

The study of some PAHs compounds in two species of clams in Euphrates River at Al-Hindiya city – Iraq.

Awaz B. Mohammed¹, Maysoon M.S. Al-Tae², Fikrat M. Hassan³

¹ Dept. Biol – Coll. Sci. kirkuk Univ, kirkuk, Iraq

² Dept. Biol – Coll. Sci. Babylon univ, Hill'a, Iraq.

³ Dept. Biol. Coll. Sci. for women, Univ. Baghdad, Baghdad, Iraq

Abstract

The present study was conducted on the Euphrates river in Al-Hindiya city river during Jul.2005 to Jun.2006. The study was included measure the concentration and distribution of some Polycyclic Aromatic Hydrocarbons (PAHs) and predict their sources in the samples of two 4species of fresh water clams(*Unio tigridis* Muller 77 and *Pseudodontopsis euphraticus* Bourguigant 1852). The lowest value among PAHs was 0.05ng/gDW for Naphthalene in clam *U. tigridis*, while the highest value of 325ng/gDW was for Benzo(ghi) Perylene in clam *P. euphraticus*. The results of statistical analysis rerffered to non significant differences in the concentration of PAHs in both species of clams and aquatic plants, while significant differences were recorded among seasons with the exception of Naphthalene. The lowest value of (0.05ng/gDw)was recorded for 2 ring-PAHs in *U. tigridis*, While the highest value of (427.28ng/gDW) for 5 ring-PAHs in *P. euph raticus* .The fat content of clams was determined and the values were between (0.8-1.5 ng/gDW) recorded during summer and autumn in *U. tigridis* and *P. euphraticus* The accumulation potential of PAHs in aquatic organisms were also investigated .

Key words :PAHs ,Clams,sources,accumulation

introduction

Polycyclic aromatic hydrocarbons are wide spread ubiquitous cotaminants in the environment [1]Water pollution by PAHs is believed to be associated with direct discharges from industrial processes ,municipal effluents and domestic sewage[2,3]. The sources of PAHs are both anthropogenic and natural in origin and include several source classes, mainly pyrogenic, petrogenic and diagenic [4,5]Several PAHs molecular ratios such as methyl phenanthrene/ phenanthrene (Mphe / phen), fluoranthene / pyrene, (flur / py), anthracene \ chrycene (An /Chry) and Benzo (b) Fluoranthene \ Benzo (k) fluoranthene (BbF / BkF) [6,7,8]were used to determine the emission source Clams have the ability to live in polluted environment and can be the useful indicators of pollution[9,10]. Bivalves tend to accumulate high levels of PAHs rather than detoxify or modify them. This may be related with the lack or inefficient cytochrome P450 system responsible for detoxification of organic pollutants. Therefore, they have been recommended for water contamination bioaccumulation studies[10]. Because there is few or no data available for PAHs compounds in Euphrates river which usually act as receiver for sewage, industrial effluents and urban and agriculture runoff, it is quite essential to obtain data base for these compounds . The principal aims of the present work is to assess the water quality of Euphrates river before Al-Hindiya barrage to Al-Kifil city through: The qualitative and quantitative determination of PAHs in two species of fresh water clams (*Unio tigridis* and *Pseudodontopsis euphraticus*).

Tools & Methods

Study area:

Figure (1) shows the site on Euphrates river under study . site was selected after passing the river a long Al-Hindiya city adjacent to populated area. two species of clam *U. tigridaes* and *P. euphraticus* were collected ,washed with tap water.

Determination of PAHs in Clam :

Extraction Procedure:

1-Samples of both species of clam were allowed to thaw at room temperature.

2-Twenty five individuals of each sample were used with three replicates .

3-Soft tissues of clam were removed and put in mixer for homogenization[12].

4-About 10gm of the homogenate was placed in a thimble for soxholet extraction for 24 hr. with 250 ml hexan and amount of anhydrous sodium sulphate were added for removing water [13].the several steps of clean up were done ,then the extract was dried and dissolved with acetonitril for anankysis.

