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Fish, Plankton Biodiversity and Physico-Chemical Parameters of Five Lakes of Deh-Akro II

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Abstract: Water samples from five extremely important lakes of Deh-Akro II, which are declared Ramsar sites and known for huge populations of endangered crocodile species *Crocodilus palustris* were analyzed for plankton and fish diversity, and physico-chemical characteristics. Salinity 6.1-37g/L, Total dissolved solids (TDS) 5674-36608 mg/L, dissolved oxygen (DO) 8.11-9.37 mg/L, Chloride 1618-8862 mg/L, Sulphate 186-880 mg/L, bicorbonate 100-450 mg/L, Silica 0.5-1.5 mg/L, hardness 110-1000 mg/L, Calcium 24-225 mg/L, Magnesium16-72 mg/L, Sodium 1000-5600 mg/L, Potassium 75-210 mg/L, Iron 40-245 µg/L, Manganese (below detection limit), Chromium BDL-26 µg/L, Nickel 6-92 µg/L and Arsenic 10-25 µg/L from four lakes indicated most of values within the limits of drinking water for livestock by Food and Agriculture Organization (FAO). However, one of the lakes, Morakhi, indicated higher contents of salts.

Zooplankton were represented with fourteen (14) species of rotifera, three (3) species of copepoda one (1) species of cladocera and two (2) species of ostracoda. The genus brachionus was the most dominant among the rotifers. All the copepoda recorded belong to hyper saline species. Among the phytoplankton, Bascillariophycea was the most diverse group recording eleven (11) species. The only fish species recorded was *Oreochromis mossambicus*, which is also adapted to higher salinity ranges. Salinity was the key parameter driving the fish biodiversity of the lake Deh-Akro II lakes.

Keywords: Biodiversity, Zooplankton, Phytoplankton, Wild life sanctuary, Fish, Endangered crocodile

1. INTRODUCTION

Deh-Akro II located in Shaheed Benazirabad district, at 68° 20' E 26° 50' N, lakes were declared a wildlife sanctuary in 1988 and are protected under the Sindh Wildlife Protection Ordinance of 1972. Deh-Akro II wetland complex consists of 25 lakes (Slaeem *et al.*, 2014) and occupies an estimated 50 km^2 area. The lakes are formed within the interdunal depressions through seepage from Nara Canal. The complex was designated a Ramsar site, wetland of international importance (No. 1283) on 5th November, 2002 (Balouch, PC-I of Deh-Akro II). These lakes are the largest known habitat of the threatened reptile *Crocodilus palustris* in Pakistan. Heavy metals have been recognized as one category of environmental contaminant affecting crocodilians (Brisbin *et al.* 1998). Therefore, crocodilians could be used as the bioindicators of environmental pollution (Manolis *et al*., 2002a). Several studies have reported the presence of mercury in crocodilian species (Hord *et al.* 1990; Heaton-Jones *et al.* 1997; Elsey *et al.* 1999; Rainwater *et al.* 2002; Rumbold *et al*., 2002).

Plankton are main components of the aquatic ecosystem and more than 75% of freshwater fishes feed on them at one or the other stage of their life-cycles (Jafri *et al*., 1999). Phytoplankton are the primary producers of aquatic ecosystems, and they serve as the prime source of food for the different groups of aquatic animals in direct or indirect manner (Rao, 1957).

In aquatic ecosystem zooplankton are the key component of food chain since they are the source to transfer the food energy from primary producers (phytoplankton) to higher trophic levels (Baloch *et al*., 2004) hence termed as secondary producers .

Despite the importance of the Deh-Akro II wetland complex, few or no studies have focused on the analysis of physico-chemical parameters, plankton and fish biodiversity of the lakes and waters of this complex. The present study focused on analysis of the plankton and fish biodiversity in relation to the physico-chemical characteristics of the lakes of the Deh-Akro II complex as well as assessment of the ecological status of the lakes in reference to conservation of the endangered crocodile *C. palustris* species.

