CHAPTER - 6
RESULTS AND DISCUSSIONS

The biological and hydrodynamic studies of ponds and lakes provide useful data for the understanding of the quality of water and functioning of these aquatic ecosystems. Among the various factors that influence the diversity of fauna and flora of reservoir systems, phytoplanktons and others algae play a pivotal role in the production of organic matter, which in turn is decided by the various environmental factors. Algal diversity, in particular seems to be very sensitive to the status of water quality in aquatic ecosystem.

Churu district is nearly rectangular in shape, covering a total area of about 16866 km². It is the part of Great Indian Desert and experiences arid to semi arid type of climate. The general topography reveals a succession of dry undulating plain which are covered by loose sand. The area of this region is characterized by various types of shifting and stabilizing sand dunes. The winters are very cold and the temperature sometimes falls below zero degree while summer months are burning and intense. An irregular dust storms and sand storms are the common features of this region. The rainfall is mainly restricted in to rainy season, thus widening the gap between precipitation and dry spell. The relative humidity remains minimum in the hot weather months and maximum during rainy months. Drought and famines are frequently occurred in this region. Due to low rainfall in this area, it is important to develop appropriate technology for conserving the rain water which may enrich our ground water resources and form the basis for supporting appropriate aquaculture. Probably because of erratic monsoon in this arid region there has been a rich tradition to conserve the water. So, the rulers of this area constructed a number of water reservoir to face the scarcity of water.

Climatic details during January 2013 to December 2014 of Churu region were recorded in the present study. The maximum temperature was recorded in the month of May (44.3 °C) and June (43.2 °C), respectively during 2013 and 2014. Much variation was observed in the maximum and minimum relative humidity in different months of the year. Maximum relative humidity was
observed in January. Total 449.5 mm rainfall occurred during 2013 and 398.4 mm in 2014.

In the present study, 10 important fresh water ponds of Churu region were selected. Fatehpuria pond is situated at south of the Sujangarh, Girdhar pond in located at the Sardarshahar and Draun pond is in the south of Gopalpura village of Churu district. Sethani Johada and Pithana Johada are very famous for their pilgrimages. Manaksar pond in Bidasar was constructed by Ghan Shyam Das and Mohan Lal Jalan in 1948. Natho Pond is situated in the south of Sujangarh. Talchhapar in Chhapar village is lies at the 27°48’ N latitude and 74°26’ E longitude. It is well known for black bucks and is also home of varieties of birds. Chadwas pond is also known as Kalyan Sagar Pond and situated in the south of Chadwas village of Bidasar tehsil. Parmana pond in Ratangarh, was constructed in the year of 1945 and receives water in the monsoon period.

**Floristic composition:**

In the present study, total 182 species belonging to 63 genera of algae were observed from different ponds of Churu region. Out of 182 algal species encountered in the study period, 74 species distributed over 28 genera belongs to Chlorophyceae, 38 to Bacillariophyceae, 14 to Euglenophyceae and 56 to Cyanophyceae. In Chlorophyceae, order Chlorococcales shows 48 species of 14 genera followed by Conjugales (Desmids) 19 species of 5 genera, Conjugales (Filamentous) 5 species of 2 genera, Chaetophorales and Charales single species each. In Bacillariophyceae, algae of Thalassiothyrionales, Naviculales, Cymbellales, Achnanthales, Fragilariales, Licmophorales, Bacillariales and Thalassiosirales orders were observed. Order Thalassiosirales was observed to be represented by two species of a single genera (*Amphora*), Naviculales by 10 species of 3 genera, Cymbellales by 13 species of 2 genera, Achnanthales by 2 species of 2 genera, Fragilariales by 2 species of 2 genera, Licmophorales by 1 species of 1 genera, Bacillariales by 5 species of 2 genera and Thalassiosirales by 3 species of a single genera. Total 14 species belongs to 3 genera (*Euglena, Phacus* and *Lepocinclis*) of Euglenales order of class Euglenophyceae were
recorded during the study period. Cyanophyceae group was observed to be represented by 56 species of 23 genera in fresh water ponds of Churu region. The maximum number of Cyanophycean algae were represented by order Nostocales (35 species) followed the decreasing order by Chroococcales (20 species) and Pleurocapsales (1 species). Gautam (1999) reported 30 species of phytoplanktons and other algae from Sethani Johra of Churu region and out of which 16 species belongs to Chlorophyceae, 8 to Cyanophyceae, 5 to Bacillariophyceae and 1 to Euglenophyceae.

