THE ABUNDANCE OF PENNATE DIATOMS (Class Bacillariophyta) AMONG THE THREE WATER BODIES AROUND WINDHOEK

By

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A report submitted to the Department of Fisheries and Aquatic Sciences, Faculty of Agriculture and Natural Resources, University of Namibia, in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Fisheries and Aquatic Sciences of the University of Namibia.

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DECLARATION

I hereby declare that this is the product of my own research efforts, undertaken under the supervision of Mr.L.Kandjengo and has not been presented elsewhere for the award of a degree certificate. All sources have been duly appropriately acknowledged.

CANDIDATE SIGNATURE:…… DATE:……

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STUDENT NUMBER: 200633660

CERTIFICATION

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This is to certify that this report has been examined and approved for the award of the degree of Bachelor of Science in Fisheries and Aquatic Science of the University of Namibia.

External examiner……

Internal examiner……

Supervisor……

Head of the Department……

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ACKNOWLEDGEMENT

First and foremost I would like to thank the almighty God for making my academic aspirations and accomplishments a reality. Then my sincere and utmost gratitude goes to my supervisor Mr.L.Kandjengo for the invaluable support and patient guidance during the course of this research work.

My gratitude goes to Mrs.B.Kachigunda for her precious time giving an insight on the statistical analysis of my study.

I am highly indebted to the Royal Norwegian Government for offering me the scholarship to pursue the BSc at this esteemed University, and the Department of Fisheries and Aquatic Sciences for its support to undertake the field work.

DEDICATION

I would like to dedicate this report to my late immediate supervisor (Kenneth Mazingaliwa) who encouraged me to pursue this study programme. It is unfortunate that he did not live to see me accomplish it.

I also dedicate it to my twin daughters (Andy and Mandy) who have had to live without a father since their birth.

ABSTRACT,

- This is the first assessment of the behavior of pennate diatoms around freshwater systems in Windhoek. The study was spread through two seasons thus winter and spring. The selected sites were not having the same catchment area. The variability and abundance was weighed against temperature and pH. A strict sampling schedule was followed to monitor the pennate diatom population at each sampling site. Water sample was collected from the three site and samples were analysed in the laboratory to check pennate diatoms under dissecting and compound microscope. The data collected at the end of the study was subjected to analysis of Non-parametric statistics. The study revealed that the abundance of the pennate diatoms is not affected by the environmental parameters (pH and temperature where their means for the two seasons were7.3 and16.0 respectively).

The abundance of pennate diatoms did not vary with changing season. The diatom abundance and distribution depended on respective habitat (site) environment.

CHAPTER ONE

1.1. INTRODUCTION

Diatoms are a type of mainly aquatic, photosynthetic algae. Similar to many other algae, they can be unicellular, colonial, or filamentous organisms and are found in marine and fresh water ecosystems as well as brackish water (Bold, 1978). Diatoms can also be found in terrestrial environments where the soil moisture is at least periodic (Bold, 1978). They can be found all around the world, from the tropics to the arctic zones (Tiffany, 1978). In water, diatoms may live attached to rock but they are best known for being part of the drifting mass (Garrison, 1997).

Diatoms are the best known of all the unicellular planktonic algae. The variety of silica shell walls on which diatom taxonomy is based has resulted in more than 10,000 taxa being described (Hostetter and stoermer, 1971). Most of the year diatoms reproduce asexually by mitosis with each daughter cell receiving half of the cell wall and regenerating a new second half (Mann,1999). In ecological studies of diatom communities, the valves are used as a taxonomic tool systematically, there are two groups of diatoms, the radially symmetrical centric diatoms and the bilaterally symmetrical pennate diatoms. Diatoms may be planktonic, benthic or facultative planktonic. Diatoms are found in both freshwater and marine environments, and are especially in the latter, where they are estimated to contribute up to 45% of total oceanic primary production (Mann, 1999).

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1.2. LITERATURE REVIEW

Extensive bibliographies and summaries of the classical diatom literature are given in Gran (1992), Lebour (1930), Cupp (1943), Henry (1964), Hostelter and Stoemer (1971) and Werner (1977). The vast literature on diatom bibliography was collated by Hasle (1976) and Gullard and Kilham (1977) who summarized the diatoms region by region, the dominant diatom flora of modern seas. This information now needs to be updated.

