QUANTITATIVE AND QUALITATIVE VARIABILITY OF EPIPHYTIC ALGAE ON THREE AQUATIC PLANTS IN EUPHRATES RIVER, IRAQ

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Abstract

The epiphytic algae were studied on three aquatic plants (*Ceratophyllum demersum, Myriophyllum verticillatum* and *Potamogeton pectinatus*) from seven stations in Euphrates River between Hindia barrage and Al-Kufa city-Iraq, during summer 2004 and spring 2005. A total of (97) species were identified, diatoms were dominant in their species number (73% from the total number), followed by chlorophyta, then cyanophyta and Euglenophyta. Variations were recorded in the species number among the host macrophyte, as well as, among different seasons for each plant. The biomass of epiphytic algae varied among the plant host, diatoms species were dominated and several genera have large number of species as *Cymbella, Gomphonema, Nitzschia* and *Synedra*. Most studied stations showed high population density.

INTRODUCTION

The different types of benthic algae (epilithic, epiphytic and epipelic) play an important role as primary producers in running water, lake and shallow fresh water ecosystems (Nozaki et al. 2003, Simkhada *et al.* 2006).The term "epiphytic algae" used by Wetzel (1964) refer to the algae attached on the surface of plants, but Allen (1971) used the term "epiphytic periphyton" to describe both the attached algae and bacteria on aquatic plants (Scheldon and Boylen, 1975). Most species of these algae cover wide area and grow in rivers, lakes and reservoir attached on plants and released by current to water flow (Tharb, 1992). The epiphytic algae act as primary producer in the food chain in water ecosystems (Dere *et al.*, 2002), and as natural food to many zooplankton, grazer and fish (Loman, 2001). The density and diversity of these algae influenced by many environmental factors such as temperature, light, location, depth, and macrophyte host, and its abundance and growth phases of host aquatic plant (Scheldon and Boylen, 1975).

The growth of epiphytic algae influenced by nutrient availability in aquatic ecosystem specially nitrogen and phosphorous compounds that reduce the photosynthetic capacity (Limpens et al., 2003). These types of algae act as indicators of the extent of water pollution (Dere *et al.*, 2003).

Many subsequent studies had reported variation in epiphytic algae biomass or species composition on different plant host (Kassim *et al.*,1997; Hadi and Al-Zubadi, 2001; Hawes and Schwarz, 1996; Douglas and Smol, 1995; Blinndow,1987)

In Iraq, the epiphytic algae was studied in different aquatic system (Hadi and Al-Saboonchi, 1989; Al-Mousawi *et al.*, 1990; Kassim et al., 2000 and Al-Saadi *et al.*, 2002).

This study aims at exploring on the epiphytic algae composition in Euphrates River at its mid region in Iraq between Al-Hindia dam and Al-Kufa city.

MATERIALS & METHODS

Three species of aquatic plants were collected from Euphrates River during four seasons (summer 2004, autumn 2004, winter 2005, and spring 2005).These were *Ceratophyllum demersum, Myriophyllum verticillatum* and *Potamogeton pectinatus*. The plant parts were placed in polyethylene bags, and then all samples were cut to shall pieces and then kept in 50 ml of distilled water. Separation of epiphytic algae from their host was carried out following the method described by Bell (1976). The epiphytic algae cells were preserved with one ml Lugol's iodine solution, it allowed for sedimentation for about (8-10) days and concentrated to (10) ml for counting (Furet and Beson-Evans, 1982). The diatoms were counted using microtransect method and non diatoms by Haemocytometer method (Martinez et al., 1975). The species diversity was calculated according to Lianso (2002). The identification of algal species followed several references (Desikachary, 1959; Patrick and Reimer, 1966; Prescott, 1973; Hadi, 1984; Al-Handal, 1994).

STUDY AREA

Seven stations in Euphrates river were selected at mid of Iraq between Al-Hindia dam and South of Al-Kufa city; about 220 km length (Fig. 1).

Some of these stations are covered with dense riverian type vegetations specially stations1, 4, 6 and 7.

The stations as the following:

1. St. 1 north of Al-Hindia dam on (1) km before river branched to Al-Hilla river and Al-Hindia river.
2. St. 2 south of Al-Saada town on (0.5) Km.
3. St. 3 before Al-Hindia city on (4) km.
4. St. 4 south Al-Hindia city on (0.5) Km.
5. St.5 in Al-Kifl city.
6. St.6 in Al-Kufa city.
7. St.7 south of Al-Kufa on (15) km in Al-Eysa region.

