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The distribution of selected Algal Genera in River Kabul

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The Chlorophyta is the most abundant and diverse group by any parameter and includes flagellated, unflagellated unicellular colonial, microalgae branched or unbranched, and macrophytic algae with parenchymatic structure. The present research focuses on 4 genera of Chlorophyta of River Kabul. The results showed that a total of 23 species belongs to 4 genera (*Cosmarium*, *Closterium*, *Ankistrodesmus*, and *Closteriopsis*) belong to different families were recorded. The highest number of species belonging to *Cosmarium* (11), *Closterium* (08), *Ankistrodesmus* (03), and *Closteriopsis* with a single (01) sp were identified. The percentage-wise *Cosmarium* (Desmidiaceae) with 47.82%, *Closterium* (Closteriaceae) 34.78%, *Ankistrodesmus* (Selenastraceae) 13.04% and *Closteriopsis* (Clorellaceae) contributed with 4.34%. Three sites were selected for collection based on the concentration of pollutants i.e unpolluted, slightly polluted, and highly polluted sites. which. All species were found in both unpolluted and slightly polluted water while they were absent in highly polluted water. In a nutshell, it is concluded that these species can be used as a bioindicator for water qualities in different parameters.

Keywords: *Closteriopsis*, *Closterium*, *Ankistrodesmus*, *Cosmarium*, Algae, Pollution

INTRODUCTION

The River Kabul is a Chitrali River that emerges from Chitral flows into Afghanistan, i.e. Unai Pass present in Paghman Mountains and comes back to Peshawar. As it flows through Kabul in the sufaid koh mountains to Peshawar therefore it is called Kabul River (Khattak et al. 2015). The River Kabul is actually the amalgamation of the River Arandu in Chitral, Kunar as it enters into Pakistan through Shalman, and then reaches the Warsak dam while then divides into several branches, these branches flow in several districts of Peshawar valley and hence irrigate a major of the area (Khan. 2002). There are three branches of River Kabul, one in

Shah Alam, the second is Naguman and the third one is Adezai. (Gresswell and Huxley. 1965) Naguman and Adezai branches are unpolluted. River Shah Alam's total length is 82,500 feet and the total slope is a foot / 98.71 feet. (Slope from origin to Mian Gujar). The unit slope of River Shah Alam a foot/835 feet. The River is used for waste material dumping and therefore is very polluted and turbid. At Zara Killi the River is bifurcated and along narrow land is present between the channels, it flows through "Mattitapo" bridge and passes by Sherkili "Khutkili" 'Matti' Asuhab Baba, Kudi, Chuger Matti and unite at Garangi Payan and Hussan Abad. Then at the Tukhat Abad I near the graveyard it bifurcates again touching the

boundaries of Gul Abad Shah Mohammad, Herina bala, and meet at Gowi. Another branch which at the same time separates from Hassan Abad meets the other one at Shah Alam and the land between is occupied by refugees and is known as Muhajer Camp (Khurasan). In (70-19 B.C) Virgil explained that algae are the most polluted because he was having the idea of decaying algae in the water. Algae could be a nuisance because they stuck into the propeller of boats and invade all other species into the water. Apart from their negative impacts most of the algae are very beneficial to the fauna and human beings. In the past century, it has been reported that one can frequently observe the poisonous algae in both the habitats of freshwaters and the seawater (Paerl et al. 2001). There is a great role of the public, media, and scientists to concern the interest for attractive chemical and biological problems associated with the toxic algae. There are different concepts of the scientist's regarding the explanation of the existence of algae (Mucina et al. 2016), that biologically they looked like water-loving, autotrophic organisms having no sterile layer or cover around their reproductive organs and they do not have true embryogenesis. As described earlier that they do water love, therefore, it is necessary to explain the nature of water because as the population increases day by day the peoples don't care about throwing the garbage in the water (Yousafzai et al. 2010, Shamshad et al. 2015). So water is becoming full of pollutant, therefore, there are three types of water pollutions which affect the growth of algae everywhere particularly in our region "River Kabul" i.e. Industrial effluents (acids, alkalied and heavy metals), agricultural runoffs (toxic chemicals, growth inhibitors, pesticides and Nitrogenous) and domestic pollution (organic material) (Abbasi et al. 2014, Rafique et al. 2019). Green algae are one of the most diverse groups of Protestants, which shows diverse morphological plant bodies. i.e. unicellular, flagellated, unflagellated, colonial, coccoids, microalgae branched, or unbranched filaments. They are cosmopolitan because they are found almost in every habitat from poles regions to deep seas, freshwater ponds, pools as well as in terrestrials regions (Azizullah et al. 2011, Leliaert et al. 2009). Green algae are also found in diverse habitats with approx. six hundred (600) genera and ten thousand (10,000) species (Ali et al. 2010). The taxonomy of algae is the identification, classification, morphological characters, and reproductive characteristics of algae happening in a particular area. (Bellinger