The terminology used by diatom taxonomists are published in Anon (1975) and Ross *et al* (1979), and the ultra structure of diatom is summarized in Jeffrey *et al*. (1990). A comprehensive review on biogeography and distribution of micro-organisms does not exist so far. Consequently, the relevant literature is highly scattered, often vague, and burdened with numerous misidentifications due to methodological shortcomings and flaws, patchy information, and lastly, the wide spread practice to use Holarctic identification to determine species from other regions (Foissner 1987,Lhotsy 1998; Hoffmann 1999; Alongi *et al*. 2002). The diatoms must not be overlooked. These tiny organisms have been around for billions of years and play major roles in chemical and biological processes. Diatoms are estimated to be responsible for 20% to 25% of all the organic carbon fixation, they are major sources of atmospheric oxygen, and are a major food source for aquatic microorganisms and insect larva (Anon, 1999).

Another important use of diatoms in the biological realm is in water quality testing. Research by Dixit *et al* (1999) shows that diatoms can be used for present water quality but also used to determine former water quality and trends over years.

Economically and industrially, diatoms are of huge importance. Billions of years of diatom frustules' being naturally fossilized has created huge deposits of these shells or diatomaceous earth. These deposits are mined to be used as filtering aids, abrasives, cleaners and paints. For an average person, this means that the wine we drink may have been filtered with the aid of diatom fossils, or the toothpaste we use may clean our teeth with the help of diatom fossils as an abrasive, and the gas we use to drive our cars may all come from a diatomaceous origin. In the growing industry of fish feed, the diatomaceous earth is used as a binder.

1.3. PROBLEM STATEMENT

This present study was designed to determine how the pennate diatoms are distributed in different freshwater systems around Windhoek (Goreangab Dam, Neudamm Dam and University of Namibia Pond) and specifically if their distribution varies with changing seasons. The three sites were chosen because of their easy accessibility and have been used previously in other courses of study.

1.4. RESEARCH OBJECTIVES

(1) The main objective of the study was to determine the abundance and distribution of pennate diatoms in three freshwater sites as well as their variation with changes in seasons.

1.5. RESEARCH HYPOTHESES

H_{01}: There is no difference in the distribution and abundance of pennate diatoms in the three Sites.

H_{11}: There is a significant difference in the distribution and abundance of pennate diatoms in the three sites.

H_{02}: There is no difference in distribution and abundance of pennate diatoms with changes of seasons.

H_{12} :There is a significant difference in distribution and abundance of pennate diatoms with changes of seasons.

1.6. SITE HISTORIES

1. Goreangab Dam (Fig. 1): Goreangab Dam catchment is about 150km^2 and situated mainly to the south of Auas Mountains .Two main rivers, Busch and the Gammams rivers, contribute the bulk of the catchment water supply to the Goreangab dam (Brand, 1962).

Fig. 1.Satellite Image of Goreangab sampling site marked with a yellow pin.

2. Neudamm Dam (Fig 2): The source for Neudamm dam is not known, no information has been found pertaining to the source of the rivers which flow into Neudamm dam.

Fig. 2. Satellite Image of Neudamm Sampling site marked with a yellow pin.

3. University of Namibia main campus Pond (Fig 3): The University of Namibia Pond whose source is Oanab dam which is located 7km to the west town of Rehoboth. Municipality of Windhoek manages the water and channels it to its clients.

Fig.3. Satellite Image of University of Namibia Sampling site marked with a yellow pin

CHAPTER TWO

2.1. MATERIALS AND METHODS

Methodology

Prior to the commencement of this study, a preliminary sampling was done from the UNAM pond and identified the pennate diatoms to be most recurring at the time and the study was spread to the other two collection sites.

