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ECOLOGY AND PHYTOREMEDIATION POTENTIALITY OF SOME SUBMERSED HYDROPHYTES

Abu Ziada, M. E.; H. S. El-Desoky; Maha. M. Al-Shami and A. K. Ftaikhan
Department of Botany, Faculty of Science, Mansoura University, Egypt.

ABSTRACT

The present study provides quantitative assessment of the hydrosoil and overlying water characteristics in addition to vegetation analysis of five aquatic habitats and their wet shorelines dominated by *Ceratophyllum demersum, Myriophyllum spicatum, Potamogton crispus, P. nodosus* and *P. pectinatus.* Experimental study was conducted to evaluate rate of release of heavy metals from living and dead hydrophytes to the surrounding water. The bottom sediments and overlying water were different markedly in the five habitats. The sediments samples were sandy textured with predominance of fine sanarticles size=0.211 – 0.104 mm), whereas sites and clay fractions constitute small proportion. Organic carbon, total soluble salts, anions and cations were generally higher in summer months. The floristic components of the five communities comprised 51 species related to 27 families. Poaceae, Asteraceae, Cyeprceae, and Potomogetonaceae were the major families contributing 45% of the recorded species. Therophytes were the common life – froms. Rate of heavy metals release from living plant samples was higher than that from the dead samples.
Keywords: Submerged hydrophytes, environmental variables, heavy metals.

INTRODUCTION

All forms of life depend on water. Sometimes harmful substances can dissolve in water; such substances that harm the quality of water are known as pollutants or contaminants. Numerous ecological changes have been observed in the Egyptian Nile system due to the environmental disturbance of aquatic regime. These changes may be responsible for the widespread of hydrophytes in canals and drains a crossing the cultivated land and lakes in Delta (Khder and serag, 1998; El-Sodany, 1998; Ahmed, 2003 and Abd El-Samae, 2007). There are many sources of water pollution such as the discharge of solid or liquid wastes containing pollutants, herbicides, pesticides, industrial poisons and organic matter as manure and sewage sludge which cause depletion of oxygen due to decomposition processes (Ahmed, 2003; Morris & Lewis, 1988 and Fairchild *et al*., 1989). The application of mineral fertilizers and organic herbicides caused toxic pollution (Juttner *et al.*, 1996 and Goltermaan, 1999).

During the last few years, heavy metals and sewage became contaminants of aquatic and wetland environments throughout the world. The occurrence of heavy metals in excess of natural loads has become a problem of increasing concern. In natural aquatic ecosystem, metals occur in low concentrations, normally at the nanogram to microgram per liter (Biney *et* *al*.,1994). Effects of habitat of aquatic plants on their morphological**,** anatomical and physiological characters have been investigated by Shams *et al*.,1986; Abd El-Fattah, 1990 and Khedr & El-Demerdash,1997).

In Egypt, little attention is given to the search on heavy metals cycling in aquatic ecosystem water –hydrosoil- biota). Also, information concerning their role in the biomagnification of heavy metals such as Pb , Zn, Cr, Cd and Fe in aquatic food webs are lacking **.** Some studies were made to qualify and determine the occurrence of trace metals in water , macrohydrophytes and /or hydrosoil ,for example Saad and Fahmy , 1985; Soltan and Awadalla ,1995; Ali & Soltan ,1999 and Ali *et al*. ,1999.

Sajwan & Ornes, 1997 and Rice *et al.* (1997) have pointed to the possibility of using macrhydrophytes as biological filters for water purification and removing the heavy metals.

Variuos ecological studies have been concerned with aquatic and canal banks weeds in the Nile Delta as example Shaltout *et al.* (1994) and Al-Sodany (1998) **.**

The objectives of the present study were; 1) To elucidate a detailed account on the favoring environmental conditions of the habitats dominated by five submersed hydrophytes , namely ; *Ceratophyllum demersum , Myriophyllum spicatum , Potamogeton crispus , P. nodosus* and *P. pectinatus* and describe the floristic composition of their communities .2) To detect micro-element release from these hydrophytes to explore their potentiates in phytoremediation.

