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EVALUATION LEVELS OF PHENOLS AND ITS DERIVATIVES IN SUEZ BAY SEAWATER

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ABSTRACT

Phenols derivatives (phenol, 2-chlorophenol, 2-Nitrophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 4-chloro-3-methylphenol, 2-methyl-4,6-dinitrophenol, 4-nitrophenol, 2,4-dinitrophenol, 2,4,6-trichlorophenol and Pentachlorophenol) were measured in Suez bay seawater and sediment (northern part of the Suez Gulf). Phenols derivatives data for sea-water varied between below detected limits and 21.99. µ/l with an average of 0.46 µ*/1*. Average values in marine sediment ranged from below detected limits to 1.08 µg/g. The total Phenols derivatives ranked in the order D2>D5>D3>D1> D4 for the drain effluent. Stronger positive correlation between the phenol and 2-chlorophenol was noticed while weak correlation were noticed with the oceanographic parameters T, pH, , DO, BOD, OOM, salinity, TSM, Oil and grease, nutrients salts.

Key words: phenol, Suez Bay, seawater, sediment

1. Introduction

Phenol derivatives are dangerous to marine environment because these compounds can be endocrine disrupters especially for fish. The definition of endocrine disrupters is exogenous agent which is disrupting production process, release, transportation, metabolism, bonding, action and elimination from natural hormone (1).In addition the natural decomposition of organic matter may be give rise to phenolic metabolites (2). Natural waters normally contain less than 1 µg/L, but concentrations up to 20 µg/L occur in some areas. Levels of 10 to 100 µg/L phenol are detectable by taste and odor.

The present study was carried out on the Suez bay (the northern part of the Gulf of Suez) The Suez bay is shallow extension of the Gulf of Suez, roughly elliptic in shape, with its major axis in the NE - SW direction (Fig.1). The average length along major axis is about 13.2 km, its average width along minor axis is about 8.8 km. The mean depth is 10 m, and the horizontal surface area is about 77.13 km 2. The bay is connected to the Gulf of Suez through most of its south eastern side, where a channel is dredged to depth of 20 m to serve navigation purposes, and it is connected to the Suez Canal by a dredged channel of 12 m depth through the north eastern side of the bay (Meshal, 1967) (3). The northern part of the bay is occupied by the city of Suez. The Suez Bay has two sources of water: The Suez Canal and Gulf of Suez waters. The circulation in the Suez Bay can followed generally by following the proper characteristics of these two water types. Meshal (1967) found that seawater from the Gulf of Suez enters the bay on the eastern side (Sinai side) while, it leaves the bay on the western side. The seawater from Suez Canal is deflected to the western coast. Therefore, there is a persistent anticlockwise circulation in the bay. UNEP (1997)(4) reported that the sediments of the southern part of the Suez Canal – north of the bay – were mainly composed of sandy mud (90 % mud and 10 % sand). A dominant north ward sediment transport was observed due to the strong tidal currents existing at this area. The Suez bay has always been an important Egyptian gate on the Red Sea since historical times. The growing activity of this harbor has led to an increasing rate of urbanization in the whole region. Taking advantage of the site location, several industries have been established along the western coastal stretch of the Suez Bay down to Adabyia in the south. These growing industrial activities coupled with the fact that Suez represents the south entrance of the Suez Canal have resulted in the transformation of the whole Suez Bay into large harbour. More than 100 ships and tankers are waiting daily for crossing the canal to the Mediterranean. The bay receives sewage and garbage both from the city of Suez and from ships awaiting transit through the Suez Canal. It also receives wastes from the industrial complex south of the Suez, including oil refineries, fertilizer plant, power stations and other industries. All refuses coming from the different sources are discharged directly or indirectly into the bay. These refuses contain very large variety of chemical residues including phenols derivatives. Such undesirable inflows disrupt the ecological balance and affect the quality of water for human use. For these reasons, the recent studies were carried out on phenols derivatives.

2. Materials and Methods

Seven seawater samples were collected from the Suez Bay during 2013-2014. Sampling carried out to uniformly cover most of the bay , as shown as in Fig. 1. Seawater Samples were collected from the selected stations using Nansen bottle.

Sediment samples were collected using a Van-Veen grab coated with polyethylene [Amini Ranjbar, 1998] (5) from the same locations of water samples during spring 2013-2014. Subsamples were taken from the central part of the grab to avoid contamination and were dried and ground. Samples of ground sediment (10 g) were soxhlet extracted with 200 mL of methylene chloride for 8 hours according to the method of APHA, 1998 (6) . A 1 N sodium hydroxide solution was added to the extracts to give a pH > 11, and the contents of the separator were shaken for 15 min. The process was repeated three times, each time the aqueous layer was removed. This procedure resulted in the transfer of acidic phenolics from the organic phase into the aqueous phase leaving polyaromatic hydrocarbons in organic phase. The organic phase was washed once with 10 ml distilled water to remove residual base, and the wash water was added to the basic aqueous phase that was reserved. To the combined water layers, a solution of sulphuric acid was added gradually till reaching pH<2. Next, three extractions of the solution with methylene chloride was performed to get phenolic portions. the organic phase was washed with 10 ml distilled water to remove residual acid. The organic phase was then concentrated to 5 ml. Analyze sample by injecting 2.0 µL of the organic phase into the gas chromatograph. (GC) model 6500 YL instrument at Temperature of 250 °C. It was equipped with a Ni 63 electron capture detector and an analytical capillary column At 1 (25m x0.32mm i.d.x thick film of Methyl polysiloxane). The column temperature was set on 100°C for 1min and then programmed to rise at a rate of 7°C/min to reach 280°C, while the detector was set at 270°C. Nitrogen was used as the carrier gas at a flow rate of 1.3 ml per min. the split ratio was 1:2. Concentrations were identified using Software by comparison the peak areas of sample retention time values with that of the corresponding pure standard compounds. Mixture of Standards of phenol, 2-chlorophenol, 2-Nitrophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 4-chloro-3-methylphenol, 2-methyl-4,6-dinitro phenol, 4-nitrophenol, 2,4-Dinitrophenol, 2,4,6-trichlorophenol and Pentachlorophenol were obtained from Sigma Chem. Co. USA. The concentration of each standard was 100 µg/ml of the mixture.

