The Qualitative and Quantitative Composition of Epiphytic Algae on *Ceratophyllum demersum* L. in Tigris River within Wassit Province, Iraq

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**Abstract:**

The present research was performed to study the qualitative and quantitative composition of epiphytic algae on the aquatic host plant *Ceratophyllum demersum* L. Four sites in Tigris River, at Wassit Governorate were covered, during the seasons of Autumn 2017, Spring 2018, and Summer 2018. The study also included measuring the physiochemical parameters (temperature of air and water, pH, water level, EC, salinity, TDS, TSS, dissolved oxygen, BOD5, alkalinity, total hardness, calcium, magnesium, total nitrogen, total phosphorus). The total number of species of epiphytic algae was 145 species, 98 species belonging to Bacillariophyceae, followed by 27 species of class Cyanophyceae, 19 species of class Chlorophyceae, 4 species of class Euglenophyceae, and only 1 species for each of Chrycophyceae and Rhodophyceae. The total number of epiphytic algae ranged from 1681×10⁴ cell/gm in Winter to 2014.95×10⁴ cell/gm in Spring. The range of biodiversity indices was (1-8.2) for Richness index, (1.5-3.2) for Shannon index and (0.3-0.65) for Evenness index.

**Key words:** *Ceratophyllum demersum* L., Epiphytic Algae, Tigris River, Wassit Province.

**Introduction:**

Epiphytic algae are attached to the surface of the aquatic plants. They play a very important role in the freshwater ecosystems; because they are source of the primary production, considered as a rich nutrition source for aquatic living organisms, they move the energy from the sediment to the water column(1), and make a balanced case between the aquatic organisms (2,3,4). Furthermore, algae contribute to oxygen production via the photosynthesis process(5). Human activities in agriculture, industry, and urbanization produce large amount of pollutants that affect the aquatic livings, making it necessary to use these livings especially the algae as indices for evaluating the water quality(6,7,8) *Ceratophyllum demersum* is considered a native plant all over the world. It is characterized by its forked appearance and exists as submerged, or might be anchored to the soil by the rhizoidal shoot which are the buried branched ends of the stem. The stems are slim and branched with one branch emerges from each node. The leaves of the plant are sessile with margins of toothed appearance, with 5 to 12 leaves branching out from each node(9).

Plenty of studies about the epiphytic algae were previously conducted(2,10, 11,12, 13). This study aimed to screen the community of epiphytic algae on the aquatic plant *C. demersum* and applying diversity indices in Tigris River at this province.

**Materials and Methods:**

The samples of water and plant were collected from four sites (Table1) (Site1: The end of Al-Aziziyah, Site2: Zubaidiyah Electricity plant, Site3: Zubaidiyah Concrete Bridge, Site4: After Zubaidiyah Concrete Bridge) selected along Tigris river in Wassit Province in the south of Iraq (Fig.1). Samples were collected on monthly basis from October_2017, to July_2018. According to previously described methods, water physiochemical parameters were measured for EC, TDS, TSS, pH, DO, BOD (14), total alkalinity, total hardness, calcium, magnesium, total nitrogen (15), total phosphorus (16), and reactive silicate (17). Plant samples were collected in plastic bags with small amount of river’s water. The shaking and scraping method was applied to separate the epiphytic algae from the plant surface. Plant samples were cut into parts of a 2-3cm length, these plant parts of the plant were shaken with 50-100ml of the environment water, then the surface of the plant was scrapped by smooth brusher. Samples
were preserved in a container with Lugol's solution for the qualitative study. For the quantitative study, samples were preserved for 10-15 days in cylinders (100ml) by using Lugol's solution for precipitation. The precipitates (20-30ml) were stored with some drops of Lugol's solution in containers that are marked with date and site. Permanent slides were prepared for the purpose of diatoms identification and the examination by light microscope (40x-100x), while temporary slides were prepared for the non-diatom identification on (100 x). The micro transect method was applied for the counting of diatom cells (100x) and the Hemocytometer (40x) was used to count the non-diatoms cells. (18, 19). Key references (20, 21, 22, 23).