2. MATERIALS AND METHODS

Samples were collected during December 2013 from the five major lakes of Deh-Akro II complex including Lake Kundho, Dhando, Drigh, Yariwari and Morakho .

Physico-chemical parameters

Water temperature was taken with the help of mercury thermometer. Water samples for chemical analysis from each lake were collected and transferred

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in precleaned and labeled bottles to the laboratory for analysis. The samples were analyzed according to the method described by Jahangir *et al.* 2013. pH was measured using a Orion 420 pH meter. Conductivity and TDS were measured using a WTW conductivity meter. The Argentometric method was used for the determination of Chloride by titration with Silver nitrate within pH range of 7-10 using Potassium chromate as indicator. Water hardness was estimated by compleximetric titration at pH 10 adjusted with ammonical solution. The titration was carried out with disodium ethylenediamine tetraacetic acid (Na_2 EDTA) in the presence of Erichrome black T indicator [3-Hydroxy-4-(1-hydroxy-2-napthyl) azo-7-nitro-1-napthlenesulphonic acid, sodium salt]. The end point was indicated by the change of color from wine-red to blue. The phenolphthalein or methyl orange alkalinity is change of color from pink to colorless or yellow to reddish respectively at the end of reaction with use of hydrochloric acid as titrant. Sulphate was determined by turbidimetric method using barium chloride as precipitating agent and gelatin for colloidal solution at the wavelength of 420nm. Dissolved oxygen was determined by Wrinkler method, the water sample was preserved in field by manganese sulphate and alkali iodide. The dissolved oxygen was determined by titration with standard sodium thiosulphate and starch as indicator. Silica was determined by reduction method using oxalic acid and complex formation of silicic molybdate using Perkin Elmer lambda 36 double beam spectrophotometer at 410 nm. The metals sodium, potassium, calcium, magnesium, iron, manganese, chromium and nickel were determined in triplicates by air acetylene atomic absorption spectrometer (Varian Spectr AA20) at wavelengths 589,766.5,422.7, 285.2, 248.3, 279.5, 357.9 and 232 nm respectively with delay time 3 seconds. The arsenic in samples was determined by using kit method (Merck, Germany).

Plankton analysis

Plankton samples were collected using plankton net (mesh size 55 µ). The samples were preserved separately in 5 % formalin on site and transferred to the laboratory for analysis. Zooplankton were identified up to species level with the help of illustrations and identification keys given by Ward and Whipple (1959), Mizuno (1964), Mizuno and Takahashi (1991) and Battish (1992). The taxonomic identification of the phytoplankton was done by Mizuno (1964), Shameel (2001) identification keys. All plankton analysis were conducted under a microscope (Nikkon Eclipse E-200) and quantified using Sedgwick-Rafter chamber.

Analysis of fish species / communities

Fish samples were collected using a cast net taking precautions due to the presence of the carnivorous crocodile species. The samples were chilled in ice and transferred to laboratory for identification using keys adapted from Talwar and Jhingran (1991). Each specimen was measured for total length (TL, cm) using a measuring tape while body weight was measured using a portable digital balance with a sensitivity of 0.1g.

3. RESULTS

Physico-chemical parameters

Water temperature of all five lakes of Deh-Akro II ranged from 19 to 21^{0}C (Table 1). Salinity was 6.1 ppt at Kundho lake, 9.5 ppt at Dhandho lake, 11. 5 ppt at Drigh and Yariwari lakes and 37 ppt at Morakhi lake. TDS ranged between 5674-9527 mg/l for four lakes, whereas Morakhi lake indicated higher amounts of TDS (36608 mg/l) close to typical ranges in seawater. Dissolved oxygen was in the range of 8.11-9.37 mg/l. The chloride and sulphate ions of all five lakes ranged between 1618-8862 mg/l and 186-880 mg/L, respectively. Bicorbonate levels ranged 100-450 mg/l while silica concentration was 0.5-1.5mg/l. Total hardness recorded ranges of 110-1000 mg/l while, the amount of calcium and magnesium ranged between 24-225 mg/l and 16-72 mg/l respectively. Sodium and Potassium concentration ranged 1000-5600 mg/l and 75-210 mg/l, respectively. Trace metals: Iron, Manganese, Chromium and Nickel concentration were 40-245 µg/l, below detection limit, BDL-26 µg/l and 6-92 µg/l, respectively. Arsenic was in the range 10-25 µg/l for all the lakes **(Table 1).**

