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RESEARCH ARTICLE

STUDIES ON THE VARIOUS ECOLOGICAL FACTORS IN THE RAIGANJ WILDLIFE SANCTUARY, WEST BENGAL, INDIA

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ABSTRACT

In the Raiganj Wildlife Sanctuary, premonsoon (March-June) was characterized by high air temperature, low percentage of relative humidity and occasional rain. The monsoon season (July – September) had high percentage of relative humidity and higher rainfall. On the other hand the postmonsoon season (October-February) was characterized by lower temperature and lesser precipitation. The pH of water of the sanctuary remained slightly acidic during monsoon season. Conductivity value was maximum during summer and minimum during winter months. BOD values have been recorded higher during premonsoon season. The minimum value of CO2 was observed during winter months. The increase in total alkalinity during summer months appeared to be due to the concentration of nutrients in water. Total suspended solid and total dissolved solid values were maximum in summer and minimum in winter. Premonsoon showed high chloride values when water level was low followed by monsoon and postmonsoon with high water levels. Nitrate value was higher during monsoon season and decreased in postmonsoon and premonsoon season. High amount of phosphate remained in the canals during summer months. The pH values of soil were recorded 6.0 and below 6.0. The nature of soil of the sanctuary seemed to be acidic. Percentage of organic carbon increased after premonsoon season in both the core and buffer region and this value became highest during postmonsoon season. High concentration of available nitrogen and available potash was observed in the core region as well as buffer region during postmonsoon than premonsoon season. Availlable phosphate content value was lower than the nitrogen and potash content of soil of the sanctuary. The physico-chemical characteristics of water expressed the poor water quality in the canals of the sanctuary. This characteristic showed maximum contamination of water due to faeces of birds. The soil of Raiganj Wildlife Sanctuary is mostly acidic, loamy type and the nature of the soil is unique for differential deposition of faeces of birds.

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INTRODUCTION

The diversity of climate of India offers suitable conditions for a rich varieties of bird life. In the last decade much effort was expended to investigate the effects of climatic factors on reproduction,survival and population dynamics (Yom – Tov, 2001; Laaksonen *et.al.* , 2006). The onset of reproduction activity is governed by results of precipitation (such as green vegetation, improved food supply etc.) rather than by actual rainfall itself (Marshall and Disney, 1957; Morel *et. al.*, 1957; Brooke, 1966; Ridpath, 1971). Ali and Ripley (1987) reported the relationship between rainfall and nesting intensity. A positive correlation between temperature and egg production has been found in many bird species (Engels and Jenner, 1956; Farner and Wilson, 1957).

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Hoyer and Canfield (1990) explained about the influence of water quality on bird abundance and species richness in Florida lakes. Mallory *et. al.* (1994) emphasized the importance of lake morphology, trophic status and aquatic macrophytes on birds abundance and species richness of Florida lakes. Consultants, limnologists and water supply managers are interested in aquatic birds because nutrients in their faeces reduce water quality in lakes and reservoirs (Manny *et.al.*, 1994). Dobrowolski *et al.* (1976) and Gremillion and Malone (1986) indicated the birds as the cause of eutrophication in several Polish wetland. Bedard *et al*. (1980) described the importance of birds in recycling the nutrients in the St Lawrence estuary. Powell *et al.* (1991) explained the bird aggregation as a major causative phenomenon for sea grass enrichment through nutrient rich excreta of birds. Available nutrients are released from the organic matter by excretion, exudation leaching, respiration and decomposition. Primary and secondary minerals may chemically decompose to form

available nutrients, or secondary minerals may be reformed form available nutrients depending on environmental conditions (Linkens and Bormann, 1972). Secondary minerals may be formed from available nutrients by the activity of organisms (Craft, 1997 and Reddy *et al.,* 2002). The eutrophication of water, which in simplest sense, means enrichment with nutrients and the resulting degradation of its quality accompanied by luxuriant growth of micro and macrophytes. The enrichment of nutrients occurs due to the disposal of domestic and farm sewage and from the run off from surrounding areas. Vollenwider (1968), reviewing the literature on eutrophication of lakes and flowing water, pointed out that domestic sewage is a major source of entrophication. There have been numerous investigations of the impact of domestic sewage on the changes in the physico-chemical and biological characteristics of freshwaters (Detembeck *et.al.*, 1996; Khedkar and Dixit, 2003). Distinct patterns of seasonal variation of physico-chemical characteristics were observed by Siddiqi and Khan (2002) and Guruprasad (2003).