MATERIALS AND METHODS

The studied sites are located in El-Dakahlyia Governorate. site 1. Kafr Demira irrigating canal located at 6 km east of Bilqas city, dominated by *Potamogeton nodosus*. Sit 2. El-Gammalyia drainage canal, dominated by *Myriophyllum spicatum* site and 3. Manzala lake which representing the habitats of *Ceratophyllum demersum, P. crispus* and *P. pectinatus*.

Hydrosoil and subsurface water samples were collected at mid-winter and mid-summer from each site. The procedures followed of estimating their variables were according to the methods recommended by Allen *et al.*, (1974), Carter & Gregorich (2008), klute (1986), Margesin & Schinner (2005) and Pansu & Gautheyrous (2006).

With regard to vegetation analysis, nomenclature of the species follows Tackholm, (1974) and Boulos, 1995. The presence of each species is expressed by the percentage of occurrence (Kent & Coker, 1992 and Jongman *et al*., 1987).

Heavy metal release experiment was designed as describe in Abu Ziada *et al.,* (1988). 200 gm living plant sample were transferred to a Jar containing 5L distilled water and connected to air pump. At 7 hours intervals water samples were taken for detection of the released Pb , Zn , Cr ,Cd and Fe ions . The experiment was repeated using 200 g of dead plant samples and the released ions measured using atomic absorption spectrophotometer as described by Allen *et al.*(1986).

RESULTS AND DISCUSSION

It is obvious from the data given in table (1) that, the five hydrosoil supporting *P. nodosus* at Kafr Demira irrigation canal , *M. spicatum* in El Gammalia drain and *C. demersum* , *P. crispus* and *P. pectinatus* in Manzala lake were generally sandy textured with predominance of fine sand which ranged between 51.89 and 62.10 % in winter and varied from 53.45 to 61.43 % in summer. Silt and clay particles were found in low proportion .Porosity reflected the nature of coarse textured soil (44.04 – 59.64 % in summer and 47.47 - 62.56 % winter) . Organic carbon content attained high values at Manzala lake as a consequence of sewage pollution . The organic carbon content of the bottom sediments of El Gammalia drainage canal and kafr Demira irrigation canal was relatively low (0.52 and 0.59 % ,respectively. Calcium carbonate contents of the hydrosoil samples have little variation . The maximum value of $CaCO_3$ was 4.33% at kafr Demira irrigation canal where *P. nodosus* flourished , whereas the minimum value was recorded at Manzala lake where *C. demersum* and *P. pectinatus* were found (1.83%). The total soluble salts of the five hydrosoil fluctuated within a narrow range and attained its highest value of 0.34 % in *C. demersum* hydrosoil. The lowest T.S.S. content was that of *P. nodosus* hydrosoil at kafr Demira irrigation canal. The amount of chlorides in the bottom sediment samples was relatively low in summer month and varied from 0.04 to 0.05 % and elevated up to 0.32 % in summer. The data compiled in Table (1) showed that sulphates are the minor constituent of soluble salts. Sulphates content was relatively higher in the bottom sediments of Manzala lake if compared with the sediments of kafr Demira irrigation canal and El Gammaliya drainage canal, where its values ranged from 0.01 to 0.02% in the tow aquatic habitats . The soluble carbonates were completely absent in all the studied hydrosoil samples, while bicarbonates were the major constituent of soluble salts with mean percentages ranged from 0.11 to 0.27%. The soil reaction of the five sediments samples was weakly alkaline to alkaline with mean PH values varied between 7.8 and 8.4 in winter months and from 7.93 to 8.93 in summer months. The data given in table (1) revealed that both sediments of aquatic habitats supporting *Myriophyllum spicatum* at El Gammalyia drainage canal and *P. pectinatus* at Manzala lake have higher concentration of lead ions (32.75-35.36% and 58.39-73.15 ppm, respectively). The lowest content of Pb ions was recorded in sediments of kafr Demira irrigation canal (17.64-24.68 ppm). The maximum concentration of Zn ions was recoded in Manzala lake where *C. demersum* found (33.49 - 41.34 ppm) The hydro-soil sample collected from *Myriophyllum P. pectinatus* and *P. nodosus* habitats have low values of Zn ions concentration, with mean values ranged between 0.77 and 1.54 ppm in winter and between 0.53 and 1.63ppm in summer.