Plankton Biodiversity

Zooplankton were represented by fourteen (14) species of rotifera in four (4) genera (i.e. *Brachionus*, *Ecuclanis*, *Mytilina* and *Keratella*), three (3) species of copepoda in three (3) genera (i.e. *Thermocyclops*, *Harpacticoid* sp. Apocyclopes) and one (1) species of cladocera (i.e. *Moina brachiata*) **(Table 2)**.

Among the rotifers *Brachionus* appeared as the most diverse genera and was recorded in all the five (5) lakes. Species wise, *Brachionus pilicatilus*, *B. urclearis* occurred at all five lakes with *B. pilicatilis* as the most abundant species. Among the copepoda, *Thermocyclops hayalinus* occurred at three lakes (Kundho, Dhandho and Drigh) while *Harpacticoid* sp. and *Apocyclopes* sp. each occurred at only three lakes (Drigh, Yariwari and Morakho). Cladocera was represented by only one species (*Moina brachiata*) with limited occurrence at Kundho lake only. Phytoplankton were represented by three phyla (i.e. Cyanophyceae, Cholorophyceae and Bacillariophyceae). Cyanophyceae was represented in five (5) species and three (3) genera and (*Microcyctis*, *Croococus* and *Oscillatoria*). Chlorophyceae was represented in only one (1) genus (i.e. *Cosmarium*). Bascillariophyceae was represented by eleven (11) species and six (6) genera (*Cymbella*, *Merismopedia*, *Navicula*, *Synedra*, *Frusturia*, *Amphora*).

Fish fauna

Oreochromis mossambicus was the only fish species occurred at all five lakes. The length and weight of largest specimen measured was 29 cm and 356 g. Average length and weight of fish were 23.7± 6.0 and 232.9± 118.7 at Kundho lake; 27.3± 1.1and 308.8± 17.7 at Dhandho lake; 25.5± 5.2 and 278.4±75.7 at Drigh lake; 25.0± 5.2 and 266.1±104.1 at Yariwari lake; 27.8± 0.8 and 314.6±24.4 Morakhi lake **(Tables 3).**

Table 1. Physico-chemical parameters of all five lakes of Deh-Akro II

Parameters	**Kundho**	**Dhandho**	**Drigh**	**Yariwari**	**Morakho**
pH	9.15	8.81	8.92	8.88	8.22
ORP mV	124.6	104.7	111.2	109	70.3
Temperature ^{0}C	19. 1	21	20	19	21
TDS mg/L	5674	7992	7532	9527	36608
conductivity ms/cm2	11.56	16.37	19.46	19.44	57.2
Salinity g/L	6.5	9.5	11.5	11.5	37.2
DO mg /L	10.11	11.16	11.12	11.37	10.94
chloride mg/L	2980	2227	2681	1618	8862
Bicarbonate mg/L	450	270	340	220	100
T hardness mg/L	750	500	110	650	1000
Sulphate mg/L	210	230	186	290	880
Ca mg/L	177	114	24	154	225
Mg mg/L	20	30	18	16	72
Na mg/L	1000	1450	2000	1070	5600
K mg/L	92	105	128	75	210
Silica mg/L	0.6	1.4	1.5	1.1	0.5
Fe µg/L	48	40	112	245	85
Mn µg/L	BD	BD	BD	BD	BD
Ni µg/L	12	92	6	53	45
Cr µg/L	14	6	BD	BD	26

BD= Below Detection Limit

Table 2. Occurrence and abundance of plankton communities of five lakes of Deha-Akro II

