CHAPTER VII

DISCUSSION

The Dal is an eutrophic lake, i.e., shallow with large quantities of organic material present at the bottom and even in suspended state; "trophy" is used here in the sense of Fageri (1954) meaning the physico-chemical nature of the lake water and this may be read with Pearsall's (1923) contention. Due to abundance in aquatic vegetation the basic fertility of the lake is high. In contrast to the usual conception that in summer there is lack of oxygen in deep waters, it has been noted that it is only in autumn that deep waters are depleted of oxygen due to the surface of lake being thickly covered with decaying macro-vegetation and lot of chlorophyllous algae which utilize the maximum oxygen. However, the results obtained in this study are typical of northern latitude temperate lakes, namely low nutrient concentration, great phytoplankton heterogeneity, it is probably caused by turbulence of lake water during spring, run off from melting snow, sudden summer storms etc.

Composition

Fig. 61 shows the total volume values of phytoplankton standing crop at 0 m to 5 m during the period of investigation. It appears that maximum development occurred at 0-1 cm and 5.0-m depth, interesting showing a gradual decrease in
numbers from 0 to 2 m, less so from 3-4 m and a sudden rise from 4-5 m. But at individual sites, the pattern was not so marked.

In 1968, data for winter alone were collected and this winter was in no way serve than the winters in 1969 or 1970. During 1969 the total quantitative counts were 861,600 cells/c.c., respectively, 698,630 cells/c.c., and for the Dal and the Nagin; and for 1970 (except winter) 561,630 cells/c.c., and 432,820 cells/c.c., respectively; but considering data except winter in both, 1970 appeared to be richer in numbers, but not in genera or species. The composition of various groups given in Tables 69 and 70 and Figs. 33-49, reveal that the composition at all the depths was even with respect to each group but there was marked deviation between the surface and the bottom layers but lesser so between the middle and the bottom layers. This deviation was more pronounced in spring (surface and bottom) and winter (middle and bottom). On the basis of the data available, the frequency of genera were as follows:

a) most common genera: Sphaerella, Gloeocystis, Chlorococcum, Oocystis, Ulothrix, Uronema, Cladophora, Oedogonium, Spirogrya, Tribonema, Melosira, Syndra, Cocconets, Navicula, Cymbella, Amphora, Epithemia, Microcystis, Gloeocapsa, Oscillatoria, Nostoc, Anabeana, Calothrix, Stigonema.

b) less common genera: Sphaerocystis, Ankistrodesmus, Crucigenia, Scenedesmus, Hormidium, Cylindrocapsa, Microspora, Pithophora, Sphaeroplea, Cheatomorpha, Zygnema, Mougeotia, Cosmarium.
Both the lakes, though not very deep, do not have a significant influx of water and the phytoplankton was characterized by Chlorophyceae and Bacillariophyceae. Willen (1961) on the other hand, found in Lake Osbysjon that the phytoplankton was characterized by Chrysophyceae during winter and Myxophyceae, desmids, and diatoms playing a secondary role. Interestingly in the present lakes the desmids were particularly insignificant. Normally our lakes do not get covered with the ice but the immediate melting of snow in the adjoining hills and plains cause great development after the ice had melted, of Chlorophyceae and Bacillariophyceae compared to Osbysjon where Myxophyceae, Chlorophyceae,
and Crytomonadineae show great development.

**Physical Conditions.**

The environment is singled out in this discussion in order to examine the relative importance of the individual factors. But the nature of the present material does not permit an examination of the combined effect of light and temperature because the phytoplankton are the result of earlier prevailing environmental conditions but the nutrient concentrations at the times of sampling afford little information about these conditions. However, temperature does, to a certain extent characterize the earlier prevailing conditions (Arnemo & Nauwerck, 1965).

During the present investigation on diurnal changes a similar trend was observed in Myxophyceae, Chlorophyceae and Bacillariophyceae which showed decrease in quantitative numbers from 1300 hrs. to 2300 hrs., the decrease in quantitative numbers being more marked in the former two groups and sudden at 1900 hrs. and 2300 hrs. This is also observed to be associated with the decrease in water temperature.

