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Algal biodiversity in some water bodies of Kota, Rajasthan, India

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Abstract

Algae are inseparable associates of the environment. There is a direct correlation of phytoplanktons to the physicochemical properties of water. Kota district situated in the southeastern parts of Rajasthan has a total area of 5198.15 sq. km. Chambal is the principal perennial river of the district. The Algal flora of Kota still remains unexplored; hence the main focus of this study is to document the Algae belonging to various groups. Since without first knowing the status of our aquatic resources especially algae of this area, we cannot have projections for their utilization. An integrated study of physico-chemical characteristics and algal flora of some randomly selected inland aquatic bodies of Kota namely Abhera pond, Kishore Sagar, Kota barrage, DCM factory and Rice fields was undertaken in the present survey. Though the selected water bodies exhibit narrow fluctuations in pH, alkalinity, total hardness, and fluoride contents but considerable variation were observed in the TDS values. The aquatic bodies harbor 63 algal species belonging to 41 genera. Chlorophyceae dominated while Bacillariophyceae was subdominant. The quantitatively determined growth of algal density was found to be maximum during winter and monsoon seasons while minimum growth was observed in summers.

Keywords: Survey, Kota, Phytoplanktons, Water bodies, Physicochemical properties.

Introduction

Algae have been known to human being since times immemorial. They are a ubiquitous group of predominantly aquatic photosynthetic organisms of the kingdom Protista having photosynthetic pigments. They are inseparable associates of the environment; they are purifiers of the environment on one hand and polluting organisms on the other. Phycology contributes an important field of botanical science having for reaching implications. The intimated orientation of algae with aquatic habitats makes them an interesting tool for such studies. There is a direct correlation between phytoplanktonic quantum and the physicochemical properties of water body. The quality of water has been assessed by the qualitative and quantitative studies of phytoplankton[1-3]. Phytoplanktons are the autotrophic (self-feeding) components of the plankton community and a key part of oceans, seas and freshwater basin ecosystems. They are the primary producers forming the first trophic level in the food chain. The fertile standing water bodies have high diversity of planktonic organism and it changes in the aquatic environment particularly in relation to silica and other nutrients[4,5]. Algal flora varies from season to season and an important feature of freshwater algal flora is its cosmopolitanism. Physicochemical parameter of water greatly affects the distribution of algae and their variation at different zones of a water body. The algal growth in a habitat influences the ecosystem and also it directly affects the aquatic environment mainly the nutrient contents. According to Goswami[6], the identification and assessment of biodiversity composition of a lake results in the conservation of aquatic system. The phytoplanktonic study is a very useful tool for water quality assessment and also helps in understanding the Lake ecosystem[7]. Natural water harbors a wide variety of aquatic fauna and flora, all of which maintain a dynamic equilibrium with the environment. The physiochemical properties of water such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), pH, conductivity etc. impairs the water quality as well as endangers aquatic life[8].

Human development and associated anthropogenic activities in watersheds can affect stream systems in a variety of ways. Changes in the physical and chemical environment of streams through increased nutrient loading and altered flow rates, stream channels and riparian habitat can engender nuisance algal blooms[9]. For example, channelization of streams for flood control purposes and the removal of riparian vegetation increase light levels and temperatures on the bottom of the streambed, and both of these factors can boost algal production and cause stream community changes[10-12]. Due to industrial growth and other human activities, the marine environment suffers from heavy pollution. It has a great impact on marine algal biodiversity. The knowledge of phyto-planktonic composition in relation to the physical and chemical characterization of water bodies helps in determining the biodiversity of a given region. The algal flora of Kota still remains unexplored; hence the present study was conducted to document the algae along with the physico-chemical properties of some selected water bodies.

Study area: Kota is situated in the southern part in Rajasthan along the banks of the Chambal River and covers an area of 527 km and having an average elevation of 271 metres. It is the 3rd largest city of Rajasthan after Jaipur and Jodhpur. The cartographic coordinates are 25.18°N 75.83°E. Sawai Madhopur, Tonk and Bundi districts bound it on the north and North West. The Chambal River forms a natural boundary separating these districts from Kota district. The point of origin of the Chambal River is the hills of Vindhya near the region of the Mhow in the district of Indore.

Kota has a semi-arid type of climate which is the next driest type of climate after deserts. It is characterized by high temperatures throughout the year. Summers starts in late March and lasts till the end of June while the temperature ranges from 40°C to 45°C.

