SUMMARY AND CONCLUSIONS
SUMMARY AND CONCLUSIONS

The Algae comprise a large and heterogeneous assemblage of relatively simple plants, which have little in common except for their characteristic oxygen evolving type of photosynthesis. The most comprehensive definition of the group appears to be that of Fritsch, who writes: ‘Unless purely artificial limits are drawn, the designation alga must include all holophytic organisms (as well as their numerous colourless derivatives) that fail to reach the level of differentiation characteristic of archegoniate plants”.

The organization of thallus in algae is basically of two types, the unicellular and the multicellular. The wide range of forms that algae exhibit arises from a modification or elaboration of these types. The cells of a multicellular thallus may be loosely held together by a mucilaginous matrix or cemented together through middle lamellae.

The alga have attracted attention since a long ago. However the marine, macrophytic forms were early to attract the attention. The microphytic and particularly the planktonic algae have attracted attention very late. Still the algae, as are the groups of other microscopic organisms, is one of the less investigated group for its forms. Although the studies on algae in India has started since early nineteenth century but much work has still to be done. Although works many aspects of algae are required to be done but the occurrence and identification of the forms of algae, in different parts of our country should be taken up on priority basis. So far very little studies have been made on the algae of Chhattisgarh region. Taking these facts in to consideration the presently proposed work was taken up.
Following were the major objectives of the present work:

1. Collection of water samples from different water bodies from within the area of Chhattisgarh State.
2. Analysis of physico-chemical characters of water
3. Take photograph of the algae in living condition
4. Hand drawn diagrams of the algae
5. Identification of the algae

Chhattisgarh state is located almost in the middle of India, surrounded all around by other states of our country at 17°46' to 24°06' North Latitude and 80°15' to 84°51' East Longitude.

Source of surface water in the state are: ponds, tams, dams, and rivers. Ponds and tams are most common surface water bodies in the central, plains of the state. These are used mainly for nistar purposes and additionally for irrigation. Almost every village, even may be very small, has at least one pond. The number of ponds may be as numerous as 126 ponds in Ratanpur village in Bilaspur district and 146 ponds in Bade Dongar village in Kanker district. Raipur, the capital city of the state, historically had as many as 100 ponds, but the number has now reduced to only about 50. Water of most of these ponds have become eutrophic, however the reason for eutrophication of these water bodies is different in city and village areas. Occurrence of cyanobacterial blooms, of Anabaena, Oscillatoria, Raphidiopsis and Spirulina, particularly during early summer months, is a common feature in the ponds of Chhattisgarh. Algae were collected from all types of lentic (ditches, ponds and dams) and lotic (nala and rivers) water bodies.

Classification of algae is changing continuously. One reason of change is the differences in opinion about the status and affinities of different groups but the more important reason of change is due to acquisition of more and more knowledge, particularly at the molecular level. With the different classification it is difficult to
agree or disagree with any one system of classification. One of the latest classification of algae, proposed, is by the Encyclopædia Britannica (Alga, 2009). In this proposed classification Cyanophyta have been excluded from the group of algae, however, they have been included among algae during the present studies. Cyanophyta have been included with the algae not to prove that they are true algae but because many phycologists still consider it proper to study this prokaryotic group with the algae. Classification of Algae, proposed, by the Encyclopædia Britannica (Alga, 2009). Is being given below in abridged form:

**Division Chlorophyta (green algae)**
- Class: Chlorophyceae,
- Class: Charophyceae
- Class: Micromonadophyceae
- Class: Pleurastrophyceae
- Class: Ulvophyceae

**Division Chromophyta**
- Class Bacillariophyceae (diatoms)
- Class Bicosoecophyceae
- Class Chrysophyceae (golden algae)
- Class Dictyochophyceae
- Class Eustigmatophyceae
- Class Phaeophyceae (brown algae or brown seaweeds)
- Class Prymnesiophyceae (Haptophyceae)
- Class Raphidophyceae (Chloromonadophyceae)
- Class Synurophyceae
- Class Xanthophyceae (yellow-green algae)

**Division Cryptophyta**
- Class Cryptophyceae

**Division Pyrrophyta (Dinoflagellata)**
Division Euglenophyta

Class Euglenophyceae

Division Rhodophyta (red algae or red seaweeds)

i. Collection, preservation and photography of algae.

