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N – alkanes in molluscs of Shatt Al-Arab river

W.A. Farid[1], H.T. Al-Saad[2] and A.H.Y. Al-Adhub[3]
[1]Technical College in Basrah, [2]Marine Science Center, [3]Science College
University of Basrah, Basrah - Iraq

Abstract This study comprises monitoring of the n-alkanes in the Shatt Al-Arab river by using the seven molluscs species as bioindicators. These species are: snails *Lymnaea auricularia*, *Theodoxus jordani*, *Physa acuta*, *Melanopsis nodosa*, and *Melanoides tuberculata* and bivalves *Corbicula fluminea* and *Corbicula fluminalis*. The species of molluscs are collected from different locations of the Shatt Al-Arab river (along the region extended from Abu Al-Khasib to Garmat-Ali) during 2004 and 2005. Each species consisted of at least 3500 adult of individuals of uniform sizes. The hydrocarbons from these species were extracted and analyzed both by spectroflurometer (total hydrocarbons) and high resolution capillary gas chromatography (n-alkanes). The concentrations of total hydrocarbons in mollusc's species of the Shatt Al-Arab river ranged from 1.93 µg/g dry weight in *T. jordani* to 26.56 µg/g dry weight in *C. fluminea*. The range of carbon chain length of n-alkanes in these individuals was ranging from C_{13} - C_{32}. The bimodal distribution with two maxima around C_{17} and C_{27} suggested two different sources of hydrocarbons both biogenic and anthropogenic. The dominance of the odd carbon numbers n-alkanes (C_{15}, C_{17}, C_{25} and C_{29}) in the mollusc's species indicated biogenic origin of hydrocarbons .The pristane values were more than those of phytane. Pristane and phytane in the mollusc's species suggest biogenic origin. CPI values are more than one indicating a biogenic origin of hydrocarbons in these species. Squalane is also present in some these species intimately related to anthropogenic sources of hydrocarbons. The presence of Unresolved Complex Mixture (UCM) reflects the anthropogenic sources. The lower fat contents were found in *T. jordani* (0.33 mg/g) and the higher were in *C. fluminea* (0.98 mg/g). A significant relationship is found between the fat contents and hydrocarbons concentrations in the tissues of molluscs species (r = 0.8 - 0.9).

Introduction

Most human activities in the Shatt Al-Arab river are scientific research, tourism, fishing, industrial and transportation. All of these activities require fossil fuels for transport and energy requirement and petroleum hydrocarbons are therefore potentially the most likely source of pollution in the river. Biogenic hydrocarbons would also be expected to present in the river which are synthesized by a biota (Al-Saad, 1995). Aliphatic hydrocarbons are a major fraction of petroleum which may be used to detect its presence. In spite of its importance, only limited information is available on the fate of hydrocarbons in the Shatt Al-Arab river. An important route is the uptake and assimilation of these compounds by aquatic organisms in

general and mollusca in particular (Cajaraville *et al*., 1995). Molluscs are well known for their ability to accumulate hydrocarbons (and other pollutants) and have been employed as indicators of petroleum contamination in many parts of the world (Cripps and Priddle, 1995).

The present paper reports the distribution and sources of aliphatic hydrocarbons (n-alkanes) in some species of molluscs of Shatt Al-Arab river.

Materials and Methods

Specimens of seven species of molluscs, *L. auricularia*, *T. jordani*, *P. acuta*, *M. nodosa*, *M. tuberculata*, *C. fluminea* and *C. fluminalis* were collected from Shatt Al-Arab river (along the region extended from Abu Al-Khasib to Garmat-Ali) during 2004 and 2005 (Figure 1). Each species consisted of at least 3500 adult individuals of uniform size. Crude oil (Basrah regular-medium-API gravity between 28-34) was supplied by Iraqi South Oil Company.

Methanol, benzene, n-hexane, methylene chloride, petroleum ether and acetone were supplied from Burdick and Jackson laboratories, Inc. Sodium sulphate and KOH were supplied by Supelco SA. Sodium sulphate was extracted with methylene chloride for 36-hours in a soxhlet. Following clean up by extraction, it was dried in an oven at 130 ˚C for about 24-hours and deactivated with deionized water at the recommended percentage prior to use.

The tissues of the animals were only pooled and macerated in a food liquidizer from which at least 3 replicates of 15 g were freeze-dried, grounded and sieved through a 63 μ metal sieve.

The procedure of Grimalt and Oliver (1993) was used in the extraction of hydrocarbons from mollusc's tissues. Ten grams of dried molluscs tissues were placed in a pre-extracted cellulose thimble and soxhlet extracted with 150 ml methanol : benzene (1:1 ratio) for 24-hours. The extract was then transferred into a storage flask. The sample was further extracted with a fresh solvent. The combined extracts were reduced in volume to ca 10 ml in a rotary vacuum evaporator. They were then saponified for 2-hours with a solution of 4 N KOH in 1:1 methanol : benzene. After extraction of the unsaponified matter with hexane, the extract was dried over anhydrous Na_2SO_4 and concentrated by a stream of N_2. The concentrated extract was cleaned up by column chromatography. A column filled with 8 g each of 5 % water deactivated alumina (100-200 mesh) is placed at the top and silica gel (100 – 200 mesh) at the bottom. The extract was then applied to the head of the column and eluted with 50 ml of n-hexane to isolate the aliphatic fraction. The fraction was reduced to a suitable volume prior to analysis by capillary gas chromatography.

