Occurrence and source of some polycyclic aromatic hydrocarbons (PAHs) in surface sediment of Diwaniah and Daghara rivers /Iraq

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Abstract:

The distribution and possible sources of 16 polycyclic aromatic hydrocarbons (PAHs) were investigated in the surface sediments of Diwaniah and Daghara rivers in AL-Qadissiah province in Iraq during the period from March 2011 to February 2012, surface sediment samples were collected from four locations in Diwaniah, and Daghara river sited along rivers and other station on Hilla river which were branched from it. Sixteen PAHs were identified and quantified in sediments sample by High performance liquid chromatography (HPLC). Concentration of total PAHs ranged between (2.19--354.55ng/g dry weight)were recorded at St.1 on Hilla river during *Aug*. and St.5 on Diwaniah river through *Mar*. respectively. with annual mean concentrations of ΣPAH ranged between (37.4--90.7 ng/g) at Hilla river and St5 on Diwaniyah respectively. The maximum concentration of individual PAH were detected of Pyrene (96.9ng/g)at St.2 on Daghara river while some high molecular weight HMW such BaP ,IND and BkF no detected during some months . Compositional pattern analysis investigated that 2-3ring of individual PAHs was highest ratio in comparing with 4,5.6 ring whereas 6ring was lowest ratio in all stations. Diwaniah and Daghara rivers were moderately polluted by PAHs (∑16PAH=250-500ng/g) while Hilla river was slightly polluted (∑16PAH <250ng/g).

Diagnostic ratios suggested that possible source of PAHs were mixed sources among pyrogenic and petrogenic origin in the study region.

The results of current study showed that total organic carbon (TOC)in sediment sample ranged between (0.2-3.2%) at Hilla and Diwaniah rivers also respectively, Grain size distribution test illustrated that sandy nature was abundant in all stations. PAHs do not correlate with the particle size distributions but it significant correlated with the content of the TOC in sediment.

1- Introduction:

Aquatic sediments are large reservoirs of physical and biological debris and act as sinks for a wide variety hydrophobic organic pollutants (1). Chemical contaminants present in the aquatic ecosystem may be immobilized and accumulated in sediments or may be subject to transformation and activation processes (2). Polycyclic aromatic hydrocarbons (PAHs) are a large group of organic compounds with at least 2 condensed rings. More than 100 different PAHs are
ubiquitously distributed in the environment, many of which possess of mutagenic, carcinogenic, and teratogenic properties (3). Sixteen PAHs have been identified as priority pollutants and 7 of them classified as probable human carcinogens by the US Environmental Protection Agency (4).

PAHs may enter the aquatic ecosystem either directly, by effluents or oil spills, or indirectly by terrestrial runoff or atmospheric deposition.

Due to their hydrophobic properties , low water solubility and relative chemical stability, PAHs entering a water body have a high affinity for suspended particles. PAHs are sorbs these particles, and eventually settle out of the water column onto bottom sediment. Thus, the PAHs concentrations in water are usually low relative to the concentrations in bottom sediment. (5). bottom sediments contain the highest levels of PAHs and represent as an adequate environmental indicator for assessment of the anthropogenic emissions of these contaminants. Therefore, sediments are particularly useful for identifying hotspots, evaluate the predominant PAH sources and to determine the most appropriate strategy for monitoring and environmental control, it is necessary to identify the most likely sources of such substances (6). The characteristics of the sediment, for example, components and species of organic matter and clay minerals, would influence the behavior and fate of sediment associated PAHs (7). PAH ratio profiles have been commonly used as a means of differentiating between those pyrolytic and petrogenic origin. For example, Phe/Ant and Fla/Pyr are two pairs of isomers whose difference in reactivity and solubility proves useful in proving a tracer of PAHs from origin (8 ,9).

In Euphrates river sediment, PAHs compounds were found in concentrations several times higher than those in water column, according to the values of the ratios (Phen./Ant, Flur/Py, BaP/BghiP and LMW-PAHs/HMW-PAHs), the distribution of PAHs in water, sediment and aquatic organisms may have the origin from different sources (Pyrogenic, Petrogenic and urban air).Moreover, strong correlation was recorded for PAHs in sediment with TOC% due to affinity to organic materials. so PAHs show no correlation with the particle size distributions but are correlated with the abundance of organic material in Euphrates river sediment (10).

Al-Taee, (2010) (11) investigated that the PAHs concentration were significant difference of the surficial sediment between the various stations of Hilla river and the highest value were recorded in the area adjacent to high way traffic across the river. therefore origin PAHs were determined as pyrogenic and petrogenic origin in Hilla river.

The primary objective of present study to determination of PAHs levels in Diwaniah and Daghara rivers and comparing their concentration at Hilla river, and distinguish the possible sources of PAHs with diagnostic ratios, also to examine the distribution, compositional pattern and relative pollution levels of PAHs with temporal variation in the sediment at study region.

2- Material and Methods:

2-1- Sampling:

The sampling sites are shown in Fig.1. surface sediments were collected during Mar 2011 up to *Feb* 2012 were collected with a grab sampler, and the top 3-5cm surface layer was carefully mixed with a stainless steel spoonful and stored in cleaned aluminum jars. The jars had been stored at -20Cº before being air dried. The dried sediment samples were then sieved to obtain fine powder(mesh:1mm).

2-1-Extraction of PAHs from sediments :

Ten grams of sediment samples was extracted by ultrasonication method . Sediments were extracted twice in 100 mL of acetone and Dichloromethan DCM (1:1) mixture . During the sonication, the water in the ultrasonic bath was replaced to prevent overheating (12). The clean-up was performed by passing the extract through a silica gel column. Non-saponified lipids and other complex components that interference with sample matrix must be removed by chromatographic column. 8gm of silica gel(70 -150 mesh) was placed in the glass column(10.5mm l.D. and 200mm length) followed by 4g neutral aluminum oxide and 1-2cm anhydrous sodium sulphate. Activated copper powder was added of top column to reduced sulphur (13).the extracts were concentrated to 2 ml and transferred to an amber vial(2ml), sealed and stored at −4C° until HPLC analysis.