Lipid determination

According to the results of previous studies, it was found that there was positive correlation between lipid content and corresponding total PAHs level (Kayal and Connell, 1995; NOAA, 2000).

- 10 gm of wet homogenate tissue was put in a thimble with addition of anhydrous sodium sulphate and place in an extractor apparatus .

- 200 ml of hexan were put in the pre-weighed flask for extraction(24 hr).

- Solvent allow to evaporate to dryness and re-weighed the flask.

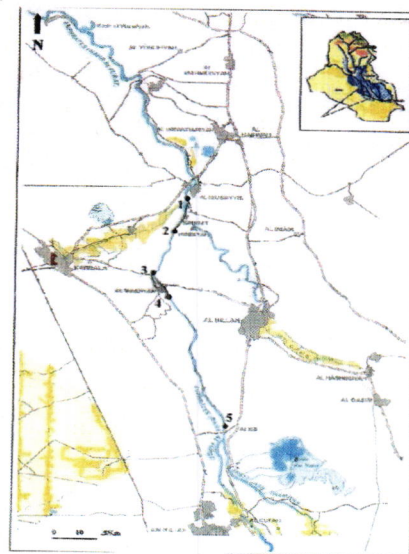


Figure (1) Map represents study sites on the Euphrates river

- The difference between the weight of flask refers to lipid content .

Blank

Laboratory reagents and glassware blanks were analyzed with each set of samples to check for interference that may have been introduced during the extraction and analytical procedure [1,4]. The aquatic organisms samples were re-extracted and treated as blank.

Calibration :

A standard solution of sixteen USEPA priority PAHs was obtained from Sigma-Aldrich company as PAHs calibration mixture in order to compare the retention times and spectra of compounds in the standard with those in the sample. The standard calibration contain the compounds: Naphthalene, Acenaphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a) anthracene, Chrycene, Benzo(b) Fluoranthene, Benzo(k) Fluoranthene, Benzo(a)pyrene, Dibenzo(a,h) anthracene, Benzo(ghi) Perylene and Indeno (1,2,3-cd) pyrene.

PAHs analysis :

The PAHs extracts of clam samples were analyzed by HPLC. The mobile phase was HPLC-grade acetonitrile and Distilled water in a linear gradient program .Ten µl of sample was injected into a stationary phase capillary column with a dimension of (15cm×4.6mm ID) and determined with UV detector at 254 nm . The flow rate

of mobile phase was kept at 1.5 ml/min. The peak in the chromatogram were identified by comparing of the retention time and spectra of standard with those in the sample.

Results and discussion

Clams have the ability to live in polluted environment and can be the useful indicators of pollution[9,10]. Bivalves tend to accumulate high concentrations of PAHs rather than detoxify or modify them. This may be related to the lack or inefficient cytochrome P450 ecosystem responsible for detoxification of organic pollutants. Therefore, they have been recommended for water contamination and bioaccumulation studies [10,14]. In the present study, we observed the community of clams in the Euphrates river during the sampling period which may be due to several environmental factors that are suitable for their growth. Among these are temperature, salinity, pH and the presence of calcium important for shell formation. Therefore these factors may influence the uptake, retention and translocation of PAHs in their bodies. Figure (2-5) and table(1&2) show the results of the present study.