Water was collected from (3) sites: Goreandab Dam, University of Namibia pond (UNAM pond) and Neudamm Dam. The 48 water samples were collected in 200ml collecting bottles. During the water collection other environmental parameters such as pH and temperature were taken at every sampling. At sampling, to the 200ml sampling bottle 10ml of 40% formalin was added to preserve the samples. However while in the sampling process, it was observed that the formalin distorted the shapes and discolored the diatom such that they became difficult to differentiate from particulate matter in the sample. The percentage of formalin used was reduced to 5ml and the observations in the laboratory were done soon after sampling.

The water samples were collected in the winter (May and June) and spring (august and September) months.

Laboratory Analysis

Back in the laboratory the 200ml water sample was sub-sampled into 3 drops of 2 replicates per bottle after shaking.

The drops were dropped onto the Petri dish which was later put under the dissecting microscope for observation of the pennate diatoms.

After the first round of winter sampling more of other microorganisms were being observed from the sampling sites and this ignited the idea of identifying them and records kept (see appendix.6.6)

2.2. STASTICAL ANALYSIS

All the data obtained from the study was done in duplicates (two bottles per site). After the sampling period the data was subjected to Non-parametric analysis of variance of a two-way completely randomized design (ANOVA) with no blocking.

Genstat statistical package was used to compute the transformed data logarithm at 5% level of significance.

CHAPTER THREE

3.1. RESULTS

The results indicated that no significant difference exists among the sites, Neudamm, Goreangab and UNAM pond in the distribution and abundance of the pennate diatoms (**P=0.250**). There were also no significant differences due to change of seasons **(P =0.0855**). as indicated on the table below.

There was no significant interaction between the season and site in terms of the diatom distribution and abundance in the sites of the study area (**P=0.422**) the table below.

Analysis of Variance

Variate: **LOGABUNDANCE**

Table 1. Analysis of Variance Table

Source of variation	d.f	s.s	m.s	v.r	F pr
SEASON	1	0.00311	0.00311	0.04	0.855
SITE	2	0.27654	0.13827	1.56	0.250
SEASON.SITE	2	0.16463	0.08232	0.93	0.422
Residual	12	1.06499	0.08875		
TOTAL	17	1.50928			

Fcrit (1,12d.f) .).....4.75

The table below shows the summary of the treatments overally there was no significant differences correlation between season and the site

Table 2. Summary Table for Treatments (*treatment: season and site*)

Season	**Site**			**Mean**
	Unam	**Goreangab**	**Neudamm**	
Winter	1.133	0.619	0.764	0.839
Summer	0.866	0.820	0.752	0.812
Grand Mean	1.00	0.719	0.758	0.826
Fpr (Interaction, 2, 12d.f)				0.422
S.e.d.				0.2432
L.S.D				0.5300
C.V %				36.1

Figure .1 below shows how the abundance was from the three sites during the winter months. In all the three samplings done during winter the UNAM pond exhibited higher numbers, Neudamm and Goreangab taking second and third place respectively.

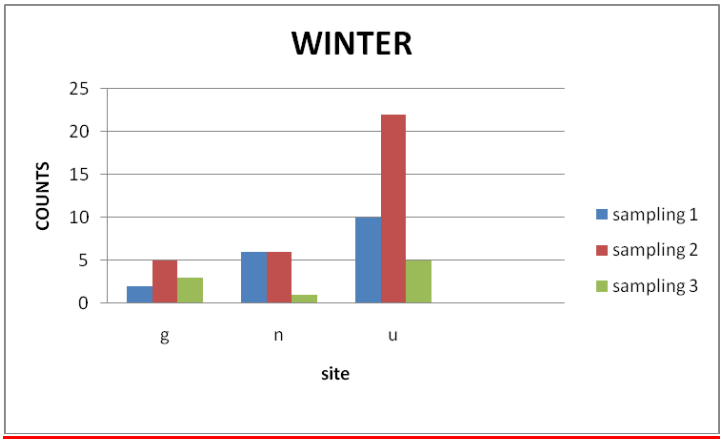

Figure 1. Abundance against site for winter sampling.(g-goreangab,n-neudamm andU-Unam)

. Figure. 2 below show how the abundance was from the three sites during the winter months. In all the three samplings done during winter the UNAM pond exhibited higher numbers, Neudamm and Goreangab taking second and third place respectively.