Results and Discussion:
The biodiversity results are illustrated in Tables 2, 3, and Fig. 1,3,4. This study recorded 145 identified species of epiphytic algae on *Ceratophyllum demersum* that belong to 48 genera as previously classified (24). 98 species belong to 24 genera were recorded for Bacillariophyceae, 27 species belong to 11 genera for Cyanophyceae, 16 species belong to 9 genera of Chlorophyceae, 4 species belong to 2 genera for Euglenophyceae, 22 species belong to 11 genera for Chrycophyceae, while each of Chrycophyceae and Rhodophyceae recorded only 1 species. The highest number of species was 85 recorded in Summer, followed by 65 species in Spring, 58 species in Autumn, with a lower number of 56 species in Winter. The spatial variations in the number of species were as follows: the highest number of 106 species was recorded in Site 4, followed by 103 species in Site1, 73 species in Site 3, and the lowest number of species was 68 in Site 2.

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site</th>
<th>The Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The end of Al-Aziziyah</td>
<td>32°49'31.44&quot; 45°02'26.49&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Zubaidiyah Electricity plant</td>
<td>32°46'31.26&quot; 45°05'15.81&quot;</td>
</tr>
<tr>
<td>3</td>
<td>Zubaidiyah Concrete Bridge</td>
<td>32°46'42.41&quot; 45°09'36.30&quot;</td>
</tr>
<tr>
<td>4</td>
<td>After Zubaidiyah Concrete Bridge</td>
<td>32°45'15.01&quot; 45°11'49.87&quot;</td>
</tr>
</tbody>
</table>

**Table 2. The Seasonal number of epiphytic algae species in classes on Ceratophyllum demersum.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Classes</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Autumn</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>2017</td>
<td>CHLOROPHYCEAE</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>2017</td>
<td>CHRYSOPHYCEAE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2017</td>
<td>BACILLARIOPHYCEAE</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>2017</td>
<td>EUGLENOPHYCEAE</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>2017</td>
<td>CYANOPHYCEAE</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>2017</td>
<td>RHODOPHYCEAE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2017</td>
<td>Total</td>
<td>58</td>
<td>56</td>
</tr>
</tbody>
</table>

In the quantitative study, the most important class was also Bacillariophyceae, as it accounted for 90 % of the total number of epiphytic algae. Chlorophyceae had the second highest percentage of 6%, each of Cyanophyceae and Rhodophyceae recorded 2% only, while the rest of classes did not show a significant percentage. The highest total number of epiphytic algae occurred in Spring season (2014.95×10⁴ cell/gm), followed by Summer (1711.13×10⁴ cell/gm), Autumn (1681×10⁴ cell/gm), and finally Winter (1681×10⁴ cell/gm). The Spatial differences were obvious in the quantitative study results; the total number of epiphytic algae was the highest in Site 4 (5759.6×10⁴ cell/gm), followed by Site1 (4201.64×10⁴ cell/gm), Site3 (3045×10³ cell/gm), and the lowest total number of epiphytic algae was in Site2 (1803.2×10⁴ cell/gm).

Bacillariophyceae was most abundant class. This phenomenon is common in the Iraqi internal
water due to their ability for wide range of environmental conditions and because of the availability of the silica in the Iraqi basins which is an important component in the Diatoms’ frustule (25, 26, 27). Cyanophyceae was more abundant than Chlorophyceae in the number of species and such result was expected since it is consistent with previous reports (28). Seasonal and spatial variations were due to the different environmental conditions and the response of epiphytic algae to these conditions (29). The highest number of species was recorded in Summer and the largest biomass occurred in Spring. These results can be due to the increase in temperature and photic zone during these two seasons. This explanation is supported by the results of the present study which recorded water temperature of 29 and 21°C and Photic zone of 89 and 87 cm in Summer and Spring, respectively. Other possible reasons can be related to day length and elevated levels of essential nutrient resulting from increase in the metabolism processes of the aquatic plants (30, 31). These results agree with those of previous studies (32).