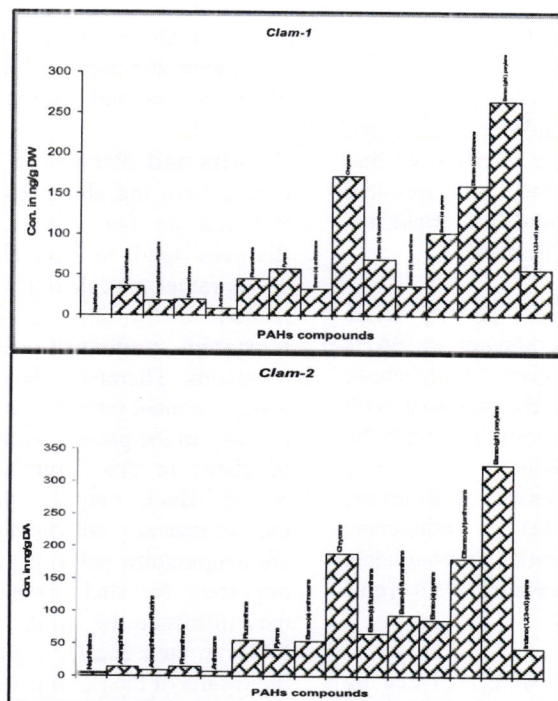
The lowest value among PAHs was 0.05ng/gDW for Naphthalene in clam *U. tigridis*, while the highest value of 325ng/gDW was for Benzo(ghi) Perylene in clam *P. euphraticus*. (Table 1 and figure 2).

Table(1): Seasonal changes in the values of PAHs (ng/g dry weight) in two species of clams (*unio tigridis* & *pseudodontopsis euphraticus*) collected from the river

<i>P. euphraticus</i>				<i>U. tigridis</i>				
Spring	Winter	Autumn	Summer	Spring	Winter	Autumn	Summer	
5.6	12.2	ND	3.6	ND	0.2	ND	ND	Naphthalene
3.3	9.7	29.0	11.3	43.7	24.0	50	25	Acenaphthalene
5.4	ND	ND	30.9	36.4	7.2	18.5	11.6	Acenaphthalene and Fluorene
4.5	28.1	7.6	16.2	58.2	8.76	5.5	7.6	Phenanthrene
7.0	6.7	4.8	7.5	12.4	7.6	4.6	6.8	Anthracene
83	58.3	50.7	24.8	ND	61.1	86.5	32.8	Fluoranthene
52.5	36.2	57.9	13.4	120.2	35.3	75.3	ND	Pyrene
81.5	44.5	67	21.0	37.4	44.2	46.2	4.0	Benzo (a) anthracene
252.3	149.3	241.7	110	240.4	147.3	255.9	43.7	Chrycene
112.9	65.1	85.1	ND	91.2	65.5	114.5	5.4	Benzo (b) fluoranthene
87.2	49.3	ND	239	83.6	53.8	ND	7.5	Benzo (k) fluoranthene
130	76.8	138	ND	120	49.5	168.3	69.2	Benzo (a) pyrene
ND	192	216.1	317.6	ND	120.8	204.6	314	Dibenzo (a,h)anthracene
295.6	533.3	432.1	41	233.2	425.1	324	75.5	Benzo (ghi) perylene
23.8	94.2	45.7	10.1	72	39.2	36.7	78.6	Indeno (1,2,3-cd) pyrene
1144.6	1355.7	1375.7	846.4	1148.7	1089.6	1390.6	681.7	Total PAHs

The lowest value of (0.05ng/gDw) was recorded for 2 ring-PAHs in *U. tigridis*, While the highest value of (427.28ng/gDW) for 5 ring-PAHs in *P. euph*

raticus (Figure 3). The fat content of clams was determined and the values were between (0.8-1.5 ng/gDW) recorded during summer and autumn in *U. tigridis* and *P. euphraticus* respectively .Several



Figure(2) :Mean concentration of PAHs compounds in the clam *Unio tigridis* and *Pseudodontopsis euphraticus* (clam1 and clam 2 respectively) collected from Euphrates river (site 4) during the study period (Jul.2005- Jun.2006)

