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Contamination of zooplankton by petroleum hydrocarbons in Shatt Al-Arab River, Basrah, Iraq.

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Abstract

This study involved seasonal investigation of different types of zooplankton from three stations :1) Al-Harthah, 2) Al-Ashare, and 3) Abu Al-Khaseeb along Shatt Al-Arab River / Basrah city, Iraq, during the four seasons of the year 2011. Numbers of abandunt zooplanktons reported in the study area were 1367,818, and 1031 indiv./m^3 in stations 1,2, and 3 respectively, mostly abundant species were *Moina affinis* (425,89, and 94), *Diaphanosoma brachyurum* (309,23, and 33), *Cyclopodia* (214, 125, and 326), and *Cirripedia larvae* (234, 252, and 324). Concentrations of total petroleum hydrocarbons were estimated in the collected zooplankton. The recorded concentrations of PHC's ranged from 80.59 µg g^{-1} dry weight in station 2 (Al-Ashar) during summer season to 274.30 µg g^{-1} dry weight in station 1 (Al-Hartha) during winter season. These concentrations reflect that the water of Shatt Al-Arab River is contaminated with oil as well as its derivatives comparing with other studies for Shatt Al-Arab River. Aquatic organisms such as zooplankton have been used extensively to assess the degree of various chemicals, including hydrocarbons and thus monitoring of the ecosystem of the River. Moreover, Some effective water parameters, temperature, pH, Dissolved oxygen, and Salinity were estimated too for water from the same stations and during the same period of time.

Key words: Petroleum hydrocarbons, Zooplankton, Shatt Al-Arab River, Accumulation, oil pollution.

Introduction

Petroleum hydrocarbon content in aquatic environment can cause deleterious effects on biota, effects which are not visible and may come to light after a long period of time (Sharma and Cyril, 2007). Holoplankton as well as meroplanktonic organisms are sensitive to exposure to hydrocarbons (Nair, 2001).

The effect of oil on zooplankton was investigated by Conover (1971), who reported that oil ingested by copepods does not apparently affect the animals. Ingestion of oil by zooplankton has also been reported by Linden *et al*. (1979). Moreover, the sublethal effects of hydrocarbons on the copepod *Eurytemora affinis* have been studied by Berdugo *et al*. (1977) and Ott *et al*. (1978).

Petroleum hydrocarbons (PHCs) originally from oil and its derivatives existing either naturally from seepage of crude oil or anthrapoginically as a result of human being activities. There is a potential environmental risk of spills when using these materials, contaminated water may present opportunities for research on the effects of PHCs on existing aquatic organisms such as zooplankton. Other sources of pollution by PHC's arises from the different types of waste and sewage. Determine the contamination of waters by PHC's point out that human health and ecological effects requires a cleanup options. Toxic and hazardous of PHCs can have a great impact on water environments (Heras *et al*.,1992). Aquatic organisms such as zooplankton have been used extensively to assess the petroleum hydrocarbons. The non-regular use of the derivatives increased their release into the environment especially the aquatic environment (Heras *et al*., 1995). PHCs characterized as fixed compounds although they shatter finally by physical, chemical, and biological factors (Atlas and Cerniglia, 1995). The danger of oil pollution could be arises due to incorporation of PHCs through food chain consequent which increase in their concentration in the upper trophic levels and this is known as inflation dynamic, and possibly result in the effect of carcinogenic or cause to kill organisms with levels minimum food such as phytoplankton and zooplankton. (Douben, 1995; Badawy *et al*., 1993; GESAMP, 1993) The aquatic organisms snapped petroleum hydrocarbons from the environment either from the water or from the suspended solids or with food or sediment (Cripps & Priddle,1995; GESAMP,1993; Heras *et al*., 1992). The rate of entrance of petroleum hydrocarbons not depend on the abundance of PHCs but also by many of the chemical and biological agents which are intern influenced directly and indirectly by environmental factor (Sastery & Miller, 1981). So oil or derivatives touching objects flouting in the surface layer or through the water column dissolved or dispersed or in the form of tar balls floating or suspended solids with food or sediment, researches done on barnacles live on environment contain tar balls accumulate petroleum hydrocarbons in their bodies (Ackman *et al*., 1996). The results of bioaccumulation give an information about the variation of accumulation and the kind of existence in nature. When the pollutant was taken the results of bioaccumulation in the present time give value information about the multiplicity of the presence of petroleum hydrocarbons and diversity of accumulation in the ecosystem. As the variation in the proportions of the presence of pollutants in a particular environment will affect the ability of taking and releasing at a certain time, if taking a particular compound rapidly and slowly put the accumulation curves will rise (Cripps & Shears,1997; Vandermulen,1990). Zooplankton