Algal fluctuation and abundance

It is necessary to understand the relative importance of the various orders and classes of algae in the composition of algal species special with regards to various localities of fresh water bodies. Such a study gives an idea about the fluctuation and abundance of the biodiversity in aquatic ecosystems. In view of this, the fluctuation and abundance in various orders and classes of algae at 10 important ponds of Churu region are discussed here below:

(a) Chlorophyceae:

In Churu region, Chlorophyceae was observed to be dominant over the Bacillariophyceae, Euglenophyceae and Cyanophyceae and contributed 40.66% of the total algal species. Data presented in the table 5.6 revealed that in various ponds of Churu region, Natho Pond (S-7) and Dron Pond (S-2) exhibited the maximum number of Chlorophycean diversity in comparison to other ponds and showed two peaks of maximum algal taxa (Fig.-5.2). Chlorococcales had their maximum diversity (33) in Natho Pond and minimum (9) in Fatehpuria Pond. Scenedesmus showed the maximum display of the Chlorococcales. Conjugales (Filamentous) was represented by maximum 3 species in Dron Pond, Chadwas Pond, Natho Pond and Sethani Johra Pond while in Talchhapar Pond and Fatehpuria Pond, Conjugales (Filamentous) did not showed their representation (Table- 5.6). Conjugales (Desmids) exhibited its best performance in Dron Pond.
Chaetophorales and Charales were poorly represented in all ponds of Churu region.

(b) Bacillariophyceae:

This group was observed to be represented by 38 species belonging to 14 genera in fresh water bodies of Churu region. Its contribution was found to be 20.88% of the total algal species. On the basis of data recorded in table 5.7, it is apparent that Bacillariophyceae exhibited fluctuation in the number of species in different water bodies. It was also observed that Natho Pond showed a single peak of maximum Bacillariophycean diversity. The percentage contribution of Bacillariophyceae among the total algal species in various ponds of this region was that of 17.39% (Talchhapar), 17.76% (Dron Pond), 34.55% ( Fatehpuria Pond), 20.0% (Girdhar Pond), 17.11% (Chadwas Pond), 19.67% (Manaksar Pond), 22.59% (Natho Pond), 16.49% (Parmana Pond), 13.33% (Pithana Johra) and 21.0% (Sethani Johra) (Table- 5.7, Fig.-5.3 & Fig. 5.4). The number of species was observed to be maximum (13) in Cymbellales order.

(c) Euglenophyceae:

This class was poorly represented with 14 species over 3 genera viz. Euglena, Lepocinclis and Phacus. This group contributed 1.65% of total algae. It showed a single peak of maximum diversity in Dron Pond. The minimum number of Euglenales diversity was found in Pithana Johra (S-9). Data presented in the table 5.3 revealed that Euglena exhibited the maximum display (8 species) of the Euglenales diversity.

(d) Cyanophyceae:

Cyanophyceae group was observed to be represented by 56 species belonging to 23 genera in different habitats of fresh water bodies of Churu region (Table-5.1). It contributed 30.77% of total algal species. Cyanophyceae showed a bimodal fluctuation recording general maxima in Dron Pond and Natho Pond (Fig.- 5.2). The algae of Chroococcales, Pleurocapsales and Nostocales orders of
this group were reported in the present study. In respect of different ponds, Chroococcales diversity was observed to be abundant in Natho Pond. Similarly, the Nostocales diversity was also recorded maximum (39 species) in Natho Pond. Plerocapsal was represented by a single genus *Myxosarcina* and observed in Site No. 3, 5, 7 and 8 (Table-5.5). Genus *Chroococcus* in Chroococcales and *Oscillatoria* in Nostocales were reported dominant in respect of species.