No	Category	Kundho	Dhandho	Drigh	Yariwari	Morakho
	Zooplankton					
	Rotifera					
1	*Brachionus pilicatilis*	+++	+++	+++	+++	+++
2	*Brachionus urceolaris*	+++	++	++	++	+
3	*Bracionus calciferous*	++	++	-	++	-
4	*Bracionus angularis*	++	++	+	+	-
5	*Brachionus rubens*	+++	++	++	++	-
6	*Brachionus forficula*	++	+	-	+	-
7	*Brachiunus dimidiatus*	++	+	-	+	+
8	*Brachionus innermis*	++	+	-	-	-
9	*Brachionus quadridentatus*	++	-	-	-	-
10	*Brachionus rotundus*	-	+	-	-	-
11	*Euclanis triquetra*	+	-	-	-	-
12	*Mytilina bicarniata*	+	-	-	-	-
13	*Mytilina sp.*	+	-	-	-	-
14	*Keratella cochlearis*	+	-	-	-	-
	Copepoda					
1	*Thermocyclops hyalines*	+++	+	+	-	-
2	*Harpacticoid sp.*	-	-	+++	++	++
3	*Apocyclopes sp.*	-	-	+	++	+
	Cladocera	-	-	-	-	-
1	*Moina brachiata*	+		-	-	-

	Ostracoda					
	Sp. 1	+++	+++	-	-	+++
	Sp. 2	+	-	-	-	-
	Phytoplankton	-	-	-	-	-
	Cyanophycaea	-	-	-	-	-
1	*Chroococus minutus*	-	-	-	-	-
2	*Microcystis aeruginosa*	+	+++	+++	-	-
3	*Microcystis incerta*	+	+	+	-	-
4	*Oscillatoria amphibia*	+++			-	-
5	*Oscillatoria amoena*	++	+	+	-	-
	Chlorophyceae					
1	Cosmarium	+	+	+	-	-
	Bacillariophyceae					
1	*Cymbella obstusiformes*	++	+	+	-	-
2	*Cymbella lurgida*	++	-	-	+	-
3	*Cymbella affinis*	+++	-	-	+	-
4	*Cymbella naviculiformes*	+	-	-		+++
5	*Cymbella prostrata*	-	-		+	+++
6	*Merismopedia elegans*	-	+	+		-
7	*Navicula cryptocephala*	-	-	-	+	+++
8	*Navicula elegance*		-	-	-	+++
9	*Synedra acus*	-	-	-	-	+++
10	*Frusturia rhomboidus*	-	-	-	-	-
11	*Amphora ovilas*	+	+	-	-	+

+++ = Abundant; ++ = Common; + = Rare; - = Absent

Tables 3. Length and weight (mean±stdev) of Tilapia (Oreochromis mossambicus) at all five lakes.

Lakes	Length (cm)	Weight (g)
Kundho	23.66± 6.01	232.9± 118.71
Dhandho	27.28± 1.13	308.8± 17.65
Drigh	25.54± 5.18	278.4±75.71
Yariwari	25.03± 5.18	266.1±104.13
Morakho	27.78± 0.78	314.6±24.40

4. DISCUSSION

Salinity of the studied lakes ranged between 6.5 to 37 ppt indicative of high salinities associated with brackish to hyper saline environments. Kundho, Dhandho, Drigh and Yariwari indicated brackish water environments and Morakhi lake recorded high salinities similar to marine environments. A large number of Seagulls observed in this lake may also confirm Morakhi lake as hypersaline to marine environments. However, it is noted that the higher salinities would be a threat to the crocodile populations of these lakes. Leslie and Spotila (2000) reported that the crocodile populations suffered marked dehydration and ceased to feed, when exposed to gradually increasing salinities (3–35 ppt.), with a short acclimation period at each salinity. The Deh-Akro II lakes recorded high levels of iron, chromium and arsenic while manganese concentrations were lower concentration than recorded elsewhere (Qianghua *et al.* 2006).