Fig. (1): Map of the Suez Bay showing the different pollution sources, offshore and inshore sampling stations during 2013

Temperature, pH and Salinity were measured using Standard Checktemp®1F Pocket Thermometer, Jenway pH Bench Meter, Model 3505 and Bench top seven multimettler Toledo AG TDS/Salinity/Resistivity meter model 8603; respectively. Dissolved oxygen (DO) was analyzed according to the modified Winkler method (Grasshoff, 1976) (7), Oxidizable Organic Matter (OOM) according to FAO method (FAO, 1976) (8) and DOD according to the method of (APHA, 1995), TSM according to the Gravimetric analysis described by (APHA, 1995) (9). Nutrient salts (nitrite, nitrate, ammonia, phosphate, and silicate) were measured spectrophotometrically according to the method of (APHA, 1995) using Beckman Du-UV Visible Single Beam Spectrophotometer,

3. Results and discussion

3.1. Physico-chemical parameters of Suez bay seawater

3.1.1. Temperature

Temperature variation in coastal and estuarine system may influence the physico-chemical characteristics and distribution and abundance of flora and fauna. During the present study temperature varied from 19.37°C (Winter 2014) to 27.00°C (Summer 2013) (Table 1).

3.1.2. pH

Major fluctuation in the pH of the sea water will alter the chemical and biological milieu of marine environment drastically. Hence, pH is one of the best indicators to find out the zone of pollution in the environmental study. The pH of marine waters is usually quite stable and ranges between 7.5 and 8.511. Water pH during this one year study varied from 7.84 (Autumn 2013) to 8.42 (Winter 2014) (Table 1). Almost all the pH values recorded were within the limits and did not show any abnormality.

3.1.3. Dissolved Oxygen

Of all the dissolved gases in water, oxygen is the most important one for the survival of aquatic biota. Issolved oxygen concentration varies mainly due to photosynthesis and respiration by plants and animals in water. Generally, the coastal waters are saturated with DO. This was also evident in the present study area. The monthly variation inthe DO was from 7.20 mg/L (Summer 2013) to 9.03 mg/L (Winter 2014) (Table 1). Majority of the stations showed a homogenous distribution of dissolved oxygen.

3.1.4. Biological Oxygen Demand

The BOD has the capacity to alter the species diversity at a particular environment if it increases beyond a limit. Input of organic matters from terrestrial sources will increase the BOD level. In the present study of one year, BOD levels in the study area varied from 4.34mg/L (Spring 2013) to 4.82 mg/L (Winter 2014) as shown in Table 1 During the period of study, BOD in all the stations recorded higher values . This could be due to microbial utilization of oxygen influenced by polluted water input.

3.1.5. Oxidizable organic matter (OOM)

The amount of oxygen required to oxidation by strong chemical oxidant is called Oxidizable organic matter . In the present study, the values of OOM showed a maximum of 18.87 mg/L during autumn 2013 and minimum of 17.10mg/L during summer 2013.

3.1.6. Salinity

Water salinity profoundly influences the abundance and distribution of the biota in coastal, marine and estuarine environments. In the present study, values of salinity showed maximum of 41.00 ppt during Winter 2014 and minimum of 40 ppt during autumn 2013 . The recorded higher values could be attributed to shallowness of water and low rainfall.

3.1.7. Total suspended matter (TSM)

TSM concentrations fluctuated between 11.70 and 15.14 mg/L and showed a significant increase during winter because of raining season and climatic conditions. The phytoplankton photosynthesis raising the decomposable organic matter (phytoplanktons grow quickly, die quickly, decompose as suspended organic matter).

3.1.8. Ammonia

Ammonia Concentrations varied from 2.90 to 23.44µM. the minimum values were recorded during summer as a result of the effect of seawater temperature.

3.1.9. Nitrite

Concentrations fluctuated between 2.30 and 3.16 µM. The maximum values during Autum that may be attributed to the continuous wave agitation that mixed the bottom water with the surface.

3.1.10. Nitrate

Nitrate is the most stable form of inorganic nitrogen in oxygenated water. Nitrate Concentrations fluctuated between 5.03 and 11.33 µM.

3.1.11. Phosphate

Phosphate Concentrations fluctuated between 0.21 and 1.28 µM and showed a significant increase during winter that may be due to the discharge of industrials effluents with the rains comes from the mountains around the bay.

3.1.12. Silicate

Silicate concentrations varied from 1.51 to 2.60µM as shown in Table 1. the lowest concentrations of phosphate and silicate during spring may be due to uptake by phytoplankton and primary producers [Al-Qutob, 2002] (10) and dilution of the effluent by normal seawater. The range of Phosphate concentrations was found to be higher than that reported of red sea by Abdelmongy (11) and Elmoselhy, 2014 and Nassar et al., 2014(12).

