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# The spatial and temporal distribution of Epipelic algae and related environmental factors in Neel stream, Babil province, Iraq

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**Abstract:** The spatial and temporal distribution of epipelic algae was studied in relation to physical and chemical parameters in Neel stream, Babil governorate. Monthly samples were taken from four sites along the stream for the period from October 2010 to June 2011. The samples were analyzed for several parameters (air and water temperature, pH, Electrical conductivity, salinity, dissolved oxygen, total hardness, calcium, magnesium and total alkalinity). The epipelic species compositions, density, biological diversity index and richness index were also studied. A total of 56 taxa of epipelic algae were identified in the present study. Diatoms were considered the most dominant species of epipelic algae. The results indicated clear spatial and temporal variations of epipelic algae.

**Key Words**: Benthic algae, Epipelic algae, Water quality, Biological indices, Hilla River, Euphrates River, Iraq

## Introduction

The study of pollutions in aquatic environment is considered one of the most important one, especially in developing countries (Hassan *et al*., 2005). In contrast, the characteristics of the aquatic system alone do not determine the nature of the dangers of human and agricultural usage for streams and rivers, but the studying of the existing organisms in that aquatic system will complete the understanding of impact of pollutant on aquatic systems (Salman *et al*., 2010; Hassan *et al*., 2010a).

Benthic algae are reefer to the type of algal habitat, these algae found on rocks, mud and organic debris etc. These algae have important role in river ecosystems as primary producers (Nozaki *et al*., 2003; Hassan *et al*., 2007a).

Benthic algae comprise different groups of algae in aquatic systems such as river and these algae are influenced by geomorphology of aquatic system and human activities (Rimet,

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2009).

There are many studies concerning phytoplankton species composition and seasonal distribution in the main river of Hilla (Hassan and Al-Saadi 1995; Hassan 1997), while a few studies talked benthic algae (Hassan *et al*., 2007a). Many authors used microalgae (particularly the benthic organisms) as bioindicators either one taxonomic group or the entire community (Dere *et al.*, 2003; Kelly and Whitton, 1998; Rimet, 2009).

This study aims to contribute to the information on benthic algae flora in the studied area, and assess the quality of water for agricultural irrigation and other domestic uses.

## Material and methods

Neel stream is one of Hilla river branches, with the length of 36 km, a width between 15 to 20 m and discharge 10 $m^3$/S. This stream feeds the irrigation areas about 103,000 acres (personal communication with directorate of water resources/ division of water resources in the Neel, Babil province, Iraq).

Four sites were selected along the studied stream (Fig. 1). The present study carried out from October 2010 to June 2011. Air and water temperature, pH, electric conductivity (by EC meter type HANNA), salinity (calculated from EC value) dissolved oxygen were measured at the field according to standard methods (APHA, 1985). Total hardness, calcium, magnesium, and alkalinity were determined according to Lind (1979).

Epipelic algae were collected according to Eaton and Moss (1966) and epipelic algae samples were fixed by lugol's solution (Vollenweider, 1974) for quantitative and qualitative studies. Epipelic algae species were identified according to many references (Patrick and Reimer, 1966; Prescott, 1982; Hadi *et al*., 1984; Al-Zubaidi, 1985; Al-Handal, 1994; Hassan *et al*., 2012).

Two biological indices were used in this study, Shannon and Weaver Index (Spellerberg and Fedor, 2003) and Richness Index (Margalef, 1970). Statistical analyses were performed by T-test and Pearson coefficient.

## Results and discussion

Table 1 summarizes the physical and chemical characteristics of the studied area. The temperature is generally high in this area throughout year; the present study has recorded lowest air and water temperature (10 ºC) respectively in winter while the highest value (32 ºC) in summer. Narrow fluctuation of pH value was noticed, the sampling months varying from7.3 to 8.6, these results also were recorded in aquatic systems in Iraq (Hassan 1997, Al-Saadi *et al*., 2008). A positive correlation between pH and temperature (r=0.56, P=0.01) was recorded that may be related to activities of algae and aquatic plants