On 11-11-1970 the observations were continued for 24 hrs. and it was observed that the surface water temperature showed a steady increase from midnight to 1700 hrs., after which there was a decline. A similar situation existed in the atmospheric temperature but the bottom temperature did not show similar trend.

The pH values at surface and bottom did not also show a regular pattern. The phytoplankton maxima in Myxophyceae and Bacillariophyceae were recorded at 1400 hrs. but in Chlorophyceae at 0900 hrs. in the surface layers, though all being comparatively lesser at 2400 hrs. However, the bottom layers in Myxophyceae and Bacillariophyceae had peak at 0400 hrs. and in Chlorophyceae at 2400 hrs. On the whole, the plankton were more gregarious in surface layers during the day due to obvious reasons.
Kondrat' Eva (1958) observed that the phytoplankton increased during day and decreased during night.

The lake water responded relatively quickly to changes in air temperature as in Hyttodammen (Arnemo, 1964) but did not delay in warming up in spring and cooling up in winter as found by Arnemo (1965).

The fluctuations in the atmospheric temperature and the surface water temperature showed more or less identical pattern. The temperature was low from November to March. After this it showed a study rise till August with rather study readings in June to September. The annual range of variation in atmospheric temperature during 1969 was 21°C and during 1970 21.1°C. The range of variation in surface water temperature respectively was 23.2°C in 1969 and 24.7°C. Maximum temperature was reflected in summer phytoplankton and autumn phytoplankton showing thereby that maximum number of phytoplankton was produced during the period of minimum fluctuations in water temperature. Thus it appears that water temperature affects the seasonal cycle of phytoplankton.

The horizontal spatial variations in temperature were not of much significance, in the Dal, there being never more than 2 degrees difference and the same may be true of vertical spatial temperature differences which showed hardly more than 1 degree difference. Arnemo and Nauwerck (1965) also found that temperature did not show much variation in horizontal and vertical direction. It appears that thermal stratification is very brief because of continual circulation. But Munawar et al. (1967) found that a polluted pond exhibited a well marked thermal stratification in summer. Taking the lakes in general it appears that a higher assimilating efficiency was correlated with higher temperatures in summer as shown by the distribution of phytoplankton and the horizontal distribution of phytoplankton with respect to temperature showed that the succession of dominant groups was Chlorophyceae and Bacillariophyceae in summer, Myxophyceae in autumn, Bacillariophyceae in winter and
Chlorophyceae in spring.

The temperature difference between winter and summer were much varied and the highest development of phytoplankton was in the middle of highest temperature times as found by Arnemo and Nauwerck (1965) in Hyttodammen. They believed that the situation was the result of the Chlorophyceae dominating the lakes at this time. No doubt this is dependant on the species composition of different groups at different times in the year, a fact which could not be determined in the present investigation. However, unlike in that lake the phytoplankton composition was numerically dominated by Bacillariophyceae followed by Chlorophyceae and Myxophyceae. The Chrysophyceae was not of much significance in the present lakes.

The Cryptomonadineae, Dinophyceae, and Euglenineae never dominated phytoplankton at any season of the year, perhaps they are prone to low temperatures and therefore well adapted to autumn conditions. Hilliard (1968) also found in Chrysophyceae that temperature had a great effect on its growth and seasonal variation. The autumn temperatures also appear to be favourable to Myxophyceae which together with the aforesaid groups are known to show the lowest efficiency of assimilation. The Bacillariophyceae dominated the phytoplankton at the end of the investigation periods, i.e., winter when the temperatures were the lowest and taking this into consideration their efficiency must be considered to be very high.