2-4-chemical analysis of PAHs:

In present study, 16 PAH congeners, including naphthalene(Nep) Acenaphthlene (Acpy), Acenaphthene (Acp), Flourene (Flu), Phenanthrene (Phe),Anthracene (Ant), Fluoranthene (Fla), pyrene (Pyr), Benzo(a)Anthracene (B[a]A), chrysene (Chr), Benzo(b)Fluoranthene (B[b]F),Benzo(k)Fluoranthene (B[k]F), Benzo(a)pyrene (B[a]P), Dibenzo(a,- h)Anthracene (D[ah]A), Indeno(1,2,3-c,d)pyrene (IND), Benzo(g,- h,i)Perylene (B[ghi]P) were determined in sediment samples by high performance liquid chromatography(KNAUER) series system(UV/vis detector) and supelcosil LC –PAHs column(50 *4.6mm, C18, 3µm particles) at the college of Pharmacy /Babylon University. The mobile phase was acetonitrile and water(both HPLC-grade) in a linear gradient program 60% acetonitrile(0.3 minute) to100% (over 2.7 min)with flow rate 2ml/min, Detector(UV:254nm) five µl of sample was injected into a stationary phase capillary column. The peak in the chromatogram were identified by comparing of the retention time and spectra of standard with those in the sample (14).

2-2 Total organic carbon (TOC%):

TOC% was determined according to (15).

2-3 Grain size analysis of sediment:

Grain size analysis of sediment was determined according to Hydrometer method as described by(16).

2.4. 2-5- Calculation and Statistical analysis:

Quantifications of PAHs were done using external standards, based on five-point calibration curves for individual compounds according to (14). Data analysis using statistical methods was performed by SPSS program were used to determination of significant differences(LSD) by one-way analysis of variance (ANOVA).in addition,

test the relationship between sediment characteristics particle size, TOC and ΣPAH

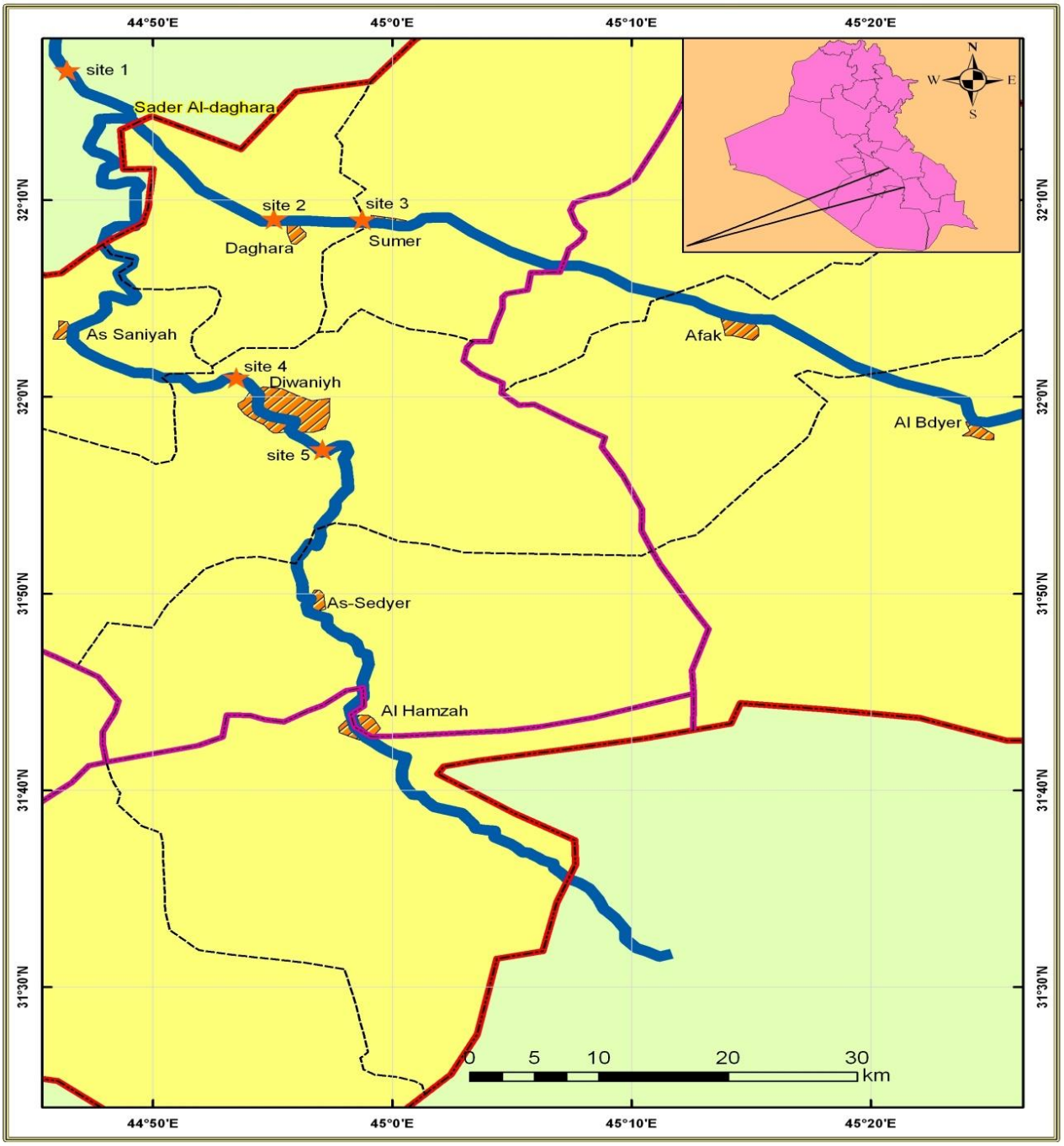

Fig. (1): Map represents study sites on Hilla ,Diwaniah and Daghara rivers.

