

# Investigation of Some Polycyclic Aromatic Hydrocarbons (PAHs) in Sediments from Euphrates River at AL-Ramadi City

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## Abstract

The current study was conducted on the Euphrates River, starting from the Ramadi Center to the city of Fallujah, in four selected sites distributed along the river during the period from (April 2021 - March 2022). Samples were collected from surface water to study the various physical and chemical properties. The study also included measuring the concentration and distribution of some polycyclic aromatic hydrocarbons (PAHs) and predicting their sources in water samples, sediments, and aquatic plants such as *Ceratophyllum demersum*, *Elodea canadensis* and *Potamogeton crispus*. The results showed that the air and water temperature ranged between ((C° 50-1) and (C° 32-6), respectively, while the values of water flow (0.3 m/S 0.65 m/S) during winter and spring, the values of pH and conductivity were Electricity and salinity fluctuated between (8.7-7.7), (1349  $\mu$ s/cm -640  $\mu$ s/cm) and (0.86 ppt -0.41 ppt) The levels of dissolved oxygen ranged between (10.3 mg/l - 7.2 mg/l). The biological oxygen BOD5 ranged from (5 mg/l - 0.7) and the results showed that the river water was alkaline in nature and very hard. Levels of (220 mg/L -65), (38mg/l - 6 mg/l) were reported for total alkalinity and suspended solids, respectively. The results indicated values between (-0.003 and (-3.93) mg/l 0.31 and (3.93). mg/l - 1.2 m/l), total total phosphorous, total nitrogen respectively. In water samples, the lowest value was recorded (0.001 ng/g.dw) Flu. Ant, while the highest value (5.14 ng/g.dw) is Acpy. The lowest concentration in sediment samples (0.001 ng/g.dw). It was reported for Nap while the highest concentration was for (8.22 ng/g.dw) Phen.

**Keywords:** PAHs, Sediments, Investigation.

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## INTRODUCTION

Polycyclic Aromatic hydrocarbons (PAHs) are a group of organic compounds, many of which are toxic or carcinogenic (Messinger, 2004; Brownell et al., 2009) Polycyclic Aromatic Hydrocarbons (PAHs) may reach aquatic environments from domestic and industrial sewage effluents, exhaust of gasoline and diesel combustion engines, surface runoff from land, deposition of airborne particulates, and especially from spillage of petroleum and petroleum products into water bodies (Hoffman et al., 1984; Prahl et al., 1984).

Because of their hydrophobicity and low water solubility and vapor pressures, PAHs tend to accumulate rapidly in sediment and various organic components in marine environments (Chiou et al. 1998; Savinov et al.2003; Magi et al. 2002; Kannan et al. 2003; Koh et al. 2004). The levels of PAHs in the sediment may be higher than those in water column. They are persist in the environment and hazardous to animals, plants and human at elevated levels (SFEI, 1998 and Geismar, 2002).

Marine sediments are one of the most important reservoirs of environmental pollutants. Because of their hydrophobic and persistent nature, PAHs entering the marine environment preferentially adsorb onto particulates and accumulate in bottom sediments of coastal and oceanic environments

(Chiou et al., 1998). Organic pollutants from sediments can be transferred into aquatic food chains via bottom-dwelling organisms. Once disturbed, the sediment can be resuspended and the contaminants can reenter the marine aquatic environment and circulate in ecosystems, resulting in secondary contamination (Zeng and Venkatesan, 1999).

## MATERIAL AND METHODS

### Collection of Samples

A study was carried out through a period from April 2021 to March 2022. From four different stations) Al-Ramadi, Al-K Haledia, AL-Habania and Al-Faloja), The sediment samples were taken by using Van veen grab sampler and stored in aluminum foil then placed in ice-packed and transferred to the laboratory then kept in the refrigerator before analysis.



Figure (1): Map of Euphrates river showing the position of stations

### Extraction of Hydrocarbon Compounds from Sediment Samples

Quantification of PAHs in sediments is necessary to understand the ecological quality of the aquatic system. (Malik *et al.*, 2011). 1 gm was extracted from sediment samples, 10 ml volume of (Dichloromethane) was added, then placed on a shaker (for half an hour at a power of 250 rpm (Miguel *et al.*, 1998), then placed in Centerfug) (2000 rpm) for 10 min, a layer of Di chloro methan is withdrawn, the water is removed using granular anhydrous sodium sulfate, we concentrate the sample by evaporating Dichloro methan in a rotary evaporator, (bath temperature 50°C) (Sanders *et al.*, 2002).

### Evaluation Indices of Oil Pollution

Many parameters have to be analyzed in order to evaluate the probable origin of Polycyclic Aromatic Hydrocarbons (pyrogenic or petrogenic). These are as follows.

#### A-Ratio of Low Molecular Weight (LMW-PAHs) to High Molecular Weight (HMW-PAHs)

Values greater than one indicate petrogenic origins from crude oil and their derivatives and values less than one are attributed to pyrogenic sources (Vrana *et al.*, 2001).

