Asian Journal of

Earth Sciences

ISSN 1819-1886

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Earth Sciences 1 (1): 31-37, 2008
ISSN 1819-1886

Seasonal Occurrence of Algae and Physicochemical Parameters of Samaru Stream, Zaria, Nigeria

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Abstract: Seasonal occurrence of algae and physicochemical parameters of Samaru stream, Zaria (11°3'N; 7°42'E), Nigeria was investigated between the dry season (November/December 2003) and rainy season (May/June 2003). Five sampling stations were chosen along the stream length (within the university community) at approximately the same distances from one station to the other. Water temperature ranged from 19.5±1.05 and 29±0.67°C; pH 7.496±0.11 and 7.07±0.07; EC 328.1±63.92 and 364.5±75.37 μs cm^{-1}, TDS 163.3±31.99 and 185.5±37.20 mg L^{-1}; DO 6.046±0.51 and 4.03±0.49 mg L^{-1}; NO_3-N 1.37±0.17 and 5.32±0.90 mg L^{-1}; PO_4-P 136±53.07 and 42.3±4.74 mg L^{-1}; BOD 0.89±0.22 and 0.32±0.07 mg L^{-1}; transparency 0.00 and 0.36±0.06 m for dry and Rainy seasons respectively for the stream. Ten species of Bacillariophyta were observed in the dry season and 2 in the rainy season; 6 species of Cyanophyta in the dry season and 7 in the rainy season; 1 species of Euglenophyta in the dry season and none in the rainy season; 11 species of Chlorophyta were in the dry season and 7 in the rainy season and 3 species of Chrysophyta in the dry season and none in rainy season. Results from ANOVA showed significant difference for all parameters observed except pH between seasons.

Key words: Algae, physicochemical parameters, stream, Nigeria

INTRODUCTION

The diversity of an aquatic system refers to the richness of biological variation in terms of the number of species found therein. The occurrence of algae in aquatic ecosystems cannot be considered alone but in relation to the prevailing environmental conditions particularly physicochemical parameters for example (Akin-Oriola, 2003; Kadiri, 2000, 2006). In both lentic (stagnant) and lotic (flowing) water bodies, algae represent the major flora. Occurrence of algae could serve as very useful indices of water quality. There is a lot of literature available that show algae as indicators of water quality (Pan *et al*., 1996; Bogaczewicz-Adamczak *et al*., 2001; Stachura-Suchoples, 2001; Nakanishi *et al*., 2004). Algae have an integrating response to their environment, fluctuation in water quality, which may be missed by intermittent chemical analysis. The evaluation of algae in stream course together with water quality parameters may suggest algae alliances of pollution status of the stream and suggest implications for water treatments. The effects of nutrient load could easily be reflected by N(nitrate):P(phosphorus) ratio a factor that controls the domination in algae species, in particular, that of blue-green or green microorganisms. Cyanobacterial blooming of a reservoir has been recorded with a decreased N:P ratio with addition of phosphorus compounds (Bryant, 1994; Watson *et al*., 1997; Clark *et al*., 2004).

To date there is paucity in the number of published works on phytoplankton in Northern Nigeria. There are no past records on the phytoplankton of Samaru stream, hence the need for the present study. This study evaluates the occurrence of algae and physicochemical parameters of Samaru stream in the dry and rainy season.

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MATERIALS AND METHODS

Study Area

Zaria (11°3'N; 7°42'E) is situated in the Northern Guinea Savanna zone with a tropical continental climate possessing distinct rainy and dry seasons. Samaru stream is lotic and transverses Samaru Village and Ahmadu Bello University, Zaria, Nigeria. Samaru stream empties into Kubanni/Ahmadu Bello University Dam. The catchment area comprises residential areas, the university and farms. The chief sources of sewage discharges to the stream are Danfodio and ICSA/RAMAT student Hostels, Ahmadu Bello University. Other sources of sewage are residential areas and Livestock. The stream has poor shading as it is bordered by plants that are predominantly herbs, a few shrubs and trees thereby exposing the water to direct sunlight.

Sampling

Five Sampling Sites were chosen along the stream course within the university community at approximately equal distances of 400 m to each other. Samples were collected on a monthly basis from November to December (Dry Season) and May/June (Rainy Season). Water Samples were collected at about 30 cm depth and one m away from the shore (APHA, 1998). Glass jars were used to collect samples for suspended algae analysis; Epiphytic algae/algae were collected by scraping the surface of submerged Macrophytes using a scalpel and the Epilithic algae were collected by scrapping rock and mud surfaces of the stream. Dark brown glass bottles (250 mL) were used to collect water samples for pH, dissolved oxygen and conductivity determinations and other physicochemical analysis.