**Ecological distribution:**

All algal flora were studied more or less which belongs to aquatic community and have diverse habitats like small stagnant water bodies (temporary or permanent), various streams (temporary or permanent), ponds, pools etc. Large water body provides the better define habitats than pools and streams. Owing to strong variations in climatic, edaphic, physiographic, topographic and geological characteristics, the arid area of Churu region shows a wide diversity of habitats. The fresh water algal communities were divided in various habitats as below in the present study:

1. **Planktonic community (P):**

Scenedesmus quadricauda var. quadrispina, Scenedesmus quadricauda var. longispina, Scenedesmus quadricauda var. maximum, Scenedesmus quadricauda var. maximum, Scenedesmus opoliensis, Scenedesmu bernardii, Scenedesmu armatus, Spirogyra ellipsoспора, Spirogyra porticalis, Spirogyra rectangularis, Spirogyra occidentalis, Mougeotia punctata, Closterium acerosum, Closterium leibleinii, Closterium dinae, Closterium gracile, Cosmariun subcostatum, Cosmariun granatum, Cosmariun botrytis var. depressum, Cosmariun botrytis var. mediolaеve, Cosmariun vexatum, Cosmariun lundellii, Euastrum bidentatum, Stau-rastrum gracile, Stau-rastrum anatinum, Stau-rastrum identatum f. minus, Stau-rastrum natator var. crassum, Stau-rastrum elongatum, Stau-rastrum tetracerum, Stau-rastrum teliferum, Pleurotaenium coronatum, Amphora ovalis, Amphora turgid, Navicula cuspidate, Navicula radiosa, Navicula semilunum, Gyrosigma scalproides, Diadesmis confervacea, Gomphonema lanceolatum, Gomphonema gracile var. lanceolatum, Gomphonema montanum var. genuinum, Gomphonema subclavatum, Gomphonema olivaceum, Gomphonema clavatoides, Gomphonema gracile, Gomphonema telegraphicum, Cymbella tumida, Cymbella affinis, Cymbella cistula, Cymbella kappi, Achnanthes microcephala, Cocconies pediculus, Fragilaria construens var. venter, Synendra dorsiventralis, Ctenophora pulchella, Nitzschia acicularis, Nitzschia obtuse, Nitzschia palea, Cyclotella bodanica, Cyclotella kutzingiana, Cyclotella meneghiniana, Euglena polymorpha, Euglena oxyuris, Euglena oxyuris var. charkowiensis, Euglena platydesma, Euglena deses var. intermedia, Euglena acus, Euglena caudata, Lepocinclis caudata, Lepociclis fusiformis, Phacus acuminatus, Phacus tortus, Phacus meson, Phacus longicauda var. longicauda, Microcystis aeruginosa, Microcystis flos-aquae, Microcystis panniformis, Microcystis smithii, Microcystis wesenbergii, Aphanocapsa littoralis, Aphanocapsa muscicola, Gloeоthece fusco-lutea, Chroococcus giganteus, Chroococcus tenax, Chroococcus turгіdus, Chroococcus turgidus var. maximus, Chroococcus minutes, Chroococcus мontanus, Chroococcus montanus var. hyalinus, Chroococcus coherens, Gomphosphaeria аponina, Merismopedia
elegans, Merismopedia punctata, Myxosarcina spectabilis, Arthrospira platensis, Arthrospira platensis f. granulate, Arthrospira jenneri, Spirulina subsalsa, Spirulina major, Spirulina meneghiniana, Spirulina labyrinthiformis, Oscillatoria subbrevis, Oscillatoria chlorina, Oscillatoria princeps, Oscillatoria chalybea, Oscillatoria curviceps, Oscillatoria proboscidea, Oscillatoria tenuis, Oscillatoria perornata, Oscillatoria acuta, Phormidium jadinianum, Lyngbya birgei, Nodularia spumigena, Raphidiopsis indica, Anabaena orientalis, Rivularia dura and Gloeotrichia rociborskii.

