Distribution of Algae and Water Quality in Waterfall Derna –Libya.

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Abstract :This study was conducted to find out the distribution of the fresh water algal species from waterfall Derna, and then the quality of water purity was calculated using the Saprobity Index scale. 48 species of algae were isolated and identified, 19 species belong to the class of Chlorophyceae, 13 of them belong to the class of Bacillariophyceae, 14 species belong to the class of Cyanophyceae and two of them belong to the class of Euglenophyceae algae. Results indicate that the waterfall of Derna was rich diversity of algae during study seasons, and this diversity indicted to quality and purity of water.
Key words : Waterfall Derna, fresh water algae, water quality

Introduction :

Algae are the typical eukaryotic organisms, which are at the lower level of the evolution. They are home to a diverse variety of habitats, ranging from small ponds to oceans of great size(Kottelat & Whitten, 1996 ; Aguirre & Riding, 2005). Freshwater algae can be found all over the world, and they are incredibly diverse, with tens of thousands, if not hundreds of thousands, of species in a wide range of forms and sizes

(Andersen, 1992; Guiry *et al*., 2014). All algae are classified into one of eight to twelve evolutionary lineages (Graham *et al*., 2008; Cock *et al*., 2010), and they're all represented in inland waters. Rivers, lakes, ponds, marshes, streams, and springs are just a few examples of freshwater ecosystems. Temperature, light penetration, and vegetation are among the factors used to classify freshwater habitats. Algae can be used as indicators for a variety of things Provide a relatively limited amount of information about ecosystem conditions. The mixtures Supplements (Kwalk *et al*., 2012) .

Algae are further classified into two subgroups, based on cell size and complexity: microalgae and macro algae. Microalgae represent the majority of the algae and are microscopic unicellular organisms (with some colony-forming species), including eukaryotic and prokaryotic species. Macro algae are eukaryotic multicellular organisms that resemble higher (Andersen, 2013)

Most algae are found in aquatic environments, with microalgae being the most frequently algae detected in water (Bellinger, & Sigee, 2010) where they function as the primary producers in the food chain (Lee, 1989). However, microalgae can be found in a variety of terrestrial environments, including extreme environments such as snowfields, desert soil, hot springs and arctic environments (Delwiche, 2007). They are also found in environments where they are exposed to extremes of pH, salt concentration and radiation (Seckbach, & Oren, 2007).

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Materials and Methods

Study Area:

Fresh water algae samples were collected from five sites at the waterfall Derna during the period from November 2020 to September 2021. Waterfall Derna is located at (32° N 21° E).

The samples of water were taken from behind the waterfall, assembly, beginning, mid and end the assembly basin.

Isolation of microalgae

Bring samples to the laboratory in plastic Gallons 5 liter during one hour and perform deposition sampling process Sedimentation , 50 ml, reservation samples for the examination and agriculture (Vantkatarman, 1969; Lee, 1980).

Collection of macro algae

Sample were collected manually from the rock. The harvested macro algae were stored in plastic bags for transportation to the laboratory. Biomass was rinsed with fresh water to eliminate other 30 materials such as small stones, plankton, etc. The macro algae was dried in the air for seven days and then placed in the oven at 40°C for 20-30 minutes to remove the remaining moisture. The sample were then well grinded with an electric mill and then stored well until use (Rao, & Parekh, 1981). .

Cultivation and Identification of microalgae

freshwater samples were added into Petri-dishes contained solution (enrichment culture) and then cultured in culturing room with constant temperature and light (25 °C and 4000 LUX intensity of light)(Cameron, 1965).

The media used for isolating the algae present in the freshwater were Rippka and Hardman(Rippka, & Herdman, 1993) medium for isolation of blue green algae and Chu 10 (Chu, 1942). Medium for isolation of diatoms, while Bold's basal medium(Bischff, &Bold, 1963 .This medium was used to isolate the Cyanophyta, The cultivation of algae by take 1 ml of the sample and grown in Petri dishes contain three types of media, the samples placed in a growth chamber and cultivation of three replicates of each sample at room temperature and under 25 M◦ lighting 4000LUX appreciation was connected LX101LUXMeter.