The samples were collected from four sampling stations. Following algal localities of Kota district of Rajasthan were taken up for the present study and are represented in Figure-1.
Locality A: Abhera Pond (Natural) -No domestic waste sewage nor any industrial effluent.
Locality B: DCM Factory - Receives industrial effluent.
Locality C: Kishore Sagar - Polluted due to sewage domestic waste, and other human activities.
Locality D: Kota Barrage (Downstream) - Only perennial source of fresh water.

Materials and methods

Sampling: Freshwater algae samples were collected using Henson's standard plankton net having pore size of 25 µm in morning hours once in a week. Samples were also collected from the selected sampling stations in airtight bottles and polythene bags. After collecting the samples, they were brought to the laboratory and observed under microscope by preparing wet mounts within 48 hrs. The remaining samples were further preserved in Lugol's solution and 4% formaldehyde solution separately for detailed study[13]. The algae belonging to Bacillariophyceae class were studied after cleaning the frustules using acid digestion technique recommended by Taylor et al.[14]. Algae were identified using the monographs and relevant available literature[15-21].

Sampling for the enumeration of phytoplankton was done monthly from October to July using plankton net. Algal patches were collected from paddy fields along Bundi Road. The collected algal material was preserved in Formalin-Alcohol–Acetic acid (90:5:5). Preliminary identification was done using Fritsch[22], Randhawa[16], Edmondson et al.[18] as basic reference. Camera lucida drawing and microphotographs were done using digital camera. Physico-chemical analysis of surface water samples of each locality was done as per methods described by APHA[23].

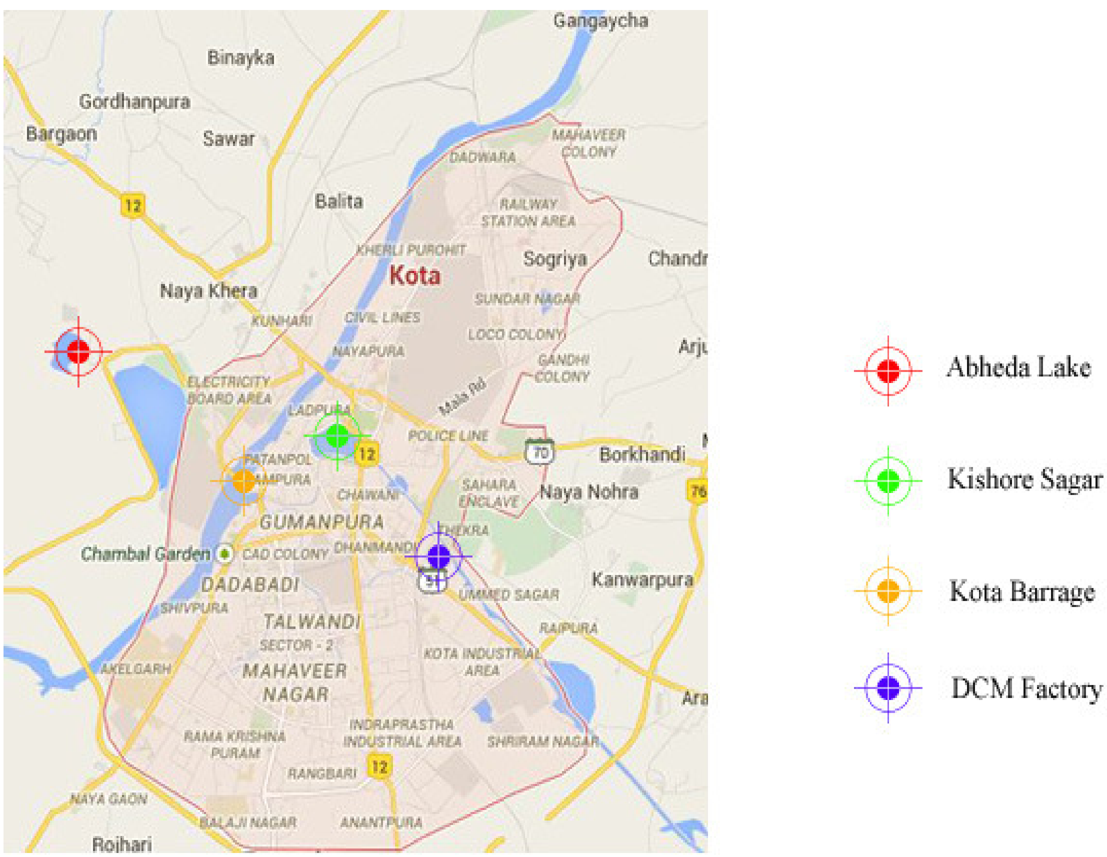

Figure-1: Study area showing surveyed localities of Kota, Rajasthan, India.