During present studies only aquatic algae have been studied. These algae were distinguished as macrophytic, attached and microphytic algae. Microphytic algae were designated as Phytoplanktons. It is difficult to put a border line between the macrophytic amd microphytic algae. Filaments of algae like *Spirogyra* may form mats and can be collected easily through hand picking while floating filaments of *Anabaena* or *Oscillatoria* may sometimes be very long but can not be collected through hand picking. Generally the algae were observed in living condition. However, for later observation and for storage they were preserved in 4% formalin or in lugol’s solution or in FAA. More frequently employed stains were methylene blue, gentian violet and acid fuchsin (up to 1% aqueous solutions).

Movement of planktonic algae was arrested using, iodine solution, gum arabic, chloroform or the isabgol seed. To render flagella visible the algae were stained with iodine solution.

Diatom frustules were cleaned through boiling in conc. HNO₃.

The microscopic algae were photographed with a CCD camera attached to the microscope, which in turn was attached to the computer for the storage of images.

ii. Analysis for physico-chemical characters:

Temperature (°C), pH, conductivity (mmhos, cm⁻¹) and total dissolved solids (mg. l⁻¹) of water samples were determined with the help of a Century, Portable, Water Analyser Kit. Analysis for other physico-chemical characters was done following Standard Methods (APHA-AWWA-WPCF, 1979). Analysis was done for the following physico-chemical characters:
a. Alkalinity: phenolphthalein, methyl orange and total alkalinity.

b. Free Carbon Dioxide (F. CO₂):

c. Dissolved Oxygen (DO):

d. Chloride (Cl⁻):

e. Hardness:

f. Nitrate-Nitrogen:

g. Total Phosphorus

h. Chemical Oxygen Demand (COD)

Physico-chemical characters of water from the water bodies:

i. Ponds:

Physico-chemical characters of the water from the ponds, investigated presently indicated a wide range of variations in the values of almost all the parameters. This indicates that with respect to physico-chemical characters the ponds differ much significantly from each other. pH values ranging from 6.1-9.0 indicated that the water of the investigated ponds has neither become too much acidic nor has become too much basic. The higher pH of 9.0 was recorded for only one of the ponds while all other ponds exhibited pH values at or below 8.1. Conductivity ranging from 94-980 m mhos cm⁻¹ indicates that none of the ponds is free from electrical conducting dissolved solids. Alkalinity ranged from the lowest value of 23 mg l⁻¹ to a maximum of 642 mg l⁻¹, a twenty times higher value than the minimum. Free CO₂ ranged from its absence in alkaline water to a maximum of 142 mg l⁻¹ in water bodies with lower pH. Dissolved oxygen concentration was more interesting. It ranged from 0 mg l⁻¹ to an exceptionally very high value of 17.9 mg l⁻¹, indicating very high super-saturation of the water with oxygen. Both the lowest as well as the highest values were recorded for highly polluted water bodies. Polluted water without plant life including both the macro and microphytes had absence of oxygen while eutrophic water bodies with
abundance of plant life and conditions conducive to photosynthesis had highly super-saturated water with oxygen. Standard deviation value of values for oxygen being greater than the mean value also indicates much variation in values for oxygen. Chloride as expected for open lentic water bodies was never zero. The values for chloride ranging from 32 – 199 mg l⁻¹ were not much significant. Total hardness registering absence in some of the water bodies was unexpected while the upper value of 307 mg l⁻¹ also appears to be slightly higher. Total phosphate values ranging from 0-1.08 mg l⁻¹ were never very high. COD values exhibited much variation with a range of as low as 0.3 to as high as 3796 mg l⁻¹. The ammonical nitrogen (NH₃) ranged from 0-3.1 mg l⁻¹, while the NO₃ had higher value of as high as 6.9 mg l⁻¹.

ii. Rivers:

Physico-chemical characters of the water from the rivers, investigated presently, also indicated a wide range of variations in the values of almost all the parameters. However, the range of variation was much lesser than the range of variation in values for pond water. This indicates that with respect to physico-chemical characters of the water the rivers differ less significantly from each other. pH values ranging from 6.9-7.7 indicated that the water of the investigated rivers had values closer to neutrality. Conductivity ranging from 230-400 m mhos cm⁻¹ also had lesser variation in values but it indicates also that the river water had always a good amount of electrical conducting substances. Alkalinity ranged from the lowest value of 27.5 mg l⁻¹ to a maximum of 98 mg l⁻¹, gain had much lesser variation. Free CO₂ was always found to be absent in the river water. Dissolved oxygen, as opposed to pond water was never totally absent, nor the river water was super-saturated with oxygen. This is mainly because of the flowing nature of the water in rivers. Chloride was never absent with lowest value of 15 mg l⁻¹ and highest value of 109.3 mg l⁻¹. The values for total hardness, ranging from 23 – 144 mg l⁻¹ were not much significant. Total phosphate values ranging from 0.1-1.08 mg l⁻¹ were, although not very high but indicated that
unlike pond water the ion is always present in river water. The upper values went up only up to 1.8 mg l\(^{-1}\). The ammonical nitrogen (NH\(_3\)) ranged within a comparatively narrow range of 0-0.9 mg l\(^{-1}\), while the NO\(_3\) had higher value of as high as 6.9 mg l\(^{-1}\).

iii. Industrial effluents:

Physico-chemical characters of the water from the industrial effluents investigated presently indicated a very wide range of variations in the values of almost all the parameters. pH values ranging from a very low value of 2.3 to a higher value of 8.31 indicated that the the industrial effluents had very wide differences in their pH values. The lowest value was obtained for a fertilizer factory (DMC) effluent. Conductivity ranged from the lowest value of 93 m mhos cm\(^{-1}\), to a very high value of 679 m mhos cm\(^{-1}\). Alkalinity ranged with very high values with the lowest value of 142 mg l\(^{-1}\) to a maximum of 3368 mg l\(^{-1}\). Free CO\(_2\) was very high with 1390 mg l\(^{-1}\) in the low pH effluent from the fertilizer factory while in the effluents from other investigated factory effluents it was either absent or the concentration was very low. Dissolved oxygen, was observed to be present in only one of the factory effluent, while could not be detected in other factory effluents. Chloride exhibited the maximum range of values from 61.37 mg l\(^{-1}\) to as high as 26576 mg l\(^{-1}\), in the effluents. Total hardness with a range of values from 27.51 mg l\(^{-1}\) to 2433 mg l\(^{-1}\), in the effluents was thus found to have higher values in the effluents. Total phosphate was also found to be present in higher concentration in almost all the factory effluents but except for its absence in one of the effluents. The higher value of 12.84 was also maximum of all the effluent as well as water samples. COD was always found to be very high for the investigated industrial effluents ranging in values from 11125-58742 mg l\(^{-1}\). Ammonical as well as nitrate nitrogen also recorded their maximum and very high values of all the effluent and water samples with maximum values of 15.3 and 360.9 mg l\(^{-1}\), but simultaneously were absent also in some of the effluents.
The present work has been concentrated more on the planktonic algae. Algae from other habitats could also have been photographed, drawn or described but due to time constraint studies have been restricted mainly to the planktonic algae. Drawing black ink diagrams of the algae is a much time requiring job and it was not possible to draw the diagrams and describe all the algae, collected and observed during the tenure of the present work.

Number of forms recorded for different groups of algae were:

- Cyanophyta: 117
- Volvocales: 10
- Ulotrichales: 14
- Chlorococcales: 153
- Desmids: 4
- Bacillariophyceae: 82
- Euglenophyta: 175

The algae recorded from the different groups were mostly pollution indicators, indicating that most of the water bodies of the state have become polluted.

With the above reported groups of algae a large number of forms from Charophyta have been observed, particularly the species of *Chara* and *Nitella* are much common in the water bodies of Chhattisgarh state. However charophytes are observed only in clear water bodies while they are totally absent in polluted water bodies.

Two genera of Rhodophyta: *Batrachospermum* and *Compsopogon* have been observed in the area. *Batrachospermum* has been recorded from several places in running water, while *Compsopogon* was recorded only once in a pond at Ambikapur, District Sarguja.
Chhattisgarh state has Mahanadi with its tributaries, mostly draining the area of the state is the major river of the state. Central part of the state is a plain land and is heavily dotted with man made ponds. These ponds are used mostly for pisciculture, hence, more detailed study of the algae, particularly the phytoplanktons, with physico-chemical characters of the water bodies is required. The present study will help in the identification of most of the phytoplanktons in the water bodies of the state. The study will form a baseline data on the planktonic algae of the state.