Identification of algae:

The definition of algae was done by making slices from each sample and examining them with light microscopy, including the shape of thallus, the nature of the cell wall, the pigment, flagella, the nature of the food saved and the size of algae. Cell-Volume on these foundations were divided into rows, ranks, families, races and species using special keys to identify freshwater algae contained in references (Prescott, 1982; Krammer, & Lange-Bertalot, 1991 b).

Determination of pH value

pH value of the water samples was determined by using pH meter (Type Toldo).

Determination of TDS and E.C value

TDS and E.C value of the water samples was determined by using (TDS Meter, Type Toldo).

Determination of nutrient in water samples

The concentration of the elements (Fe, Ni, N, P) were measured by using Spectrophotometer. All concentrations of the studied samples were calculated from standard curves of each metal. The concentration of the elements (Na, Ca. and K) were measured by using Flam photometer

(Type Jenway), all measurements were conducted at the central laboratory of chemistry of faculty of science (Omer El-Mukhtar University).

Use algae as indicator of water quality by using Saprobity Index equation

This can be calculated for each sample according to species and ranks defined to the equation (Dresscher, & Mark. 1976).

$$SI = \frac{Chloro + Diat + 3(Period + Chryso + Conju)Eugel + 3(Ciliate)}{Ciliate + Eugel + Chloro + Diat + Perid + Chryso + Conjiu}$$

Results

Isolation and identification of freshwater algae from Waterfall Derna- Libya. Freshwater samples have been collected from five regions from waterfall Derna which were micro and macro algae and have been identified. A total of 48 algal genera (30 species) was recorded in the study area. 19 species of them were belonging to Chlorophyta (15 families), 13 species belonging to Bacillariophyta (9 families), 14 species belonging to Cyanobacteria (10 families), 2 species belonging to Euglenophyta (one family). Tables (1,2,3 and 4).

Algae as indicator of water quality

The results from table (5) indicate that the all water samples are clean. Sample one and sample three located in the Saprobity Zone α- Oligosaprobic. While samples two and four and five located in the Saprobity Zone β- Oligosaprobic. Depended on Saprobity Index equation (SI).that is clear in table (5).

Discussion:

The fresh water environments particularly rivers and waterfalls show great variations because of the changing environmental factors. The occurrence of algae in water is further dependent on different factors such as temperature, light penetration, turbidity and availability of dissolved nutrients. These factors further determine the survival, distribution and occurrence of algae in accordance with their adaptive features.

The present study showed that algal flora consisted of 30 species belonging to 48 genera, 35 families, 24 orders, 4 divisions, were collected from different sites from Derna waterfall. This rich flora can be related to nutrients and other environmental factors that required the growth of algae. This richness in diversity is consistent to (Bhakta *et al*., 2011). Algae from the division of Bacillariophyta and Chlorophyta especially the desmids *Scenesdesmus* sp. are highly sensitive to changes in the environmental parameters that could be considered as a bio-indicator for monitoring water quality (Coesel, 1983; Leclercq, 1988). Chlorophyta were found high abundance during study seasons represented by 19 genera and 14 species. The high abundance of Chlorophyta indicates more productive water (Rasuol, 2013; Aziz, & Rasoul, 2016). The increase in green-algae during the early autumn months can be attributed to the moderate temperature, alkaline pH and moderate concentration of phosphorus.

