Environmental study on the effect of heavy metals on the life cycle of Some Odonata naiad in the north regions of Basrah, Iraq

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Abstract

An environmental study was conducted on Odonata in the waters of North Basrah from October 2020 to May 2024, to assess the relationship between environmental factors and pollutants. The study covered six aquatic stations and evaluated the density of Odonata naiads monthly. The results showed:

- The highest numerical density of naiads was 5.28 naiads /6 draws in December and 4.52 naiads /6 draws in the Sharsh site.
- The impact of trace elements on the population density of naiads, where a high inverse correlation was found between cadmium and population density in the city site (-0.969).
- A good inverse relationship between copper and lead and population density in the Thaghr site (-0.982/-0.626).
- The impact of trace elements on the age and number of molts of Odonata naiads in the laboratory, where a direct relationship was found between the concentration of cadmium, zinc, and nickel and the number of molts.

The study provided valuable insights into the impact of pollutants on Odonata in the waters of North Basra and can contribute to the development of environmental protection strategies.

Keywords: Cadmium, Copper, Lead , Odonata , Zinc.

Introduction

The Odonata are the most variable insect. Six thousand (6,000) species are recorded all over the word, (Brooks and Corbet, 2008). It is notably difficult to conduct a classification study to Odonata. They are considered as a vivid and significant indicators to the health of different ecosystems. They are the most beautiful insects ever as they are characterized by their bright colours and various external morphology, (Samway, 1993). The Odonata rank is divided into two suborders: the Zygoptera and Antisoptera, (Mitra, 2003 and 2006). (Córdoba -Aguilar *et al.*, 2003) claimed another classification for the Odonata which consists of three suborders: Zygoptera, Antisoptera, and Anisozygoptera.

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The name Dragonflies is given to the big Odinata in North America while the name Damselflies refers to the small Odonata due to their slim bodies and their weakness in flying, (Giles, 1998; Corbet and Brooks, 2008).

The life cycle of Odonata is very complicated and contains two separated stages which are totally different as they rely on the wa aquatic ter ecosystem. These stages are: Larval Life Stage and Adult Life Stage. The naiads that are hatched from eggs reside in aquatic plants tissue or reside directly in aquatic are totally aquatic naiads and stay during their moulting stage (~ 10 moulting) in aquatic till their final transformation when they enter into an adult stage, which will be after many months or years depending on the rank, (Corbet, 1999). Mary, 2013 indicated in her study the importance of naiads stage of the Odonata is that they consume the largest amount of different mosquito larvae that transport diseases. As result, the Odonata naiads are significant factors in biological resistance that limit and control the main cause of many diseases, (Chatterjee *et al*., 2007).

As most of their life is spent in the stage of naiads, it found that the naiads stage is influenced by the environmental changes more than the adultness stage, (Bried *et al*., 2015). The distribution and availability of many aquatic insects, such as Odonata naiads, in the aqua environment depend largely on their sensitivity to pollution or ecological changes, (Scheffer *et al*., 1984; Vinson, Hawkins, 1998; Che Salmah *et al*., 2005; Sivaramakrishnan, 2005; and Milesi *et al*., 2009). Most of the residential quarters, industrial facilities, and agricultural projects are usually constructed close to aquatic resources due to the importance of that resource to the maintenance of these projects and facilities as it provides their needs and then leads the aquatic resources to be exposed to different pollution issues as result of that is spilled or dumped in of industrial, agricultural, and domestic wastes, (Awad and Abdulsahib, 2007).

Both Bothner *et al*., 2002; and Bay *et al*., 2003 indicated that the pollution resulted in the coast areas close to the big cities generated from large coast population who reside close to these coasts and the large amount of the sewerage aquatic that spilled into these beaches. This leads to insert these pollutants into the wet lands environments and rivers mouths, especially, those lie close to the industrial areas. As result, the pollution rate is greatly increased in particular the pollution by the chemical elements, (Jayaprakash *et al*., 2005).

The pollution by the heavy elements causes the distribution or destruction of large amounts of living creatures when they are exposed to. It also causes congenital malformations, skin inflammatory, infertility, low fertility rate, shortening, or reduction in other important species if they are appeared in a higher concentrations than their naturally rates and when being exposed to for long periods of time, (Morel *et al*., 1991; Taobi *et al*., 2000). The heavy elements are characterised, in comparison to other pollutants, that they are not dismantle or decompose into more simple forms. They transport through multiple paths via the food chains and they are able to accumulate at various living creatures tissues, (Gulfraz *et al*., 2001).

The heavy elements pollution in the aqua environment are either natural that include all activities that generated without human interference such as: soil wash, weather soil erosions, (Kabata and Pendias, 2001), sand storms, active volcanos, and forests fire. Their impact reaches the aqua environment at the end, (Kennish, 2019). The death of the living creatures and sediments restructuring into the aquatic surface by the aquatic currents bring more heavy elements, (Abdullah *et al*., 2007; Gambrell, 1994); or unnatural sources that are resulted from human activities such as: transportation, machine internal combustion, human operations, chemical fertilizers usage, pesticides, power station, factories waste, petroleum refinery operations, and domestic waste, (Tao *et al*., 1999; Fernandez and Olalla, 2000).