Winter season showed low diversity and biomass of epiphytic algae because the plant was not present in all the study sites during this season. This absence of the host plant was due to the rainfall caused erosion of C. demersum, where this plant is free floating and has no roots (9).

The highest diversity and total numbers of epiphytic algae were recorded in the sites 4 and 1, possibly because these sites were surrounded by agriculture areas and grazing activities, rendering that they were vulnerable for the organic pollution as explained in previous studies (33). Lower number of species and biomass was recorded in the Site 3, which is likely due to the swimming and fishing activities. The reduction in the site 2 has possibly resulted from the polluted drainages from the adjacent electricity plant. Some genera such as, Cocconites, Rhocosphenia, Gomphonema, Navicula, Nitztchia and Synedra existed continuously during the period of the study due to their tolerance to the surrounded environmental conditions and their position of steady means for attaching on the hosted aquatic plants. The genus Cocconites attaches by the encrusting form, Rhocosphenia and Gomphonema by the short or long stalk, Navicula and Nitztchia by the mucilaginous tube, and Synedra by the mucilage pads (32, 34).
Table 3. The seasonal total number of epiphytic algae on *C. demersum* and their percentages. (= not found)

<table>
<thead>
<tr>
<th>Season</th>
<th>Aut. 2017</th>
<th>%</th>
<th>Wint. 2018</th>
<th>%</th>
<th>Spri. 2018</th>
<th>%</th>
<th>Sum. 2018</th>
<th>%</th>
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<tr>
<td>CHLOROPHYCEAE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><em>Cladophora glomerata</em> (L.) Kützing</td>
<td>0.01</td>
<td>0.00</td>
<td>0.4</td>
<td>0.02</td>
<td>0.55</td>
<td>0.02</td>
<td>15.35</td>
<td>0.89</td>
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<tr>
<td><em>Cladophora</em> sp.</td>
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<td>0.03</td>
<td>-</td>
<td>-</td>
<td>0.05</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
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<tr>
<td><em>Cosmarium botrytis</em> Meneghinii</td>
<td>0.2</td>
<td>0.01</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>0.17</td>
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<tr>
<td><em>Mougeotia</em> sp.</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8.575</td>
<td>0.50</td>
</tr>
<tr>
<td><em>Oedogonium undulatum</em> (de Bréb.) A. Braun</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26.2</td>
<td>1.53</td>
</tr>
<tr>
<td><em>Oedogonium</em> spp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>0.00</td>
<td>64.4</td>
<td>3.76</td>
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<tr>
<td><em>Oedogonium</em> sp.</td>
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<td>0.04</td>
<td>0.4</td>
<td>0.02</td>
<td>0.4</td>
<td>0.01</td>
<td>-</td>
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<tr>
<td><em>Pediastrum boryanum</em> (Turt.) Meneghinii</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
<td>0.01</td>
</tr>
<tr>
<td><em>P. duplex var. clathratum</em> (A. Braun) Lagerheim</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.05</td>
<td>0.00</td>
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<tr>
<td><em>P. simplex</em> Meyen</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>1.95</td>