Analysis of Physicochemical Parameter

Temperature readings were taken in situ using (°C) mercury thermometer. pH, total dissolved solids and conductivity were measured using a Hannan Instrument (Portable pH/EC/TDS/ Temperature m) model No. H1991300. Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) were determined using the Azide modification of Winkler method (Lind, 1979). Nitrate-nitrogen and Phosphate-phosphorus were determined using a HACH DR/2000 Direct Reading Spectrophotometer. Transparency was measured using a secchi disc.

Analysis of Algae

All samples collected were put in plastic containers that had been properly washed and labeled accordingly. Water from the stream was added enough to cover the material, the containers were kept open, well aerated and illuminated by light. With this algae could be kept for study for a long time without much growth (Prescott, 1977).

Data Analysis

Data obtained for physicochemical parameters between the dry and rainy season were compared using Analysis of Variance at 5% level of significance. Means and Standard errors were also obtained for each parameter for both seasons.

RESULTS

A total of 40 algae taxa were encountered throughout the study period. Twelve species belonging to Chlorophyta were observed in the dry season which include: *Scenedesmus quadricauda*, *Cosmarium panamense*, *Closteridium lonula*, *Euastrum pectrinatum*, *Closteridium* sp. *Micriasterias* sp. *Zaynemopsis desmidioides* sp. *Ondylosium pannum*, *Scenedesmus incrassatutus*, *Euastrum* sp. *Euastrum prainii*, *Cosmarium magactiferum*. Seven species also of Chlorophyta dominated in the

Table 1: Algal diversity for algal divisions in the rainy and dry season in Samaru strea, Zaria Nigeria

Algal division									
Bacillariophyta		Cyanophyta		Euglenophyta		Clorophyta		Chrysophyta	
Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season
Surirella ovalis	*Nitzchia* sp.	*Planktothrix rubescence*	*Anabaena* sp.	*Euglena* sp.		*Cosmarium magactiferum*	*Clausteridum* sp	*Chrysococcus rufescence*	
Denticular tenius	*Nitzchia dessipata*	*Phormidium retzil*				*Euastrum prainii*	*Chlamydomonas globosa*	*Heterothrix ulothricoide*	
Surirella oblonga		*Spirulina* sp.	*Nostoc* sp.			*Euastrum* sp.	*Oedegonium crispum*	*Stichochrysis* sp.	
Diponeis elliptica		*Anabaena subcylindrica*	*Spirulina* sp.			*Cosmarium panamense*	*Sphaeroplea annulins*		
Polyblepharides sp.		*Planktothrix* sp.	*Planktothrix prolifica*			*Micriasterias* sp.	*Ulothrix variabilis*		
Frustulia rhomboids		*Anabaena* sp.	*Phormium tenure*			*Zygnemopsis desmidioides*	*Staurodesmus* sp.		
Nitzchia sp.						*Scenedesmus incrassatutus*			
Pinnularia viridis						*Euastrum pectrinatum*			
Navicular						*Closteridium lonula*			
*Roico*sp *henia* sp.						*Scedesmus quadricauda*			
						Spondylosium plannum			
						Closteridium sp.			

Table 2: Physicochemical parameters determined In the dry and rainy seasonin Samaru stream