#### B-Ratio of Benzo (a) Anthracene / (Benzo (a) Anthracene+ Chrysene). BaA/ (BaA+Chr)

Less than 0.2 implies petrogenic, from 0.2 to 0.35 indicates either petrogenic or pyrogenic origins, and larger than 0.35 implies pyrogenic sources (Yunker *et al.*, 2002; Tolosa *et al.*, 2004; Gao *et al.*, 2007)).

#### C-Ratio of Fluoranthene to Pyrene (Fl/Py).

Values greater than 1 have been used to indicate pyrogenic origins and values less than 1 are attributed to petrogenic source (Qiu, 2009).

#### D- Ratio of chry/BaA

Values greater than 1 referred to petrogenic sources from oil and its refined products such as diesel fuel, Fuel oil from urban vehicles traffic products (Doong and Lin, 2004).

## RESULTS

### Low Molecular Weight PAHs (LMW-PAHs) in Sediment

The results of this study were verified in Figures (2 & 3), while the annual average concentration in Table (1) of low molecular weight polycyclic aromatic hydrocarbons in sediments are (Nap, Acpy, Acp, Flu, Phe and Ant). Monthly changes in average individual PAHs were significant during March excluding Acp during January while lowest during August excluding Acpy through September. The concentration of LMW-PAHs fluctuated during months and stations in Table (1).

#### Acenaphthene (Acp)

The highest and lowest concentration of NaP ranged in the sediment samples (0.001-4.65 ng/g) at Station 1, February 2 and April, respectively. With annual mean concentration (1.06 ng/g). Statistical analysis indicates a statistically significant relationship NaP between months and stations (LSD = 1.19 ,0.87).

#### Acenaphthalene (AcpY)

The maximum concentration of Acpy (7.08 ng/g) was recorded in station 2 during the month of February, while the lowest concentration (0.001 ng/g) was detected in station 4 during the month of July, the annual average (1.87 ng/g). Statistical analysis indicated significant differences in Acpy concentration between months (LSD = 1.41).

#### Acenaphthene (Acp)

The concentration of Acp in sediment samples ranged (0 - 5.28 ng/g) in station 1, during February for high concentration and station 4 during September for low

concentration. Average annual concentration (1.55 ng/g). The statistical analysis indicates a statistically significant relationship for Acp concentrations between months (LSD = 1.32).

### Fluorene (Flu)

The highest concentration (7.08 ng/g) was detected in Station 3 during the month of February, while the lowest concentration (0.001 ng/g) was detected in Station 3 during the month of September, with an annual average of its concentration (1.88 ng/g). Statistically, Flu concentrations indicated a relationship. Statistically significant between months LSD = 0.93.

### Phenanthrene (Phen)

Phe concentration. In the sediment samples between (8.22 ng/g) in Station 1 during the winter (February) to (0.002 ng/g) in Station 2 during June, with an annual average

concentration of 1.72 ng/g) of the total PAHs. Statistically, the differences in the concentration of Phe. They were significant between months (LSD = 1.19). respectively.

### Anthracene (Ant)

High Ant concentration in sediment samples (6.69 ng/g) was observed in Station 1 during December, while Ant concentration was not recorded in Station 3 during May. The average annual Ant concentration (1.70 ng/g) Statistical analysis indicates a statistically significant difference in Ant concentration between months LSD = 1.43.

