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Petroleum Hydrocarbons, heavy metals, physico-chemical parameters and impacting factors on diversity and abundance fish species in the Garmat Ali River

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ABSTRACT

The Garmat Ali River was studied by evaluating petroleum hydrocarbons, some heavy metals (Copper, Zinc, Chromium and Bromine)and the physicochemical properties of the water and their effect on the diversity and abundance of fish in this river. The analytical method for the measurement of total petroleum hydrocarbons concentrations was carried with infrared (IR) spectroscopy, while the atomic absorption spectrometer type, Shimadzu 1800 PC, (Japan) was used for measurement of target heavy metals. The current results showed a slight fluctuation in petroleum hydrocarbons concentrations (PHCs) during the months of 2020, and these values were within the permissible environmental limits. The four heavy metals were characterized by low levels ranging between 0.01 and 0.7 mg/l during months of 2020. The findings revealed that the conductivity rates were higher than the permissible limits. The higher values were (6440 µs/cm) for August, as well as the higher value of TDS were (3059 mg/l) for April which was above than the permissible limits for human. The study concluded that Garmat Ali River suffers from a significant decrease in the water quality, consequently, fish species possessing wide ranges of tolerance to the limiting factors have been prevailed, specially salinity, therefore three species had the highest relative abundance in the Garmat Ali River, *T. whiteheadi, P. abu* and *C. gibelio*, which accounted for 47.13% of the total number of species.

Key words : *Water pollutants, Physicochemical parameters, Fish diversity, Garmat ali river*

Introduction

Rivers are regarded as one of the main resources for supplying water for different purposes, such as for drinking, irrigation, fisheries, production ofanimal, industrial, electric power production, and other actions. Sometimes these resources at some place whichbecame vulnerable to industrial waste disposal, sewage, and additionally agricultural drainage (Loucks and van Beek, 2017).

The Garmat Ali River is located in the north of the city of Basra (southern Iraq), and it is one of the important short rivers that flow and drain into the Shatt al-Arab River. This river has been exposed to multiple influences resulting from hydrological and anthropogenic activities. This river was affected by the Euphrates Riverwater, these wateraltered its flow away from the northeast of Al-Hammar Marsh, throughout the past years, which led to a clear reduction in the water level in the marshes, and thus the salinity of the water increased greatly compared to previous years. Consequently, it nega-

tively affected the quantity and quality of water of the Garmat Ali River in Basra.

Many researchs has supported the deterioration in the water quality of the Shatt al-Arab River which due to the decrease in fresh water discharges from the Tigris and Euphrates rivers, in addition to the adverse effects of salt interference from the Arabian Gulf. over the past decade (Al-Jaberi1*et al*., 2016, Lateef *et al.*, 2020).

Several research papers have examined the quality of surface and ground water in Basrah Province such as study of Yaseen *et al*., (2019) in assessing of Garmat Ali River for irrigation which reported that EC, TDS, Na, and Cl values were high values and they pointed out that the river water was inappropriate for irrigation where it can cause a lot of damage to the plant and soil. Moreover, study by Hamdan *et al*., (2018) evaluated the water quality of Shatt Al-Arab River and its branches (Iraq) during previous years, they concluded that this water was not good and belonged to the middle class, while its inland branches were classified as the worst case. There are also international studies on the effect of physiochemical characteristics on abundance and fish diversity such as study by Huang *et al*., (2019) they studied river habitat includes all the biological, chemical and physical features in a Lijiang River, China, they exposed that conductivity, altitude, turbidity, velocity, wetted width and depth had a great associations with sh assemblages, they found that different habitats play significant part in the growth and breeding for the sh community which lead to richness in total species while habitat homogeneity may lead to a decline in sh diversity and species richness. As well as, Study of Piria *et al*. (2019) on Sava River in Croatia, they identified many major of human activities exposed to wide range of stressors included water pollution and invasion by exotic species which threat categories to fresh water biodiversity and ecosystem process.

Fish assemblage in the Shatt Al-Arab River and Garmat Ali River composition and structure were distinctly varied due to location differences and corresponding with hydrological alterations. Whether, distribution of populations closely related to habitat features for instant natural conditions practically temperature control behavior and all biological activities of aquatic organisms (Huang *et al*., 2019).

