
ASSESSING THE DIVERSITY AND ABUNDANCE OF AQUATIC INSECTS ODOPONYI
SEASONAL STREAM IN NAGONGERA SUBCOUNTY, TORORO DISTRICT

BY

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DECLARATION.

I KULOBA ISAAC hereby declare that this research report is my real and genuine work and to the best of my knowledge no plagiarism has been done. Where such a case of similar work, proper citations have been indicated.

Signature; 

Date; ...19/09/2024.....

APPROVAL.

This research on Assessing the diversity and abundance of aquatic insects Odoponyi seasonal stream in Nagongera sub county, Tororo District has been submitted for examination with the approval of my supervisor;

Ms. Hellen Namusana;

Signed... *Namusana alt*

Date... *19/09/2024*

DEDICATION.

This research report is dedicated to my beloved mum Robina Watsemba, and mama Elizabeth Mwaka who tried all possible ways of supporting me unconditionally and encouraging me emotionally and psychologically towards the completion of this research within the stipulated time.

ACKNOWLEDGEMENTS

Glory be to the Almighty God who has given me the gift of life and unconditional mercy towards whatever I have gone through in the course of my studies.

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ABSTRACT

Aquatic insects are fundamental components in aquatic ecosystems due to their significant roles that they play in these habitats which mainly ecosystem health bio-monitoring. This study aimed to assess the diversity and abundance of aquatic insects in Odoponyi seasonal stream in Nagongera Subcounty, Tororo District. Sampling was conducted at multiple sites, above 100m apart and insect samples were identified upto family level and quantified.

A total of seventy-four (74) insects have been collected from the selected sites of Odoponyi seasonal stream in Nagongera Subcounty which includes three orders and eleven families. Across this aquatic habitats, hemiptera(30) and Odonata(33) were more at site 1 than site 2 and 3, while the least order recorded was coleoptera with nine(11) insect species collected. Results on family relative abundance indicate that Notonectidae family had the greatest relative abundance (36.49%) among the aquatic insects collected, followed by Coenagrionidae and Libellulidae family (18.92%), dysticidae(9.46%), corduliidae(4.05%), Aeshinidae, Nepidae and Gyrinidae(2.70%) and finally Gerridae, Hydrophilidae and and Hydraenidae with the least relative abundance (1.35%) along the stream.

The diversity indices indicate higher dominance of aquatic insects at site 1 (0.4386) than site 2 (0.3633) and site 3 (0.36). However, site 2 and site 3 had higher diversity (1.055) and evenness (0.954) than site 1 (0.9038) and evenness (0.823). Further efforts should be fostered in terms of duration for data collection and using other methods for data collection since this data was collected using kick net method. Preferably for better results, a hydraulic sampling device ought to be used.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Globally, the changes in land use; a pressure resulting from population growth are a threat to the river and stream ecosystems around the whole world (Ferreira et al., 2023). This is in a way that humans greatly alter the river ecosystems in various ways thus affecting the initial conditions of the aquatic habitat (Finlay, 2011). The urbanization process needs the construction of houses, an increase in agricultural areas and water demands to meet the basic needs of the growing population (Ayele & Tarekegn, 2020). The benthic community is suppressed due to such different uses of the land to poor productivity in the ecosystem diversity and abundance of aquatic insects (Malacarne et al., 2016). The climate changes as driven by anthropogenic activity of man has affected water availability and quality especially in USA and Africa, signifying that the aquatic ecosystem is in danger (Emmanuel Augustine Etukudoh et al., 2024). According to Tuomisto, (2010), Diversity refers to the variety of different species within a given ecosystem or community whereas Abundance refers to the total number of individuals of a particular species in a given ecosystem.

In Sub Saharan Africa, aquatic components are integral components of fresh water ecosystems playing fundamental roles in nutrient cycling, energy transfer and food web dynamics (Fasnacht, 2018). They are particularly sensitive to environmental changes making them excellent indicators of water quality and ecological health, therefore their abundance and diversity is of significant reflection on the quality and health of the aquatic ecosystems (Coayla-Peñaloza et al., 2024). According to Starr & Wallace, (2021), aquatic insects are comprised of more than 88,500 described species from approximately 13 orders. According to Grigoropoulou et al., (2023), of the total global aquatic biodiversity, aquatic insects comprise of 64% implying that they are abundant than other organisms within the aquatic ecosystem. The diversity and abundance of aquatic insects serve as important indicators of ecosystem health and changes in their populations can have cascading effects on other organisms within the food chain (Hershey et al., 2010). Therefore, alterations in the composition and structure of aquatic insect communities can disrupt ecosystem functioning, such as nutrient cycling and organic matter composition (Malacarne et al., 2024).

