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Species composition and distribution of Freshwater diatoms from Upper Dilimi River, Jos, Nigeria

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Abstract: *As component of an exhaustive investigation on the ecological studies of diatom communities of River Dilimiin Jos, the spatio-temporal variation of four different diatom communities was investigated.As a derivative of these studies, a comprehensive compilation was made of the diatomflora of the upper mainstream channel of the river. Two hundred and nine (198 pennate and 11 centric) diatom speciesbelonging to twenty five families and forty genera were recorded. The genera most represented belong to Pinnularia (26 taxa), Gomphonema (26 taxa), Cymbella (21 taxa), Navicula (19 taxa) and Eunotia (14 taxa). Gomphonema parvulum (Kutz.) Grunow, Nitzschia palea (Kütz.) Smith, Navicula arvensis and Cymbella minuta Bleisch ex Rabh Husted were the most noticeable diatoms with respect to both frequency of occurrence and relative abundance across samples.*

Keywords:*Algae, Checklist, Diatoms, River Dilimi, Jos*

I. Introduction

Studies on Nigerian diatoms are few and they do not representthe vast geographic variability of the nation. It is clear from literatures that most attention in the country was given to marine and brackish waters or on waters from the southern part of the country.Some of the works in this category include [1 - 7]. Thus, thenorthern region remains relatively unexplored and underrepresented in major diatom reports.

The small number of publications on the diversity of diatoms in freshwater inland rivers makes it difficult to compare results with the relatively few studies from southern part of the country.Report of freshwater algal flora from this part of the country will not only add to the knowledge of the flora but will also serve as a reference point for monitoring future changes on this assemblage as the river becomes progressively polluted. It is also expected that it will stimulate research collaboration and increase coordination in current and future ecological research on the inland rivers of the country.

Thus, the work was an attempt to provide an inventory of diatom of Upper Dilimi River, Jos, Nigeria.

II. Materials And Methods

Study area

The Jos Plateau (8°22' – 9° 30' E: 8° 50' – 10°10' N) is a highland area in north-central Nigeria. The landscape is predominated by plutonic and volcanic rocks with sediments of alluvium and other unconsolidated deposits [8]. Jos, because of its elevation (300 to 600 metres is characterized by lower temperatures (average daily temperatures of 21°C) and serves as source of many streams and rivers one of which is Dilimi River [9].

Dilimi River is the main drainage system of Jos and its surroundings whicharises from the spring sources from hills around the Jos old Airport area. Itflows through the major metropolis in an approximately northeast direction for about 400km before it confluence with the Hadejia River which flows into Lake Chad[10]. As the Jos Plateau is granitic, the river is generally oligotrophic with slight enrichment in the downstream sections from unregulated releases of effluents from Jos Abattoir, Liberty dam spill over, local mine washings, Yan-Shanu Market, Naraguta leather works and other sundry and domestic effluents as it drains the metropolis [10].

Methods

Sample collection

Diatoms samples were collected on a bi-monthly basis from April 2005 to December 2005 fromfive sampling sites on the main stream channel (Table 1) to reflect differences in environmental gradients. Four diatom communities were sampledseparately in accordance with [11and 12] to get as broad as possible, an estimate of the species composition. The Phytoplankton samples were collected by using 55µm mesh-sized plankton net, epilithic diatoms were collected by brushing seven to ten cobbles or small boulders [12].Epiphytic samples were collected from different parts of plant materials with representative diatom growth by shaking, squeezing and washing the plants portions as the case may be. Toothbrush or scraper was used to dislodge them from plant surface in the washing dish. Epipsammic communities on loose sediments (sand) were collected by

the use of spoons and spatula and transferredto washing dish and subsequently into a sample bottle. The dislodged suspensions from each group of substrate type at site were composited [13] and preserved in 4% formalin.