(Geographical information systems unit(GIS) /College of Art. Al-Qadissiah Univ).

3-Results and Discussion:

3-1-PAHs concentrations in sediment:

Sixteen PAHs were identified and quantified in sediment samples of both Diwaniyah, Daghara and Hilla rivers by HPLC chromatogram peaks. The significant of PAHs concentration in sediment samples were demonstrated between months and stations. Annual mean concentration of total and individual PAHs, rang and ± SD of individual and carcinogenic PAHs(cPAHs) listed in table (1).The results of current study(Fig.2) showed that high and low concentration of total PAHs ranged between (2.19--354.55ng/g dry weight) were recorded at St.1 on Hilla river during *Aug*. and

St.5 on Diwaniyah river through *Mar*. respectively. with annual mean concentrations of ΣPAH ranged between (37.4 -90.7 ng/g) at Hilla river and St.5 on Diwaniyah river respectively. The statistical analysis referred to significant differences for total PAHs among months ($LSD_{0.05}$=54.4) and not significant were detected among Stations. The maximum concentration of individual PAH were detected of Pyrene (96.9ng/g)at St.2 on Daghara river while others PAHs no detected during some months especially, that those PAHs have high molecular weight such Benzo(k)Anthracene ,Benzo(ghi)Pyrelene and Indeno(1,2,3-c,d)pyrene with annual mean concentration (12.87 , 0.22) were recorded for Pyrene and IND respectively .

The monthly variation of sum concentration ∑PAHs in sediment samples(Fig.2) showed that high concentration of total PAHs (142.8, 326.2, 212.18, 190.6,354.55 ng/g) were observed during *Mar*. for Hilla and Daghara river (St.2,3) and Diwaniyah river(St.4&5) respectively, so winter and spring months at every station were much more than hot months specially on *Aug*. which were decreased to (2.19, 6.5 , 10.55 , 8.97, 10.3ng/g) respectively. This unique seasonal variations could be attributed to increasing of automobile number , bricks and asphalt factory, changes of discharge capacity, flow rate, section river area as well as its resuspension into the river water column, sedimentation process, adsorption, accumulation and the pollutants sorbed on the sediment particles may be increased by many sources of PAHs. The internal space heating and industrial emissions were the dominant source of PAHs in the atmosphere (17 ,18). Atmospheric deposition , with higher levels of PAHs in the wet weather season probably due to precipitation, runoff and wind direction especially for low molecular weight PAHs(such as Nap. mostly derived from motor vehicle emissions and wood combustion(19).

Hilla river pass through agriculture regions only from Hashimiah town to Ssder AL-Daghara village while Diwaniah and Daghara river traverse suburban regions with high relatively of human activities as well as both rivers are down stream of Hilla river (figure 1) This finding is consistent with studies from other geographical locations (13). Therefore, the results of present study were elevated by comparison with results's Al-Taee (11). So our results in these rivers were lower than others rivers in the world for example, (in China) Shi *et al*., (2005)(21) find that concentration of 16 PAHs in Tianjin river were ranged (1.943-787 ng/g). whereas, in sediment of Haihe River were between 255.4-775 ng/g.(22).while in India PAHs concentration ranged among (5.24- 3722.8 ng/g.dw).in Gomti river sediment(34), also (13) find that the concentration of polycyclic aromatic hydrocarbons in surficial sediment was (29 -5375ng/g) in the Savanah river (USA).

Organisms living in PAH-contaminated environments can absorb these compounds through their body surface and gills or by ingestion of contaminated sediment or particles and then transfer contamination through the aquatic food web. Therefore ,determination of sediment associated PAHs is necessary of ecological risk assessment ,biological effect level, bioavailability of PAHs and biological sediment accumulation factor(BSAF) for aquatic organisms especially, deposit feeder or infaunal species in aquatic ecosystem. Based on the correlation between impacted river environments and the occurrence of PAHs in sediments, (23 ,24) suggested classification criteria whereby an area is considered "highly contaminated" when concentrations of total PAHs are higher than 500 ng/g, "moderately contaminated" when concentrations range from 250 to 500 ng/g and "slightly contaminated" when concentrations are lower than 250 ng/g. These criteria have often been used to assess the level of contamination of sediments (25,26 and 27).

According to these criteria, the sediments of Hilla river at St.1(Σ16PAHs = 142.8 ng/g) is slightly contaminated while St.2, 5 on daghara and Diwaniah rivers (Σ16PAHs = 326.21 ,354.55 ng/g) respectively which are locate within urban, suburban and industrial areas, were classified as moderately contaminated by PAHs. Seven carcinogenic PAHs are known to be risk to aquatic animals in sediment were observed with annual mean concentration(5.7 , 6.1, 5.5, 6.2, 7.4ng/g) in Hilla, Diwaniyah and Daghara rivers respectively. Benzo(a)Pyrene as a key of carcinogenic(cPAHs) was recorded high concentration (18.2ng/g) in this group on Hilla river during *Mar*. with high mean concentration(1.33ng/g). this results were lower than those in Dongjiang river(south China). The sum of these seven PAHs (ΣPAH_7) concentrations ranged from(330-1410ng/g) at 47 location on sediment (28), which are much more than in branches of Hilla river sediment.(29).