In spatially trends spread and fish assemblage distribution in the Shatt Al-Arab River can divide into three ecological guilds. The first at the north section of the river be characterized by low concentrations of salinity and freshwater species dominated. The second fish species guild included the middle section of the river distinguished by increased salinity values, represented a mix of fresh and marine water fish species, whereas the third ecological guild the down river section exhibit high salinity levels, biodiversity, and large number of individuals, dominated by marine fish species (Mohamed and Abood, 2017).

Numerous studies conducted by academic researchers for the purpose of assessing the river's water for agricultural or industrial purposes indicated that the river water has become inappropriate for human, industrial or agricultural use in recent years, in addition to the diversity and abundance of fish that live in this region has been greatly affected. Therefore the aim of the current study was to find out water pollutants (Total petroleum hydrocarbon, heavy elements (Bromine, Chromium, Copper, and Zinc) and the physicochemical parameters and their effects on the diversity and abundance of fish which are found in this river.

Materials and Methods

Study region

Garmat Ali River is located in the north of the city of Basra (southern Iraq), a waterway between the east Hammar marsh and Shatt Al-Arab River (Figure 1). It consists of the confluence of the Al-Mashab and Al-Silal branches, which extend within Al-Hammar marsh for an approximately distance of twenty kilometers. The River covers a distance of about 6 km length and 280 m width. The mean depth is 9 m.

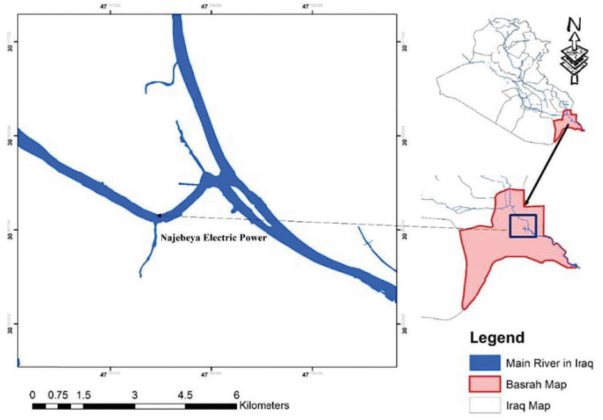

Fig. 1. Study area in Garmat Ali River, Basrah- southern Iraq

The commencement and termination date of experiment was Jan. – Dec. 2020. Aquatic samples which were from this river were conducted in three replicate once a month from the site location.

Water Physicochemical Parameters

The water samples were transported to the laboratory of marine science center and then the samples were directly filtered through Whitman 541 filter paper. Nitric acid was used to acidify the filtered samples and then stored them at a temperature (4 °C) before analysis. The parameters were included Chloride (Cl), Nitrate (NO_3), Sulphate (SO_4) and Phosphate (PO_4) which measured by using standard procedures methods (APHA 1998). Concentration of hydrogen ions (pH), temperature (°C), electrical conductivity (μScm^{-1}) and total dissolved solids (TDS) were checked by using multimedia water checker (YASI) model 556 MPS.

Heavy metals analysis

To indicate the nature and sources of poisoning elements, heavy metals, the total Copper (Cu), Zinc (Zn), Chromium (Cr) and Bromine (Br) in water samples were measured after digestion process (Islam *et al*., 2015). The atomic absorption spectrometer type, Shimadzu 1800 PC, (Japan) was used for measurement of target heavy metals. In addition to that, the standard curve method was used for calculated the concentration of metals.

Extraction of Petroleum Hydrocarbon and analysis

Water samples were extracted three times using by extraction method for TPHC was the EPA 3510 liquid-liquid extraction (Adeniji *et al.,* 2017a and Adeniji *et al.,* 2017b). The analytical method for the measurement of TPHC concentrations was carried with infrared (IR) spectroscopy (EPA Method 418.1) using Basrah crude oil standard at 310 and 360 nm as excitation and emission wavelengths, respectively.