can accumulate petroleum hydrocarbon and concentrate both aliphatic and aromatic hydrocarbons. Moreover, the metabolites are resistant to depuration. The retention of oil may create long term consequences (Nair, 2001). Al-Imarah, *et al*. (2003) reported a concentrations of PHCs expressed in terms of Basrah crude oil equivalent, in the range of 2.6 – 20.5 and 2.63 – 15.39µg/g during April 1982 and October 1995 respectively. Al-Timari, *et al.* (2003) reported a high level of dissolved matter for petroleum hydrocarbons in the range of 80 µg/l in the Deep port during May 2001, while the low level was 0.91 µg/l found in Shatt Al-Basrah canal during 9-10 July 2001. The highest level of suspended matter for petroleum hydrocarbons was 33.4 µg/g in Khour Abdullah during May 2001, and the lowest level (8 µg/g) was found in Shatt Al-Basrah canal and Khour Al-Zubair port regions during 9-10 July 2001. While along the coast of Kollam (Quilon), south west coast of India the petroleum hydrocarbon content was highest at Tangasseri nearshore (21.95 3g/l) and lowest at Paravur offshore (9.403g/l), (Sharma and Cyril, 2007). Berrojalbiz, *et al.* (2009) studied the accumulation and cycling of polycyclic aromatic hydrocarbons in zooplankton. Al-Saad, et al. (2009) reported that the mean concentrations of Total Petroleum Hydrocarbons (TPH) in the waters of southern Iraqi marshlands were ranged from 0.012 µg/l in the lower reaches (Al-Barkha) to 0.037 µg/l in the upper reaches (Al-Baghdadia 1), while in the sediment samples the mean values ranged from 0.030 µg/g in the lower reaches (Um-Alneach) to 0.96 µg/g dry weight in the upper reaches (Al-Baghdadia 2).
Due to these facts, the studies on the relation of zooplankton distribution and abundance to petroleum hydrocarbon content along the Shatt Al-Arab River assume key importance and significance. The main aim of this study was to estimate the concentrations of petroleum hydrocarbons in zooplankton. The importance is to contribute to the monitoring findings of pollution in Shatt Al-Arab River on a bases of positions and seasonal varieations.. This organisms regarded as the first cycle of the food chain which gives a risk on human health and their livestock.

Materials and Methods

Horizontal surface zooplankton samples were collected seasonally from three selected stations along Shatt Al-Arab River during 2011 as listed in table I and shown in figure 1.

Table I. Sampling stations and their positions.

No.	Site	N	E
1	Al-Harthah	30° 36′ 14.42 ″	47° 45′ 50.83″
2	Al-Ashar	30° 31′ 11.14″	47° 50′ 43.99″
3	Abu Al-Khaseeb	30° 27′ 53.55	47° 59′ 49.21″

A plankton net of 40 cm mouth aperture and 0.090mm mesh-size was used. A flow meter was mounted at the mouth of the net, to record the actual amount of water passed through the net, as it was pulled behind a boat which is running at its lowest speed for 15 min., and the reading of the flow meter was taken before and after towing. Samples were preserved in freeze.

The volume of water filtered by the net was estimated from the following expression (De Bernardi, 1984) :

$$V = \Pi \ r^2 d$$

Where:

V = volume of water filtered by the net measured in cubic meters

Π = (3.14)

r = half diameter of the net mouth aperture, (20 cm)

d = number of revolutions of the flow meter multiplied at 0.3.

