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Study on the Impact of Hydrocarbon Pollution on Water of Northern Basra and Its Effects on the Life Cycle of Dumsefly Naiads

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ABSTRACT

An environmental study was conducted to some **Odonata** to examine the relationship between environmental elements and Pollutants in Water of North Basra from **October 2020 to May 2024**. The study covered six water stations. **(1) Sharash Site:** (a) **First Station**: Shat El Arab (Current Stream) and (b) **Second Station**: Al-Shaheen Ponds (Still Water). **(2) Thagher Site**: (a) **Third Station**: Tigris River Coast (Current Stream) and (b) **Fourth Station**: Al-Neherat Ponds (Still Water). **(3) Mdainah Site:** (a) **Fifth Station:** Euphrates River Coast (Current Stream) and (b) **Sixth Station**: Al-Jallal Ponds (Still Water). The study measured **Odonata** naiads number density on monthly basis from **October 2023 to May 2024**. It was found that the highest number density, **4.52** Naiads per 6 draws in Sharash Site and **5.28** Naiads /6 Draws on December.

The study indicated that the hydrocarbon concentration rate, **39.59**, was in Sharash Site: Al-Shaheen Ponds, and there is **Direct Relationship** between the total hydrocarbon and the number density of **Odonata** Naiads. In the sense that the highest Naiads number was in Sharash Site: Shat El Arab, and Thagher Site: Al-Neherat Ponds, Mdainah Ponds: and Al-jallal Ponds, **5.21, 4.88, 4.88** alternatively at total hydrocarbon concentrations rates **35.27**, **29.88**, and **13.44** alternatively at correlation factor **0.855/0.510/0.791** alternatively.

The Impact of total hydrocarbon concentrations upon the age levels and number of moulting of **Odonata** showed that the longest age period is **98.66** with **4.33** moulting that occurred to laboratory grown **Odonata** Naiads when the total hydrocarbon concentrations were **29.88** as a medium rate. The study also showed a very weak **Inverse Relationship** between the **Odonata** Naiads age duration and the total hydrocarbon concentrations rate where the coefficient factor reached **0.463**.

1. 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**).

There is another classification for the **Odonata** which consists of three suborders: **Zygoptera, Antisoptera, (Aguilar et al, 2003**) and **Anisozygoptera.**

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 water ecosystem. These stages are: **Larval Life Stage** and **Adult Life Stage**. The Naiads that are hatched from eggs reside in water plants tissue or reside directly in water are totally water Naiads and stay during their moulting stage (about 10 moulting) in water 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**).

The naiads stage of the **Odonata** is the stage where usually they, in comparison with other predator Naiads, consume the largest amount of mosquitos that transport diseases, (**Mary, 2013**).

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**).

The distribution and availability of many water insects, such as **Odonata**, 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**).**Takamura et al, 1991** found, in their study, that different types of water pollution lead to reduce the types and numbers of **Odonata**. This findings led many ecologists to the satisfaction to use the selective gatherings of types as evidences to distribution locations depending on the physical changes ad pollution, (**Thiele et al, 1994** and **Schmidt, 1985**).

The petroleum hydrocarbon is one of the critical ecological issues. This is not true because of their large quantities only but to their naming as well, (**Tsai and kao, 2009**).

The oil spills and industrial, agricultural, and urban pollution are major causes of aqua ecological systems pollutants. The destruction of valuable resources for water creatures is a threatening risk to numbers and types of these water creatures, (**Pourang et al, 2005**).

A study by **Al-Timari, 2001**, **Bedhani, 2014,** and **Karem, 2017** mentioned that there are two sources for hydrocarbon compounds that existed in sediments, quarters, and water in general: **Biological** and **Non-Biological**.

Moreover, the petroleum and its by-products are the main source for hydrocarbon compounds that pollute the aqua ecological system. These sources reach these environments through petroleum and its by-products transportation operations as well as the accompanied accidents, (**Osuagwu et al, 2013**). The industrial radiations, accidents, spills, naval activities, petroleum and its by-products transportation, balance water pumping, washing loafing berths, and export ports are other sources for hydrocarbon pollution. It is estimated that the resulted pollution is **6 Million Tons** annually, (**Al-Atbee, 2018; N.R.C., 2003**).