Results and discussion

The main danger to our environment is the population which is increasing at a higher pace, and the harmful gases coming from the industries. Pollution of water bodies has become a universal concern. Physiochemical properties are governed by rain, evaporation, adjoining neurotic water and intensities of pollution[24]. Study of algal types and density provides a useful indication of pond status and effluent quality (Srivastava). Studies on the phytoplankton of Indian ponds in relation to their environmental conditions have been made by Munawar[25], Khan and Siddiqui[26], Jagetiya et al.[27]. The production of phytoplankton mainly depends on temperature, turbidity and nutrients[28] and some others physicochemical properties of the water body helps in evaluation of the polluted water habitats.

Physical parameters of selected localities of Kota are represented in Table-1. The collected water sample is colourless in almost all the sampling stations. There is almost no odour in the water collected from Abhera Lake and Kota Barrage while water samples from Kishore Sagar and DCM factory have some stinky smell showing their polluted nature.

Turbidity was higher at Abhera (2NTU) while in the remaining water bodies they were negligible. A high level of turbidity affects the aquatic life indirectly[29]. Thus the values obtained in the present survey departs from the normal trend since Abhera pond is situated on the outskirts of Kota and is less polluted as it neither receives domestic waste, nor any industrial effluents.

pH values were alkaline and more than 7 (7.8 at Abhera and Kishore Sagar and 7.5 at Kota Barrage) and favorable in terms of nutrient status and total alkalinity. However, pH value was slightly acidic (6.2) in DCM factory which may be due to discharge of industrial effluents.

Total alkalinity and calcium are related factors. The total alkalinity of surface water recorded in the present study was mostly due to bicarbonates and ranged between 60-110 ppm and confirms the good productivity level of the water bodies under consideration.

According to the total hardness of water Abhera and Kota Barrage were classified as soft water bodies (less than 60 mg/l) and Kishore Sagar and DCM Factory seem to be hard water bodies (more than 90 mg/l). The amount of chloride content gives an idea about nature and extent of pollution. In present study maximum chlorides (1360 ppm) were found at DCM Factory and minimum (10 ppm) were observed at Abhera and Kota Barrage. TDS values ranges to a greater extent and is found minimum in Abhera lake (124 ppm) while maximum in DCM factory (8320 ppm) clearly showing that this algal locality is the most polluted as it receives industrial effluents.

At the selected sampling stations pertaining to different seasons it was observed that there is a horizontal variation in algal distribution of various classes. In the present study, the physico chemical properties of water found to have significant correlation with the Phytoplankton’s count. The evaluation of phytoplankton revealed that the water bodies and paddy field harbor algae representing five classes namely Chlorophyceae, Euglenophyceae, Bacillariophyceae, Cyanophyceae, and Xanthophyceae, belonging to 41 genera and 63 species (Table-2).

Table-1: Physical parameters of selected localities of Kota, Rajasthan, India.

Parameters	Abhera Lake	Kota Barrage	Kishore Sagar	DCM Factory
Colour	Almost colourless	Almost colourless	Almost colourless	Almost colourless
Odour	Almost no smell	Almost no smell	A bit smell	Almost no smell
Atmospheric temperature	26°C to 34°C	26°C to 34°C	26°C to 34°C	26°C to 34°C
Water temperature	25.5°C to 30.5°C	25.5°C to 30.5°C	25.5°C to 30.5°C	25.5°C to 30.5°C
Turbidity	Slightly turbid	Clear	Clear	Clear
pH	7.8	7.5	7.8	6.2
Calcium Hardness (ppm)	45	50	70	480
Magnesium Hardness (ppm)	35	30	40	360
Chlorides (ppm)	10	10	20	1360
Alkalinity (ppm)	90	90	110	60
Total Dissolved Solids (ppm)	124	228	276	8320

Table-2: Number of genera and species of various algal classes.