The material was processed according to methods applied by [12].To enhance diatom identification, a portion of each sample was acid cleaned line with the procedure outline in [11] using a mixture of sulphuric acid oxalic acid. The permanent diatom preparations were made using Naphrax as mountant and the diatoms identified under Olympus binocular. Identification was based on the following [11, 14 - 17]

Table 1: Description of sampling sites in Upper Dilimi River, Jos, Nigeria.

Site	Distance from source (km)	Location	Altitude (m)	Grid reference	
				Latitude	Longitude
1	1.3	Near Rayfield. Jos.	1230	$8^{O}54^{I}$E	$9^{O}54^{I}$N
2	5.0	Nasarawa Bridge, Dilimi street, Jos.	1160	$8^{O}54^{I}$E	$9^{O}55^{I}$N
3	10.5	Student village Bridge, Farin-Gada road, Jos.	1090	$8^{O}53^{I}$E	$9^{O}58^{I}$N
4	16.5	Beyond Naraguta Village, off Jos-Bauchi road, Jos	1040	$8^{O}54^{I}$E	$10^{O}00^{I}$N
5	23.2	Behind Barikin Babale, off Jos-Bauchi Road, Jos	890	$8^{O}57^{I}$E	$10^{O}54^{I}$N

III. Results

Physico-chemical

The summary of physical and chemical attributes of water recorded across year and season are presented in Table 2. Generally, the surface water of the river was characterized by high turbidity (6 – 90 FTU), high conductivity (132 - 1300µmhoscm^{-1}), moderate dissolved oxygen content (1.0 – 12mg/l), and high alkalinity (25 – 499mg/l). Micro nutrients, NO_3-N and PO_4-P recorded moderately high values of between 1.0 – 6.6mg/l and 0.5 – 2.9mgl^{-1} respectively.

Varied degree of responses was observed with sites and months of sampling. Differences between year and season with respect to Physico-chemical attributes were also significant in some cases.

Biological

Two hundred and nine diatoms distributed across twenty five families and forty genera (Table 2 &4) were encountered during the study. The families most represented were Pinnulariaceae (27 taxa) followed by Gomphonemataceae (26 taxa), and Cymbellaceae (22 taxa) while seven of the families were represented only once. Pennate diatoms were the dominant groups with 198 species while centric diatoms had 11 species. The genera most represented (Figure 1) were *Pinnularia* (26 taxa), *Gomphonema* (26 taxa), *Cymbella* (21 taxa), *Navicula* (19 taxa)and *Eunotia* (14 taxa). *Aulacoseira, Coscinodiscus,Cyclotella, Stephanodiscus* spand *Thallassiosira* were the only centric genera recorded. From the study, six genera had greater than 10 species, 12 genera had less than five species while up to sixteen genera (40%) were represented by only a single species.

The rank of the 19 major diatom taxa, according to frequency of occurrence and mean abundance in samples is shown in Table 5.Frequency of occurrence in samples ranged from 0.42 to 99.17%. *Gomphonema parvulum*, *Nitzschia palea*, *Navicula arvensis* and *Cymbella minuta* were most predominant, occurring either consistently or widespread during the survey. Six species occurred in more than 50 per cent of the sample, 133 species occurred in 5% or less while 38 species (15.83%) occurred only once during the survey. All the other taxa (90.4%) not included in the list had a frequency of occurrence of less than 30%.

The mean abundance of species ranged from 0.17 to 41.32%.*Gomphonema parvulum* was the most abundant followed by *Nitzschia palea* and *Navicula arvensis*. The other taxa excluded from the list (Table 5) had mean abundance of less than 1.0 percent.