Then the result was divide by 10,000 to convert the result unit per cubic meter. The number of individuals were calculated in the sample diluted to 1000 ml in the manner prescribed by (APHA 2006), and expressed the result as cubic meter.

No. ind./m^3 = (C * VI) / (VII * VIII)

Where:

C = the number of individuals in the subsample

VI = volume of sample (ml)

VII = the size of the subsample (10 ml)

VIII = volume of water filtered in cubic meters

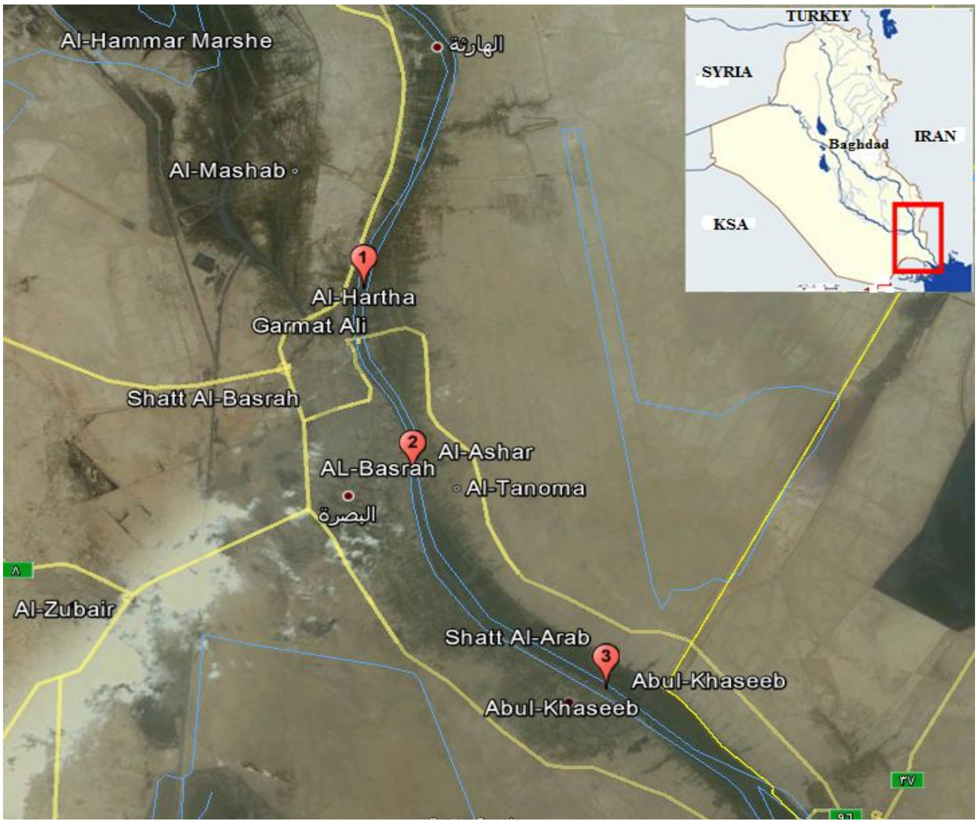

Figure 1. Map of Shatt Al-Arab River showing the sampling stations

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Dry weight of the zooplankton were estimated by filtering the sample through a filter paper of a known weight, using a vacuum pump. Then the paper was oven – dried at 60 ºC until there were no change in the weight of the filter paper and the dry weight was recorded. By subtracting the dry weight of the filter paper from that of the paper with the sample, the dry weight of the sample could be obtained. Then the dry weights were converted into mg/m^3 by dividing the weight of the sample by the volume of the sample filtered.

They kept in a clean glass jar and stored at 20 ºC. Samples were passed on glass fiber filter paper (Gf / F) and freeze – dried. Extraction procedure employed was based upon that of Grimalt and Oliver (1993).