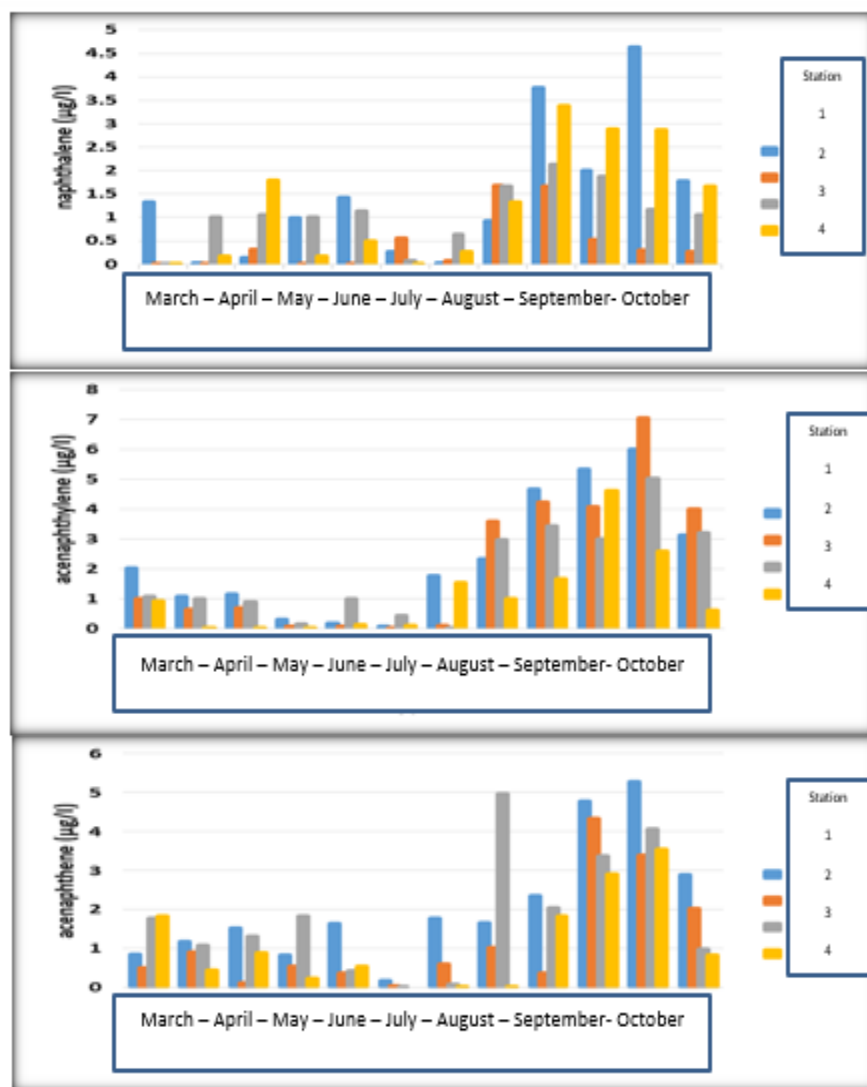


Fig.(2) Monthly variations of Nap, Acpy. and Acp. concentrations in sediment samples during study period (April.2021-March.2022).

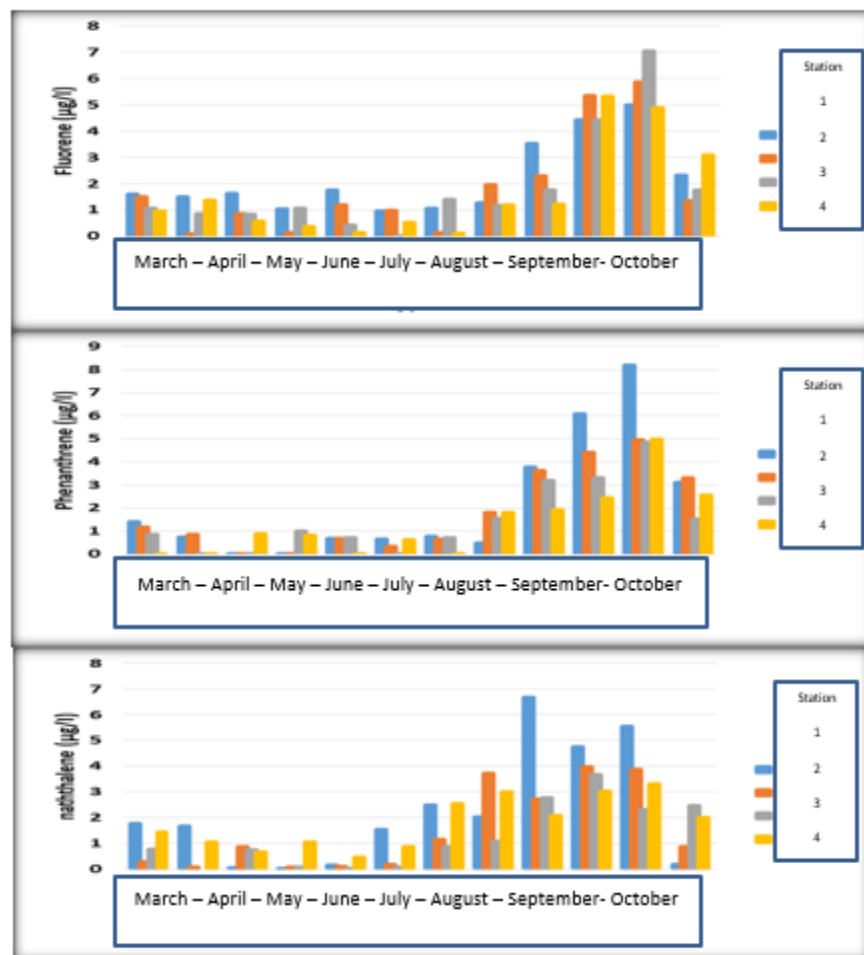


Fig. (3) Monthly variations of Flu., Phe. and Ant. concentrations in sediment samples during study period (April.2021-March.2022).

### High Molecular Weight PAHs (HMW-PAHs) in Sediment

#### Fluoranthene (Fla)

The results showed that the maximum concentration of Fla. (5.58 ng/g) at plant 4 during December, while the lowest concentration. (0.01 ng/g) in station 1, 2, during April and June respectively, the results indicated that the annual average concentration (1.38 ng/g) of the total PAHs. Fla concentrations were significant between months only (LSD = 1.26), respectively.

#### Pyrene (Py)

The highest concentration of Pyr. In the sediment samples, it ranged between (7.34 ng/g) in Station 1 during the month of January, while the lowest concentration (0.009 ng/g) recorded in Station 3 during December, the annual average concentration (2.03 ng/g) of the total aromatic hydrocarbons Multicyclic Statistical analysis indicates significant differences in Pyr concentration between months (LSD = 1.44).

