp.	1	1	1
Synedra acus	1	.	.
— delicatessima	.	2	1
Surirella sp.	1	.	.
Pleurosigma acuminatum	1	.	.
Attheya zachariasae	1	1	1
Melosira sp.	641900 (4)	1	4
Cyclotella sp.	414600 (4)	1	1
Asterionella formosa	.	1	2
Diatoma elongatum	.	3	1

1 = plankton present, 2 = plankton scarce, 3 = much plankton, 4 = very much plankton 5 = plankton abundant.
In 1941 the quantity was expressed in numbers of organisms per 10 liters of water.

	August 28, 1941	September 30, 1955
p_H	not determined	7,9
$KMnO_4$-consumption	18	15
B.O.D.[1]) (mg/1)	not determined	3
Methylenblue-test	not determined	no decoloration after 96 hours
NH_4 (mg/1)	0,2	0,0
NO_2 (,,)	0,02	0,0
NO_3 (,,)	0,0	0,0
Cl_2 (,,)	29	57

[1]) B.O.D. = Biochemical Oxygen Demand. The ogygen consumption of a sample water in 5 days at 22° C in the dark.

The amounts of inorganic substances have changed a little. The rate of alteration, however, is probably not essential, because these two observations may show extremes of the normal values. Anyhow, the character of the plankton community has not changed. The biological valuation of water gives a better insight than the chemical valuation, for temporary changes in chemical composition of the water may have no influence on the total character of the plankton. So we conclude, that no important alteration in the water of the old branch occurred.

6. The plankton population in the transitional zone

The clearness of the water among the waterplants is very high. The non-living substances settle between the waterplants by lack of turbulent watercurrents. The turbidity of the open water must decrease towards the shore. The non-motile organisms will also settle unless they float by means of photo-assimilatory products, such as fats and oils. We may follow this in several plankters of the open water by taking samples at regular intervals, starting from the centre of the water and ending between the zone of waterplants. Table 4 gives the results of the samples and figure 1 the sampling points.

In studying the tables, we see that the motile plankters like the *Cladocera*, certain *Rotifera* and the *Protozoa* start disappearing at the outer zone of the area of waterplants. Others like the *Flagellatae* and the non-motile plankters, float among the waterplants far into shallow water. The non-motile organisms are carried by the horizontal currents and settle gradually. The motile organisms evendently at once return to the open water. In this they will succeed the better, the more their swimming ability and their positive phototactic reaction is developed. The following organisms flee the shallow zone of waterplants: *Diaphanosoma brachyurum, Bosmina longirostris, Daphnia longispina, Cyclops oithonoides, Asplanchna priodonta, Trichocerca capucina, Gastropus stylifer, Tintinnidium fluviatile, Phacus* and *Peridinium*. A number of motile and non-motile plankters such as *Asterionella formosa, Melosira, Fragilaria, Keratella cochlearis, Difflugia lobostoma* and *Aphanizomenon flos aquae* are found everywhere. They decrease in numbers in the shallow water.

The same is found in comparing the total quantity of plankton in the samples of table 1. Near the shore of the riverbranch the quantity of total plankton is less than in the centre of the water. This is shown in figure 1. In the hatched part of the map, the plankton is most abundant.

A remarkable distribution was shown by the statoblasts of *Plumatella repens*, which float free on the water surface. Apparently they are distributed by the action of the wind. We find them in the outmost border of the floating waterplants.

The plankton samples of the shallow zone contain many other species of micro-organisms belonging to bottom and shallow water dwellers. In table 4 at the sampling places 25, 26, 27 and 28 we note Crustaceans like *Ceriodaphnia pulchella, Sida crystallina, Alona sp., Acroperus harpae* and *Acroperus harpae;* the Rotifer *Euchlanis;* the Protozoon *Difflugia;* nearly all Desmidiacea; filamental Algae; strips of diatoms and larvae of insects. They all are almost or totally lacking in deep open water.

The samples do not show any correlation with the degree of covering or the species of waterplants.