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<td><em>S. bijuga</em> (Turt.) Lagerheim</td>
<td>0.05</td>
<td>-</td>
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<td>0.00</td>
<td>3.95</td>
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<tr>
<td><em>S. opoliensis</em> P. Richter</td>
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<td>0.56</td>
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<td><em>S. quadriradiata</em> (Turt.) de Brébisson</td>
<td>2.55</td>
<td>0.13</td>
<td>-</td>
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<tr>
<td><em>Spirogyra</em> sp.</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1</td>
<td>0.00</td>
<td>233.25</td>
<td>13.63</td>
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<td><em>Staurastrum gracile</em> Ralfs</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.25</td>
<td>0.01</td>
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<td><em>Stigeoclonium stagnatile</em> (Haz.) Collins</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>93.85</td>
<td>5.48</td>
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<td><em>Uniothrix</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.7</td>
<td>0.04</td>
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<td>CHRYSOPHYCEAE</td>
<td>Dinobryon sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.05</td>
</tr>
<tr>
<td>BACILLARIOPHYCEAE</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A-CENTRALES</td>
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<td><em>Aulacoseira granulata</em> (Ehr.) Ralfs</td>
<td>51.55</td>
<td>2.65</td>
<td>-</td>
<td>-</td>
<td>8.65</td>
<td>0.42</td>
<td>126.15</td>
<td>7.37</td>
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<td><em>Aulacosira italicum</em> (Ehr.) Kützing</td>
<td>-</td>
<td>-</td>
<td>46.25</td>
<td>2.75</td>
<td>20.65</td>
<td>1.02</td>
<td>-</td>
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<tr>
<td><em>Aulacoseira varians</em> Agardh</td>
<td>49</td>
<td>2.52</td>
<td>92.45</td>
<td>5.50</td>
<td>151.75</td>
<td>7.53</td>
<td>39.9</td>
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<td><em>Coscinodiscus</em> sp.</td>
<td>9.65</td>
<td>0.50</td>
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<td>8.15</td>
<td>0.40</td>
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<tr>
<td><em>Cylotella comta</em> Kützing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13.1</td>
<td>0.65</td>
<td>-</td>
<td>-</td>
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<tr>
<td><em>Cylotella meneghiniiana</em> Kützing</td>
<td>113.4</td>
<td>5.82</td>
<td>18.75</td>
<td>1.11</td>
<td>35.3</td>
<td>1.75</td>
<td>39.9</td>
<td>2.33</td>
</tr>
<tr>
<td><em>C. striata</em> (Kütz.) Grunow</td>
<td>60.65</td>
<td>3.11</td>
<td>7.25</td>
<td>0.43</td>
<td>16.55</td>
<td>0.82</td>
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<td>-</td>
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<td></td>
</tr>
<tr>
<td><em>A. hungarica</em> Grunow</td>
<td>22.4</td>
<td>1.15</td>
<td>10.9</td>
<td>0.64</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td><em>A. microcephala</em> (Kütz.) Grunow</td>
<td>35.315</td>
<td>1.81</td>
<td>151.4</td>
<td>9.01</td>
<td>9.05</td>
<td>0.44</td>
<td>215.9</td>
<td>12.61</td>
</tr>
<tr>
<td><em>A. minutissima</em> Kützing</td>
<td>81.25</td>
<td>4.17</td>
<td>170.3</td>
<td>10.13</td>