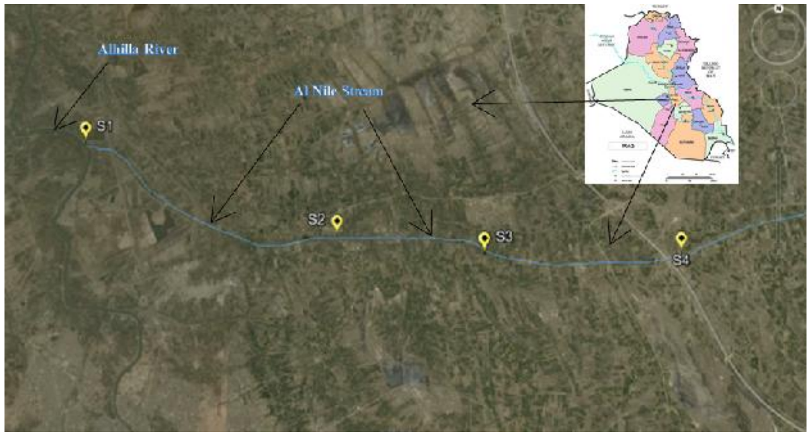


**Fig. 1: Sites of the study area.**

(Davies *et al*., 2008). A positive correlation has recorded with salinity (r=0.39, P=0.05) and magnesium (r=0.37, P=0.05) due to the deposition of magnesium in the form of $MgCl_2$ and thereby thus increasing pH value (Bhandari and Nayal, 2008)

Electrical conductivity ranged between (852-1035 µS/cm) while water salinity ranged between (0.3-0.6 ‰). Increase in both EC and salinity values was noticed in aquatic systems that influence agricultural and industrial activities (APHA, 1976). The highest values of EC were obtained during spring and summer, these results agreed with other studies (Hassan 2004, Alkam *et al*., 2002). The study results revealed that Neel stream is oligohaline according to Reid (1961).

The present study shows closely values of dissolved oxygen between sites. The lowest dissolved oxygen (4 mg/L) was recorded in dry season (summer), while the highest value was 9.6 mg/L, the lower values may be due to the increase of decomposition and discharge of domestic and agriculture waste into steam (Adeyemo *et al*., 2008). The dissolved oxygen is important limiting factor for many aquatic organisms and as important criteria for classification of aquatic systems (Golterman *et al*., 1978). A negative correlation between dissolved oxygen and temperature (air and water, r=-0.044, P=0.01and r=-0.45, P=0.01 respectively), EC and salinity (r=-0.48, P=0.01 and r=-0.41, P=0.05 respectively), this negative correlation has been mentioned before by Welch (1952).

Total hardness ranged between (340-800 mg $CaCO_3$/L) while calcium and magnesium hardness (56.11-256.5 mg $CaCO_3$/L) (23.94-96.91 mg $CaCO_3$/L) respectively, while total alkalinity ranged between (40-264 mg $CaCO_3$/L)

**Tab. 1: Rang, mean of physical- chemical and biological parameters in Neel stream during the study period.**

| Parameters | Sites | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Temperature °C (air) | 10-29 (18.77) | 10-32 (18.77) | 11-32 (19.66) | 12-32 (19.77) |
| Temperature °C (water) | 10-27 (17.88) | 11-27 (16.88) | 11-27 (18.11) | 11-27 (18.33) |
| pH | 7.3-8.6 (8.05) | 7.3-8.5 (8.05) | 7.3-8.5 (8.07) | 7.3-8.5 (8.13) |
| Elecric conductivity µS/cm$^2$ | 592-1035 (776.89) | 581-1017 (765.11) | 578-1010 (761.22) | 587-1017 (767.78) |
| Salinity ‰ | 0.3-0.6 (0.45) | 0.3-0.6 (0.43) | 0.3-0.6 (0.43) | 0.3-0.6 (0.43) |
| Dissolved oxygen mg/l | 4-11.3 (7.85) | 4.2-9.2 (6.75) | 4.4-9 (7.15) | 4.4-8 (6.88) |
| Total hardness mgCaCO3/l | 480-800 (608.89) | 410-800 (581.11) | 370-760 (557.78 ) | 340-800 (553.33) |
| Calcium mg $CaCO_3$/l | 76.15-168.33 (110.9) | 56.11-184.36 (129.14) | 68.13-200.4 (141.17) | 96.19-256.51 (148.73) |
| Magnesium mg $CaCO_3$/l | 43.08-91.37 (69.21) | 52.63-96.91 (62.26) | 30.93-79.6 (49.29) | 18.90-84.38 (43.61) |
| Total alkalinity mg/l | 55-244 (169.89 ) | 50-284 (184.22) | 46-210 (163.56 ) | 40-228 (161.33) |
| Nitrite µg/l | 0.0-21 (1.18) | 0.7-9.79 (2.86) | 0.0-7 (1.94 ) | 0.0-9.3 (2.12) |
| Nitrate µg/l | 7.9-124.7 (51.74 ) | 12.1-104.2 (46.4 ) | 5-111.81 (46.29 ) | 8.4-150.7 (55.21) |
| Phosphate µg/l | 0.0-22 (3.44 ) | 0.0-3 (0.33) | 0.0-12 (1.6) | 0.0-221 (8.04) |
| Total No. of Phytoplankton (cell. 10-4/cm2) | 63.2-2412.8 (567.8) | 136.5-1307.8 (622.25) | 106.6-3092.8 (746.37) | 126.4-3235.8 (824.24) |