A perkin-Elmer Sigma 300 capillary gas chromatography equipped with flame ionization detector and splitless mode injection part was used to determine aliphatic compounds. Quantification of peaks and identification of hydrocarbons in the chromatograms was achieved by A Perkin-Elmer computing injection model LC-100. The fused silica capillary column used was a wall coated open tubular (WCOT) of 50 m x 0.25 mm l. d. S E (methyl

silicone) (Perkin-Elmer). Helium was used as a carrier gas with a linear velocity of 1.5 ml/min. The operating temperatures for detector and injector were 350 and 320 °C respectively. The column was operated under temperature programmed as follows: Initial temperature = 60 °C, initial time = 4 minutes, final temperature = 280 °C, final time = 30 minutes and rate = 4 °C/minute. The Unresolved Complex Mixture (UCM) was measured by using planimetry.

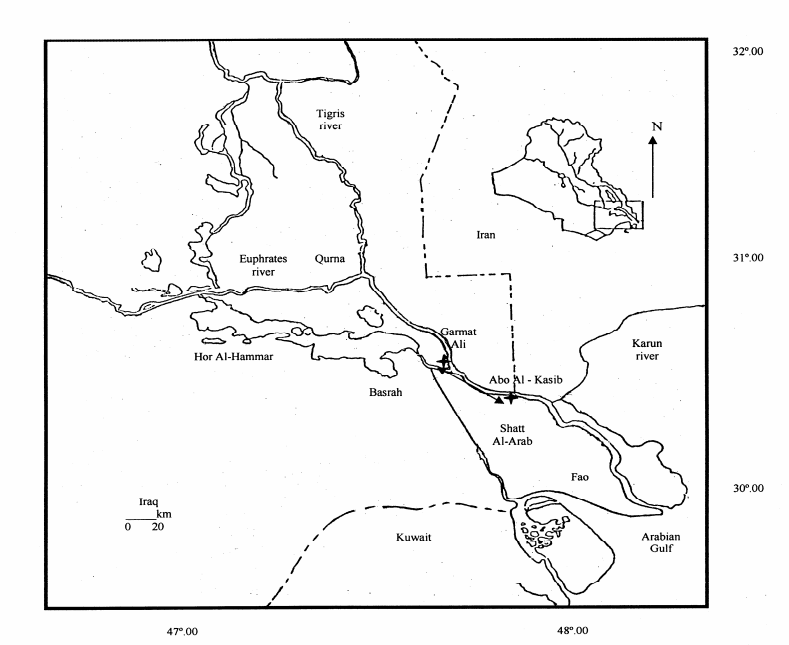

Fig. 1. Map of sampling location.

The procedure used by Al-Saad (1995) was employed to determine the fat content of mollusc's samples. Three grams of each freeze- dried sample was soxhlet extracted with a 2:1 mixture of petroleum ether and acetone for 24-hours. The extracts were reduced in volume in a rotary vacuum evaporator, and subsequently reduced to exactly 1 ml by a stream of purified nitrogen. Ten µl of the concentrated extracts were taken by a Hamilton syringe and weighted after evaporation of the solvent.

Strenuous efforts were made to minimize the contamination of the samples; for such contamination would otherwise yield in erroneous results. Throughout the procedure, a great care was taken to ensure that samples were not contaminated; it is very important to avoid an unnecessary exposure of the samples (whether the solvent or the final extract) to the atmosphere or other potential contamination sources. However, procedural blanks of all reagents and glassware that were used during the analysis are periodically determined. It is preferred to eliminate contamination sources

rather than adjusting or correcting the data that were actually obtained according to the blank value.

The standards of aliphatic (n-alkanes) compounds were used in the capillary gas chromatography supplied by Supelico and Chrompack (Figure 2).

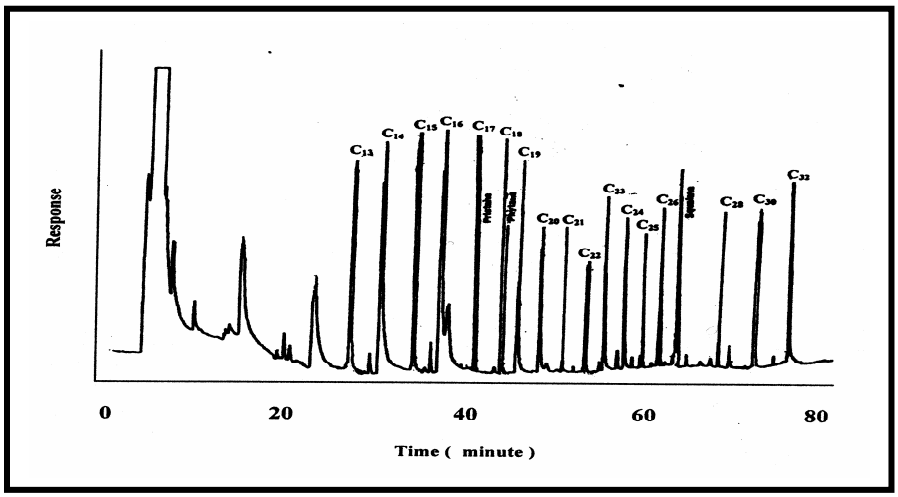

Fig. 2. Capillary Gas Chromatography of n – alkanes Standard .