TABLE 4. Plankton and microorganisms from the deep water and the covered zone near the shore in the Kil-south. (August 16, 1955)

Samplingplaces :	19	20	21	22	23	24	25	26	27	28
Crustacea :	in open deep water					between the waterplants				
Diaphanosoma brachyurum	1	2	2	1	1	1	.	.	.	.
Bosmina longirostris	1	1	1	1	1	.	.	.	.	.
Daphnia longispina	1	1	2	2	1	.	.	.	.	.
Ceriodaphnia pulchella	1	1	.	.	.	1	1	1	1	.
Sida crystallina	.	.	.	.	.	.	1	.	.	.
Alona sp.	.	.	.	.	.	.	.	.	1	1
Acroperus harpae	.	.	.	.	.	.	.	1	1	.
Graptoleberis testudinaria	.	.	.	.	.	.	.	.	1	.
Chydorus sphaericus	.	.	.	.	.	.	1	1	1	1
Peracantha truncata	.	.	.	.	.	.	1	1	1	.
Cyclops oithonoides	3	3	3	3	2	1	1	1	.	.
— *albidus*	.	.	.	.	.	.	.	.	1	1
Diaptomus gracilis	1	2	2	2	1	.	.	.	1	.
Leptodora kindti	.	1	1	.	.	.	.	.	.	.
Scapholeberis mucronata	.	.	.	.	.	.	.	.	1	.
Ostracoda	.	.	.	.	.	.	.	1	1	1
Rotifera :										
Polyarthra trigla	1	2	2	2	2	3	2	1	.	1
Notholca longispina	1	1	.	.	.	.	.	.	.	.
Keratella cochlearis	3	4	3	2	2	1	1	1	1	1
— *quadrata*	.	.	1	.	.	.	.	.	.	.
Rattulus sp.	.	.	.	.	.	.	.	.	.	1
Filinia longiseta	2	1	2	2	2	2	1	.	1	.
Asplanchna sp.	1	2	1	1	1	1	1	.	.	.
Gastropus stylifer	1	1	1	1	1	1	.	1	.	.
Trichocerca capucina	1	1	1	1	1	1	.	.	.	.
Brachionus bidens	1	.	.	.	.	.	.	.	.	.
Euchlanis dilatata	.	.	.	.	.	.	.	.	.	1
Protozoa :										
Tintinnopsis lacustris	.	.	1	.	.	.	.	.	.	.
Tintinnidium fluviatile	1	1	1	1	1	1	.	1	.	.
Difflugia lobostoma	1	1	1	1	1	1	1	1	1	1
— *pyriformes*	.	.	.	.	.	.	.	.	.	1
— *aculeata*	.	.	.	.	.	.	.	1	1	1
Arcella vulgaris	1	.	.	.	.	.	.	.	1	1
Euglena sp.	1	1	1	.	1	1	.	1	.	.
Phacus longicauda	1	1	1	1	1	1	1	.	.	.

TABLE 4. Continued

Sampling places:	19	20	21	22	23	24	25	26	27	28
	in open deep water					between the waterplants				
Insecta:										
Corethra larvae	.	1	.	.	.	.	.	.	.	.
Ceratopogon larvae	.	.	.	.	.	.	.	.	1	.
Chironomus larvae	.	.	.	.	.	.	1	.	.	1
Ephemerid larvae	.	.	.	.	.	.	.	1	.	.
Bryozoa:										
Plumatella repens (cysts)	.	.	.	.	.	.	4	4	2	2
Flagellatae:										
Mallomonas sp.	1	1	.	.	.	.	.	.	.	.
Eudorina elegans	1	1	1	1	1	1	1	1	.	.
Pandorina morum	1	1	1	1	1	1	1	1	.	.
Trachelomonas sp.	2	1	1	1	.	1	1	1	.	1
Ceratium hirundinella	1	1	1	1	1	1	1	1	1	1
Peridinium sp.	1	1	1	1	1	.	.	.	.	.
Dinobryon sertularia	1	.	1	1	.	1	1	1	.	1
Chlorophyceae:										
Scenedesmus quadricauda	1	.	1	.	.	.	.	1	.	.
Pediastrum duplex	1	1	1	1	1	1	1	1	.	1
— *tetras*	.	.	1	.	.	1	1	1	.	.
Mougeotia sp.	.	.	.	.	.	.	.	.	.	1
Desmidiaceae:										
Docidium sp.	.	.	.	.	.	.	.	.	1	1
Staurastrum sp.	1	.	.	1	.	.	1	.	.	1
Cosmarium sp.	1	.	.	.	.	.	.	.	.	.
Closterium sp.	.	.	1	.	.	.	.	1	.	1
Cyanophyceae:										
Ankistrodesmus sp.	1	.	.	.	1	.	.	.	.	.
Aphanizomenon flos-aquae	2	2	2	2	3	2	1	1	1	1
Anabaena sp.	.	.	1	1	.	.	.	.	.	.
Richteriella botryoides	.	.	2	.	.	.	.	.	.	.
Actinastrum hantzschii	1	.	.	.	.	1	.	1	.	1
Oscillatoria sp.	.	.	.	.	1	1	1	1	1	.
Diatomeae:										
Asterionella formosa	2	2	2	2	2	2	2	1	2	2
Synedra delicatessima	2	2	1	1	2	1	1	1	.	1
Diatoma elongatum	1	.	.	.	.	1	1	1	.	.
Diatoma strips	.	.	.	.	.	.	.	.	3	1
Fragilaria crotonensis	1	1	2	1	1	1	1	1	.	1
Melosira granulata	4	5	5	5	5	4	3	3	3	3
Cyclotella sp.	1	.	.	.	.	.	.	.	.	.
Attheya zachariasae	1	1	.	1	.	.	.	.	.	.
Melosira sp.	.	.	1	.	1	.	.	.	.	.
Total number of species:	41	32	36	29	28	28	28	32	25	30