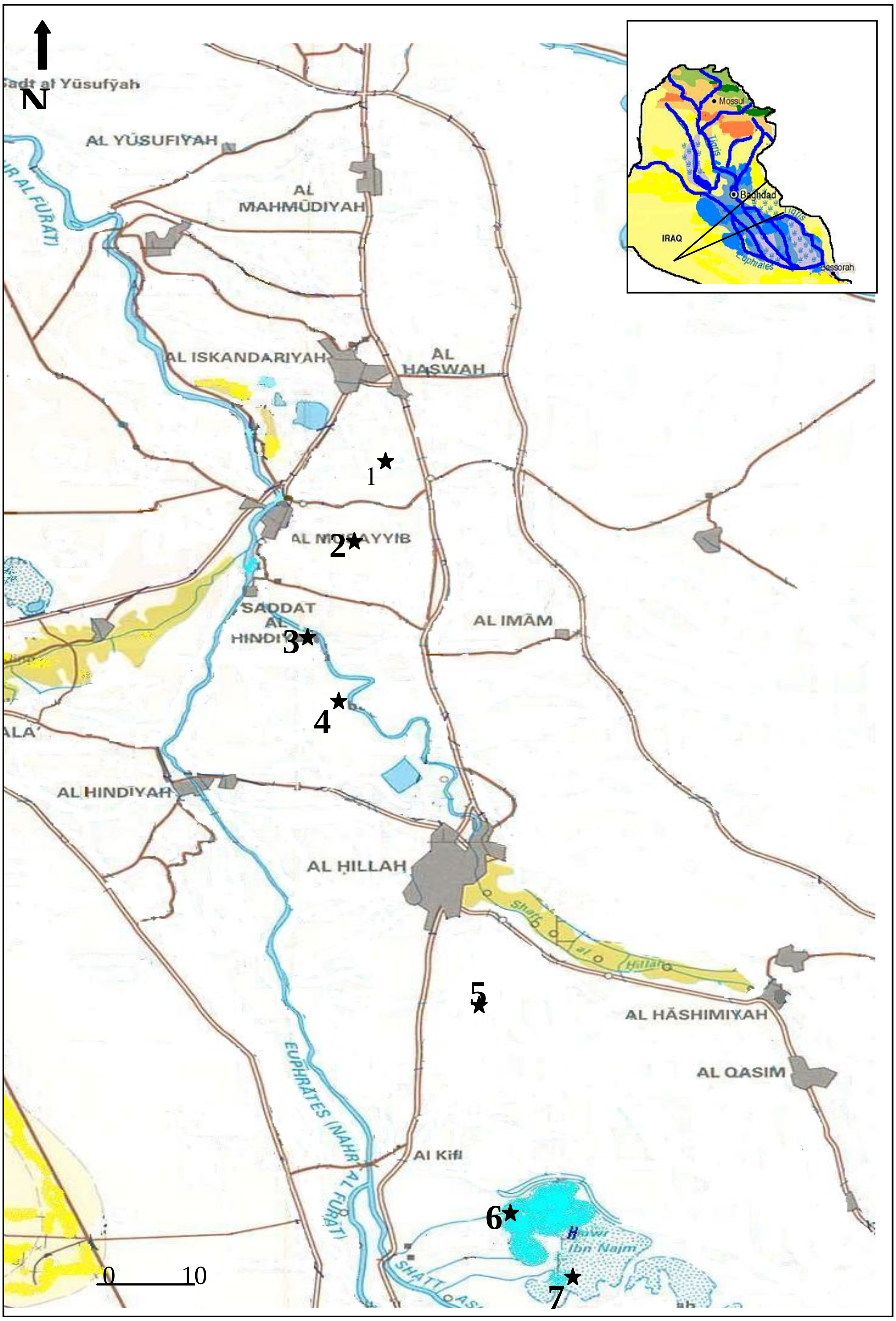

Fig 1: Map of the study area.

RESULTS

The physical and chemical features and heavy metals in water of Euphrates River in the study area were described by Salman (2006). The study area was light alkaline, very hard, good aeration. High value of nitrate recorded in comparative to value of nitrite and phosphate. Calcium was the most dominant cation, while sulphate and silicate were dominant anions.