Table (1): Physico-chemical parameters of Suez bay seawater during 2013-2014

parameter	Spring 2013	Summer 2013	Autumn 2013	Winter 2014
T	**21.86**	**27.00**	**20.09**	**19.37**
pH	**7.98**	**8.20**	**7.84**	**8.42**
DO	**7.36**	**7.20**	**8.24**	**9.03**
BOD	**4.34**	**4.40**	**4.77**	**4.82**
OOM	**17.56**	**17.10**	**18.87**	**18.14**
salinity	**40.17**	**40.20**	**40.00**	**41.00**
TSM	**12.86**	**11.70**	**14.71**	**15.14**
Oil and grease	**28.00**	**14.70**	**90.86**	**68.29**
NH_3	**8.53**	**2.90**	**23.44**	**12.65**
NO_2^-	**2.75**	**2.30**	**3.16**	**2.59**
NO3	**6.59**	**5.20**	**11.33**	**5.03**
PO_4^{3-}	**0.21**	**0.70**	**1.06**	**1.28**
SiO_3^-	**1.51**	**2.60**	**1.82**	**1.78**

3.2. Phenol and phenol derivatives in Suez bay seawater

Seasonally, in spring season 2013 Phenol and Chlorophenol are representing the most abundant phenol in Suez Bay. Phenol concentrations were found between below the detection limit at station V to a maximum value 0.22 µg/l at station I . Chloro phenol lie below the detection limit at stations V and VI while station V was recorded the highest level during spring season being 1.05µg/l., 2,4-dinitrophenol and pentachlorophenol were found in levels 3.6 and 1.2 µg/l respectively at stations IV and VI and nearly most of the other phenol derivatives lie below the detection limit as shown as in **Table (2)** and **Fig (2)**. Such results revealed that the presence of chloro phenols is marked to the source of petroleum industries and hypochlorite as antifouling agent. Oil refineries in Suez have many activities like crude oil refining, oil processing which produce: Naphtha, Gasoline, fuel gas, fuel oil, petroleum cook, sulpher, hydrogen, lubrication oils The area is being affected by the companies` activity where they utilize sea water (as coolant) in cooling systems (Heat exchangers, water coolers .etc.) and discharges is back to the sea but containing some leaked oil refining products. Hypochlorite unit has been constructed on shoreline to use sea water to produce hypochlorite which is being used as an anti-fouling for the cooling water systems to avoid fouling growth inside the tubes of the heat exchangers which reduces the cooling process efficiency consequently. The impact of this Hypochlorite dosing operation into the water inlet stream is that not all the amount of hypochlorite is being consumed a residual considerable quantity of hypochlorite is being recycled again to the see water body, in the presence of phenol (which is leaked through cooling water systems from lubrication oil extraction units)and its derivatives and suitable reaction/combination conditions some Chlorophenol compounds are being introduced to the marine environment , which I could detect during my research. Discharge rate from SOPC ranging from (1500 – 3000) m^3/hr. of sea water contaminated with (10-15ppm) of oil which means that the oil pollution from this company only is (150 – 400) m^3/year of oil. For Nasr Petroleum company Discharge rate ranging from (1500 – 3000) m^3/hr. of sea water contaminated with (10-15ppm) of oil which means that the oil pollution from this company only is (200 – 400) m^3/year of oil. All previously dominant phenolic compounds concentrations exceed the permissible levels by EEA.

In summer season 2013, the same trend occurred as in spring season Phenol and Chlorophenol are representing the most abundant phenol in Suez Bay. The phenol was vary between 0.04 µg/l at statin II and 0.15 µg/l at station VII while Chlorophenol levels ranged between 0.21 and 0.73 µg/l for the same stations in phenol. 4-nitrophenol, 2-methyl-4,6-dinitrophenol and 2,4-dichlorophenol were noticed at station II and IV being 0.7. 5.19 and 4.74 µg/l respectively wile all the other stations nearly free from the derivatives of phenol or lie below the detection limits.

In autumn season (2013), phenol and chlorophenol were noticed in all stations except at station V and VII (only phenol was recorded). 4-Chloro-3-methylphenol was found

at stations II and VI of 1,74 and 13.01 µg/l respectively while 2,4-dinitrophenol, 2,4-dinitrophenol and 4-nitrophenol were noticed at stations II and VII being 3.32.21.99 and 0.73 µg/l respectively. 2-methyl-4,6-dinitrophenol and pentachlorophenol were observed at stations I,II and and VII and their levels reached about 4.96,5.84 and 2.00 µg/l for 2-methyl-4,6-dinitrophenol and 1.84, 4.29 and 10.15 µg/l.

In winter season (2014) and from obtained data in **Table (5)** and **Fig.(5)**, phenol and chlorophenol were noticed with all stations while 4-chloro-3-methylphenol was found in station IV only, 4-nitrophenol was recorded in stations V and VII, 2-methyl-4,6-dinitrophenol was found in three station (I,V and VII) while pentachlorophenol was observed at stations I and VII.

Table (2): Phenol and phenol derivatives concentrations in the study area during spring 2013.

Compound	I	II	III	IV	V	VI	VII
Phenol	0.22	0.21	0.13	0.14	N.D.	0.13	0.15
Chlorophenol	1.05	0.71	0.62	0.68	N.D.	N.D.	0.74
Nitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dimethylphenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dichlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
4-chloro-3-methylphenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4,6- trinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4- dinitrophenol	N.D.	N.D.	N.D.	3.6	N.D.	N.D.	N.D.
4- nitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2-methyl-4,6-dinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
pentachlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.	1.2	N.D.