19 t/m 24 = open water
25 = 100% *Nymphaea alba*
26 = 50% *Nymphaea alba*
27 = 100% *Nymphoides peltata*
28 = 100% *Nymphaea alba*

See also map fig. 1

Depth: 19 = 2 meters
20 = 3 „
21 = 4 „
22 = 5 „
23 = 3 „
24 = 2 „
25 t/m 28 = 1—2 „

The whole column of water from bottom to surface was vertically hauled.

TABLE 5. Microorganisme of the shallow parts of the Kil-south. (August 23, 1955)

Sampling places	29	30	31	32	33	34	35	36	37	38	39
	South-eastern part							Southern part			
Crustacea :											
Acroperus harpae	1	1	2	2	1	2	.	.	1	1	.
Alona quadrangularis	1	1	.	1	.	.	.	1	.	1	.
Scapholeberis mucronata	1	.	.	1	.	1	.	1	.	.	.
Simocephalus vetulus	.	1	1	1	1	1	.	.	.	1	.
Ceriodaphnia pulchella	.	1	2	.	.	1	1	.	.	.	.
Camptocercus macrurus	.	.	1	.	.	.	.	1	.	.	.
Peracantha truncata	1	.	1	1	.	.	.	1	.	.	.
Eurycercus lamellatus	.	.	1	1	.	.	.	.	.	.	.
Chydorus sphaericus	.	.	.	.	1	.	.	.	.	.	1
Diaphanosoma brachyurum	.	.	.	.	1	.	.	1	.	.	.
Graptoleberis testudinaria	.	.	.	.	1	.	.	1	.	.	.
Bosmina longirostris	.	.	.	.	.	.	1	.	.	.	.
Sida crystallina	.	.	.	.	.	.	.	.	.	.	1
Ostracoda	1	1	1	1	1	1	1	1	1	1	1
Cyclops sp.[1])	1	1	1	1	1	2	2	1	1	1	1
Canthocamptus	.	.	1	1	1	1	.	1	.	.	.
Rotifera :											
Euchlanis dilatata	1	1	.	1	.	1	.	1	1	1	1
Brachionus bakeri	1	1	.	.	1	1	1	.	.	1	.
Salpina mucronata	1	1	1	1	1	.	1	1	.	.	1
Gastropus stylifer	.	1	1	1	.	1	.	.	.	.	.
Pterodina patina	.	1	1	.	1	1	1	.	.	.	.
— *mucronata*	.	1	.	.	.	.	.	.	.	.	.
Philodina aculeata	.	.	.	.	.	1	.	.	.	1	.
Dinocharis pocillum	.	.	.	.	.	1	.	.	.	.	1
Pompholyx sulcata	.	.	1	1	.	.	.	.	.	.	.
Cathypna luna	.	.	.	1	.	1	1	.	.	.	.
Trichocerca cylindricus	.	.	.	1	.	1	.	.	.	.	.
Floscularia mutabilis ?	.	.	.	.	.	.	1	.	.	.	.
Anureopsis hypelasma	.	.	.	.	.	.	1	.	.	.	.
Polyarthra trigla	.	.	.	.	.	.	2	1	.	1	1
Keratella cochlearis	.	.	.	.	.	.	1	1	.	1	1
Filinia longiseta	.	.	.	.	.	.	1	.	.	.	1
Monommata longiseta	.	1	.	.	.	.	.	.	.	1	.
Metopidia sp.	.	.	.	.	1	.	.	.	.	.	.
Notholca longispina	.	.	.	.	.	.	.	.	.	1	.
Noteus quadricornis	.	.	.	.	.	.	1	.	.	.	.
Synchaeta pectinata	.	.	.	.	.	.	1	.	.	.	.
Asplanchna sp.	.	.	.	.	.	.	1	.	.	.	.
Stephanops lamellaris	.	.	.	.	.	.	.	.	.	1	1
Trichocerca capucina	.	.	.	.	.	.	.	.	.	.	1
Protozoa :											
Arcella vulgaris	1	1	2	2	2	2	2	2	.	1	1
Difflugia corona	1	.	.	1	.	1	1	1	.	1	1
— *lobostoma*	.	1	.	.	1	1	1	1	1	1	1
— *pyriformes*	.	.	1	.	.	.	.	.	.	.	.
— *acuminata*	.	.	.	.	.	.	.	1	.	.	.
Phacus longicauda	1	.	.	.	.	.	.	.	.	.	.
— *pleuronectes*	.	1	.	.	1	.	1	.	.	.	.
Euglena sp.	.	.	.	.	1	1	.	.	.	.	.
Insecta :											
Corethra larvae	.	.	.	1	1	.	1	.	.	.	.
Chironomus larvae	1	.	1	.	.	1	.	1	1	.	.
Ephemerid larvae	.	1	.	.	.	1	.	1	1	.	.
Vermes :											
Nematodes	.	.	1	1	.	1	.	1	.	.	.
Stylaria lacustris	.	.	1	.	.	1	.	1	.	1	.
Chaetogaster limnei	.	.	.	1	.	.	.	.	.	.	.
Plumatella repens (cysts)	.	.	.	.	.	.	1	3	3	1	3
Asellus aquaticus	.	.	.	1	.	.	.	1	.	.	.