The accumulation of birds often alters the chemical composition of soils and may change the performance of plants and the competitive interactions between them, favouring nutrient-demanding species. Soil around seabird colonies tends to be enriched with N and P, soluble salts and organic matter (Smith, 1978,1979), while pH may either increase (Gillham, 1960; Bukacinski *et. al.*, 1994) or decrease (Hogg and Morton, 1983). Headley (1996) reported that the role of seabirds as the main vectors moving heavy metals (either essential micronutrients or purely toxic) to Arctic peat soils. Raiganj Wildlife Sanctuary has wet monsonic climate and rich in flora and fauna especially avifauna but there are very few information regarding ecology of the sanctuary except some reports of Dutta (1992). However, it is important to note that this kind of study is almost lacking from this sanctuary. Keeping in view the importance of such ecological factors, the present study was undertaken to assess the climatic condition and physico-chemical variables of water and soil of the Raiganj Wildlife Sanctuary.

MATERIALS AND METHODS

Meteorological data (temperature, humidity and rainfall) of 2007and 2008 were recorded and the average values of the data were presented graphically on a monthly basis to get an overview of the climatic conditions of the study area.

Water analysis

Water samples were collected fortnightly in clear glass bottles from the surface of the canal water. Water samples were taken from three selected zones of the canals of the sanctuary during premonsoon (March-June), monsoon (July-September) and post monsoon (October-February) period of the year. Temperature (surface water) was recorded on the spot using Centigrade Thermometer. The pH, total dissolved solid (TDS) and conductivity of the water samples were measured on the spot by using water analysis kit. All other physico-chemical analysis were done in the departmental laboratory within 24 hours of collection of the samples. Preservation of water samples was done at 4°C temperature. Chemical analysis of the sample was done according to the standard methods (APHA, 1995). Mean values of all the observations were taken into consideration.

Soil analysis

The dugout (maximum 15 cm depth from surface) soil samples were collected from three selected sites of the core and buffer region of the sanctuary. The soil samples were air-dried, crushed, sieved (<2 mm) and kept at 4°C temperature. Soil samples were taken during premonsoon, monsoon and postmansoon periods of the year . Soil pH, organic carbon, available nitrogen, phosphorus and potassium were measured (Baruah and Barthakur, 1997; Walkley and Black, 1934; alkaline permanganate and Bray method respectively). Mean values of all the observations were taken into consideration.

RESULTS

Climatic conditions

Climatic conditions during premonsoon (summer), monsoon and postmonsoon (winter) seasons were observed in the Raiganj Wildlife Sanctuary during the study period. The figures (Fig. 1,2,3,4) indicate the seasonal variations during the years (2007 to 2008).

Premonsoon season (March to June)*:*

During the year 2007, the recorded average maximum temperature, minimum temperature, percentage of relative humidity and rainfall of premonsoon season ranged form 24.03°C to 26.13°C , 13.23°C to 21.93°C, 69.26 % to 61.97% and 0.806mm to 3.333mm respectively. During the year 2008, the recorded average maximum temperature, minimum temperature, percentage of relative humidity and rainfall of premonsoon season ranged from 24.39°C to 26.43°C , 14.16°C to 22.13°C , 70.13% to 62.37% and 0.774mm to 2.833mm respectively.

Monsoon season (July to September): During the year 2007, the recorded average maximum temperature, minimum temperature, percentage of relative humidity and rainfall of monsoon season ranged from 24.94°C to 23.93°C , 19.26°C to 16.63°C , 81.03% to 82.87% and 5.806mm to 14.333mm respectively. During the year 2008, the recorded average maximum temperature, minimum temperature, percentage of relative humidity and rainfall of monsoon season ranged from 25.55°C to 24.27°C , 19.32°C to 17.26°C , 81.13% to 83.23%, and 5.645mm to 9.666mm respectively.