#### Benzo (A) Anthracene (BaA)

Minimum and maximum values of (BaA) (1.51-2.34 ng/g) were recorded in station 3 during January, while BaA concentration was not recorded in station 1,2,4 during April, June and August, with an annual average of (0.59). ng/g) Statistically, the analysis indicates significant differences in BaA concentration between months (LSD = 0.72).

#### Chrycene (Chry)

The range of Chry concentrations was determined at (0.006 - 7.1 ng/g) at station 4 during February, while the lowest concentration in station 1 during October, respectively, with an annual average of (1.76 ng/g). Significant differences were recorded (LSD = 1.18) for concentrations of Chry between the months.

#### Benzo (b) Fluranthene (BbF)

The highest concentration of BbF in sediment samples was (3.01 ng/g) in station 4 during the month of February, while no concentration was recorded in station 1,2,3 during April, May and June, with an annual average concentration of (0.65

ng/g) of the total aromatic hydrocarbons. multi-ring. Statistical analysis indicates that there are statistically significant differences in BbF concentration between months (LSD = 0.58).

**Benzo(k) Fluranthene(BkF)**

The highest concentration of BkF in sediment samples (ng/g 1.89) was in Station 3 during the month of February, while no concentration was recorded in Station 2,3,4 during August and May, with an annual average of its concentration (0.47 ng/g). Statistical analysis indicates significant differences Statistical significance in BkF concentration between months only (LSD = 0.56).

**Benzo(a) Pyrene(BaP)**

The highest concentration of (BaP) in sediment samples (2.34 ng/g) was recorded in (Station 2) during the month of January, while no concentration was recorded in the 1.4 station, with an annual average of its concentration (0.67 ng/g).. Statistical analysis indicates that Significant differences in BaP concentration between months only (LSD = 0.56).

**Dibenzo(a,h)Anthracene (DbA)**

The highest concentration of (DbA) in sediment samples was (2.023 ng/g) in Station 1 during January, while the lowest value (0.001) ng/g was recorded in Station 4 during August. The average annual concentration of DbA was (0.63 ng/g). of

the total polycyclic aromatic hydrocarbons. Statistical analysis indicated significant differences in DbA concentration between months only (LSD = 0.52).

**Benzo(ghi) Peyrelene (BghiP)**

The concentration of (BghiP) fluctuated between (1.97 ng/g) recorded in Station 3 during the month of November, while the lowest value (0.002) ng/g was recorded in Station 3 during the month of April with the annual average of its concentration (0.69 ng/g) of ΣPAHs. Statistical analysis indicated statistically significant differences only between the months of the study, LSD = 0.72.

**Indeno(1,2,3-cd)Pyrene(IND)**

The highest concentration of (IND) in sediment samples (2.8 ng/g) was in station 2 during the month of February, while no concentration was recorded in station 4 during May, June and July, with an annual average of its concentration (0.58 ng/g) of the total multiple aromatic hydrocarbons. loops. Statistical analysis indicated statistically significant differences only between the months of the study, LSD = 0.69.

The seven carcinogenic polycyclic aromatic hydrocarbons (Ba)A, B(b)F, B(k)F, B(a)P, D(a,h)A, B(ghi)P and IND were detected in the sediment sample. In the current study in Table No. (8), it is known that it poses a threat to aquatic animals in the sediments. The annual average concentration (4.19, 4.22, 4.47, 4.2 ng/g.)

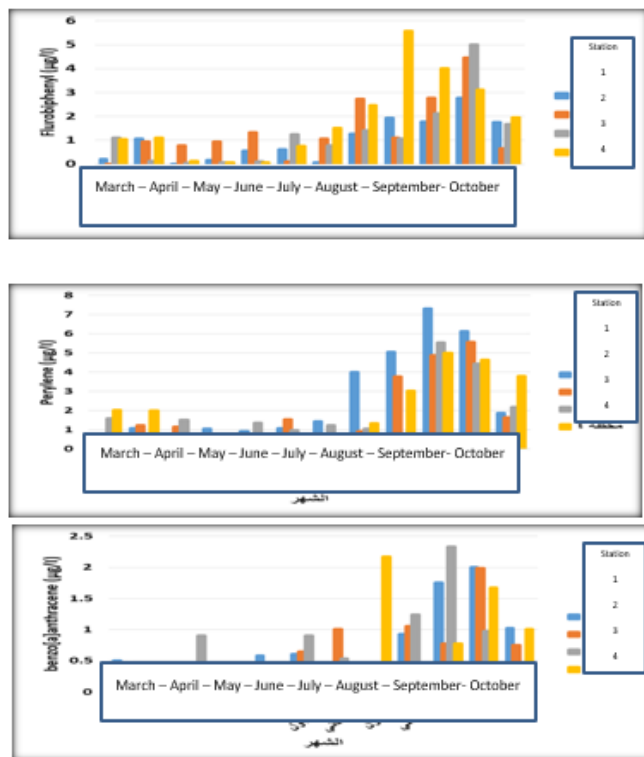


Fig. (4) Monthly variations of Fla., Pyr. and B(a)A concentrations in sediment samples during study period(April.2021-March.2022).