Objectives

Given the widespread presence of the naiads and their direct association with physical and chemical factors, the study aimed to:

1. Conduct an environmental study that included measuring several environmental factors and calculating the monthly population density of naiads in selected aquatic bodies.
2. Study the relationship between heavy metal pollution and naiad population density in some aquatic sample sites in northern Basrah.
3. Evaluate the levels of some heavy elements (zinc, lead, cadmium, copper, and nickel) in the aquatic of six stations from which nymphs were collected: Al-Sharsh, Al-Thaghr, and Al-Madinah.

Methodology

Field Study

Sample Collection

The Odonata naiads were on monthly basis from six stations (a) Mdainah Site: 1) Euphrates Coast, 2) Al-Jallal Ponds and Qurna District: (b) Thagher Site: 3) Tigris Coast and 4) Neherah Ponds; (c) Sharash Site: 5) Shat El Arab Coast, 6) Al-Shaheen Ponds (Figure 1). The collection lasted for Eight months starting from October to May (from 08:00 am to 11:30 am) in the day term Three times from each pond. The pond is divided based on its estimated form size into Three parts: Middle and Corners, (Usinger, 1974) and (Lamelas-Lopez *et al*., 2017), the Odonata naiads were collected by using a sieve with 22cm diameter, and 1xml for the hole size. The sieve was dipped into aquatic in an area close to the bottom and then dragged for 25 to 50 cm for one minute and be raised quickly and in a circular motion to get rid of aquatic, this process is repeated for (6 times). We adopted the number of beats to calculate the number density. It was (6 beats) for each time. The naiads were ascended by a brush and to be put in big vessels with a quantity of ponds aquatic and some plants. Then they moved to the laboratory to be brought up with data recording.

The Laboratory Study

Odonata naiads Biological Study

The Odonata naiads which were collected from the aforementioned stations, were brought up. The primary ages selection was conducted by using plastic container, (30x30cm) in dimension and (20cm) in height with oxygen pumps. The round was Three times for each station totalled (18 repetitions), Image (1), the study included bringing up the small Ischmura naiads. We adopted the nutrition by Chironomidae larvae and mosquitos (Cham, 2007; Rice, 2008).