A total of 97 taxa of epiphytic algae belonging to the Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae were identified on the three study plants during the study period (Table 1). The predominant algae was Bacillariophyceae with 65, 46, 48 species on the *C. demersum*, *P. pectinatus*; and *M. Verticillatum* respectively. The sub dominant algae were Chlorophyceae, with 11, 8, and 7 species, and Cyanophyceae with 7, 8, and 7 on the *C. demersum*, *P. pectinatus*; and *M. Verticillatum* respectively. During the study period some species of the Euglenophyceae, mainly *Euglena elastica* and *Phacus* sp. were found on *C. demersum* and *M. Verticillatum*.

Bacillariophyceae biomass ranged between 161 cell/g in station 5 on P. pectinatus, and 84217 cell/g in station 1 on *M. verticillatum*, while Chlorophyceae biomass were ranged between 20 cell/gm in station 3 on *M. verticillatum* and (370) cell/g in st.1 on plant *C. demersum* (Fig. 3). Cyanophyceae were ranged between 29 cell/g in station 3 on *C. demersum*, and 247 cell/g in station 1 on the same plant, but Euglenophyceae were recorded lower number than other epiphytic algae in present study, it was ranged between 5 cell/g in station 7 on *M. verticillatum* and 19 cell/g in station 1 on *C. demersum*. The epiphytic algae were recorded lower total count (161cell/g) in summer 2004 and higher total count (48300cell/g) in winter 2005 (Table-2, and Fig. 3).

Table (1) shows some genera with high number of species such as; *Nitzschia* (11), *Cymbella* (9), *Gomphonema* (9) and *Synedra* (7), and also there were varied numbers of species on the studied host macrophyte.

Table (4) shows the species richness and Shannon diversity index (H'). The highest value of species richness (84317) was hosted by *M. verticillatum* at station1, and the lowest value (161) on *P. Pectinatus* at station 5.

Table (4) summarizes the Shannon diversity index (H') of epiphytic algae data on three macrophyte at Euphrates river during the study period. The high values of Shannon diversity index were recorded at station 1 on the studied plants (C. *demersum* and *M. Verticillatum*) and lowest values were recorded on *P. pectinatus*. In table 5, the means of Sorensen similarity indices are presented in correlation diagrams, the highest values of Sorensen similarity index were recorded between stations 3 and 7 (27.7%), also the similarity of community composition between stations 4 & 5 were slight high (14.6%) and the same with stations 3 and 5 (13.7%). While the similarity between station 1 and other stations were low.

Table (6) summarized the macrophyte appearance at the study station during the study period.

DISCUSSION

Number of epiphytic algae species varied according to the host macrophyte. Highest number of algae species were attached on *Myriophyllum verticillatum*, followed by *Ceratophyllum demersum* and *Potamogeton pectinatus* (Fig. 2). The biomass of epiphyte algae also varied according to stations and seasons (Table 2 and 3). This variation in biomass may be due to nutrients concentration, released substances from macrophyte and pollution (Kassim *et al*., 1997; Kassim *et al*., 2000a ;Wetzel, 2001).

Diatoms (Bacillariophyceae) are the dominant group in all samples (73% from total number), Chlorophyceae, Cyanophyceae and Euglenophyceae formed 14.4%, 10.3%, 2.06% respectively from total number of epiphytic algae , these result agreed with other studies (Hadi and Al-Saboonchi, 1989; Kolayli *et al*., 1998; Kassim *et al*., 2000; Al-Saadi *et al*., 2002; Dere *et al*., 2002).

The difference in total number of epiphytic algae species in the present study may be due to different factors such as; plant growth period, plant horizontal state in water, morphological shape of leaves, physical and chemical factors (Al-Saadi and Al-Mayah, 1983; Hadi and Al-Saboonchi, 1989; Kassim *et al*., 2000b; Dere *et al*., 2002).

The present study showed a significant difference ($P<0.05$) between total cell count of epiphytic algae on C. demersum and a few stations (1,2 and 4), while on others host-macrophyte (*P. pectinatus* and *M. verticillatum*) the significant difference appeared within stations 1,2,3 and 5. The same results showed between the main group of epiphytic algae and the studied stations. The total cell count of epiphytic algae on *C. demersum* and *M. verticillatum* showed negative related with dissolved Co ($r=-0.396$, $P<0.05$), while other dissolved heavy metals (Cd, Fe and Ni) showed positive related ($r=0.324$, $P<0.05$; $r=0.396$, $P<0.05$; and $r=0.359$, $P<0.05$ respectively). There was no relation between dissolved and particulate heavy metals and the groups of epiphytic algae.

Diversity indices were used as indicators of water quality (Stevenson & Bahls, 2003). The total cell count of genera may provide a more robust measure of diversity than species richness, and slight increase in nutrient enrichment can increase species richness in water streams (Stevenson & Bahls, 2003).