T1

The hydrosoil samples have variable values of Cr ions concentration. It was higher in Manzala lake 51.47 - 59.35 ppm in *Ceratophyllum* habitat, 71.25-71.86 ppm in *P .crispus* habitat and 25.67 - 35.32 ppm in *P. pectinatus* habitat. Cadmium ions concentration in the different hydrosoils attained higher levels in *P .pectinatus* habitat (107.3 - 129.5 ppm), in *Myriophyllum* habitat (62.38 - 90.54 ppm) and P. nodosus habitat (50.93 - 114.32 ppm). The Cd ions content was very low and ranged between 1.32 and 1.92 ppm and from 0.72 to 0.82 ppm in bottom Sediments of *C. demersum* and *P. crispus* habitats, respectively. The hydrosoil samples of the five aquatic habitats attained high ferric ions content with mean values of 38.58 and 36.1 ppm, 35.17 - 37.57 ppm and 26.96 - 39.87 ppm in hydrosoils supporting *P. pectinatus, P. nodosus and C. demersum,* respectively. While at *Myriophyllum* and *P. crispus* habitats , the Fe ions concentrations possess low values and ranged between 11.56 and 18.25 ppm and between 27.36 - 28.95%, respectively.

Concerning the characters of water supporting *C. demersum* , *M. spicatum, P. crispus, P. nodosus and P. pectinatus* , the data given in table (2) revealed that the organic carbon content of water was relatively high in El Gammalia drain and showed little variation. In kafr Demira irrigating canal and Manzala lake, organic carbon content of water was increased in summer and decreased in winter. Total soluble salt content has a narrow range of variation. It is varied from 0.24 to 0.33 g/L in winter and from 0.24 to 0.29 g/L. These results are coincide with those obtained by Khattab and El-Gharably (1986). Chlorides content of water samples supporting *M. spicatum* at El-Gammalia drin has high value of 0.11 - 0.10 g/L and the intermediate values at Manzala lake where *Ceratophyllum* and *P. pectinatus* grow (0.7 - 0.1 g/L). the low values at P. crispus habitat. Sulphates attained relatively high levels in Manzala lake. It showed the same trend of chlorides content in the different water bodies. Sulphates represent the main soluble anions and ranged from 0.14 to 0.25g/L.

Soluble carbonates were completely absent in all the studied water samples, while bicarbonate were determined in low concentration, which ranged from 0.02 to 0.05g/L. Stumm and morgan (1970) reported that, PH is a master control parameter in the aquatic environment governing the chemical and biological system of water bodies. The water PH values measured in all water bodies varied from neutral to slightly alkaline with narrow range of variation from habitat to other (Table 2). The water PH values of *P. crispus, P. nodosus and P. pectinatus* were relatively higher than those of *M. spicatum and C. demersum* habitats . Cations determination showed that, Pb ions concentration has its highest values at *C. demersum* habitat (0.83 and 0.91 mg/L) and the lowest Pb content was recorded in water samples supporting *P. crispus*. The maximum values of Zn and Cr content were recorded in Manzala lake at habitat of *P. crispus* (0.29-0.35 mg/L) while that of Cd and Fe recorded in at El gammalia drain where *M. spicatum* grows, with mean valus = 0.88 and 0.74 mg/L, respectively. Similar observations were obtained by many authors Abu Ziada, 1987; El Habibi *et al.,* 1988. and Khedr El- Demerdash, 1996.

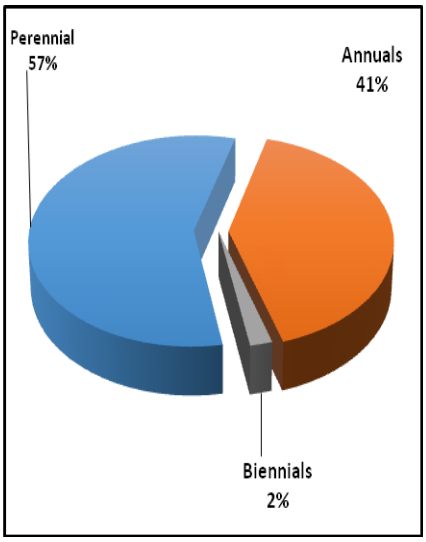
T2

Experimental study was conducted to evaluate the periodical change in the rate of release of heavy metals from living and dead hydrophytes to the surrounding water in their habitats, table 3 . The released Pb ions from living *Ceratophyllum* plant was higher (2. 27 mg/ 100g) then decline to 0.702 mg /100g after 2 days . The rate of release of pb ions from the dead plant samples was fluctuated from 1. 343 to 1.650 mg/100 g .It is obvious from the obtained data that, the rate of release of heavy metals from the living rooted submersed macrohydrophytes decreased with pass of time . In case of dead plants, the rate of released heavy metals was gradually increased with time .