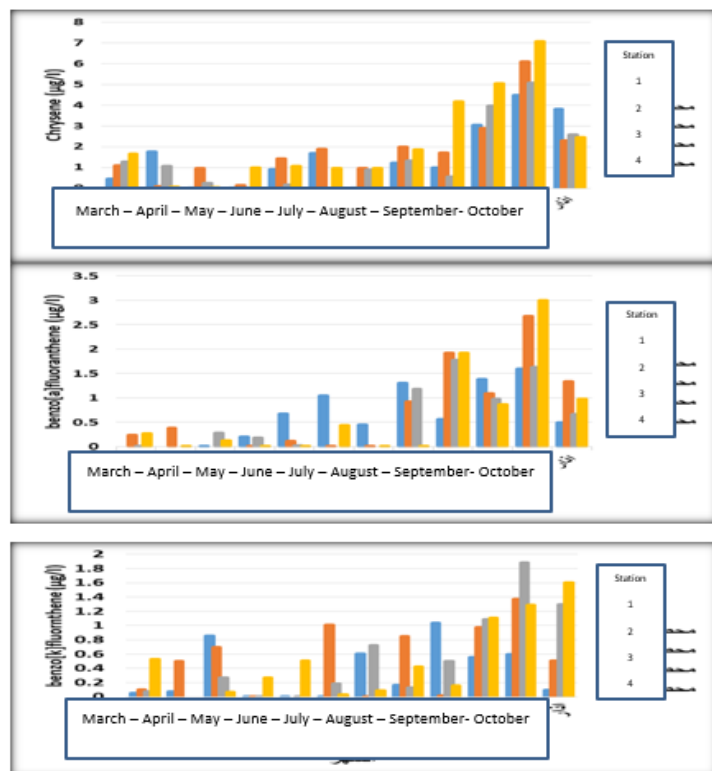


Fig. (5) Monthly variations of Chr, B(b)F and B(k)F concentrations in sediment samples during study period(April.2021-March.2022).

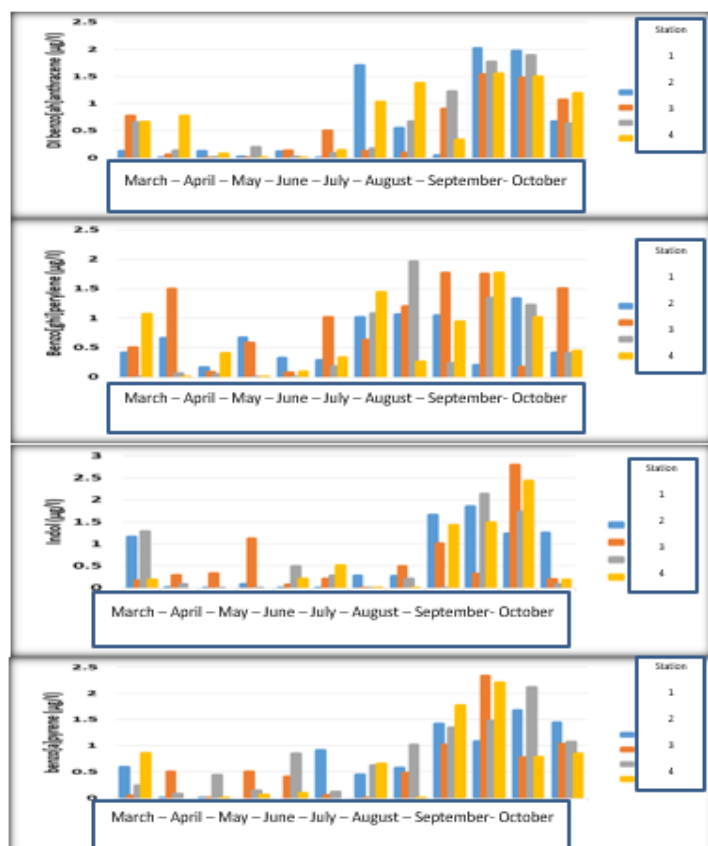


Fig.(6) Monthly variations of B(a)P, D(a,h)A, B(ghi)P and IND concentrations in sediment samples during study period(April.2021-March.2022).

Table 1. Annual mean concentrations (ng/g.dw) of 16 PAHs, range and mean±SD of individual PAH and carcinogenic (cPAHs) in sediment of study stations during (April 2021- March 2022)