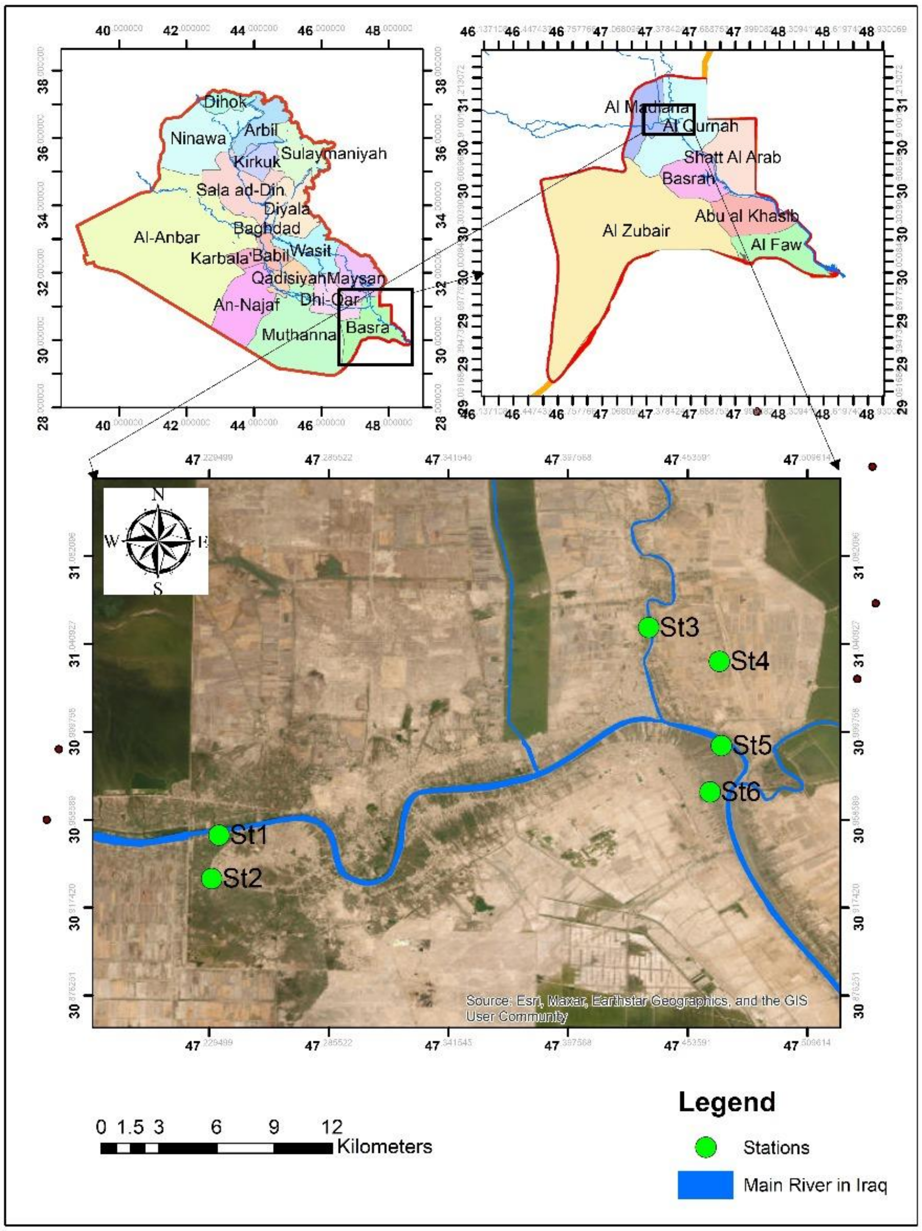

Figure1. Map showing study stations

Image 1. Rearing naiads of the odonata in the laboratory.

The naiads were monitored by calculating the moulting number and interval between each moulting. The naiadsappearance features were monitored during the moulting and pictured. The naiads ages and figures are shown in Image (2).

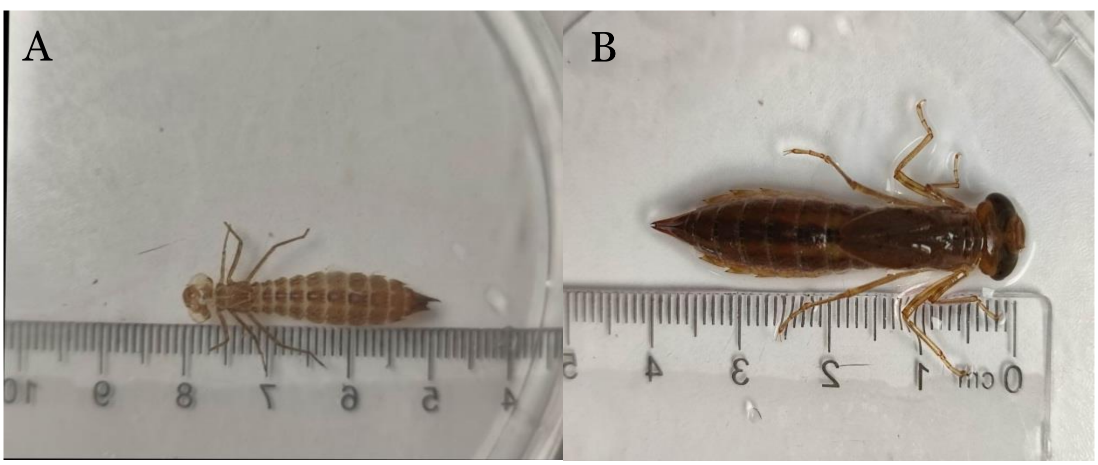

Image 2. A- A dragonfly naiad under study after moulting B- exuvia

Estimation of trace elements

Trace elements were estimated for the two seasons of autumn and summer during which the naiads of the tremors were collected and their numerical density was calculated, where aquatic samples taken from the study stations were digested according to the APHA (1995) method as follows:

1- Take 50 ml of the sample in a 200 ml beaker and add 5 ml of concentrated nitric acid HNO3.
2- Place the beaker on a hot plate at a temperature of 70 °C where we notice the evaporation of the liquid solution and the appearance of white salt crystals, so we lift the beaker from the heat source before drying.
3-Add drops of hydrochloric acid HCI at a concentration of (2.0-5.0 mol/L) with the completion of the sample with distilled aquatic to a volume of 50 ml, and keep it in polyethylene tubes until measurement in the laboratories of the Marine Science Center University of Basrah by ICP PRO.

Samples Diagnosis

The samples were diagnoses based on the external features with classification importance for Odonata class. We used graded lenses and a different sizes ruler. The sizes and parts of the bodies of both naiads and adult insects were measured by using anatomic microscope. The samples were diagnosed by Prof. Dr. Huda Kadhum Ahmed, from Marine Science Centre, The University of Basrah. The Study of the Relationship between the Heavy Elements Pollution and Odonata Naiads Life Cycle. The term required for the small Odonata naiads – Ischnura evansi- life cycle completion was measured, (Morton, 1919), and was compared with the heavy elements concentrations to determine their impact upon Odonata naiadslife cycle through the correlation factor, (Al-Rawi, 2000).

$$R = \frac{(\mathrm{N} \times \sum x\, y) - (\sum x\, y) - (\sum x \times \sum y)}{\sqrt{N \times \mathrm{x}2 - (\sum x)2} \times \sqrt{N \times y2 - (\sum y)2}}$$

Statistics Analysis

The data of experiment findings in this study classified and analysed according to the complete random design of the laboratory experiments for factor dual activities experiments by using SPSS Statistics Program. The mediums were compared to the L.S.D. in 0.05 probability rate. They also were analysed according to the complete sectoral random design for the field experiments and compered to mediums on 0.01 probability rate.