Postmonsoon season (October to February): During the year 2007, the recorded average maximum temperature, minimum temperature, percentage of relative humidity and rainfall of postmonsoon season ranged from 23.55°C to 21.14°C , 15.26°C to 09.75°C , 80.06% to 82.32% and 10.161mm to 0mm respectively. During the year 2008, the recorded average maximum temperature, minimum temperature, percentage of relative humidity and rainfall of postmonsoon season ranged from 23.94°C to 22.57°C , 15.77°C to 10.97°C , 80.35% to 83.06% and 7.903mm to 0mm respectively.

Water characteristics

The table (table-1) indicates the water parameters of the Raiganj Wildlife Sanctuary.

Water temperature**:** Trend of monthly fluctuation in the surface water temperature was exactly identical to that of the

atmospheric temperature. The temperature remained minimum during the winter season (around 18.23°C). It was increased during the summer months to a maximum around 22.96°C.

***pH*:** The pH value ranged form 5.86 to 6.31. It was decreased during the monsoon season.

***Conductivity*:** Conductivity varied from 0.05ms to 0.07ms. Conductivity decreased during winter season followed by progressive increases during summer.

***Biological oxygen demand (BOD)*:** Biological oxygen demand (BOD) values ranged 1.05 mg /l to 1.62 mg/l. BOD values became higher during summer months.

***Free CO2*:** The Free CO2 showed peak during summer months and decreased in the rainy season and winter months.

***Total alkanity*:** High values of total alkalinity were observed during summer and became lower in the rainy and winter season.

***Total Hardness*:** The higher value of total hardness was recorded during summer (25ppm) which had a decreasing trend in monsoon season and lowest in winter.

***Total suspended solid*:** The maximum value of total suspended solid appeared in summer and the minimum value was recorded in winter.

***Total dissolved solid*:** Total dissolved solids (TDS) were observed to be minimum during monsoon and the maximum values were recorded during the summer months.

Chloride: The chloride content was increased during the summer season (8.35ppm) but later decreased during rainy season (7.13ppm) and post monsoon periods (6.24ppm).

***Nitrate*:** The high nitrate content was recorded during monsoon season (1.21ppm) and decreased with the beginning of the summer (0.42ppm).

***Phosphate*:** The phosphate content was observed to be highest during summer season (1.79mg/l) and decreased through the rainy season. The lowest value was observed during winter season (1.12mg/l).

Soil characteristics

The table (table-2) indicates the soil parameters of the Raiganj Wildlife Sanctuary.

***pH*:** The pH values ranged from 5.0 to 6.0. The high value of pH was recorded at the buffer region of the sanctuary in premonsoon season (6.0) and the low value of pH was observed at the core region of the sanctuary in postmonsoon season (5.0).

***Organic Carbon*:** Percentage of organic carbon deposition varied from 0.5% to 1.0%. The organic carbon content was increased during postmonsoon season at the core region and decreased during premonsoon season at the buffer region.

***Available Nitorgen*:** The maximum value of available nitrogen was recorded at the core region in winter (195 kg/hector) and the minimum value was recorded during the summer months at the buffer region (165 kg/hector).

***Available Phosphate*:** The available phosphate content ranged form 40 kg/hector to 47 kg/hector. The high value of available phosphate was observed during postmonsoon season at the core region and decreased during premonsoon season.

***Available Potash*:** The available potash content was appeared maximum during winter months and minimum during summer months. The high value was recorded at the core region during postmonsoon (125kg/hector) season and low value was observed at the buffer region (120kg/hector) during premonsoon.