Table 2: Summary Statistics for Physico-Chemical Characteristics of Water at Dilimi River, Jos (2004 to 2006)

Physical Character	Overall	Year			Season		
		Year 1	Year 11	p - value	Wet	Dry	p - value
Air Temperature (°C)	28.17(±0.50)	30.40(±0.60)	26 (±0.60)	p < 0.01	29.7(±0.60)	26.60(±0.70)	p < 0.01
Min - Max	16.00 - 38.00	26.00 - 38.00	16.00 - 32.00		25.00 - 38.00	16.00 - 32.00	
Water Temperature (°C)	22.18(±0.53)	23.90(±0.40)	20.4(±0.90)	p < 0.01	24.50(±0.30)	19.80(±0.80)	p > 0.05
Min - Max	11.00 - 28.00	19.00 - 28.00	11.00 - 26.00		21.00 - 28.00	11.00 - 25.00	
Mean Width (m)	7.70(±0.56)	7.80(±0.80)	7.60(±0.81)	p > 0.05	8.84(±0.91)	6.56(±0.62)	p < 0.01
Min - Max	1.08 - 15.30	1.19 - 15.30	1.08 - 15.3		1.19 - 15.30	1.08 - 12.40	
Mean Depth (m)	0.35(±0.02)	0.35(±0.03)	0.34(±0.03)	p > 0.05	0.41(±0.04)	0.28(±0.02)	p > 0.05
Min - Max	0.09 - 0.93	0.09 - 0.87	0.13 - 93.00		0.18 - 0.93	0.09 - 0.46	
Current (ms^{-1})	0.5(±0.03)	0.51(±0.03)	0.49(±0.05)	p > 0.05	0.58(±0.04)	0.42(±0.03)	p > 0.05
Min - Max	0.15 - 1.00	0.16 - 0.94	0.15 - 1.00		0.15 - 1.00	0.16 - 0.91	
Discharge (m^3s^{-1})	1.53(±0.23)	1.50(±0.31)	1.55(±0.36)	p > 0.05	2.24(±0.40)	0.81(±0.11)	p < 0.01
Min - Max	0.03 - 7.21	0.11 - 7.07	0.03 - 7.21		0.07 - 7.21	0.03 - 2.67	
Turbidity (FTU Units)	43.3(±2.94)	42.00(±4.00)	45.00(±4.00)	p > 0.05	48.00(±3.00)	39.00(±5.00)	p < 0.05
Min - Max	6.00 - 90.00	6.00 - 85.00	10.00 - 90		18.00 - 85.00	6.00 - 90.00	
pH	7.22(±0.07)	7.06(±0.08)	7.39(±0.10)	p < 0.01	7.00(±0.07)	7.44(±0.10)	p < 0.01
Min - Max	6.20 - 8.65	6.20 - 7.80	6.20 - 8.65		6.20 - 7.70	6.40 - 8.56	
Alkalinity ($mgl^{-1}CaCO_3$)	158.2(±16.84)	120.43(±18.03)	195.97(±27.03)	p < 0.01	82.03(±10.08)	234.37(±25.54)	p < 0.01
Min - Max	25.00 - 499.00	25.00 - 324.00	46.00 - 499.00		25.00 - 254.00	37.50 - 499.00	
Conductivity (μScm^{-1})	404.32(±32.86)	382(±37.58)	426.60(±54.29)	p > 0.05	372.60(±52.07)	432.03(±40.16)	p > 0.05
Min - Max	132.00 - 1300.00	142.00 - 870.00	132.00 -1300.00		144.00 -1300.00	132.00 - 825.00	
Dissolved oxygen (mgl^{-1})	7.57(±0.36)	7.22(±0.48)	7.93(±0.53)	p > 0.05	8.12(±0.44)	7.02(±0.55)	p > 0.05
Min - Max	1.00 - 12.00	1.50 -12.00	1.00 -11.80		2.00 - 12.00	1.00 - 11.80	
Nitrate-Nitrogen (mgl^{-1})	3.83(±0.17)	3.52(±0.26)	4.10(±0.21)	p < 0.05	4.14(±025)	3.58(±0.21)	p > 0.05
Min - Max	1.50 - 6.50	1.50 - 6.50	2.00 - 6.20		1.50 - 6.20	1.50 - 6.50	
Phosphate-Phosphurus (mgl^{-1})	1.73(±0.07)	2.02(±0.08)	1.49(±0.10)	p < 0.01	1.96(±0.08)	1.53(±0.11)	p < 0.01
Min - Max	0.50 - 2.80	1.30 - 2.80	0.50 - 2.60		1.10 - 2.60	0.50 - 2.80	
Sulphate (mgl^{-1})	17.97(±0.98)	18.05(±1.35)	17.80(±1.27)	p > 0.05	16.83(±0.96)	19.10(±1.70)	p > 0.05
Min - Max	10.00 - 38.00	12.00 - 38.00	10.00 - 25.00		10.00 - 25.00	12.00 - 38.00	