Results

Calculation of Density of the Odonata Naiads

As far as Table (1) is concerned, it is clear that the highest rate of Odonata naiads number density was 5.28/6 draws in October, which were not different from 4.78, 4.33, and 4.00 naiads /6 draws in October, January, and February respectively. While the lowest Odonata naiads number density was 22.2 naiads/6 draws in March. Whereas the highest rate of Odonata naiads number density was 4.52 naiads/6 draws at Sharash Site in comparison with the lowest which were 3.35 and 3.52 naiads/6 draws at both Thegher and Mdainah Sites respectively. The finding of the interference showed that the highest number density were at Sharash Site in December 6.84 naiads/6 draws against the lowest number density at Sharash Site in March totalled 1.67 naiads/6 draws.

Table 1. The population density of the naiads of the study sites in northern Basrah during Eight months.

Thagher Site	population density of Odonata naiads			
	Sharash Site	Thagher Site	Mdainah Site	Average
October	5.33	4.50	4.50	4.78
November	4.00	4.84	2.33	3.72
December	6.84	3.34	5.67	5.28
January	6.67	3.50	2.84	4.33
Febraury	5.17	3.34	3.50	4.00
March	1.67	1.84	3.17	2.22
April	3.67	2.83	3.17	3.22
May	2.84	2.67	3.00	2.83
Average	4.52	3.35	3.52	
LSD.05	sites	Months	Interference	
	1.301	0.797	2.254	

Effect of trace elements on Naiad's density in North of Basrah Area

The Table (2) shows the impact of the rare elements upon the naiadsnumber density. It clear that there is a weak inverse relationship between cadmium and the naiads number density at Sharash Site and a moderate Inverse Relationship at Thagher Site and a very high inverse relationship at Mdainah Site. While the Copper had a weak direct relationship with the naiads number density at both Sharash and Mdainah Sites and a good inverse relationship at Thagher Site. There is also a weak inverse relationship for the Lead at Sharash Site against a high inverse relationship was for the Lead at Thagher Site and a good direct relationship at Mdainah Site. Whereas, there was a weak inverse relationshop for both Nickel and zinc at Thagher Site and high inverse relationship at Mdainah Site. This table findings showed that the highest Odonata naiads number density rate was at Thagher Site's Neherat Ponds station and Sharash Site's Al-Shaheen Ponds and Mdainah Site's Euphrates Coast stations totalled respectively: 5.33, 5.83, and 6.33 in autumn. These came in harmony with the reduction in Cadmium concentration rates. The correlation factor indicated a direct relationship between the number density and both copper and nickel at Sharash Site. The increase in number density came in harmony with the increase in these both elements. A moderate inverse relationship appeared between the naiads number density and the decrease in Copper, Cadmium, and Lead concentrations at Thagher Site. While at Mdainah Site, the correlation factor indicated an inverse relationship between the increase in number density and the decrease in both nickel and Zinc concentrations that accompanied an increase in both Copper and Lead concentrations.

Table (2) Effect of trace elements on the population density of Odonata naiads in the northern regions of Basrah.

population density of Odonata naiads				**Element concentration (unit Ppb)**				
				Cd	**Cu**	**Pb**	**Ni**	**Zn**
Sharash Sit	Autumn	Shat El Arab	4.22	0.194	9	4.176	4.014	50.8
		Al-Shaheen Ponds	5.83	0.105	20.73	5.789	61.89	120.6
	Spring	Shat El Arab	3.73	0.146	11.1	12.59	7.536	56.33
		Al-Shaheen Ponds	3.33	0.088	17.78	6.304	51	184.2
Thagher Site	Autumn	Tigris Coast	3.44	0.124	10.57	8.254	7.038	37.92
		Al-Neherat Ponds	5.33	0.021	4.492	0.19	11.24	15.04
	Spring	Tigris Coast	1.1	0.3	16.88	27.11	4.086	25.25
		Al-Neherat Ponds	4.44	0.331	17.17	6.918	52.14	567.9
Thagher Site	Autumn	Euphrates Coast	6.33	1.154	52.58	39.39	5.299	76.41
		Al-Jallal Ponds	1.94	0.105	10.64	2.86	39.62	325.2
	Spring	Euphrates Coast	4.55	0.996	44.03	45.58	7.631	79.69
		Al-Jallal Ponds	2.33	0.143	70.62	15.21	40.2	123.8
Correlation coefficient								
Sharash Sit				-0.07	0.482	-0.33	0.445	-0.1
Thagher Site				-0.55	-0.63	-0.98	0.435	0.302
Thagher Site				-0.96*	0.289	0.676	-0.95	-0.73