Season	Location	Month	Water temperature (°C)	pH	EC (µs cm^{-1})	TDS (mg L^{-1})	DO (µg L^{-1})	Nitrate Nitrogen (µg L^{-1})	Phosphate (µg L^{-1})	Bod (µg L^{-1})	Transparency (m)
Dry season	Station 1	Nov	17.00	7.86	502.00	251.00	2.05	1.60	425.00	2.20	0.00
		Dec	18.00	7.64	776.00	388.00	5.10	1.45	375.00	1.80	0.00
	Station 2	Nov	18.00	7.14	372.00	185.00	5.90	1.45	185.00	1.30	0.00
		Dec	17.00	7.39	318.00	159.00	6.50	1.20	280.00	1.10	0.00
	Station 3	Nov	18.00	7.14	351.00	171.00	6.40	2.40	45.00	0.75	0.00
		Dec	15.00	7.69	290.00	145.00	7.30	1.90	50.00	0.71	0.00
	Station 4	Nov	22.00	8.13	317.00	158.00	7.00	0.80	0.00	0.10	0.00
		Dec	21.00	7.06	138.00	69.00	5.40	0.60	0.00	0.30	0.00
	Station 5	Nov	25.00	7.60	101.00	50.00	7.31	1.20	0.00	0.29	0.00
		Dec	24.00	7.31	116.00	57.00	7.50	1.05	0.00	0.31	0.00
		Means±SE	19.50±1.05	7.50±0.11	328.10±63.92	163.3 0±31.99	6.05±0.51	1.37±0.17	136±53.07	0.89±0.22	0.00
Rainy season	Station 1	May	29.00	7.24	502.00	282.00	1.20	7.40	30.00	0.58	0.20
		June	26.00	7.17	542.00	271.00	3.30	7.80	33.00	0.52	0.20
	Station 2	May	28.00	7.19	634.00	293.00	2.50	7.50	25.00	0.32	0.60
		June	26.00	7.34	628.00	314.00	5.50	7.60	29.00	0.28	0.60
	Station 3	May	30.00	7.23	479.00	250.00	4.10	7.40	70.00	0.54	0.55
		June	28.00	7.12	482.00	241.00	5.60	7.50	65.00	0.56	0.55
	Station 4	May	32.00	7.01	101.00	63.00	5.50	1.50	45.00	0.1	0.35
		June	29.00	6.84	92.00	45.00	5.70	1.70	41.00	0.08	0.35
	Station 5	May	32.00	6.89	97.00	52.00	2.80	2.50	45.00	0.12	0.10
		June	30.00	6.62	88.00	44.00	4.10	2.30	40.00	0.08	0.10
		Mean±SE	29.00±0.67	7.07±0.07	364.5 0±75.37	185.5 0±37.20	4.03±0.49	5.32±0.90	42.30±4.74	0.32±0.07	0.36±0.06
		ANOVA (between season)	13.20588**	1.327838ns	29.75**	29.91**	4.18*	368.52**	49.11**	19.16**	

* = Significant at p<0.05, ** = Highly significant at p<0.01, ns = Not significant at p<0.05, EC = Electrical Conductivity; TDS = Total Dissolved Solids; DO = Dissolved Oxygen; BOD = Biochemical Oxygen Demand

rainy season. These are: *Straurodesmus* sp. *Clausteridium* sp. *Chlamydomonas globosa*, *Chlamydomonas* sp. *Ulothrix variabilis*, *Oedogonium crispum*. The group Bacillariophyta had ten species in the dry season which are *Surirella ovalis*, *Denticular tenius*, *Surirella oblonga*, *Diploneis elliptica, Polyblepharides* sp. *Frustulia rhomboids*, *Nitzchia* sp. *Rhoicosphenia* sp. *Pinnularia viridis* and *Navicula* sp. while *Nitzchia* sp. and *Nitzchia dessipata* were the only species recorded in the rainy season. Euglenophyta recorded only one species (*Euglena* sp.) in the dry season. The blue greens (Cyanobacteria) recorded six species (*Planktothrix rubescence*, *Phormidium retzil*, *Spirulina* sp. *Anabaena subcylindrica*, *Planktothrix* sp. and *Anabaena*) in the dry season and seven species (*Anabaena* sp. *Planktothrix* sp. *Nostoc* sp. *Spirulina* sp. *Planktothrix prolifica*, *Phormium tenure* and *Lyngbya* sp.) in the rainy season. Chrysophyta was represented in the dry season by three species which were: *Chrysococcus rufescence*, *Heterothrix ulothricoide*, *Stichochrysis* sp. and none in the rainy season (Table 1).

Water temperature was found to have a mean value of 19.50°C in the dry season while in the rainy season it was 29°C. pH readings were found to be 7.50 and 7.07 for dry and rainy season, respectively, though this was not found to be significantly different between the season. During the dry season electrical conductivity (328.1 µs cm^{-1}) and total suspended solids (163.3 mg L^{-1}) were found to be lower than what was obtained in the rainy season (364.5 µs cm and 185.5 mg L^{-1} for EC and TDS, respectively). Dissolved Oxygen (DO) was found to be lower (4.03 µg L^{-1}) in the rainy season than the dry season (6.05 µg L^{-1}), accordingly Biochemical Oxygen Demand (BOD) 0.89 µg L^{-1} in dry season and 0.32 µg L^{-1} in rainy season. N:P concentration and ratios were 1.37 µg L^{-1}, 136 µg L^{-1} and 1:99 for dry season and 5.32 µg L^{-1}, 42.30 µg L^{-1} and 1:7 for rainy season. Due to the low water level/depth during the dry season, transparency could not be determined but in the rainy season it was 0.36 m. All parameters except pH determined between the rainy and rainy season were significantly different at $p>0.05$ (Table 2).

