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Diagnosis and ecological distribution of aquatic (Hemiptera: Heteroptera) in Sullein marsh in Basrah, South of Iraq

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Abstract - Present study was done during the period between April 2012 and March 2013 in Sullein Marsh, Basrah South of Iraq. Results recorded four families, four genera and four species of hemipteran insects community in different seasons. The families are Corixidae included the species *Sigara lateralis* (Leach, 1817), Macrovellidae included the species *Macrovelia hornii* (Uhler, 1872), Pleidae included the species *Plealeachi* (McGregor and Kirkaldy, 1899) and Mesovillidae included two species *Mesovelia vittigera* (Horvath, 1895) (apterous) and *M. vettigera* (macropterous). Some physico-chemical parameters were measured, such as air and water temperatures, salinity, pH, dissolved oxygen and concentration of heavy metals (Fe, Pb, Cu, Zn) in water. Analysis showed that air and water temperatures correlated with distribution of aquatic Hemiptera, the highest numbers of insects were collected in Winter months and lowest numbers collected in Summer months, the maximum rate of air temperature was 41 ºC in July and the minimum was 13 ºC in January, the maximum and the minimum rates of water temperatures were 32 ºC and 7 ºC in the same months, the maximum range of DO was 11 mg/l in January and the minimum was 8 in July, the maximum concentration of salinity was 3.3 g/l in July and the minimum was 2.8 g/l in January and February. About pH the maximum range was 8.2 in January and the minimum was 7.4 in June and July. Maximum concentration of Fe, Pb, Cu and Zn were 215.01, 22.78, 18.54 and 223.14 µg/l respectively in July.

Keywords: Iraqi Marshes, Aquatic Hemiptera, Corixidae, Macroveliidae, Mesoveliidae, Pleidae.

Introduction

Water bugs are the most abundant insects in the order Hemiptera, Suborder Heteroptera, consisting of two infraoders: Nepomorpha (the true water bugs) stay their lives beneath the water surface, and Gerromorpha (the semiaquatic bugs) spend most of their lives on surface of water (Chen *et al.*, 2006). Nepomorpha possess antennae shorter than the head and inserted below the eyes, while Gerromorpha have antennae longer than the head (Bauchard, 2004). Most of them are predators which feed on captured prey by sucking body fluid from them by piercing sucking mouth parts (Papacek and Zettel, 2000). They can found almost in every type of aquatic habitat throughout the world including lakes, torrential streams, highly saline pools, acid peat swamps, phytotelmatus, coastal waters and estuaries, ground water, hot springs and even pools of crude oil seeping from the ground (Yule and Yong, 2004), except the genus *Halobates*: Gerridae is almost exclusively marine and is unique in having the only known species to live in open ocean (Andersen and Cheng, 2004).

The importance of the aquatic hemipterans is used as a biological control agents against disease-carrying mosquitoes (Mohanraj *et al.*, 2012), some of them may cause a painful bites like the family Belostomatidae (Cardoso *et al.*, 2009). Corixidae are very abundant in ponds and lakes form an important food source for fishes and other animals. In some countries like Thailand, Colombia and China it used as food by local people like the families Gerridae, Nepidae and Belostomatidae (Hanboonsong *et al.*, 2000). Aquatic hemipterans stand out as an important group of aquatic insects which have considered important in environmental reclamation of aquatic habitats and are often used to determined toxins in an environment (Papacek, 2001), they have indicator value because their lives do not depended on water quality (Lloyd, 2003). Although there are large water bodies in Iraq especially in Basrah, there are few studies about aquatic insects especially the order Hemiptera. One of the largest water bodies is the Iraqi Marshes, which consider one of the world's largest wetland ecosystems, have been undergoing extensive restoration. This process was implemented to remedy the damage done between 1991 to 2003, when the Marshes were drained and reduced to a tenth of their original size. Reflooding efforts after 2003 have now restored the Marshes one-third their original size, making them now largest wetland area in the Middle East covering 8000 square kilometers (Hussain *et al.*, 2006). The marshes play a vital role in the maintenance of biodiversity in the Middle East due to their unique characteristics and isolation from other comparable systems, so the aim of these study is to know the monthly distribution of Aquatic Hemiptera in Sullein-Marsh in Basrah south of Iraq, some physical parameters also were been measured such as air and water temperatures, salinity, pH and dissolve oxygen. The concentration of some heavy metals were measured like Lead (Pb), zinc (Zn), copper (Cu) and iron (Fe), and studies the relationship between their concentration with the distribution of Aquatic Hemiptera.