<td>13.6</td>
<td>0.67</td>
<td>177.85</td>
<td>10.39</td>
</tr>
<tr>
<td><em>Amphora veneta</em> Kützing</td>
<td>-</td>
<td>-</td>
<td>1.3</td>
<td>0.07</td>
<td>-</td>
<td>-</td>
<td>2.25</td>
<td>0.13</td>
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<tr>
<td><em>Bacillaria paradoxa</em> Grmeli</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>11.6</td>
<td>0.57</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Caloneis bacillum</em> (Grn.) Mereschkowsky</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6.25</td>
<td>0.36</td>
</tr>
<tr>
<td><em>Cocconeis pediculus</em> Ehrenberg</td>
<td>36.35</td>
<td>1.87</td>
<td>67.85</td>
<td>4.03</td>
<td>200.85</td>
<td>9.96</td>
<td>75.95</td>
<td>4.43</td>
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<tr>
<td><em>C. placentula</em> Ehrenberg</td>
<td>158.05</td>
<td>8.12</td>
<td>153.45</td>
<td>9.13</td>
<td>237.5</td>
<td>11.78</td>
<td>20.25</td>
<td>1.18</td>
</tr>
<tr>
<td><em>C. placentula var. euglypta</em> (Ehr.) Cleve</td>
<td>226.34</td>
<td>11.66</td>
<td>149.85</td>
<td>8.92</td>
<td>234.45</td>
<td>11.63</td>
<td>65.55</td>
<td>3.83</td>
</tr>
<tr>
<td><em>C. placentula var. lineata</em> (Ehr.) Cleve</td>
<td>38.05</td>
<td>1.95</td>
<td>88.25</td>
<td>5.25</td>
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<td><em>Cymatopleura solea</em> (Brb.) W. Smith</td>
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<td>0.05</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Cymbella affinis</em> Kützing</td>
<td>-</td>
<td>-</td>
<td>19</td>
<td>0.94</td>
<td>0.25</td>
<td>0.01</td>
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<tr>
<td><em>C. aspera</em> (Ehr.) Cleve</td>
<td>8.7</td>
<td>0.45</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td><em>C. cistula</em> (Hemp.) Grunow</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.65</td>
<td>0.21</td>
</tr>
<tr>
<td><em>C. tumida</em> (Brb.) V. Heurck</td>
<td>12.35</td>
<td>0.63</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
<td>0.05</td>
</tr>
<tr>
<td><em>C. turida</em> (Greg.) Cleve</td>
<td>5.195</td>
<td>0.27</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td><em>Diatoma elongata</em> (Lyngbya) C. Agardh</td>
<td>60.75</td>
<td>3.12</td>
<td>26.1</td>
<td>1.55</td>
<td>52.4</td>
<td>2.60</td>
<td>109.9</td>
<td>6.42</td>
</tr>
<tr>
<td><em>D. elongata var. minor</em> Grunow</td>
<td>-</td>
<td>-</td>
<td>12.7</td>
<td>0.75</td>
<td>-</td>
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</tr>
<tr>
<td><em>D. elongata var. temus</em> C. Agardh Van Heurck</td>
<td>-</td>
<td>-</td>
<td>5.1</td>
<td>0.30</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td><em>Diatoma vulgaris</em> Bory</td>
<td>43.05</td>
<td>2.21</td>
<td>33.65</td>
<td>2.00</td>
<td>31.9</td>
<td>1.58</td>
<td>39.65</td>
<td>2.31</td>
</tr>
<tr>
<td><em>D. vulgaris var. brevis</em> Grunow</td>
<td>-</td>
<td>-</td>
<td>0.8</td>
<td>0.04</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>D. vulgaris var. ovalis</em> (Fricke) Hustedt</td>
<td>-</td>
<td>-</td>
<td>0.95</td>
<td>0.05</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Diploneis ovalis var. oblongella Naegeli - - - - - - - 1.15 0.06
Epithemia zebra (Ehr.) Kützing - - - - - - - 2.05 0.11
Fragilaria bidens Heiberg - - - - - 62.35 3.09 - -
F. brevistriata Grunow - - - - - 68.55 3.40 - -
F. constriens (Ehr.) Grunow - - 26.4 1.57 - - 5.75 0.33