DISCUSSION

Rainfall, interacting with the atmosphere, vegetation, rocks and soil, is the major source of dissolved solids in Samaru stream. Groundwater entering the stream is another source. Mentioning dissolved solids alone without Electrical conductivity will not be complete as Conductivity is determined by the amount of solids that are dissolved in the water. Electrical conductivity of this stream falls within the Class I of the Classification of African waters by Talling and Talling (1965). In this classification waters with ionic content <600 µS cm^{-1} belong to Class I, 600-6000 µS cm^{-1} Class II and 6000-160,000 µs cm^{-1} Class III. Even when TDS is determined it does not tell us the exact type of materials or elements that make it up. One can always deduce that the first rains result in relatively high nutrient load in streams. In addition, higher values of EC, TDS and Nitrate-Nitrogen in the rainy season is as a result of surface runoff. This agrees with the work of Kemdirim (2005) on the hydrochemistry of Kangimi reservoir, Kaduna state (Northern) Nigeria and disagrees with that of Chindah and Braide (2004) on the Lower Bonny River, Niger Delta (Southern) Nigeria. Higher dissolved oxygen (DO) supports more phytoplankton than low DO as the case between the dry and rainy seasons in this investigation. The consequence of higher phytoplankton population may have urged up the Biochemical Oxygen Demand (BOD) of the water body to a level higher than that in the rainy season.

The current findings indicate clearly that more algal species were recorded in the dry season than the rainy season. On individual levels there was higher Cyanobacteria population in the rainy season perhaps due to the low N:P ratio of the water body (Watson *et al*., 1997). The variation in algae composition with seasons in this stream could be attributed to changes in physical conditions like temperature and transparency. Where in the dry season temperatures are usually lower which allow for the dissolving of oxygen (increasing DO), hence more supporting for algae growth. This finding agrees with the study of Cetin and Yildirim (2000) that reported that the seasonal pattern of algal growth showed a clear relationship with the water temperature. Availability of oxygen in water bodies is dependent on the life in it and also the Nitrate-Phosphate ratio. This could account for the high number of the members Cyanobacteria and Chlorophyta in this stream in the rainy and dry seasons, respectively. The presence of more number of species of Chlorophyta and Bacillariophyta in the stream is indicative of a relatively clean water body in the dry season. The presence of high number of desmids is indicative of an oligotrophic condition in the stream (Whitton *et al*., 1991). The presence of higher number of species of Chlorophyta mainly desmids is typical of African waters (Kalff and Watson, 1986; Kebede and Belay, 1994; Kadiri, 1996). The occurrence of higher number of species of desmids is characteristic of low nutrient of the stream. It is a well established fact that desmids are characteristic of fresh water environments with poor ionic composition (Kadiri, 1996, 1999; Nwankwo, 1996). The representation of higher members of Cyanophyta in the rainy season is consequent of several factors which include increased temperature, low N/P ratios and low vulnerability to grazing by zooplankton (Kadiri, 2000). The rainy season was the period with the highest Nitrate-Nitrogen concentration which is known to support the formation of blooms (Blomqvist *et al*., 1994; Anderson *et al*., 1998; Zimba *et al*., 2001). Cyanobacteria exhibit in addition to the above adaptability to regulate buoyancy, as well as the regulation of pigment pools in response to both quantity and quality of light (Klemer *et al*., 1996; Zimba *et al*., 1999, 2006). Hence it could be said the presence of higher number of species of the Chlorophyta and Cyanophyta in the dry and rainy season, respectively is indicative of the water quality in the two seasons.

Samaru stream is oligotrophic in nature with circumneutral pH and significantly varied physicochemistry. The water chemistry is affected mainly by domestic activities around the catchment. The occurrence of algae indicates higher numbers of green algae in the dry season and blue green algae in the rainy season, respectively which can be said to be a clear representation of the stream physicochemistry in the two seasons.

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