2. Epiphytic community on Algae (EA):
Characium nasutum, Characium ambiguum, Gomphonema montanum var. genuinum, Gomphonema clavatoides and Achnanthes microcephala.

3. Epiphytic community on Plants (EP):
Stigeoclonium stagnatile, Amphora ovalis, Navicula elegans, Navicula exigua, Cymbella cistula, Cymbella kappi, Fragilaria construens var. venter, Nitzschia hantzschiana, Cyclotella bodanica, Cyclotella kutzingiana and Gloeotrichia rociborskii.

4. Algal community on moist rocks or stones (R):
Oocystis gigas, Scenedesmus arcuatus, Scenedesmus bijugatus var. disciformis, Scenedesmus quadricauda var. quadrispina, Scenedesmu armatus, Spirogyra ellipsospora, Spirogyra porticalis, Spirogyra rectangularis, Spirogyra occidentalis, Closterium acerosum, Closterium dinae, Staurastrum identatum f. minus, Staurastrum elongatum, Staurastrum teliferum, Pleurotaenium coronatum, Stigeoclonium stagnatile, Amphora ovalis, Amphora turgida, Navicula elegans, Navicula exigua, Navicula radiosa, Navicula protracta, Diadesmis confervacea, Gomphonema parvulum, Gomphonema gracile var. lanceolatum, Gomphonema subclavatum, Cymbella affinis, Cymbella cistula, Achnanthes microcephala, Fragilaria construens var. venter Synendra dorsiventralis, Nitzschia obtuse, Nitzschia hantzschiana, Hantzschia amphioxys,
Cyclotella bodanica, Cyclotella kutziangiana, Cyclotella meneghiniana, Chroococcus giganteus, Chroococcus turgidus var. maximus, Chroococcus montanus, Chroococcus montanus var. hyalinus, Oscillatoria proboscidea, Oscillatoria perornata, Phormidium jadinianum, Pseudanabaena schmidlei, Scytonema simplex, Tolypothrix tenuis, Rivularia dura, Calothrix wembaerensis and Calothrix marchia.

5. Bloom forming algal community (B):
   Chlorella vulgaris, Hydrodictyon reticulatum, Scenedesmus obliquus, Scenedesmus quadricula, Microcystis aeruginosa, Microcystis flos-aquae, Microcystis panniformis and Microcystis wesenbergi.

6. Moist soil community (S):
   Selenastrum gracile, Chara braunii, Gyrosigma acuminatum, Gyrosigma scalpoides, Gomphonema lanceolatum, Gomphonema gracile var. lanceolatum, Gomphonema subclavatum, Gomphonema olivaceum, Gomphonema telepographicum, Cymbella kappi, Cocconies pediculus Cyclotella bodanica, Cyclotella meneghiniana, Aphanocapsa littoralis, Chroococcus turgidus, Johannesbaptistia pellucid, Myxosarcina spectabilis, Oscillatoria limosa, Oscillatoria tenuis, Oscillatoria rupicola, Oscillatoria margaritifera, Oscillatoria rubescens, Lyngbya martensiana, Lyngbya majuscula, Lyngbya birgei, Nodularia spumigena, Anabaena orientalis, Pseudanabaena schmidlei and Nostoc calcicola.

7. Common community in all habitats (C):
   Ankistrodesmus falcatus var. acicularis, Ankistrodesmus convolutes, Ankistrodesmus spiralis var. fasciculatum, Ankistrodesmus sigmoides, Selenastrum gracile, Kirchneriella lunaris, Pediastrum simplex, Pediastrum duplex, Pediastrum duplex var. genuinum, Pediastrum tetras, Pediastrum tetras var. tetraodon, Tetraedron gracile, Tetraedron minimum, Tetraedron tumidulum, Coelastrum cambricum, Coelastrum microporum, Scenedesmus
obliquus, Scenedesmus dimorphus, Scenedesmus acuminatus, Scenedesmus bijugatus var. bicullularis, Scenedesmus bijugatus var. alternans f. parvus, Scenedesmus bijugatus var. graevenitzii, Scenedesmus bijugatus var. flexuosus, Scenedesmus ecornis, Scenedesmus protuberans, Scenedesmus quadricula, Scenedesmus quadricula var. quadrispina, Scenedesmus quadricula var. longispina, Scenedesmus quadricula var. westii, Scenedesmus quadricula var. maximum, Scenedesmus opoliensis, Cosmarium botrytis var. depressum, Staurastrum anatimum, Staurastrum natator var. crassum, Staurastrum tetracerum, Euglena caudata, Microcystis aeruginosa, Microcystis flos-aquae, Chroococcus tenax, Merismopedia elegans, Merismopedia punctata, Oscillatoria subbrevis and Oscillatoria chalybea.