Results and Discussion

The range of carbon chain length of n-alkanes for the species of mollusca of Shatt Al-Arab river was C_{13} - C_{32} (Table 1 and Figure 3). The total concentrations of n-alkanes in the tissues of molluscs varied from 1.50 µg/g dry weight (DW) in *T. jordani* to 8.78 µg/g DW in *C. fluminea* during Summer and from 2.26 µg/g DW to 12.37 µg/g DW during Autumn, whereas they ranged from 3.15 µg/g DW to 12.44 µg/g DW and from 1.78 µg/g DW to 5.31 µg/g DW during Winter and Spring (Table 2). Talal (1999) found that the concentrations of total n-alkanes in the species of molluscs of Shatt Al-Arab river were ranging from 2.80 µg/g DW in *T. jordani* to 5.75 µg/g DW in *C. fluminalis* during Summer and from 3.03 µg/g dry weight to 8.58 µg/g DW during Winter with carbon numbers ranged from C_{13} to C_{32}. Al-Saad (1995) found that the concentrations of total n-alkanes in aquatic plants of Shatt Al-Arab estuary ranged from 4.57 µg/g DW to 11.45 µg/g DW with carbon numbers from C_{14} to C_{33} and the zooplankton contains n-alkanes in carbon numbers ranged from C_{13} to C_{32} with a total concentrations of 13 µg/g DW to 16 µg /g DW , while the bacteria carbon numbers of n-alkanes ranged from C_{13} to C_{30} with a total concentrations of 38.28 µg/g DW Moreover the, the fish species contain n-alkanes of carbon numbers ranged from C_{13} to C_{32} with a total concentrations varied from 3.45 µg/g DW to 13.12 µg/g DW.

Table 1. Concentrations of n-alkanes (µg/g dry weight) in molluscs species tissues from Shatt Al -Arab river during 2004 – 2005 .

Season	Species	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}
Summer	*L . auricularia*	---	0.05	0.08	0.17	0.05	0.08	0.15	0.22	0.17	0.10	0.19	0.13	0.22	0.05	0.10	0.07	0.15	0.03	0.01	---
	T . jordani	---	---	0.04	0.08	0.20	0.13	0.16	0.21	0.12	0.10	0.15	0.09	0.06	0.04	0.05	0.03	0.02	0.02	---	---
	P . acuta	0.02	0.04	0.05	0.18	0.13	0.16	0.14	0.15	0.18	0.13	0.11	0.10	0.12	0.10	0.18	0.06	0.07	0.03	0.03	0.01
	M . nodosa	0.02	0.03	0.08	0.09	0.16	0.18	0.22	0.23	0.26	0.18	0.28	0.19	0.24	0.20	0.23	0.20	0.13	0.10	0.06	0.03
	M . tuberculata	---	---	0.03	0.03	0.07	0.08	0.12	0.13	0.16	0.18	0.22	0.26	0.24	0.20	0.25	0.12	0.10	0.06	0.05	0.03
	C . fluminea	0.12	0.18	0.24	0.26	0.44	0.46	0.52	0.50	0.56	0.50	0.54	0.58	0.64	0.72	0.86	0.50	0.42	0.32	0.24	0.18
	C . fluminalis	---	---	0.05	0.05	0.25	0.21	0.09	0.21	0.24	0.19	0.21	0.31	0.27	0.26	0.29	0.24	0.24	0.14	0.09	0.02
Autumn	*L . auricularia*	---	---	0.04	0.08	0.29	0.26	0.20	0.24	0.26	0.16	0.23	0.20	0.28	0.26	0.34	0.25	0.14	0.11	0.04	0.04
	T . jordani	---	---	0.02	0.03	0.18	0.22	0.17	0.20	0.18	0.16	0.17	0.10	0.12	0.09	0.16	0.19	0.11	0.08	0.06	0.02
	P . acuta	---	---	---	0.06	0.22	0.28	0.30	0.24	0.30	0.25	0.26	0.21	0.27	0.22	0.25	0.16	0.21	0.09	0.08	---
	M . nodosa	0.04	0.04	0.09	0.18	0.37	0.25	0.46	0.55	0.65	0.48	0.62	0.41	0.46	0.36	0.60	0.53	0.39	0.20	0.09	0.03
	M . tuberculata	---	---	0.04	0.19	0.25	0.33	0.27	0.31	0.40	0.31	0.28	0.18	0.12	0.12	0.27	0.28	0.25	0.13	0.10	0.04
	C . fluminea	0.03	0.08	0.11	0.18	0.32	0.38	0.29	0.43	0.53	0.82	1.43	1.97	0.68	0.57	1.21	0.14	1.98	0.76	0.28	0.18
	C . fluminalis	0.05	0.10	0.17	0.30	0.55	0.35	0.53	0.45	0.66	0.57	1.02	0.52	0.40	0.42	1.07	0.37	0.35	0.17	0.15	0.12
Winter	*L . auricularia*	---	---	0.04	0.08	0.29	0.26	0.20	0.24	0.26	0.16	0.23	0.20	0.28	0.26	0.34	0.25	0.14	0.11	0.04	0.04
	T . jordani	---	---	0.02	0.03	0.18	0.22	0.17	0.20	0.18	0.16	0.17	0.10	0.12	0.09	0.16	0.19	0.11	0.08	0.06	0.02
	P . acuta	---	---	---	0.06	0.22	0.28	0.30	0.24	0.30	0.25	0.26	0.21	0.27	0.22	0.25	0.16	0.21	0.09	0.08	---
	M . nodosa	0.04	0.04	0.09	0.18	0.37	0.25	0.46	0.55	0.65	0.48	0.62	0.41	0.46	0.36	0.60	0.53	0.39	0.20	0.09	0.03
	M . tuberculata	---	---	0.04	0.19	0.25	0.33	0.27	0.31	0.40	0.31	0.28	0.18	0.12	0.12	0.27	0.28	0.25	0.13	0.10	0.04
	C . fluminea	0.03	0.08	0.11	0.18	0.32	0.38	0.29	0.43	0.53	0.82	1.43	1.97	0.68	0.57	1.21	0.14	1.98	0.76	0.28	0.18
	C . fluminalis	0.05	0.10	0.17	0.30	0.55	0.35	0.53	0.45	0.66	0.57	1.02	0.52	0.40	0.42	1.07	0.37	0.35	0.17	0.15	0.12
Spring	*L . auricularia*	0.01	0.01	0.01	0.09	0.12	0.16	0.16	0.16	0.19	0.14	0.17	0.20	0.23	0.14	0.17	0.14	0.09	0.03	---	---
	T . jordani	---	---	0.01	0.01	0.10	0.09	0.08	0.09	0.09	0.17	0.18	0.15	0.19	0.17	0.20	0.10	0.09	0.06	---	---
	P . acuta	---	---	0.04	0.02	0.17	0.03	0.12	0.14	0.15	0.14	0.16	0.18	0.16	0.14	0.16	0.13	0.12	0.10	0.02	0.02
	M . nodosa	0.01	0.01	0.02	0.04	0.21	0.23	0.27	0.20	0.24	0.18	0.28	0.21	0.19	0.21	0.18	0.17	0.17	0.14	---	---
	M . tuberculata	0.01	0.01	0.09	0.08	0.14	0.20	0.21	0.16	0.18	0.17	0.16	0.15	0.23	0.12	0.22	0.11	0.08	0.05	0.02	0.02
	C . fluminea	---	---	0.05	0.06	0.37	0.42	0.28	0.43	0.52	0.36	0.28	0.16	0.53	0.24	0.79	0.20	0.22	0.20	0.17	0.03
	C . fluminalis	0.01	0.01	0.02	0.02	0.14	0.21	0.19	0.15	0.31	0.23	0.15	0.12	0.32	0.18	0.45	0.20	0.16	0.14	0.13	0.05