Rotifera appeared as the most diverse group among the zooplankton, included fourteen (14) species. In this group, 10 out of the 14 species belonged to the genus *Brachionus* and are reportly a preferred food for many species fish larvae (Guerguess, 1993). *Brachionus urceolaris*, *B. pilicatilis*, *B. dimidiatus* occurred at wide ranges of salinity (6.5to 37.2) indicating urehaline adaptations in these species. Most of the *Brachionus* species recorded in the present study are reported to survive in wide range of salinities (Baloch and Soomro, 2004). The occurrence of an additional species, *Keratella*, is also reported from a wide range of salinity (De Manuel *et al.*,2000).

Among the copepods Thermocyclops *hyalines* were restricted to only brackish water environments (Kundho, Dhandho, Drigh and Yariwari). The other copepod species including *Apocyclop* sp. and Harpacticoid sp. occurred at Drigh, Yariwari and Morakhi lakes suggesting that these species survive both brackish to marine environments. *Apocyclop* sp. is a brackish water species, and has previously been reported from saline environment (Baloch *et al.* 2004).

Oreochromis mossambicus was the only fish species found during the survey, this species has tolerance to higher salinity (Mirza, 1990; Achakzai *et al*., 2013). The maximum length (TL) of *O. mossambicus* recorded during the present study was 29 cm, which is higher than the maximum lengths recorded from Manchar lake (26 cm) (Achakzai *et al*. 2013). This suggests that the species achieved better growth in higher salinities, and that food was more available in these lakes with no commercial exploitation due to the numerous crocodiles in the lakes. In overall, salinity of the lakes appeared as the driving factor for the fish biodiversity. Reduced fish biodiversity indicating the restricted food for the crocodile lakes, hence can be considered as serious issue from the conservation point of view. It can further be concluded that increased salinity of the lakes of Deh-Akro II appeared as a serious issue, which seems to affect primary productivity and fish biodiversity. In long run population of endangered crocodile can be effected due to depleted food and dehydration.

For the mitigate measures to improve the habitat of crocodile the quality of water of these lakes can be improved through permanent source of water from adjacent Nara Canal. This will also improve the feeding grounds for the dwindling crocodile population in Deh-Akro II.

REFERENCES:

Abbasi, S. A., (1998). *Water Quality Sampling and Analysis*, Discovery Publishing House; New Delhi

Achakzai, W. M., S. Sadozai, W. A. Baloch, N. Memon, (2013). Length-weight relationship and condition factor (Peters, 1852) from Manchar lake Distt. Jamshoro, Sindh, paksitan. SURJ. (Science Series) 45**(2):** 201-206.

Allen, S. E.,(1989). *Chemical Analysis of Ecological Materials*, Blackwell Scientific Publications, London, 2nd ed.

Baloch, W. A., A. N. Soomro and S. I. H. Jafri, (2004). Zooplankton of highly saline water body near Hyderabad, Sindh. SURJ (Sci. Ser.), 36 **(1):** 25-28

Baloch, W. A. and A. N. Soomro, (2004). Planktonic Rotifers Occurring in the Adjacent Areas of Hyderabad. Pakistan J. Zool. 36**(4);** 319-322.

Battish, S. K., (1992). Freshwater zooplankton of India. Oxford and IBH Publishing Co., New Delhi.

Balouch, S. A. PC-I of Deh-Akro II, Govt of Sindh wild life departments by, Conservator of Wild life Government of Sindh.

Brisbin I. L Jr., C. H. Jagoe, K. F. Gaines, J. C. Gariboldi (1998). Environmental contaminants as concerns for the conservation biologyof crocodilians. In: Crocodiles. Proc 14th Working Meeting Croc Spec Grp, SSC-IUCN, 155–173.

Chang, M. S., G. S. Gachal, A. H. Qadri S. I. H., Jafri, Z. Khowaja, M. A., Kalhoro, K. H. Memon, M. Y. Sheikh, (2014). Physicochemical assessment and its impacts on marsh crocodiles in Deh Akro II wildlife sanctuary. International Journal of Biosciences 4 **(3):** 85-96.