and Sige. 2015) Therefore it is obvious to give them a proper order, so after the conventional effort of The taxonomy of algae is the identification, classification, morphological characters, and reproductive characteristics of algae happening in a particular area. of (Bellinger and Sige. 2015), and (Round and Palmer. 1966), etc, on the classification of algae particularly based on morphology, anatomy, and reproduction numerous other criteria have been open to this elements to classify them, e.g. cellular organization, nature of chloroplast, pigments, flagella, endoplasmic reticulum, structure under electron microscope, component of the cell wall and physio-chemistry (John and Maggs. 1997).

The *Closterium* genus is associated with its nearer or closest one unicellular algae related to land plant which is marked as the best charophycean green alga based on its sexual reproduction. *Closterium* has a crescent shape while some of its species having a needle-like composition, some are broader having their end curved (Amintarti et al. 2020). Their cell ends are mostly narrow and rounded at the edge. These algae have a unicellular structure. Sometimes a narrow bridge divided the cell into two compartments in which a small spherical nucleus is present. A large folded chloroplast is being synthesized by each semi-cell for performing photosynthesis. It has a yellow or brown porous cell wall which secretes mucilage, while some species comprise girdle bands commonly present in the cell wall (Kumar et al. 2015). *Ankistrodesmus* are those that need strong attention in Chlorophyceae class. Most commonly prevail in the tropical and moderate aquatic environment, only those whose nutrient content is high. The increased growth rate of these genera in culture is thoroughly used in physiological studies (Melaku. 2017). The *Cosmarium* genus is closely related to platform dismsids. This genus is artificial ambiguous and its origin is polyphyletic. Their cells are solitary which is free-living, its pores of mucilage seldomly occur (Zhou and von Schwardenberg. 2020). The feature of the specimens like how it's cell measure, it's shape, presence or absence of granules, length of the cell, it's width is considered as important for special to be identified. Its cell wall is smooth, granulated (granules are present. The Cone shape is not familiar, the genera are ancient and belonging to the family of Desmidiaceae. Masses of species are artificial (Xi et al. 2007). The *closteriopsis* genus is identified by fusiform solitary cells containing only one chromatophore

and a lot of pyramids arranged lengthwise. Lammermann lays down his new genus into the desmidiales which is closely related to the genera of closterium. It is recommended that Closteriopsis look more like the Rhidium genus. They can generally be differentiated by the size of its cell, the total number of paranoid present, and also by its chloroplast shape. Closteriopsis acicularis is mostly familiar, it's assurance is not abundant and its occurrence is not abundant also an ingredient of phytoplankton (Stoyneva et al. 2005). The Microalgae algae form a significant part of algal populations in the habitats of freshwater. On the other hand, their huge morphological characteristics and the complexity of understanding a few features have tiresome taxonomy. These and other core of the matter clarifies the deficiency of data on microalgae algae in District Peshawar (Shamshad, Khan. 2015, Sarim and Shaheen. 2007). On a worldwide range, there is a need for further information regarding their environmental division and it seems essential to write up a review on the taxonomical feature of microalgae green algae (ur Rehman et al. 2019). The filament is an amazing adoptive form: microalgae green algae grow very much rapidly increase their size and mass and adapting to the new environment more rapidly than non-microalgae algae. Branches characterized diversity which permits the algae a superior use of water in limited spaces and an improved dominance of absorption's Seccession from uncomplicated filaments with quick expansion while the branched filaments species shows a slow increase in their production, can be reasonably observed very frequently in the ecosystems of freshwater (Margalef. 1983). (Margalef et al. 2001) format references as per journal style

MATERIALS AND METHODS

In Peshawar valley, there were 3 locations nominated to evaluate the genera diversity and ecology of Kabul River. These spots include unpolluted, slightly polluted, and highly polluted water. The algal diversity regarding water quality variations was recorded. The four genera under consideration were collected from different habitats. The samples were collected, preserved, and stored in the herbarium of Islamia College Peshawar. The preservative used was neutral Lugol's Iodine solution, 0.5 ml per 100 ml water sample, and stored for a short time (Edler and Elbrächter 2010). The physical and chemical properties of water from the samples were

determined using HANNA HI98190 portable meter and HANNA HI98703 meter in the laboratory.