The Laboratory Study

The Samples Diagnosis

The samples were diagnosed by Prof. Dr. Huda Kadhum Ahmed from Marine Science Centre at The University of Basrah. Many species were diagnosed at the study sites and included Odonata naiads,Ischnura evansi (Morton, 1919) naiads at Mdainah Site: Euphrates River Coast; Sharash Site: Al-shaheen ponds and Shat EL Arab; Thagher Site: Neherat Ponds and Tigris River Coast. This specie was the most common. And Hemianax ephippiger, (Burmeister, 1839)¸at Mdainah Site: Euphrates River Coast; and Thagher Site: Neherat Ponds, The Crocothemis servilia (Drury, 1770) naiads at Sharash Sites: Shat El Arab; Mdainah Site: Al-Jallal Ponds,and Sympetrum striolatum (Charpnetier, 1840) naiads, at Mdainah Site: AL-Jallal Ponds; Sharash Site: Shat El Arab; and Orthetrum sabina, (Drury, 1770), at Mdainah Site: Al-Jallal Ponds (Image3).

Sympetrum striolatum ***Ischnura evansi*** ***Hemianax ephippige***

Orthetrum Sabina ***Crocothemis servilia***

Image 3. The species of Odonata naiads in the study sites of North Basrah region.

Laboratory study of the lifespan and molting of naiads of the Odonata

As far as Table (3) is concerned, it appeared thatthe lowest age level 46.333 days at Thegher Site: Tigris River, and a moulting rate reached 2.667,in comparison withthe highest age level is 98.667 days at Thegher Site: neherat Ponds and mouting rate reched 4.333 which is a significantly dfferent from Tigris River aquatic at Thegher Site, In the meantime, no significant difference at the age level at the other areas, where the highest appeared at Sharash Site: Al-Shaeheen Ponds, which reached 77.667days and in moulting rate reached 4.000 While the highest moulting rate of the naiadswas 4.667 at Mdainah Site: both Euphrates River and Al-Jallal ponds. No significant difference appeared at the moulting quantity at the study areas with the lowest rate of moultingat Tegher Site: Tigris River Coast which was 2.667.

Table 3. Age periods and moults of naiadsof the odonata in the aquatic of the study sites in the laboratory

Sit of		Number molts	Age period	Adults
Sharash	Shat El Arab	3.667	74.33	66.7
	Al-Shaheen Ponds	4	77.67	100
Thagher	Tigris Coast	2.667	46.33	100
	Al-Neherat Ponds	4.333	98.67	100
Mdainah	Euphrates Coast	4.667	71.67	100
	Al-Jallal Ponds	4.667	70.67	100
$LSD_{0.01}$		NS	30.83	NS

Estimation of the concentrations of colored trace elements in the aquatic of the study sites in the northern Basrah regions

Cadmium Element

The statistics results at Table (4) indicated that the highest rate of cadmium was at Mdainah Site's Euphrates Coast station totalled 0.630 ppb. with a significant different from other stations followed by 0.57 ppb. at Al-Jallal Ponds station. While the lowest was 0.073 at Thagher Site's Tigris Coast station followed by Sharash Site's Al-Shaheen Ponds station totalled 0.117 ppb. Whereas autumn exceeded the rate by the highest cadmium concentration rate totalled 0.486 which referred to a significant difference from spring which was 0.132 ppb. The interference showed the superiority of Al-Jallal Ponds by recording the highest cadmium rate totalled 0.996 ppb. with a high significant difference from other stations and in both seasons where the lowest was 0.021 ppb. in spring at Thagher Site's Neherat Ponds, north.

Table 4. Cadmium concentrations in the aquatic of the study stations in the northern Basrah regions during Eight months (Unit Ppb).

Cd	Sharash		Thagher		Mdainah		
Season	Shatt Al Arab	Al-Shaheen Ponds	Tigris Coast	Al-Neherat Pond	Euphrate Coast	Al-Jallal Ponds	Average
Autumn	0.194	0.146	0.124	0.3	1.154	0.996	0.486
Spring	0.105	0.088	0.021	0.331	0.105	0.143	0.132
Average	0.15	0.117	0.073	0.316	0.63	0.57	
LSD.05	Season	0.209	Rivers	0.363	Interference	0.513	

Copper Element

The statistics results at Table (5) indicated that the highest rate of copper was at Mdainah Site's AL-Jallal Ponds station totalled 57.322 ppb. with a significant different from other stations followed by 31.606 ppb. at Thagher Site's Tigris Coast station in comparison with the lowest copper concentration totalled 7.505 ppb. at Thagher Site's Tigris Coast station with significant difference from other stations. In autumn, it was the highest rate of copper concentrations totalled 24.086 ppb. without a significant difference from the spring season which was 23.570 ppb. it is clear from the interference between both time and site factors, the highest rate was 70.617 ppb. at Mdainah Site's Al-Jallal Ponds station in spring season with a significant difference from other stations followed by 52.577 ppb. at Mdainah Site's Euphrates Coast station. The lowest rate was 4.492 ppb .at Thagher Site's Tigris Coast in spring season with a significant difference from Mdainah Site's Al-Jallal Ponds station in spring season with a significant difference totalled 66.125 ppb.