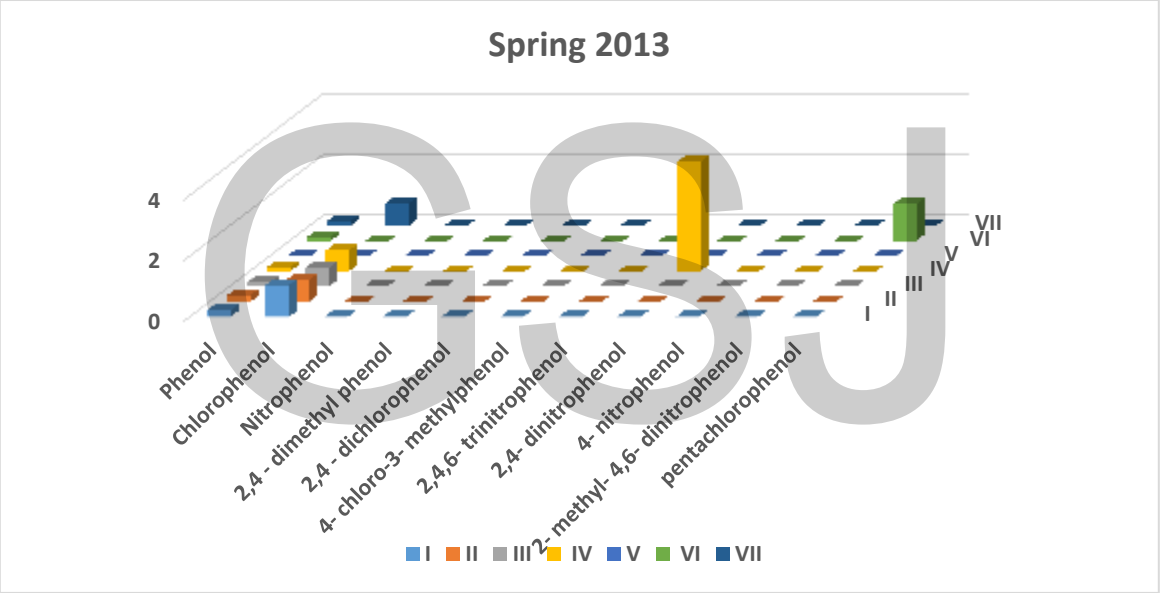

Fig.(2) phenol and phenol derivatives concentrations in the study area during spring 2013-2014.

Table (3): Phenol and phenol derivatives concentrations in the study area during summer 2013.

Compound	I	II	III	IV	V	VI	VII
Phenol	0.11	0.04	0.01	0.06	0.09	0.11	0.15
Chlorophenol	0.52	0.21	0.03	0.31	0.42	0.54	0.73
Nitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dimethylphenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dichlorophenol	N.D.	N.D.	N.D.	4.737	N.D.	N.D.	N.D.
4- chloro-3-methylphenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4,6-trinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
4-nitrophenol	N.D.	0.70	N.D.	N.D.	N.D.	N.D.	N.D.
2- methyl-4,6-dinitrophenol	N.D.	5.19	N.D.	N.D.	N.D.	N.D.	N.D.
pentachlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

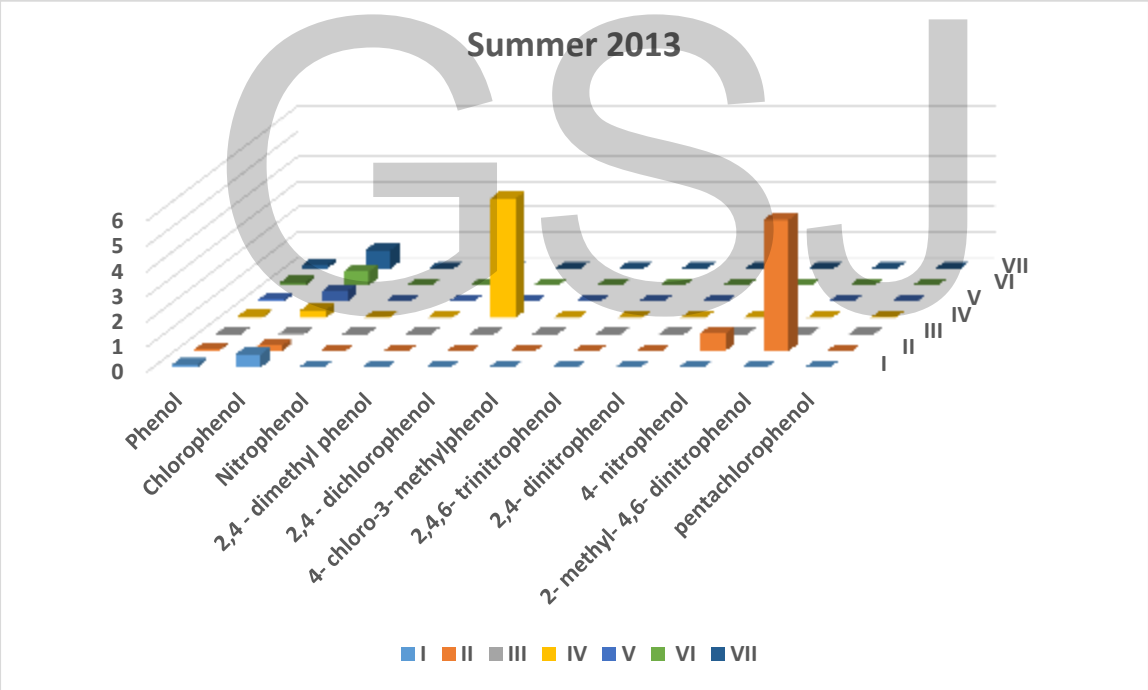

Fig. (3): Phenol and phenol derivatives concentrations in the study area during summer 2013-2014.