RESULTS AND DISCUSSION

Unpolluted Water

The unpolluted water is mainly present in Serdaryab, Naguman, and Shah Alam up to Muhajer camp. A total of 23 species of unicellular microalgae algae that belonged to 04 genera were collected from those areas and identified. The most common genus was *Cosmarium* with 11 species (Zarina et al. 2014) *Closterium* with 8 species, *Ankistrodesmus* with 3 species (Gardner et al. 1997), and *closteriopsis* with one specie were recorded.

The determination of water at the unpolluted site showed that Calcium as CaCO_3 is 146 Mg/L Chloride - Cl^{-1} is 22 Mg/L and conductivity is 699 $\mu\text{S/cm}$, Magnesium- MgCO_3 is 164 Mg/L, M-alkalinity- CaCO_3 is 317 Mg/L, Nitrate- NO_2^{-1} is nil, P-alkalinity- CaCO_3 is nil pH of water is 7.05, Potassium as K^{+1} is 7.40 Mg/L, sodium as Na^{+1} is 55 Mg/L, Sulphate as SO_4^{-2} is 117 Mg/L, TDS is 417 Mg/L and Total hardness (CaCO_3) is 321 Mg/L, TSS is 4 Mg/L

Table1: Three Existence spots of Genus *Cosmarium* with changed water qualities

S. NO	Species	Presence spot		
		UPW*	HPW*	SPW*
1	<i>C. acutum</i>	+	-	+
2	<i>C. botrytis</i>	+	-	+
3	<i>C. braunii</i>	+	-	+
4	<i>C. broomei</i>	+	-	+
5	<i>C. crenatum</i>	+	-	+
6	<i>C. protractum</i>	+	-	+
7	<i>C. quadrum</i>	+	-	+
8	<i>C. quinarium</i>	+	-	+
9	<i>C. subcostatum</i>	+	-	+
10	<i>C. subcrenatum</i>	+	-	+
11	<i>C. triplicatum</i>	+	-	+

*UPW= Unpolluted Water, *HPW= Highly polluted water, *SPW= Slightly Polluted water

Table 2: Three Occurrence spots of Genus *Ankistrodesmus* with unlike water qualities

S. No.	Species	Existence locations		
		UPW*	HPW*	SPW*
1	<i>A. falcatus</i>	+	-	+
2	<i>A. falcatus var. mirabilis</i>	+	-	+
3	<i>A. falcatus var. tumidus</i>	+	-	+

*UPW= Unpolluted Water, *HPW= Highly polluted water, *SPW= Slightly Polluted water

Table 3: Presence of Genus Closteriopsis at Three Nominated Areas with Dissimilar Water Qualities

S. NO.	Species	Presence Areas		
		UPW*	HPW*	SPW*
1	<i>C. longissima</i>	+	-	+

*UPW= Unpolluted Water, *HPW= Highly polluted water, *SPW= Slightly Polluted water

2: Highly polluted water (Mian Gujar):

After village Kankola an incredibly polluted canal meet with the River, the pollution is so intensified that it changes the color of the water even if the upper waters are not turbid, then at Bela Neko Khan and Chersi geranda near Mian Gujar village extremely polluted water meet up with the River, this polluted tributary is known as River Shah Alam. The species identified from this polluted site of River Kabul are:

A total of the collected samples of polluted water of River Kabul. The analysis of water at the polluted site showed that Calcium (CaCO₃) is 245 Mg/L, Chloride (Cl⁻¹) is 230 Mg/L and conductivity is 1138 μS/cm, Magnesium (MgCO₃) 175 Mg/L, M-alkalinity (MgCO₃) is 495 Mg/L, Nitrate (NO₂⁻¹) is 15 Mg/L, P-alkalinity (CaCO₃) is 40, pH of water is 8.54, Potassium as K⁺¹ is 20 Mg/L, sodium as Na⁺¹ is 170 Mg/L, Sulphate as SO₄² is 230 Mg/L, TDS is 880 Mg/L while Total hardness (CaCO₃) is 462 Mg/L and TSS is 17 Mg/L.