Table 3. List of Diatoms found in the Upper River Dilimi, Jos. Nigeria (2004-2006).

Taxa	Taxa
Class: Bacillariophyceae	**Family: Anomoeoneidaceae**
Order: Centrales	*Anomoeoneis serians* (Breb.) Cleve
Family:Aulacoseiraceae	*Anomoeoneis sphaerophora* (Ehrenb.) Pfitzer
Aulacoseira distans (Ehrenb.) Simonsen	*Anomoeoneis* sp.
*Aulacoseira granulata (*Ehrenb.) Simonsen	**Family: Bacillariaceae**
Aulacoseira granulata (Ehrenb.)Simonsen var. *angustissima*	*Denticula elegans* f.*valida*Pedic
Family:Coscinodiscaceae	*Denticula elegans* Kütz.
	Hantzschia amphioxys (Ehrenb.) Grun.
Coscinodiscus sp	var.*capitata* Pant.
Family: Stephanodiscaceae	*Hantzschia amphioxys* (Ehrenb.) Grunow
Cyclotella atomus Hust.	*Nitzschia amphibia* Grunow
Cyclotella caspia Grunow	*Nitzschia frustulum*(Kützing) Grunow
*Cyclotella comensis*Grunow	*Nitzschia hantzschiana* Rabenh.
	Nitzschia intermedia Hantzsch ex Cleve et
Cyclotella meneghiniana Kütz.	Grunow
Cyclotella ocellata Pant.	*Nitzschia linearis* (Agardh) Smith
Cyclotella stelligera Cleve et Grunow	*Nitzschia microcephala*Grunow
Stephanodiscus sp	*Nitzschia minuta* Bleisch
Family:Thalassiosiraceae	*Nitzschia palea* (Kütz.) Smith
Thallassiosira sp	*Nitzschia palea* 2
Class: Bacillariophyceae	*Nitzschia paleacea* Grunow
Order: Pennales	*Nitzschia recta hanzschianaex* Rabenhorst
Family: Achnanthaceae	*Nitzschia romana* Grunow
Achnanthes coartata (Breb.) Grunow	**Family: Brachysiraceae**
Achnanthes deflexa Reimer	*Brachysira styriaca* (Grunow) Ross
Achnanthes exigua Grunow var. *heterovalva* Krasske	**Family: Catenulaceae**
Achnanthes exigua Grunow	*Amphora coffeaeformis*(Agardh) Kütz.
Achnanthes flexella (Kütz.) Brunow	*Amphora obtusa* Greg.
Achnanthes inflata (Kütz.) Grunow.	*Amphora ovalis* Kütz.
Achnanthes lanceolata var. *rostrata* Hustedt	*Amphora pediculus* (Kütz.) Grunow
Achnanthes lanceolata (Breb.) Grunow	*Amphora submontana* Hust
Achnanthes microcephala (Kütz.) Grunow	*Amphora veneta* Kütz.
Cocconeis pediculus Ehrenb.	**Family: Cymbellaceae**
Cocconeis pediculus sp 2	*Cymbella affinis* Kütz.