This results supports the finding of(Tilman *et al*., 1986). who reported that green algae shifted for dominance at intermediate temperature high atmospheric or water temperature along with the bright sunshine is an important factor in the periodicity of Chlorophyceae (Butcher, 1946). In this research, moderate phosphate-phosphorus concentration was one of the most important factors for green-algae abundance. Casabianca & Posada (1998) showed that the growth of Chlorophyceae was not affected by high nutrients but their growth become delayed at a lower phosphate-phosphorus concentration and with the temperature above 24°C. The occurrence of some green algae like *Cosmarium melanosporum* and *Closterium striolatum* in study area was due to of Ca in percentage ranges between 4.7 to 5.12, and named as calcified algae (Christensen, 1964) .

Cyanophyceae are the second and low occurrence group represented by 6 species belonged to 14 genera. Cyanophyceae were found in almost all sites, Cyanophyceae are successful in a wide range of environments because they have a versatile metabolism (Hamadamen, 2015). Ratio of dissolved inorganic N: P which created favorable condition for better propagation of this group of algae. Generally, blue-green algae may form these water blooms particularly during the periods of warm and calm weather (Palmer, 1980) . Bacillariophyceae are the group showed their higher proportion in the phytoplankton community during spring season. A moderate temperature, alkaline pH, and high nutrients concentration may be the reason for the dominance of Bacillariophyceae in the spring. Among this, moderate temperature is one of the important factors (Affan *et al*., 2005), was observed at a moderate water temperature, alkaline pH, and high nutrient concentrations during spring. Kant, & Anand ,(1978)suggested that high temperature favors the growth of diatoms, but Venkateswarlu (1969) observed an inverse relationship between diatoms and temperature. According to Welch (1942) diatoms flourish in winter and in spring when the water is also riches in nitrate and phosphate. In this research, Euglenophyceae was found to be represented mainly by the genera of a *Euglena gracilis* and *Euglena viridis*. The decrease in the appearance of euglena algae is attributed to the low of organic nutrients and the high water purity during study seasons. The study by Phang, & Ong (1988) suggested that euglenoids were dominant in water rich with organic loads at elevated temperature. Generally, Euglenophyceae were acid tolerant, growing optimally at pH 3.5 to 7 (Olaveson, & Nalewajko 2000). But rare occurrence occurred at alkaline pH, which might be due to lowest efflux of domestic sewage. Thus, the euglenoids are the best indicator of organic pollution. Data showed that the freshwater sites have the greater abundance of 19 species (69%), that belongs to Chlorophyceae (15 families), 14 species (44%) owned to Cyanophyceae (10 families), 13 species (48%) to Bacillariophyceae, 1 specie (6%) 1(family) to Euglenophyceae. This results agree with the finding of(Elsalhin & Abobaker 2018). However sixteen species (41.03%) were found belongs to Chlorophyceae (13 families), seven species (17.95%) owned to Cyanophyceae (4 families), fifteen species (38.46%) to Bacillariophyceae (12 families) and one species (2.56%) to Charophyceae. Most of the species were Chlorophyta, followed by Bacillariophyta, a few species of Cyanophyceae.

In general, different Algae flora species can tolerate different ranges of temperature as well as light and nutrient limitation. These tolerance levels determine the dominance of different species within different seasons. Hence, the seasonal changes in the dominant classes of algae flora can be explained in terms of not only the variations in water temperature, but also in relation to the competition for nutrients. It was observed that the non-polluted water showed a high pH (alkaline) which is good for the algal growth (Michelutti *et al*., 2006). showed that the diatom diversity showed high levels of sensitivity towards the change in pH, climate and alkalinity, that the potassium values were higher in winter than the rest of the seasons, where it was 5.88mg/L and these results are consistent with the Libyan standard specifications and also agree with the World Health Organization, which are do not exceed pass 12 mg/L. The sodium values ranged between 9.16 to 13.56 mg/L in the freshwater samples, and these values are considered low compared to the permissible limit for the element sodium with the Libyan standard specifications. The values of phosphorous in freshwater samples during study seasons ranged between 0.0002 to 0.0006 mg/L, are consistent with El-Adl (2006) studies conducted on some open water source such as the Nile River in Egypt that the values of phosphorus do not exceed 1mg/L. Ranged the amount of Nitrogen in study area between 2.25 to 6.23 mg/L. The values are within the permissible limit the according to the standard Libyan measurement which was 10 mg/L.