In East Africa the rate of population increase is at a faster rate, the anthropogenic pressure on aquatic ecosystem is rapidly increasing disrupting the rich aquatic biodiversity in the streams (Okorondu et al., 2022). Uganda as a country of interest, particularly in Tororo District clearly displays the population growth rate results and therefore all these impart pressure on land use practices within this District for instance the available forested areas being cleared for settlement and town enlargement (Anguti et al., 2022). The same pressure is imparted on the aquatic ecosystems through surface and underground flow to the streams affecting the survival rate of aquatic insects through limitation of their survival rate as the conditions within the streams become unfavourable (Egor & Birungi, 2020). Thus, the diversity and abundance of aquatic insects provides an initial insight into the types of ecological processes that regulate aquatic insect population. The distribution of aquatic insects among stream habitats reflects, to some degree, the distribution of benthic resources (e.g., food, oxygen, and predators) and provides information about how communities might respond to changes in environmental parameters such as increased sedimentation and changes in flow (Starr & Wallace, 2021). This research aims to investigate the diversity and abundance of aquatic insects in Odoponyi seasonal stream in Nagongera sub county, Tororo District.

1.2 Statement of the problem

Seasonal streams, characterized by altering dry and wet phases display unique challenges for biodiversity conservation due to their extreme variability (Giam et al., 2017). However, Odoponyi seasonal stream like many other seasonal streams faces increasing threats from environmental changes, like climate variability, pollution and habitat modification yet supporting life of aquatic macro invertebrates including aquatic insects at large. This stream has not been adequately researched as far as the diversity and abundance aquatic insects is concerned.

A study previously conducted along this stream by Turyahabwe et al., (2023) centered on investigation of the spatio-temporal variations in water quality and fish assemblages as a response to ecosystem disturbance from the selected agricultural landscapes in Tororo District. However, this was too general and left behind one of the most fundamental aquatic living organisms; which are the aquatic insects within Odoponyi seasonal stream. Therefore to fulfill this missing gap, this

study fully aim at assessing the diversity and abundance of aquatic insects in Odoponyi seasonal stream.

1.3 Objectives of the study

1.3.1 General objective

To determine the diversity and abundance of aquatic insects in Odoponyi seasonal stream.

1.3.2 Specific objectives

1. To identify the aquatic insects in Odoponyi seasonal stream.
2. To determine the diversity and aquatic insects in Odoponyi seasonal stream.
3. To assess the abundance of aquatic insects in Odoponyi seasonal stream

1.4.0 Hypotheses

1.4.1 Null hypothesis

There is no significant difference in the diversity and abundance of aquatic insects in Odoponyi seasonal stream.

1.4.2 Alternative hypothesis.

There is a significant difference in the diversity and abundance of aquatic insects in Odoponyi seasonal stream.

1.6 Scope of the study.

This study scope encompasses various aspects of the diversity and abundance of aquatic insect populations in Odoponyi seasonal stream in Nagongera sub county, Tororo District. It covered multiple sampling periods to capture the seasonal variations and the fluctuating water levels to supporting life of insect populations.

The research study aimed at identifying insects of different forms within this seasonal stream. Sampling was done using a kick net which was considered as the efficient method of sampling within this particular stream. The Global Positioning System, GPS was used to get the coordinates indicating the specific location of the sites where the aquatic insects were collected.

1.7 Justification of the study

The assessment of diversity and abundance of aquatic insects along this stream was necessary due to the stream's unique ecological status and potential for unstudied biodiversity.

Research findings from this study will be used to raise awareness among local communities about the importance of protecting freshwater ecosystems and the role they play in supporting biodiversity and ecosystem services due to the fact that seasonal streams often support unique insect communities adapted to varying water availability. It will also fill a gap in the understanding of the diversity and abundance of aquatic insects in Odoponyi seasonal stream that has been lacking.