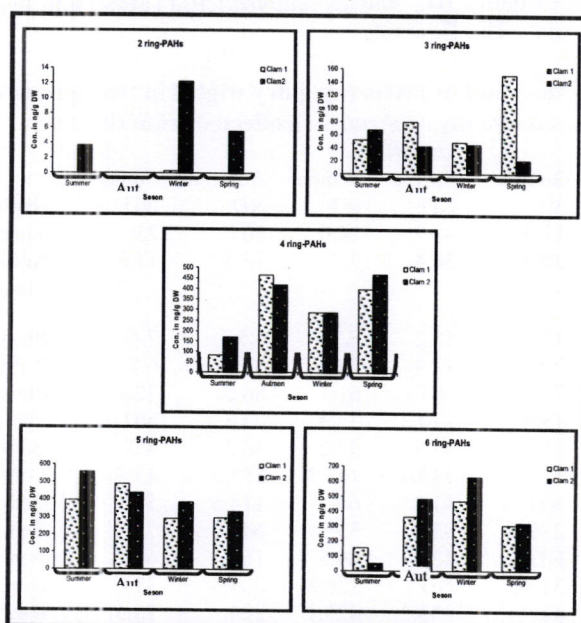


Figure (3): Seasonal changes in the mean concentrations of 2ring, 3ring, 4ring, 5ring and 6ring-PAHs compounds in the both types of clams *Unio tigridis* and *Pseudodontopsis*

PAHs accumulated in clam tissues several orders of magnitude higher than those in the water and sediments[15]. and the main routes for taking PAHs are through filtration of water for some times and ingestion of sediments[16].. Therefore, the patterns of PAHs distribution are similar to those in water and sediments.

The results referred to positive correlation between PAHs in both species of clams and those in water and sediments which dominated by high molecular weight PAHs(figure 4).

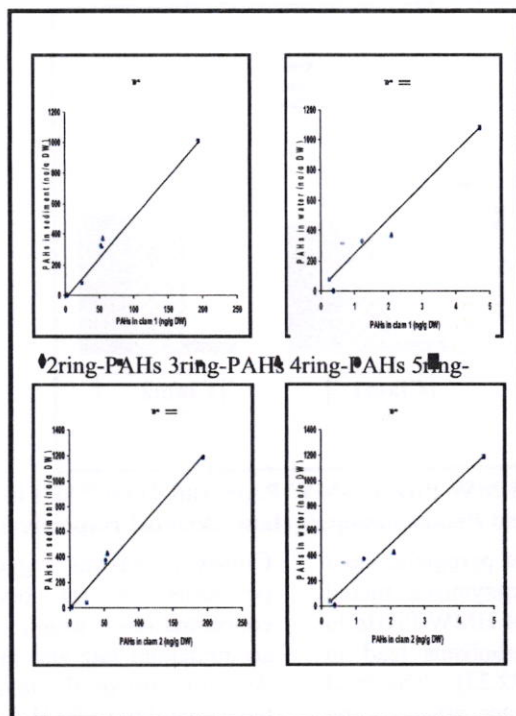
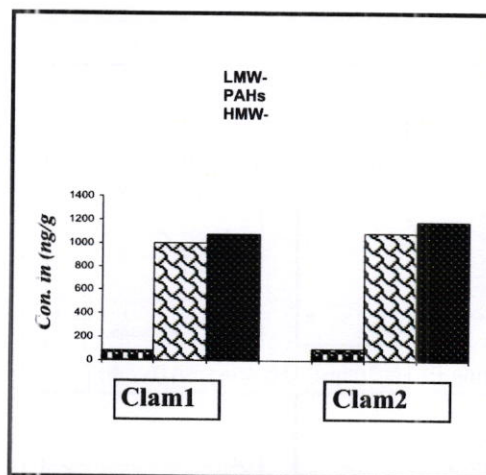


Figure (4): Relationship between the concentrations of 2ring, 3ring, 4ring, 5ring and 6ring-PAHs and total PAHs in the both types of clams *tigridis* and *Pseudodontopsis euphraticus* (clam1 and2 respectively) with those in water and sediment of Euphrates river.