at sites 4 and 2 in October 2010 and May 2011 respectively, the lowest values of alkalinity during this study may be due to dilution factor (Trivedi and Goei, 1984) in addition to increasing of photosynthesis rates by algae and precipitation of carbonate (Hassan 1997). A positive correlation between Alkalinity and each of EC and salinity was recorded (r=0.44, P=0.01)و (r=0.33, P=0.05 respectively) in the current study. Significant differences were obtained in alkalinity values between the studied months but there was no significant difference among sites.

A total of 56 taxa of epipelic algae were identified in the present study. Table 2 illustrates the list of identified epipelic algae, these algae belong to Bacillariophyceae (16 genera and 36 species), Cyanophyceae (7genera and 14 species), and Chlorophyceae (3 genera and 3 species). Euglenophyceae (1 genes; 2 species) and Pyrrhophyceae (1 genus; 1 species). Bacillariophyceae (Diatoms) was the most dominant taxa in the studied area during the study period, this existence of diatoms was also observed in other aquatic systems in Iraq (Hadi *et al*., 1984; Maulood *et al*., 1993; Hassan and Al-Saadi, 1995) this may be due to its ability to sense wide environmental factors changes (Mooser *et al*., 1996). The present study observed absent of diatoms in some study months that may be became phytoplankton due to the effects of winds or water movements (Montoya, 2009). Pennate diatom is a dominated group of diatoms and this is a character freshwater environment (Altuner, 1984; Cetin and Sen, 2004; Hassan *et al*., 2010b).

Some species of epipelic algae were recorded as dominate species such as *Navicula cryptocephala* and *Cocconeis placentula*, this result was also recorded in another study on epipelic algae (Kolayli *et al*., 1998), while the genera *Navicula* , *Nitzschia* and *Cymbella* have recorded the largest number of species. These species have been considered as indicators for pollution (Shashi Shekhar *et al*., 2008, Sahin, 2004; 2005).

Cyanophyceae came after diatoms in epipelic composition which does not agree with other studies in Hilla Rriver on phytoplankton (Hassan *et al*., 2010b), also this group was dominating in summer and autumn that may be related to temperature rise and may lead to increase their competitiveness ability in contrast with other group of epipelic algae, in contrast with low temperatures that reduces their ability to photosynthesis (Plinski and Jozwiak, 1999). Existence of some genera such as *Phormidium*, *Anabaena*, *Oscillatoria*, and *Spirulina* in the studied area indicated that this area was polluted (Mason, 1991; Sahin *et al*., 2010). Cyanophyceae and Euglenophyceae recorded more diverse in sites 2, 3 and 4 more than in site 1. This result may indicate that site 1 is less polluted than other sites.

The third group of epipelic after diatoms and Cyanophyceae was Chlorophyceae but with less number of genera and species, this finding was also observed in the study on Balik Lake in Turkey (Gonulot *et al*., 2009).