The study indicated that the water in the collected samples from the Derna waterfall is poor in heavy metals. Where the percentage of Iron was between 0.3 to 1.2 mg/L and the

percentage on Nickel between 0.5 to 1.2. These results agree with Madyan (1999) on the drinking water of the city of Benghazi. During the present study investigation pH value was neutral. The majority of algae grow best in water at or near the neutral point of pH, alkaline in nature. The alkaline pH was more favorable for most of the algal species. According to literature (Villadolid *et al*., 1954) the optimum pH for the growth of microalgae was 7.3 to 8.3.

Accordingly, algae play important ecological role in the understanding of aquatic ecosystems (Wehr & Sheath 2015). their productivity and water quality. More over the habitat conditions and composition play an important role in determining the freshwater algal communities. Results were consistent with Dresscher, & Mark(1976) where the quality of water purity was clean between regions α- Oligosaprobic and β- Oligosaprobic. This purity is attributed to the increases diversity of algae flora.(E.C) varied in the different seasons of the samples of the waterfall Derna. The highest value in the autumn season and the lowest value in the winter season. These results agree with the previous report by Alshaaki (1996) on the assessment of the water situation in the Ghadwa area, where the results ranged between 450-2300 µS.

The total dissolved salts (TDS) in the study samples the highest in the summer and les in autumn. The valuation is consistent with the global health organization and Libyan standard specification of drinking water 100 mg/l

The diversity of algae during the study seasons is attributed to the purity of the water. A source of water is considered pure if it contains the highest diversity of algae and the lowest density of algae(El-Adl, 2006).

The study of algae especially phytoplankton is a mirror that reflects the physical structure and changes that occur in the water from time to time (Adam *et al*., 1990). so we use the algae species as indicator to pollution or purity of water (Polat & Isak 2002) .

.توزيع الطحالب وجودة المياه في شلال درنة – ليبيا

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المستخلص: أجريت هذه الدراسة لمعرفة توزيع أنواع طحالب المياه العذبة من شلال درنة ومن ثم تم حساب جودة نقاء المياه باستخدام مقياس مؤشر Saprobity Index. تم عزل وتحديد 48 نوعًا من الطحالب ، 19 نوعًا تنتمي إلى فئة Chlorophyceae ، 13 منها تنتمي إلى فئة Bacillariophyceae ، 14 نوعًا تنتمي إلى فئة Cyanophyceae واثنان منها تنتمي إلى فئة الطحالب Euglenophyceae. تشير النتائج إلى أن شلال درنة كان غنيًا بتنوع الطحالب خلال مواسم الدراسة ، وهذا التنوع يدل على جودة ونقاء المياه.

الكلمات المفتاحية: شلال درنة ، طحالب المياه العذبة ، جودة المياه.

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Table (1): The Diversity of Chlorophyta during of seasons.

Algal species	Orders	Families
Ankistrodesmus monoraphides	Sphaeropleales	Selenastraceae
Ankistrodesmus convolutes	Sphaeropleales	Selenastraceae
Chlamydomonas reinhardtii	Chlamydomonadales	Chlamydomonadaceae
Chlorella vulgaris	Chlorellales	Oocystaceae
Chlorococcum sp.	Chlamydomonadales	Chlorococcaceae
Cladophora sauteri	Cladophorales	Cladophoraceae