TABLE 5. Continued

	South-eastern part						Southern part				
Flagellatae :											
Peridinium cinctum	1	1	1	1	1	.	.	.	.	.	.
Ceratium hirundinella	.	.	.	.	.	.	1	1	1	.	1
— *curvirostre*	.	.	1	1	2	1	1	.	.	.	.
Dinobryon sertularia	1	1	1	1	2	1	1	1	.	1	2
— *stipitatum*	.	.	.	.	.	.	.	.	.	.	1
Synura uvella	.	1	1	1	2	1	.	.	.	.	.
Trachelomonas volvocina	.	.	.	.	.	.	.	.	.	.	1
— *hispida*	.	.	.	.	.	.	1	.	.	.	.
— *armata*	.	.	.	.	.	.	1	.	.	.	.
— sp.	.	1	.	.	.	.	.	.	.	.	.
Eudorina elegans	.	.	.	.	.	1	1	.	.	1	1
Chlorophyceae :											
Pediastrum duplex	1	1	.	.	.	1	1	.	.	1	1
— *tetras*	1	.	.	.	.	.	.	.	.	.	.
Scenedesmus quadricauda	.	.	.	.	.	.	.	.	.	1	1
Spirogyra sp.	1	.	1	1	.	1	1	1	1	1	1
Mougeotia sp.	3	1	1	.	1	1	.	.	1	1	1
indet. green-algae filaments	4	3	.	.	.	3	.	.	.	.	.
Desmidiaceae :											
Staurastrum gracile	.	.	.	.	.	.	.	.	.	.	1
— sp.	.	.	.	.	1	.	.	.	.	.	.
Cosmarium botrytis	1	1	.	.	1	.	.	.	.	.	.
— sp.	.	1	1	1	.	1	.	.	.	1	.
Euastrum sp.	1	.	.	.	.	.	.	.	.	.	.
Penium sp.	.	.	.	.	.	.	.	.	.	.	1
Closterium moniliforme	.	1	1	1	1	1	.	1	1	.	1
Docidium sp.	.	1	.	.	.	1	.	.	.	.	.
Cyanophyceae :											
Aphanizomenon flos-aquae	1	.	.	.	2	1	2	1	1	2	1
Oscillatoria sp.	.	.	.	.	.	.	1	.	.	1	.
Diatomeae :											
Fragilaria crotonensis	1	1	.	.	.	1	1	.	1	1	1
Diatoma elongatum	1	.	.	.	.	.	1	.	.	.	1
Pinnularia viridis	1	1	.	1	.	.	.	.	.	.	.
Asterionella formosa	1	1	.	.	1	1	1	1	1	2	1
Gomphonema sp.	.	1	.	.	.	.	.	.	.	.	.
Epithemia zebra	.	1	.	1	1	.	.	.	.	.	.
Synedra delicatissima	.	.	1	1	1	1	1	.	1	1	1
Melosira granulata	.	.	.	.	1	1	4	3	2	3	3
Nitzschia sigmoidea	.	.	.	.	.	.	1	.	.	1	.
Diatoma strips	.	.	.	.	.	.	.	.	.	1	1
Synedra acus	.	.	.	.	.	.	.	.	.	2	.
Total number of species	28	34	29	36	31	43	40	30	17	36	36