Family: Achnanthidiaceae	*Cymbella amphicephala* Nageli
Achanthidium minutissimum (Kütz.) Czar.	*Cymbella angustata* (W.Sm.) Cleve
Family: Amphipleuraceae	*Cymbella aspera* (Ehrenb.) Perag.
Frustulia rhomboides var. *capitata*	*Cymbella cistula* (Ehrenb.) Kirchner
Frustulia rhomboides (Ehren) DeToni var. *Crassinaria*	*Cymbella cuspidata* Kütz.
Frustulia rhomboides (Ehrenb.) De Toni	*Cymbella cymbiformis* Agardh
Frustulia rhomboides var. *amphipleuroides*(Grunow) *De Toni*	*Cymbella delicatula* Kutz.
*Frustulia rhomboides*var. *saxonica* (Raben) De Toni	*Cymbella Hustedtii* Krasske
Frustulia sp	*Cymbella inaequilis (Ehrenb.) Raben.*
Frustulia vulgaris (Thwaites) De Toni	*Cymbella lanceolata* (Ehrenb.) Kirchner

Table 3. Continuation

Taxa	***Taxa***
Cymbella lunata Smith	*Synedra delicatissima* Smith
Cymbella mexicana (Ehrenb.) Cleve	*Synedra parasitica var subconstricta*(Grunow) Hust.
Cymbella microcephala Grunow	*Synedra radians Kutz.*
*Cymbella minuta*var*selesiaca* (Bleisch) Reimer	*Synedra rumpens* Kütz.var. *familiaris* (Kütz.) Hust.
Cymbella minuta Bleisch ex Rabh.	*Synedra tenera* Smith
Cymbella minuta var *pseudogracilis*	*Synedra ulna* (Nitz.) *Ehren.*var. *biceps* (Kütz.) Schönf.
Cymbella naviculiformis Auersw.	*Synedra ulna* (Nitz.) Ehrenb.
Cymbella proxima Reimer	**Family: Gomphonemataceae**
Cymbella triangulum (Ehrenb.) Cleve	*Gomphonema sp.*
Cymbella turgidula Grunow	*Gomphonema acuminatum* Ehrenb.
Encyonema sp	*Gomphonema affine* Kütz.
Family: Diadesmidaceae	*Gomphonema angustatum* (Kütz.) Rabenh.
Diadesmis confervacea Kütz.	*Gomphonema consector* Hohn & Hellerman
Diploneis elliptica (Kütz.) Cleve	*Gomphonema gracile* Ehrenb.
Diploneis oblongella (Nägeli) A.Cleve	*Gomphonema gracile* 2
Diploneis ovalis (Hilse) Cleve	*Gomphonema insigne* Greg.
Family: Eunotiaceae	*Gomphonema instabilis* Hohn & Hellerman
Eunotia arcus Ehrenb.	*Gomphonema intricatum* Kutz.
Eunotia camelus Ehrenb	*Gomphonema intricatum* var *pumila* Grunow
Eunotia curvata (Kütz.) Lagerst.	*Gomphonema lacus-rankala* Gandhi
*Eunotia diodon*Ehrenb.	*Gomphonema parvulum* f. *lanceolata* (Grun.) Muller
Eunotia flexuosa (Bréb.) Kütz.	*Gomphonema montanum SchuMann*
Eunotia formica Ehrenb.	*Gomphonema montanum var. acuminatum* f. *maha. Sar. et kam.*
Eunotia incisa Greg.	*Gomphonema olivaceoides* Lyngb.
Eunotia lapponica Grunow ex Cleve	*Gomphonema olivaceum* (Hornem.) Bréb.
Eunotia pectinalis (Dillwyn) Rabenh.	*Gomphonema parvulum* (kutz.) Grunow.
Eunotia praerupta Ehrenb.	*Gomphonema sphaerophorum* Ehrenb.
Eunotia rhomboidea Hust.	*Gomphonema subclavatum* (Grunow) Grunow.
Eunotia serra Ehrenb.	*Gomphonema subclavatum* var *mexicanum*(Grunow) Patrick
Eunotia sp.	*Gomphonema subtile* var. *sagitta* (SchuMann) Grunow.
Eunotia sudetica Müller	*Gomphonema truncatum* Ehrenb.
Family: Fragilariaceae	*Gomphonema truncatum Ehrenb.* var. *Capitata*
Amphicampa mirabilis Ehrenb.	*Gomphonema truncatum* var *elongata* (Perag and Horib.) *Patrick*
Fragilaria brevistriata Grunow	*Gomphonema turris* Ehrenb.
Fragilaria capucina Desm.	**Family: Mastogloiaceae**
Fragilaria capucina var*mesolepta Rabenh*	*Mastogloia smithii* Thwaites
Fragilaria intermedia Grunow	**Family: Naviculaceae**
Fragilaria vaucheriae (Kütz.) Petersen	*Navicula* sp.
Fragilaria virescens Ralfs	*Navicula arvensis* 2
Fragilaria lapponica Grunow	*Navicula arvensis* Hust.
Meridion anceps (Ehrenb.) D.M. Williams	*Navicula crucigera*(Smith) Cleve
Synedra acus Kutz.	*Navicula cuspidata* (Kutz.) Kutz.
Synedra amphicephala Kütz.	*Navicula detenta* Hust..