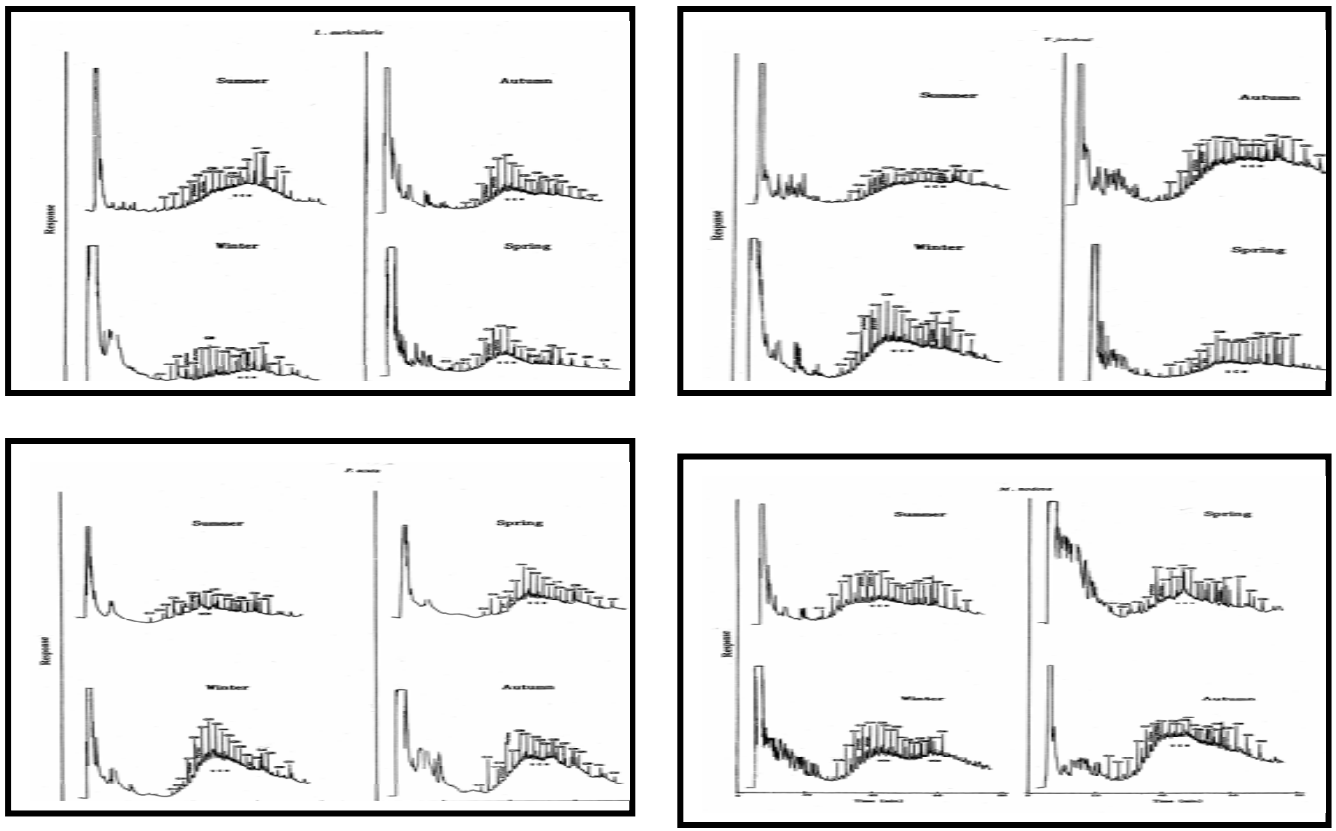

Figure 3. Capillary gas chromatograms of n-alkanes concentrations in molluscan tissues from Shatt Al-Arab river during 2004-2005