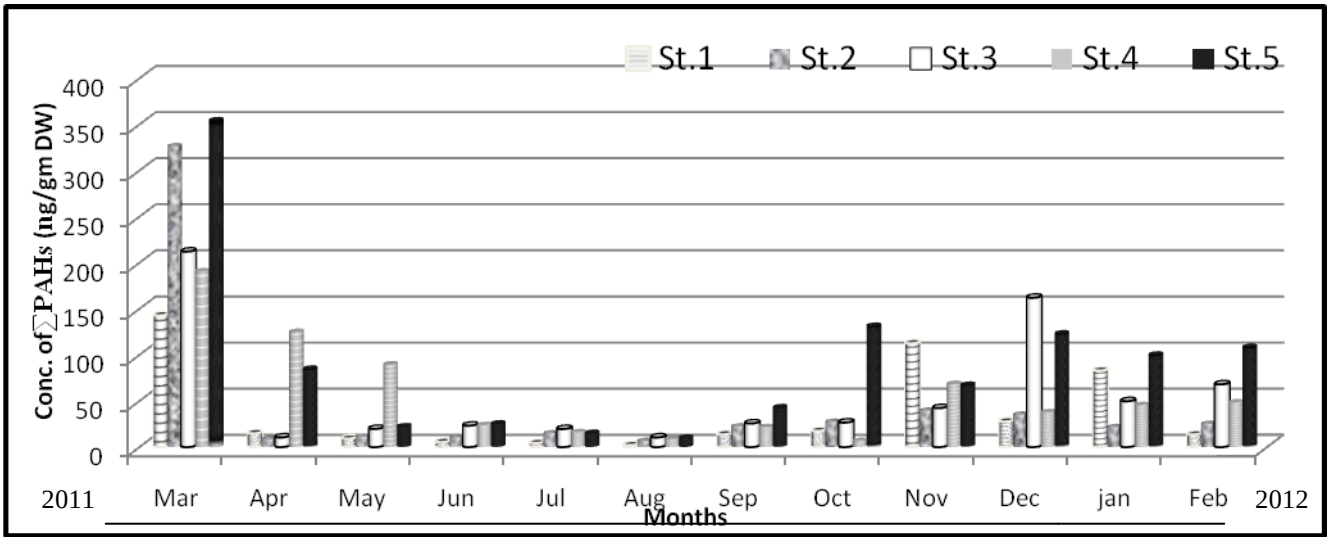

Fig.(2): The monthly variation of sum concentration ∑PAHs in sediment samples at study stations from *Mar*.2011-*Feb*.2012.

Table (1):Annual mean concentration (ng/g) of 16 PAHs ,rang and mean±SD of individual PAH and carcinogenic(cPAHs) in sediment of study stations during (*Mar*.2011-*Feb*.2012).

Stations / PAHs(ng/g)	Hilla river	Daghara river		Diwaniah river		Mean conc.
	St.1	St.2	St.3	St.4	St.5	
Nap	0--54.4 9.2±15.8	0.76 -60.76 8.54±16.6	1.45-76.2 16.3±22.6	0-37.96 10.11±10.63	1.8-76.4 16±20.3	12.1
Acpy	0.14-28.75 5.7±8.5	0.05-62.03 9.6 ±17.6	1.61-59.4 13±17.1	1.5-34.86 11.4±11.7	2.2-68.46 15.9±18.6	11.14
Acp	0.05-5.9 1.2±1.6	0.05-4.03 0.99±1.14	0.26-5.36 2.1±1.7	0.32-2.96 1.7±1.4	0.36-7.05 2.2±2.33	1.6
Flu	0.13-8.24 1.6±2.5	0.24-13.1 1.9±3.61	0.14-12.37 2.1±3.5	0-6.3 1.8±1.9	0.12-18.32 6.6±6.95	2.8
Phen	0.023-1.3 0.4±0.5	0.06-2.1 0.44±0.6	0.1-2.8 0.7±0.8	0.1-2 0.76±0.8	0.1-5.3 1.5±1.7	0.8
Ant	0.1-8.21 1.4±2.3	0.21-12.66 1.8±3.5	0.42-16.62 3±4.65	0.31-15.98 4.6±4.8	0.8-18.92 5.9±5.4	3.32
Fla	0.03-8.48 1.8±2.5	0.14-5.72 1.4±1.7	0.33-18.5 3.4±5.3	0.22-18.2 3.85±5.1	0.9-31.06 8.3±8.96	3.76
Pyr	0.53-41.2 10.02±15.1	1.62-96.9 12.4±26.74	1.3--20 7.6±5.3	1.77-40.1 14.5±22.7	2.2-57.63 19.9±20.3	12.87
BaA	0.05-4.94 0.92±1.5	0.07-6.1 0.84±1.7	0.1-2 0.9±0.7	0.13-1.71 1.1±1.73	0.11-4 1.35±1.2	1.02
Chry	0.04-1.8 0.33±0.5	0.041-24.21 2.53±6.9	0.084-16 2.3±4.5	0.3-12.48 2.2±3.35	0.4-53.58 6.9±14.8	2.85
BbF	0.14-1.94 0.6±0.54	0.09-2.3 0.5±0.6	0.17-4.4 1.2±1.5	0.4-5.71 1.2±1.6	0.2-7.5 1.85±2.4	1.1
BkF	0.1-2.51 0.5±0.7	0.08-4.1 0.6±1.13	0-4.22 0.8±1.2	0- 2.66 0.6±0.7	0-6.96 1.2±1.9	0.73
BaP	0.08-18.2 1.9±5.1	0.1--12.4 1.7±3.64	0.02-7 1±1.93	0-7.2 1.2±2.1	0-2.4 0.8±0.8	1.33
DbA	0.1-- 4 1.3±1.5	0.11--8 1.2±2.2	0.11-5.3 0.9±1.4	0-6 1.2±1.7	0.08-6.2 1.5±2	1.21
BghiP	0--1.14 0.4±0.43	0--9.4 0.9±2.7	0-3.04 0.4±0.86	0-3.2 0.6±0.92	0.1-1.14 0.5±0.4	0.6
IND	0.08-0.3 0.2±0.1	0.02-2.5 0.3±0.7	0-1.5 0.2±0.45	0-1.48 0.3±0.45	0.1-0.6 0.12±0.2	0.22
Annual mean of ∑PAHs	**37.4**	**45.7**	**55.9**	**56.9**	**90.7**	--
Annual mean of cPAHs	**5.7**	**6.1**	**5.5**	**6.2**	**7.4**	--