29 = between *Schoenoplectus lacustris*
30 = „ „ „
31 = „ *Equisetum fluviatile* see also map fig. 1
32 = „ „ „
33 = bottom between *Nymphea alba* (submerged)
34 = *Sparganium erectum*
35 = open water (shallow)
36 = *Typha angustifolia*
37 = *Phragmites communis*
38 = „ „
39 = „ „

[1]) In the south-eastern part *Cyclops albidus*, in the southern part *C. oithonoides*. Greatest depth 1 meter.

TABLE 6. Micro-organisms present in the shallow Kil-north. (August 19, 1955).

Sampling-places :	40	41	42	43	44	45	46	47	48	49
Crustacea :										
Cyclops sp.	1	1	3	3	3	3	2	1	2	2
Sida crystallina	1	1	.	.	.	.	.	.	.	.
Ceriodaphnia pulchella	1	.	1	1	.	.	1	.	1	.
Alona sp.	2	1	1	1	.	.	.	1	.	.
Chydorus sp.	1	1	1	2	.	.	.	2	1	1
Bosmina sp.	.	.	.	.	.	.	1	.	.	.
Camptocercus macrurus	1	.	.	.	.	.	.	.	.	1
Scapholeberis mucronata	1	1	.	.	.	.	.	1	.	1
Peracantha truncata	1	1	.	1	.	.	.	1	.	1
Camptocercus rectirostris	2	.	1	.	.	.	.	.	.	1
Graptoleberis testudinaria	1	1	.	1	.	.	.	1	.	.
Acroperus harpae	1	.	1	1	.	.	.	.	.	1
Ostracoda	1	.	1	1	.	.	.	1	.	1
Harpacticids	1	.	.	.	.	.	.	.	.	.
Diaphanosoma brachyurum	.	1	.	.	.	.	.	.	.	.
Eurycercus lamellatus	1	1	1	.	.	.	.	.	.	1
Simocephalus vetulus	.	.	3	.	.	.	.	.	1	1
Diaptomus sp.	.	.	1	.	.	.	1	.	1	.
Pleuroxus trigonellus	.	.	.	1	.	.	.	.	.	.
Rotifera :										
Scaridium longicauda	.	.	.	.	.	.	.	.	1	.
Asplanchna sp.	.	1	.	1	1	1	2	.	.	.
Pterodina patina	1	1	1	1	.	.	.	1	.	1
Salpina mucronata	1	.	.	.	.	.	.	.	.	.
Euchlanus dilatata	1	.	1	.	.	.	.	1	1	.
Brachionus bidens	.	1	.	1	.	.	.	1	1	.
— *bakeri*	1	1	1	1	.	.	.	1	.	.
Rattulus sp.	1	1	.	.	.	.	.	1	.	.
Diurella stylata	.	.	.	1	.	.	.	.	.	.
Monostyla quadridentata	.	.	.	.	.	.	.	.	1	.
Keratella cochlearis	.	1	1	3	4	4	4	1	1	1
— *quadrata*	.	1	1	1	1	1	1	.	.	.
Polyarthra trigla	.	1	1	2	1	1	1	1	1	.
Filinia longiseta	.	.	.	1	2	1	2	1	.	.
Gastropus stylifer	.	1	.	.	1	1	.	.	.	.
Anureopsis hypelasma	.	1	.	1	1	1	.	1	1	.
Mastigocerca carinata	.	.	.	.	.	.	.	.	1	.
Cathypna luna	.	.	.	.	.	.	.	1	1	.
Dinocharis pocillum	.	.	.	.	.	.	.	1	1	.
Monostyla lunaris	.	.	.	.	.	.	.	.	1	.
Synchaeta sp.	.	.	.	1	1	1	1	1	.	.
Rotifer vulgaris	.	.	.	1	.	.	.	.	.	.
— *neptunius*	.	.	.	1	.	.	.	.	.	.
Protozoa :										
Arcella vulgaris	3	2	1	1	.	1	1	1	1	1
Difflugia lobostoma	3	1	1	1	.	1	1	1	1	1
— *corona*	1	1	.	.	.	.	.	1	.	2
— *pyriformes*	.	.	.	.	.	.	.	.	1	.
Phacus longicauda	.	1	.	1	1	.	1	1	1	.
— *pleuronectes*	.	.	.	.	.	.	.	1	1	.
Insecta :										
Chironomus-larvae	1	.	1	1	1	1	1	.	.	1
Corethra-larvae	.	.	.	.	1	1	1	.	.	.
Corixa sp.	.	.	1	.	.	.	.	.	.	.
Ephemerids	.	.	.	.	.	.	.	.	.	1
Bryozoa :										
Plumatella repens (cysts)	2	1	1	3	.	1	.	3	1	1
Stylaria lacustris	1	.	.	.	.	.	.	.	.	.
Nematods	.	.	1	.	.	.	.	.	.	.