Danilov (1963) pointed out that seasonal changes were mainly dependant on water temperature in Gidigich reservoir. Hanebrink (1965) however, found that high temperature of surface water caused decrease in planktonic counts in Sardis reservoir. The position in our lakes is summarized below:

<table>
<thead>
<tr>
<th>Season</th>
<th>Temperature</th>
<th>Phytoplankton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>5.5/3.3</td>
<td>153,840</td>
</tr>
<tr>
<td>Summer</td>
<td>26.8/23.9</td>
<td>222,460</td>
</tr>
<tr>
<td>Autumn</td>
<td>16.2/13.0</td>
<td>224,920</td>
</tr>
<tr>
<td>Winter</td>
<td>3.6/2.6</td>
<td>260,380</td>
</tr>
</tbody>
</table>
The pH values did not show a marked fluctuation, thus does not prove to be useful as an index of productivity (Moyle, 1946), and it remained usually at near about 7.0. The range of variation was 6.2 to 8.4 in 1969 and 5.9 to 8.6 in 1970. The pH of surface waters in the various zones of the lakes (Figs. 64 and 65) also corroborate this fact. Narrow fluctuations in pH have also been recorded in lakes by Kato (1941), Henson et al. (1961), and Michael (1969). The afternoon readings were always higher than those of the morning hours as also found by Michael (i.e.) and as remarked by Bhardwaja (1940) this is attributed to photosynthesis and respiratory activities of various organisms in winter.

Normally the seasonal fluctuation in water level did not have a close relationship with the amount of rainfall because it is not the rains but the melting of snow on the nearby mountains and clear demarcation of different seasons that regulates the seasonal biological rhythms in contrast to that in tropics where according to Carter (1960) it is rainfall that is responsible for it. However, in 1969, a situation did exist when the rainfall caused an abnormal situation.

In March the water level in the Dal was 4.47 m as maximum in the deeper parts and 0.53 m as the minimum near the banks. The level of water went up with the onset of the heavy rains in the last part of April because of considerable amount of snowfall i.e. 97 mm on 29th April 1969. Due to that the water level in the Dal in the month of May was 5.0 m in the centre and 0.92 m near the banks. Similarly in the Nagin also the fluctuations were of the same magnitude. In March the maximum in the centre was 5.39 m while as minimum near the banks was 0.43 m and with rains, in May it was 6.71 m and 1.24 m respectively. In August it went down to 5.91 m in the centre and 0.57 m near the bank.

These heavy rains and snowfall had a great impact on the vegetation. The floating vegetation was altogether washed ashore with nothing being on the surface of water. The second great thing was the delay in the flowering season of almost all the flowering plants present in the lakes.
The phytoplankton were less in frequency correspondingly.

**Chemical conditions.**

Watanabe (1964) found that succession of phytoplankton in lakes was affected by the nutrient salts released by submersed trees and grasses. Willen (1959) found that extra quantities of phosphate increased phytoplankton development both numerically and volumetrically except when high production of filamentous algae and diatoms occurred.

Mc Combie (1953), Bamforth (1958) have observed that silt, microscopic organisms, and suspended water organic matter are the factors effecting transperancy of water. Thus fluctuations in turbidity values were observed during the present studies in June to October. This was practically due to the silt being washed in the rains and the same getting settled subsequently. According to Jermolajev (1958) heavy and deep turbulence is known to prevent development of phytoplankton and also zooplankton which feed on them. Thus the plankton content of the lakes was comparatively lower during July and August and the total phytoplankton counts were lower than those in winter.

On the other hand, the fluctuations of dissolved oxygen contents did not reveal a definite seasonal trend. Perhaps temperature and rainfall do not directly influence the amount of oxygen present and it is possible that at any given period, as suggested by Michael (1969), the quantity of dissolved oxygen is dependent on the various biological processes taking place in the medium.

The concentration of carbon dioxide was found from zero in July to maximum of 5.7 in November. The absence of CO₂ in July was related with the presence of heavy phytoplankton populations of Chlorophyceae as also found by Armitage (1962) in U.S.A. The increase in CO₂ content showed a close relationship with the increase in numbers of diatoms. The pH values showed a corresponding decrease during this period thereby indicating an inverse relationship between
these two factors as also observed by Micheal (1969). The total alkalinity values of the lake ranged between 91 ppm to 120 ppm but the alkalinity values did not show a regular pattern except that the higher values were associated with higher values in dissolved oxygen and carbon dioxide. The higher values in summer can no doubt be compared with the rise in temperature which induces excessive evaporation thus causing increase in alkalinity (see also Hazelwood and Parker, 1961). Mookerjee and Bhattacharya (1949) have stated that rainfall decrease total alkalinity. This is also shown by our data of 1969 (see Tables 44 and 56).