Table (4): Phenol and phenol derivatives concentrations in the study area during autumn 2013

Compound	I	II	III	IV	V	VI	VII
Phenol	0.09	0.05	0.18	0.16	N.D.	0.11	0.03
Chlorophenol	0.44	0.23	0.86	0.02	N.D.!	0.55	N.D.
Nitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dimethyl phenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dichlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
4-chloro-3-methylphenol	N.D.	1.74	N.D.	N.D.	N.D.	13.01	N.D.
2,4,6-trinitrophenol	N.D.	3.32	N.D.	N.D.	N.D.	N.D.	N.D.
2,4-dinitrophenol	N.D.	21.99	N.D.	N.D.	N.D.	N.D.	N.D.
4- nitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.73
2- methyl-4,6-dinitrophenol	4.96	5.84	N.D.	N.D.	N.D.	N.D.	2.00
pentachlorophenol	1.84	4.29	N.D.	N.D.	N.D.	N.D.	10.15

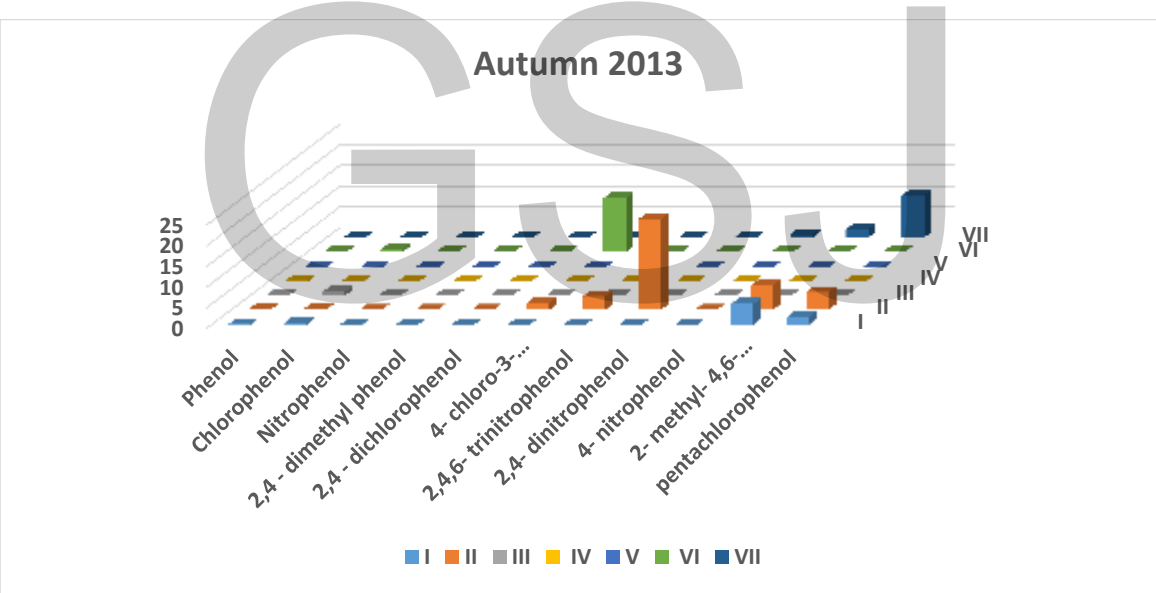

Fig. (4): phenol and phenol derivatives concentrations in the study area during autumn 2013-2014.

Table (5): phenol and phenol derivatives concentrations in the study area during winter 2014.

	I	II	III	IV	V	VI	VII
Phenol	**0.04**	**0.16**	**0.03**	**0.14**	**0.15**	**0.05**	**0.03**
Chlorophenol	**0.20**	**0.79**	**0.64**	**0.67**	**0.72**	**0.27**	**0.13**
Nitrophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2,4 - dimethyl phenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2,4 - dichlorophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
4- chloro-3- methylphenol	**N.D.**	**N.D.**	**N.D.**	**5.61**	**N.D.**	**N.D.**	**N.D.**
2,4,6- trinitrophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2,4- dinitrophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
4- nitrophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**0.01**	**N.D.**	**10.05**
2- methyl- 4,6- dinitrophenol	**1.71.**	**N.D.**	**N.D.**	**N.D.**	**4.55**	**N.D.**	**5.76**
pentachlorophenol	**6.50**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**6.31**