The results of Shannon index showed different values among stations and the host plants. The highest values of Shannon index was hosted on the studied plants at station 1 (0.16). The host plant *C.*

demersum showed highest values than other studied host plants (*M. verticillatum* and *P. pectinatus*) these results are agreeing with Kassim *et al.* (2000a). The Shannon index is a function of both the number of species in the sample and the distribution of individuals among these species, and complexly with water pollution (Dreslik, 1999). The different values of Sorensen similarity indices between the study stations could be due to environmental factors and pollution (Wan Maznah and Mansor, 1999).

The diversity and richness of epiphytic algae were high correlated with growing and metabolic state of host macrophyte (Kassim *et al.*, 2000), and many factors influence of species diversity such as light density, temperature and nutrient concentration (Hassan, 1997).

Table (1): Species of epiphytic algae and their host macrophytes, (C.d.)= Ceratophyllum demersum; (P.p.)= Potamogeton pectinatus; and (M.v.)= Myriophyllum verticillatum. (+) present, (-) absent.

Taxa	C.d.	P.p.	M.v.
Class: Cyanophyceae			
Anabaena spp.	+	+	-
Chroococcus minor (Ktz.) Naegeli	+	+	+
C. limneticus Lemmermann	-	+	+
Microcystis aeruginosa Kuetzing	+	-	+
Merismopedia glauca (Ehr.) Naegeli	-	+	+
M. tenuissima Lemmermann	+	+	-
Nostoc sp.	+	-	+
Oscillatoria sp.	+	+	+
Spirulina major Kützing	+	+	+
Rivularia sp.	-	+	-
Class: Chlorophyceae			
Chlamydomonas sp.	+	+	+
Chlorella sp.	+	+	+
Cladophora sp.	+	-	+
Cosmarium hammeri Reinsch	+	-	-
Oedogonium sp.	-	+	-
Scenedesmus acuminatus (Lag.) Chodat	+	+	+
S. dimorphus (Turp) Kuetzing	-	+	+
S. armatus Chodat	+	+	-
S. longus Meyen	+	+	-
Tetrahedron regular Kuetzing	+	-	-
Spirogera sp.	+	+	+
Pediastrum simplex Meyen	+	-	+
P. duplex Meyen	+	-	-
Class: Bacillariophyceae			
Acnanthes lanceolata (Breb.) Grunow	+	+	+
Amphora ovalis (Ktz.) Kuetzing	+	-	-
Bacillaria paxillifer (O.F. Müller) Hendey	+	+	+
Cocconeis placentata Ehrenberg	+	+	+
C. pediculus Ehrenberg	+	+	+
Cymatopleura solea (Breb.) W. Smith	-	+	+
Cymbella minuta Hilse ex Rabenhorst	+	+	+
C. affinis Kuetzing	+	+	+

C. lanceolata (Ehr.) Kirchner	+	+	+
C. cistula (Ehr.) Kirchn.	+	+	+
Cymbella ventricosa Kuetzing	-	+	+
C. tumida (Brébisson) Van Heurck	+	+	+
C. aspera (Ehr.)H. Paragallo	+	+	+
C. amphicephala Naegeli	+	+	+
C. cuspidate Kuetzing	+	+	+
Cyclotella atomus Hustedt	+	+	+
C. meneghiana Kuetzing	+	+	+
C. comta (Ehrenberg) Kuetzing	+	+	+
Diatoma hiemale (Roth) Heiberg	+	-	-
D.a vulgare Bory de Saint-Vincent	+	+	+
D. tenue Agardh	+	+	-
Eunotia curvata (Kuetzing) Lagerstedt	+	-	-
Epithemia zebra (Ehr.) Kuetzing	+	-	-
Flagilaria capucine Desmacieres	+	+	+
F. bervistriata Grunow	+	+	+
Gomphoneis olivaceum (Horme) P. Dawson ex Ross et sims	-	+	-
G. olivaceiodes (Hustedt) J.R. Carter	+	-	-
Gomphonema acuminatum Ehrenberg	+	+	+
G. gracile Ehrenberg	+	-	+
G. graoilo Ehrenberg	+	-	+
G. intricatum Kuetzing	+	-	-
G. parvulum (Kuetzing) Kuetzing	+	+	+
G. subclavatum (Grunow) Grunow	+	-	-
G. truncatum Ehrenberg	+	+	+
Gyrosigma attenuatum (Kuetzing) abenhorst	-	+	+
G. spenceri (Quek.) Griff et Henfr.	-	+	-
Melosira varians C. Agardh	+	+	+
Aulacoseria granulata (Ehrenberg) Simonsen	+	+	+
Mastogolia bruunii Grunow	+	-	+
Mastogolia sp.	+	-	-
Navicula lanceolata (Ag.) Kuetzing	+	-	+
N. radiosa Kuetzing	+	-	+
N. odiosa Wallace	+	-	-
N. viridula (Kuetzing) Ehr.	+	+	+
N. cryptocephale Kuetzing	+	+	+
N. peregrine (Ehrenberg) Kützing	+	-	-
N. zanoni Hustedt	+	-	+
Nitzschia apiculata (Greg.) Grunow	+	+	+
N. denticula Grunow	+	+	+
Nitzschia dissipata (Kuetzing) Grunow	-	+	+
N. fasciculate (Grun.) Grunow	+	+	+
N. granulata Grum.	+	-	+
N. hungarica Grunow	+	-	+
N. linearis W. Smith	+	+	-
N. microcephala Grunow	+	-	-
N. obtusa W.Smith	+	+	-
N. palea (Ktz.) W. Smith	+	+	+
N. vermicularis (Ktz.) Hantzsch	+	+	+
Pleurosigma delicatulum W. Smith	+	+	-
Pinnularia major (Kuetzing) Rabenh.	+	+	-
Rhopalodia gibba (Ehrenb.) O. Muleler	+	-	-
Rhoicosphenia curvuts (Kuetzing) Grunow	+	-	+
Synedra ulna (Nitzs.) Ehrenberg	+	+	-