CHAPTER TWO: LITERATURE REVIEW

2.0. Introduction.

Insects are categorized into terrestrial and aquatic insects. Aquatic insects in also exist in their aquatic habitat and most people ask how such insects survive under water. Other people tend to mistake them to be other aquatic organisms and not insects. However, the existence of aquatic insects has provided a basis of research in the roles played by this insects in such habitats, the conditions that favor their availability and their distribution as a result of disturbance from man and his activities.

2.1 Role of aquatic insects in seasonal streams

Aquatic insects play various roles in seasonal streams and across all their stages of life and their existence in seasonal streams communicate a lot as far as external pressures are concerned to the seasonal streams (Theses & Birrell, 2023). These insects include the shredders, scrapers, collectors and predators and in this kind of diversity, they are able to effectively utilize and exhaust their environment in a systematic manner; among which their roles are discussed below;

2.1.1 Decomposition

According to Syahnita,(2021) aquatic insects particularly the shredders of caddisflies and stoneflies aid in decomposition by breaking down organic matter like wood and leaves into fine particles that are used by other organisms within the aquatic habitat. Similarly, a study conducted by Fasnacht, (2018) indicates how mayflies and midges contribute to nutrient recycling by breaking down organic matter and facilitating movement of nutrients between different parts of the ecosystem.

2.1.2 Food web contributions

Aquatic insects widely contribute towards food web by acting as primary consumers by feeding on algae, plants and detritus, as well as acting as prey for other aquatic organisms like fish thus facilitating effective energy transfer within the aquatic habitat.

2.1.3 Bio-indication to ecosystem health

As far as environmental health is concerned, aquatic insects serve as bio-indicators where their presence depending on the abundance and diversity indicate whether the stream is heavily disturbed or slightly disturbed or undisturbed. According to Lancaster & Briers, (2008), aquatic insects indicate seasonal changes due to the presence of lifecycles synchronized with the wet and dry periods. According to Mahmoud & Riad, (2020) polluted habitats are inhabited by tolerant species of aquatic insects and the unpolluted habitats have diverse and abundant aquatic insects, thus acting as indicators to water quality

2.1.4 Role in forensic entomology.

Much as the water quality parameters like P^H temperature and presence of pollutants complicate the colonization process, some aquatic insects are of great importance in crime investigation of dead bodies in the aquatic habitats (Rabi., 2024). The blow flies of Calliphoridae family in order Diptera arrive few minutes following death and the time a body has been submerged in water can be estimated based the developmental stages of the aquatic insects present, which can also be estimated using the species succession and larval development rates (Bartkowska et al., 2023).

2.2. Insect abundance and diversity in seasonal Streams

Aquatic insects contribute to 64% of the total number of macro invertebrates in the aquatic habitat (Grigoropoulou et al., 2023).

Their abundance and diversity are essential indicators of water quality and ecological health (Malacarne et al., 2016). According to Viza et al., (2024), seasonal streams exhibit distinct temporal patterns in their hydrological regimes, which influence the diversity and abundance of aquatic insects. During periods of low flow, benthic insects such as Chironomidae, Baetidae, and

Elmidae dominate due to their ability to tolerate dry conditions(Coayla-Peñaloza et al., 2024). However in fast flowing streams, ephemeral species like heptageniidae thrive due to their flattened bodies to reduce resistance, strong tarsal claws for holding onto surfaces and adhesive pads on legs to assist in maintaining position on slippery surfaces(Ditsche et al., 2023).

A study conducted by Finlay, (2011) reveals that abundance and diversity of aquatic insect is influenced by various environmental factors such as temperature, pH, dissolved oxygen levels, nutrient availability, and substrate type. Temperature alters dissolved oxygen and water levels thus significantly affecting the distribution and abundance of aquatic insects in seasonal streams (Johnson et al., 2024). Similarly, nutrient availability has been shown to influence the growth rates and species richness of benthic macroinvertebrates thus determining the distribution and abundance of aquatic insects (Haubrock, 2024).

In the upstream of most seasonal streams, the diversity and abundance of aquatic insects is greater than the midstream and lower stream reaches due to increasing levels of disturbance along the stream thus altering habitat quality (Atkinson et al., 2024).

2.3 Impact of anthropogenic activities on the diversity and abundance of aquatic insects.

Aquatic insects play a vital role in freshwater ecosystems as they serve as primary producers, decomposers, and top predators. The influence of man and his activities either near or far away from the stream, sustainably or unsustainably have an impact on the diversity and abundance of aquatic insects in seasonal streams.