Generally the Euglenophyceae exists in polluted water systems (Round, 1984; Edward

**Tab. 2: The identified epipelic algae taxa in Neel stream during the study period.**

| Taxa | St. 1 | St. 2 | St. 3 | St. 4 |
|---|---|---|---|---|
| CYANOPHYCEAE | | | | |
| *Anabaena constricta* (Szafer) Geitler | | | (0-183) | - |
| *Dichothrix compacta* (Agardh) Born. and Flah | - | (0-109.8) | - | - |
| *Gloeocapsa polydermatica* Kützing | (0-36.6) | (0-36.6) | - | - |
| *Lyngbya chaetomorphae* Iyengar & Desikachary | - | (0-73.2) | - | - |
| *L. sp.* | - | - | - | (0-36.6) |
| *L. taylorii* Drouet & Strickland | - | (0-36.6) | - | - |
| *Oscillatoria acuta* Brühl & Biswas | (0-109.8) | (0-109.8) | (0-36.6) | (0-183) |
| *O. chalybea var. Insularis Grander* | - | - | - | (0-36.6) |
| *O. limnetica* Lemmermann | (0-73.2) | (0-183) | (0-109.8) | (0-73.2) |
| *O. prolifica* (Grev) | (0-73.2) | (0-73.2) | (0-36.6) | (0-36.6) |
| *O. sp.* | - | - | - | (0-183) |
| *O. tenuis* Agardh | - | - | - | (0-36.6) |
| *Phormidium tenue* (Meneghini) Gomont | (0-292.8) | (0-36.6) | (0-146.4) | (0-366) |
| *Spirulina meneghiniana* Zanardini ex Gomont | (0-73.2) | (0-109.8) | (0-73.2) | (0-73.2) |
| CHLOROHYCEAE | | | | |
| *Cerasterias staurastroides* West & G.S.West | (0-36.6) | - | - | - |
| *Chlamydomonas* sp. | (0-109.8) | (0-73.2) | (0-73.2) | (0-36.6) |
| *Pediastrum sp.* | - | - | (0-36.6) | - |
| PYRRHOPHYCEAE | | | | |
| *Chroomonas nordstedii* Hansgirg | (0-73.2) | (0-73.2) | - | (0-36.6) |
| EUGLENAPHCEAE | | | | |
| *Euglena* sp. | - | (0-36.6) | - | - |
| *E. spirogyra* Ehrenberg | - | (0-146.4) | (0-36.6) | (0-36.6) |
| BACILLARIOPHYCAEA | | | | |
| *Cyclotella meneghiniana* Kützing | (0-60) | (0-35) | (0-35) | - |
| *C. ocellata* Pantocsek | (0-40) | (0-73.2) | - | - |
| *Stephanodiscus tenuis* Hustedt | - | (0-31.6) | (0-33.3) | (0-40) |
| *Pennales* | | | | |
| *Achanthes saxonica* Krasske ex Hustedt | (0-30) | - | - | (0-35) |
| *Cocconeis diminuta* Pantocsek | (0-66.6) | (0-33.3) | (0-99.9) | (66.6-90) |
| *C. placentula Ehrenberg* | (0-90) | (0-94.8) | (0-125) | (0-200) |
| *Cocconeis placentula var. lineate* (Ehrenberg) van Heurck | (0-40) | (0-315) | (0-125) | - |
| *Cymatopleura solea* (Brébisson) W.Smith | (0-80) | - | (0-70) | - |
| *Cymbella affinis* Kützing | (0-80) | (0-210) | (0-560) | (0-56.6) |