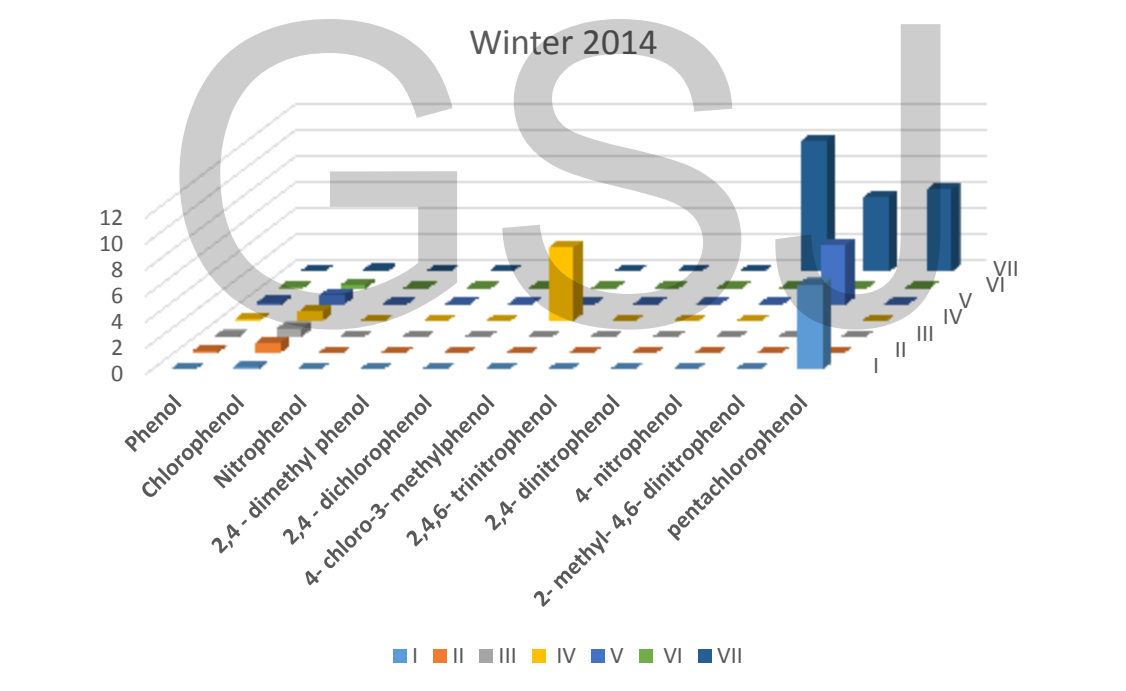

Fig. (5): Phenol and phenol derivatives concentrations in the study area during winter 2013-2014.

3.3. Phenol and phenol derivatives in Suez bay sediment

In sediments results as shown as in **Table (6)** and **fig.(6),** the Phenol and Chlorophenol gave positive detections with all sampling stations during the period of study with concentrations ranging from 0.01 µg /g (at station II) to 0.22 µg /g (at station V) for phenol and from 0.01(at station I) to 1.05 µg /g at station V) for Chlorophenol. Nitrophenol, 2,4,6-trinitrophenol, 2,4-dinitrophenol and 4-nitrophenol were detected only in one sample at station 0.45, 1.29, 0.07 and 0.20 µg /g respectively. 2-methyl-4,6-dinitrophenol was detected in tow sampling stations at I and II with concentrationsd of 2.84 and 0.27 µg /g respectively. pentachlorophenol are not detected in stations IV,V and VI while in the other four sampling points recorded about 0.60, 0.28, 3.17 and 2.16 µg /g respectively.

Table (6): phenol and phenol derivatives concentrations in sediment of the Suez bay water during 2013-2014.

Compound	I	II	III	IV	V	VI	VII
Phenol	**0.02**	**0.01**	**0.07**	**0.14**	**0.22**	**0.13**	**0.09**
Chlorophenol	**0.01**	**0.05**	**0.36**	**0.67**	**1.05**	**0.65**	**0.45**
Nitrophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**0.20**
2,4 -dimethyl phenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2,4-dichlorophenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
4-chloro-3-methylphenol	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2,4,6-trinitrophenol	**N.D.**	**N.D.**	**1.29**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2,4-dinitrophenol	**0.07**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
4- nitrophenol	**0.20**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
2-methyl-4,6-dinitrophenol	**2.84**	**0.27**	**N.D.**	**N.D.**	**N.D.**	**N.D.**	**N.D.**
pentachlorophenol	**0.60**	**0.28**	**3.17**	**N.D.**	**N.D.**	**N.D.**	**2.16**