At different sites, the water PH values ranged from 7.43-8.54 while temperature values of water and air were between 6-27⁰c and 6-39⁰c, respectively.

At different sites, the water PH values ranged from 7.43-8.54 while temperature values of water and air were between 6-27⁰c and 6-39⁰c, respectively.

Table 4: Three selected sites for the occurrences of Genus Closterium with changed water qualities.

S.NO.	Species	Selected sites Diversity		
		UPW*	HPW*	SPW*
1	<i>C. acerosum</i>	+	-	+
2	<i>C. diana</i>	+	-	+
3	<i>C. lanceolatum</i>	+	-	+
4	<i>C. leibleinii</i>	+	-	+
5	<i>C. littorale</i>	+	-	+
6	<i>C. parrulum</i>	+	-	+
7	<i>C. pritchardianum</i>	+	-	+
8	<i>C. striolatum</i>	+	-	+

*UPW= Unpolluted Water, *HPW= Highly polluted water, *SPW= Slightly Polluted water

Species of the different site are:

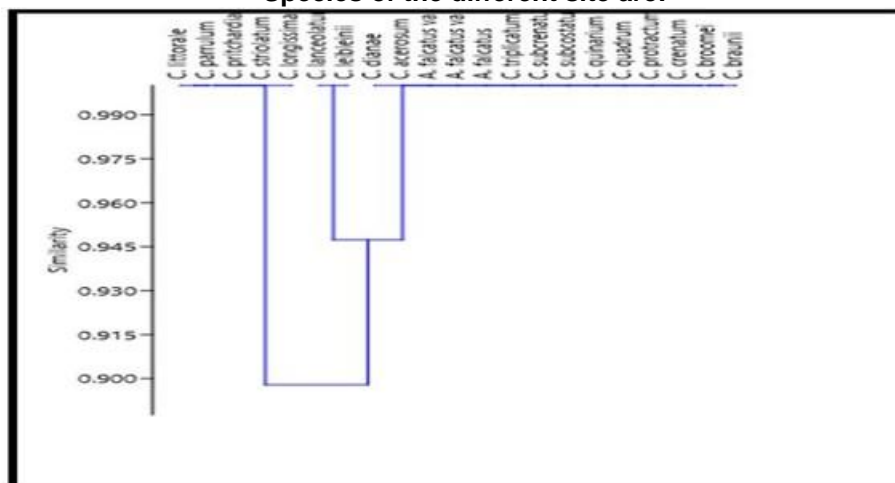


Figure 1: Bray-Curtis hierarchical clustering of Species found in the water of the river

3: Slightly polluted water (Khazana):

The aggregate of species that identified from several places of slightly polluted water (Khazana) are:

The analysis of water at the slightly polluted site showed that Calcium as CaCO₃ is 188 Mg/L Chloride as Cl⁻¹ is 29 Mg/L and conductivity is 690

µS/cm, Magnesium, as MgCO₃ is 170 Mg/L, M-alkalinity (CaCO₃) is 319 Mg/L, Nitrate (NO₂-1) is 5, P-alkalinity (CaCO₃), is 17, pH of water is 7.54, Potassium as K⁺¹ is 14.50 Mg/L, sodium as Na⁺¹ is 64 Mg/L, Sulphate as SO₄⁻² is 134 Mg/L, TDS is 431 Mg/L while Total hardness as CaCO₃ is 311 Mg/L and TSS is 4 Mg/L

The figures along with the names of the species and chemical analysis are given.