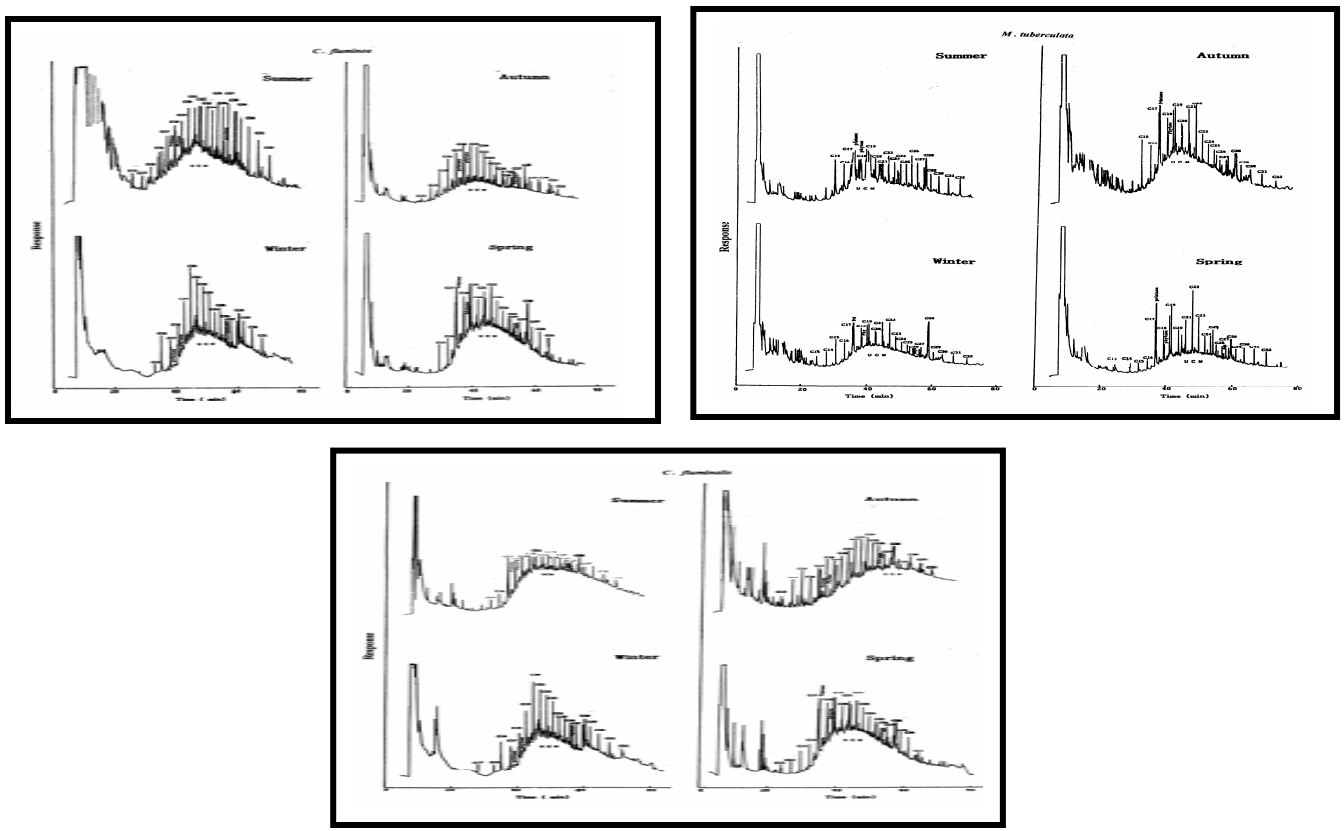

Figure 3. (continued). Capillary gas chromatograms of n-alkanes concentrations in molluscan tissues from Shatt Al-Arab river during 2004-2005.

Table 2. Pristane, phytane, squalane, CPI, UCM, total n-alkanes (µg/g dry weight), odd and even carbon number, pristane/phytane , C_{17}/pristane and C_{18}/phytane ratios in molluscs species tissues from Shatt Al-Arab river during 2004 – 2005.