	St.1	St.2	St.3	St.4	Total Mean conc
Nap	0.03-4.65 2.25±2.27	0.001-1.69 1.51±1.61	0.08-2.14 1.25±1.26	0.01-3.39 1.80±1	1.06
Acpy	0.09-6.02 2.35±2.04	0.04-7.08 2.15±2.35	0.008-5.05 1.86±1.61	0.001-4.62 1.11±1.38	1.87
Acp	0.17-5.28 2.08±1.55	0.04-4.35 1.19±1.37	0.01-4.98 1.83±1.58	0-3.56 1.09±1.19	1.55
Flu	0.98-5.01 2.19±1.38	0.12-5.89 1.83±1.91	0.001-7.08 1.84±1.98	0.6-5.36 1.67±1.8	1.88
Phen	0.009-8.22 2.18±2.64	0.002-4.98 1.84±1.78	0.009-4.86 1.49±1.54	0.005-5.01 1.35±1.5	1.72
Ant	0.01-5.56 2.25±2.27	0.09-3.89 1.51±1.61	0-3.68 1.25±1.26	0.47-3.31 1.80±1	1.70
Fla	0.01-2.78 1.03±0.89	0.01-4.48 1.42±1.26	0.07-5.02 1.25±1.37	0.08-5.58 1.83±1.71	1.38
Pyr	0.09-7.34 2.55±2.45	0.02-5.59 1.84±1.87	0.009-5.55 1.78±1.61	0.02-5.01 1.93±1.81	2.03
B(a)A	0-0.93 0.62±0.7	0-1.011 0.57±0.6	0.02-1.25 0.64±0.69	0-2.18 0.51±0.75	0.59
Chry	0.006-4.51 1.55±1.52	0.1-6.13 1.82±1.59	0-5.09 1.44±1.64	0.07-7.1 2.22±2.16	1.76
B(b)F	0-1.38 0.65±0.57	0-2.68 0.73±0.88	0-1.78 0.56±0.67	0.002- 3.01 0.64±0.95	0.65
B(k)F	0.001-1.04 0.34±0.37	0-1.38 0.51±0.48	0-1.89 0.52±0.62	0-1.61 0.51±0.54	0.47
B(a)P	0-1.68 0.68±0.62	0.008-2.34 0.60±0.66	0.08-2.12 0.80±0.64	0-2.21 0.61±0.74	0.67
D(b)A	0.009-2.023 77.9±125.2	0.002-1.54 828.52±1186	0.09-1.78 107.7±349.4	0.001-1.56 471.7±859.6	1.73
B(ghi)P	0.17-1.34 0.64±0.39	0.08-1.78 0.91±0.64	0.002-1.97 0.55±0.68	0.006-1.78 0.66±0.59	0.69
IND	0.008-1.86 0.66±0.72	0.01-2.8 0.59±0.78	0.008-2.14 0.53±0.75	0-2.44 0.54±0.80	2.06
Annual mean of $\Sigma$ PAHs	18.45	18.04	18.53	21.83	
Annual Mean of cPAHs	4.19	4.22	4.47	4.2	

**Note: Carcinogenic(c PAHs) are darkens squares**

#### Sources of PAHs in the sediment:

Fla/(Fla+Pyr). BaA/(BaA+Chr), Ant/(Phe+Ant) according to molecular weight Yunker et al. (2002).

The ratios of Ant/(Ant+Phe) in the current study were (0.45-0.57 <0.35), for station 4 and station 2 respectively, and it was suggested that their source is pyrolytic.

The BaA/(BaA+Chry) values in the water sample (0.18-0.30 <0.1), refer to Station 4 and Station 3, respectively. Suggested to come from combustion

While the ratio, (0.28 -0.48) was <0.4 Fla/(Fla+Pyr) for station 4 and station 1 on (petroleum sources).

are shown in Figure (28) and Table (8) according to the ring number and molecular weight. 2-3 rings including the polycyclic aromatic hydrocarbons Nap, Acpy, Acp, Flu ; Phen and Ant Phen and Ant ranged between( 18.85 - 82.75%). In Station 2 and Station 4, the 4-ring PAHs include Flu Pyr, B(a)A and Chry (6.62to 60.36 %).at station 1 and station 4; The high molecular weight 5 rings PAHs include B (b) F, B (k) F, B (a) P and DbA (0.91-58.71%) were recorded in station 1 and station 1 while 6 rings (IND and B (ghi)) was (0.11-58.71%)in Station 1 and Station 4.

#### Composition pattern of PAHs in the sediment

Percentage composition and monthly variation percentage (%)2,3,4,5-6 rings in sediment samples from study stations

Table (2): Average percentages of individual polycyclic aromatic hydrocarbons in sediment samples for Euphrates River sites during the study period (April 2021 - March 2022)

Site	Ratio	Ant/(Ant+Phe)	BaA/(BaA+ Chry)	Fla/(Fla+Pye)	Sources
S.1	0.507	0.285	0.287	0.287	Pyrogenic, petrogenic and urban air
S.2	0.451	0.238	0.435	0.435	Pyrogenic, petrogenic and urban air
S.3	0.456	0.307	0.412	0.412	Pyrogenic, petrogenic and urban air
S.4	0.571	0.186	0.486	0.486	Pyrogenic, petrogenic and urban air