Fish samples and calculate of diversity and abundance

Fish samples were regularly monthly collected from the studying area by using several methods drift and fixed gill net (30 to 80 m, mesh size 19 to 52 mm), (60 to 100 m length, 22 mm mesh size) cast net (9 m diameter with 19x9 mm mesh size), seine nets (50 to 80 m length, 4 to 6 m height) and electro-fishing by generator engine (provides 300-400V and 10A). Fishes were counted and identified to species following (Al-Faisal, 2020; Fricke *et al*., 2021). Analysis of fish assemblage as following: Relative abundance according to Walag *et al*. (2016). Measuring fish diversity index and Shannon index by Huang *et al.* (2019), evenness and richness index followed by Nyitrai *et al.* (2012).

Results and Discussion

Petroleum hydrocarbons

The mean of petroleum hydrocarbons concentration measured from in study site of Garmat Ali River is shown in Table 1 and Figure 2. The current results showed a slight fluctuation in petroleum hydrocarbons concentrations (PHCs) during the months of

Table 1. Mean concentrations of petroleum hydrocarbons (µg/l) and heavy metals (mg/l) in Garmat Ali River water during months 2020

Month	PHCs	Cu	Br	Cr	Zn
January	4.7	0.025	0.3	0.05	0.7
February	1.5	0.02	0.07	0.03	0.03
March	1.7	0.03	0.4	0.02	0.02
April	2.72	0.03	0.022	0.08	0.7
May	2.72	0.06	0.02	0.03	0.01
June	2.35	0.03	0.15	0.04	0.03
July	5.36	0.029	0.3	0.05	0.5
August	0.37	0.05	0.1	0.37	0.01
September	1.81	0.02	0.08	0.03	0.01
October	1.72	0.03	0.04	0.04	0.02
November	1.71	0.03	1.08	0.05	0.03
December	1.85	0.04	0.07	0.03	0.02
Environmental Limited*	<10µg/l	<1 mg/l	<1mg/l	<0.1mg/l	<5mg/l

*Canadian environmental quality guidelines

2020, and these values were within the permissible environmental limits (< 10 µg/l). The month of July recorded the highest concentration (5.36µg/l), followed by January (4.7µg/l), while the remaining months recorded very low concentrations. Generally, the Garmat Ali River is affected by the waters of the Shatt al-Arab River, and the latter is completely affected by many factors, the most important of which is the tidal movement coming from the waters of the Arabian Gulf, which is characterized by the activity of oil transportation, and thus the transfer of petroleum hydrocarbons concentrations during the tidal movement, especially in the hot summer season when the water drainage coming from the Tigris and Euphrates rivers is little.

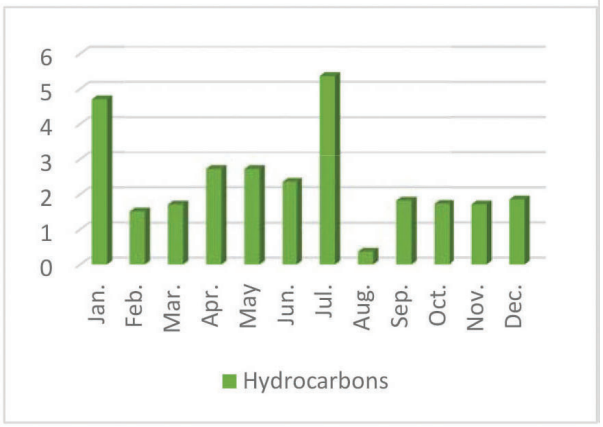

Fig. 2. Monthly variations of Petroleum hydrocarbons concentration in Garmat Ali River

Previous studies have shown the presence of petroleum hydrocarbons in the waters of the Arabian Gulf and the Shatt al-Arab river up to the north of the city of Basra in Qurna. Review by Al-Imarah *et al*. (2007) in water and sediments of northwest Arabian Gulf, reported that the concentrations of petroleum hydrocarbons in waters of Iraqi regional waters were to range 2.5–47 µg /l and 1.62–31.1 µg/g in dissolved and particulate phases of water at Shatt Al- Arab River. Levels of petroleum hydrocarbons increased in the inner waterways from the north towards the south (the estuary of the Shatt al-Arab). They attributed the reason for the increase in pollutants in the water and sediments, which was the illegal transportation of crude oil and its derivatives through the waterways in southern Iraq. Moreover, oily ballast water which discharging from small ships, and coming from the oil refineries located on the banks of the waterways (Shuaiba on the Shatt al-Basra and Abadan on the Shatt al-Arab River).