Season	Species	Odd	Even	CPI	Pri	Phy	Pri/Phy	C_{17}/Pr	C_{18}/Phy	Squlane	UCM	Total
Summer	*L . auricularia*	1.12	0.90	1.24	0.04	0.02	2.00	1.25	4.00	---	1.07	2.02
	T . jordani	0.80	0.70	1.14	0.18	0.11	1.63	1.11	1.18	---	0.07	1.50
	P . acuta	1.03	0.96	1. 07	0.10	0.08	1.25	1.30	2.00	---	0.02	1.99
	M . nodosa	1.68	1.43	1.17	0.15	0.14	1.07	1.06	1.28	---	1.98	3.11
	M . tuberculata	1.24	1.09	1.13	0.07	0.06	1.16	1.00	1.33	---	3.40	2.33
	C . fluminea	4.58	4.204	1.09	0.42	0.32	1.31	1.04	1.43	0.62	3.12	8.78
	C . fluminalis	1.73	1.63	1.06	0.18	0.16	1.12	1.38	1.31	0.18	1.20	3.36
Autumn	*L . auricularia*	1.82	1.60	1.13	0.24	0.20	1.20	1.20	1.30	---	1.04	3.42
	T . jordani	1.17	1.09	1.07	0.20	0.16	1.25	0.90	1.37	---	3.26	2.26
	P . acuta	1.89	1.51	1.25	0.29	0.19	1.52	0.75	1.47	---	0.88	3.40
	M . nodosa	3.77	3.03	1.24	0.30	0.28	1.07	1.23	0.89	0.11	3.20	6.80
	M . tuberculata	1.98	1.89	1.04	0.41	0.20	2.05	0.60	1.65	---	6.19	3.87
	C . fluminea	6.86	5.51	1.24	0.72	0.64	1.12	0.44	0.59	0.31	3.95	12.37
	C . fluminalis	4.95	3.37	1.46	0.46	0.32	1.43	0.19	1.09	0.21	8.09	8.32
Winter	*L . auricularia*	2.64	2.23	1.18	0.63	0.48	1.31	0.66	1.06	0.18	1.27	4.87
	T . jordani	1.67	1.48	1.12	0.33	0.29	1.13	0.57	0.72	0.09	2.47	3.15
	P . acuta	2.52	2.12	1.18	0.43	0.26	1.65	0.72	1.38	0.29	1.54	4.64
	M . nodosa	4.40	3.17	1.38	0.47	0.42	1.11	1.23	0.83	---	2.47	7.57
	M . tuberculata	3.14	3.11	1.00	0.52	0.50	1.04	1.19	1.18	0.20	1.05	6.25
	C . fluminea	6.92	5.52	1.25	1.22	1.15	1.06	0.68	1.66	0.32	2.30	12.44
	C . fluminalis	4.45	3.93	1.13	1.13	0.98	1.15	0.63	0.91	0.03	2.30	8.38
Spring	*L . auricularia*	1.15	1.07	1.07	0.11	0.10	1.10	1.09	1.60	---	0.72	2.22
	T . jordani	0.94	0.84	1.11	0.18	0.14	1.28	0.55	0.64	---	1.22	1.78
	P . acuta	1.10	0.90	1.22	0.13	0.09	1.44	1.30	0.33	---	0.92	2.00
	M . nodosa	1.57	1.39	1.12	0.15	0.14	1.07	1.40	1.64	---	2.19	2.96
	M . tuberculata	1.34	1.07	1.25	0.20	0.19	1.05	0.70	1.05	0.02	3.39	2.41
	C . fluminea	3.21	2.10	1.52	0.42	0.32	1.31	0.88	1.31	0.62	2.92	5.31
	C . fluminalis	1.88	1.31	1.43	0.18	0.16	1.12	0.77	1.31	0.18	2.91	3.19

The variation of hydrocarbons content in the species of molluscs form Shatt Al-Arab river (the same location) may be attributed to feeding pattern, type of habitat and fat contents.

Based on the different concentrations of n-alkanes that were observed in the species of molluscs of Shatt Al-Arab river (Table 1), a direct relationship is found between concentrations of total n-alkanes and fat contents of the species of molluscs (r = 0.8 - 0.9) (Table 3 and Figure 4) . Similar results were reported by other investigators , Gold-Bouchot *et al.* (1995) have found that oyster with high lipid content took up more fuel oil (314 µg/g) from the water than low lipid oysters (161 µg/g). Menon and Menon (1999) reported that the clams, oysters and mussels differed in their rates of hydrocarbons uptake, possibly due to difference in filtering rates and a mounts of lipids.

The bimodel distribution with two maxima around C_{17} and C_{27} suggest two different sources of hydrocarbons both biogenic and anthropogenic (Figure 3).

Al-Saad (1995) reported that the n-alkanes in Shatt Al-Arab river might have originated from biogenic sources such as algae, particularly Diatoms, bacteria activity and higher plants, in addition to the anthropogenic sources.

Biogenic sources of hydrocarbons are indicated by the dominance of the odd carbon numbers n-alkanes (C_{15}, C_{17}, C_{25}, C_{29}) in the species of molluscs of Shatt Al-Arab river, which may be accumulated into the animals tissues indirectly through water, either from solution or adsorbed to suspended particles, while feeding or by their feeding directly on phytoplankton, algae or plants. Bivalves molluscs are filter feeders, mostly on phytoplankton, although some feed on detritus (Dame, 1996). Most snails are vegetarians scraping algae from structures with their radulas, or eating macroalgae and other plants (Macan, 1974). Youngblood and Blumer (1973) and NRC (2003) reported that the n-alkanes with odd carbon numbers of C_{15}, C_{17} and C_{19} were commonly found in algae. Stephanou (1992) showed that the C_{25} to C_{32} odd carbon number n-alkanes were indicative of higher plants.

The presence of pristane and phytane in the species of molluscs of Shatt Al-Arab river supports the biogenic origin of hydrocarbons. It was reported that the isoprenoids resulted mainly from aquatic organisms either directly as in the case of pristane, from fish, zooplankton and from decomposition of algae, and phytane originating from several types of bacteria and from deposition of algae or these isoprenoides come indirectly from aquatic biomolecules such as chlorophyll (Simoneit, 1991). Pristane and phytane have also been reported to be derived from bacteria (Saliot, 1981). The pristane may be the major hydrocarbon of some anaerobic bacteria representing 46.5 % of the total hydrocarbons, whereas phytane may occur at lower concentrations (0.3 – 2.5 % of total hydrocarbons). Didyk *et al.* (1978) indicated that the chlorophyll from land-plant sources providing the high molecular weight n-alkanes could serve as a source of some isoprenoids. Although, the presence of pristane and phytane generally associated with biogenic origin of hydrocarbons. Cormier *et al.* (2000) and Daniel (2004) mentioned that the weathered petroleum products might include pristane and phytane as a natural by-product. On the other hand, the anthropogenic contribution of hydrocarbon is evident from the presence

Table 3. Fat contents (mg/g) in the species of molluscs tissues from the Shatt Al-Arab river during 2004-2005.