Materials and Methods

The study was done between April 2012 to March 2013, in Sullein Marsh, Basrah, south of Iraq, and the collection was done in two locations, the first one was a small pool on the margin of Shatt Al-Walhan, which have 8 m length, 5.5 m wide and 45 cm width, and have vegetation include *Phragmites australis* and *Bacopa moniera*, and algae of the genus *Chladophora*. While the second location was a small branches from Shatt Al-Walhan, which have 20 m length, 4.5 m wide and 2 m width, and have vegetation include *Phragmites australis* and *Bacopa moniera*, and algae of the genus *Chladophora*.

The collection was done twice month between 8:00 to 10:00 morning, it was done by using a sieve with diameter 20 cm and mesh size 1 mm (Dursun, 2011), or by a circular net with diameter 40 cm and mesh size 1 mm (Subramanion and Sivaramakrishnan, 2007). The location of samples was divided into four corner and derived the sieve or the net into the water for one minute three times for dividing insects, insect that move fast on the surface of water were collected by disturbed the vegetation by the sieve or the net for one minute three times, the collected insects then put in alcohol 70%, and take to the laboratory for identification and classification. The identification was done by using stereoscope with the help of standard keys like Savage (1990), Bouchard (2004), Nieser and Chen (2005), Subramanian and Sivaramakrishnan (2007) and Stearns and Kenneth(2008), the length of the insects and their parts were taken, and draw by using Camera Lucida,

then calculated to know their monthly distribution and then stored in alcohol 70%.

Some physical parameters were measured like air and water temperatures, salinity, pH and dissolve oxygen, water samples were taken for measuring the concentration of heavy metals, it taken in cages 2 L size with adding some drops of concentration Nitric acid to made the pH acid, then taken to the laboratory to digestion. The digestion was done by using APHA (1995) method. The measuring of the heavy metals was done by using Atomic Absorption Spectrophotometer.

Statistical analysis was done by using SPSS, using one-way analysis of variance ANOVA and the rates were compared with Revised Least Significant Difference R.L.S.D. ($p< 0.05$) (Al-Rawi and Khalaf-Allah, 1980)

Results

The results of this study showed that specimens were identified to four species from four families, (Corixidae, Pleidae, Mesoveliidae and Macroveliidae).

Family Corixidae has one species, *Sigara lateralis* (Leach, 1817) (Picture 1) (Fig. 1), small has size between 5-6 mm, the head is triangular in ventral view (Fig. 1-A), the zone extending ventrally from between the eyes on the anterior surface is flatted in male and convex in female. The beak broad and triangular without distinct segments with six transverse lines ,the antennae shorter than head has three segments ,concealed bellow the eyes. Pronotum yellow with 9-12 transverse dark lines. The hemielytron wing consists of three sections, a mid-proximal clavus, a lateral-proximal corium and distal membrane. Fore tarsus of males scoop-like and edged with setae, and carried stout, short, brown palar pegs on the anterior surface, forming a straight line (Fig. 1-B). Anterior margin of the abdominal segments straight and parallel in females (Fig. 1-C), while they irregularly curved ,never parallel in males. The abdomen in males bear a small, beak, toothed plate (strigil) on the posterior margin of the sixth tergum (Fig. 1-D).

Family Mesoveliidae has two species, *Mesovelia vittigera* (Horvath, 1895) (apterous) (Picture 2) and *M. vittigera* (Horvath, 1895) (macropterous) (Picture 3). Body slender, antennae longer than the head, beak cylindrical, legs with dark spines, the middle femora have 10 well developed spines (Fig. 2-A), all legs of similar length and with three tarsal segments, claws inserted at apex. Female sternite 8 simple without processes, male has single tuft of short black bristles placed on segment 8 near its base. In apterous specimens size was 3ml, yellow, all sutures brown (Fig. 2-B), macropterous specimens size was 2.5 ml, and veins of hemelytra almost black, in male the wings short don't cover abdomen's end (Fig. 2-C), while in female they are long and extend beyond the apex of abdomen (Fig. 2-D).

Family Macroveliidae has one species, *Macrovelia hornii* (Uhler, 1872) (Picture 4, Fig. 3), body slender, color brown, the inner margin of the eyes are arcuate, ocelli are present, scutellum concealed by the pronotum, legs spineless and the tarsi are three segmented, the claws are apical (Fig. 3-A). Wings contain six closed cells (Fig. 3-B).