Heavy metals concentration

The concentrations of dissolved heavy metals in Garmat Ali River water are summarized in Table 1 and Fig. 3. In this study, four heavy metals Cu, Br, Cr and Zn measured in river waters, they are characterized by low levels ranging between 0.01 and 0.7 mg/l during months of 2020. These concentrations were within the permissible limits of Canadian environmental quality (CCME 2008). This corresponds to a study findings of Al-Asadi *et al*., (2020) observed that a uniform distribution andlow concentrations of most elements in the river water which were (<5 µg/l) for Cr, as well as their study designated that the contaminated sources of river were the air deposits of gaseous releases from oil manufacture and electrical generators. The low level of concentrations of these minerals in river water may be due to their solubility, which decreases in the water in addition to being heavy metals associated with suspended colloids through the adsorption process (Mimba *et al*. 2017).

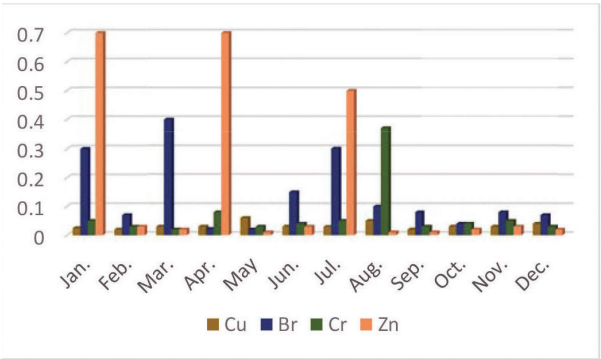

Fig. 3. Monthly variations of concentration of heavy metals (mg/l) in Garmat Ali River water

The results demonstrated that the distribution pattern of heavy metals in Garmat Ali River water are in the order of Zn > Br > Cu > Cr. Significant differences (<0.05) were recorded for zinc than other elements, especially in January and April. Garmat Ali River impacted by industrial effluents with high organic matter discharged untreated, moreover, effected by domestic sewage which caused to dump a lot of heavy metals. This is in agreed with results of Aljabri *et al.* (2016) on concentrations of six metals included Cu and Zn in river sediments which were detected in this study in range (31 – 40 mg/l) for Cu, and (108 – 127 mg/l) for Zn.

Physicochemical parameters

The parameter mean of electrical conductivity, total dissolved substances, and chloride measured in current study for Months 2020 is shown in Figure 4. The current findings revealed that the conductivity rates were higher than the permissible limits. The higher values were (5455 and 6440 µs/cm) for July and August (Figure, 4), this was due to the lack of water coming from the Tigris and Euphrates River, in addition to the tide water coming from the Arabian Gulf during this period. Furthermore, the recorded values of TDS limits were (3059and 2625 mg/l) for April and July respectively that was above than the permissible limits for human reported in CCME (2008) that permissible limit (conductivity and TDS) for drinking water (1000, 500) respectively as well as these values higher than permissible levels for agricultural useswhich are reported in Zaman*et al*. (2018)(<1500 µg/l for electric conductivity and < 2000 mg/l for TDS). Our findings are consistent with the study conducted by Yaseen *et al*. (2019) in assessment of Garmat Ali River for irrigation purposes, whose recorded values mean were (4390 µg/l) for EC and (2912mg/l) for TDS, as well as they concluded that the excess salinity was under the class of inappropriatefor watering and irrigation.

During the months, the drainage rates of the Shatt Al-Arab water will change the discharge rate ranged between 243 and 273.0 m3 / sec as well as the conditions of the tide and the low levels of water resulted in an increase in the electric conductivity and total dissolved substances (TDS) (Al-Mahmood, 2009). Consequently, the low level of water in Garmat Ali River effected on its validity when we think in various uses, especially in the months in which the water drainage is reduced, months of summer, as well as in the tide and tidal states, the conductivity and (TDS) will increased compared with previous years. The variation of water quality of Garmat Ali river prejudiced by the marine salt from Arabian Gulf and the chemical ions inflow from the Tigris and Euphrates Rivers.