DISCUSSION

In different tropical countries as well as in India, premonsoon, monsoon and postmonsoon seasons are usually observed. In the Raiganj Wildlife Sanctuary, premonsoon (March-June) was characterized by high air temperature (average maximum temperature 26.13°C in 2007 and 26.43°C in 2008 in the month of June) , low percentage of relative humidity (average 54.87 % in 2007 and 55.33 % in 2008 in the month of April) and occasional rain (average 0.806 mm in 2007 and 0.774 mm in 2008 in the month of March). The monsoon season (July – September) had high percentage of relative humidity (average 82.87 % in 2007 and 83.23% in 2008 in the month of September) and higher rainfall (average 14.333 mm in 2007 and 9.666 mm in 2008 in the month of Septermber). On the other hand the postmonsoon season (October-February) was characterized by lower temperature (average minimum temperature 8.42°C in 2007 and 9.74°C in 2008 in the month of January) and lesser precipitation (average 0 mm in 2007 and 2008 in the month of December, January and February). Many researchers have analyzed the effect of ambient temperature on egg size and reproductive performance in bird Stevenson and Bryant, 2000; Barkowska *et.al.* , 2003; Saino *et. al*., 2004). The relationship between rainfall and reproductive performance is thought to be due to the positive effect of rainfall on food availability for adults and / or chicks (Boag and Grant, 1984; Zann *et.al.,* 1996). Recently, several studies that tested the effects of rainfall- related factors on bird breeding performance were based on testing specific hypotheses rather than on looking for correlations (Coe and Rotenberry, 2003; Bolger *et.al.*, 2005). Rainfall could act as a proximate factor triggering the beginning of specific physiological processes such as sex hormone production or gonad growth (Hau *et. al.*, 2004; Flugione *et. al*., 2005). In comparison to temperature and rainfall, the influence of humidity on clutch size, egg size and other breeding parameters were less known. Aslan and Yavuz (2010) observed that egg length was positively affected, not only by rainfall but also by an increase in humidity in House Sparrow. The water and air temperature was found to go more or less hand in hand presumably due to standing water and relatively small size of the water body in the present study. According to Welch (1952) smaller the body of water, more quickly it reacts to changes in the atmospheric temperature. The pH of water of the canals remained slightly acidic during monsoon season. It may be due to high concentration of faeces of birds. Conductivity value was observed maximum during summer and minimum during winter months. This was due to the increased salt concentration by evaporation in summer months. Low values in winter may be due to the dilution effect of rainfall (Saijo *et.al*., 1997).

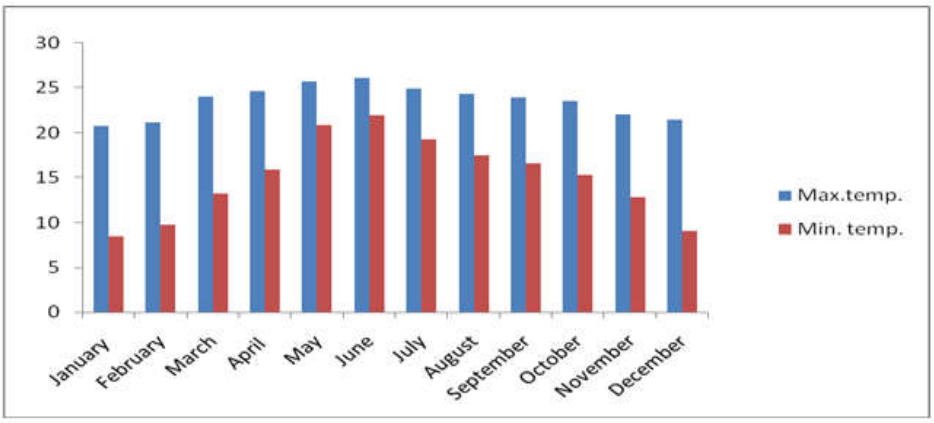

Fig. 1. Average maximum and minimum temperature of the months in the year 2007 at Raiganj Wildlife Sanctuary

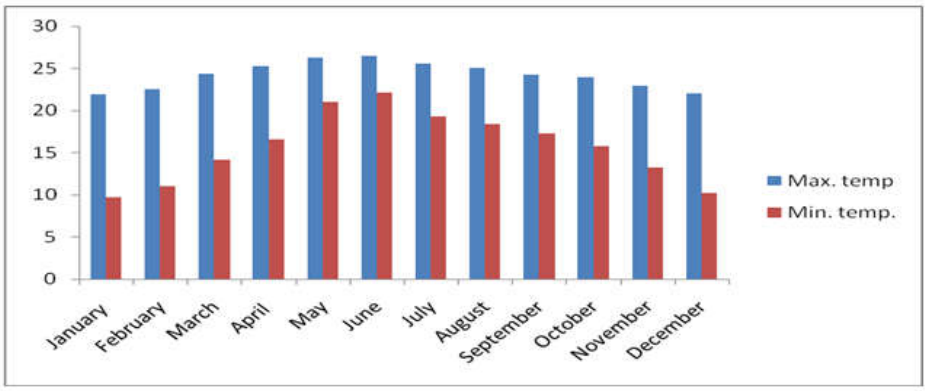

Fig. 2. Average maximum and minimum temperature of the months in the year 2008 at Raiganj Wildlife Sanctuary