According to Nolan et al., (2023), Anthropogenic activities such as agriculture runoff, mining activities, and infrastructure development can negatively impact the diversity and abundance of aquatic insect communities in seasonal streams. A study conducted by Contieri & Bosquê, (2024) reveals that anthropogenic activities such as pesticide use during farming introduces nitrogen and other chemical components through surface runoff and underground movement into the streams thus affecting the functional diversity and abundance of aquatic insects in the aquatic ecosystem.

In streams where sand mining is prominent, the bedding is disturbed each and every time and therefore availability of aquatic insects in such habitats is limited as a result of sedimental disturbance along the stream (Andem et al., 2023).

CHAPTER THREE: METHODOLOGY

3.1 The study area

This research was carried out on Odoponyi seasonal stream in Nagongera sub county, Tororo district. This stream is known to be draining the lowland areas of eastern Tororo and is located between Latitude: $0^{\circ} 46' 7.19''$ N and Longitude: $34^{\circ} 01' 20.14''$ E. It joins river Manafwa in Butaleja after a distance of 39km(Turyahabwe et al., 2023). River manafwa joins river mpologoma as one of the major tributary, draining into lake Kyoga. Its head waters originate from elevated areas within Tororo with channels such as Abongiti Kisoko channel, Rutengo channel, Morikiswa channel Rukuli and Pajagoti channel Odoponyi stream covering such a distance of 39km supports various human activities despite of its seasonality. Fig.1. For example the upper catchments of the stream transverse artificial forests of eucalyptus trees, grazing grounds, followed by subsistence rice growing and other cultural food crops in the middle catchments, after which there is sugarcane farm then through the papyrus swamp vegetation before draining into river Manafwa.