Our data reported the higher values mean of Chloride in Figure (4) were (800 and 866 mg/l) for May and June correspondingly which were higher than permissible standard limit for drinking or industrial uses (< 250 and < 600) respectively (CCME 2008).Chloride ions are causes environmental harm especially to organisms living in water. High chloride concentrations are toxic, carcinogenic, or mutagenic contaminants or cause disorders of the endocrine glands (Granato *et al*., 2015). Most of the chloride ions sources in the raw waters of the river were due to the salt tides coming from the Arabian Gulf waters during the hot season which contained a high quantity of Cl element.

The current results showed that the pH was constant across all month samples and all values were in the alkaline direction (7.2-7.9) (Figure 5). However, pH in water from Garmat Ali River are within acceptable levels. Aquatic life thrives in aquatic habitats when the pH is close to a narrow and critical range, moreover, when the pH decreases, the solubility of minerals in the water increases and becomes more toxic in addition to affecting the growth performance of aquatic organisms (Mota *et al*., 2018). Water temperature values ranged from (19 ºC) in January – (30.9 ºC) in July (Figure 5) the average values were within guide lines of permissible levels (<35 ºC).

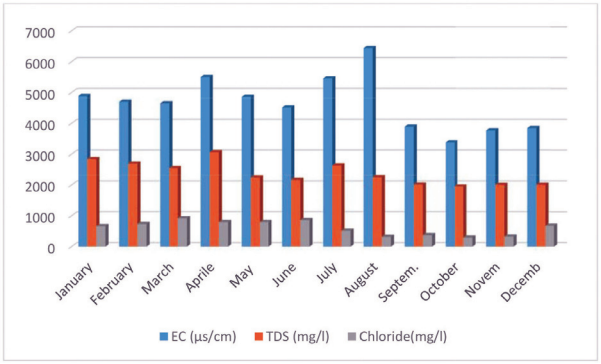

Fig. 4. Monthly variations of EC, TDS and Chloride values in Garmat Ali River water

Sulphate data average in study location of

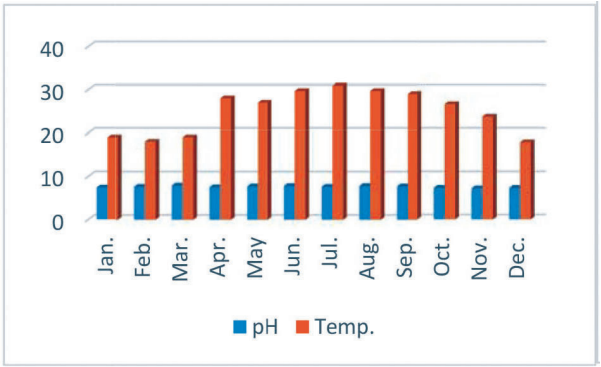

Fig. 5. Monthly variations of pH and Temperature (ºC) in Garmat Ali River water. Permission limit (6-9.5) for pH and (<35 ºC) for temperature

Garmat Ali River were 718 and 265 mg/l for high and low values in Jun and October respectively, their values were exceeded than standard values of CCME (2008) for drinking or for agriculture uses (Fig. 6). Sulfate contamination causes an increase in alkaline and sulfide concentrations that lead to hydrolysis and increased eutrophication. As well as increasing the concentration of sulfate causes a significant decrease in the production of biomass and thus the growth rate will decrease (Geurts *et al*., 2009).

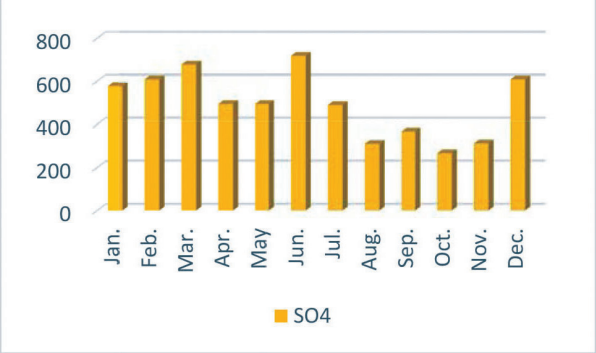

Fig. 6. Monthly variation of sulphate values mean in Garmat Ali River during 2020. Permissible limit 200 and 400 mg/l for drinking and agricultural uses

The current findings of monthly variations of PO_4 and NO_3 concentrations showed in Figure (7). The high concentration of PO_4 recorded (2 mg/l) in April and May. The source of these elements is their presence mainly from agricultural drainage waters as well as industrial raw materials (Grela *et al*., 2020). Regarding NO_3, plant and fish that live in a water medium that contain large amounts of nitrate concentrations, they will grow with many problems with their quality. NO_3 data range in the current study were (0.7 – 1.9 mg/l). PO_4 and NO_3were within the recommended range for aquatic life (< 3 mg/l for PO_4 and <50 mg/l for NO_3) (Philminaq, 2016).