2. MATERIALS AND METHODS

The Field Study

Sample collection

The Naiads of the odonata were collected monthly from six stations (Al-Madinah- Euphrates Coast and Al-Jalal Pools, Al-Qurna - Al-Thaghr - Tigris Coast and Al-Nahirat Pools, Al-Qurna - Al-Sharsh - Shatt Al-Arab Coast and Al-Shaheen Pools) for a period of eight months from October to May during the daytime from (8:00 to 11:30 am) with three replicates from each pond. The pond was divided into three sections according to its shape and size, including the middle and corners(Usinger, 1974) and (Lamelas-Lo´pez, et al. ,2017), and using a sieve with a diameter of 22 cm and a hole size of 1x1 mm. The Naiads of the odonata were collected by placing the sieve under the water and near the bottom and pulling it for a distance of 25-50 cm for a minute, then raising it quickly and in a circular motion to get rid of the water. The process was repeated six times, where the numerical density was calculated based on the number of strokes at a rate of 6 strokes for each replicate. The Naiads were raised by Brush and place them in large containers with a quantity of pond water and some plants and transfer them to the laboratory for the purpose of breeding them, recording the required information and taking photographs.

The Laboratory Study

Life cycle study of Naiads of the odonata

Naiads of the early ages, which were collected from the above-mentioned stations, were reared using plastic tanks 30 cm long, 20 cm wide and 20 cm high, with three replicates for each station, totaling 18 replicates (Figure 1). The study included rearing young odonata Naiads using the same water and plants that were collected from the above stations, at laboratory temperature, and fed based on mosquito larvae and Chironomidae Cham (2007) and Rice (2008).

Figure (1): Rearing Naiads in the laboratory

The ages of the Naiads were monitored by calculating the number of molts and the period between one molt and the next, photographing the molts and the naiad ages, and monitoring the morphological characteristics of the Naiads during the molting process.

Estimation of petroleum hydrocarbons in station water

The total concentration of petroleum hydrocarbons contaminating the water of the collection stations was estimated for two seasons (autumn and spring), where the (UNEP) 1989 method was adopted for extraction, which included the following:

1 - 5 liters of the sample were taken and 50 ml of chloroform were added to it, shaken for 30 minutes to ensure that the chloroform was mixed with all the sample contents, the precipitated layer was collected and another 50 ml of chloroform was added and shaken again, the precipitated layer was collected and added to the first part.

2 - The mixture was passed through a glass column about 20 cm long containing glass wool at the bottom followed by alumina and anhydrous sodium sulfate Na2So4 from the top, respectively, after that the extract was collected and left to evaporate to 3 ml, then nitrogen gas was used to reach dryness.

3- We re-dissolve it in regular hexane and measure it with a Spectrofluorophotometer in the laboratories of the Marine Science Center - University of Basra.

Diagnosis of samples

The samples of the Naiads of the odonata under study were diagnosed based on the external morphological characteristics of taxonomic importance for the order of tremors. Rulers of different sizes and graduated lenses were used, as well as the dissecting microscope to measure the dimensions of the bodies and parts of the Naiads and adults.

The samples were diagnosed by Prof. Dr. Huda Kazim Ahmed - Marine Sciences Center - University of Basra.

Studying the Relation between Hydrocarbon Concentrations and Life Cycle of Odonata Naiads

The period required for completing the life cycle of the small Odonata naiad stage and its type was studied and compared to the concentrations of the hydrocarbon in order to determine its impact upon the life cycle of the Odonata Naiads through coefficient factor, (**Al-Rawi, 2000**).

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

The 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. The mediums were compared to the L.S.D. in 0.05 probability rate by using SPSS Statistics Program. They also were analysed according to the complete sectoral random design for the field experiments and compered to mediums on 0.01 probability rate.

3. RESULTS

The Calculation of Number Density of the Odonata Naiads at the Study Sites

As far as Table (1) is concerned, it is clear that the highest rate of Odonata Naiads number density was 4.52/6 draws at Al-Sharash Site in comparison to the lowest rate of Odonata Naiads number density which was 3.35/3.52/6 draws on October and January at both Thagher and Mdainah sites alternatively. While the highest Odonata Naiads number density was 5.28/6 draws in December and it did not significantly differ from 4.78, 4.33, and 4.00/6 in October, January, and February alternatively. The lowest Odonata Naiads number density was 22.2/6 draws in March. The findings showed an interrelation that the highest Odonata Naiads number density at Al-Sharash Site in December, 6.84/6 draws fronted with the lowest Odonata Naiads number density at Al-Sharsh Site in March, 1.67/6 draws.