Results and discussion

Some environmental parameters were measured during this study in the water of the studied stations as drawn in figures 2 and 3. Water temperatures fluctuated between 15.5 °C during winter in Al-Hartha staion (No.1) to 28.3 °C during summer in Al-Ashar staion (No. 2). The lowest salinity (1.4 ‰) was recorded in station No. 1 during winter, and the highest value (2.3 ‰) was recorded in station No. 3 during summer due to the effect of saline water from Arabian Gulf during tide. Whereas the pH varied from 6.4 – 8.8 during winter in stations 3 and 1 respectively, and the dissolved oxygen recorded from 6.0 mg/l during summer in St. 3 to 11.6 mg/l during winter in St.2.

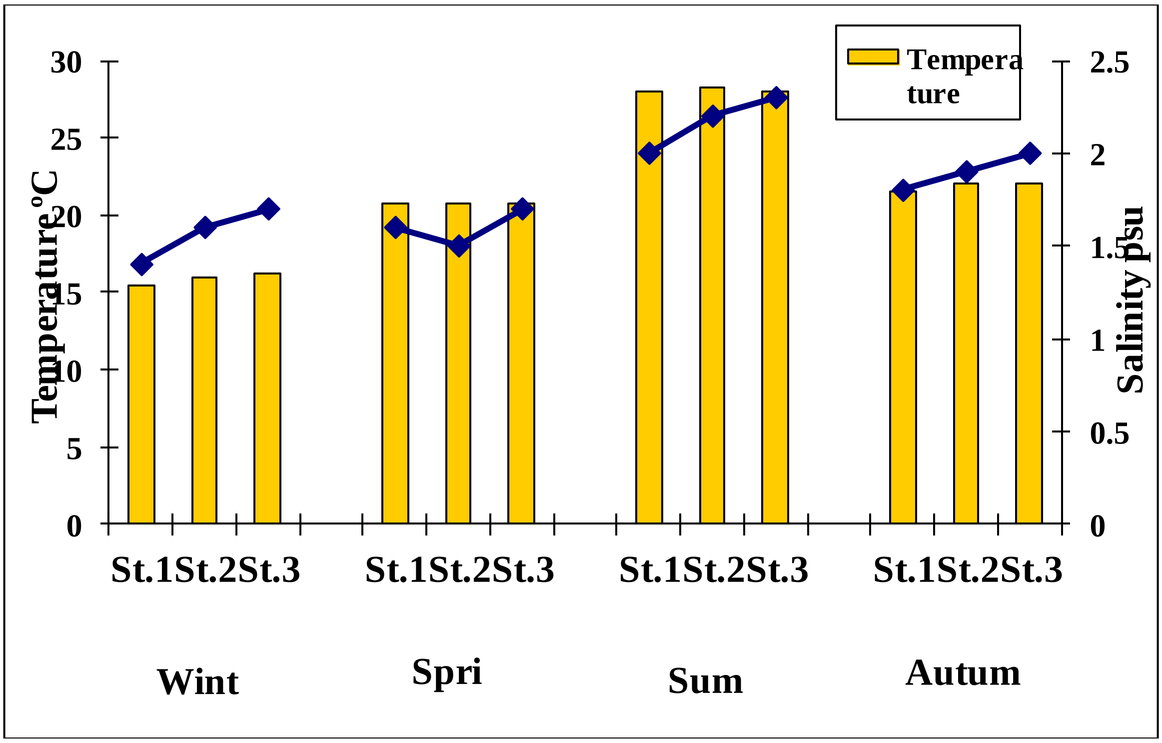

Fig.2. Measured parameters in the waters of studied stations, yellow blocks for temperature and blue line for salinity.