The graph below shows how the three site faired interms of pennate abundance. Figure 2 below shows how the abundance was from the three sites during the winter months.

In all the three samplings done during winter the UNAM pond exhibited higher numbers, Neudamm and Goreangab taking second and third place respectively.

The figure below shows how the three site faired interms of pennate abundance.

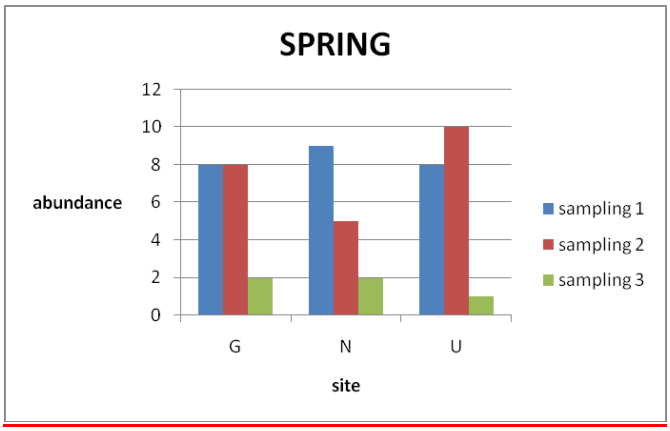

Figure 2. Abundance against site for summer sampling(G-goreandab,n-neudamm and u-Unam)

CHAPTER 4

4.1. DISCUSSION

The results indicate no significant difference between the three sites, (Neudamm, Goreangab and Unam) in the distribution and abundance of the pennate diatoms **(p=0.250)**.

There are no significant differences due to change of seasons as seen from the (Table.2) summary table of means (**P=0.0855**).

There was no significant correlation between the season and site in terms of the diatom distribution and abundance in the three sites of the study area **(P=0.422)**.

Graph. 1. Above show that the abundance in the winter month was low in Goreangab Dam for all the three (3) samplings, this was due to the way the water that is fed to the dam is treated by the municipality.

In winter sampling the Neudamm diatom abundance mean was **0.764** and it dropped to **0.752** in the spring sampling and this could have been due the dam drying up.

There were slight differences on the environmental parameters and they seemed to have no effect on the diatom growth in all study sites (see appendices 6.2 and 6.3).

The diatom abundance in Goreangab depended on how long the water was standing.

Sampling three (3) of the spring was low for all the sites this could have been caused by not shaking the sampling bottles in the laboratory. The diatoms could have settled at the bottom of the sampling bottle. This lead to erroneous results to even other two sites.

4.2 CONCLUSION

This study provides information on the abundance and distribution of pennate diatoms among freshwater water bodies around Windhoek from winter to spring. The study did investigate how the pennate diatoms are distributed and their abundance, three sites were chosen and they exhibited different characteristics in the manner diatoms flourished. The study revealed that the abundance of the pennate diatoms is not affected by the environmental parameters (pH and temperature where their means for the two seasons were7.3 and16.0 respectively). The abundance of pennate diatoms did not vary with changing season. Insignificant correlation between the sites and the season was observed. Pennate diatoms are found in most of the water bodies around Windhoek as seen from the different sites which were selected regardless of their sources.

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6.0. APPENDICES

Appendix .6.1. Raw Data for the Winter Sampling

SEASON	SAMPLE NUMBER &DATE	REPLICATE	SITE	TALLY	TOTAL
WINTER	1-13/05/2010	1	Goreangab Dam	-	

	2-12/05/2010	1	Goreangab Dam	I I	
	1-07/06/2010	2	Goreangab Dam	I I I I I	
	2-07/06/2010	2	Goreangab Dam	-	
	1-30/06/2010	3	Goreangab Dam	II	
	2-30/06/2010	3	Goreangab Dam	I	
					10
	1-12/05/2010	1	Neudamm Dam	I I I	
	2-12/05/2010	1	Neudamm Dam	I I I	
	1-07/06/2010	2	Neudamm Dam	I I I I I	
	2-07/06/2010	2	Neudamm Dam	I	
	1-30/06/2010	3	Neudamm Dam	I	
	2-30/06/2010	3	Neudamm Dam	-	13
	1-12/05/2010	1	Unam Pond	I I I I I I I I	
	2-12/05/2010	1	Unam Pond	I I	
	1-07/06/2010	2	Unam Pond	I I I I I I I I I I I I I I I I I I I I I I I	
	2-07/06/2010	2	Unam Pond	I I I I I I I I	
	1-30/06/2010	3	Unam Pond	I I I	
	2-30/06/2010	3	Unam Pond	I I	
					37

