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RESEARCH ARTICLE

Physico-chemical assessment and its impacts on Marsh Crocodiles of Karachi Zoological Garden

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Abstract

In order to assess the water quality and its impacts on Marsh Crocodile population in Karachi Zoological Garden was carried out during the months of January to December 2008. To determine the microbial contamination, detection of pollutant indicator organisms in water samples, to examine the physico-chemical parameters were performed. To examine the physico-chemical parameters were analyzed which are temperature of air and water, electrical conductivity, total dissolved solids, calcium, magnesium, bi carbonate, chloride, sodium, potassium, sulphur, carbonate, biological oxygen demand and dissolved oxygen with the recognized standard method of world health organization. Marsh Crocodiles are considered endangered in Pakistan due to hunting pressure in the past decades and habitat degradation. Various contaminants were estimated below the detection range while other chemicals were found within the normal range. It was observed that the range of contamination, proximity of pollution sources and water quality of pond suggest that the species is under threatened in Karachi Zoological Garden.

Introduction

Karachi Zoological garden was established in 1878. After independence of Pakistan the old name Ram Garden was changed in 1947 and renamed it as Karachi Zoo or Karachi Zoological Garden (KZG). It is located at Nishtar road and Sir Agha Khan road Karachi. In reptilian house Adults, juveniles and newly born hatchlings of crocodilians are exhibited and conserve them for their growth and development in captive farm. The maximum depth of Crocodile pond is recorded between 3-6 feet. Various environmental factors in aquatic habitats include different physical properties of water such as solubility of gases and solids, light penetration, temperature, solids and salinity. Physico-chemical factors such as hardness, phosphate and nitrates are very essential for the growth of primary productivity. Examination of water quality is among frequently conducted for every month in KZG. Hence, the present study was based on the estimation of the physico-chemical parameters of KZG, Karachi, Sindh, Pakistan. The most important and endangered species of crocodilian, the Marsh crocodile is found in KZG Karachi (WWF-Pakistan, 2007). For aquatic life the availability of good quality of water is important for the prevention of diseases and survival in aquatic habitats. The major sources of contamination may be due to leakage of supply lines or pollution from damaged sewerage pipe lines, shallow water tables and due to anthropogenic activities.

The present study on water quality related with its impacts on crocodilian health was carried out first time in KZG Sindh, Pakistan. In aquatic life ecological changes depend upon the physico-chemical factors of water bodies. The present study of physico-chemical factors provides the information and influence on health and growth of Marsh crocodiles. The major aim of this study was to determine the water quality and its impacts on population of Marsh crocodile in KZG Karachi, Sindh, Pakistan.

Material and Methods

Determination of physico-chemical properties of pond water was carried out during January to December 2008. Water samples were collected from surface and bottom layers by using Van Dorn plastic bottles (1.5 lit) from crocodile pond randomly. We were kept them in polythene plastic bottles, previously soaked in 10% nitric acid for 24 h and rinsed with ultrapure water obtained from lab water system. When we were reached at the laboratory, the water samples collected from each station were mixed in acid washed bucket to make one composite sample, rinsed with ultrapure water and kept under 4 °C till further analysis. The analytical data of water quality was ensured through careful standardization and duplicate samples. Determination of physico-chemical parameters were carried out by standard methods of analysis (APHA, 1998).

Water sampling was carried out from 11:00 am to 3:00 pm at monthly intervals. Analysis of Physico-chemical parameters like as temperature of water, depth and transparency, the secchi disk measurement was done during water sampling. Determination of temperature level the mercury thermometer was dipped into the water samples to a depth of 15 cm for 2-5 minutes, range of pH was determined with Orion Model 420 A pH meter, EC, TDS and Na was measured with WTW 320 conductivity meter. The alkalinity, hardness, chloride and phosphate were measured with standard methods of APHA, 1998. For analysis of Ca, HCO_3 and HCO; the titration method (2310) was applied. The Mg and K was examined with Spectrometer. The BOD was determined with Winkler method and DO was examined with Oxygen meter (Jenway Model 9071).

RESULTS:

The physico-chemical parameters and presence of nutrient content in water play a vital role in the distributional patterns and species composition of primary organisms (Sahato et al., 2004). In aquatic biodiversity, environmental factors include various physical properties of water, like as solubility of gases and solids, light penetration, temperature, salinity and density. Factors of physico-chemical parameters such as pH, hardness, phosphate and nitrate are very important for growth and dispersal of phytoplankton on which zooplankton and other consumers depend for their survival. Condition of hydrographic of crocodile pond of KZG, seasonal and physico-chemical change in water level affect the abundance and distribution of aquatic life. Determination of physico-chemical parameters were collected from crocodile pond in KZG (**Table 2**).

Temperature of air/water °C: Temperature is the most important parameter which can directly related to chemical reaction in water bodies. It is the important physico-chemical parameter which directly influences on the aquatic biodiversity and it will reduce the dissolved oxygen in aquatic habitats. During our observation it was recorded that the highest temperature of air found during the month of June 38 °C and lowest was observed in the month of January 22 °C (**Table 2**). Temperature of water was recorded the highest in the month of June 34 °C and lowest was observed in the month of January 19 °C (**Table 2**).

pH: The highest level was observed during the month of January 7.85 and lowest level was observed in the month of October 6.50 respectively (**Table 2**).