Class	Number of Genera	Number of Species
Chlorophyceae	14	23
Euglenophyceae	2	3
Bacillariophyceae	13	18
Cyanophyceae	11	18
Xanthophyceae	1	1
Total	41	63

Five groups of algae dominated the various localities selected for the present survey. Chlorophyceae constituted the dominant component of phytoplankton with 14 genera (Figure-2) whereas Bacillariophyceae was sub dominant with13 genera (Figure-3). Cyanophyceae was third dominant group of phytoplankton with 11 genera (Figure-4) followed by Euglenophyceae and Xanthophyceae. In the present survey, *Lyngbya* was specifically found at rice fields while *Gleocapsa*, *Chlorella*, *Spirogyra*, *Microcystis* was present in all the selected water bodies, whereas *Vaucheria* seems to represent a single genus of Xanthophyceae found at Abhera lake only.

The class with the highest species abundance was the Chlorophyceae (23 species) followed by Bacillariophyceae and Cyanophyceae having 18 species each, Euglenophyceae is represented by only 3 species (Figure-5) while the class with the least abundance was Xanthophyceae which had only one species (Figure-6, Table-2).

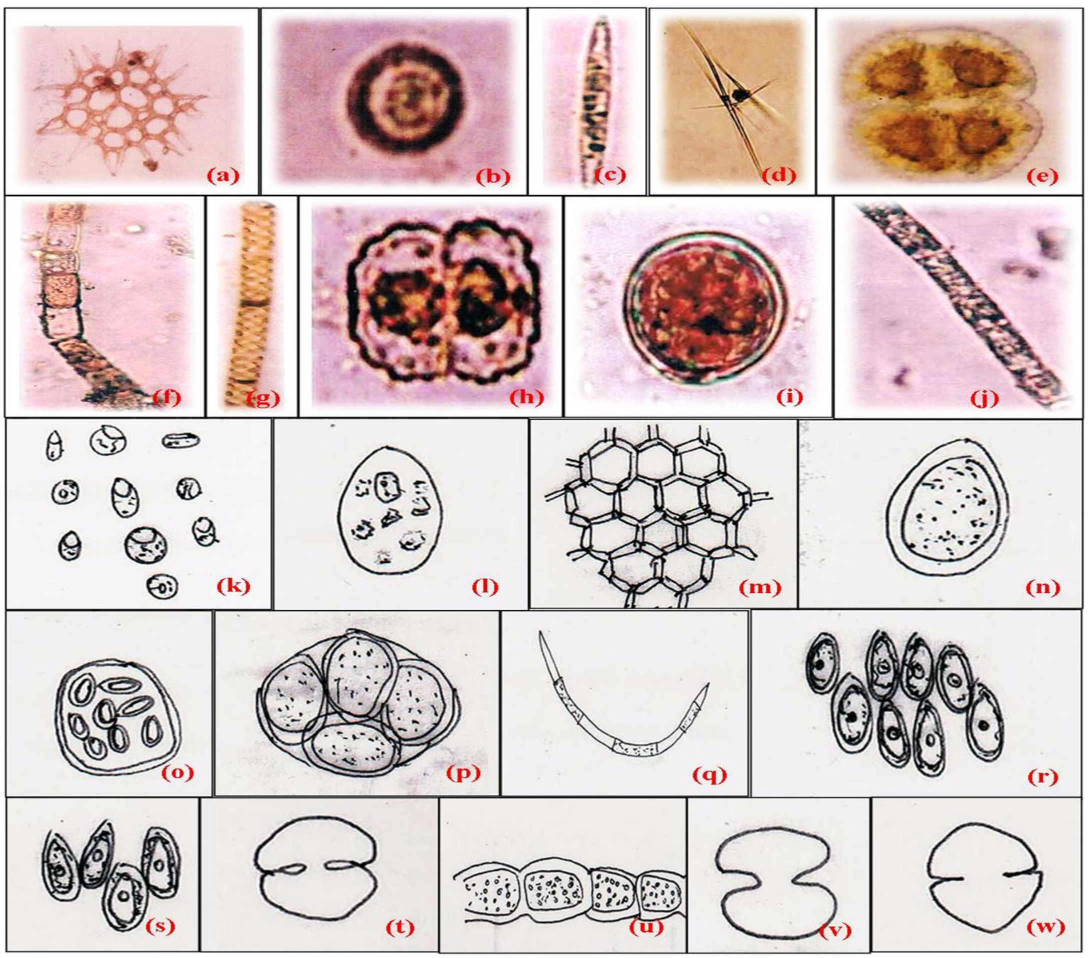

Figure-2: *Chlorophyceae* (a) *Pediastrum* sp. (b) *Chlorella* sp. (c) *Closterium lunula* (d) *Ankistrodesmus* sp (e*) Cosmarium* sp (f) *Oedogonium* sp. (g) *Spirogyra* sp. (h) *Cosmarium* sp. (i) *Spiro-gyra zygospore* (j) *Ulothrix* sp. (k) *Chlamydomonas epiphytica* (l) *Chlorococcum* sp. (m) *Hydrodictyon* sp. (n) *Chlorella vulgaris* (o) *Oocystis elliptica* w.et. west (p) *Oocystic gigas Archer* (q) *Ankistrodesmus falcatus var. mirabilis* (r) *Scenedesmus Bijugatus fu. Irregularis willie* (s) *Scenedesmus Bijugatus var. garvenitzii* (bernand) (t) *Cosmarium Gelatitum* Nordst (u) *Microspora* sp. (v) *Cosmarium bibculatum* Bred (w) *Cosmarium subtamidum Nordst*