8. Algal community in small stagnant water bodies (Sw):

Oocystis gigas, Ankistrodesmus falcatus var. acicularis, Ankistrodesmus convolutus, Ankistrodesmus sigmoides, Nephrochlamys subsolitaria, Pediastrum simplex var. duodenarium, Pediastrum duplex var. reticulatum, Scenedesmus acuminatus, Scenedesmus bijugatus var. flexuosus, Scenedesmus quadricula var. westii, Mougeotia punctata, Closterium leibleinii, Staurastrum identatum f. minus, Staurastrum natator var. crassum, Staurastrum elongatum, Staurastrum tetracerum, Chara braunii, Gomphonema gracile, Nitzschia acicularis, Euglena oxyuris var. charkowiensis, Euglena acus, Lepocinclis caudata, Phacus meson, Gloeothece fusco-lutea, Chroococcus giganteus, Spirulina meneghiniana and Raphidiopsis indica.

9. Algal community attach on dead or decaying contents (A):

Gloeotaenium loitlesbergerianum, Nephrocytium agardhianum, Pediastrum simplex, Pediastrum simplex var. echinulatum, Pediastrum integrum, Coelastrum cambricum, Coelastrum microporum, Coelastrum cambricum var. intermedium, Scenedesmus dimorphus, Scenedesmus arcuatus, Scenedesmus bijugatus var. alternans f. parvus, Scenedesmus bijugatus var. graevenitzii, Scenedesmus bijugatus var. disciformis, Scenedesmus bijugatus
Increased human activities over the recent past years are imposing a greater stress on these fresh water ecosystems of this area, resulting in changing their features. In present study, Parmana Pond and Girdhar pond were observed to be much polluted water bodies because of its connection with different sewage channels and other anthropogenic activities. A huge number of polythene and domestic wastes were mixed regularly and due to such activities, natural quality of water has been changed and deteriorated to great extent. Pollution may bring about an enrichment of the algal nutrients in water bodies and this may selectively stimulate the growth of a few types of algae, producing massive surface growth or blooms that in turn reduce the quality of water (Palmer, 1980).

In the present study, some Chlorophycean (Chlorella vulgaris, Hydrodictyon reticulatum, Scenedesmus obliquus, Scenedesmus quadricauda) and Cyanophycean (Microcystis aeruginosa, Microcystis flos-aquae, Microcystis panniformis, Microcystis wesenbergii) algae were reported as a bloom forming community. The certain forms of such algae may frequently include in toxic to man and animals drinking to water or living in it.

From the above discussion, it can be concluded that:

1. There was extreme variation in monthly temperature and relative humidity in the area studied.
2. The annual precipitation was low and highly variable and mainly restricted to the rainy season.

3. Presence of *Euglena, Oscillatoria, Scenedesmus, Ankistrodesmus, Nitzschia, Navicula, Phacus, Gomphonema* and *Anabaena* supported the eutrophic status of lake.

4. Fresh water ponds of Churu region showed a very rich algal biodiversity.

5. Different ponds of Churu region showed distinct fluctuation, distribution and abundance in algal species.

6. Natho Pond, Dron Pond and Sethani Johra (Pond) supported the good number of species in comparison to other ponds.

7. Maximum algae were reported as a planktonic form of habitat.

8. On the basis of algal species, experimental ponds were found to have diversified groups of algae dominated by Chlorophyceae followed by Cyanophyceae, Bacillariophyceae and Euglenophyceae.