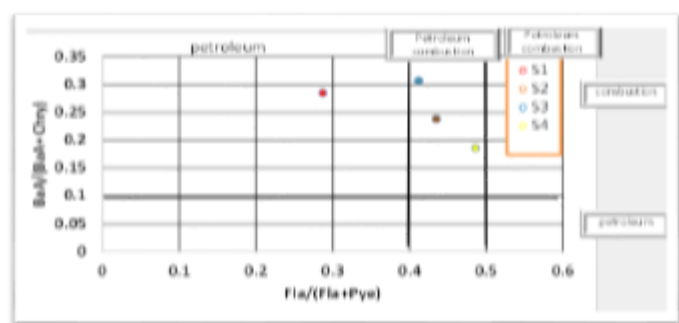
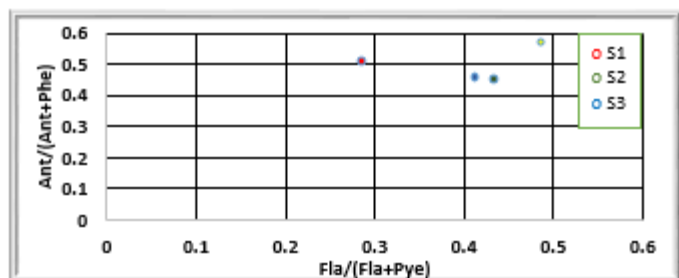


Figure (7) cross plot of the isomerization ratio of polycyclic aromatic hydrocarbons (Fla/(Fla+Pyr) vs Ant)/(Ant+Phe and BaA)/(BaA+Chry). Yunker, (2002.)

Table (3): Monthly variation percentage (%) of 2-3,4,5,6 ring in sediment sample at study stations during period among (April 2021 - March 2022)

	No. Rings	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
St.1	2-3	71.15	56.77	74.13	58.69	58.71	37.76	56.73	45.51	62.74	56.57	59.24	50.95
	4	10.15	36.05	6.62	23.06	58.71	39.73	11.01	33.89	22.65	28.76	26.36	32.35
	5	6.19	0.91	16.34	4.28	58.71	19.57	22.96	13.60	7.75	10.41	9.99	10.34
	6	12.51	6.27	2.91	13.96	58.71	2.94	9.30	7.01	6.87	4.26	4.40	6.36
St.2	2-3	55.24	32.12	40.63	18.85	38.85	23.95	42.01	58.40	51.05	54.02	48.16	51.72
	4	22.04	28.43	43.60	33.08	48.30	45.58	46.04	24.49	26.17	26.92	34.30	23.58
	5	14.39	17.68	9.84	11.36	10.37	17.11	2.30	9.92	13.23	14.11	11.92	17.24
	6	8.33	21.77	5.93	36.71	2.48	13.36	9.65	7.19	9.54	4.94	5.62	7.46
St.3	2-3	45.54	62.44	56.20	79.16	54.70	22.92	38.25	59.77	65.82	46.36	48.61	50.62
	4	35.94	31.73	31.60	12.45	24.73	60.36	35.04	17.17	12.37	32.93	30.77	30.23
	5	8.03	3.44	11.51	8.09	13.15	7.66	15.59	13.35	20.75	12.51	14.93	16.87
	6	10.48	2.39	0.70	0.29	7.42	9.05	11.12	9.71	1.06	8.19	5.88	2.28
St.4	2-3	38.35	43.55	82.75	64.80	39.82	36.25	43.27	45.76	38.42	47.08	45.53	42.66
	4	35.13	45.24	5.41	26.88	39.90	39.40	25.72	42.83	40.73	32.96	33.92	36.51
	5	17.16	11.10	4.90	8.18	13.34	10.25	17.13	9.93	13.32	12.73	13.47	18.29
	6	9.37	0.11	6.95	0.14	6.94	14.11	13.88	1.47	7.53	7.24	7.07	2.54

## DISCUSSION

PAH concentrations in sediments have been extensively studied by several authors and the toxic effect of these pollutants has been evaluated (Narbone et al., 1999; Tay et al., 2003; Geffard et al., 2003; Thorsen, 2004). The chemical analysis showed that the total concentration of PAHs during the study months ranged between (18.04-21.83ng/g dry weight) in station 2 and station 4, respectively. This is because seasonal changes can be changes in discharge capacity, flow rate, river area as well as plankton in the water column. The process of sedimentation, adsorption, accumulation and uptake of pollutants on sediment particles can be increased due to many sources of PAHs such as oil spills, waste water Health and industrial emissions dominate the atmospheric source of PAHs (Panther et al., 1999; Lee et al., 2001). The concentration of PAHs in the water column was lower than in the sediments due to their water-repellent properties, low water solubility, and relative chemical stability. The same conclusion was obtained by (Guo et al., 2009). The maximum concentration of individual PAHs was detected for phenanthrene (8.22 ng/g) in station 1 while other PAHs were not detected in some months in particular, high molecular weight PAHs such as Benzo(k)Anthracene, Benzo(ghi) Perylene and Indeno(1,2,3-c,d)pyrene. The average annual concentration ranged between (2.03 -0.47) Pyr and B(k)F. The monthly variability of  $\Sigma$ PAHs in the sediment samples showed that the higher concentration of PAHs was observed during February and January in the winter months where each station was much more than the warmer months especially during August. Also, the concentration of PAHs in water and sediments showed a negative correlation with air and water temperature. Among the proposed classification criteria, an area is considered "highly polluted" at PAH concentrations above 500 ng/g, "moderately polluted" when concentrations range from 250 - 500 ng/g, and "slightly polluted" when concentrations are less than 250. ng/g. These criteria are often used to assess the level of sediment contamination (Notar et al., 2001; Venturini and Tommasi, 2004; De Silva et al., 2007). According to these criteria, the total Euphrates sediment concentration ranged between 18.04-21.83 ng/g.dw for Station 2 and Station 2, respectively, so it is slightly polluted, which falls within the classification of urban and industrial areas. The Fla/(Fla + Pyr) ratio was 0.28 -0.48 < 0.1 indicating that the main source is of pyrogenic origin. The previous study focused on sources for different polycyclic aromatic hydrocarbons. Low to moderate temperatures, such as burning wood and coal and the abundance of low molecular weight PAHs (Lake et al., 1979), while at high temperature, the predominance of high molecular weight PAHs (Lee et al., 1977). Figure (26) shows the relationship between  $\Sigma$ PAHs (total PAHs) and individual PAHs (2,4,5,6,3-2 rings). 2-3 ring polycyclic aromatic hydrocarbons including Nap, Acyp, Acp, Flu ; Phen and Ant; ranged between (44.87%-57.14%) of  $\Sigma$ PAHs in St.4 and St.1 respectively; The 4-ring PAHs include Flu Pyr, B(a)A and