This may be related to the low solubility of these compounds and resistance to microbial and photodegradation and biota metabolism. Therefore they tend to accumulate in the sediment and biota [17,18,19]. Similar results were obtained by Roper *et al.* (1997) [20], whom recorded the accumulation of Pyrene, Chrycene and Benzo(a) Anthracene. The present results referred to significant differences for PAHs in both types of clams with seasons which may be due to the change in different environmental factors as temperature, water concentrations that may influence the rate of different physiological processes in the clams. Therefore the concentrations of PAHs were expected to change [21]. High concentrations of PAHs in clams were recorded during the cold seasons rather than the hot seasons.

This may be related with the mechanisms as volatilization, photolysis, sedimentation and hydrological processes that may cause the variation in the concentrations of PAHs in water and sediments and thus the concentrations of PAHs in clams. In general wide range of physical (rate of mixing, rate of sedimentation,

diffusion of pollutant between sediment pore water and water column and resuspension), Chemical (pH, sediment organic content, organic matter characteristics) and biological (Biotransformation, lipid content, organism size or age, organism behavior, diet as sediment ingestion, feeding mechanism and organism response to physicochemical conditions) factors that have the potential to affect the bioavailability of PAHs in the clam [17]. Some individual PAHs showed high concentrations during summer which may be related to the recent input from atmosphere or the loads of sewage effluents close to the site where the clams were collected. Also the procedures of extraction, clean-up, storage and condition of analysis, efficiency of HPLC were all the factors that affected the concentrations recorded. However the blanks of all reagents, glassware's and samples were done and recorded no contamination but few exception. In these cases the concentrations were almost corrected. The present results referred to high concentration for HMW-PAHs in comparison with low molecular weight PAHs LMW-PAHs in both species of clams (Figure 5).



Figure(5):Mean concentration of LMW-PAHs, HMW-PAHs and Total PAHs in both species of clams *Unio tigridis* and *Pseudodontopsis*(clam 1&clam2 respectively)

These results leads to the suggestion of pyrogenic input of PAHs. Also the lack of detoxifying enzymes as mixed function oxidase(MFO) and resistant of HMW-PAHs to microbial, photodegradation and metabolisms lead to their accumulation in the tissues [10,22,23]. The lipid content of tissues is an important factor affecting the concentrations of PAHs in the organisms [13,17,18]. Because of the lipophilic properties of PAHs, they tend to accumulate in the lipid. Therefore there is a positive correlation between PAHs concentrations and lipid content [11,24]. Similar correlation was recorded in present study ($r = 0.964$, $P < 0.01$) for *Unio tigridis* and ($r = 0.972$, $P < 0.01$) for *Pseudodontopsis euphraticus*.

Crosby (1998) was suggested that the accumulation of pollutants in fat body never reach the toxic concentrations which may be related to slow accumulation rate and the loss of fat by organisms that does not provide the toxic level. One way to assess the bioavailability of PAHs in the environment is to compare individual PAH concentration in the organisms to PAHs concentrations in water ($BCF = \text{concentrations of PAHs in organism} / \text{Concentrations in the water}$) and sediment ($BSAF = \text{concentrations of PAHs in organisms} / \text{concentrations in the sediment}$) as demonstrated by other researchers [19,26,27,28] (table2).