S. fasciculata (Ag.) Kuetzing	+	+	+
S. capitata Ehrenberg	+	+	+
S. acus Kuetzing	+	-	-
S. tenera W.Smith	+	-	+
S. delicatissima W.Smith	+	-	-
S. pulchella (Ralfs) Kuetzing	+	+	+
Surirella ovalis de Brebisson	+	+	-
Stephanodiscus niagarae Ehrenb.	+	-	+
Class: Euglenoceae			
Euglena elastica Prescott	+	-	+
Phacus sp.	-	-	+

Table 2: Seasonal biomass of epiphytic algae (cell/g) on the host-macrophyte, at the studied stations.

Host	Season	Site 1	Site2	Site 3	Site 4	Site 5	Site 6	Site7
Ceratophyllum demersum	**Summer 2004**	4025	-	-	5129	460	835	299
	Autumn 2004	6670	-	-	3036	5543	-	399
	Winter 2005	25300	-	11500	2415	-	2760	8510
	Spring 2005	15594	-	9680	18090	13950	14437	11789
Potamogeton pectinatus	**Summer 2004**	207	-	-	1081	161	7360	184
	Autumn 2004	1081	-	-	-	-	-	1704
	Winter 2005	27600	-	-	9085	-	-	14112
	Spring 2005	10143	-	-	17800	-	7523	11075
Myriophyllum verticillatum	**Summer 2004**	1287	-	-	2875	1253	971	1506
	Autumn 2004	1380	-	-	1920	2806	749	1823
	Winter 2005	48300	-	3634	20150	-	-	13791
	Spring 2005	33350	-	5460	17490	-	20180	24889

(-) absence of host macrophyte.

Table (3): Average cell number of epiphytic algae class (cell/g) at all study stations. (-) absence of plants; (C.d.)= Ceratophyllum demersum; (P.p.)= Potamogeton pectinatus; and (M.v.)= Myriophyllum verticillatum

	St.	C.d.	**P.p.**	**M.v.**
Cyanophyceae	1	247	180	110
	2	-	-	-
	3	29	-	21
	4	139	49	39
	5	94	52	61
	6	75	31	40
	7	81	55	29
Chlorophyceae	1	370	271	195
	2	-	-	-
	3	69	-	20
	4	115	71	69
	5	59	37	47
	6	61	45	54
	7	71	71	81
Bacillariophyceae	1	51589	39031	84217
	2	-	-	-
	3	21180	-	9094
	4	28670	27966	42435
	5	19953	161	4059
	6	18032	14883	21900
	7	20997	27075	42009
Euglenophyceae	1	19	-	15
	2	-	-	-
	3	-	-	-
	4	18	-	9
	5	-	-	-
	6	-	-	-
	7	7	-	5
Total	1	52225	39482	84537
	2	-	-	-
	3	21278	-	9135
	4	28942	28086	142552
	5	20106	250	4167
	6	18032	14959	21994
	7	21156	27201	42124
	Total	161739	110178	204509

Table (4): Species richness (s), mean (±SD), Shannon diversity index (H') and Sorenson similarity index (sor) of epiphytic algae on three macrophytes at Euphrates river during 2004-2005.