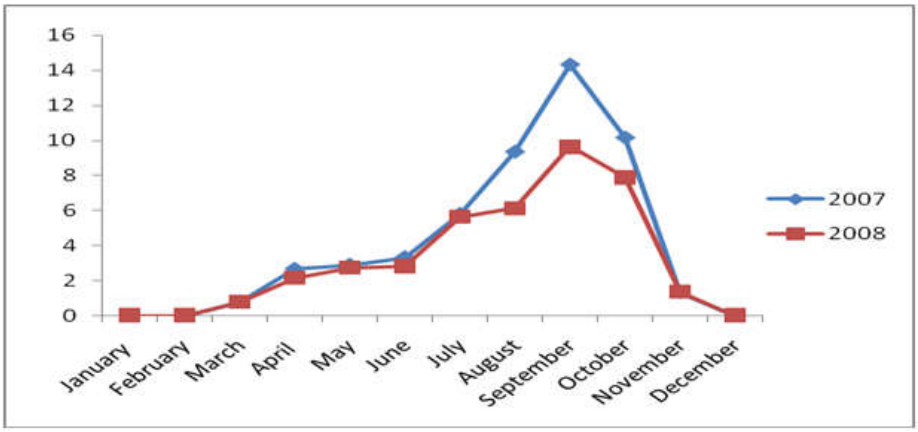

Fig. 3. Average percentage of relative humidity of the months in the year 2007 and 2008 at Raiganj Wildlife Sanctuary

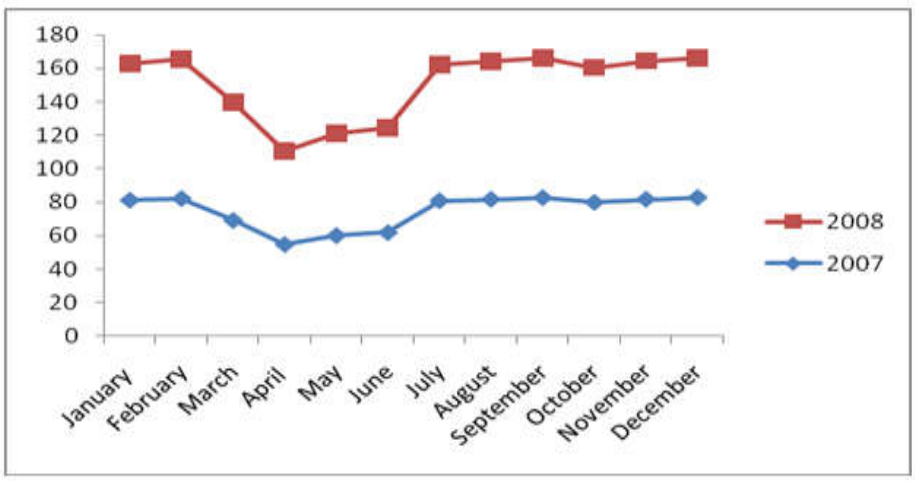

Fig. 4. Average rainfall of the months in the year 2007 and 2008 at Raiganj Wildlife Sanctuary

Table 1. Water parameters of the Raiganj Wildlife Sanctuary during premonsoon, monsoon and postmonsoon season

Parameters	Premonsoon	Monsoon	Postmonsoon
Air Temperature (^{0}C)	21.80	21.37	16.89
Water Temperature (^{0}C)	22.96	22.72	18.23
pH	6.31	5.86	6.11
Conductivity (mS)	0.07	0.06	0.05
BOD (mg/l)	1.62	1.43	1.05
Free Carbon-di-oxide (mg/l)	14.26	13.41	13.95
Total Alkalinity (mg/l)	27.6	23.5	26.4
Total Hardness (ppm)	25	22	20
Total Suspended Solid (ppm)	0.08	0.06	0.05
Total Dissolved Solid (ppm)	0.05	0.02	0.03
Chloride (ppm)	8.35	7.13	6.24
Nitrate (ppm)	0.42	1.21	0.94
Phosphate (mg/l)	1.79	1.48	1.12