Table(2):BioConcentration Factors and BioSediment Accumulation Factors for PAHs in clams *tigridis* and *Pseudodontopsis euphraticus* (clam 1 & clam 2 respectively)

compound	Con.in water (µg/L).	Con. in sediment (ng/gDW)	Con. in clam1 (ng/gDW)	BCF	BSAF	Con. in clam2 (ng/gDW)	BCF	BSAF
Nap	0.42	4.55	0.05	0.12	0.12	5.35	12.83	11.76
Acpy	0.02	1.21	35.68	1784	320	13.33	666.5	110.16
Acp&Flu	0.09	3.98	18.43	204.8	50.16	1.98	22	22.81
Phen	0.05	16.57	20.02	400.4	13.1	14.1	282	8.51
Ant	0.12	3.93	7.85	65.42	1.98	6.5	54.17	16.39
Fluor	0.07	7.02	45.1	644.3	69.56	54.2	774.28	77.21
Py	0.04	11.47	57.7	1442.5	54.48	40.0	1000	34.87
BaA	0.06	7.20	49.61	826.3	49.61	53.5	891.67	74.31
Chry	0.69	29.40	171.83	249.02	63.32	188.33	272.54	64.06
BbF	0.15	11.78	69.15	531.9	63.59	65.78	506	55.84
BkF	0.49	10.75	36.23	73.94	36.53	93.87	191.19	89.31
BaP	0.88	19.98	101.75	115.6	55.17	86.2	97.95	43.14
DbA	0.61	21.36	159.85	262.1	120.85	181.43	297.43	126.61
BghiP	0.64	65.47	264.45	413.2	134.25	325.21	508.14	152.3
IND	0.63	32.66	56.63	89.88	18.78	43.45	68.97	13.3

The present results referred to BCF that ranged between (0.12-1784) in *Unio tigridis* for Naphthalene and acenaphthalene respectively and (12.83-1000) in *Pseudodontopsis euphraticus* for Naphthalene and Pyrene respectively suggested that HMW-PAHs were rapidly accumulated in tissues than LMW-PAHs

This may be related to the linear relation between BCF and water partition coefficient (K_{ow}). The high number, the more tendency to bioaccumulation and may be greater for HMW-PAHs. [17]. reported that the BCF

concentrations from (6-236) were recorded for clam *Rangia cuneata* and cited the concentration of (1000) for 3 ring-PAHs in Oyster. The present study results referred to the concentration of BSAF range between (0.12-320) recorded for Naphthalene and acenaphthalene respectively. [27]. cited that the concentration of BSAF for PAHs was 0.2 or less indicating no significant bioconcentration of PAHs from sediment. However the BSAF of PAHs from sea water were 10.3 to 1349 indicating low to moderate potential for accumulation of

PAHs from sediment . The concentration of BSAF less than 1 referred to lowered bioavailability of PAHs for organisms[26] . However several factors should be explained the decreased BSAF concentrations of some individual PAHs .These include differences in hydrophobic character between mussel lipid and sediment organic carbon, lack of steady state condition for clam, the sediment phase and the capacity of clam to assimilate some PAHs[28]. In comparison of PAHs in both species of clams recorded in the present study with