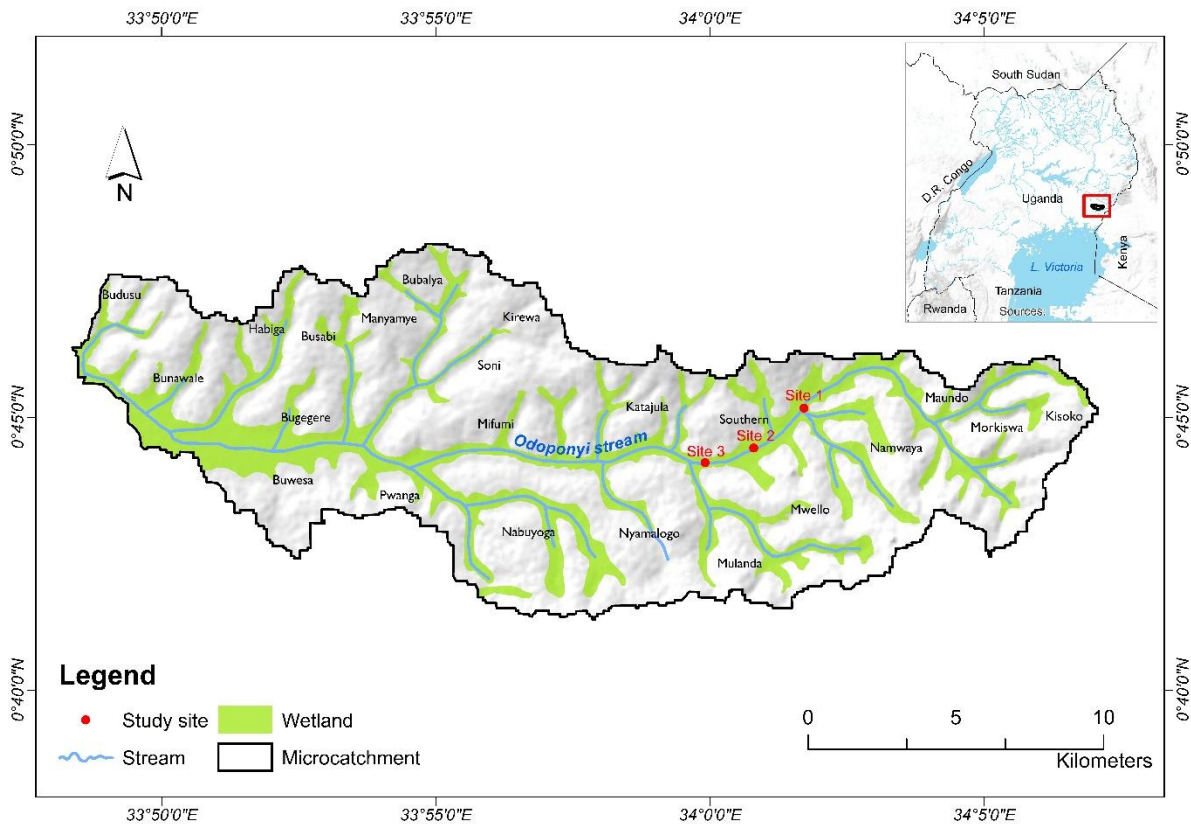


Figure 1: Map showing the location of the selected sampling sites along Odoponyi seasonal stream.

3.2. Study sites

The study sites selected were three in number within the mid of the stream. These included Site 1, followed by Site 2 which was 1.5km away from site 1 and finally Site 3 which was also 1.5km away from Site 2. This sites were selected because of their easy accessibility for use of the kick net; which was the main and readily available equipment taken for collection of the aquatic insect samples.

3.3 Sampling period.

The sampling period of this study was from May to August 2024. These months were selected because they are intermediate between the dry and wet season in Tororo District.

3.4 Sample collection

The sample collection was done using a kick net

This was made of a large square screen net mesh of size 0.3mm, 1m wide between two metallic poles with two handles measuring 1m from the top of the net frame, therefore 2m high from the bottom of the net frame to the top of the handles. The net was held by one person downstream of the targeted aquatic insect habitat against the flow of water. Another person kept on disturbing the bedding of the stream 1m in front of the net frame by kicking the substrates in the stream. As a result, there was dislodging of the insects, which were eventually carried by the stream flowing water into the kick net. Kicking each aquatic habitat lasted for 3 minutes.



Figure 2: Aquatic insect sampling using a kick net.

3.5 Sorting and treatment of the aquatic samples

The samples from the kick net were then poured on a white rectangular trough for sorting.

The samples obtained from respective sampling sites as determined by the GPS were put into a bottle containing 70% ethanol, sealed, labeled and kept, ready for laboratory analysis. Identification of the collected samples was effectively done using the field guide known as aquatic macro invertebrates of South Africa described by Gerber & Gabriel, (2002).



Figure 3: Picking of aquatic samples from the trough after kick netting.

3.6 Data analysis

All the data collected from May to August was subjected to Analysis of Variance (ANOVA) test and the T-test to compare the diversity and relative abundance of aquatic insects at various sampling sites of Odoponyi seasonal stream.

The data was also analyzed using Shannon-Weiner index to determine the diversity of aquatic insects. The formula below was used to determine Shannon index

$$(H'); (H' = - \sum p_i \ln p_i);$$

Where p_i is the proportion n/N of individuals of one particular species (n) and N is the total number of species.

The abundance of insect pollinators will be calculated using the Simpson index ($D = \frac{\sum (n(n-1))}{N(N-1)}$) where N is number of individuals of all species and n is number of individuals of a specific species.

4.0 RESULTS

Identification of aquatic insects.

A total of seventy four insects collected from the selected sites were identified based on their characteristics up to family level. Using this criteria of identification, a total of eleven families were identified and notonectidae family had the greatest number of insects identified whereas hydraenidae, hydrophilidae and gerridae families had one insect in each identified as detailed in the table below.

Order	Family	Total of insects identified	
Odonata	Coenagrionidae	14	33
	Corduliidae	3	
	Aeshnidae	2	
	Libellulidae	14	
Coleoptera	Gyrinidae	2	11
	Dysticidae	7	
	Hydraenidae	1	
	Hydrophilidae	1	
Hemiptera	Notonectidae	27	30
	Nepidae	2	
	Gerridae	1	
Total		74	74

Table 1: identification of aquatic insects in Odoponyi seasonal stream.

4.1 Insect diversity

A total of seventy-four (74) insects were collected from the selected sites of Odoponyi seasonal stream in Nagongera Subcounty. This includes three orders and eleven families. At site one, there were more insects collected and greatly varying in species. Whereas at site two, I recorded the least number of insect families. Across this aquatic habitats, hemiptera(30) and Odonata(3) were more at site 1 than site 2 and site 3, while the least order recorded was coleoptera with nine(11) insect species collected; Fig.4.