TABLE 6. Continued.

Flagellatae :										
Dinobryon sertularia	.	1	1	2	5	5	4	1	1	1
— *divergens*	.	1	1	2	5	5	4	1	1	1
Synura uvella	.	.	.	.	.	.	.	.	1	.
Ceratium hirundinella	.	1	.	.	.	.	1	.	.	.
Ceratium curvirostre	.	1	.	.	.	.	.	.	.	1
Mallomonas sp.	.	.	.	.	5	5	2	.	.	.
Peridinium sp.	.	1	1	.	4	4	2	1	.	1
Trachelomonas sp.	.	1	1	1	1	1	.	.	.	.
Euglena sp.	.	1	1	.	3	3	1	1	.	1
Volvox aureus	.	.	1	.	.	.	.	.	.	.
Chlorophyceae :										
Scenedesmus quadricauda	.	1	.	.	.	.	.	.	.	.
Pediastrum duplex	.	1	.	.	.	.	.	.	1	.
Mougeotia sp.	1	1	.	.	.	.	.	.	1	2
Spirogyra sp.	1	.	1	.	.	.	.	.	.	.
Desmidiaceae :										
Closterium moniliforme	1	.	.	.	.	1	.	.	.	.
— *pronom*	.	1	.	.	.	.	.	.	.	.
— sp.	.	.	.	1	.	.	.	.	1	1
Cosmarium botrytis	.	1	.	1	.	.	.	.	1	.
Staurastrum sp.	.	.	1	.	.	.	.	.	.	.
Cyanophyceae :										
Dyctiosphaerium ehrenbergi	.	.	.	.	.	.	.	.	2	.
Arthrospira sp.	.	.	.	.	.	.	.	.	1	.
Aphanizomenon flos-aquae	3	2	1	.	.	.	.	.	.	.
Osciliatoria sp.	.	1	.	.	.	.	.	.	.	1
Botryococcus brauni	.	.	.	.	.	.	.	.	.	1
Diatomeae :										
Diatoma elongatum	.	1	.	.	.	.	.	.	.	.
Navicula div. sp.	.	.	.	.	.	.	.	.	1	1
Melosira granulata	4	3	1	.	.	.	.	.	.	.
Diatoma strips	3	1	.	1	.	.	1	.	.	3
Fragilaria crotonensis	1	1	1	.	.	.	.	.	.	.
Asterionella formosa	2	2	1	.	.	.	.	1	.	1
Synedra delicatessima	.	1	.	1	.	.	.	1	1	1
Nitzschia sigmoidea	.	.	.	.	.	.	.	.	1	.
Total numbers of species :	33	45	35	35	18	20	23	30	34	31

40 = *Nymphaea, Nuphar, Utricularia;* covering 75%
41 = „ „ „ „ 50%
42 = *Potamogeton obtusifolium*
43 = *Nuphar*: covering 25%
44 = ± open water, shallow
45 = ± open water, shallow
46 = ± open water, shallow
47 = *Nymphaea* and *Nuphar*; covering 75%
48 = *Potamogeton* in connecting ditch
49 = *Nymphaea* near the bottom.

1 = plankton present
2 = „ scarce
3 = „ much
4 = „ very much
5 = „ abundant

Greatest depth 2 meters.
See also map fig. 3.

7. POND PLANKTON OF THE KIL-SOUTH

The shores of the Kil-south are shallow and covered by waterplants. The large south-eastern part is wholly covered with the leaves of *Nymphaea alba, Nymphoides peltata* and *Nuphar luteum* and there is a dense growth of *Utricularia vulgaris* and *Potamogeton spp.* (see fig. 1). The covering of plants at the surface of the water ends abruptly towards the deep open water on the west-side. The depth of the water in the covered zone with floating vegetation is no more than 2 meters. Samples of micro-organisms were taken by vertical hauls from bottom to surface between the waterplants at different spots. The species are recorded in table 5.