Note : Carcinogenic(c PAHs) are darkens squares .

3-2- Sources of PAHs in the sediment:

Different sources of PAHs have different PAHs patterns. anthropogenic PAHs are formed mainly via two mechanisms: incomplete combustion of fossil fuels and discharge of petroleum-related materials. In current study (fig.3) show the sources of PAHs in the sediment of Hilla, Diwaniyah and Daghara rivers sites were assessed by the isomer ratios of individual PAHs compound Fla/(fla+Pyr), BaA/BaA+Chry) ,Ant/(Phen+Ant),according to molecular weight (yunker ,2002).

The ratio of Fla/(fla+Pyr), ranged between(0.1-0.3) at St. 2 and St.3in same river respectively .while BaA/BaA+Chry) ratios between(0.16 -0.73) were recorded at 5 and St1 also respectively. The ratio of Ant/(Phen+Ant), were close to each other is (0.75-0.84) at St1 and St4 respectively, while was (0.11-0.22) at St.3 and St.1 respectively with the mean concentration of (0.17).

(6) they suggested that a BaA/(BaA+Chry) ratio <0.2 indicates petrogenic sources, a ratio between 0.2 and 0.35 indicates a mixed origin, and a ratio >0.35 implies pyrogenic sources. A ratio of Fla/(Fla+Pyr) <0.4 is consistent with petroleum inputs; a value between 0.4 and 0.5 indicates liquid fossil fuel (vehicle and crude oil) combustion ;and a ratio >0.5 implies grass, wood, or coal combustion.

To determine the sources of PAHs in sediment sample, Fla/(Fla+Pyr) against Ant/(Ant+Phe) and BaA/(BaA+Chry).The ratios of Ant/(Ant+Phe) in present study were 0.75-0.8 >0.1, suggested that a pyrolytic origin. while BaA/(BaA+Chry) ratio was(0.16-0.74)indicated that to mixed sources as pyrogenic and petrogenic at all stations. Fla/(Fla+Pyr) ratio was 0.1-0.3>0.1 suggested that key source as pyrogenic origin.

Previous study focused on differences of PAHs sources with changes of ignition temperature, At low to moderate temperature such as wood and coal combustion the low molecular weight of PAHs compounds are abundant (30). while at high temperature, the high molecular weight parent PAH compounds are dominant (31). Therefore, on account of the anthropogenic source, the low molecular weight parent PAHs have both petrogenic and combustion (low temperature pyrolysis) sources, whereas the high molecular parent PAHs are predominantly pyrogenic. In Al-Qadissiah province there are 28 bricks and asphalt factories which are operating by fossil fuel and then release huge amount from soot and gases emissions (32). furthermore, we demonstrated many pipe of municipal wastewater were discharge directly to these rivers and several vehicles washing places randomly distributed along rivers, as well as textile and tire factories at south Diwaniyah city(St.5), all these sources and others may be as mainly sources of PAHs in study region.

3-3- Composition pattern in the sediment:

The percentage composition of 2,3,4,5-6 rings in the sediment samples of study stations show in figure (4) and table(3) according to ring number and molecular weight. 2-3ring PAHs include Nap, Acyp, Acp, Flu ; Phen and Ant ranged between (50.97-53.11%) at St.2 and St.3 on Daghara river ; 4-ring PAHs include Flu Pyr, B(a)A and Chry were represented (25.28 to 40.28%)at St.3 and St.5 ;high molecular weight 5-rings PAHs include B(b)F,B(k)F ,B(a)P and DbA, were recorded (5.9 - 11.32%) at St.5and St.2 while 6-ring are IND and B(ghi) were(0.66- 2.71%) at St.5 and St.3. The compositional pattern of PAHs in sediment samples was studied by ring number and molecular weight of PAHs compounds. Table(4) show the monthly

changes of percentage 2-3,4.5,6 ring to total PAH in the sediment samples which were fluctuated during study period. low molecular weight (2-3)rings was formed high ratio (82.9%) to total PAHs during *May* at St.4 while low percent was 17.42% at St.2 during *Apr*. however, HMW 4,5,6 rings have more than ratios of LMW at some station ,4ring was recorded (10.04-69.7%) at St.1and St.5 during *Apr*.and *Oct*. respectively. The percentage of 5-rings was ranged (1.55-24.5%) at St.1and St.2 during *Nov*. and *Feb*. also respectively. maximum ratio of 6 ring compounds in sediment sample was (7.3%) at St.1 during *Feb*. while no detected in some stations and months. PAH composition pattern is helpful to determine the contaminant source and illustrate the fate and transport of PAHs in multimedia environment (33). Different sources of PAHs have different PAHs patterns. In current study 2-3 ring such Nap, Ant and Ant was dominant in all station due to incomplete combustion of fossil fuels and discharge of petroleum-related materials. At high temperature, the high molecular weight parent PAH compounds are dominant (31). These results are in accordance with that reported by (21&34).