References

1. R.Doong, & Y. Lin, Characterization and distribution of Polycyclic Aromatic hydrocarbon contaminations in surface sediment and water from Gao-Ping river, Taiwan).*Water Research*, 38 (2004) 1733-1744.
2. B.X. Mai, J.M. Fu, G. Zhang, Z. Y.Lin, G .Min,; Sheng, & X.Wang, Polycyclic Aromatic Hydrocarbons in sediments from pPearl river & estuary, China : spatial and temporal distribution and sources.*Applied Geochemistry*. 16(2001) 1429-1445.
3. LZhu, ,J.Wang,, H.Shen,Pollution survey of Polycyclic Aromatic Hydrocarbons in surface water of Hazhou,China .*Chemosphere*.56 (2004) 1085-1095 .
4. M.Sander, , S. Sivertsen , G. Scott Origin & distribution of Polycyclic Aromatic Hydrocarbon in surficial sediment from the Savannah river.*Arch.Environ.Contam.Toxicol*. 43(2002)438-448.
5. S. Dahle,V.M. mastishof, G.G. Evenset. Polycyclic aromatic Hydrocarbons (PAHs)in bottom sediments of kara seashelf, Gulf of Ob and Yenisei Bay .*The science of total environment* 306 (2004)438-448.
6. R.J. Woodhead, R.J. Law, P. Mattiessen. Polycyclic Aromatic Hydrocarbons in surface sediments around England and Wales , and their possible biological significance.*Marine pollution Bulletin*. 38(1999) 773-790.
7. M.B. Yunker. L. R. Snowdon, R.W. Macdlaud, J.N.Smith,,M.G.Flowler,F.A.Malaghlin,A.L Danyashevskaya, , V. L.Petrova, G.L. Ivanov. Polycyclic Aromatics Hydrocarbon composition and potential sources for sediment samples from the beafort and Barents Seas.*Environmental Science & Technology*, 38(1996) 1310-1320.
8. W.J. Walker, R.P. McNutt, & C. K. Malsandk. The Potential contribution of urban runoff to surface sediments of the Passaic river. *Chemosphere*, 38(1999) 363-377.
9. T.K. Graczyk, R Faye, R Cranfield.. &, D.B. Conn .Recovery of water borne *Cryptosporidium parvum* oocysts by fresh water benthic clams *Cobacula fluminea*.*Applied & Environmental Microbiology* (1998)..
10. H.L. Phelps. Sources of bioavailable toxic pollutants in the Anacostica.Final report to the DC water resources researche Center,(2002).
11. S.Kayal&D.W.Conell.PolycyclicAromaticHydrocarbons in biota from the Brisbane river Estuary, Ausralia, *Estuarine*.40(1995) 475-493.
12. F.Gagnon,T.Tremblay,J.Rouette,J.F.Cartier.Chemil fish harvested on the north shoreof St.Lawrence river lower estuary .*Environmental Health Perspective*. 121 (2004) 1-9.
13. NOAA(National Oceanic and Atmospheric Administration), Contaminant levels in muscle of four species of recreational fish from New York,2000)
14. SFEI(SanFrancisco Estuary institute,Monitoring Results:Sediment monitoring. Report,1998.
15. Mohammed,A.B,Qualitative and Quantitative Studies of Some Polycyclic Aromatic Hydrocarbons (PAHs) and Limnology of Euphrates river from Al-Hindiya Barrage to Al-Kifil City – Iraq . Ph. D. Thesis,Univ. of Babylon,(2007),Babylon,Iraq.
16. J.M Roper, D. S Cherry, J.W. Simmers,& H.E. Tatem.Bioaccumulation of PAHs in the zebra mussel at Times Beach, Buffalo, NewYork.*Environmental Monitoring & Assessment*, 46, (1997) 267-277.
17. R.Eisler, Polycyclic Aromatic Hydrocarbon hazrds to fish, Wild life and vertebrates.Asynoptic review.US fish and wild ilfe service.*Biological Report*, 85,(1987)1-1).
18. EHC-202(Environmental Health Crteria). Selected non-heterocyclic aromatic hydrocarbon.*International Program on Chemical Safety*(1998).
19. Environmental Protection Agency (EPA). Bioaccumulation testing and interpretation for the purpose of sediment Quality assessment.Status and needs. USEPA. Bioaccumulation analysis Work group, Washington (2000).
20. J.M. Roper, D. S. Cherry, J.W. Simmers & H.E. Tatem. Bioaccumulation of PAHs in the zebra mussel at Times Beach, Buffalo, New York. *Environmental Monitoring & Assessment*, 46(1997) 267-277.
21. L.A. Helfrich, & R.J. Neves. Sustaining americasa aquatic biodiversity fresh water mussel: Biodiversity and conservation US Fish and Wild life Service. (2003).
22. N Kazanci, S Glrin,. Disribution of oligochaeta species as bioindicators of organic pollution in Ankara stream and their use in biomonitoring.*Zoology Journal*, 2 (1998) 83-87..
22. U. Kistro, & N. Irah, Role of Algae in fate of carcinogenic Polycyclic Aromatic Hydrocarbons in the aquatic environment. *Ecotoxicology & Environmental safety*, 41(1998)83-89.
23. J.F Narbone,, J.E Djomo,,D. Ribera, V. Ferrier, & P. Garrgues. Accumulation kinetics of Polycyclic Aromatic Hydrocarbons adsorbed to sediment by the mollusk *Corbicula fluminea*(1999).
24. T.H. AL-Saad,. Abase line study on the petroleum hydrocarbons pollution in Shatt Al-Arab river. M.SC. Thesis, Basrah Univ. (1983),Basrah, Iraq.
25. D.G. Crosby. *Environmental Toxicology and Chemistry*. New York, Oxford. (1998).