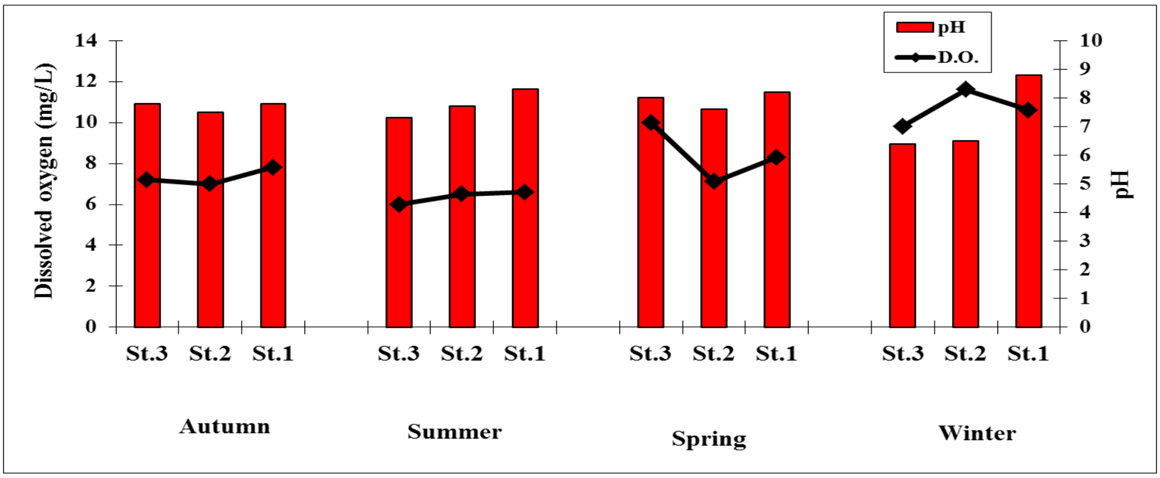

Fig.3. Measured parameters in the waters of studied stations, red blocks for pH and black lines for dissolved oxygen.

Abundance of zooplanktons in the three selected stations alomg Shatt Al-Arab river (annual average) are depicted in Table (II). The most abundance species were *Moina affinis* (425,89, and 94ind./m^3), *Diaphanosoma brachyurum* (309,23, and 33 ind./m3), *Cyclopodia* (214, 125, and 326 ind./m3), and *Cirripedia larvae* (234, 252, and 324 ind./m3).The total species abundance were 1367,818, and 1031 ind./m^3 recorded in

Table II : Distribution of zooplankton (ind./m^3) in the selected stations along Shatt Al-Arab River (annual average) during 2011.

Zooplankton	St. 1	St. 2	St. 3
Chydorus sphaericus	24	28	9
Moina brachiate	36	91	3
Moina affinis	425	89	94
Macrothrix spinosa	3	22	61
Diaphanosoma orghidani	25	8	2
Diaphanosoma brachyurum	309	23	33
Alona cambouei	13	2	4
Bosmina longirostris	18	7	1
Total of Cladocera	**853**	**270**	**207**
Calanoida	9	11	8
Cyclopoida	214	125	326
Harpacticoida	2	5	1
Nauplii larvae	21	82	88
Total of Copepoda	**246**	**223**	**423**
Rotifera	23	58	66
Cirripedia larvae	234	252	324
Ostracoda	1	2	1
Amphipoda	1	3	1
Zoea larvae	6	8	2
Insecta larvae	3	2	7
Total of zooplankton	**1367**	**818**	**1031**

stations 1,2, and 3 respectively, being the highest in station 1 due to its lower effected by pollutants. The biomass of zooplankton varied from 4.8 mg/m^3 in Al-Hartha (st. No. 1) during summer to 22.9 mg/m^3 in Al-Ashar (st. No. 2) during spring (Fig. 5).