Family Pleidae has one species, *Plea leachi* (McGregor and Kirkaldy ,1899) (Picture 5, Fig. 4), body convex 2.8 ml long, head small (Fig. 4-A), eyes red, antennae shorter than head and concealed bellow eye, beak cylindrical, hemelytra with dense sculpture consisting of minute polygonal pits (Fig. 4-B), hind wing usually vestigial. legs of similar length although hind legs slightly longer and fringed with swimming hairs, two well developed claws at the end of each legs (Figs. 4-C, D and E).

Picture 1. *S. lateralis.*

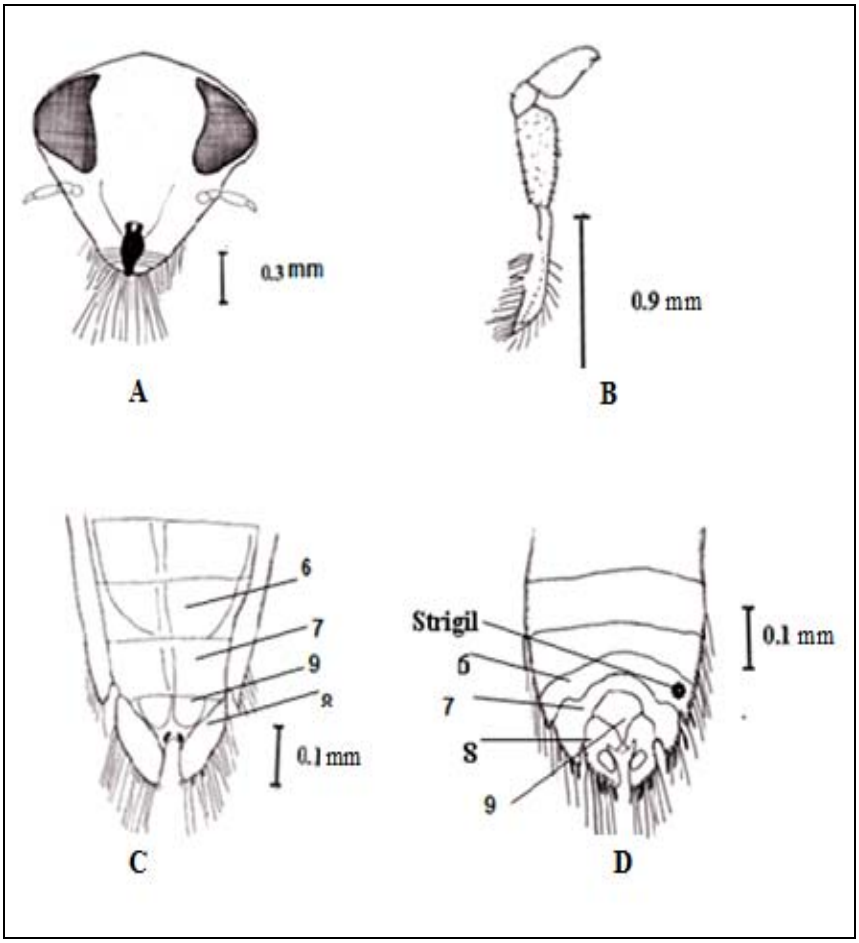

Figure 1. A: Ventral view of the head of *S. lateralis*, B: Male fore leg, C: Ventral view of female's abdomen, D: Ventral view of male's abdomen.

Picture 2. *M. vittigera* (apterous).

Picture 3. Female of *M. vettigera* (macropterous)