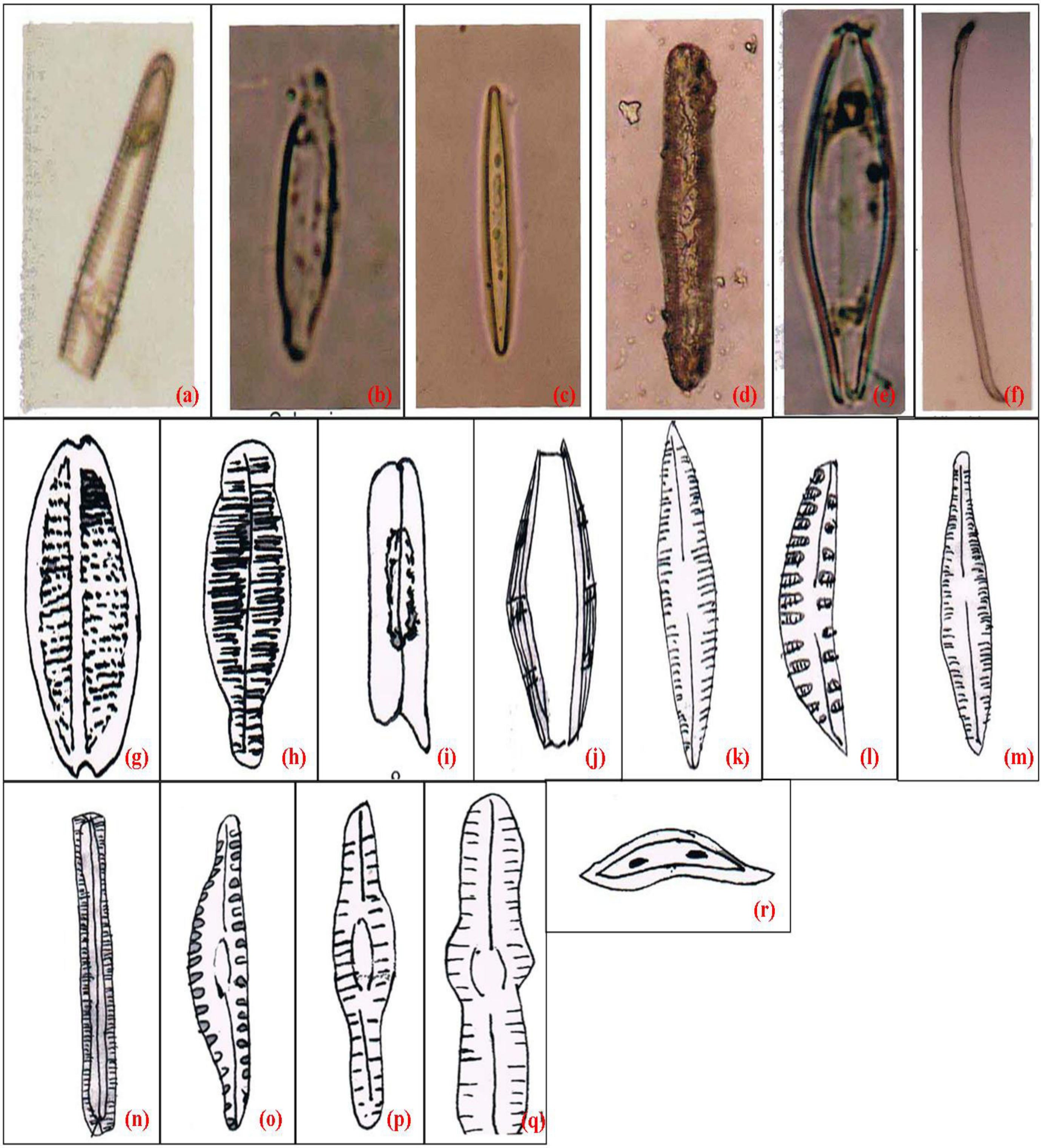

Figure-3: BACILLARIOPHYCEAE (a) *Rhocospenia curvata* (b) *Caloneis* sp. (c) *Navicula radiosa* (d) *Pinnularia nobilis* (e*) Pinnularia treavylyana* (f) *Nitzshia* sp. (g) *Cocconeis placentala var. linaeta* (h) *Achananthes inflate* (i*) Flagilaria* sp. (j) *Amphora ovalis* Kuetz (k) *Cymbella osmanabadesis* (l) *Cymbella tutgida* (Grug) Cleve (m) *Gomphonema sumatrense Fricfle* (n) *Synedra ulna (Nitz Her* (o) *Navicula vulpine* (p*) Pinnularia simplex Gandhi* (q) *Pinnularia acrospheria var. undulate Cleve* (r) *Hantzichia sp.*