F. cupicina Desmazières - - - - 76 3.77 - -
Gomphonema acuminatum Ehrenberg - - 13.2 0.78 - - - -
G. augur Ehrenberg - - 1.95 0.11 - - - -
G. constrictum var. capitata (Ehr.) Cleve - - 8.25 0.49 - - 0.65 0.03
G. bohemicum Reichelt & Fricke S. - - - - 7.4 0.36 - -
G. gracile Ehrenberg - - - - - - - 1.25 0.07
G. lanceolatum Ehrenberg - - 14.85 0.88 - - 1.6 0.09
G. longiceps Ehrenberg - - 29.7 1.76 - - - -
G. olivaceum (Lyng.) Kützing 43.75 2.25 42.2 2.51 68.75 3.41 0.4 0.02
G. parvulum (Ehr.) Grunow 42.65 2.19 57.65 3.43 146.2 7.25 0.75 0.04
G. sphaerophorum Ehrenberg 13.3 0.68 40.9 2.43 - - 4.45 0.26
G. truncatum Ehrenberg - - - - 26.6 1.32 - -
Mastogloia braunit Grunow - - - - - - 3 0.17
Mastogloia smithii Thwaites - - - - - - 1.15 0.06
Navicula cincta (Ehr.) Kützing 42.5 2.18 - - 13.2 0.65 4.75 0.27
N. cryptocephala Kützing 51.25 2.63 1.15 0.06 12.65 0.62 7.95 0.46
N. cuspidata Kützing 30.05 1.54 9.9 0.58 - - 1.9 0.11
N. granulata Grunow - - - - - - - -
N. gracilis Hantzsch 11.8 0.61 - - - - - -
N. gregaria Donkin 11.5 0.44 - - - - - -
N. halophila (Grun.) Cleve - - - - - - 0.4 0.02
N. inflata Donkin 23.85 1.22 7.9 0.47 4.95 0.24 4.45 0.26
N. oblonga (Kütz.) Kützing - - - - - 0 0.55 0.03
N. radiosus Kützing 23.65 1.21 7.25 0.43 - - - -
N. recta J. Brun & Heribaud - - 0.95 0.05 - - - -
N. rhyncocephala Kützing 10.25 0.53 - - 8.25 0.40 - -
N. spicula (Dick.) Cleve - - - - - - 0.05 0.00
Navicula sp. - - - - - - 0.15 0.00
Nitzschia amphibia Grunow 37.05 1.90 83.9 4.99 - - 1.55 0.09
N. apiculata (Greg.) Grunow 18.05 0.93 - - - - - -
N. clausii Hantzsch - - - - - 3.3 0.16 - -
N. dissipata (Kütz.) Grunow - - 11.9 0.70 - - - -
N. filiformis (W. Smith) Hustedt - - 2.95 0.17 4.45 0.22 1.75 0.10
N. fonticola Grunow - - 7.75 0.46 - - - -
N. frustulum Kützing - - - - - - 6.75 0.39
N. granulata Grunow 35.4 1.82 - - - - - -
N. hanitzchii Rabenhorst - - 1.15 0.06 17.75 0.88 - -
N. microcephala Grunow - - - - - 0.1 0.00
N. obtusa W. Smith 28.95 1.49 22.95 1.36 13.65 0.67 1.65 0.09
N. paelea (Kütz.) W. Smith - - 37.45 2.22 - - 1.25 0.07
N. romana Grunow 7.6 0.39 - - - - - -
N. scalaris (Ehr.) W. Smith 15.5 0.80 17.15 1.02 - - - -
N. sigma (Ehr.) W. Smith - - 1.3 0.07 - - 0.25 0.01
N. sigmoidea (Ehr.) W. Smith 110.5 5.67 - - 18.55 0.92 - -
N. sublinearis Hustedt - - 0.65 0.03 - - - -
pinnularia subcapitata - - - - 32.5 1.61 - -
pinnularia viridis(Nitzs.) Ehrenberg - - - - 3.7 0.18 - -
Pleurosigma salinarum Grunow 38.45 1.97 - - - - - -
Rhizosolenia curvata (Kütz.) Grunow 64.35 3.30 32.65 1.94 105.65 5.24 - -
Rhizosolenia gibba (Ehr.) Müller - - - - - - 2.5 0.14
Synedra acus var. radians Kützing - - - - 16.1 0.79 0.75 0.04
S. affinis Kützing 59.7 3.07 13 0.77 - - - -
S. capitata Ehrenberg 7.65 0.39 - - - 4 0.23
S. fasciculata (Kütz.) Grunow 4.3 0.22 16.35 0.97 - - - -
S. filiformis Grunow - - - - 7.85 0.38 - -
S. nana F. Meister - - - - 8.25 0.40 - -
S. tabulata (C.Agardh) Kützing - - 14.55 0.86 - - - -
S. ulna (Nitzs.) Ehrenberg 99.5 5.11 43.45 2.58 170 8.43 10.1 0.59
The results of biodiversity indices are illustrated in table 4. Richness index seasonal values varied between 1 and 8.2 in winter and summer respectively. This result agrees with the recorded numbers of species in these seasons and sites. Shannon index values were higher than 1 for all sites and seasons which indicate a high diversity and the dominance of a wide range of species (35).