Macrophyte	Station	Species richness (s)	mean (±SD)	H'	sor
Ceratophyllum demersum	**1**	51589	12897 (±9636.7)	0.16	6.27
	2	-	-	-	-
	3	21180	5295(±6159.1)	0.12	15.27
	4	28670	7167(±7373.6)	0.13	11.28
	5	19953	4988(±6480.9)	0.11	16.21
	6	18032	4508(±6719.4)	0.10	16.90
	7	20997	5249(±5814.6)	0.12	15.40
Potamogeton pectyinatus	**1**	39031	9757(±12714.7)	0.15	5.64
	2	-	-	-	-
	3	-	-	-	-
	4	27966	6991(±8266.8)	0.15	7.87
	5	161	40(±80.5)	0.004	-
	6	14883	3720(±4296.8)	0.12	14.80
	7	27075	6768(±6867.3)	0.14	8.14
Myriophyllum verticilatum	**1**	84317	21079(±23603.2)	0.16	4.85
	2	-	-	-	-
	3	9094	2273(±2729)	0.06	44.97
	4	42435	10608(±9551.5)	0.14	9.63
	5	4059	1014(±1332.3)	0.03	100.76
	6	21900	5475(±9812.1)	0.10	18.67
	7	42009	10502(±11166.3)	0.14	10.09

Table (5): Samples serial number indicated by the host macrophyte, season of collection, and sample stations

Sample No.	Host Macrophyte	Season	St. No.
1	*Ceratophyllum demersum*	Summer 2004	1
2	*Ceratophyllum demersum*	Summer 2004	4
3	*Ceratophyllum demersum*	Summer 2004	5
4	*Ceratophyllum demersum*	Summer 2004	6
5	*Ceratophyllum demersum*	Summer 2004	7
6	*Ceratophyllum demersum*	Autumn 2004	1
7	*Ceratophyllum demersum*	Autumn 2004	4
8	*Ceratophyllum demersum*	Autumn 2004	5
9	*Ceratophyllum demersum*	Autumn 2004	6
10	*Ceratophyllum demersum*	Autumn 2004	7
11	*Ceratophyllum demersum*	Winter 2005	1
12	*Ceratophyllum demersum*	Winter 2005	3
13	*Ceratophyllum demersum*	Winter 2005	4
14	*Ceratophyllum demersum*	Winter 2005	6
15	*Ceratophyllum demersum*	Winter 2005	7
16	*Ceratophyllum demersum*	Spring 2005	1
17	*Ceratophyllum demersum*	Spring 2005	4
18	*Ceratophyllum demersum*	Spring 2005	6
19	*Myriophyllum verticillatum*	Summer 2004	1
20	*Myriophyllum verticillatum*	Summer 2004	4
21	*Myriophyllum verticillatum*	Summer 2004	5
22	*Myriophyllum verticillatum*	Summer 2004	6
23	*Myriophyllum verticillatum*	Summer 2004	7
24	*Myriophyllum verticillatum*	Autumn 2004	1

25	*Myriophyllum verticillatum*	Autumn 2004	4
26	*Myriophyllum verticillatum*	Autumn 2004	5
27	*Myriophyllum verticillatum*	Autumn 2004	6
28	*Myriophyllum verticillatum*	Autumn 2004	7
29	*Myriophyllum verticillatum*	Winter 2005	1
30	*Myriophyllum verticillatum*	Winter 2005	3
31	*Myriophyllum verticillatum*	Spring 2005	1
32	*Myriophyllum verticillatum*	Spring 2005	6
33	*Potamogeton pectinatus*	Summer 2004	1
34	*Potamogeton pectinatus*	Summer 2004	4
35	*Potamogeton pectinatus*	Summer 2004	5
36	*Potamogeton pectinatus*	Summer 2004	6
37	*Potamogeton pectinatus*	Summer 2004	7
38	*Potamogeton pectinatus*	Autumn 2004	1
39	*Potamogeton pectinatus*	Autumn 2004	7
40	*Potamogeton pectinatus*	Winter 2005	1
41	*Potamogeton pectinatus*	Spring 2005	7