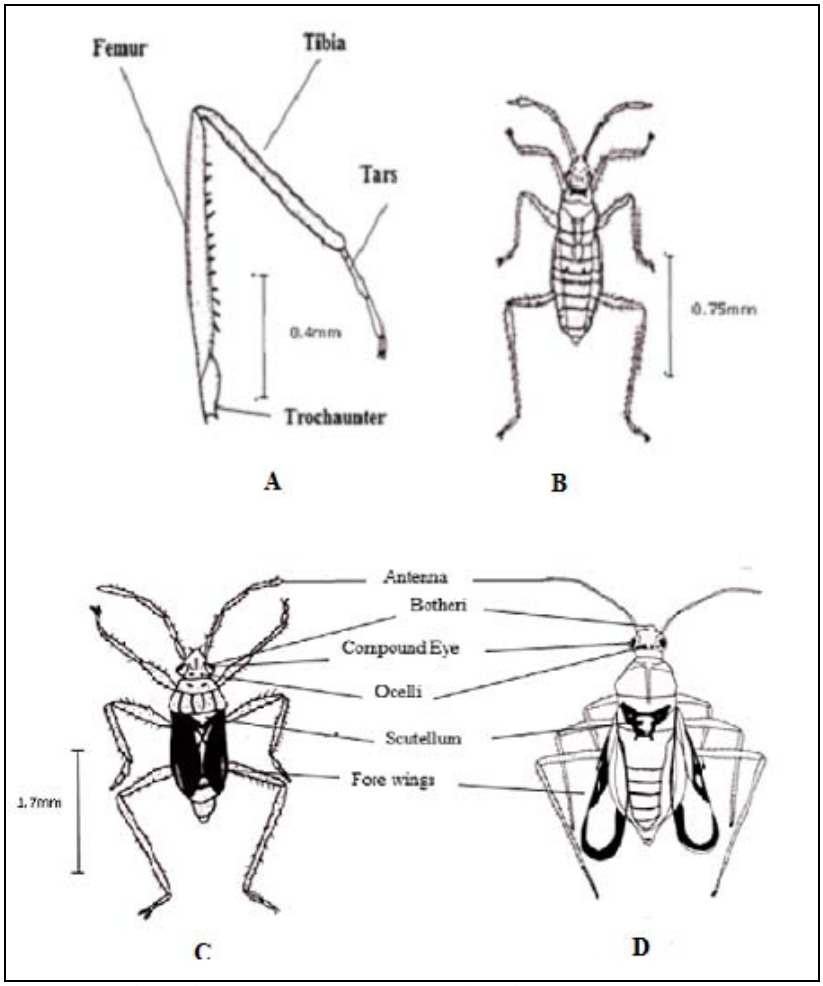

Figure 2. A: Fore leg of *M. vettigera*, B: Female of *M. vettigera* (apterous), C: Male of *M. vettigera* (magropterous), D: Feale of *M. vettigera* (magropterous).

Picture 4. *M. hornii.*

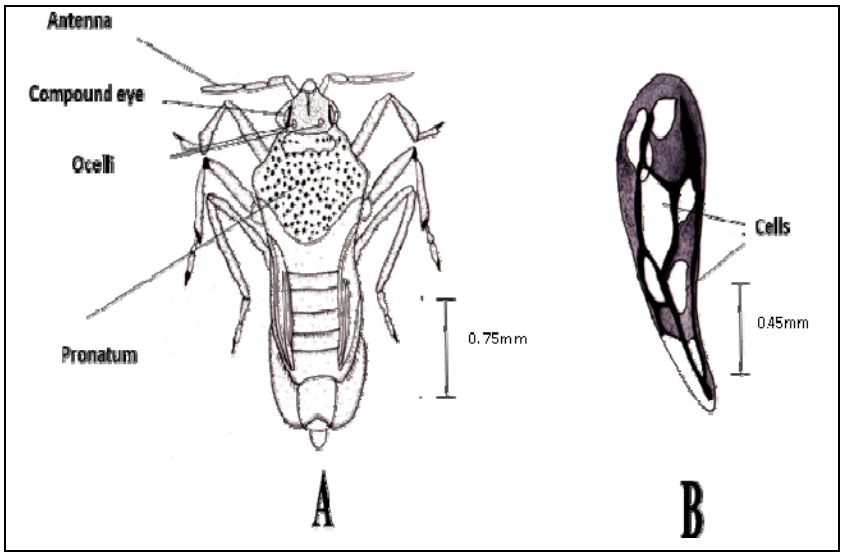

Figure 3. A: Ventral view adult of *M. hornii*, B: Fore wing.

Picture 5. *P. leachi.*

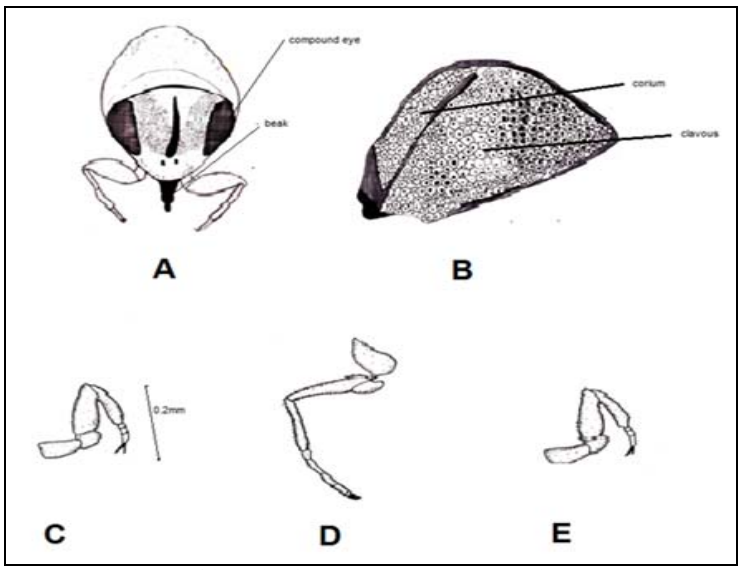

Figure 4. A: Ventral view of head of *P. leachi*, B: Fore wing, C: Fore leg, D: Mid leg, E: Hind leg.