Electrical Conductivity: The level of EC was recorded the highest 870 us/cm in the month of December and lowest was observed 645 us/cm in the month of March (**Table 2**). However, in pond fluctuation was observed in water samples due to the flow of rain water. The standard level of EC is 400 us/cm recognized by world health organization. The water quality is depends upon the quantity of total dissolved solids (TDS).

Total Dissolved Solids: The level of TDS was recorded the highest 560 mg/l during the month of May and lowest level 435 mg/l during the month of April (**Table 2**).

Turbidity: The highest level of turbidity was recorded 128 NTU during the month of July and lowest level 95 NTU was recorded during the month of February (**Table 2**).

Calcium: The highest level of calcium was observed 89 mg/l during the month of March and lowest level 40 mg/l was observed during the month of September (**Table 2**).

Magnesium: The highest level of magnesium was observed 64 meq/l during the month of April and lowest level 32 meq/l was observed during the month of June (**Tale 2**).

Hardness: The highest level of hardness was observed 450 mg/l during the month of February and lowest level 210 mg/l was observed during the month of June (**Table 2**).

Bicarbonate: The highest level of bicarbonate was observed 425 mg/l during the month of January and lowest level 200 mg/l was observed during the month of October (**Table 2**).

Alkalinity: The highest level of alkalinity was observed 8.4 mg/l during the month of April and lowest level 5.6 mg/l was observed during the month of October (**Tale 2**).

Chloride: The highest level of chloride was observed 87 mg/l during the month of February and lowest level 49 mg/l was observed during the month of April (**Table 2**).

Table 1. Physicochemical parameters of Karachi Zoological Garden and their analytical procedure during 2008

Variables	**Abbreviations**	**Units**	**Analytical method**
Temperature	Temp	°C	Mercury thermometer
pH	pH	pH unit	pH meter
Electrical Conductivity	EC	uS/cm	Conductivity meter
Total Dissolved Solids	TDS	Mg L^{-1}	WTW 320
Turbidity	Tur	NTU	Nephlometric turbidity unit
Calcium	Ca	Mg L^{-1}	Titration (EDTA)
Magnesium	Mg	Mg L^{-1}	Titration (EDTA)
Hardness	Hard	Mg L^{-1}	Titration (Silver nitrate)
Bi Carbonate	HCO_3	ppm	Titration (2310)
Alkalinity	Alkaline	Mg L^{-1}	Titration (Silver nitrate)
Chlorides	Cl	Mg L^{-1}	Titration (Silver nitrate)
Sodium	Na	Meq	WTW 320
Potassium	K	Mg L^{-1}	Titration (EDTA)
Sulphate	SO_4	Mg L^{-1}	Titration (2310)
Carbonate	HCO	ppm	Titration (2310)
Biological Oxygen Demand	BOD	Mg L^{-1}	Winkler method
Dissolved Oxygen	DO	Mg L^{-1}	Winkler method

Table 2. Analysis of physico-chemical parameters of KZG during 2008

	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Date	12	10	14	15	11	4	12	13	14	10	9	13
Time	1:00	1:30	1:00	12:30	1:00	1:00	1:30	12:30	1:00	11:00	1:00	1:30
Temp: Air °C	22	27	27	26	32	38	34	27	26	26	24	23
Temp: H_2O °C	19	24	24	23	28	34	26	24	23	23	21	20
pH	7.85	7.15	7.15	7.17	7.10	7.0	7.6	6.80	7.5	6.50	7.4	7.60
EC mu/scm	735	690	712	645	745	840	804	818	790	818	835	870
TDS mg/l	510	458	554	435	560	536	510	442	405	448	425	452

Turbidity	102	95	125	123	106	109	128	116	118	109	116	122
Ca mg/l	70	86	89	76	42	48	43	44	40	44	41	48
Mg meq/l	56	60	52	64	32	22	34	41	38	41	36	45
Hardness mg/l	356	450	410	435	308	210	270	280	270	280	267	295
HCO_3 ppm	425	350	310	405	385	300	312	300	340	200	354	320
Alkalinity	8.0	7	7	8.4	7.2	6.00	6.7	6.0	6.4	5.6	6.8	7.1
Cl mg/l	80	87	76	49	76	71	68	61	56	61	73	68
Na meq/l	54	74	48	51	60	57	46	50	42	50	58	53
K mg/l	17	18	14	16	13	15	13	10	16	12	21	17
SO_4 mg/l	16	26	36	30	27	24	22	21	28	21	23	25
CO_3 ppm	0	0	0	0	0	0	0	0	0	0	0	0
BOD mg/l	4.5	3.4	3.4	3.5	3.4	3.6	3.5	2.9	4.1	4.3	4.2	3.8
DO mg/l	3.9	5.75	5.75	5.2	5.1	5.9	5.2	5.4	3.4	4.8	3.5	5.7

Sodium: The highest level of sodium was observed 74 mg/l during the month of February and lowest level 42 mg/l was observed during the month of September (**Table 2**). Sodium concentration increases mostly during the winter season while concentration of sodium decreases during the summer season.