De Manuel, J., (2000). The rotifers of the Spanish reservoir: Ecological, Systematical Zoogeographical remarks. Linnetica **(19):** 91-167.

Elsey, R. M, V. A. Lance, L. Campbell, (1999). Mercury levels in alligator meat in south Louisiana. Bull Environ Contain Toxicol **(63):**598– 603.

Guerguess S. K., (1993). Distribution of some rotifers in the Egyptian inland waters. Bulletin of National Institute of Oceanography and Fisheries, Egypt, **(19):** 249-275. http://www.fao.org/docrep/003/t0234e/T0234E07.htm

Hord, L. J., M. L. Jennings, A. Brunell, (1990). Mercury contamination of Florida alligators. In: Crocodiles. Proc 10th Working Meeting Croc Spec Grp, SSC-IUCN, 229–2.

Heaton-Jones, T. G., B. L. Homer, D. L. Heaton-Jones, S. F. Sundlof, (1997). Mercurydistribution in American alligators (Alligator mississippiensis) in Florida. J. Zoo Wildl Med **(28):** 62–70.

Jafri, S. I. H., M.A. Mahar and S. M. Leghari, (1999). Diversity of fish and plankton in Manchhar lake (Distt.Dadu) Sindh, Pakistan. *Proc. Semi. Aq. Biodiv. Pakistan*, pp. 63-70. (Eds.): Q.B. Kazmi and M.A. Kazmi. MRC and Dept. of Zoology, Univ. of Karachi

Jahangir, T. M., M. Y. Khuhawar, S. M. Leghari, M. A. Mahar, M. S. Balouch, (2013). Water quality assessment of Haleji lake (Sindh, Pakistan), A Ramsar recognized site" Journal of Chemical Society of Pakistan. **(35):** 3, 1004-1016.

Leslie A. J. and J. R. Spotila, (2000). Osmoregulation of the Nile crocodile, *Crocodylus niloticus*, in Lake St. Lucia, Kwazulu:Natal, South Africa, Comparative Biochemistry and Physiology Part A 126, 351–365.

Mizuno, T. and E. Takahashi, (1991). An illustrated guide to Freshwater Zooplankton in Japan. Tokai University Press.

Mizuno, T., (1964). Illustrations of freshwater plankton of Japan. Hoikusha, 1964, 351Pp.

Manolis S. C, G. J. W. Webb, A. R. Britton (2002a) Crocodilian and other reptiles: Bioindicators of pollution. In: The Finniss River; a natural laboratory of mining impacts: Past, present and future.

Qianghua, Xu., Shengguo Fang, Zhenwei Wang, Zhiping Wang, (2006). Heavy Metal Distribution in Tissues and Eggs of Chinese Alligator (Alligator sinensis), Arch. Environ. Contam. Toxicol. **(50):** 580–586.

Rainwater T. R., B. M. Adair, S. G. Platt, T. A. Anderson, G. P. Cobb, S. T. McMurry. (2002). Mercuryin Morelets crocodile eggs from Northern Belize. Arch Environ Contam Toxicol **(42):** 319–324.

Rumbold, D. G., L. E. Fink, K. A. Laine, S. L. Niemczyk, T. Chandrasekhar, S. D. Wankel, C. Kendall, (2002). Levels of mercuryin alligators (*Alligator mississippiensis*) collected along a transect through the Florida Everglades. Sci Total Environ. **(297):** 239–252.

Rao, V. S., (1975). An ecological study three ponds of Hyderabad, India III. The phytoplankton, Volvocales, Chroococcales and Desmids. *Hydrobiologia,* 47 **(2):** 319-337.

Standard Methods For The Examination Of Water And Wastewater, American Public Health Administration (APHA), NW, Washington, DC.18th ed. (1992).

Shameel, M., (2001). An approach to the classification of algae in the new millennium. *Pakistan* J. Mar. Biol., 7 **(1-2):** 233-250.

Ward, H. B. and G. C. Whipple, (1959). Freshwater biology 2nd ed. WT Edmonson John Willey and Sons INC, New York 1248.