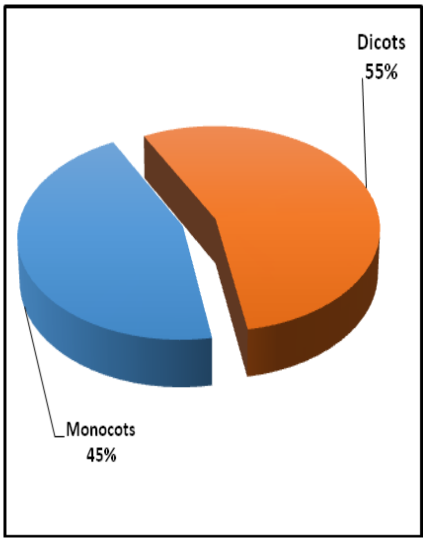
The present study indicates the ability of the submersed hydrophytes to absorb minerals from the bottom sediments, accumulate them and release some of the micro-elements to water .Consequently, the mechanical control of aquatic weeds may leads to minimize the level of water pollution by heavy metals . Abu ziada, *et al*.1988; Serag et al.,1999; and Larson, 1999 mentioned that, the macrohydrophytes were used for removing agricultural chemicals and contaminants from water and helping to improve drinking water quality.

Floristically, the total number of hydrophytes and terrestrial canal bank plants recorded in the present study was 51 species. These species could be classified into three major groups according to their durations (life – span): 29 perennials (57%) a single biennial (2%) and 21 annuals (41%), see Fig. (1). Of them 23 monocots and 28 dicots (Fig. 2) .These species are related to 27 families . Out of the families; Poaceae, Asteraceae, Cyperaceae and Potamogetonaceae are the major families contributing 45% of the total number of the recorded species. Families Convolvulaceae , Polygonaceae . Chenopodiaceae , Umbelliferae and Amaranthaceae are represented by two speceae each . Another eighteen families each represented by a single speceae (Fig .3) It is clean from Fig.(4) that , Therophytes represent the most common life- from (28%),followed by Geophytes and helophytes (24 % each), then hydrophytes represented by nine species (21%) and finally the hemicryptophytes (Fig.4). Concerning the floristic categories there were nine chorotypes including Mediterranean, Irano- Turanian , Pantropical, Euro-Siberian, and Cosmopolitan are well represented, see Fig. (5) . The obtained results are coincide with those obtained by Ahmed (2003) and Abo El-Lil (1987).