Chry, which ranged from (26.33%-35.17%) in St.1 and St.4. The 5 rings high molecular weight polycyclic aromatic hydrocarbons include B(b)F, B(k)F, B(a)P and DbA, recorded (10.48%-13.90%) in St.1 and St.3. While 6 episodes IND and B(ghi)P were (5.95%-8.09%) in St.1 and St.2. Monthly percentage of individual PAHs to total PAHs ( $\mu$ g/l) from the sediment sample in Table No. (11). Low molecular weight (2-3) rings constituted a high percentage (82.75%) of the total PAHs during June at St.4, while the low percentage was 18.85% at St.2 during July. However, HMW, 5, 6, 4 episodes have more than LMW ratios at some stations. 4 episodes (5.41-60.36%) Station 4 during June and St.3 during September respectively. The percentage of the five episodes ranged (0.91-58.71%) in and St.1 during May and August also, respectively. The maximum percentage of 6 episodes in the sediment sample was (0.11-58.71%) in station 1 during August and station 4 during May, respectively. The PAH formation pattern is useful for determining the source and fate of pollutants and the transport of PAHs in the environment and media (Gigliotti et al., 2002). Various sources of various polycyclic hydrocarbons. In the current study 2-3 episodes as Nap. Ant. and Phe.. were prevalent in all stations due to incomplete combustion of fuels, fossil fuels, parks and petroleum (Lee et al., 1977). These results are in agreement (Shi et al., 2005; Malik et al., 2011). Therefore the sediment distribution is very similar to PAHs in water (Maskaoui et al., 2002). Monthly changes in total organic carbon (% TOC) in sediment samples ranged between (0.2 -4.3%) and this concentration is higher than the concentrations obtained by Al-Tae, (2002); (2010) in Shatt al-Arab and Hilla rivers (1.09, 0.302%) respectively and is relatively comparable with that found by Al Azawey, (2012) while the percentage of total organic carbon in the studied river is relatively higher than what was observed by Salman (2006). Because of the hydrophobic nature of PAHs, the present results indicate a significant positive correlation between TOC% and total PAHs in sediments ( $r=0.872$  ;  $P<0.05$ ). The results are in agreement with those obtained by other researchers in the Euphrates and Hilla rivers (Mohamed, 2007; Al-Tae, 2010 and Al-Azawey, 2012).

Table (3): Comparison of concentrations of PAHs Compounds in sediments samples from Al- Euphrates River with their concentrations in other areas of Iraq and the world

References	Concentrations (ng/g)	Locations
Al-Saad, 1995	42.8 – 56.70	Shatt Al-Arab and NW Arabian Gulf
Al-Saad, 1987	0.2 – 76.25	Shatt Al-Arab and NW Arabian Gulf
Al-saad and Al-Timari, 1989	0.59 – 2.07	Hor Al-Hammar
Al-Hamdi, 1989	6.88-39.85	Khor Al-Zubair and N.W.Arabian Gulf
Al-Khatib, 2008	0.1- 145.8	Hor Al – Howaiz
Al-Tae et al., 2010	26.668-900.042	Shatt Al-Hilla
Al-Khion, 2012	12.15-47.38	Iraqi coast regions
Al-Taie, 2013	0.252-10.363	Al-Azim Marshes
Hatzianestis et al., 1998	31-176.3	Aegean sea
Zakaria et al., 2002	4 -924	rivers in Malaysia
Zhou et al., 2000	247 - 480	Xiamen Harbor/ China
Doong and Lin, 2004	8.0 - 356	Geo – ping river/china
Bakhtiar et al., 2009	306-7968	Lagant river /Malaysia
Kafilzadehet al., 2011 The	167.4-530.3	kor river /Iran

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