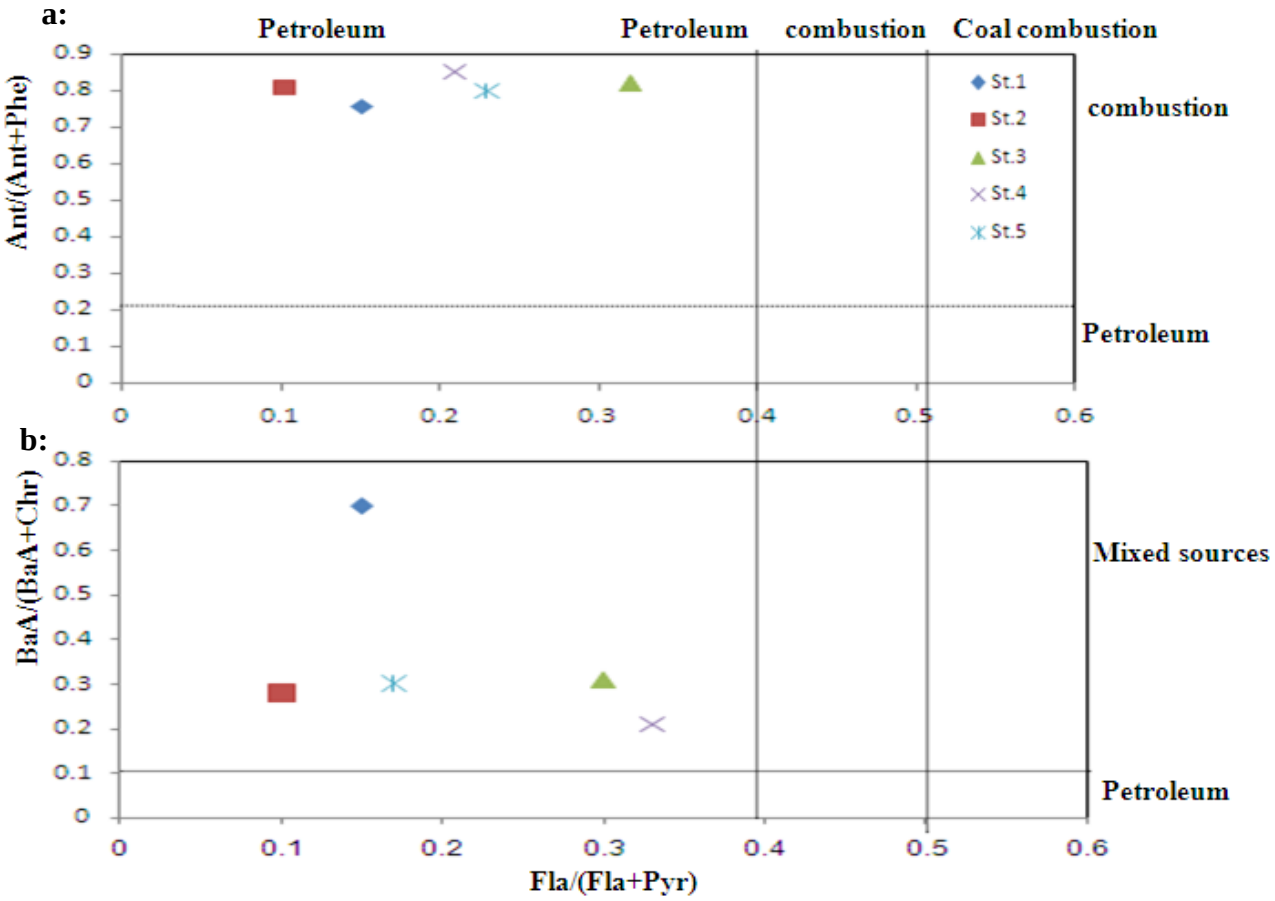

Fig.(3): PAHs Cross plot for the isomer ratio of a. Fla/(Fla+Pyr) versus Ant/(Ant+Phe) and b. Vs. BaA/(BaA+Chr) in sediment .Yunker,(2002)

3-4: Total Organic Carbon and Grain size in the sediment:

Monthly variations of total organic carbon(TOC%) in the sediment samples by table(2). The concentration between (0.4 -3.5%) were recorded at St.1 during *Jul*. and St.5 on *Mar*. respectively with the annual mean percentage of(0.99%). The

statistical analysis referred to significant relationships of TOC % concentration with the total PAHs in the sediment($r=0.6$, $P<0.01$).

The results of current study in figure (5) shows percentage of sand, silt and clay of sediment samples collected from study stations. Sandy grain was abundant in all stations. high ratio of sand (75.4%)were recorded at St.1whil lowest ratio (64.4%)were recorded at St.5. the percentage of silt and clay were not significant difference with station because of similarity of study region nature . maximum and minimum ratio of silt were(17.4, 13 %) at St.1,4 and (22.6, 9.4%) at St. 1, 5 respectively.

The relationship between total PAHs on sediments and organic carbon content was significant only in highly contaminated sites where total PAHs concentration was in excess of 2 µg/g.(35 ,36). the sorption of PAHs to sediment will be affected by both organic matter content and the inorganic matrix e.g., clay minerals (37).furthermore, pH, salinity, desorption, sedimentation and PAHs concentration in water column. the microorganism activities in surface sediment will be mineralized of PAHs. So the distribution of PAHs in sediment was not correlated with grain size .therefore , our results were compatible with others studies on sediment of Euphrates river.(10)and (29) in Hilla river.