Considering the phytoplankton as a whole the present studies reveal the peak period to be winter (December-March) mainly because of the preponderance of the diatoms in this period and it appears that with gradual rise in temperature in water from Feb. onwards provided optimum conditions for growth and reproduction of Chlorophyceae. As plankton form the direct food of different species of the fish and the grazing activity of zooplankton also cause fluctuations in phytoplankton abundance (Sladek 1958). Thus it has been found that individual genera show different seasonal patterns but most of them together exhibit a single annual peak, and the difference in the yearly variation in the quantity of plankton in the two lakes under consideration is rather a routine feature as found by Welch (1962), Dineen (1963), and Micheal (1969). However, variations in total amount of planktons in different months is known to have direct effect on fish growth (Fig. ). This has also been found the case by Micheal (1969) and others for references see Micheal 1969).

Talling (1966) recorded thermo-stratification in December and January with depletion of oxygen, decrease of pH, and an increase of silica in deeper waters. Nitrates and iron were the limiting factors for phytoplankton growth in December-February, and August maxima. Fee (1967) found that high water with resulting turbidity during spring acted as a major limiting factor in diatom populations.
Fig. 61 shows a comparison of total phytoplankton counts in relation to composition of water. It appears that in Chlorophyceae the peak in summer was associated with the highest values of turbidity, D.O, and alkalinity but CO₂ and silicate values were minimum. Understandably these values were maximum in winter when Bacillariophyceae had the peak values (Fig. 35). The higher values of dissolved oxygen are significant and this supported the higher assimilation efficiency of the group. The maximum development of the rest of the groups in autumn is correlated with lower values of dissolved oxygen, and alkalinity.

The periodic rise of silicates in July and October, was 0.675 ppm and 0.560 ppm respectively while as the maximum silicates were in December, being 1.50 ppm.

From the ionic composition of the bottom layers at different sites in the lakes (compared in Figs. 35) we find that the bottom phytoplankton flora shows the following relationship with the ionic composition of the respective sites:

The Dal, July

<table>
<thead>
<tr>
<th>Zones</th>
<th>Station No.</th>
<th>Total phyto plankton</th>
<th>% organic Matter</th>
<th>% total N₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>4,5</td>
<td>140-240</td>
<td>1.135-2.269</td>
<td>0.056-0.143</td>
</tr>
<tr>
<td>S</td>
<td>3</td>
<td>120</td>
<td>0.154</td>
<td>0.070</td>
</tr>
<tr>
<td>NW</td>
<td>6</td>
<td>nil</td>
<td>0.86</td>
<td>0.025</td>
</tr>
<tr>
<td>W</td>
<td>1,2</td>
<td>120-660</td>
<td>0.619-0.722</td>
<td>0.030-0.036</td>
</tr>
</tbody>
</table>

November

<table>
<thead>
<tr>
<th>Zones</th>
<th>Station No.</th>
<th>Total phyto plankton</th>
<th>% organic Matter</th>
<th>% total N₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>4,5</td>
<td>220-330</td>
<td>2.238-4.74</td>
<td>0.143-0.23</td>
</tr>
<tr>
<td>S</td>
<td>3</td>
<td>120</td>
<td>1.960</td>
<td>0.093</td>
</tr>
<tr>
<td>NW</td>
<td>6</td>
<td>540</td>
<td>3.01</td>
<td>0.150</td>
</tr>
<tr>
<td>W</td>
<td>1,2</td>
<td>1020-1140</td>
<td>1.854-4.00</td>
<td>0.091-0.200</td>
</tr>
</tbody>
</table>