Table 2. Soil parameters at Raiganj Wildlife Sanctuary during premonsoon, monsoon and postmonsoon season

Parameters	Pre monsoon		Monsoon		Post monsoon	
	Core region	Buffer region	Core region	Buffer region	Core region	Buffer region
pH	5.8	6.0	5.4	5.7	5.0	5.3
Organic Carbon (%)	0.6	0.5	0.8	0.6	1.0	0.7
Available Nitrogen (kg/hector)	180	165	185	170	195	182
Available Phosphate (kg/hector)	42	40	45	43	47	45
Available Potash (kg/hector)	122	120	124	121	125	122

The conductivity is proportional to the amount of dissolved substances (Michael, 1984). BOD values have been recorded higher during premonsoon season. Low values during winter months may be due to lesser quantity of total solids /dissolved solids / suspended solids (Guruprasad, 2003). The minimum value of free CO2 was observed during winter. The high value of this parameter was recorded in summer months which might be due to decomposition of organic matter by microbes in the bottom resulting in the rapid production of free carbon-di-oxide (Antwi and Ofori-Danson, 1993). The increase in total alkanity during summer months appeared to be due to the concentration of nutrients in water. Adebisi (1980) showed alkalinity to be inversely correlated with the water level. A decreasing trend of total hardness was found during monsoon and postmonsoon season. Generally the dilution of hardness depends with the advent of rains (Mulholland, 1997) and increases with the decrease in water levels (D'Angelo and Reddy, 1994). Total suspended solid and total dissolved solid values were maximum in summer and minimum in winter.

The high value of TSS and TDS in summer was due to high rates of decomposition, evapo-transpiration and increase in particle concentration. Premonsoon showed high chloride values when water level was low followed by monsoon and postmonsoon with high water levels. The rise of chlorides might be due to increased summer temperature (Swarnalatha and Narsing Rao, 1998). Nitrate value was higher during monsoon season and decreased in premonsoon and postmonsoon season. The maximum value of nitrate in rainy season might be due to high concentration of faeces of birds which came through rain water. Munawar (1970) observed that in summer, denitrifying bacteria break up nitrates into nitrites and ammonia. High amount of phosphate in the canals during summer months may be due to the concentration of nutrients in water and possible release of phosphate from sediments (Reddy *et. al.*, 2002). In the present study, the pH values of soil were recorded 6.0 and below 6.0. It indicated that the nature of soil of the sanctuary was acidic. Percentage of organic carbon increased after premonsoon season in both core and buffer region and this values became highest during postmonsoon season.

High concentration of available nitrogen and available potash was observed in the core region as well as buffer region during postmonsoon than premonsoon season. Available phosphate content value was lower than available nitrogen and available potash content of the soil of the sanctuary. The variation of soil characteristics may be influenced by faeces of birds. It is clear that during premonsoon season when birds were not present, the values of soil content were minimum and it became higher during monsoon season and later, when birds breeded in the sanctuary and these values were maximum during postmonsoon season and later, when birds breeded in the sanctuary and these values were maximum during postmonsoon season, when parent and young birds both deposited their faeces on soil of the sanctuary. Datta (1992) also reported that this small area is unique in its varied nature of soil which may be a function of differential deposition of faeces of birds. Luis *et al.* (2002) observed that the sea bird influence has apparently transformed the soil conditions in Chafarinas Islands: soluble K and NO3 have increased > 20-folds, and available P, K, F, Zn, salinity, N and OC (from 1.4 to 3 %) Contents > 2-8 fold, compared with control soils. It has been demonstrated for several seabird species (including seagulls, Burger *et al.*, 1978) that K contents of seabird faeces may be higher (upto 3-fold) than their P contents. In the present study available potash content also was higher than available phosphate content of the soil of the sanctuary.

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