Table No. (1) The population density of the Naiads of the study sites in northern Basra during 8 months

Average	Mdainah Site	Thagher Site	Sharash Sit	The months
4.78	4.50	4.50	5.33	October
3.72	2.33	4.84	4.00	November
5.28	5.67	3.34	6.84	December
4.33	2.84	3.50	6.67	January

4.00	**3.50**	**3.34**	**5.17**	**/Febraury**
2.22	**3.17**	**1.84**	**1.67**	**March**
3.22	**3.17**	**2.83**	**3.67**	**April**
2.83	**3.00**	**2.67**	**2.84**	**May**
	3.52	**3.35**	**4.52**	**Average**
	Interference	**months**	**sites**	**LSD.05**
	2.254	**1.301**	**0.797**	

The Study of Impact of Total Hydrocarbon in the Water of Study Area upon the Number Density of Odonata Naiads

As far as **Table (2)** is concerned, that the highest **Odonata** Naiads number density was at Mdainah Site, Euphrates River Coast, and Thagher Site: Al-Neherat Ponds, Sharash Site, and AL-Shaheen Ponds, totalled: **23.92/29.88/** and **39.59** alternatively and on the other part, there was the lowest **Odonata** Naiads number density at: Mdainah Site: Al-Jallal Ponds; Thagher Site: Tigris River Coats; totalled **1.83** for both sites at total hydrocarbon concentrations reached **13.44** and **26.73** alternatively.

The findings showed a **Direct Relationship** between the total hydrocarbon concentrations and the **Odonata** Naiads number density at the three study sites. It was a medium **Direct Relationship** at Thagher Site and a good **Direct Relationship** at both Sharash and Mdainah Sites.

Table No. (2) The effect of total hydrocarbons on the population density of Naiads of the northern Basra regions.

Total hydrocarbon concentration			**Population density of Naiads**	**Sites**		
Average	**Spring**	**Autumn**				
23.92	12 . 48	35.367	5.21	**Euphrates Coast**	**Mdainah**	*1*
13.44	11 . 94	14.94	1.83	**Al-Jallal Ponds**		*2*
26.73	14 . 77	38.697	1.83	**Tigris Coast**	**Thagher**	*3*
29.88	9 . 053	50.7	4.88	**Al-Neherat Ponds**		*4*
35.27	21 . 037	49.51	4.17	**Shat El Arab**	**Sharash**	*5*
39.59	23 . 47	55.71	4.88	**Al-Shaheen Ponds**		*6*
	15.45	40.82		**Average**		
	0,791 **Mdainah**	0,510 **Thagher**	0,855 **Sharash**	**Correlation coefficient**		

The Laboratory Study

The Samples Diagnosis

The samples were diagnosed by **Prof. Dr. Huda Kadhum Ahmed** from **Marine Science Centre** at **The University of Basra**. Many types were diagnosed at the study sites and included **Odonata** Naiads, ***Hemianax Ephippiger***, (**Burmeister, 1839)**,at Mdainah Site: Euphrates River Coast; and Thagher Site: Neherat Ponds ,and ***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 type was the most common. The ***Sympetrum Striolatum* (Charpnetier, 1840)** Naiads, , at Mdainah Site: AL-Jallal Ponds; Sharash Site: Shat El Arab; and ***Crocothemis Servilia* (Drury, 1770)** Naiads at Sharash Sites: Shat El Arab; Mdainah Site: Al-Jallal Ponds; and ***Orthetrum Sabina*, (Drury, 1770)**, at Mdainah Site: Al-Jallal Ponds.

Ischnura evansi

Hemianax ephippige

crocothemis servilia

sympetrum striolatum

orthetrum Sabina

Image (2): The Naiads of the tremors identified in the waters of the study sites in the areas of northern Basra.

The Laboratory study of Age Level and Water Grown Odonata Naiads Moulting

As far as **Table (3)** is concerned, it appeared that the 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 water 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 **77.667**days and in moulting rate reached **4.000** in comparison with the lowest age level **46.333** days at Thegher Site: Tigris River, and a moulting rate reached **2.667**.

While the highest moulting rate of the Naiads was **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 moulting which was **2.667** at Tegher Site: Tigris River Coast.