Species	Fat Content (mg/g)
L . auricularia	0.47 ± 0.02
T . jordani	0.33 ± 0.04
P . acuta	0.43 ± 0.02
M . nodosa	0.68 ± 0.03
M . tuberculata	0.57 ± 0.03
C . fluminea	0.98 ± 0.01
C . fluminalis	0.86 ± 0.04

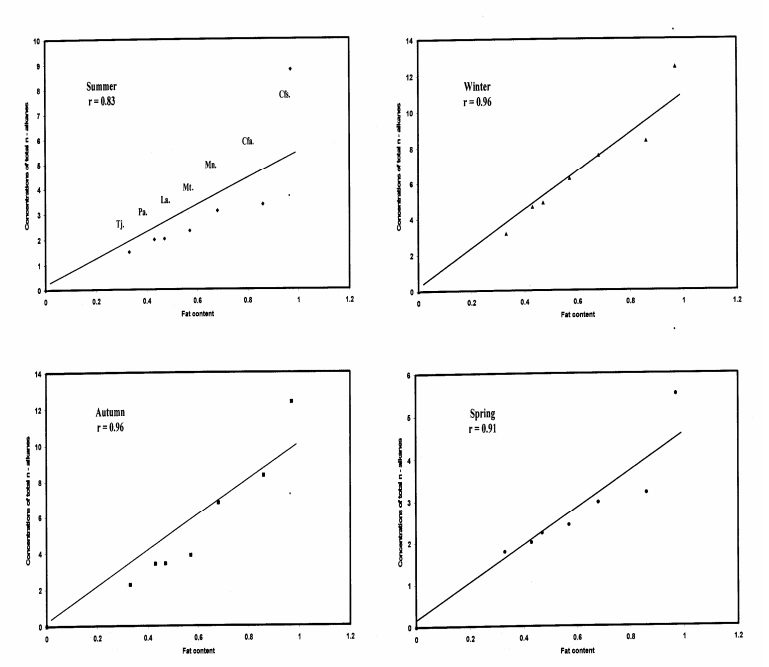

Figure 4. The relationship between the fat contents (mg/g) and the concentrations of total n-alkanes (µg/g dry weight) in the molluscs species of the Shatt Al-Arab river.

of the unresolved complex mixture (UCM) in all of the samples of molluscs species analyzed.

The UCM (Unresolved Complex Mixture) represents components resistant to weathering and bacteria degradation and their presence in chromatograms has frequently been taken as an evidence of petroleum contamination (Moore and Allen, 2000). Al-Saad and DouAbul (1984) found high level of unresolved materials in the mussels *C. fluminalis* from Shatt Al-Arab river which must be attributed to mixture of iso-and cycloalkanes. Gough and Rowland (1990) reported that UCM might be introduced into aquatic environment either fluvially or by aeoline transports. Al-Saad (1995) showed that the UCM detected in his study could be related to the production, use and transportation of petroleum products. In general, the presence of UCM is normally associated with petroleum contamination. However, there are possible sources of UCM other than human activities like those synthesized by some anaerobic non-photosynthetic bacteria and green algae which are widely distributed in natural environment (Gough *et al*., 1991).

This study also shows that the presence of even-carbon numbers n-alkanes in the species of molluscs may be related to the contribution of artificial sources. The same conclusion has been arrived by Al-Saad and DouAbul (1984).

The Carbon Preference Index (CPI) is an important parameter in relation to hydrocarbon sources. CPI of the species of molluscs of Shatt Al-Arab river ranged from 1.00 in *M. tuberculata* to 1.92 in *L. auricularia* which may indicate biogenic sources of hydrocarbons in these species. Ehrhadt and Burns (1993) reported that, if CPI is more than one, the sources of hydrocarbons are biogenic, and if it is smaller than one, the sources are anthropogenic. Al-Saad (1995) found that the aquatic plants, zooplankton, bacteria and fish of Shatt Al-Arab river contained high CPI values which indicated a biotic origin of these alkanes.

The presence of squalane as a major organic constituent in the species of molluscs may serve to indicate the polluted nature of the region. It was reported that squalane might originate from living organisms or from artificial sources. Al-Saad (1995) concluded that the presence of squalane in Shatt Al-Arab river may originate from anthropogenic sources. Burns *et al*. (1982) reported elevated concentrations of squalane in aquatic organisms caught from the Omani coastal waters which is constantly subjected to oil pollution.

This paper shows that the species of molluscs of Shatt Al-Arab river contain a measurable amount of n-alkanes. A comparison between the results of this study and those values obtained elsewhere has been held in Table (4). The concentrations values of n-alkanes in the species of molluscs of Shatt Al-Arab river obtained in the present study were within the values obtained elsewhere.

Conclusions and Recommendations

The species of molluscs from Shatt Al-Arab river were found to contain measurable amount of aliphatic hydrocarbons. The compounds seem to be

Table 4. Comparison of concentrations of n-Akanes compounds in the molluscs species of the Shatt Al-Arab river with these molluscs from other parts of the world.