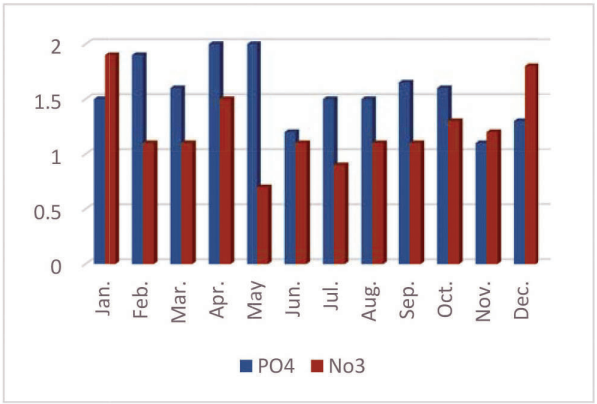

Fig. 7. Monthly variations of PO_4 and NO_3 concentrations (mg/L) in Garmat Ali River. Permission limit (<3 mg/l) for PO_4, and (<50 mg/L) for NO_3

Regarding turbidity in current findings recorded high value (24.5 NTU) in Jun and July, This increases is due to the water mixing with the highly turbid waters coming from the Arabian Gulf, especially during the hot months. Turbidity could provide more protection for young fish from predators; however, it has been shown that excessive turbidity negatively effects on the survival and hatching of eggs, feeding and growth efficiency (especially filter feeders), and population size; it is also considered an influencing factor inan orientation mechanism for migration from and to the estuary and thus, it can have a significant impact on the abundance and distribution of estuarine fish (Albaret *et al*., 2004; Hazelton, and Grossman, 2009).

Species composition

A total of 2071 individuals of fish represented 29 fish species, 24 genera, and 16 families belonging to bony fishes were collected from the Garmat Ali River. In terms of the number of species Cyprinidae, the most abundance family formed four species, followed by Cichlidae and Mugilidae three species of each, whereas Bagridae, Clupeidae, Poeciliidae, and Sillaginidae two species each. Other families included one species each.

Fish diversity in the Garmat Ali River consists of ten native species, 11 marine species, and eight alien species. The monthly changes in this three-component addressed in Figure 9. The native species comprise 27.43% of the total caught fluctuated from three species in June and seven in March and July, while the marine species represented 26.99% of the total number of species, varied from one species in December to seven species in May and October. The alien species formed 45.58% differ from four species in December to eight species in February.

The present study corresponding with Mohamed *et al.* (2013) when they executed a study on Garmat Ali River and found 26 fish species included nine marine species and six alien species, but disagree with Mohamed *et al.* (2017) in terms number of species when they recorded 34 species eight were native, 18 marine and eight alien species these varia-

tions due to spatial and temporal variations with the differences in fishing tools and methods.

Relative abundance

Three species preceding the relative abundance in the Garmt Ali River comprised 47.13% of the total number of species, *Thrayssa whiteheadi* formed 16.90% of the total caught ranged from 13.68% in May to 20.92% in October, *Planilizaabu* 15.69% vary from 10.42 in January to 20.00% in December, and *Carassius gibelio* 14.53% of the total number of species differ from 9.38% in January to 18.78% in June (Figure 10).

Previous study conducted on the Garmt Ali River and adjacent regions mentioned to dominated *P. abu*, *T. whiteheadi*, *C. gibelio*, *O. aureus*, this results coincidentally with the finding of (Mohamed *et al.*, 2017). The current study recorded 13 species have low proportions of less than 1% were at last of list *Mystuspelusius*, *Nematalosa nasus*, and *Sillago arabica* (Table 1), most of these were migratory marine species and tolerant resident species have a high ability to affording large concentrations of salinity, this consequences corresponding in terms the number of individuals of each species with many studies conducted the Basrah provinces, southern Iraq in the world such as (Mohamed *et al*., 2017; Abdalhsan *et al*., 2020). In addition Abundance of aquatic organisms had relationship with several hydrographic parameters such as surface temperature and inorganic surface turbidity (Sobrino *et al.*, 2020).