The table does not show any characteristic difference between the populations of micro-organisms at the different points among the vegetations of *Nymphaea, Nuphar, Phragmites, Equisetum* etc.

Only the total population of the south-eastern part and the southern part differ. The micro-organisms of the southern part are nearly all plankters occurring in open water also. The following lists give the different species of the southern part and the south-eastern part:

Occurring mostly in the south-eastern part:	Occurring mostly in the southern part:
Simocephalus vetulus	*Euchlanis dilatata*
Ceriodaphnia pulchella	**Polyarthra trigla*
Salpina mucronata	**Keratella cochlearis*
Gastropus stylifer	**Filinia longiseta*
Pterodina patina	**Notholca longispina*
Arcella vulgaris	*Difflugia corona*
**Phacus* sp.	**Difflugia lobostoma*
**Peridinium cinctum*	**Ceratium hirundinella*
Ceratium curvirostre	**Eudorina elegans*
Synura uvella	**Aphanizomenon flos-aquae*
most Desmidiacea	**Asterionella formosa*
larvae of insecta	**Melosira granulata*
	Plumatella repens (statoblasts)

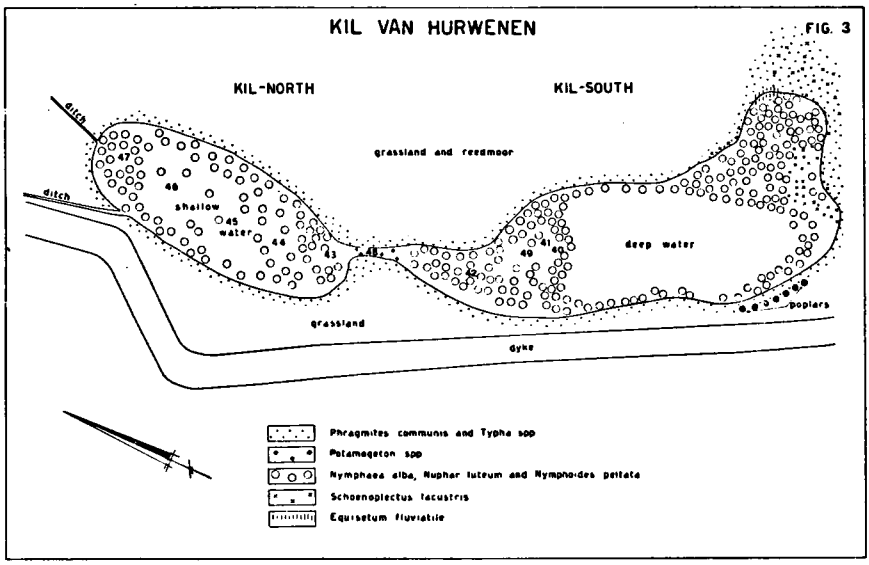
The species marked * occur in the deep open water of the Kil also. Their distribution in the vegetation near the shore has been caused by currents, carrying them far into the vegetation of the southern part. This part is the wind-exposed side of the Kil. The south-eastern part is not influenced by the open water. The water is not deep, the floating vegetation acts as a light screen, the water stagnates, vertical currents only occur. Therefore the environmental circumstances are different. The presence of the Peridinian, *Ceratium curvirostre,* and a few other plankters, is striking, because they live in oligotrophic waters. REDEKE (1948) notes, that this species is found in heather pools. Recently, *C. curvirostre* was found in the "Vechtplassen" near Kortenhoef, a reed and moorland with some shallow oligotrophic waters. (see "Kortenhoef" 1955). Probably this part of the Kil is also oligotrophic. On the sampling place 33, where *Ceratium curvirostre* occurs most abundantly, a chemical analysis of the water has been made and also of the open water at point 11.

	Sampling place 33	Sampling place 11
p_H	7,3	7,9
$KMnO_4$-consumption	15	15
NH_4 (mg/1)	2	3
Methylenblue-test	no decoloration after 96 hours	no decoloration after 96 hours
NH4 (mg/)	0,0	0,0
NO_2 (,,)	0,0	0,0
NO_3 (,,)	0,0	0,0
Cl_2 (,,)	60	57

There is no real difference between the two samples. An oligotrophic character of the water is chemically not present. The small total quantity of plankton apparently gives the water an oligotrophic character.