Results showed that the maximum numbers of insects were recorded in Winter months and the minimum numbers recorded in Summer months as show in Table (1) and Figure (5). Maximum numbers of *S. lateralis*was 48 in January, and the minimum numbers was 22 in July and August, maximum numbers of *M. vittigera* (apterous) reached to 23 in February, and the minimum numbers was 9 in July, maximum numbers of *M. vettigera* (macropterous) recorded maximum numbers in March reached 23 and the minimum numbers was 12 in December and January, *M. hornii* has recorded maximum numbers reached to 38 in February and April, and the minimum numbers was 27 in July. *P. leachi* has recorded maximum numbers reached to 29 in February, and the minimum numbers was 14 in July. Figure (6) show rates of air and water temperatures, analysis showed that air temperature correlated with distribution of aquatic Hemiptera ($r = -0.215$, $p<0.01$), the maximum rate was 41 ºC in July and the minimum was 13 ºC in January. Water temperature correlated with distribution of aquatic Hemiptera ($r = -0.172$, $p< 0.01$), the maximum rate was 32 ºC in July and the minimum was 7 ºC in January. Figure (7) show rates of Salinity, DO and pH, dissolved oxygen correlated with distribution of aquatic Hemiptera ($r = -0.04$, $p< 0.01$), the maximum range was 11 mg/l in January, and the minimum was 8 in July. Salinity correlated with distribution of aquatic Hemiptera ($r = -0.134$, $p< 0.01$), the maximum range was 3.3 g/l in July and the minimum was 2.8 g/l in January and February (Fig. 4). About pH ($r = -0.12$, $p< 0.01$) the maximum range was 8.2 in January and the minimum was 7.4 in June and July. Figure (8) and Table (2) shows the concentration of heavy metals, maximum concentration of Fe reached 215.01 µg/l in July and minimum concentration was 155.56 µg/l in January. The maximum and minimum concentrations of Pb were 22.78 and 12.39 µg/l in the same months, about Cu the maximum concentration reached 18.54 µg/l in July and minimum concentration was 9.14 µg/l in December, about Zn the maximum concentration reached 223.14 µg/l in July and minimum concentration was 185.49 µg/l in January.

Table 1. Monthly distribution of aquatic Hemiptera species in Sullein Marsh during April 2012 - March 2013.

Months	*S. lateralis*	*M. hornii*	*M. vittigera* (apterous)	*M. vittigera* (macropterous)	*P. leachi*	Total
April 2012	25	38	12	23	20	118
May	24	33	11	22	18	108
June	23	30	10	18	16	97
July	22	27	9	14	14	86
August	22	28	11	15	15	91
September	25	30	12	16	18	101
October	28	31	14	16	22	111
November	30	33	16	17	23	119
December	38	34	20	12	25	129
January 2013	48	35	23	12	28	146
February	40	38	20	16	29	143
March	32	36	15	21	25	129
Total	357	393	173	202	253	1378

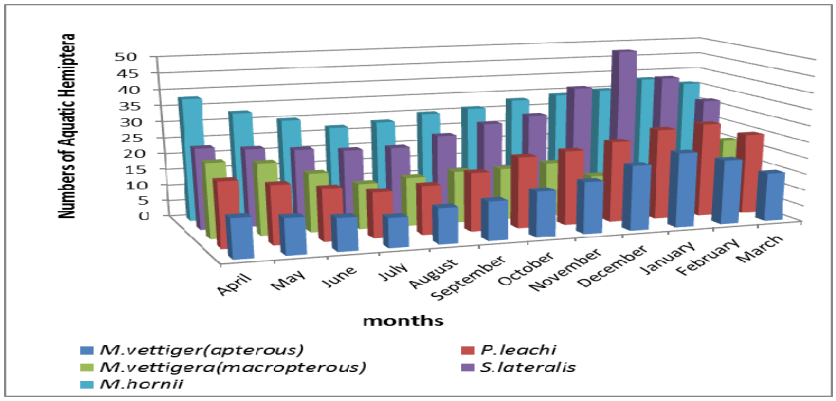

Figure 5. Monthly distribution of aquatic Hemiptera in Sullein Marsh during April 2012 to March 2013.