Potassium: The highest level of potassium was recorded 21 mg/l during the month of November and lowest level 10 mg/l was recorded during the month of August (**Table 2**).

Sulphate: The highest level of sulphate was recorded 36 mg/l during the month of March and lowest level 16 mg/l was recorded during the month of January (**Table 2**).

Carbonate: The concentration of carbonate was observed zero during the whole study period (**Table 2**).

Biological Oxygen Demand: The highest level of BOD was observed 4.5 mg/l during the month of January and lowest level 2.9 mg/l was observed during the month of August (**Table 2**).

Dissolved Oxygen: The highest level of DO was observed 5.9 mg/l during the month of June and lowest level 3.4 mg/l was observed during the month of September (**Table 2**).

DISCUSSION:

In physico-chemical parameters the seasonal fluctuation caused similar rise in dissolved oxygen range has been recorded during the winter season (Singh et al., 1980). Reduction in microbial decomposition of dead organic matter caused due to low organismal respiration demand, increased submerged macrophytes growth and solubility of atmospheric oxygen by reduction in temperature level (Rao, 1986). The results of pH and alkalinity values shows that the Crocodile pond water remained slightly alkaline throughout the study period due to sufficient amount of water comes from water supply. The permissible limits of hardness is recognized 200 mg/l by world health organization. In water samples the range of hardness was estimated little higher from above the guidelines given by WHO (1984). Increasing the level of hardness in water bodies could be due to the flow of rain water. Salinity and magnesium concentration was observed in acceptable limit but the concentration of electrical conductivity and total dissolved solids were substantially high; this increased probability indicates that there could be some contamination and waste particles accidentally added into the water bodies. The chloride which is a pollution indicating parameters i.e. related with the sewage contamination with the degradation products into the water bodies. In the pond of crocodile the

range of chloride was estimated in higher level. The recognized range of chlorides is 250 mg/l acceptable for drinking purposes. However, the level of Ca, K, SO_4, HCO_3, CO_3, COD and BOD was observed in elevated concentration compared to the maximum permissible limits (Table 2). The salinity in water bodies is the most important factor which can be directly effect on the biodiversity (Khuhawar and Mastoi, 1995) and they have observed the higher salinity in water bodies from the different aquatic resources. The physico-chemical variables of KZG when we have compared with other water bodies of Sindh: such as Keenjhar lake Thatta, (Chloride 38.9 mg/l, salinity 0.05 mg/l, alkalinity 200 mg/l; Khuhawar et al., 1998); Haleji lake Thatta (Alkalinity 525 mg/l, chloride 75 mg/l, TDS 338 mg/l; Khuhawar et al., 1998); Hamal lake Larkana (Hardness 670 mg/l, chloride 1750 mg/l, alkalinity 275 mg/l; Khuhawar, 1998); Bakar lake Sanghar (TDS 580 mg/l, alkalinity 550 mg/l, hardness 210 mg/l; Jafri et al., 1997) and Hub Dam Karachi (Transparency 2.1-3.3 m, pH 6.8-7.5, dissolved oxygen 3.1-5.3 mg/l, salinity 0.15-25 ppt, total dissolved solids 502 ppm; Iqbal and Kazmi, 1998) ; these studies indicate that all these water resources possessed the typical fresh water characteristics despite the progressive eutrophication. In the crocodile pond of KZG observed that the process of eutrophication was higher due to shallowness of basin and range of most of the physico-chemical parameters was gone up high, beyond the permissible limits recommended by world health organization (1984). Crocodiles which mostly focuses their attention on of important issue is related with water pollution that is directly concerned with the health of human beings (Chang et al., 2012). The quality of water is the main factor to determine the aquatic life related with their health (Gachal et al., 2001, 2004 and 2006). The crocodile pond is faced by many shortcomings within its impacts and prediction on crocodile population (Chang et al., 2013). The crocodile population is threatened by water quality and insufficient space of pond in KZG. The seasonal flooding and heavy rain can also damage the nesting and destroy the eggs of crocodiles in their native habitats (Santiapillai et al., 2001). The variation and access limits of physico-chemical parameters in water quality was estimated and hazards chemicals were examined during the analysis of water samples in the laboratory analysis which causing the direct harmful effects on crocodile population. It was evidenced that the current crocodile population in KZG extremely threatened with the interaction of large number of people and many visitors disturb them and low water level and its quality and insufficient food amounts and usually reduces the suitability of the habitat for increasing population of Marsh crocodile. The flourishing breeding of Marsh crocodiles have made the pond too small for the expanding population of crocodile which is naturally rough and tough for its longevity. The space of crocodile pond is not sufficient for increasing population of crocodile and they required a large sized pond for their healthy growth and survival. During our observation the water quality and water level is not suitable for their healthy growth in current small space of pond.

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