Table 5. Concentrations of copper element in the aquatic of the study stations in the northern Basrah regions during Eight months (Unit Ppb).

Cu	Sharash		Thagher		Mdainah		
Season	Shat El Arab	Al-Shaheen Ponds	Tigris Coast	Al-Neherat Pond	Euphrates Coast	Al-Jallal Ponds	Average
Autumn	9.409	11.1	10.52	16.88	52.58	44.03	24.09
Spring	20.73	17.78	4.492	17.17	10.64	70.62	23.57
Average	15.07	14.44	7.505	17.02	31.61	57.32	
LSD.05	Season	19.77	Rivers	34.24	Interference	48.42	

Nickel Element

As far as Table (6) results statistics analysis, it is clear that the highest nickel concentration rate totalled 32.953 Ppb. was at Sharash Site's Shat El Arab station where there was not a significant difference from both Sharash Site's Al-Shaheen Ponds and Thagher Site' Neherat Ponds stations as well as Mdainah Site's Euphrates Coast station totalled respectively: 29.267, 28.15, 22.460, and 23.916 for each station. While there was a significant difference from Thagher Site's Tigris Coast station totalled 9.139. it was also apparent that the highest rate of concentration of this element was in spring season totalled 42.682 ppb . with a significant difference from the lowest rate of concentration in autumn when it was 5,934 ppb. It was clear from the interference between both time and site factors the highest rate of concentration of nickel was 61.892 Ppb. at Sharash Site's Shat El Arab station in spring season with a significant difference from Sharash Site's Shat El Arab and Thagher Site's North Neherat Ponds stations and both Mdainah Site's Euphrates Coast and Al-Jallal Ponds stations in spring season. The lowest fate of this element concentration was at Sharash Site's Shat El Arab in autumn season totalled 4.014

Ppb. with a significant difference from Sharash Site's Al-Shaheen Ponds and Thagher Site's North Neherat Ponds stations totalled respectively: 50,997 and 52.144 Ppb.

Table 6. Nickel concentrations in the aquatic of the study stations in the northern Basrah regions during Eight months (Unit Ppb).

Ni	Sharash		Thagher		Mdainah		
Season	Shat Al Arab	Al-Shaheen Ponds	Tigris Coast	Al-Neherat Pond	Euphrates Coast	Al-Jallal Ponds	Average
Autumn	4.014	7.536	7.038	4.086	5.299	7.631	5.934
Spring	61.892	50.997	11.239	52.144	39.62	40.2	42.682
Average	32.953	29.267	9.139	28.115	22.46	23.916	
LSD.05	Season	6.68	Rivers	11.56	Interference	16.35	

Lead Element

As far as table (7) is concerned, it is clear that the highest rate of lead concentration was 30.391mg/l. at Mdainah Site's Al-Jallal Ponds station without a significant difference from Mdainah Site's Euphrates Coast and Thagher Site's North Neherat Ponds stations totalled respectively: 21.126mgs/lt. and 17.012 Ppb. for each station against a rate of concentration reached 4.222 Ppb. at Thagher Site's Tigris Coast station with a significant difference from the highest rate at Mdainah Site's Al-Jallal Ponds station. It is also clear that the highest concentration rate of lead was 22.848mg/l. in autumn with a significant difference from the lowest rate totalled 6.211 Ppb. in spring season. It was apparent that the highest rate of concentration was 45.575 Ppb. at Mdainah Site's Al-Jallal Ponds station without a significant difference from Thagher Site's North Neherat Ponds and Mdainah Site's Euphrates Coast stations totalled respectively: 27.106 Ppb. and 39.392 Ppb. in autumn. While the lowest rate was 0.190 Ppb at Thegher Site's Tigris Coast Station in spring season with a significant difference from Mdainah Site's Euphrates Coast and Al-Jallal ponds and Thagher Site's North Neherat Ponds stations.

Table 7. Concentrations of lead in the aquatic of the study stations during Eight months (Unit Ppb).