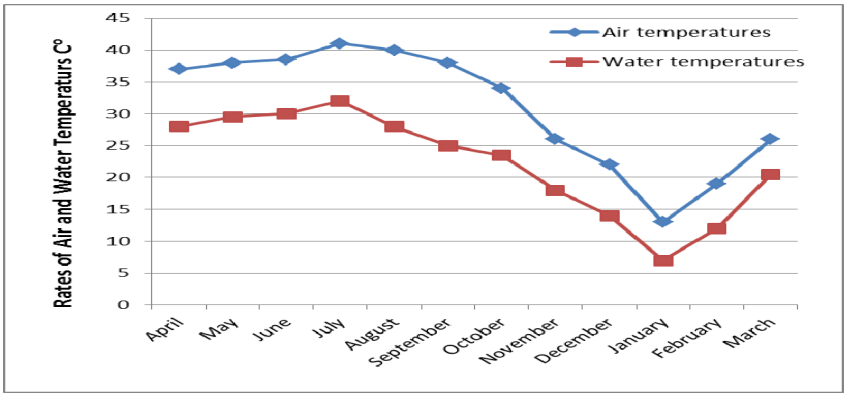

Figure 6. Rates of air and water temperatures in Sullein Marsh during April 2012 to March 2013.

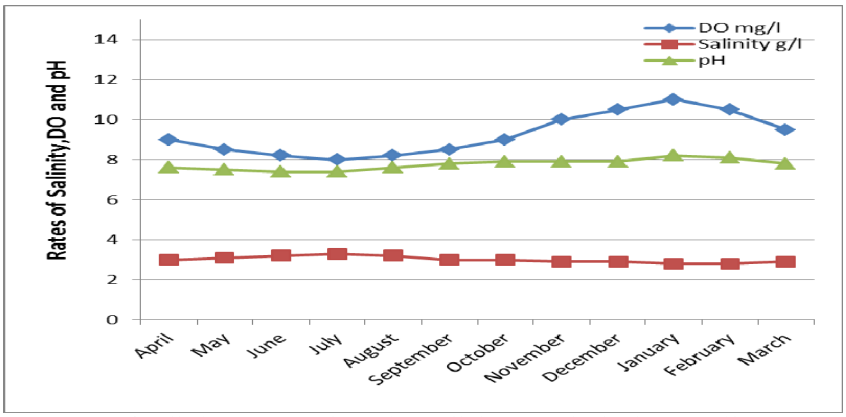

Figure 7. Rates of salinity, DO and pH in Sullein Marsh during April 2012 to March 2013.

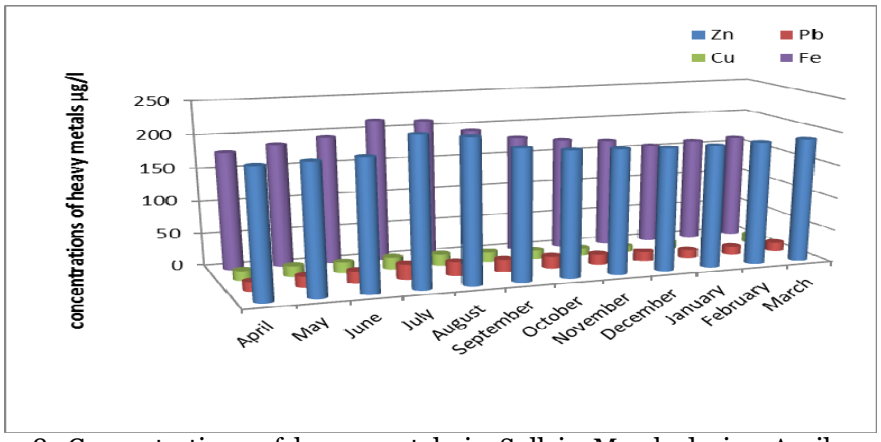

Figure 8. Concentrations of heavy metals in Sullein Marsh during April 2012 to March 2013.

Table 2. Heavy metals concentration µg/l in Sullein Marsh during April 2012 - March 2013.