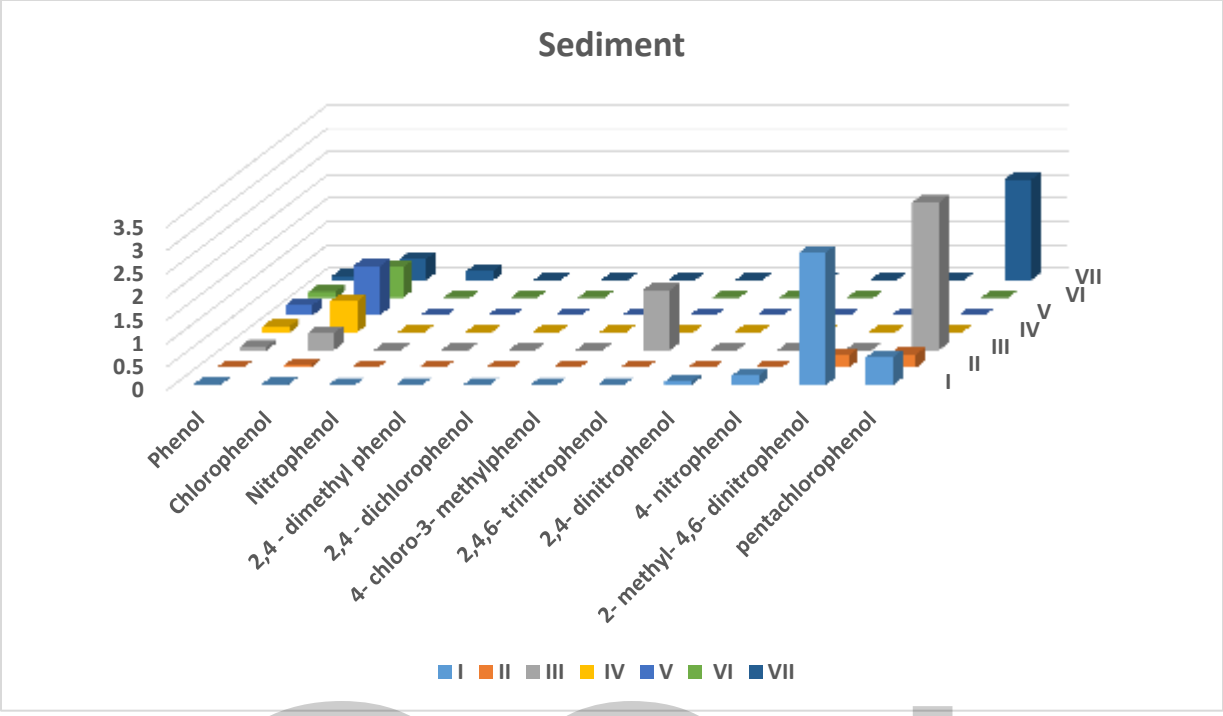

Fig.(6): phenol and phenol derivatives concentrations in the sediment of the Suez bay water during 2013-2014.

3.4. Phenol and phenol derivatives in drain effluents into Suez bay seawater

The results obtained from the analysis of industrial and waste effluents that enter the waters of Suez bay indicate that phenol is present in all samples except drains D3 and D4 while that the chlorophenol is found in all samples except drain D4 Table (6). All the other phenol derivatives nearly abent in the drains water. so the D1-D5 are the main sources of phenol and chlorophenol in Suez bay.

Table (7): phenol and phenol derivatives concentrations in the study area (Effluent discharge to suez bay) during the study period (2013-2014).

Compound	D1	D2	D3	D4	D5
Phenol	0.04	0.16	N.D.	N.D.	0.15
Chlorophenol	0.21	0.76	0.35	N.D.!	0.72
Nitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.
2,4 - dimethyl phenol	N.D.	N.D.	N.D.	N.D.	N.D.
2,4 - dichlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.
4- chloro-3- methylphenol	N.D.	N.D.	N.D.	N.D.	N.D.
2,4,6- trinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.
2,4- dinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.
4- nitrophenol	N.D.	N.D.	N.D.	N.D.	0.01
2- methyl- 4,6- dinitrophenol	N.D.	N.D.	N.D.	N.D.	N.D.
pentachlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.

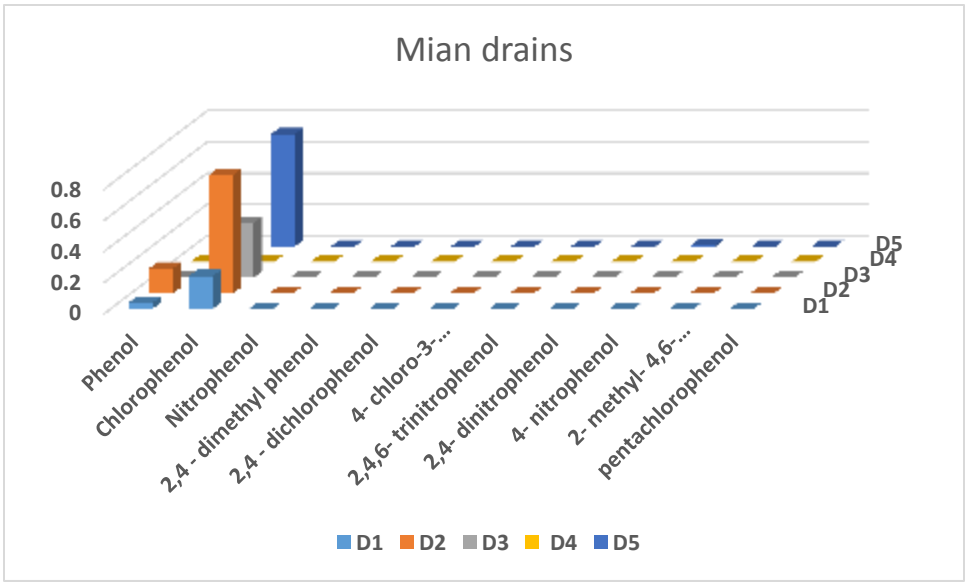

Fig.(7): phenol and phenol derivatives concentrations in the main drains in the Suez bay water during 2013-2014

Strong significant positive correlation confident between phenol and cloroohenol was found (r =0.7044, p = 0.02) while weak negative correlation between the phenol and most of the oceanographic parameters as shown as in **Fig.(8).**

It is clear from the results obtained that concentrations of phenol and its derivatives have not yet reached the hazardous limits according to the permissible limits globally or through the Egyptian Environment Law. A little attention studies in Suez bay area, so this new study is considered a reference given to the first time in the area of Suez bay.