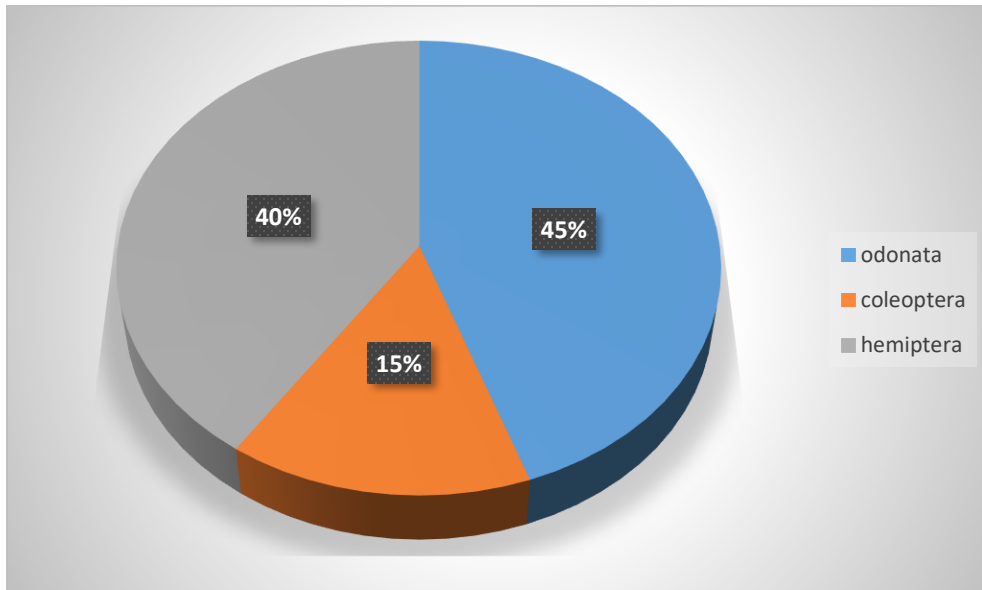


Figure 4: Diversity of aquatic insects in Odoponyi seasonal stream.

Among the total of three insect orders collected from Odoponyi seasonal stream, Odonata represented the greatest percentage (45%) followed by Hemiptera(40%) and lastly Coleoptera which was the least (15%).

4.2 Relative abundance of aquatic insects in Odoponyi seasonal stream.

Results below for insect family relative abundance indicate that Notonectidae family had the greatest relative abundance (36.49%) among the aquatic insects collected, followed by Coenagrionidae and Libellulidae family(18.92%), dysticidae(9.46%), corduliidae(4.05%), Aeshinidae, Nepidae and Gyrinidae(2.70%) and finally Gerridae, Hydrophilidae and Hydraenidae with the least relative abundance (1.35%) along the stream; Fig. 5.