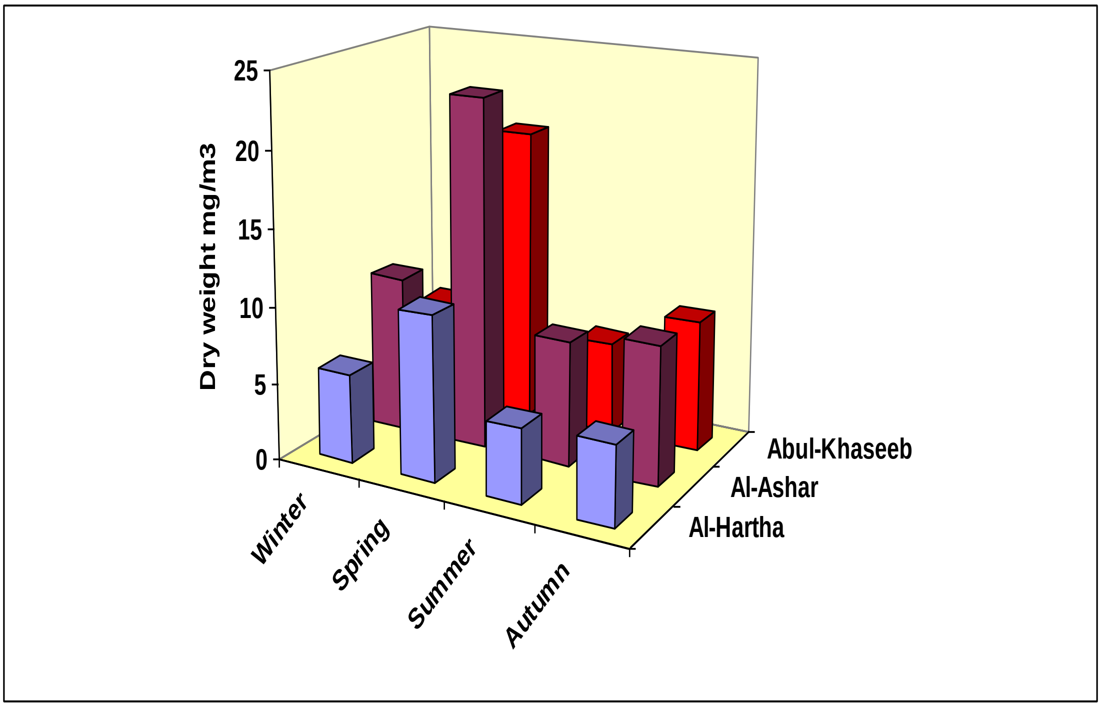

Figure (5): Dry weight of the zooplankton mg/m^3 at three stations in Shatt Al-Arab River during the study period.

It is appeared that zooplanktons in the waters of Shatt Al-Arab River are capable to accululate certain amounts of petroleum hydrocarbons, a significant differences in accumulation of petroleum hydrocarbons in zooplankton and the seasons were found, the higher value was 274.30 µg g^{-1} during winter in Al-Hartha (st. No. 1) and the lowest value was 80.59 µg g^{-1} during summer in Al-Ashar (st. No. 2) as shown in table III and Fig 6.

Table (III) Concentrations of total hydrocarbons in Zooplankton (Copepod samples (µg g^{-1}dry weight) collected from the three stations 1,2,and 3 along Shatt Al- Arab River.

Stations	Seasons			
	Winter	Spring	Summer	Autumn
1	274.30	206.20	169.01	180.22
2	138,62	126.42	80.59	98.32
3	112.54	88.33	131.40	155.13