Table (3) Age periods and moults of Naiads of the odonata in the waters of the study sites in the laboratory

Adults	Age period	Number of molts	Sit	
66.7	74.333	3.667	Shat El Arab	Sharash
100	77.667	4.000	Al-Shaheen Ponds	
100	46.333	2.667	Tigris Coast	Thagher

100	**98.667**	**4.333**	**Al-Neherat Ponds**	
100	**71.667**	**4.667**	**Euphrates Coast**	**Mdainah**
100	**70.667**	**4.667**	**Al-Jallal Ponds**	
NS	**30.83**	**NS**	**$LSD_{0.01}$**	

The Evaluation of the Total Hydrocarbon Concentrations at Study Area Water in North Basra

As far as **Table (4)** is concerned, it appeared that the highest rate of the total hydrocarbon concentrations totalled **39.59** which was at Sharash Site: Al-Shaheen Ponds. Whereas the lowest rate of total hydrocarbon concentrations was at Mdainah Site: AL-Jallal ponds totalled **13.44**. It also clear from the aforementioned table that the highest rate of total hydrocarbon concentrations was in autumn season totalled **40.82** from a side, and the lowest total hydrocarbon concentrations was in spring season totalled **15.45** from the other side. We can see from the interrelationship between both the time and place factors that the highest total hydrocarbon concentrations totalled **55.71** and **50.7** at Sharash Site: Neherat Ponds in spring season.

Table No. (4) Average concentrations of total hydrocarbons in the water of the study stations of the northern Basra regions.

Total hydrocarbon concentration			**Sites**	
Average	**Spring**	**Autumn**		
23.92	12 . 48	35.367	**Mdainah-Euphrates Coast**	*1*
13.44	11 . 94	14.94	**Mdainah- Al-Jallal Ponds**	*2*
26.73	14 . 77	38.697	**Thagher-Tigri Coast**	*3*
29.88	9 . 053	50.7	**Thagher-Al-Neherat Ponds**	*4*
35.27	21 . 037	49.51	**Sharash -Shat El Arab**	*5*
39.59	23 . 47	55.71	**Sharash-Al-Shaheen Ponds**	*6*
	15.45	40.82	**Average**	

The Laboratory Study of the Impact of Total Hydrocarbon Concentrations upon the Age Level and Moulting Number of Odonata Naiads

As far as **Table (5)** is concerned, it is clear that the highest age level medium value was at Thegher Site: neherat Ponds totalled **98.66** in comparison to the moulting quantity totalled **4.33** at total hydrocarbon concentrations totalled **29.88** from a side, and the lowest age level totalled **46.33** at Thegher Site: Tigris River Coast totalled **2.66** at total hydrocarbon concentrations totalled **26.73**, from the other side. While the coefficient factor showed a very weak **Inverse Relationship** between the age level of the **Odonata** Naiads and the total hydrocarbon concentrations at study area water, where the Naiads grown. In the meantime, we have a weak **Direct Relationship** between the laboratory grown Naiads moulting quantity and total hydrocarbon concentrations at the study area water that were sued for Naiads growth.

Table (5) The effect of hydrocarbons on the age period and number of molts of Naiads of the tremors raised in the waters of the study areas in the northern Basra regions .

Age period	**Number of molts**	**Total hydrocarbon concentration**	**sites**	
74.33	**3.66**	**23.92**	**Shat El Arab**	**Sharash**
77.66	**4**	**13.44**	**Al-Shaheen Ponds**	
46.33	**2.66**	**26.73**	**Tigris Coast**	**Thagher**
98.66	**4.33**	**29.88**	**Al-Neherat**	

			Ponds	
71.66	**4.66**	**35.27**	**Euphrates Coast**	
70.666	**4.66**	**39.59**	**Al-Jallal Ponds**	**Mdainah**
-0.037	0.463	**Correlation coefficient**		

4. _DISCUSSION

The Field Study

Age Density of Odonata Naiads

There is, in favour of coefficient factor between the age density and the study factors, a positive coefficient factor between the age density and hydrocarbon concentrations at the study area water and the highest Odonata Naiads number density appeared at Medainah Site: Euphrates River Coast; Thegher Site: Neherat Ponds; and Sharash Site: Al-Shaheen ponds totalled **5.21/4.88/** and **4.88** alternatively at the total hydrocarbon concentrations totalled **23.92/29.88** and **39.59** alternatively at each site. This proved that the ability of **Odonata** Naiads to familiarize themselves with the surrounding circumstances. There is also a weak **Inverse Relationship** between the temperature increase and **Odonata** Naiads number density at Sharash Site ponds. This may be due to the shallowness of water at these ponds and the low quantity of water plants and trees which led to an increase in the acquired heat through the ponds water besides the reflection of the heat from the ground which gave a moderate temperature suitable for the survival and activity of the **Odonata** Naiads. **Corbet, 1999** refer in their study to the impact of the temperature as a main factor upon the distribution. They notice that the behaviour of the mature insects and Naiads are largely influenced by the changes in the temperature such as the daily presence and the flight season.