Months	Fe	Pb	Cu	Zn
April 2012	178.1	14.45	14.62	191.53
May	186.2	16.71	15.93	193.37
June	193.3	18.53	16.23	196.21
July	215	22.78	18.54	223.14
August	211.2	20.93	17.75	215.93
September	193.5	19.53	15.64	197.12
October	178.6	18.64	13.12	190.35
November	171.5	16.23	11.37	188.23
December	166.8	14.86	9.14	186.02
January2013	155.6	12.39	10.58	185.49
February	159.3	12.81	11.87	186.83
March	161.1	13.93	12.51	188.13

Discussion

Results show that there were four families belonging to suborder Heteroptera, order Hemiptera were recorded in the study area of marshes of Basrah south of Iraq, these families were Corixidae and Pleidae belonging to infraorder Nepomorpha, Mesovellidae and Macrovellidae belonging to infraorder Gerromorpha. Family Corixidae has one species (*S. lateralis*), family Macrovellidae has one species (*M. hornii*), family Pleidae has one species (*P. leachi*) and family Mesovillidae has two species (*M. vittigera* (apterus) and *M. vittigera* (macropterus)). Family Mesovellidae like others semi-aquatic bugs belonging infraorder Gerromorpha have wing polymorphism which occur in macropterous (Long-winged-LW) and brachypterous (Short-winged-SW) or fully apterous, neither brachypterous nor apterous individuals able to fly (Cermacova and Ditrich, 2009). These non-dispersal specimens have allocated energy into reproduction rather to migration (Roff and Fairbairn, 1991). Wing polymorphism is partly genetically determined in some species (Spence and Anderson, 1994), or controlled by environmental conditions in most species, the most significant factors are photoperiod and temperature, population density, food shortage and substrate desiccation during larval development, temperature thus seems to have crucial effect on wing polymorphism (Cermakova and Ditrich, 2009), permanent water bodies are occupied by both macropterous and apterous specimens, temporary sites are almost exclusively colonized by macropterous individual (Ditrich *et al.*, 2008).

In Iraq there were few studies for the order of aquatic Hemiptera, Brown (1953) recorded *S. lateralis* and *S. assimilis*, Jaczewski (1964) recorded *S. albiventris* and *S. hoggarica*, Derwesh (1965); Kaddou (1967) and Abddul-Rassoul (1976) also recorded *S. lateralis* (Fieber, 1848), Mezher (2008) recorded *S. assimili*, Geraci *et al.* (2011) recorded three species belonging to suborder Heteroptera in Iraqi Marshes, *S. septemlineata* (Corixidae), *M. furat* (Mesovellidae) and *Plea minutissima* (Pleidae). In the neighbors countries of Iraq there were different studies that recorded fauna of Hemiptera, in Kuwait Al-Houty (2011) recorded *S. lateralis*, in Iran Linnavuori (2009) recorded different genus belonging to the species *Sigara*, like *S. nigrolinetalingrohinata* (Fieber, 1848), *S. assimilis* (Fieber, 1848), *S. samanitigranes* (Junsson, 1986), *S. hoggarica* (Poisson, 1929) and *S. lateralis*. In Turky, Dursun (2011) recorded *S. nigrolineata* (Fieber, 1848), *S. triata* (Linneus, 1758), *S. lateralis* (Leach, 1817) and *P. minutissima* (Leach, 1817). The study revealed that the maximum air temperature values were recorded during the Summer months and the lowest in Winter months, this temperature reading indicates a great impact on the abundance and distribution of aquatic hemiptera as more species were collected at relatively low temperature than were there was high temperature, so the maximum insects were collected in Winter months, and the lowest numbers were collected in Summer months. The results show that the maximum numbers of insects were recorded at the lowest water temperatures in Winter months while the minimum numbers recorded at high temperatures in Summer months. The difference of water temperatures may depend on climate and the environment nearby the stream as well as sampling time, wind, water mixing and amount of sun light. Water temperature effects the numbers of aquatic insects since each species require a specific range of water temperature to live in because of the different respiratory rate and metabolism (Thani and Phalaraksh, 2008).

Results also show that the maximum numbers of insects recorded at the lowest salinity rates in Winter months and the minimum numbers recorded at the highest

salinity rates in Summer months. Some bugs tolerant with high salinity (Arnold and Ormerod, 1997; Martinoy *et al.*, 2006; Garrido and Munilla, 2008), different authors have identify salinity as the most important factor regulating species composition (Cognetti and Maltagliati, 2000). Result show that the maximum rates of dissolved oxygen and pH recorded in Winter months and minimum rates recorded in Summer months. The results also recorded highest rates of heavy metals like Zn, Cu, Pb and Fe in Summer months and the lowest rates in Winter months. Aquatic Hemiptera are tolerant to chemical and biological stress and are typically capable to surviving in any parameter water (Wollmann, 2001), and are very good indicators of water qualities since they have various environmental disturbances tolerant levels (Arimoro and Ikomi, 2008; Susmita *et al.,* 2013).