Table 3. Continuation

Taxa	Taxa
Navicula flanatica Grunow	*Pinnularia substomatophora* Hust..
Navicula lanceolata (Agardh) Ehrenb.	*Pinnularia sudetica* (Hilse) Hilse var. *commutata*
Navicula mutica var *undulata* (Hilse) Grunow	*Pinnularia torta* (Mann) Patrick
Navicula mutica Kütz.	**Family: Pleurosigmataceae**
Navicula mutica Kütz. fo. *intermedia* Hust.	*Gyrosigma acuminatum* (Kütz.) Rabenh.
Navicula mutica var *cohnii* (Hilse) Grunow	*Gyrosigma exilis*(Grunow) Reimer
Navicula pupula Kütz.var. *Capitata*Hust.	*Gyrosigma modiferam* comb nov
Navicula pusilla Smith	**Family: Rhoicospheniaceae**
Navicula radiosa Kütz.	*Rhoicosphenia curvata* (Kütz.) Grunow.
Navicula rhynchocephala Kütz.	*Epithemia turgida* (Ehrenb.) Kütz.
Navicula symmetrica Patrick	*Rhopalodia gibba* (Ehrenb.) Müll.
Navicula tripunctata (Mull.) Bory	**Family: Sellaphoraceae**
Navicula wardii Patrick	*Fallacia pygmaea* (Kütz.) Stickle et Mann
Family: Neidiaceae	*Sellaphora pupula* (Kütz.) Mereschk.
Neidium affine (Ehrenb.) Pfitzer	*Sellaphora pupula* 2
Neidium productum (Smith.)	**Family: Stauroneidaceae**
Neidium rudimentarum A Boyer	*Craticula cuspidata* (Kütz.) Mann
Neidium sp	*Stauroneis anceps* Ehrenb.
Family: Pinnulariaceae	*Stauroneis anceps* f. *gracilis* Raben.
Caloneis bacillum (Grunow) Cleve	**Family: Surirellaceae**
Pinnularia abaujensis (Pant.) R.Ross.	*Cymatopleura solea* (Breb)Smith var. *solea*
Pinnularia abaujensis (Pant.) var. *rostrata*	*Cymatopleura* sp.
Pinnularia abaujensis (Pant.) Ross var. *linearis*	*Surirella angusta* Kutz.
Pinnularia acrosphaeria (Bréb.) W.Smith	*Surirella ovalis* Breb.
Pinnularia appendiculata (Agardh) Cleve.	*Surirella tenera* Greg.
*Pinnularia biceps*Greg.	
Pinnularia bogotensis var *undulata* A Boyer	
Pinnularia bogotensis (Grun. ex Schmidt) Cleve	
Pinnularia borealis Ehrenb.	
Pinnularia brebissonii (Kütz.) Rabenh.	
Pinnularia divergens Smith	
Pinnularia divergens Smith var. *bacillaris* (Perag) Mills	
Pinnularia gibba var *linearis* Hust.	
Pinnularia legumen Ehrenb.	
Pinnularia maior (Kütz.) Raben.	
Pinnularia mesolepta (Ehrenb.) Smith	
Pinnularia microstauron (Ehrenb.) Cleve	
Pinnularia parva var *minuta* Strup.	
Pinnularia stauroptera (Grun.) Cleve	
Pinnularia stomatophora (Grunow) Cleve	
Pinnularia stomatophoroides Mayervar. *ornata* Cleve	
Pinnularia subcapitata Greg var. *paucistriata* (Grun) Cleve	
Pinnularia subcapitata Greg.	