Figure 2: Selected sites of the River

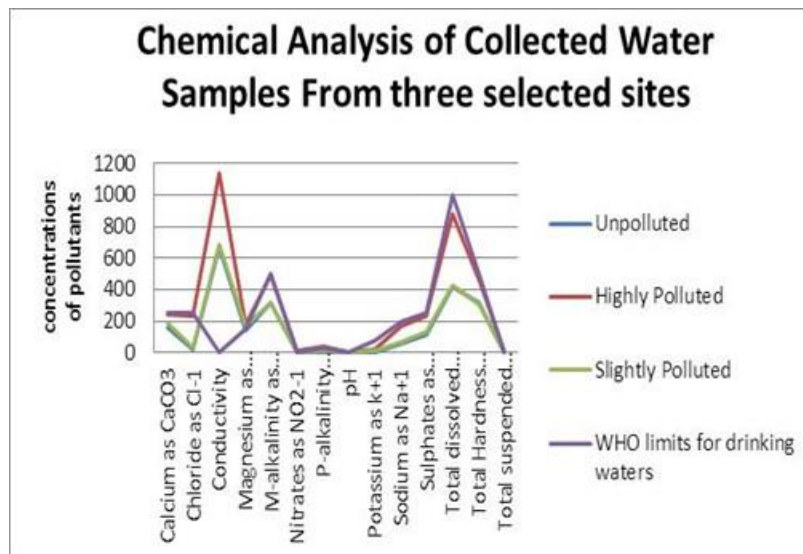


Figure 3: Water quality of selected sites

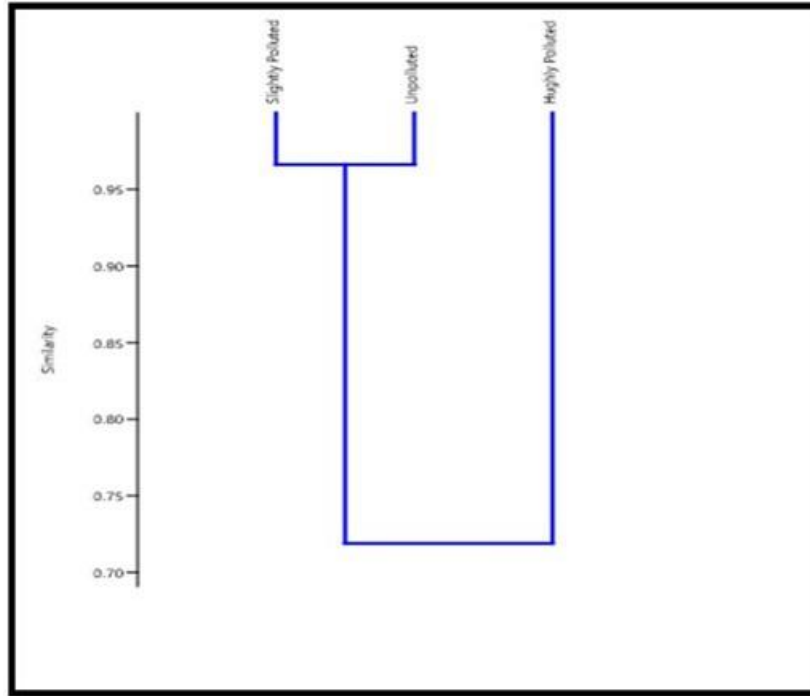


Figure 4: Bray-Curtis hierarchical clustering of pollutants found in the water of the river