T3



Fig(1)life-span of the recorded Species



Fig(2)classifcationof the recorded species

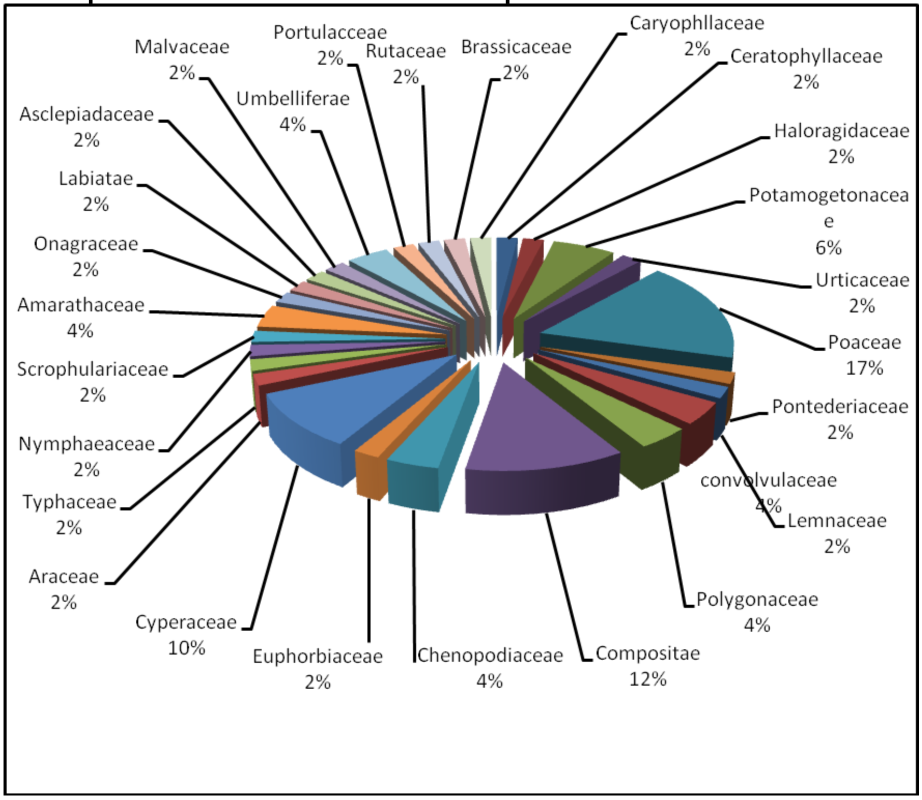


Fig (3) plant families of the recorded species

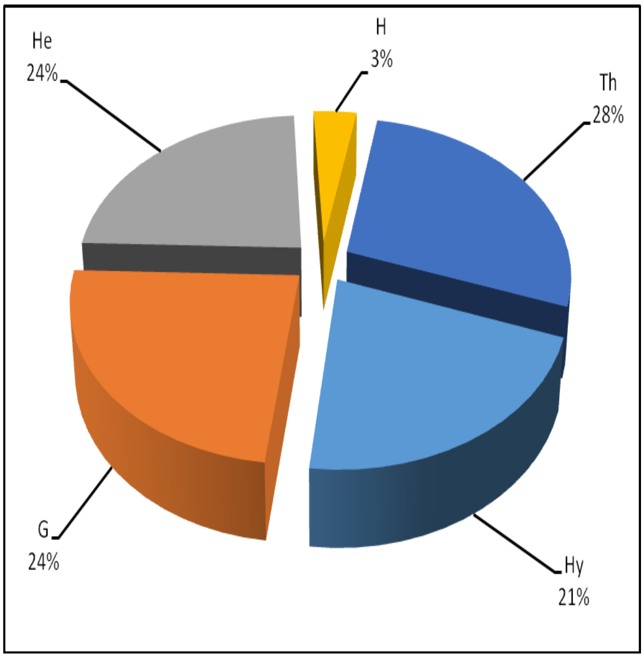


Fig (4) Life-form spectra of the recorded species

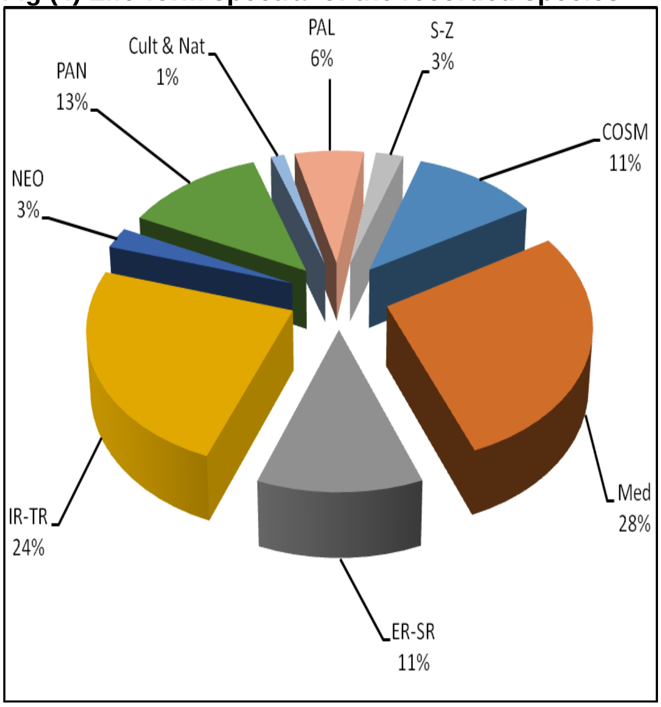


Fig (5) chorotypes of the recorded species

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البيئة وامكانية النباتات المائية المغمورة لمعالجة التلوث

محمد السيد علي ابو زيادة ، حشمت سليمان الدسوقي ، مها محمد الشامي و أمين خضير فتيخان

قسم النبات – كلية العلوم – جامعة المنصورة

تناول هذا البحث دراسة الخصائص البيئية (الرواسب القاعية والمياه) والتركيب النوعي لخمس عشائر نباتية يسودها نخشوش الحوت والمريوفيليم وثلاثة أنواع نباتية تابعة لجنس البوتاموجيتون .