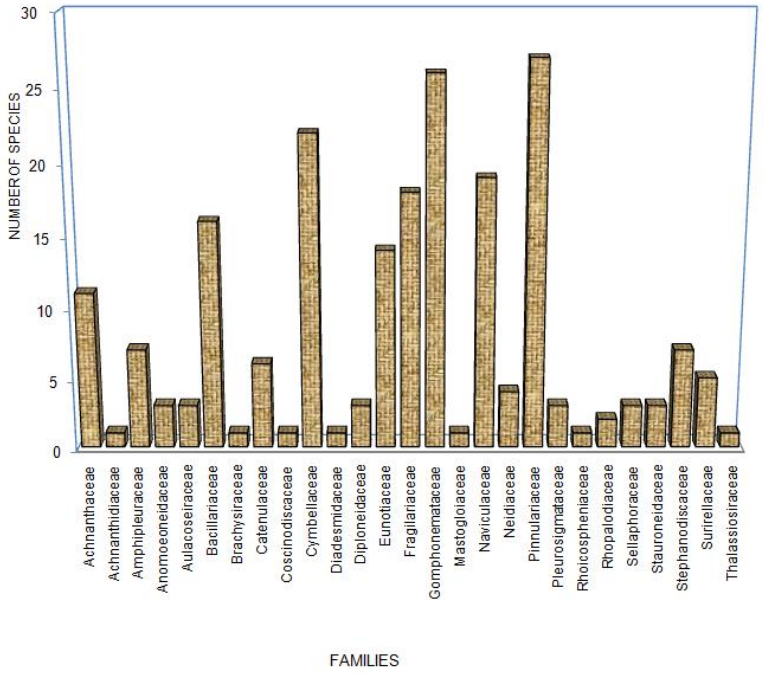

Figure 1. The distribution of Diatom species across families in Dilimi River, Jos, Nigeria (2004-2006).

Table 4: Number of diatom genera and species represented in each in Upper Dilimi River, Jos, Nigeria (2004-2006).

S/No	Genus	Number of Taxa	S/No	Genus	Number of Taxa
1	*Achnanthes*	9	21	*Fallacia*	1
2	*Achanthidium*	1	22	*Fragillaria*	7
3	*Amphicapsa*	1	23	*Frustulia*	7
4	*Amphora*	6	24	*Gomphonema*	26
5	*Anomoeoneis*	3	25	*Gyrosigma*	3
6	*Aulacoseira*	3	26	*Hantzschia*	2
7	*Brachysira*	1	27	*Mastogloia*	1
8	*Caloneis*	1	28	*Meridion*	1
9	*Cocconeis*	2	29	*Navicula*	19
10	*Coscinodiscus*	1	30	*Neidium sp*	4
11	*Craticula*	1	31	*Nitzschia*	12
12	*Cyclotella*	6	32	*Pinnularia*	26
13	*Cymatopleura*	2	33	*Rhoicosphenia*	1
14	*Cymbella*	21	34	*Rhopalodia*	1
15	*Denticula*	2	35	*Sellaphora*	2
16	*Diadesmis*	1	36	*Stauroneis*	2
17	*Diploneis*	3	37	*Stephanodiscus*	1
18	*Encyonema*	1	38	*Surirella*	3
19	*Epithemia*	1	39	*Synedra*	9
20	*Eunotia*	14	40	*Thallassiosira*	1
Total			40		209