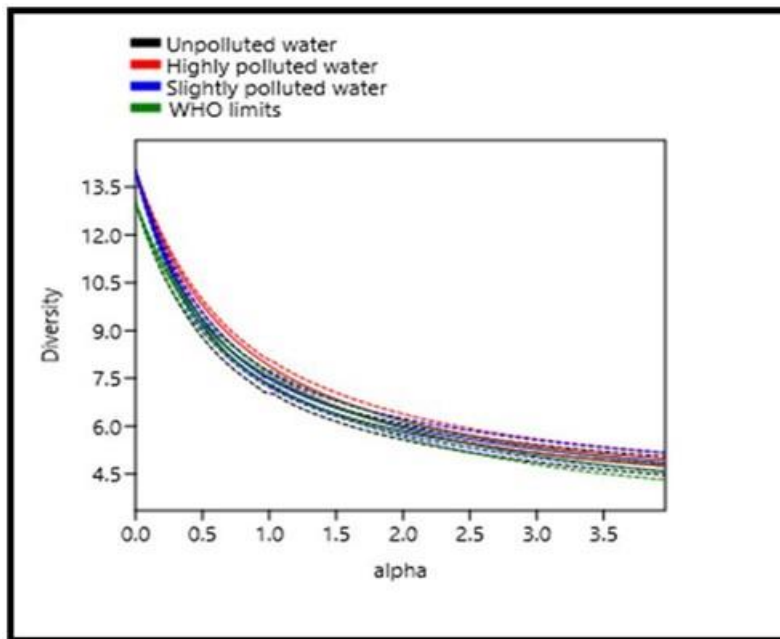


Figure 5: Diversity of pollutants

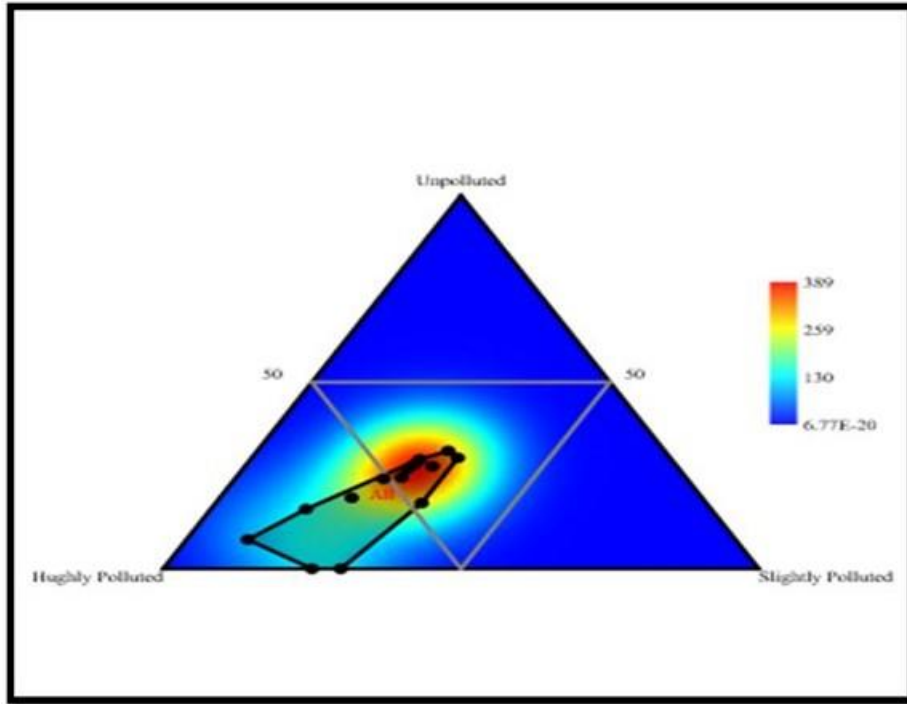
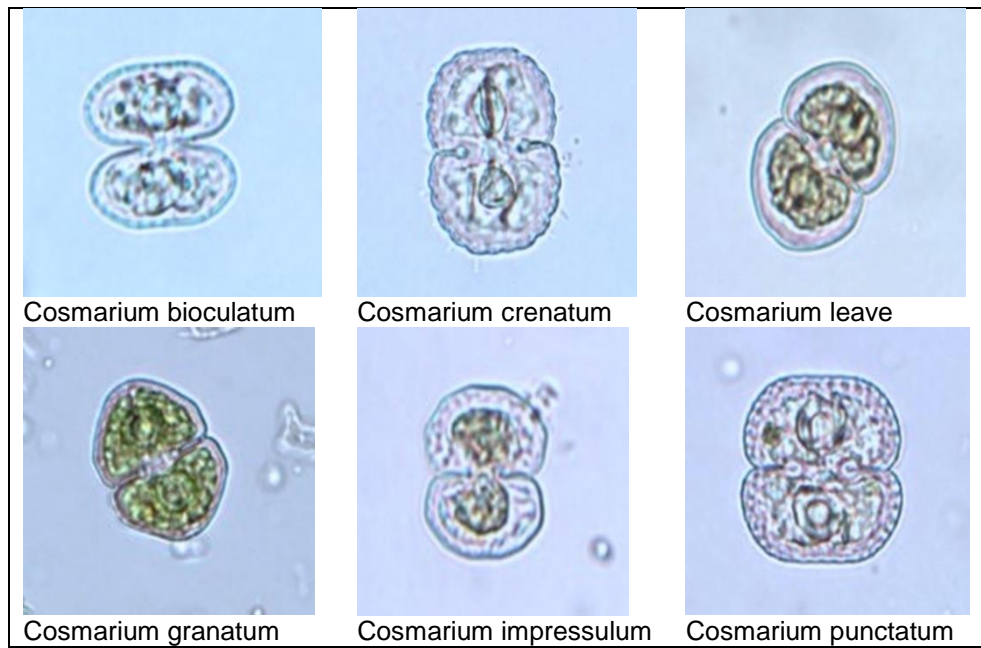