26. V.A. Mc Farland. Estimation bioaccumulation potential in Dredged sediment regulation. National sediment bioaccumulation Conference(1995)..
27. K.M. Brookes. Literature Review computer model and assessment of the potential

28. Environmental risks associated with creosote treated wood products used in aquatic environment. Westernwood preservers institute. (1997).
29. W.A. Thorsen, W.G. Cope, D. Shea. Bioavailability of PAHs : Effects of soot carbon and PAH source. Environmental Science & Technology, 38(2000)2029-2037.

دراسة بعض مركبات ال PAHs في نوعين من المحار في نهر الفرات من سدة الهندية - العراق

اواز بهروز محمد¹، ميسون مهدي صالح الطائي²، فكرت مجيد حسن³

¹كلية العلوم، جامعة كركوك، كركوك، العراق

²كلية العلوم، جامعة بابل، الحلة، العراق

³علوم نبات، جامعة بغداد، بغداد، العراق

الملخص

أجريت الدراسة الحالية على نهر الفرات ابتداء من سد الهندية إلى مدينة الكفل) حوالي 292 كم (وواقع خمس محطات موزعة على طول النهر للفترة من تموز 2005 ولغاية حزيران 2006. كما تضمنت الدراسة قياس تركيز وتوزيع بعض المركبات الأورماتية الحلقية ومعرفة أصل هذه المركبات في نوعين من محار المياه العذبة. *Unio tigridis* Muller 77 and *Pseudodontopsis euphraticus* Bourguigant 1852 كانت أقل قيمة بلغت 0.05 نانو غرام /غرام وزن جاف (للمركب نفتالين في المحار (*Unio tigridis*) بينما أعلى قيمة كانت 325ng /gDW للمركب Benzo(ghi) Perylene Benzo(ghi) Perylene في المحار. *P. euphraticus* نتائج التحليل الإحصائي تشير إلى عدم وجود فروقات معنوية لتراكيز ال PAHs في كلا النوعين من المحار بينما سجلت فروقات معنوية بالنسبة إلى الفصول. عدا مركب النفثالين..بلغت أقل قيمة 0.05 (نانو غرام /غرام وزن جاف (للمركب ثنائي الحلقة في المحار (*Unio tigridis*) بينما أعلى قيمة كانت 427.28 (نانو غرام /غرام وزن جاف (للمركب الخماسي الحلقة في المحار (*Pseudodontopsis euphraticus*). تم تقدير كمية الدهن في المحار وكانت القيم تتراوح بين 0.8 – 1.5 ملغم /غرام وزن جاف (خلال الصيف والخريف في المحار (*unio tigridis*) والمحار (*Pseudodontopsis euphraticus*) على التوالي وسجل ارتباط معنوي موجب بين كمية الدهن والتركيز الكلي لل (PAH) في المحار. اعتمادا على نتائج النسب (Phen/ Ant) و (Flur/py) و (Bap/ Bghip) و (LMW-PAH/HMW-PAH) فإن توزيع مركبات ال (PAHs) في الماء يأتي من أصل مصادر مختلفة (نفطي و حراري و هواء المد) وكذلك تم تقدير الجهد التراكمي لمركبات ال PAHs في نوعي المحار.