جمعت عينات من الرواسب القاعية والمياه تمثل تلك العشائر من ترعة ري كفر دميرة ومن مصرف الجمالية وبحيرة المنزلة – تم تحليلها فيزيائياً وكيميائياً واظهرت النتائج اختلاف خصائص التربة والمياه في البيئات المختلفة وفي فصل الصيف عنه في الشتاء. وكانت التربة رملية القوام ويسود الرمل الناعم كافة الدقائق, وكان الغرين والطين ضعيفا التمثيل. أما نسبة الكربون العضوي والأملاح الكلية الذائبة وأيضاً الأنيونات والكايتونات كانت أعلى في الصيف عن الشتاء.

أوضحت الدراسة الفلورية للعشائر أنها تشمل ٥١ نوع نباتي تنتمي لسبع وعشرين فصيلة منها النجيلية والمركبة والسعدية والبوتاموجيتونية كانت الأعلى تمثيلا. وأن النباتات قصيرة الاجل Therophytes كانت الأهم بين خمسة صور للحياة. ودلت النتائج أن معظم النباتات تتبع اقليم البحر المتوسط واقليم ايران – الأناضول واقليم أوربا وسيبيريا .

أجريت تجربة معملية باستخدام اناء زجاجي به ماء مقطر ومتصل بمضخة هواء لتقيم انبعاث العناصر الثقيلة من عينات نباتية حية وأخرى ميتة وأظهرت النتائج أن معدل انطلاق العناصر الثقيلة من العينات الحية يبدأ عالياً ثم يتناقص تدريجياً مع مرور الوقت وكان العكس من حالة النباتات الميتة حيث كان انطلاق العناصر كان بطيئاً ثم يتزايد بمرور الوقت.

لذلك فالمقاومة الميكانيكية واليدوية لإزالة النباتات المائية من بيئاتها المائية تقلل من التلوث وتساعد على تنقيه المياه من العناصر الثقيلة.

Table (1) Analysis of subsurface soil samples supporting of some submersed hydrophytes in kafr Demira irrigating canal, Manzala lake, and El Gammalia derain . Por.= porosity , Org.C.=organic carbon and T.s.s. =total soluble salts .

Plant	Physical characteristics: Mechanical Analysis: Soil fractions(%)					Chemical characteristics							Heavy metals in soil(mg kg^{-1})				
								Analysis of 1:5 water extract									
	Coarse sand	fine. Sand	Silt	Clay	Por. %	Org.C %	$CaCO_3$ %	T.s.s. %	Cl^- %	$SO4^{-2}$ %	HCO_3 %	pH	Pb	Zn	Cr	Cd	Fe
mid winter																	
C. demersum	28.00	58.41	9.58	3.99	48.92	0.86	1.83	0.20	0.04	0.015	0.11	8.40	10.48	33.49	51.47	1.92	26.96
M. spicatum	27.21	61.76	6.93	4.10	55.24	0.52	4.00	0.30	0.05	0.01	0.27	8.37	32.75	1.54	25.26	90.54	18.25
P crispus.	27.33	60.14	8.07	4.44	51.09	0.58	3.17	0.25	0.04	0.03	0.21	8.20	30.27	15.23	71.25	0.82	27.36
P. nodosus	35.95	51.89	6.93	4.86	47.47	0.59	3.33	0.19	0.04	0.02	0.15	7.80	17.64	0.77	28.14	50.93	35.17
P. pectinatus	21.69	62.10	10.38	5.97	62.56	1.54	2.83	0.15	0.05	0.01	0.13	8.33	73.15	1.36	25.67	107.30	36.10
mid summer																	
C. demersum	31.37	55.83	9.83	3.81	48.75	2.08	4.00	0.34	0.23	0.01	0.12	8.93	20.47	41.34	59.35	1.32	39.87
M. spicatum	29.48	59.37	6.96	4.73	44.04	0.66	2.17	0.19	0.12	0.01	0.19	8.07	35.36	0.97	15.86	62.38	11.56
P crispus	27.72	61.41	8.20	4.01	52.07	1.74	3.67	0.25	0.32	0.02	0.19	8.70	30.21	21.36	71.86	0.72	28.95
P. *nodosus*	32.41	53.45	9.78	3.11	47.47	0.73	4.33	0.18	0.04	0.02	0.13	7.93	24.68	0.53	18.02	114.32	37.57
P. pectinatus	23.69	61.43	10.80	3.98	59.64	0.80	1.83	0.36	0.04	0.01	0.26	8.43	58.39	1.63	35.32	129.51	38.58