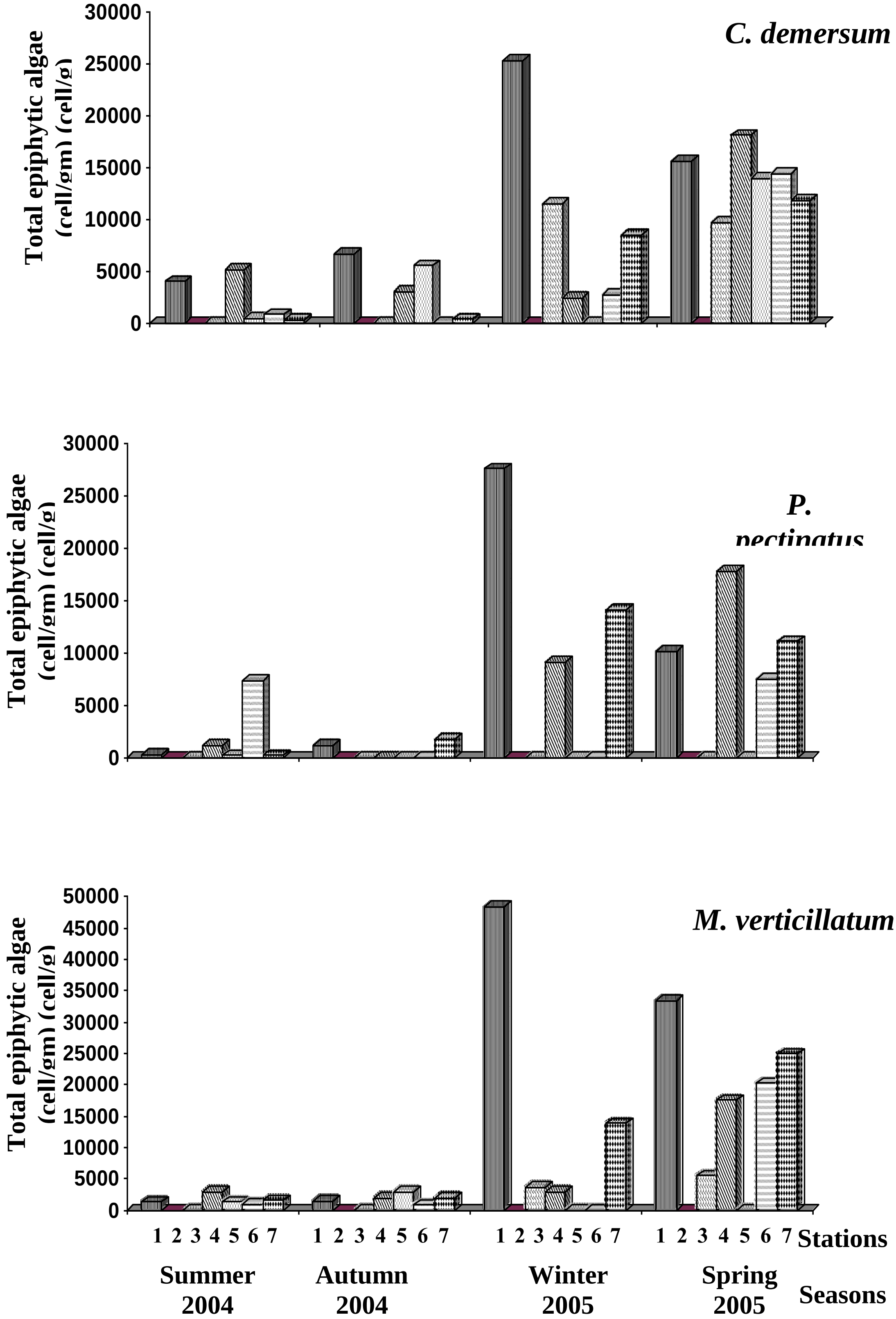

Figure (2): Seasonal variety in number of Epiphytic algae on the host Macrophyte at studied stations.