Closterium striolatum	Desmidiales	Closteriaceae
Cosmarium melanosporum	Desmedales	Desmedaceae
Crucigenia quadrata	Sphaeropleales	Scenedesmaceae
Haematococcus pluvialis	Chlamydomonadales	Haematococcaceae
Nannochloropsis sp.	Chlorellales	Oocystaceae
Oedogonium sp.	Oedogoniales	Oedogoniaceae
Oocytes gigas	Chlorellales	Oocystaceae
Pandorina sp.	Chlamydomonadales	Volvocaceae
Scenedesmus quadricauda	Sphaeropleales	Scenedesmaceae
Spirogyra inflata	Zygnematales	Zygnemaceae
Stigeoclonium sp.	Chaetophorales	Chaetophoraceae
Ulothrix zonata	Ulotrichales	Ulotrichaceae
Stichococcus bacillaris	Prasiolales	Prasiolaceae
19 Species	10 Orders	15 Families

Table (2): The Diversity of Cyanophyta during of seasons

Algal species	Order	Familis
Anabaena circinalis	Nostocales	Nostocaeae
Lyngbya sp.	Oscillatoriales	Oscillatoriaceae
Microcoleus sp.	Chroococcales	Microcystaceae
Microcystis sp.	Chroococcales	Microcystaceae
Nostoc piscine	Nostocales	Nostocaeae
Nostochopsis labatus	Stigonematales	Nostochopsidaceae
Oscillatoria princeps	Nostocales	Oscillatoriaceae
Phormidium sp.	Oscillatoriales	Phormidiaceae
Rivularia sp.	Rivulariales	Rivulariceae
Scytonema sp.	Nostocales	Scytonemataceae
Spirulina sp.	Spirulinales	Spirulinaceae
Synechococcus aeruginosus	Synechococcales	Synechococcaceae
Merismopedia punctuate	Chroococcales	Chroococcaceae
Coccochloris sp.	Chroococcales	Chroococcaceae
14 species	7 Orders	10 Families

Table (3): Diversity of Bacillairophyta during of seasons

Algal species	Order	Families
Asterionella formosa	Fragilsriales	Fragilariaceae
Caloneis bacillum	Naviculales	Naviculaceae
Cymbella cistula	Cymbellales	Cymbellaceae
Diatoma sp.	Fragilariales	Fragilariaceae
Fragilaria capucina	Fragilariales	Fragilariaceae
Gomphonema sp.	Cymbellales	Gomphonemataceae
Gyrosigma attenuata	Naviculales	Pleurosigmataceae

Melosira granulata	Melosirales	Melosiraceae
Navicula lanceolata	Naviculales	Naviculaceae
Nitzschia palea	Bacillariales	Bacillariaceae
Pinnularia sp.	Naviculales	Pinnulariaceae
Synedra sp.	Fragilsriales	Fragilariaceae
Tabellaria flocculosa	Tabellariales	Tabellariaceae
13 Species	6 Orders	9 Families

Table (4): The Diversity of Euglenophyta during of seasons

Algal species	Order	Families
Euglena gracilis	Euglenales	Euglenaceae
Euglena viridis	Euglenales	Euglenaceae
2 Species	1 Order	1 Families

Table (5): Determine the purity of water during study seasons by used Saprobity Index.

Samples	Saprobity Index	Class of water Quality	Saprobity Zone
Sample 1	1.2	Clean	α- Oligosaprobic
Sample 2	1	Clean	β- Oligosaprobic
Sample3	1.2	Clean	α- Oligosaprobic
Sample 4	1	Clean	β- Oligosaprobic
Sample 5	1	Clean	β- Oligosaprobic

Table (6): Estimation of chemical elements and pH, E.C, TDS, in water samples during study seasons(mg /l).

Analysis Type	Autumn	Winter	Spring	Summer
Ca	5.12	4.165	4.167	4.167
K	3.14	3.12	5.88	1.48
Na	13.55	13.4	13.56	9.16
Ni	1.22	1.24	0.565	1.22
Fe	1.23	1.26	1.242	0.363
P	0.0002	0.0002	0.00006	0.0002
N	6.23	5.26	2.25	5.75
E.C	899µS	898µS	889µS	901µS
TDS	685	601	406	415
pH	7.1	7.1	7.1	6.92