The Nain, July

<table>
<thead>
<tr>
<th>Zones</th>
<th>Station No.</th>
<th>Total phyto plankton</th>
<th>% organic Matter</th>
<th>% total N₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>4,5</td>
<td>0-140</td>
<td>1.064-1.982</td>
<td>0.103-0.149</td>
</tr>
<tr>
<td>S</td>
<td>3</td>
<td>260</td>
<td>0.395</td>
<td>0.015</td>
</tr>
<tr>
<td>NW</td>
<td>6</td>
<td>340</td>
<td>1.96</td>
<td>0.093</td>
</tr>
<tr>
<td>W</td>
<td>1,2</td>
<td>60-700</td>
<td>1.96-4.74</td>
<td>0.098-0.23</td>
</tr>
</tbody>
</table>

Contd.
In the Dal, the maximum development was in July at Station No. 3 but in November at Station Nos. 1 & 2. The organic matter (%) at the former was 1.960 while at the latter 0.619-0.722. The phytoplankton counts seemed to show a positive correlation with the percentage of total nitrogen, with the increase in the latter the former also showed rise in numbers.

Population dynamics

The lakes consist of four distinct zones on the basis of macrovegetation but none of these sites characterised the lakes as a whole. The water from Telbal Nala into the Hazaratbal lake does not disturb the biological and environmental conditions except along the adjoining 5-6 m (the outlet at the Dal gate is largely responsible for causing such changes but this area was not considered in the present study). A comparison of data from the various sites in both the lakes indicate that horizontal heterogeneity was never significant and existed only within short distances (in this connection see also Weimann, 1942 and his views on classification and dynamics of shallow waters). Thus the species composition in both the lakes was about the same but the difference of total phytoplankton at various stations and together at zones exhibited and showed a marked variation as shown below:

<table>
<thead>
<tr>
<th>Dal</th>
<th>NE</th>
<th>S</th>
<th>NW</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>161,910</td>
<td>153,295</td>
<td>122,940</td>
<td>195,520</td>
</tr>
<tr>
<td>Nagin</td>
<td>64,570</td>
<td>74,400</td>
<td>32,130</td>
<td>81,910</td>
</tr>
</tbody>
</table>
The variation in numbers was more pronounced in Myxophyceae, Chlorophyceae, and Bacillariophyceae at all the levels in these four main sites. Further the condensed data on the quantitative representation and genera composition reveals that (1) the number of forms with significant quantitative representation was comparatively larger in the Dal. (2) There was no indication of mass outbreaks of genera (singly or collectively) in either lake. (3) Only a few (25) genera were regularly observed at all the sites in the Dal. The irregularities in temporal and horizontal distribution were the rule in the Nagin but less so in the Dal. (4) Significant differences existed between the sites as to the quantities and composition of plankton in both the lakes. No group was exclusively restricted to one site which indicated less of violent surface motion. However, Chlorophyceae and Bacillariophyceae were always highest in numbers at sites 1-12 except, for the absence of Chlorophyceae in winter.

The vertical distribution was strongly pronounced. Some groups known to have their maximum development above the bottom sediments were somewhat unrepresented in mixed samples. The Bacillariophyceae in winter showed the strong pronouncement in vertical distribution but Chlorophyceae and Chrysophyceae had in spring. The Chlorophyceae were almost unrepresented in the middle layer in winter in 1969. The Myxophyceae exhibited this difference in autumn.

However, the horizontal heterogeneity is also due to "local reduction of wave action" (Welch, 1952; Arnemo, 1964) and also the indirect relation with larger aquatic plants. For lakes with rapidly encroaching vegetation as in parts of the Dal and the Nagin there is information about the development of horizontal heterogeneity for various environmental factors (Puke, 1949; Gyéysztor, 1961). Arnemo (1965) has found that in zooplankton the vertical stratification was practically nil and that the horizontal
distribution was not homogenous and irregular, and this was attributed to the different distribution of higher plants. He also found the temperature to be the main factor effecting the populations.

**Seasonal**

The Myxophyceae had peak development in October but the four dominant genera, *Gloeocapsa*, *Oscillatoria*, *Calothrix*, and *Microcystis*, had peaks in Nov. 1968; and *Oscillatoria* had a secondary peak in September 1969 as well.