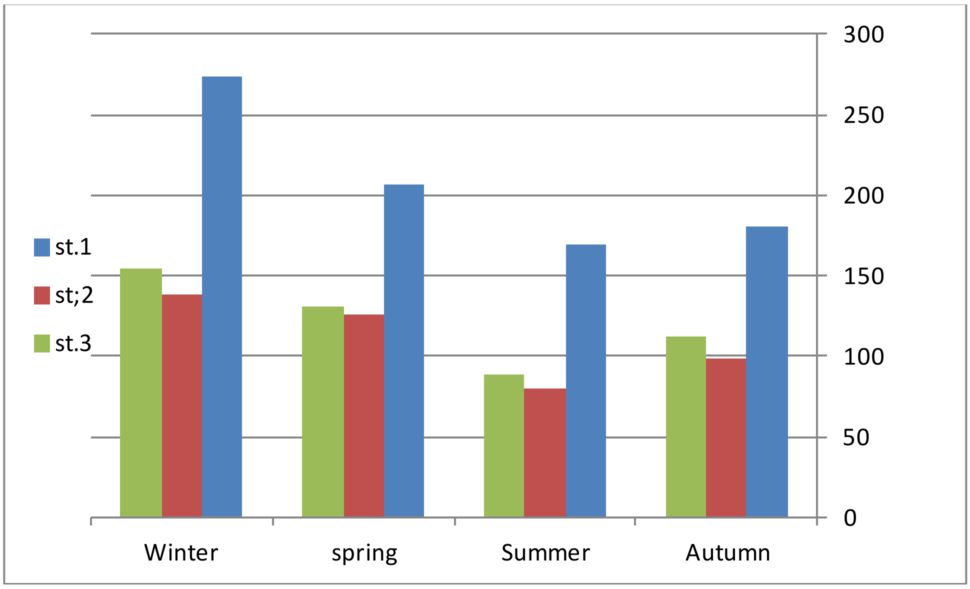

Figure (6): Hydrocarbons µg/g dry weight of zooplankton at three stations in Shatt Al-Arab River during the study period.

The hydrocarbons concentrations was ranged between 0.0055 µg/mg dry weight/m^3 in Al-Ashar (st. No. 2) during spring to 0.0473 µg/mg dry weight /m^3 in Al-Hartha (st. No. 1) during winter (Fig. 7).

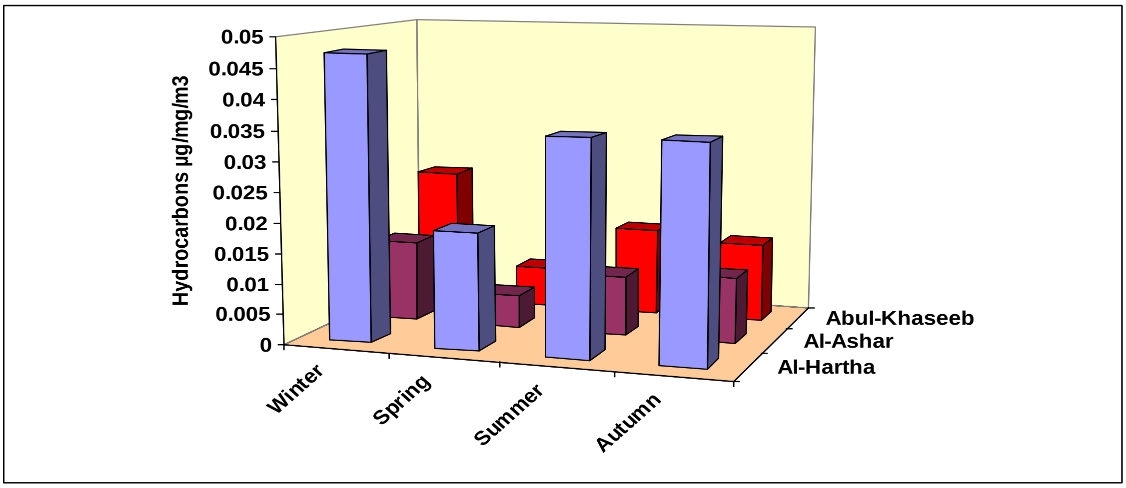

Figure (7): Hydrocarbons µg/mg/m^3 at three stations in Shatt Al-Arab River during the study period.

The reason may be that the aromatic petroleum hydrocarbons with medium and high molecular weights are dissolved in water and can access zooplankton and accumulate in the tissues, this behavior is consistent with the findings of Cajaraville *et al*., (1995) and entering either by feeding on other objects which their bodies are saturated with