4-Conclusion:

The concentrations of total PAHs were higher for the sediments of urban and industrial areas, represented by the Diwaniah and Daghara rivers, while sediments from the Hilla river showed significantly lower concentrations. The predominance of Phe, Flu, Pyr and Nap suggests that municipal sewage may be a significant source of PAHs as well as pyrogenic sources by fusil fuel and biomass incineration. PAHs associated sediment higher than those presence in overlying water in Hilla ,Diwaniah and Daghara river according to our previous study on same river section(20).

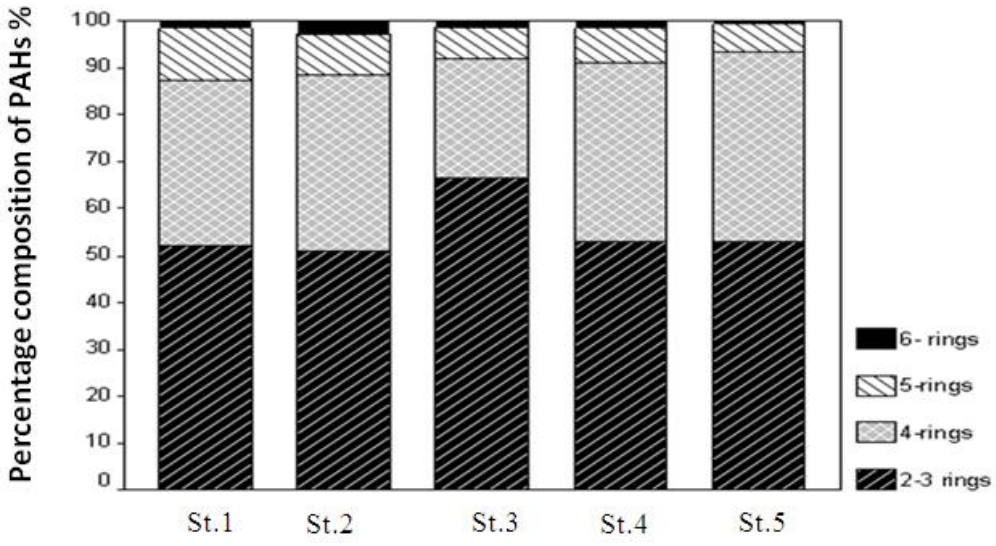

Fig.(4) percentage composition of 2-3,4,5-6 rings in the sediment samples of study stations .2-3ring PAHs include Neph, Acyp, Acp, Flu ; Phen and Ant ;4-ring PAHs include Flu Pyr, B(a)A and Chry,; 5-rings PAHs include B(b)F,B(k)F ,B(a)P and DbA, 6-ring are B(ghi)P and IND.

Table(2):monthly changes in the percentage of Total Organic Carbon (TOC%) in the sediment samples of study stations.

Stations	TOC%				
	Hilla River	Daghara River		Diwaniah River	
Months (2011-2012)	**St.1**	**St.2**	**St.3**	**St.4**	**St.5**
Mar.	2.4	2.6	3.2	1.6	3.2
Apr.	2.2	1.5	1.4	0.4	0.6
May	1.4	1.6	0.6	0.8	1.6
Jun	2.1	1.2	1.6	1.3	1.8
Jul	0.4	0.8	1.6	1.3	1.4
Aug	1.2	1.2	1.7	1.2	1.3
Sep	2.6	2.2	1.6	1.4	2.6
Oct	2.4	2	2.2	1.6	2.2
Nov	2.8	1.6	3	1.2	2.9
Dec	1.4	0.4	1.2	0.2	3.2
Jan	1.7	2.6	1.4	0.8	2.4
Feb	2.2	2.6	2.8	1.8	2.6

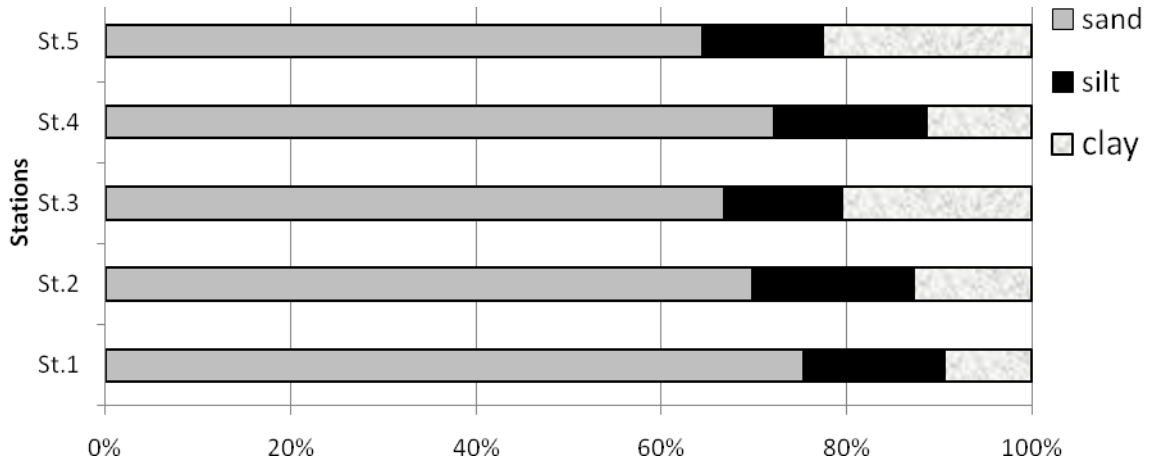

Fig.(5): Grain size analysis of Hilla, Diwaniyah and Daghara rivers sediment during the study period(*Mar*.2011-*Feb*.2012).

Table(3): Monthly percentage variation of 2-3,4,5,6 rings in sediment sample during study period (*Mar*.2011-*Feb*.2012).