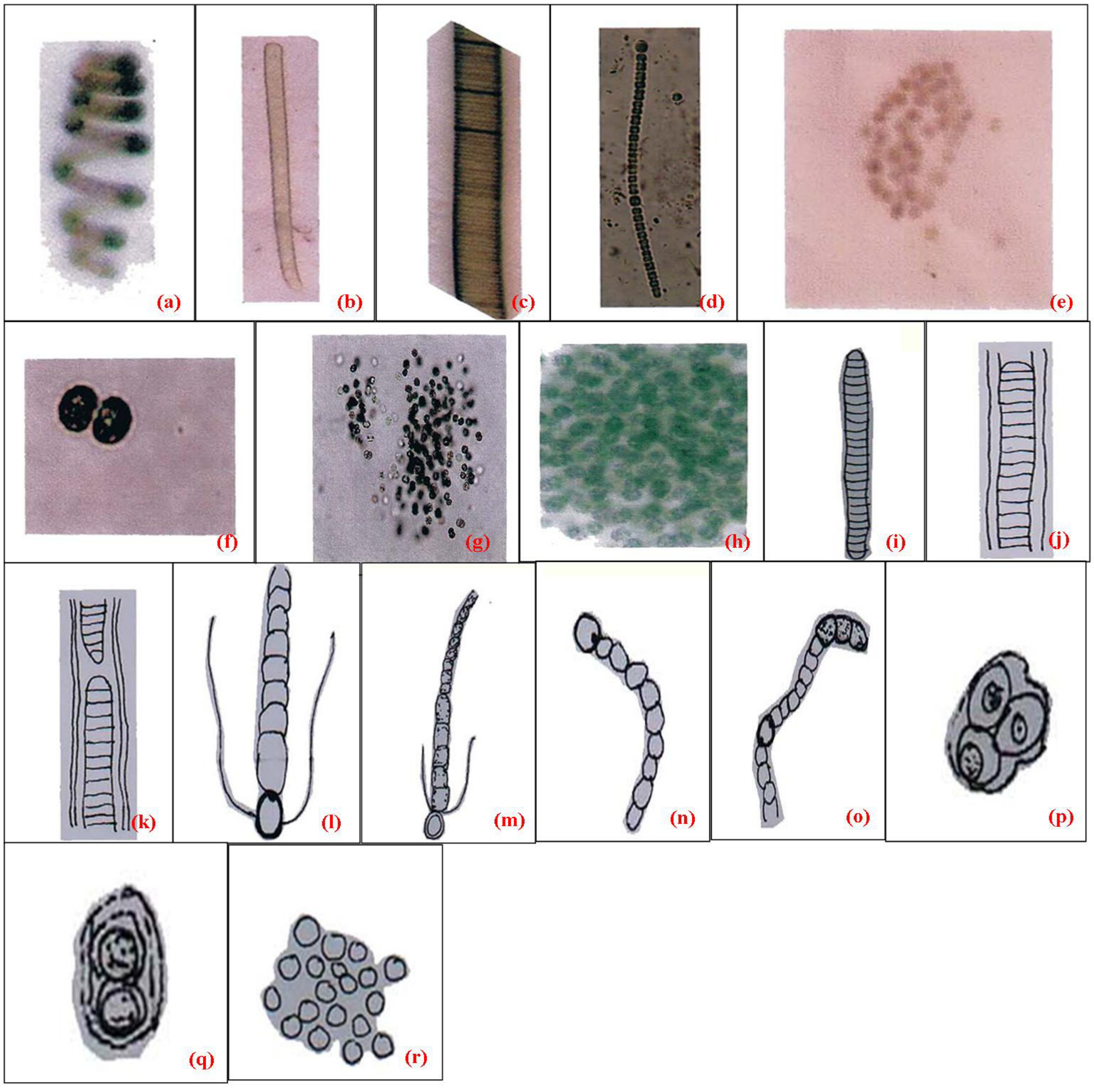

Figure-4: Cyanophyceae (a) Spirulina sp. (b) Oscillatoria sp. (c) Oscillatoria sp. (d) Anaebaena sp. (e) Aphanocapsa sp. (f) Chroococus sp. (g) Anacystis sp. (h) Microcystis sp. (i) Oscillatoria tenuis (j) Lyngbya ceylanica (k) Lyngbya confervoides (Rivularia aquatic (m) Rivularia buccariana (n) Nostoc commune (o) Nostoc mucsorum (p) Gleocapsa magna (Breg) Kutz (q) Gleocapsa decorticns (r) Aphanocapsa littoralis

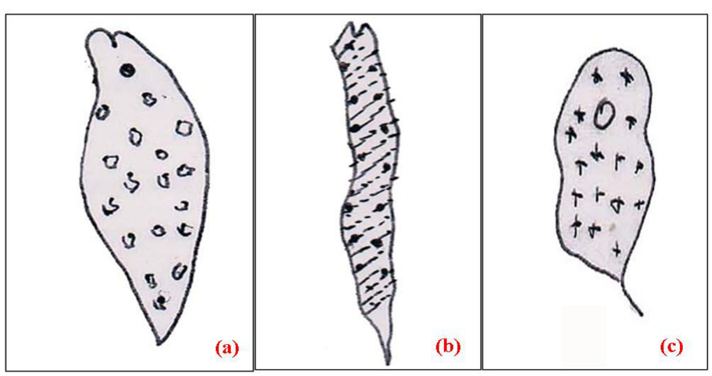

Figure-5: Euglenophy Ceae (a) Euglena gracilis klebs (b) Euglena spirogyra (c) Phacus acminatus

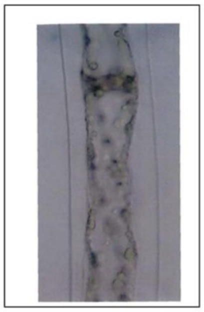

Figure-6: EUGLENOPHYCEAE: Vaucheria sp.

Conclusion

The tropical status of a water body can be evaluated by its physicochemical parameters which would help to formulate the control measures and monitor the impact of human activities on biological diversity of the water body. In the present study it is clearly seen that the physicochemical characteristics of water is greatly influenced by the anthropological activities and hence it directly affects the phytoplankton population residing in water bodies. Algae assist in the purification of polluted water bodies by consuming inorganic nutrients. A recent trend is to use algae in the biological control in the treatment of effluent. The present work indicates that some Chlorophyceaen and Bacillariophyceaen forms tolerates organic pollution and also resist the stress caused by pollutants and so they can be used as an an "indicator organism".

The physico-chemical and biotic characteristics of water are interrelated and often driven by the surrounding land uses that determine the quality of water at point sources that enter the freshwater streams. Algae are used as marker species for indicating the nature of pollution and recently biological indicators have been proved to be more reliable to examine the trophic status than the chemical factors. Lastly, without first knowing the status of the aquatic bodies specially the algal flora, we cannot have projections for their utilization.

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