The Chlorophyceae as a group had their peak in August but of the various orders the situation was that Chlorococcales, Ulotrichales, Cladophorales, and Oedogoniales had their peak in August but Volvocales, Chaetophorales, conjugales, and Siphonales in July (Figs. 66-67). Further, some of the dominant genera individually had their peaks in different months (Figs. 68-109) e.g. *Chlorococcum*, *Scenedesmus*, *Ulotrix*, *Uronema*, *Cladophora*, and *Cosmarium* had peak in November in 1968; but during 1969 and 1970 their peaks, respectively, were in August, September, July, August and September. *Scenedesmus*, *Uronema*, and *Cosmarium* during 1970 had the peaks in August alone.

The Bacillariophyceae had a peak in January and also in Feb. and a secondary peak in October. The position with respect to genera was the same. The Cryptomonadineae had their peak in Sept.-Oct. the Dinophyceae and Euglinineae in August-September.

Javornicky et al. (1962) in his study on seasonal changes, the quantity of entire phytoplankton in the trophogenic layer (0-3 m) found that June showed abundance of Phytoplankton in deeper layers and Javornicky (1965) found Myxophyceae with two peak vegetation phase in Slapy reservoir. He also recorded irregularity in the temporal distribution of seasonal maxima of summer vegetation of phytoplankton. Arnemo et al. (1965) found the higher values of phytoplankton in July and lower in October Spencer (1950) has noted an
autumnal outburst of diatoms. Paganelli (1962-63) (in an artificial lake) in Italy found that Chrysophyceae, diatoms, and Chlorophyceae had three maxima: spring (May), Summer (June, July), and Autumn (October).

Fig. 110 shows distribution of phytoplankton (groupwise) in summer along the zones in our lakes; the phytoplankton showed winter poverty (except in Bacillariophyceae) and spring increase as recorded by Braraud et al. (1968) along the Norwegian West Coast. Stroikina (1963) found seasonal peaks of Myxophyceae in summer, diatoms and Chrysophyceae in spring and a general decrease in phytoplankton in summer and autumn. In our lakes the Myxophyceae had the seasonal peak in autumn; the diatoms in winter, and the Chrysophyceae in summer, the summer being the period of great activity (in general). Babaev (1965) however recorded that the diatoms were dominant in winter and less in summer. Considering the year as a whole, there was a gradual increase in numbers from spring to winter but a sudden fall from winter to spring. In contrast, Bjorg (1952) found in Norway, phytoplankton populations sparse in winter, increasing in summer (especially diatoms) and reaching a peak in September, declining onwards. Gianotti (1962-63) found that the average monthly levels of phytoplankton were strikingly lower than those of the winter months of the same year. Similar was the case in our lakes (in sensu Lato). The situation in our lakes appears to be modified by winter peak of diatoms.
Fig. 61. Total volume values of phytoplankton standing crop at 0-5m during the period of investigation.
Fig. 64. Monthly distribution of Conjugales, Chlorococcales, Ulotrichales, and Volvocales: October 1968 to October 1970 in the Dal.

Fig. 65. Monthly distribution of Siphonales, Oedogoniales, Cladophrales, Chaetophorales: October 1968 to October 1970 in the Dal.
Fig. 66. Monthly distribution of Volvocales, Chlorococcales, Conjugales and Siphonales: March 1969 to October 1970 in the Nagein.

Fig. 67. Monthly distribution of Ulotrichales, Oedogoniales, Cladophorales, and Chaetophorales: March 1969 to October 1970 in the Nagein.

Fig. 68. Monthly distribution of Chlorococcum in the Dal: October 1968 to October 1970.

Fig. 69. Monthly distribution of Ocovatia in the Dal: October 1968 to October 1970.

Fig. 70. Monthly distribution of Scenedesmus in the Dal: October 1968 to October 1970.

Fig. 71. Monthly distribution of Ulothrix in the Dal: October 1968 to October 1970.