Figure 6: Density map (Ternary plot) of pollutants of the river



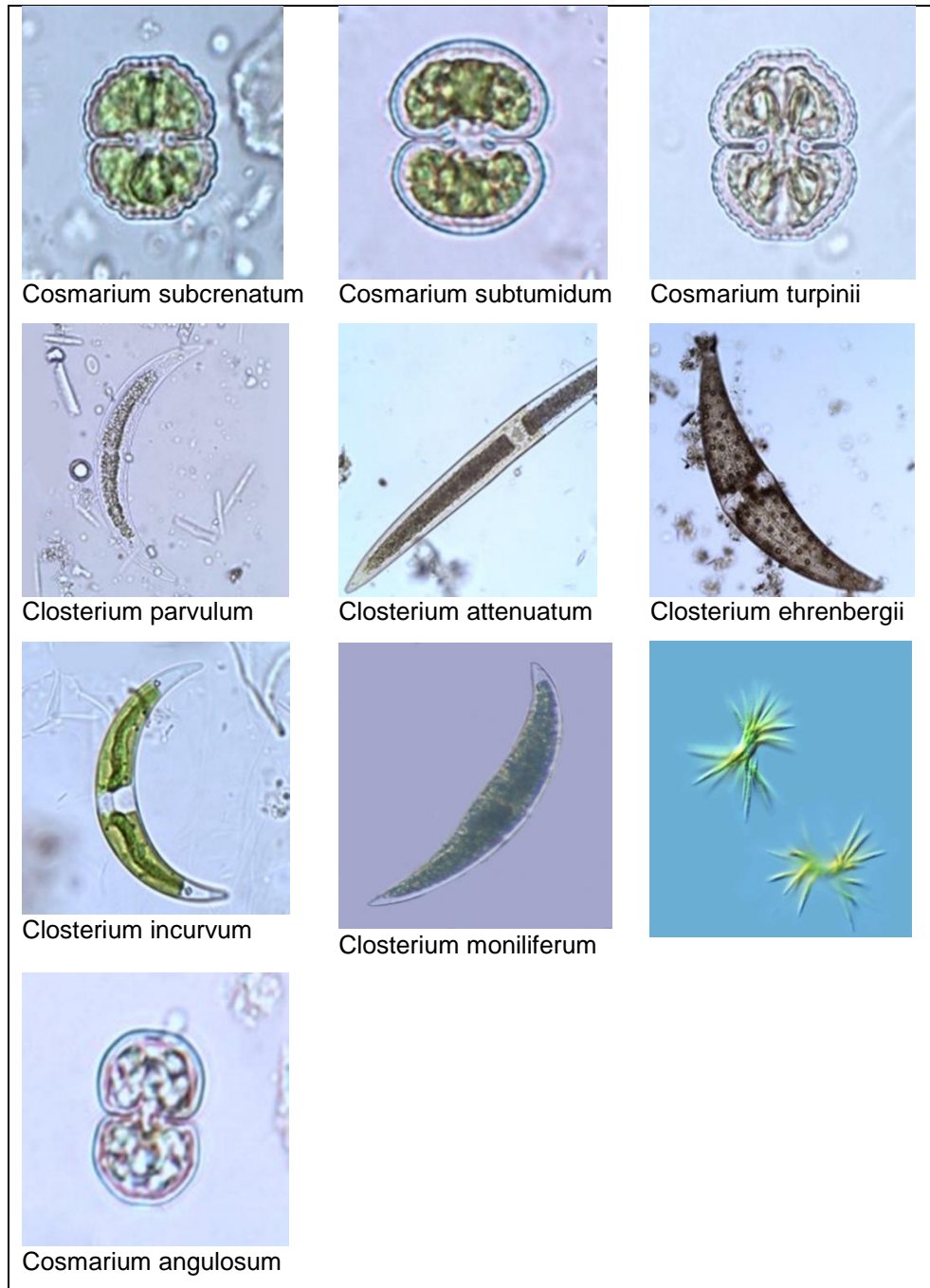


Figure 7: Pictures of selected species listed.

CONCLUSION

The presence of genus *Cosmarium*, *Closterium*, *Ankistrodesmus*, and *Closteriopsis* in unpolluted water and slightly polluted water investigated that they can be used as a bioindicator for the checking of water quality at different parameters. The mentioned genera also concluded that they are resistant to unpolluted and slightly polluted water conditions and more susceptible to polluted water quality resulting in the absence of species from the stated genera. In addition, these genera do not make algal bloom in unpolluted and slightly polluted water.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

KR and SU designed and performed the experiments and also wrote the manuscript. AAS, MM, and AAK performed data analysis. TK, TY ZAB and KR prepared and reviewed the manuscript. All authors read and approved the final version.

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