petroleum hydrocarbon, or by feeding on plants or ingestion of contaminated water, or transmit the pollutant through the soft parts of the
Body, or by breathing through feathers gills. Then zooplankton put these compounds abroad by metabolizing them by means of extraction, or storing them in storage locations. Aromatic hydrocarbons entering and stored inside the bodies of organisms faster than aliphatic hydrocarbons due to higher portability of the soluble compounds s in water and the amount of adipose tissue (Zhou *et al*., 1996, 1997). It is well known that zooplanktons are an important factor in the short-term removal of petroleum residues from open ocean surface waters (Sleeter and Butler, 1982).
The contrast quarterly accumulation hydrocarbons may be several reasons the most important temperatures and this was confirmed by Payne, *et al*. (1985) that the high temperatures during summer leads to fragmentation of the compounds with high molecular weights which lying and flying atoms carbon least of C15.
Spilled oil and its derivatives in the water are effected heavily by natural processes in the environment leading to alteration of the amount of their contents of the hydrocarbon compounds and then upon their accumulation in the aquatic organisms. After oil or derivatives spills, immediately several processes are occurring and configured surface layer evaporate and disperse,causing the reduction of more than 50% of the oil spilled during the first few days and disappears gasoline and kerosene completely "during this time, the oils sticky may suffer shorthand" less than 25% during this period (GESAMP, 1993). More over, oxidation and other types of oxidative stress are affecting the spilled oil and its derivatives, especially compounds containing oxygen, such as aliphatic acids and aromatic alcohols and phenols and mostly products are dissolving in water and increase their spreading in the water column (FAO, 1977). The remaining oil slicks with high density characterized by painted dark able to absorb sunlight very efficiently, raising
temperature of the water surface to higher than normal, leading to the killing or idle or destruction of certain organisms (Ehrhardt, et al. 1992). An irregular leakage in southern Iraqi rivers may be due to industrial processes or waste from loading band transportation of ships.

Conclusion

The finding of this study showed that the zooplankton in Shatt Al-Arab River plays a great role in the removal of petroleum hydrocarbons exists within the water column and increase their concentrations in the particulate phase. More over, zooplanktons in the waters of Shatt Al-Arab River seems to be a potential source for transfer of

Petroleum hydrocarbons towards the North Waste Arabian Gulf. The accumulation of petroleum hydrocarbons by zooplanktons depend on the seasons and positions, therefore they could be used as a bio indicator for the accumulation of polluted materials.

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تلوث العوالق الحيوانية بالهيدروكربونات النفطية
في شط العرب، البصرة، العراق

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مركز علوم البحار ، جامعة البصرة ، البصرة ، العراق

الخلاصة
تضنت هذه الدراسة تقييم الانواع المختلفة من العوالق الحيوانية في ثلاث مواقع منتخبة من شط العرب وهي 1) الهارثة و 2) العشار و 3) ا بي الخصيب خلال المواسم الاربعة لسنة 2011. تم تحديد توجد اعداد من العوالق الحيوانية بحدود 1367 و 818 و 1031 فرد لكل متر مكعب في المحطات 1 و 2 و 3 على التوالي . وكانت اكثر الانواع تواجداً Moina affinis (425، 89، و94)فرداً \ متر^3 و Diaphanosoma brachyurum (309، و 23، و 33) فرداً \ متر^3 ، و Cyclopodia (214، 125،و 326)فرداً \متر^3 ، و Cirripedia larvae (234 ، 252 ، و 324) فرداً \ متر^3 في المحطات 1 و 2 و 3 على التوالي. حسبت تراكيز المركبات الهيدروكربونية النفطية الكلية في العوالق الحيوانية المستجمعة فصليا من المحطات الثلاث حيث تراوحت من 80.59 مايكروغرام/غرام وزن جاف في المحطة الثانية (العشار) خلال فصل الصيف إلى 274.30 مايكروغرام/غرام وزن جاف في المحطة الأولى (الهارثة) خلال فصل الشتاء. أن هذه التراكيز تعكس مدى تلوث شط العرب بالنفط ومشتقاته بالمقارنة مع الدراسات المنجزة على النهر. أن الكائنات المائية كالعوالق الحيوانية تستخدم على نطاق واسع في تقييم مدى التلوث بالمواد الكيميائية ومن ضمنها المركبات الهيدروكربونية وكذلك استخدامها في مراقبة النظام البيئي في شط العرب . فظلاً عن ذلك تم قياس بعض العوامل المؤثرة كدرجة الحرارة والاس الهيدروجيني والاوكسجين المذاب والملوحة في مياه شط العرب .

الكلمات المفتاحية: المركبات الهيدروكربونية، العوالق الحيوانية، شط العرب، تراكم، تلوث نفطي.