<table>
<thead>
<tr>
<th>Surface</th>
<th>Middle</th>
<th>Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>------</td>
<td>------</td>
</tr>
</tbody>
</table>
Fig. 72. Monthly distribution of *Uronema* in the Dal: October 1968 to October 1970.

Fig. 73. Monthly distribution of *Gladophora* in the Dal: October 1968 to October 1970.

Fig. 74. Monthly distribution of *Cedogonum* in the Dal: October 1968 to October 1970.

Fig. 75. Monthly distribution of *Spirogyra* in the Dal: October 1968 to October 1970.

Fig. 76. Monthly distribution of *Coenogonium* in the Dal: October 1968 to October 1970.

Fig. 77. Monthly distribution of *Cymbellar* in the Dal: October 1968 to October 1970.

Fig. 78. Monthly distribution of *Epithemia* in the Dal: October 1968 to October 1970.

Fig. 79. Monthly distribution of *Cocconeis* in the Dal: October 1968 to October 1970.
Fig. 80. Monthly distribution of *Amphora* in the Dal: October 1968 to October 1970.

Fig. 81. Monthly distribution of *Melosira* in the Dal: October 1968 to October 1970.

Fig. 82. Monthly distribution of *Cryptomonas* in the Dal: October 1968 to October 1970.

Fig. 83. Monthly distribution of *Peridinium* in the Dal: October 1968 to October 1970.

Fig. 84. Monthly distribution of *Euglena* in the Dal: October 1968 to October 1970.

Fig. 85. Monthly distribution of *Gleocapsa* in the Dal: October 1968 to October 1970.
Fig. 86. Monthly distribution of *Oscillatoria*

Fig. 87. Monthly distribution of *Calothrix* in

Fig. 88. Monthly distribution of *Microcystis* in
Fig. 89. Monthly distribution of *Chlorococcum* in the Nagin: March 1969 to October 1970.

Fig. 90. Monthly distribution of *Oocystis* in the Nagin: March 1969 to October 1970.

Fig. 91. Monthly distribution of *Scenedesmus* in the Nagin: March 1969 to October 1970.

Fig. 92. Monthly distribution of *Ulothrix* in the Nagin: March 1969 to October 1970.

Fig. 93. Monthly distribution of *Uronema* in the Nagin: March 1969 to October 1970.

Fig. 94. Monthly distribution of *Cladophora* in the Nagin: March 1969 to October 1970.

Fig. 95. Monthly distribution of *Oedogonium* in the Nagin: March 1969 to October 1970.

Fig. 96. Monthly distribution of *Spirogyra* in the Nagin: March 1969 to October 1970.
Fig. 97. Monthly distribution of *Cosmarium* in the Nagin: March 1969 to October 1970.

Fig. 98. Monthly distribution of *Cymbella* in the Nagin: March 1969 to October 1970.

Fig. 99. Monthly distribution of *Epithemia* in the Nagin: March 1969 to October 1970.

Fig. 100. Monthly distribution of *Cocconeis* in the Nagin: March 1969 to October 1970.

Fig. 101. Monthly distribution of *Amphora* in the Nagin: March 1969 to October 1970.

Fig. 102. Monthly distribution of *Melosira* in the Nagin: March 1969 to October 1970.

Fig. 103. Monthly distribution of *Cryptomonas* in the Nagin: March 1969 to October 1970.

Fig. 104. Monthly distribution of *Peridinium* in the Nagin: March 1969 to October 1970.
Fig. 105. Monthly distribution of Euglena in the Nagin: March 1969 to October 1970.

Fig. 106. Monthly distribution of Cleocapsa in the Nagin: March 1969 to October 1970.

Fig. 107. Monthly distribution of Oscillatoria in the Nagin: March 1969 to October 1970.

Fig. 108. Monthly distribution of Calothrix in the Nagin: March 1969 to October 1970.

Fig. 109. Monthly distribution of Microcystis in the Nagin: March 1969 to October 1970.
Fig. 110. Groupwise distribution of phytoplankton in summer along the zones.

- Bacillariophyceae
- Chlorophyceae
- Cyanophyceae