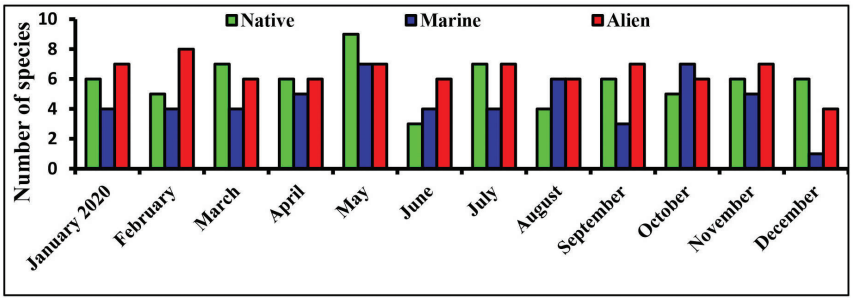

Fig. 9. Monthly fluctuations in the number of native, marine and alien species in the Garmat Ali River

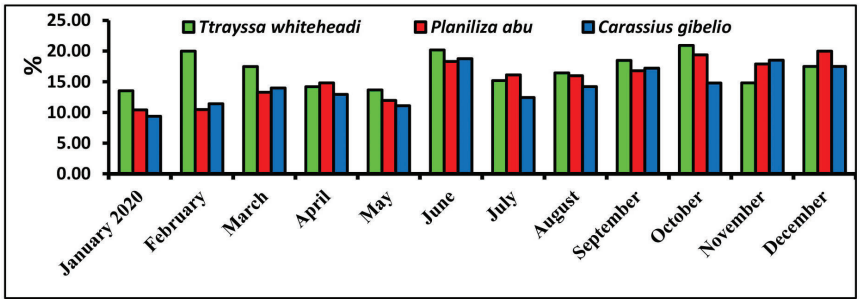

Fig. 10. Monthly variations in relative abundance of the three species preceding study region.

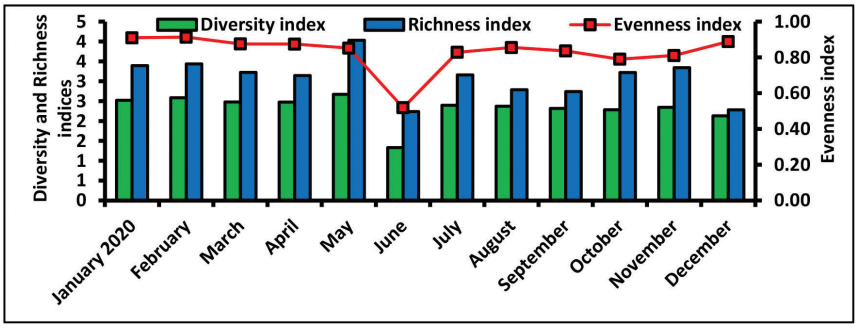

Fig. 11. Monthly variations of ecological indices in the Garmat Ali River during January to December 2020.

Table 1. Monthly variations in species relative abundance in Garmat Ali River from January to December 2020