Appendix 6. 2 .Winter sample -Environmental parameters

SITE	DATE	P^H	TEMPERATURE[^{0}C]
Neudamm Dam	13/05/2010	7.33	16.0
Goreangab Dam	13/05/2010	8.37	20.5
Unam Pond	13/05/2010	8.9	15.0
Neudamm Dam	07/06/2010	7.8	16.2

Goreangab Dam	07/06/2010	8.7	18.3
Unam Pond	07/06/2010	9.06	16.5
Neudamm Dam	30/06/2010	6.02	12.3
Goreangab Dam	30/06/2010	6.2	16.3
Unam Pond	30/06/2010	6.7	14.9

Appendix 6.3. Spring data record sheet

SEASON	SAMPLE NUMBER &DATE	REPLICATE	SITE	TALLY	TOTAL
summer	1-05/08/2010	1	Goreangab Dam	II	
	2-05/08/2010	1	Goreangab Dam	IIIIII	
	1-03/09/2010	2	Goreangab Dam	III	
	2-23/09/2010	2	Dam	IIII	
	1-23/09/2010	3	Goreangab Dam	I	
	2-23/09/2010	3	Goreangab	II	

			Dam		
					18
	1-05/08/2010	1	Neudamm Dam	IIII	
	2-05/08/2010	1	Neudamm Dam	IIIII	
	1-03/09/2010	2	Neudamm Dam	II	
	2-23/09/2010	2	Neudamm Dam	III	
	1-23/09/2010	3	Neudamm Dam	II	
	2-23/09/2010	3	Neudamm Dam	-	
					16
	1-05/08/2010	1	Unam Pond	II	
	2-05/08/2010	1	Unam Pond	IIIIII	
	1-03/09/2010	2	Unam Pond	IIII	
	2-03/09/2010	2	Unam Pond	IIIIII	
	1-23/09/2010	3	Unam Pond	II	
	2-23/09/2010	3	Unam Pond	I	
					21

Appendix 6.4 Spring Sample- Environmental Parameters

SITE	DATE	P^H	TEMPERATURE[^{0}C]
Neudamm Dam	05/08/2010	8.06	16.8
Goreangab Dam	05/05/2010	7.0	18.0
Unam Pond	05/08/2010	7.8	14.2
Goreangab Dam	03/09/2010	7.0	18.2
Neudamm Dam	03/09/2010	8.0	16.3

Unam Pond	03/09/2010	5.5	10.2
Neudamm Dam	23/09/2010	8.7	17.9
Goreangab Dam	23/09/2010	8.7	22.6
Unam Pond	23/09/2010	7.0	25.0

Appendix 6.5. Data summary sheet

WINTER SAMPLING DATA

	SITES			
SAMPLING	GOREANGAB DAM	NEUDAMM DAM	UNAM POND	
1	2	6	10	
2	5	6	22	
3	3	1	5	
TOTAL	10	13	37	
				60

SPRING SAMPLING DATA

	SITES			
SAMPLING	GOREANGB DAM	NEUDAMM DAM	UNAM POND	

1	8	9	8	
2	8	5	10	
3	2	2	1	
TOTAL	18	16	21	
				55

WINTER SAMPLING DATA

SAMPLING 1			SAMPLING 2			SAMPLING 3		
Goreangab	Neudamm	unam	Goreangab	Neudamm	unam	Goreangab	Neudamm	unam
2	6	10	5	6	22	3	1	5

SPRING SAMPLING DATA

SAMPLING 1			SAMPLING 2			SAMPLING 3		
Goreangab	Neudamm	unam	Goreangab	Neudamm	unam	Goreangab	Neudamm	Unam
8	9	8	8	5	10	2	2	1