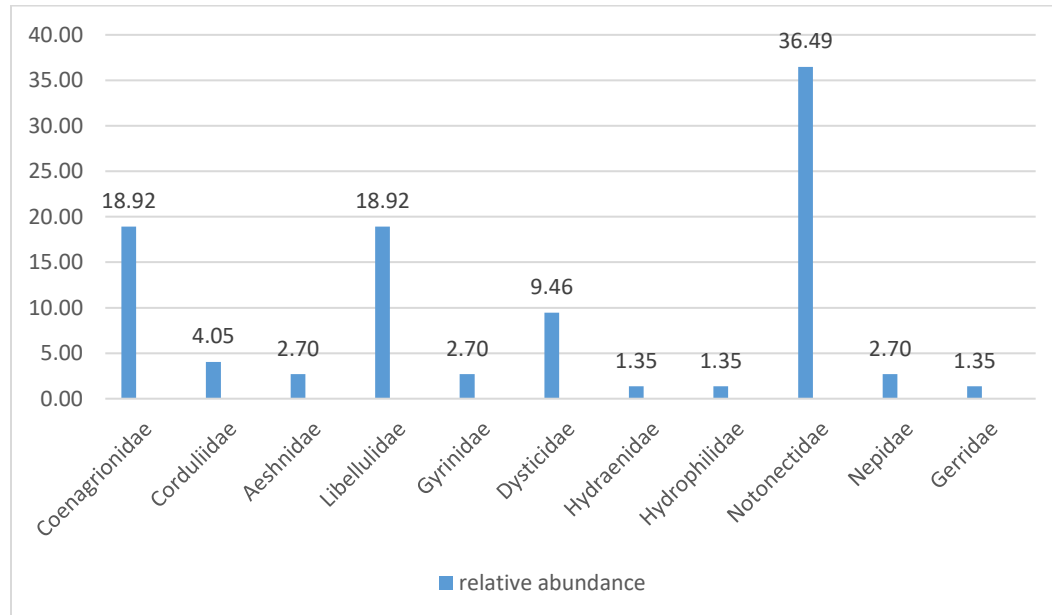


Figure 5: Relative abundance of insect species based on family.

Table 2: Diversity Indices of aquatic insects at different sites.

	site 1	site 2	site 3
Taxa_S	3	3	3
Number of insects.	52	17	5
Dominance_D	0.4386	0.3633	0.36
Simpson_1-D	0.5614	0.6367	0.64
Shannon_H	0.9038	1.055	1.055
Evenness_e^H/S	0.823	0.9574	0.9572

The diversity indices above indicate higher degree of dominance of aquatic insects at site 1 (0.4386) than site 2 (0.3633) and site 3 (0.36). The insects were more abundant at site 1 (52) than site 2 (17) and site 3 (5). However, site 2 and site 3 had higher diversity (1.055) and evenness (0.954) than site 1 (0.9038) and evenness (0.823)

Table 3: Hypothesis Testing using T-test and Two-way ANOVA

N:	3	N:	3		
Mean:	17.333	Mean:	5.666		
95% conf.:	(-12.303 46.)	95% conf.:	-0.495		
Variance:	142.33	Variance:	4.333		
Difference between means:	11.667				
95% conf. interval (parametric):	(-7.7464 31.08)				
95% conf. interval (bootstrap):	(2.3333 24.667)				
t :	1.6686	p (same mean):	0.17053	Critical t value (p=0.05):	2.776
Uneq. var. t :	1.6686	p (same mean):	0.2299		
Monte Carlo permutation:	p (same mean):	0.4022			
Exact permutation:	p (same mean):	0.4			

From table 4 above, the Two-Way ANOVA statistical analysis at 5% showed no significant difference in species diversity and abundance of aquatic insects between the different sites where sampling was done since the calculated t-value (1.6686) was less than the critical t-value (2.776), and the p-value (0.17953 or 0.2299 for significance difference) was greater than the significant level (0.05), this fails to reject the null hypothesis (H₀) and this indicated that the observed differences were likely due to chance.

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATION.

5.1 DISCUSSION.

A total of 74 insect species which were collected using the kick netting technique. This method was efficient enough for collection of these insects from their respective habitats.

Among these insects collected were 3 orders and 11 families of insect species from Odoponyi seasonal stream along the along the stream in Nagongera Subcounty, Tororo District.

The results reflected that there were more insects collected at site 1 than at site 2 and site 3. The aquatic insects were distributed basing on the resources available and habitat favorability along this stream. Aquatic insects of Notonectidae family were more abundant, were they dominated during reduced water levels in the in the stream. This family plays a very significant role in aquatic ecosystems, by reducing rampant spread of malaria preying on mosquito larvae and they are abundant during reduced water levels, slow flowing or stagnant water which is in agreement with Floore, (2007). Aquatic insects of Coenagrionidae family were also more abundant at Site 1 than the remaining Sites sampled. This is because of habitat favorability, where this Site was surrounded by a eucalyptus forest leaves fall in the stream providing a suitable habitat for survival of insects of this family. This is in line with Martens, (2001) who acknowledged that that the dead plant tissue in aquatic habitats are oviposition sites of Coenagrionidae insects. However, some of these insects for example those belonging to Corduliidae and Aeshnidae families are very sensitive to water contamination, as contaminated water is not a favorable habitat for them except the tolerant species that exists irrespective of the level of contamination. This is in line with Vinci et al., (2023), who clearly explained the effect of cultivation practices on aquatic ecosystems as they affect aquatic insect diversity and abundance. The findings of these research are also in agreement with Ferreira et al., (2023) who elaborated on the vulnerability of small streams and limitations in the diversity and abundance of aquatic life within such streams. At site one, the aquatic habitat has not been over disturbed by human activities since its located where the stream transverses a eucalyptus plantation. Therefore there were quite favourable conditions of these insects for survival in addition to the food source that is accessed as the stream keeps on flowing towards the downstream.