Further investigations on this subject are required.

It is interesting to note, that C. *curvirostre* (and also *Utricularia vulgaris*) is absent in the Kil-north.



8. Plankton of the Kil-north

The Kil-north has no deep water. It communicates with the other part of the Kil and periodically with the river (see map fig. 3). The depth is about 2 meters, the bottom is covered with a thick layer of mud and there is a dense growth of waterplants. The centre is almost free of waterplants. Table 6 enumerates the plankton species. The sampling places are given in figure 3.

The pond plankton from the Kil-north differs from the Kil-south. To the naked eye already, the colour of the water clearly differs. The southern part is light-brown, the northern part yellowish-brown. The total numbers of species in the Kil-north is far smaller than in the Kil-south. The number of individuals of each species on the other hand is much higher. This is a phenomenon often seen in waters with abundant organic and inorganic substances. The majority of the plankters in the open water of the Kil-north and of the Kil-south are listed here:

Kil-north most important species of the open water :	*Kil-south* most important species of the open water :
Cyclops sp. (*albidus* e.o.)	*Cyclops oithonoides*
Keratella cochlearis	*Keratella cochlearis*
Filinia longiseta	*Filinia longiseta*
Dinobryon sertularia	*Polyarthra trigla*
Dinobryon divergens	*Aphanizomeneon flos-aquae*
Mallomonas caudata	*Asterionella formosa*
Peridinium sp.	*Synedra delicatessima*
Euglena sp.	*Melosira granulata*

The above data show, that there is a real difference between the two parts. This is caused by different environmental circumstances. In the Kil-north the vegetation is denser and the water shallow. The Chlorophycea, Desmidiacea, Cyanophycea and Diatomea are absent in the open water. Flagellatae such as *Dinobryon, Mallomonas, Peridinium* are present in relative large numbers and various species. As a rule Flagellatae develop well in wind-protected shallow waters. The Kil-north is protected by a high dike and high poplars.

A chemical analysis of the water was made for comparison. The result as compared with that of the Kil-south is as follows:

	Kil-north	*Kil-south*
p_H	7,6	7,9
KMnO4-consumption	21	15
NH_4 (mg/1)	0,0	0,0
NO_2 (,,)	0,0	0,0
NO_3 (,,)	0,0	0,0
Cl_2 (,,)	78	57
B.O.D. ,,	6	3
Methylenblue-test	no decoloration after 96 hours	no decoloration after 96 hours

The chemical analyses do not differ much. The amount of chlorine and organic matter is a little higher in the Kil-north. The B.O.D. is low, but as high as for the river Waal. The influence of polluted riverwater is demonstrated by chemical and biological analysis.

The plankton in the Kil-north is eutrophic and the total number of species increases among the waterplants.

9. Summary

An inventarisation of the plankton living in an old branch cut off from the river Waal has been made on August 16, 19 and 23, 1955. In the deep part lake plankton (Limnoplankton) was found, and in the shallow parts pond plankton (Heleoplankton) occurs.

Some rare plankters typical for oligotrophic waters were found in a certain part of the river branch. A chemical analysis of this part of the water shows no real difference with other parts.

The part of the old branch connected with the river Waal has a plankton community of its own. This is caused by the polluted river water.

The horizontal distribution of plankton on August 16, 1955, was investigated.

The vertical distribution of plankton investigated on August 28, 1941, is also given.

10. Conclusions

1. In eutrophic shallow water oligotrophic habitats may occur.
2. An investigation into the micro-organisms and the chemical compounds in the water of an old river branch of the Waal, shows the influence of polluted water on orginally unpolluted water.
3. Conservation of unpolluted old river branches is therefore emphasized. A selection should be made of yet existing unpolluted old river branches, and some of the best protected as nature reservates.

LITERATURE

HEUSDEN, G. P. H. VAN —
1945 Waarnemingen in enige „wielen" in de Betuwe. — Tijdschrift van het Kon. Nederl. Aardrijksk. Gen., 52 (2).

GRAAF, Fr. DE —
1955 De micro-organismen van plankton, lasion en bodem van het plassengebied Het Hol. — Published in: „Kortenhoef", Stichting „Commissie voor de Vecht en het oostelijk en westelijk plassengebied". — Amsterdam, 1955.

REDEKE, H. C. —
1948 Hydrobiologie van Nederland. — Amsterdam 1948.

WELCH, P. S. —
1935 Limnology.

For sale by the Administration of the Zoological Museum, Amsterdam
Price f 1.50 (Dutch Guilders)