The increase in hydrocarbon levels is attributed, in this water, maybe to the increase in the mud sediments as was the case at Al-Shaheen and Neherat ponds or it may be attributed to the connection of these ponds with the sewerage water or the irrigation channels because of their location at the farms and residential areas. **Tehrani, 2013** and **EPRI, 2000** refer to that the sediments at the rivers close to the cities centres contain high **PAHs** due to their influence in the rain rate and the rain water drifting to the roads and sewerage water. These reasons are in accordance to this study findings. **Kafilzadh et al, 2001** refer in their study that the hydrocarbon aromatic compounds are by nature Lipophilic that are unsaturated in water which makes them tend to stick to the planktons within the water column then end at the sediments. The value of hydrocarbon compounds are determined at the sediments of the petroleum pollutants being the storage surfaces of these compounds. The type of the sediments type determines their values more than those in the sand sediments, (**Al-Saad et al, 2000**).

In the other side, there is the lowest number density at both sites of Mdainah: AL-Jallal ponds; and Thegher Site: Tigris Rover Coast totalled **1.83** at both sites at total hydrocarbon concentrations totalled **13.44** and **26.73** alternatively. This can be justified to the nature of the site which is characterized by the high temperature due to the direct exposure to the sun rays that increases the vaporization rate and the increase in the activities of the microscopic creature that dissect the petroleum hydrocarbon. The high temperature motivates these creatures to destroy **PAHs** via **Biodegradation** and especially those that have low particle weights, (**Al-Timari, 2000** and **2008)**.

Leahy and Colwell, 1990 mention in their study the maximum metabolic activity of the degradation bacteria to the petroleum compounds which subject to the heat extension at (**40˚- 30**˚). The photo oxidation also is connected to the increase of light duration time and the density of sun rays, (**Al-Timari et al, 2003**). As result of high temperature in Iraq climax, the petroleum compounds levels are decreased from the mentioned levels, (**Abdul-el-Redha, 1997**).

5. THE LABORATORY STUDY

The Age Levels and Odonata Naiads Moulting Quantity

The coefficient factor between the age levels and the moulting quantities and the study factors show a negative connection between the age levels and the hydrocarbon concentrations and a weak positive connection between the moulting quantity and the hydrocarbon concentrations at the study areas water. The longest age period appeared at Thegher Site: Neherat pond totalled **98.66** days and a number of moulting totalled **4.33**. While in Sharash Site: Al-Shaheen ponds the age level totalled **77.66**, which may refer to the suitability of these pond water to the activities of the Naiads. The highest rate of hydrocarbon concentrations at Neherat and Al Shaheen ponds were **50.71** and **55.71** alternatively. This meant that the percentage of hydrocarbon concentrations rates between **50** and **55** is suitable for the activities of the Naiads. This also refers to the

accumulative of the hydrocarbon concentrations at the water of the ponds which are connected to both Tigris River and Shat El Arab as result of the sediments incurred by the emissions come from the Oil Fields in West Qurna site carried by northwest wind into North Qurna sites and water, which ay descent with rain in November and December. **Al-Khateeb, 2008** and **Dhale et al, 2003** mention that the large gas emissions of hydrocarbon is linked with rain water or via touching of air and water and resulted a water pollution with petroleum as result of law solution of hydrocarbon in water and are easily absorbed by the planktons at the surface of water within the column of water to be precipitated and become a storage body for many of the anti-water pollutants. The risk of such pollutants appears in their tendency to the biological accumulation inside the water microscopic creatures, (**Ali et al, 2015** and **Muthkumar et al, 2013)**. This is accompanied with the presence of high concentrations of zinc totalled **296.554**. As this element plays a significant role in the activity and ending up the Naiads life cycle, **Soazig and Mare, 2003** show that zinc is one of the important basic trace element in the metabolism, growth, and reproduction processes. They are needed in low quantities.

The lowest age period was in Thegher Site: Tigris River totalled **46.33** with moulting number totalled **3** at hydrocarbon concentration rate totalled **26.73**. This is considered as a conditioning by the Naiads to maintain their species as the pond contains large quantities of predators such as: fish and frogs and the source of food is reduced which mainly represented by mosquito larvae, therefore, the increase of the self-endeavouring as an attempt for survival. Both **Capman, 1999** and **Elgar and Crespi, 1992** refer to the influence of life cycle with source absence or reduction with the availability of persons in high quantities. This influence is clear at the low food resources. **Mary, 2013** refers that the big **Odonata** Naiads tend to be the most common predators during the larvae stage of diseases transport mosquito. **Khan, 2014** confirms in his study that **Odonata** Naiads consume approximately **50** larvae per hour.

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