There were different studies that show the ability of families of aquatic Hemiptera to live in different environmental parameters, in Iraq Hussein *et al.* (2006) showed that maximum air temperature values were recorded during Summer months in July and the lowest values recorded in Winter months in January, the range of air temperatures were (17-38) ºC. Water temperature exhibited large seasonal variation with the lowest Winter temperature about 10 ºC and Summer highs over 30 ºC typical of the arid climate of southern Iraq, while maximum of salinity was 3.2 g/l in July and minimum was 0.45 g/l in January, about DO, however the marshes were well oxygenated so the maximum DO was 12 mg/l in January and the minimum was 6 mg/l in July, about pH the maximum was 8.2 in July and the minimum was 7.5 in January. Garrido *et al.* (2011) recorded that Corixidae and Pleidea found at water temperature (19.4-24.3) ºC, pH (6.7-8.9) and DO (2.4-14.2) mg/l. Thani and Phalaraksh (2008) recorded Corixidae at water temperature between 19.3-28 ºC, pH 7.1-8.7 and DO 1.1-11.2 mg/l. Popoola and Otalekor (2011) recorded aquatic Hemiptera at water temperature (26 ºC), pH (6.69), DO (1.16 mg/l), Zn (1.52 mg/l), Cu (0.51 mg/l) and Fe (0.01 mg/l). Cook and Clark (2011) recorded that Corixidae and Pleidae found at pH 6.75-10.7. Joshi (2012) recorded that Corixidae and Pleidea found at pH 4-8 and DO 5-10 mg/l. Das and Gupta (2012) recorded lowest numbers of Corixidae and Mesovellidae in Winter at air temperature (28-33 ºC), water temperature (25.11-31.04 ºC), pH (4.42-7.24) and DO (6.06-8.22 mg/l). Barahona *et al.* (2005) recorded Corixidae at air temperature (18.05-28.3C°), salinity (31.7-51.7 g/l), pH (7.71-8.28) and DO (8.32-15.6 mg/l).

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دراسة تصنيفية وبيئية لحشرات نصفية الأجنحة المائية (Hemiptera: Heteroptera) في هور صلين في البصرة/جنوب العراق

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المستخلص - أجريت الدراسة الحالية للفترة من نيسان 2012 ولغاية آيار 2013 في هور صلين في البصرة - جنوب العراق. سجلت أربعة عوائل وأربعة أجناس وأربعة أنواع من حشرات نصفية الأجنحة المائية aquatic Hemiptera في مواسم مختلفة. العوائل التي سجلت هي عائلة قوارب الماء Corixidae وضمت النوع *Sigara lateralis* (Leach, 1817) وعائلة ضاربات الماء الكبيرة Macrovellidae وضمت النوع *Macrovelia hornii* (Ulher, 1872) وعائلة السابحات على الظهر القصيرة Pleidae وضمت النوع *Plea leachi* (McGregor and Kirkaldy, 1899) وعائلة دبابات الماء أو ضاربات الماء المتوسطة Mesovillidae وضمت النوعين *Mesovelia vittigera* (Horvath, 1895) (apterus) (نوع غير مجنح ونوع مجنح (macropterus) *M. vittigera*. قيست بعض العوامل البيئية مثل درجات حرارة المياه والهواء والملوحة والأس الهيدروجيني والأوكسجين المذاب. كما قيست نسب بعض المعادن الثقيلة للمياه مثل الحديد Fe والرصاص Pb والنحاس Cu والخارصين Zn. وأظهرت نتائج التحليل الإحصائي تأثير درجات حرارة الهواء والمياه في توزيع وانتشار حشرات نصفية الأجنحة المائية، وسجلت أعلى أعداد لها خلال أشهر فصل الشتاء وأدناها خلال أشهر فصل الصيف، وبلغت أعلى معدلات لدرجات حرارة الهواء 41 مº في شهر تموز وأدناها 13 ºم في شهر كانون الثاني. أما أعلى وأدنى معدل لدرجات حرارة المياه فبلغ 32 و 7 ºم خلال الأشهر أنفسها. كما بلغ أعلى معدل للأوكسجين المذاب 11 ملغم/لتر في كانون الثاني وأدناه 8 ملغم/لتر في تموز. بلغ أعلى تركيز للملوحة 3.3 غم/لتر وأدناه 2.8 غم/لتر في كانون الثاني وشباط. أما الأس الهيدروجيني فبلغ أعلى تركيز له 8.2 في كانون الثاني وأدناه 7.4 في تموز. سجلت أعلى تراكيز لمعادن Fe و Pb و Cu و Zn في تموز وبلغت 215.01 و 22.78 و 18.54 و 223.14 ميكغم/لتر على التوالي.