However, the Two-Way ANOVA statistical analysis at 5% confidence interval shows no significant difference in the diversity and abundance of aquatic insects in Odoponyi seasonal stream. This therefore fails to reject the null hypothesis. This is not in line with Graf et al., (2023) who found out that undisturbed habitats are rich in abundance and diversity of aquatic insects than the anthropogenic altered habitats of the aquatic insects.

5.2 CONCLUSION

The main aim of this study was to determine the diversity and abundance of aquatic insects in Odoponyi seasonal stream within the selected sites in Nagongera Sub County, Tororo district. However, findings from this research indicate that Site 2 and site 3 had higher diversity and abundance of aquatic insects than Site 1 despite the fact that dominance of insects was higher at site 1 than site 2 and 3. The rate of disturbance of the stream was found to be increasing with reference to the human activities along the stream which include mainly subsistence farming of various agricultural crops like rice, maize and sugarcane.

5.3 RECOMMENDATION

This information will assist stake holders enhance strategies that should be laid down to protect and conserve aquatic biodiversity as a key technique for ensuring complete and effective ecosystem functioning. However, these results require further verification, in terms of duration for collection of aquatic insect samples. Further efforts should be done using other methods, since this research majorly relied on the kick net as the efficient equipment for collection of aquatic samples. I therefore recommend the use of Hydraulic sampling device that generates a suction pressure for pulling the aquatic insects. This will be efficient since some insects are small, others are very fast in escaping for example diving beetles, and a suction pressure can pull them to be captured as samples for investigation of the diversity and abundance of aquatic insects within this stream.

6.0 APPENDIX

Appendix 1. Distribution of aquatic insects in the selected sites of Odoponyi seasonal stream

Order	Family	Sites			Total	
		One (1)	Two (2)	Three (3)		
Odonata	Coenagrionidae	12	1	1	14	33
	Corduliidae	2	0	1	3	
	Aeshnidae	2	0	0	2	
	Libellulidae	11	3	0	14	
Coleoptera	Gyrinidae	1	0	1	2	11
	Dysticidae	1	5	1	7	
	Hydraenidae	1	0	0	1	
	Hydrophilidae	1	0	0	1	
Hemiptera	Notonectidae	18	8	1	27	30
	Nepidae	2	0	0	2	
	Gerridae	1	0	0	1	
Total		52	17	5	74	

Appendix 2: Plates with aquatic insect samples from selected sites of Odoponyi seasonal stream.



Plate 1 and 2: Samples from Site 1, Odoponyi seasonal stream



Plate 3 and 4: Samples from site two, Odoponyi seasonal stream.

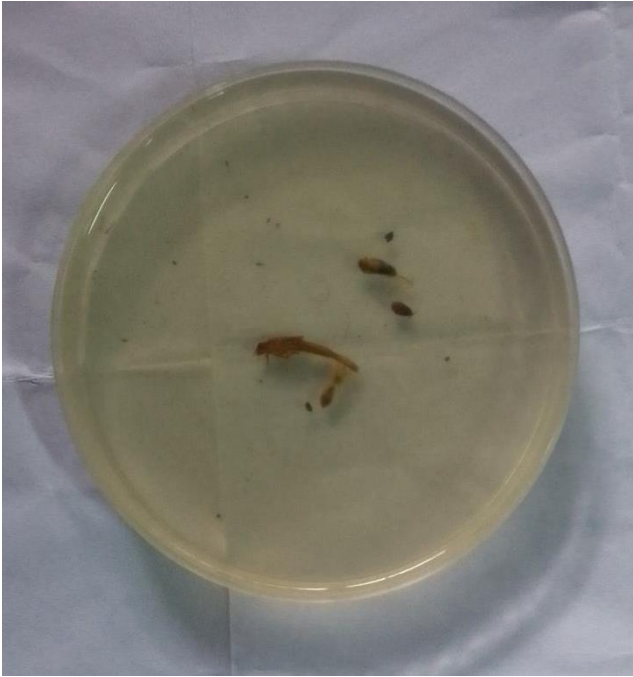


Plate 5: Samples from site 3, Odoponyi seasonal stream.

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