Stations		No. Rings	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
St.1	LMW	**2-3**	45.14	52.3	68.6	43.2	58.7	33.3	58.1	43.7	74.9	54.1	34.8	41.2
	HMW	**4**	36.4	36.7	10.04	30.5	17.3	36.99	34.2	51.8	22.53	19.5	55.4	30.92
		5	18.6	9	17.7	19.4	18.4	24.6	6.3	3.93	1.55	21.2	8.1	20.6
		6	0.15	2	3.7	6.82	5.6	5	1.3	0.6	0.98	4.9	1.73	7.3
		∑	55.15	47.7	31.44	56.72	41.3	66.59	41.8	56.33	25.06	45.6	65.23	58.82
St.2	LMW	**2-3**	49.15	17.42	60.6	51.83	36.4	45.32	37.2	41.7	74.4	77	52.3	54.99
	HMW	**4**	38.56	75.5	23.4	33.2	56.9	45.2	53.4	53.4	17.8	18.4	30.5	19.2
		5	8.52	5.2	13.1	11.2	5.9	8.2	8.05	4.8	6.9	4.3	13.4	24.5
		6	3.8	1.87	2.8	3.7	0.86	1.3	1.4	0.07	0.85	0.3	3.8	1.3
		∑	50.88	82.57	39.3	48.1	63.66	54.7	62.85	58.27	25.55	23	47.7	45
St.3	LMW	**2-3**	66.5	48.9	64.6	64.1	40.6	70.14	36.5	41.1	77.14	75.1	69.22	70.1
	HMW	**4**	21.6	41.9	25.6	23.5	46.97	19.24	53.6	52.98	20.7	19.6	24.5	24.3
		5	9.7	9.15	9.2	10	11.4	9.8	8.9	5.9	1.7	4.8	5.3	4.2
		6	2.2	0	0.44	2.4	0.96	0.7	0.89	0	0.35	0.4	0.6	1.35
		∑	33.5	51.05	35.24	35.9	59.33	29.74	63.39	58.88	22.75	24.8	30.4	29.85
St.4	LMW	**2-3**	49.7	21.2	82.9	70.5	45.8	51.6	58.6	34.4	60	69.8	55.5	62.12
	HMW	**4**	38.03	73.4	12.1	20.7	41.94	35.9	30.1	42.3	31.13	22.42	33.3	31.6
		5	9.93	3.7	4.65	7.2	10.8	10.14	9.2	23.1	8.66	7.8	9.1	3.93
		6	2.5	1.7	0.3	1.6	1.4	2.2	2.1	0	0	0	2.1	2.6
		∑	50.46	78.8	17.05	29.5	54.14	48.24	41.4	65.4	39.79	30.22	44.5	38.13
St.5	LMW	**2-3**	54.3	49.6	57.6	64.7	54	52.2	37.9	23.1	77.9	49.7	65.7	67.6
	HMW	**4**	41.3	38.8	23.2	24.1	35.6	38.9	51.7	69.7	20.2	38.1	30.7	29.9
		5	4.35	9.5	17.8	9.13	7.8	7.1	8.2	6.3	1.7	11.5	3.1	2.23
		6	0.11	2.1	1.33	2.1	2.5	1.7	0.21	0.8	0.15	0.64	0.45	0.26
		∑	45.76	50.4	42.33	35.33	45.9	47.7	60.11	76.8	22.05	50.24	34.25	32.39

Note : ∑is for 4,5,6 ring only.

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تواجد ومصدر بعض المركبات الهيدروكربونية الاروماتية متعددة الحلقات في الرواسب السطحية لنهري الديوانية و الدغارة/العراق.

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الخلاصة

نفذت الدراسة لبيان تواجد بعض المركبات الهي دروكوبونية الاروماتية متعددة الحلقات(PAHs), ومصادرها المحتملة في الرواسب السطحية لنهري الديوانية والدغارة في محافظة القادسية/العراق خلال الفترة من آذار 2011 إلى شباط 2012 جمعت عينات الرواسب من خمس محطات توزعت بواقع محطتين على كل نهر ومحطة أضافية على نهر ا لحلة لغرض المقارنة.تم تشخيص وقياس تركيزات هذه المركبات (PAHs) على عينات الرواسب باستخدام جهاز الكروماتوغرافيا السائل عالي الكفاءة HPLC .أظهرت نتائج الدراسة أن مدى تراكيز ال PAHs بلغت(2.19--354.55 ng/g))سجلت في نهر الحلة خلال شهر اب ونهر الديوانية في المحطة 5 خلال شهر آذار على التوالي . تراوح المعدل ا لسنوي لتراكيز هذه المركبات(37.4-90.7 ng/g) في نهري الحلة والديوانية على التوالي ،سجل مركب ال Pyrene أعلى تركيز (96.9ng/g) بين المركبات الأخرى . أظهرت نتائج التركيب النوعي للمركبات ارتفاع نسبة المركبات ذات الأ وزان الجزيئية الواطئة بالنسبة للمجموع الكلي على حساب المركبات ذات الأوزان الجزيئية العالية .كما شخصت المصادر الرئيسية للتلوث بهذه المركبات في منطقة الدراسة على أنها ذات أصل نفطي وحراري.وصنف نهري الديوانية والدغارة على أنها معتدلة التلوث أما نهر الحلة فكان ملوثا بدرجة اقل بهذه الملوثات . إن محتوى رواسب الأنهار في مواقع الدراسة من المادة العضوية تراوح بين(0.2-3.2%)أظهرت دراسة التوزيع ألحجمي لحبيبات لرواسب أن الطبيعة الرملية كانت هي السائدة .أما العلاقة مابين تراكيزالPAHs الكلية مع محتوى المادة العضوي ة فكانت ايجابية ولكنها لم تكن كذلك مع توزيع حبيبات الرواسب.