**Tab. 2: Continued**

| Taxa | St. 1 | St. 2 | St. 3 | St. 4 |
|---|---|---|---|---|
| BACILLARIOPHYCAEA | | | | |
| *C. cistula* (Hemprich in Hemprich & Ehrenberg) Kirchner | - | (0-35) | (0-100) | (0-40) |
| *C. leptoceros* (Ehrenberg) Kützing | - | - | (0-140) | - |
| *C. naviculiformis* Auerswald ex Heiberg | (0-40) | - | (0-35) | (0-800) |
| *C. tumida* (Brébisson) van Heurck | - | (0-33.3) | - | - |
| *C.* sp. | (0-40) | - | (0-280) | - |
| *C. turgida* (Ehrenberg) Hassall | (0-35) | - | - | (0-33.3) |
| *Diatoma vulgare Bory* | - | - | - | (0-40) |
| *Diploneis pseudoovalis* Hustedt | - | - | - | (0-33.3) |
| *Eunotia valida* Hustedt | (0-40) | - | - | - |
| *Gomphonema abbreviatum* C.Agardh. | (0-30) | (0-73.2) | (0-245) | (0-50) |
| *Gyrosigma kuetzingii* (Grunow) Cleve | (0-200) | (0-105) | (0-33.3) | (0-200) |
| *G. spencerii* (J.W.Bailey ex Quekett) Griffith & Henfrey | - | (0-33.3) | - | - |
| *Melosira ambigua* (Grunow) Simonsen | (0-66.6) | (0-35) | (48.3-60) | - |
| *M. granulata* (Ehrenberg) Ralfs | - | - | - | (0-50) |
| *Navicula clementis* Grunow | (0-120) | (0-99.9) | (0-99.9) | (0-109.8) |
| *N. gastrum* (Ehrenberg) Kützing | - | (0-245) | - | (0-33.3) |
| *N.* sp. | (0-480) | (0-640) | (0-832) | (0-1320) |
| *Nitzschia apiculata* (W.Gregory) Grunow | (0-200) | (0-80) | (0-120) | - |
| *N. dissipata* (Kützing) Grunow | - | - | - | (0-80) |
| *N. fasciculate* (Grunow) Grunow | (0-299.7) | (0-120) | - | - |
| *N. linearis* (C.Agardh) W.Smith | - | - | - | (0-70) |
| *N. longissima* (Brébisson) Ralfs | (0-120) | (0-36.6) | - | (0-21.6) |
| *N. vermicularis* (Kützing) Hantzsch | (0-160) | (0-60) | (0-105) | - |
| *Surirella ovalis* var. Salina (W. Smith) Van Heurck | (0-66.6) | - | (0-66.6) | (0-80) |
| *S. ovalis* Brébisson | (0-120) | - | - | - |
| *S.* sp. | (0-40) | - | - | - |
| *Synedra ulna* (Nitzsch) Ehrenberg | (0-520) | (0-31.6) | (0-31.6) | (0-80) |

and Ugwnmba, 2010), which led to consider that sites 2, 3 and 4 are polluted by organic materials.

The total cells number of epipelic algae was ranged between $63.2\times10^4$ cells/L and $3235.8\times10^4$ cells/L at sites 1 and 4 in March and May 2011 respectively. Many factors have the role in density of epipelic algae such as temperature, light intensity, and dilution factor (Muller, 1994; Kolayli and Sahin, 2009; Polge *et al.*, 2010) in addition to the activities of agriculture's and sewage thrown into study area (Gonulot *et al.*, 2009). Significant differences of epipelic algae density were observed among studied months.

The Shannon index was 0.61-2.49, 0.80-2.14, 0.17-2.06 and 0.55-2.1 at sites 1, 2, 3 and 4 respectively. The richness index was ranged 3.1 to 3.8 at sites 3 and 1 respectively. Shannon index reflex the number of species in the sample and the distribution of individuals among the existing of species. Other sites have closely values of richness index (Tab. 3).Both used indices in this study were related to factors influence on epipelic algal diversity (Hassan *et al.*, 2007a,b).

**Tab. 3: Shannon Index and Richness of Neel stream during study period**

| Sites | 2010 | | | 2011 | | | | | | Richness index |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | |
| 1 | 2.08 | 1.39 | 1.81 | 2.49 | 1.09 | 0.69 | 0.61 | 1.54 | 0.69 | 3.8 |
| 2 | 1.47 | 0.83 | 0.8 | 1.23 | 1.41 | 2 | 1.04 | 2.14 | 1.16 | 3.6 |
| 3 | 2.02 | 0.17 | 1.03 | 1.74 | 1.8 | 1.72 | 1.28 | 2.06 | 1.08 | 3.1 |
| 4 | 2.1 | 1.6 | 1.48 | 1.28 | 0.55 | 0.96 | 1.4 | 1.9 | 1.5 | 3.2 |

The study results indicated that the stream has dominated by diatoms, and followed by Cyanophyceae. The study area may be suffers from organic pollution which encourages the use of epipelic algae as environmental indictors.

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