Evenness index values exceed 0.5 in all seasons and sites except in the Site 2 (adjacent to the electricity station) where the value was 0.47 indicating the distribution of biomass among species within the community was not moderate (36). Both of Richness index and Shannon index showed high diversity of epiphytic algae in the study sites, reflecting the suitable quality of Tigris river water for the life of aquatic livings according to a previous study (37).
The physiochemical factors are illustrated in table 5. Temperatures recorded high values in Summer while the lowest were in Winter according to climate variations in Iraq (38). Values of electrical conductivity, salinity, and total dissolved solids were elevated in Summer in accordance to temperatures, because of salts dissolving increase, where the low values in these parameters occurred by the dilution resulted from increasing water level (10). Total suspended solids were increased in Spring due to the increasing of water level and drainages from rounded areas (38). pH values showed a slight change since the aquatic ecosystems in Iraq are characterized by the buffer feature (39).

The dissolved oxygen values were increased in Winter and decreased in Summer, because the increasing temperatures reduce the dissolved oxygen (40).

The increase of BOD5 in Spring was related to the activities of the organism, and increasing of organic materials (1). Alkalinity was increased in Spring due to the increase of the decomposition processes (40). The results of the total hardness showed that the river is very hard according to previous limits (41). This result agrees with this of a previous study (42). The recorded concentration of calcium was higher than that of magnesium, which is a normal feature of waters (43). Total phosphorus concentration was elevated in Summer and decreased in Spring.

The concentration of total nitrogen was increased in Winter due to the eroding drainages from the surrounded areas, while the low concentration in Summer might be due to the decrease of the flows that contain nitrogen (44,45).

Table 4. Seasonal average of diversity indices of epiphytic diatom on C. demersum during the study period.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Season Site</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richness Index</td>
<td>St.1</td>
<td>5.1</td>
<td>5.1</td>
<td>4.6</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>St.2</td>
<td>3.1</td>
<td>1</td>
<td>3.4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>St.3</td>
<td>3.5</td>
<td>4</td>
<td>4.5</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>St.4</td>
<td>6</td>
<td>5</td>
<td>4.3</td>
<td>9</td>
</tr>
<tr>
<td>Shannon Index</td>
<td>St.1</td>
<td>3.1</td>
<td>2.7</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>St.2</td>
<td>2.2</td>
<td>1.5</td>
<td>1.5</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>St.3</td>
<td>2</td>
<td>2.8</td>
<td>2.8</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>St.4</td>
<td>3.2</td>
<td>3.2</td>
<td>3.2</td>
<td>2.9</td>
</tr>
<tr>
<td>Eveness Index</td>
<td>St.1</td>
<td>0.6</td>
<td>0.55</td>
<td>0.53</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>St.2</td>
<td>0.4</td>
<td>0.3</td>
<td>0.5</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>St.3</td>
<td>0.42</td>
<td>0.5</td>
<td>0.58</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>St.4</td>
<td>0.6</td>
<td>0.65</td>
<td>0.48</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Table 5. Physiochemical characteristics of Tigris River’s water during study seasons