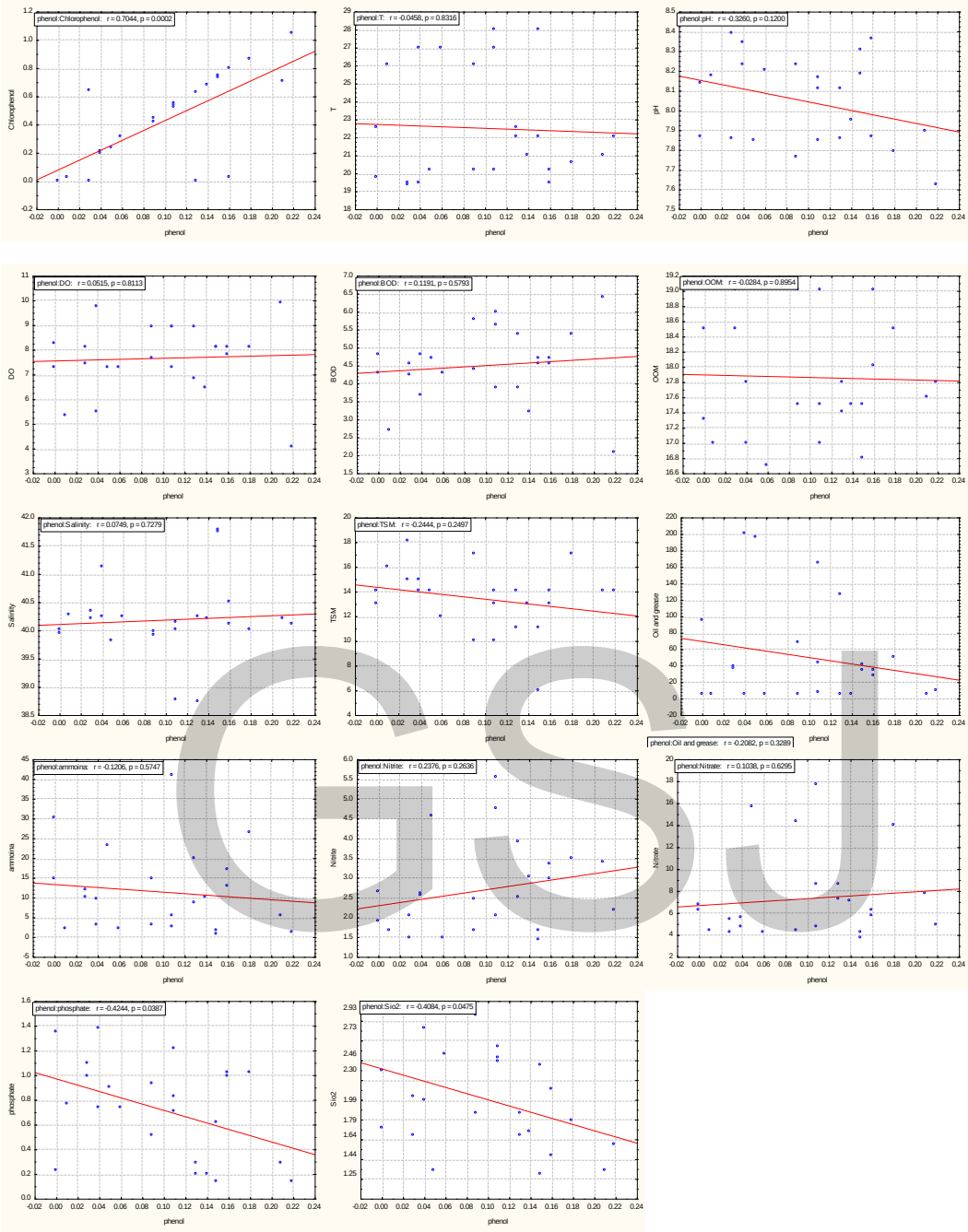

Fig.(8): Correlation coefficient between phenol and Chlorophenol with oceanographic parameters 2013-2914

References

(1) Rosenkranz, F., Cabrol, L., Carballa, M., Donoso-Bravo, A., Cruz, L., Ruiz-Filippi, G., Chamy, R., Lema, J. M., Water Res. 2013, 47, 6739–6749.

(2) Hoak, R. (1962) : lnt. J. Air Water PoHut. ~, 521.

(3) Meshal, A. H. (1967): A physical study of water pollution in Suez Bay (Hydrography of Suez Bay). M. Sc. Thesis, Fac. Sci., Cairo University.

(4) UNEP (1997). Global environmental outlook. United Nations. New York, Oxford, Oxford University Press.

(5)Amini Ranjbar, G.H., 1998. Heavy metal concentration in surficial sediments from Anzali Wetland, Iran: Water Air Soil Poll. 104, 305–312.

(6) APHA., 1998. Standard Methods for the Examination of Water and Wastewater: 19th edition, Amer. Public Health Assn., Amer. Water Works Assn., Water Pollution Control Fed., APHA, New York, N.Y.

(7) Grasshoff, K., 1976. Methods of Sea Water Analysis. Ver-lag Chemie Weinhein, New York, pp. 1–317

(8) FAO,1976. Manual of methods in aquatic environmental research part I: permanganate value (oxidability) of organic matter in natural waters. FAO Fisheries Technical Paper, No 137, pp. 169.

(9) APHA., 1995. Standard Methods for the Examination of Water and Wastewater: 19th edition, Amer. Public Health Assn., Amer. Water Works Assn., Water Pollution Control Fed., APHA, New York, N.Y.

(10) Al-Qutob, M., Hase, C., Tilzer, M.M., Lazar, B., 2002. Phytoplankton drives nitrite dynamics in the Gulf of Aqaba, Red Sea: Mar. Ecol. Prog. Ser. 239, 233–239.

(11) Abdelmongy, A.S., El-Moselhy, K.M., 2015. Seasonal Variations of the Physical and Chemical Properties of Seawater at the Northern Red Sea, Egypt: Open Journal of Ocean and Coastal Sciences 2, 1-17.

(12) Nassar, M.Z., Mohamed, H.R., Khiray, H.M., Rashedy, S.H., Seasonal fluctuations of phytoplankton community and physicochemical parameters of the north western part of the Red Sea, Egypt: Egyptian Journal of Aquatic Research 40, 395–403.