Table (2) Analysis of subsurface water samples supporting five submersed hydrophytes growing in kafr Dimera irrigating canal, Manzala lake, and El Gammalia derain. Org.C.=organic carbon. T.S.S =total soluble salts and E.C.=Electric conductivity.

Plant	Chemical characteristics						Heavy metals (mg/L)				
	Org.C g /L	T.s.s. g /L	Cl^- g /L	SO_4^{2-} g /L	HCO_3 g /L	pH	pb	Zn	Cr	Cd	Fe
mid winter											
C. demersum	0.62	0.33	0.10	0.19	0.05	8.00	0.83	0.20	0.13	0.04	0.58
M. spicatum	1.00	0.29	0.11	0.25	0.02	7.67	0.12	0.07	0.20	0.88	0.74
P crispus.	0.83	0.32	0.06	0.25	0.03	8.13	0.01	0.29	0.35	0.24	0.63
P. nodosus	0.62	0.24	0.08	0.19	0.04	8.10	0.30	0.20	0.13	0.04	0.58
P. pectinatus	0.62	0.28	0.06	0.19	0.04	8.10	0.17	0.24	0.23	0.04	0.41
mid summer											
C. demersum	0.74	0.24	0.07	0.14	0.02	7.97	0.91	0.32	0.31	0.11	0.98
M. spicatum	0.82	0.28	0.10	0.19	0.04	7.57	0.30	0.14	0.29	0.78	0.92
P crispus.	0.66	0.27	0.09	0.19	0.05	8.30	0.02	0.23	0.15	0.24	0.67
P. nodosus	0.40	0.27	0.10	0.16	0.03	8.20	0.29	0.24	0.13	0.10	0.56
P. pectinatus	0.61	0.29	0.09	0.16	0.03	8.20	0.12	0.17	0.29	0.12	0.44

Table (3). Rate of release of heavy metals from living and dead hydrophytes through 2 days.

Samples	Heavy metals mg/100g	Submersed hydrophytes				
		C. demersum	***M. spicatum***	***P. crispus***	***P. nodosus***	***P. pectinatus***
Living	Pb	2.27 - 0.70	1.27 - 0.05	1.42 - 0.35	1.49 - 0.760	0.91 - 0.190
	Zn	0.01 - 0.10	0.05 - 0.02	0.03 - 0.01	0.04 - 0.001	0.02 - 0.003
	Cr	0.24 - 0.01	0.28 - 0.02	0.38 - 0.19	0.18 - 0.110	0.39 - 0.184
	Cd	0.46 - 0.06	1.18 - 0.58	0.37 - 0.22	0.02 - 0.007	0.76 - 0.284
	Fe	2.40 - 1.63	1.60 - 0.91	1.31 - 1.35	2.16 -1.491	1.80 - 1.255
Dead	Pb	1.65 - 1.34	0.33 - 1.33	0.15 - 0.48	0.10 - 0.870	0.17 - 0.730
	Zn	0.04 - 0.010	0.01 - 0.09	0.02 - 0.04	0.02 - 0.060	0.01 - 0.080
	Cr	0.04 - 0.17	0.08 - 0.7	0.06 - 0.35	0.04 - 0.050	0.09 - 0.23
	Cd	0.02-0.21	0.03 - 0.08	0.19-0.13	0.54 - 0.920	0.01 - 0.78
	Fe	0.09 - 2.75	0.16 - 1.41	0.84 - 1.55	0.09 - 1.839	0.05 - 0.966