Location	**Concentratio (µg/g)**	**Species and Reference**
Galveston Bay	2 - 34	*Crassostrea virginosa* Ehrhardt (1972)
Narragansett Bay	0 - 25	*Saxidomus giganteus* Farrington and Quinn (1973)
Kiel Bight	0.7 - 33.2	*Mytilus edulis* Ehrhardt and Heinemann (1975)
Western Port Bay (Australia)	0.4 – 7.5	*Nassarius vibex* Burns and Smith (1977)
Southren Baltic Sea	0 – 89	*Mytilus edulis* Law (1983)
Gulf of Mexico	1.4 – 20.7	*Ostero lurida* Wade *et al.* (1991)
Signy Island, UK.	0.18 – 0.56	*Yoldia eightsi* Cripps and Priddle (1995)
Canada	0.11 – 15.66	*Mytilus edulis* Zhou *et al.* (1996)
British Columbia	23 - 98	*Maya arenori, Thais haemastoma* Birtwell and McAllister (2000)
San Francisco Bay, California	0.55 – 77.8	*Mytilus galloprovincialis* Phillips *et al.* (2003)
Shatt Al-Arab River	1.50 – 12.44	Present study

derived from both biogenic and anthropogenic sources. The aliphatic hydrocarbons found in the present molluscs are due to food and water sources, type of habitat, environmental factors, and lipid content.

In general the concentrations of aliphatic hydrocarbons in the species of molluscs of Shatt Al-Arab river are within the values obtained elsewhere in the world.In an area subjected to a chronic input of petroleum into the water, the analysis of these species of molluscs provides the means of identification input sources, types of hydrocarbons present in the stream, and approximate average concentrations of hydrocarbons in the water. Petroleum projects in the water system should emphasize on indicator species such as molluscs. Every possible effort should be made to minimize petroleum input into the Shatt Al-Arab river environment. Outfall licenses should be strictly enforced and should be amended to specify permissible levels on the basis of the most toxic fractions of petroleum released into the river environment. Oil pollution associated with boating activities could be controlled by enforcing stringent regulations on oil discharge and providing pump stations similar or superior to the facilities for tanker ballast water treatment. A monitoring project using species of molluscs in areas subjected to pollution hydrocarbons has already been commenced.

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الالكانات الاعتيادية في نواعم شط العرب

فريد، وسام عبد الامير[1]، السعد، حامد طالب[2] والعضب، عبد الحسين يوسف[3]
[1]الكلية التقنية في البصرة، [2]مركز علوم البحار، [3]كلية العلوم، جامعة البصرة، البصرة العراق

المستخلص تضمنت الدراسة الحالية مراقبة الهيدروكاربونات في نهر شط العرب باستخدام سبعة انواع من النواعم وهي خمسة أنواع من القواقع (*L. auricularia* و *T. jordani* و *P. acuta* و *M. nodosa* و *M. tuberculata*) ونوعين من المحار (*C. fluminea* و *C. fluminalis*) كمؤشرات حيوية. جمعت عينات النواعم من مناطق مختلفة من شط العرب (على طول المنطقة الممتدة من أبو الخصيب إلى كرمة علي) خلال عام 2004 - 2005. استخدم على الأقل 3500 من كل نوع من النواعم من الأفراد البالغة المتشابه بالحجم. استخلصت الهيدروكاربونات من هذه العينات و قيست بواسطة جهاز الغاز الكروماتوغرافي المزود بالعمود الشعري ذي تقنية الفصل العالية. تراوح تركيز ألالكانات الكلية في نواعم شط العرب من 1.50 مايكروغرام/غرام

وزن جاف في قوقع *T. jordani* إلى 12.44 مايكروغرام/غرام وزن جاف في المحار *C. fluminea*، مع وجود سلسلة من ذرات الكابون تراوحت من 13 إلى 32. أن وجود ذروتين لتوزيع ألالكانات و أعلى قيم لذرات الكاربون 17 و27 في نواعم شط العرب دل على وجود مصدرين للهيدروكاربونات أحدهما من اصل طبيعي (حيوي) والأخر من اصل غير طبيعي (غير حيوي). أن سيادة ألا لكانات الاعتيادية ذات العدد الفردي لذرات الكاربون في نواعم شط العرب يشير إلى الأصل الحيوي للهيدروكاربونات. كانت قيم البرستين اكبر من قيم الفايتين وان وجود نظائر الهيدروكاربون، البرستين والفايتين في نواعم شط العرب دليل على الأصل الحيوي للهيدروكاربونات. أن وجود ألالكانات الاعتيادية ذات العدد الزوجي لذرات الكاربون في نواعم شط العرب يتعلق بالاصل غير الحيوي للهيدروكاربونات. كانت قيم معامل تفضيل الكاربون اكبر من واحد وهذه تشير إلى الأصل الحيوي للهيدروكاربونات في نواعم شط العرب. أن وجود مركب السكوالين في نواعم شط العرب يتعلق بالأصل غير الحيوي للهيدروكاربونات. و وجود الخليط المعقد من المركبات غير المنفصلة يعكس الأصل غير الحيوي للهيدروكاربونات في نواعم شط العرب . كان اوطأ محتوى دهني في القوقع *T. jordani* (0.33 مليغرام/غرام) في حين كان أعلى محتوى دهني في المحار *C. fluminea* (0.98 مليغرام/غرام). وجد بان هناك علاقة معنوية (تراوح معامل الارتباط بين 0.8 – 0.9) بين المحتوى الدهني وتركيز الهيدروكاربونات في أنسجة نواعم شط العرب.