Table 5: Rank Percentage Occurrence and Mean Abundance of Twenty most predominant taxa found in Dilimi River during the study period.

Rank	Taxa	Samples where taxon was encountered (%)	Mean abundance for species in sample (%)
1	*Gomphonema parvulum* (kutz.) Grunow	99.17	41.32
2	*Nitzschia palea (Kütz.)* Smith	96.25	40.10
3	*Navicula arvensis* Hust.	85.83	35.76
4	*Fragilaria virescens* Ralfs	55.00	22.92
5	*Pinnularia microstauron* (Ehrenb.) cleve	53.33	22.22
6	*Cymbella angustata* (Smith) Cleve	50.42	21.01
7	*Cyclotella ocellata* Pant.	48.75	20.31
8	*Cymbella minuta* var. *selesiaca* (Bleisch) Reimer	48.33	20.14
9	*Cymbella minuta* Bleisch ex Rabh.	47.92	19.97
10	*Gomphonema sphaerophorum* Ehrenb.	45.83	19.10
11	*Nitzschia intermedia Hantzsch*	44.58	18.58
12	*Nitzschia palea* 2	41.25	17.19
13	*Navicula flanatica* Grunow	40.42	16.84
14	*Brachysira styriaca* (Grunow) Ross	38.33	15.97
15	*Synedra ulna* (Nitz.) Ehrenb.	36.67	15.28
16	*Pinnularia appendiculata* (Agardh) Cleve	36.25	15.10
17	*Cyclotella atomus* Hust.	31.67	13.19
18	*Nitzschia hantzschiana* Rabenh.	31.67	13.19
19	*Craticula cuspidata* (Kütz.) Mann	30.83	12.85

IV. Discussion

The number of diatom species (209) observed in the upper Dilimi River is quite high and comparable to other published studies from other larger tropical rivers within and outside the Nigeria [18]. Majority of diatoms identified in the study were from the pennate group which is in conformity with the species composition in similar reports from the southern part of the country[18 -22]. The relatively higher abundance and frequency of occurrence for *Gomphonema parvulum*,*Nitzschia palea* and *Navicula arvensis* agrees with reports by [18] who listed *Nitzschia palea* and *Gomphonema parvulum* as one of the more frequently occurring pennate diatoms in Ologe lagoon [23]. Oliveira *et al*. (2001) also observed same for *Gomphonema parvulum* in all the study areas of some temperate rivers and lotic environments in Brazil respectively [24]. This is because the two species are pollution tolerant and resistant to organic pollution in water and so infer nutrient enrichment [13 &25]. Hence, the occurrence of *Nitzschia palea and Gomphonema parvulum* in abundance across the streamis an indication of earlier organic enrichment of the water as reported [26&27].Potapova *et al*. (2005) also reported that in urban streams, the relative abundance of pollution tolerant species was often higher than in less affected streams [23].

From the checklist, Dilimi River was dominated by a few species that occur frequently in abundance and in combination with a large number of rare species that occur occasionally. An observation indicated in many reports [28, 29 & 30].

V. Conclusion

This study as it stands has contributed to the understanding of the local, regional and national biodiversity. It has also provided a background database for future reference and for more detailed investigations on diatom assemblages in the region. It has indicated the extent to which the considerable literature from southern part of the country is relevant to the region.

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