Pb	Sharash		Thagher		Mdainah		
Season	Shatt Al-Arab	Al-Shaheen Ponds	Tigris Coast	Al-Neherat Pond	Euphrates Coast	Al-Jallal Ponds	Average
Autumn	4.176	12.59	8.254	27.11	39.39	45.58	22.85
Spring	5.789	6.304	0.19	6.918	2.86	15.21	6.211
Average	4.982	9.445	4.222	17.01	21.13	30.39	
LSD.05	Season	10.14	Rivers	17.56	Interference	24.83	

Zinc Element

As far as Table (8) statistics results analysis is concerned, it appeared that the highest rate of concentration of zinc at Thagher Site's Neherat Ponds station totalled 296.554 Ppb. without a significant difference from Mdainah Site's Euphrates Coast station totalled 200.813 Ppb. against the lowest rate recorded at Thagher Site's Tigris Coast station totalled 26.484 Ppb. with a significant difference from Thagher Site's North Neherat Ponds and Mdainah Site's Euphrates Coast totalled respectively: 296.554 and 222.813 Ppb. for each station. The highest rate was 222.783 Ppb. in spring season with a significant difference from the lowest rate totalled 54.399 Ppb. in autumn. It is clear from the interference between time and site that the highest rate of zinc concentration was at Thegher Site's Neherat Ponds station in spring season totalled 567.861 Ppb. with a significant difference from all other stations in both seasons in comparison with the lowest rate of concentration totalled 15,043 Ppb. at Thagher Site's Tigris Coast station in spring season with a significant difference from Mdainah Site's Euphrates Coast station totalled 325.218 Ppb.

Table 8. Zinc element concentrations in the aquatic of the study stations in the northern Basrah regions during Eight months (Unit Ppb).

Zn	**Sharash**		**Thagher**		**Mdainah**		
Season	Shatt Al-Arab	Al-Shaheen Ponds	Tigris Coast	Al-Neherat Pond	Euphrates Coast	Al-Jallal Ponds	Average
Autumn	50.8	56.33	37.92	25.25	76.41	79.69	54.4
Spring	120.6	184.2	15.04	567.9	325.2	123.8	222.8
Average	85.68	120.3	26.48	296.6	200.8	101.7	
LSD.05	Season	76	Rivers	131.7	Interference	186.2	

Laboratory study of the effect of heavy metals on the lifespan and number of molts of naiads of the odonata

The results in Table (9) proved that the longest age level was recorded at Thagher Site's Neherat Ponds station which reached 98.66 with a number of moulting reached 4.33 in harmony with the high cadmium, zinc, and nickel concentrations totalled respectively: 0.316, 296.554, and 28.115 and moderate rate of concentrations of both lead and copper totalled respectively: 17.012 and 17.024 in comparison with the shortest age level recorded at Thagher Site's Tigris Coast station totalled 46.33 with the lowest rate of moulting reached 2.66 against the lowest rate of rare elements concentrations reached totalled: 0.073, 4.222, 7.505, 26.484, and 9.139 for cadmium, lead, copper, zinc, and nickel respectively. The correlation factor findings showed a moderate to a good Direct Relationship between the concentrations of cadmium, zinc, and nickel and the number of moulting. There was a weak Direct Relationship between both lead and copper; while there was a weak Direct Relationship between the concentration rate of cadmium, lead, copper, and zinc and the age levels of the Odonata naiads and a good Direct relationship between both nickel and age level.

Table 9. Effect of trace elements on the age period and number of molts of naiads of the Odonata reared in the aquatic of the study areas.

Sit	Water type	Element concentration (Ppb)					Number of molts	Age period
		Cd	Pb	Cu	Zn	Ni		
Sharash	Shat El Arab	0.15	4.982	15.07	85.68	32.95	3.66	74.33
	Al-Shaheen Ponds	0.117	9.445	14.44	120.3	29.27	4	77.66
Thagher	Tigris Coast	0.073	4.222	7.505	26.48	9.139	2.66	46.33
	Al-Neherat Pond	0.316	17.01	17.02	296.6	28.12	4.33	98.66
Mdainah	Euphrates Coast	0.63	21.13	31.61	200.8	22.46	4.66	71.66
	Al-Jallal Ponds	0.57	30.39	57.32	101.7	23.92	4.66	70.67
Correlation coefficient(Cd)							0.828	0.215
Correlation coefficient (Pb)							0.84	0.299
Correlation coefficient(Cu)							0.72	0.077
Correlation coefficient (Zn)							0.651	0.86
Correlation coefficient (Ni)							0.542	0.775

Discussion

Field Study

The highest population density of naiads was found in the Al-Thaghr - Al-Nahirat Ponds and Al-Sharsh - Al-Shaheen Ponds sites, reaching 5.33 and 5.83, respectively, for the fall season,this may be due to a decrease in lead and cadmium concentrations, which have a toxic impact upon the living creatures and usually depress their behaviour, and an increase in the concentrations rate of nickel, copper, and zin, which are important elements in the metabolism process. Yunus (2015) classified the heavy elements based on the following: the important nutrition group that includes: copper, iron, goblet, chrome, manganese, and zinc; and the supposedly useful elements group that includes: silicon, vanadium, boron, and nickel; and useless elements group that includes: barium, aluminium, antimony, arsenic, cadmium, lead, mercury, silver, thallium, strontium, etc. While the naiads number density is increased at Euphrates despite of an increase in lead and copper concentrations to a specific rate which may be due to the increase of zinc concentration as the latter is deemed to be a basic element for the living creatures' growth and activity in addition to the suitability of the environmental factors to reproduction and naiads activity. These aquatic surfaces are characterised in autumn with extreme temperature and high concentration in melted in aquatic oxygen with a decrease in total salt rates.