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Season</th>
<th>Autumn 2017</th>
<th>Winter 2018</th>
<th>Spring 2018</th>
<th>Summer 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temp. (°C)</td>
<td>25.8 ±5</td>
<td>22.5 ±5.6</td>
<td>25 ±4.2</td>
<td>37 ±5</td>
<td></td>
</tr>
<tr>
<td>Water Temp. (°C)</td>
<td>19.3 ±2.2</td>
<td>17 ±2.1</td>
<td>21 ±3.8</td>
<td>29±2</td>
<td></td>
</tr>
<tr>
<td>Light intensity(cm)</td>
<td>65.12±12.14</td>
<td>60±9.3</td>
<td>87±8</td>
<td>89.3±6.2</td>
<td></td>
</tr>
<tr>
<td>Electrical conductivity E.C(μs/cm)</td>
<td>1087.12±31</td>
<td>1029±142.5</td>
<td>88.8±141</td>
<td>1217±101</td>
<td></td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>0.6±0.01</td>
<td>0.6±0.08</td>
<td>0.5±0.08</td>
<td>0.7±0.06</td>
<td></td>
</tr>
<tr>
<td>T.D.S (mg/l)</td>
<td>695.7±20</td>
<td>658±91</td>
<td>568±90</td>
<td>778.9±64</td>
<td></td>
</tr>
<tr>
<td>T.S.(mg/l)</td>
<td>0.4±0.2</td>
<td>0.8±0.6</td>
<td>2±0.7</td>
<td>0.6±0.3</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.4±0.07</td>
<td>7.7±0.19</td>
<td>7.15±0.4</td>
<td>7.4±0.2</td>
<td></td>
</tr>
<tr>
<td>Dissolved oxygen (mg/l)</td>
<td>9.4±1.05</td>
<td>10±0.7</td>
<td>6.6±1.7</td>
<td>4±1.5</td>
<td></td>
</tr>
<tr>
<td>BOD</td>
<td>2.05±1.05</td>
<td>1.7±0.5</td>
<td>2.5±0.6</td>
<td>2.3±1</td>
<td></td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>125±85</td>
<td>202±42.3</td>
<td>254±18</td>
<td>136.8±65</td>
<td></td>
</tr>
<tr>
<td>Total Hardness</td>
<td>333±113.4</td>
<td>382±97</td>
<td>367.5±110</td>
<td>342±89</td>
<td></td>
</tr>
<tr>
<td>Calcium(mg/L)</td>
<td>123.9±29.9</td>
<td>134.7±33.5</td>
<td>96.3±25.2</td>
<td>68.1±6.5</td>
<td></td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>12.2±3.4</td>
<td>41.7±20.2</td>
<td>23±14.1</td>
<td>18.6±17</td>
<td></td>
</tr>
<tr>
<td>Total phosphate (mg/L)</td>
<td>0.5±0.28</td>
<td>0.74±0.26</td>
<td>1±0.2</td>
<td>1.6±0.9</td>
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<tr>
<td>Total Nitrogen (mg/L)</td>
<td>2.8±1.6</td>
<td>4.5±1</td>
<td>3.3±0.4</td>
<td>2.1±0.6</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion:

The results revealed that the variations of Epiphytic algae was affected by the type of activities in the nearby areas and with the seasonal variations in the factors of temperature, transparency, and nutrients. Bacillariophyceae was the most dominant class.

Conflicts of Interest: None.

References:


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التركيب الكمي والنوعي للطحالب الملتصقة على نبات الشمبلان في نهر دجلة ضمن محافظة واسط/ العراق

جنان شاوي الحساني

الخلاصة:

تضمنت الدراسة الحالية الدراسة النوعية والكمية للطحالب الملتصقة على النبات المائي الغاطس الشمبلان في أربع مواقع مختلفة ضمن نهر دجلة/محافظة واسط (من خريف 2017 إلى صيف 2018) تم قياس العوامل الفيزيائية والكيميائية (درجة حرارة الماء والهواء وألوان الهيدروجين ومستوى الماء والوصولية الكهربائية والموجة عناية الكلية والمواد العقلية الكلية والإكسجين الطابع المنظمي للإكسجين والكامل الكلوي ونحو. الكلي). يبلغ عدد الكلي للأنواع المصنفة 145 نوع، 98 نوع من الطحالب العنصبية، و 19 نوع من الطحالب الخضر، 3 أنواع من الطحالب البوعلورية الناتجة عن واحد فقط لكل من الطحالب البوعليات الشمبلان والطحالب الحمراء، عدد الأنواع تغير حسب موقع الدراسة حيث كان 103، 68، 73 و 106 في مواقع الدراسة 1، 2، 3 و 4 على التوالي، عدد الكلي للطحالب المصنفة تراوح بين 1803.2×5759.6 خليلا/غم(وزن رطب). تم تطبيق انواع التتابع دليلاً وشانون، ودليلاً التكافؤ.

الكلمات المفتاحية: نبات الشمبلان، الطحالب الملتصقة، نهر دجلة، محافظة واسط.