Species	Family	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Thrayssawhiteheadi	Engraulidae	13.54	20.00	17.48	14.20	13.68	20.19	15.21	16.44	18.49	20.92	14.81	17.50	16.90
Planilizaabu	Mugilidae	10.42	10.48	13.29	14.81	11.97	18.31	16.13	16.00	16.81	19.39	17.90	20.00	15.69
Carassius gibelio	Cyprinidae	9.38	11.43	13.99	12.96	11.11	18.78	12.44	14.22	17.23	14.80	18.52	17.50	14.53
Orechromis aureus	Cichlidae	10.42	5.71	11.89	14.20	5.13	15.49	14.29	12.00	14.29	15.31	13.58	13.75	12.36
Poecilialatipinna	Poeciliidae		6.67	8.39	8.02	9.83	8.45	11.52	8.44	3.36	2.04	1.23		6.33
Tenualosailisha	Clupeidae			4.90	7.41	13.25	8.45	6.45	3.56	4.62	3.06	1.23		5.26
Coptodonzillii	Cichlidae	15.63	6.67	6.99		2.56	1.41	5.99	9.33	6.72		5.56	10.00	5.21
Silurustriostegus	Siluridae	4.17	5.71	2.80	4.94	5.13	1.41	0.92		2.52	2.55	5.56	2.50	2.95
Orechromisniloticus	Cichlidae	5.21	2.86		3.70	0.85		1.38		4.62	4.59	8.02		2.51
Alburnusmossulensis	Leuciscidae			2.80	4.32	7.26		1.38	4.00		4.08	0.62	2.50	2.46
Gambosiaholibrooki	Poeciliidae	3.13	3.81	3.50	3.09	3.85	0.94		3.11	2.52			3.75	2.12
Cyprinus carpio	Cyprinidae	4.17	6.67	4.20		1.71		5.07	0.89	1.26	1.53	1.85		2.08
Planilizaklunzingeri	Mugilidae		1.90		3.70		3.29		3.56	1.68	5.10			1.79
Leuciscus vorax	Leuciscidae	7.29	5.71	1.40	0.62	0.43		0.46	5.33	0.42			6.25	1.74
carasobarbussublimus	Cyprinidae		2.86	1.40		2.14	1.41	1.38		2.52	1.02	4.32		1.50
carasobarbus luteus	Cyprinidae	3.13	3.81		3.70	0.85		0.46		2.10		1.85	3.75	1.30
Acanthopagrusarabicus	Sparidae					1.28	0.94	4.15	0.44		2.04	0.62		0.97
Silago sihama	Sillaginidae	1.04			1.85	2.14			1.33		1.02	0.62		0.72
Acanthobramamarmid	Leuciscidae	2.08		2.10		2.14				0.84			2.50	0.68
Mastacembelusmastacembelus	Mastacembelidae	3.13		3.50		0.85			0.44			1.23		0.63
Hemiculterleucisculus	Xenocyprididae		2.86		0.62			0.92				1.85		0.43
Hyporhamphuslimbatus	Hemiramphidae	4.17		0.70			0.94				0.51			0.39
Planilizasubviridis	Mugilidae		1.90		1.23				0.89		1.02			0.39
Aphaniusdispar	Cyprinodontidae	2.08				1.71					0.51			0.34
Periophthalmus waltoni	**Gobiidae**		**0.95**			**0.85**		**0.92**						**0.24**
Bathygopbiusfuscus	Gobiidae	1.04				0.85						0.62		0.19
Mystuspelusius	Bagridae				0.62			0.92						0.14
Nematalosa nasus	Clupeidae					0.43					0.51			0.10
Sillago arabica	Sillaginidae			0.70										0.05

Diversity indices

There are evidence variations in ecological indices among the study months in the study area. The diversity index ranged from 1.33 in June to 2.67 in May with range 2.33. The evenness index fluctuated from 0.52 in June to 0.91 in January and February with range 0.83. The richness index values varied between 2.24 in June to 3.44 in February with range 3.08 (Figure 11).

Diversity index showed as poor, while evenness index semi-balanced and richness index values seems half an integrated (Jorgensen *et al.*, 2010). Ecological indices results exhibit evidence tendency towards results of previous studies executed in Basrah province in recent years such as (Mohamed *et al.*, 2015; Abdullah, 2017). Thus, fish diversity and populationin aquatic ecosystem have been linked to external environmental drivers and internal biological interactions (Zhang *et al.*, 2018).

Conclusion

We conclude from the current study that Garmat Ali River suffers from a significant

decrease in the water quality associated with the low flow rates from the Euphrates River as well as The interference from the salt tides from the Gulf, which greatly affected many of the water's physicochemical properties, on the other hand, a slight increase in the concentrations of petroleum hydrocarbons and some heavy elements, all of which led to a change in the diversity and abundance of fish of this river. Consequently, fish species possessing wide ranges of tolerance to the limiting factors have been prevailed, specially salinity, therefore three species had the highest relative abundance in the Garmat Ali River, *T. whiteheadi, P. abu* and *C. gibelio*, which accounted for 47.13% of the total number of species.

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