Moreover, as result of the shallow water at Sharash Sites and the lack in aquatic plants and trees which lead to an increase on the acquired temperatures by the ponds as well as the reflection of earth heat, these aquatic surfaces have moderate temperatures which makes them suitable for the survival and the activity of the naiads. Corbet (1999) referred in his study to the impact of the temperatures as a major factor in distribution. He noticed the great influence of changes in temperatures on the adult insect behaviour and the naiads such as the daily appearance and the flight season.

Laboratory Study

The Age Level and the Number of Moulting in Odonata Naiads

The longest age level was recorded at Thagher Site's Neherat Ponds Station totalled 98.66 days with rate of moulting reached 4.33, while at Sharash Site's Al-Shaheen Ponds station the longest age level was 77.66 days. This may indicate the suitability of the ponds aquatic at these stations to the activity of the naiads. The highest arsenic concentration rate was recorded at Neherat Ponds station and totalled 296.554 as it has a big role in the activity and maturity of naiadslife cycle. Soazig and Marc (2003) showed that arsenic is one of the rarest basic elements that are important in metabolism process, growth, and reproduction that living creatures need in little amounts and any increase in their concentrations is regarded as toxic. Whereas, the shortest age level was recorded at Thagher Site's Tigris Coast station totalled 46.33 days with number of moulting reached 2.66 with low rate of concentration of both arsenic and nickel, which is considered as an conditioning by the naiads to survive. The pond consists large numbers of predators such as fishes and frogs which leads to the low rate of food source that is represented basically by mosquito larvae, thus, the self-endeavour is increased as an attempt for survival. Chapman (1999) referred to influence of life cycle with the low and absent of food sources and the availability of high density of population. This influence is very clear at the low food levels. Khan (2014) emphasis in his study that odonata naiads are the most common predators. They consume 50 mosquito larvae in one hour. Mary (2013) mentioned that the big odonata naiads are the most common predators that feed on the disease transport larvae.

The highest rate of cadmium at Euphrates and Al-Jallal Ponds was in autumn and both copper and lead recorded an increase in heavy elements concentration rates at Mdainah aquatic surfaces due to the increase in aquatic pollution as result of accumulative petroleum operations and sewerage aquatic spillage that are usually move upstream of Euphrates river at time of high tide of Shat El Aran river due to the dam between both Mdainah and Chebaish Districts which stops the flow of Euphrates river toward Qurna District, the highest rate of concentrations of nickel was in spring season at this study sites and it concentrated at Sharash Site due to the sediments that are brought by Tigris from upper areas and the sediment by Tigris flow in Maysan city that are linked with Shat El Arab in Sharash. The pollution by lead element at some living creatures such as Lymnaea stagnalis may lead to a depression in their behaviour such as motion, eating, tentacles, and moulting (Pyatt *et al*, 2002).

Conclusions

1-Anisoptera naiads are dominant in shallow, shallow ponds.

2-The genus Hemianax ephippiger exhibits behaviors similar to zygoptera , as they are found on the stems of aquatic plants, unlike Anisoptera , which bury their bodies in the mud.
3-The effect of heavy metals on Odonata naiads is limited.
4-Naiads activity increases in December when air temperature drops and water temperature moderates.
5-Zygoptera are dominant in water bodies along river coasts.

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دراسة بيئية عن تأثير المعادن الثقيلة على دورة حياة بعض حوريات الرعاشا2ت في شمال البصرة، العراق

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المستخلص

أجريت دراسة بيئية على الرعاشات في مياه شمال البصرة من أكتوبر 2020 إلى مايو 2024، لتقييم العلاقة بين العناصر البيئية والملوثات. غطت الدراسة ست محطات مائية، وقيّمت كثافة أعداد حوريات الرعاشات شهرياً. أظهرت النتائج:

-أعلى كثافة عددية للحوريات كانت 5.28 حورية/6 سحبات في ديسمبر و4.52 حورية/6 سحبات في موقع شرش.

-تأثير العناصر النزرة على الكثافة السكانية للحوريات، حيث وجد ارتباط عكسي عالي بين الكادميوم والكثافة السكانية في موقع المدينة (-0.969).

-علاقة عكسية جيدة بين النحاس والرصاص والكثافة السكانية في موقع الثغر (-0.982/-0.626).

-تأثير العناصر النزرة على عمر وعدد مرات انسلاخ حوريات الرعاشات في المختبر، حيث وجدت علاقة مباشرة بين تركيز الكادميوم والزنك والنيكل وعدد مرات الانسلاخ. قدمت الدراسة رؤى قيمة حول تأثير الملوثات على الرعاشات في مياه شمال البصرة، ويمكن أن تساهم في تطوير استراتيجيات حماية البيئة.

الكلمات المفتاحية: الكادميوم، الرصاص، النيكل، الرعاشات، الزنك .