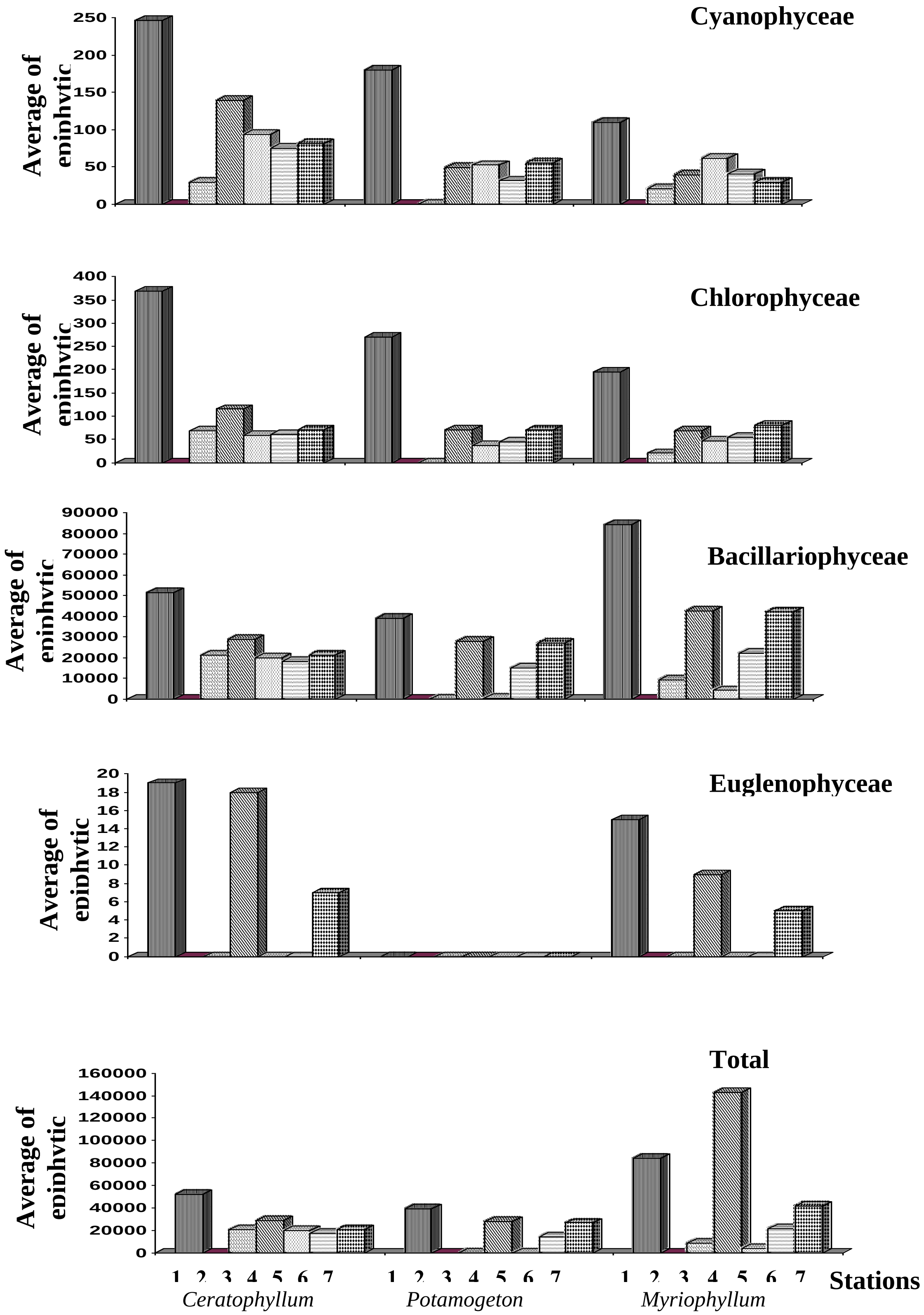

Figure 3: Average number of epiphytic algae class on the studied host-macrophyte at studied stations during study period (2004-2005).

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التغير الكمي والنوعي للطحالب الملتصقة على ثلاثة نباتات مائية في نهر الفرات، العراق

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المستخلص

تـم دراسـة الطحالـب الملتصـقة علـى ثلاثـة نباتـات مائيـة هـي *Ceratophyllum demersum* و *Myriophyllum verticillatum* و *Potamogeton pectinatus* في نهر الفرات بين سدة الهندية ومدينة الكوفة في وسط العراق في سبع محطات مختارة للمدة من صيف 2004 ولغاية ربيع 2005. شخص 97 نوعا من هذه الطحالب، سادت فيها الطحالب الدايتومية بنسبة 73% جاءت بعدها الطحالب الخضر والخضر المزرقة واليوغلينية على التوالي. اختلفت أنواع الطحالب تبعاً لنوع النبات العائل، تنوعت كذلك على نفس النبات تبعاً لمواسم الدراسة ومحطاتها. كانت الدايتومات هي السائدة من حيث الكتلة الحية وأحتوت بعض اجناس الطحالب الدايتومية على أكبر عدد من الانواع مثل *Cymbella* و *Gomphonema* و *Nitzschia* و *Synedra*. أظهرت اغلب محطات الدراسة كثافة سكانية عالية.