PARASITIC INFECTION IN *Melanoides tuberculanta* FROM IGUEDO COMMUNITY IN OVIA SOUTH WEST LOCAL GOVERNMENT AREA EDO STATE, NIGERIA

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A DISSERTION PRESENTED TO THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE (B.Sc) DEGREE IN THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY, UNIVERSITY OF BENIN, BENIN CITY

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CERTIFICATION

This is to certify that this project work was carried out by Osayande Amber OSAGIODUWA, with Matriculation Number: LSC2103672, of the Department of Animal and Environmental Biology, University of Benin, Benin City, Edo State, Nigeria.

Dr. (Mrs.) O. Edo-Taiwo ______________________________

(Project Supervisor) SIGNATURE and DATE

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(Head of Department) SIGNATURE and DATE

DEDICATION

This project work is dedicated to God Almighty, for bringing me this far in life. I am truly grateful.

ACKNOWLEDGMENT

I want to acknowledge my wonderful project supervisor Dr. (Mrs.) O. Edo-Taiwo for her guidance and support in the course of carrying out my project work. I would also like to extend my heartfelt gratitude to my lecturers Dr. Nosakhare Erhumwnse, Prof. Awaritoma, and other esteemed lecturers in this great Department of Animal and Environmental Biology. I also appreciate my outstanding Head of department Prof. Isioma Tongo for her hard work.

My esteemed regards to my Lovely Parents, MR. & MRS. EMMANUEL OSEMWENGIE, who financially supported my educational pursuit, I say, remain Blessed by God Almighty and to my Wonderful course mates Enoghene, Anthonia, God'swill , Favor, Samuel, Gift and all others for their encouragement and support I love you all. And finally I thank God almighty for his unfailing grace and mercy upon me, I am grateful for how far he has brought me.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF PLATE

ABSTRACT

Snail-borne parasitic infections remain a major public health concern in tropical regions, where freshwater snails serve as intermediate hosts for several trematode parasites. This study investigated the prevalence of parasitic infection in *Melanoides tuberculata* from Iguedo Community in Ovia South-West Local Government Area, Edo State, Nigeria**,** to determine the extent of parasitic infection and highlight its public health implications. Snails were collected from Iguedo River in May and July, 2025. A total of 123 *M. tuberculata* were collected and examined for trematode infection using both cercarial shedding and visceral dissection methods. Out of the 123 snails examined**,** four were infected with an overall infection prevalence of 3.25%**.** Infection was only recorded in May. The larval stages of trematode parasites recovered were rediae and three cercaria types including Cercariaeum, Echinostome and Gymnocephalous cercariae. The cerceriae recovered from the infected snails were released after slight pressure was applied on the rediae mounted on the microscope slide. This study recorded a low prevalence of trematode infection among *M. tuberculata* in Iguedo River, an indication of low level of active transmission during the study period in the area. However, given the high level of human contact with the river for bathing, washing, and fishing**,** there is the possibility of potential risk for transmission of snail-borne parasitic diseases. Therefore, the need for continuous surveillance, environmental management, and health education on safe water use cannot be overemphasized to minimize the risk of infection and safeguard community health.

CHAPTER ONE

1.0 INTRODUCTION

Snails are important components of many terrestrial and aquatic ecosystems, serving as vital links in food webs and contributing to nutrient cycling (Barker, 2001). As primary consumers, they feed on plant materials and detritus, and are in turn eaten by vertebrates and some invertebrate species, thus maintaining ecological balance (Collins, 1991). Importantly, snails serve as intermediate hosts for various parasitic organisms, including trematodes, nematodes, and cestodes, which have complex life cycles that require snails to complete certain developmental stages (Paraense, 1985; Brown, 1994).

Parasitic infection in snails can affect the host's survival, fertility, and behavior, which may influence snail population dynamics and ecosystem function (Lafferty, 1993). Furthermore, some parasites harbored by snails have a direct effect on human and animal health, acting as vectors for diseases such as *schistosomiasis*, a neglected tropical disease caused by trematodes of the genus *Schistosoma* (Rollinson *et al.*, 2013). Understanding the patterns of parasitic infection in snail populations is therefore crucial for both ecological studies and disease control.

1.1 EVOLUTIONARY HISTORY OF SNAILS

The class Gastropoda, which includes snails, evolved from primordial mollusks more than 500 million years ago during the Cambrian epoch. Originally sea creatures, early gastropods were mobile and protected by their coiled shell and torsioned body design (snail-world.com, 2024). They evolved into freshwater, marine, and terrestrial forms over geological time. Significant diversification took place in the Cretaceous period and beyond, with the shift to land snails

(*Stylommatophora* clade) most likely starting in the Late Paleozoic to Mesozoic eras (snail-world.com, 2024; Nature, 2019). According to PLOS One (2016), contemporary freshwater pulmonate snails like *Biomphalaria, Bulinus*, and *Lymnaea* are descendants from marine ancestors that evolved to adapt to freshwater environments. Diversification periods in snail groups often correspond to geological occurrences, including mass extinctions and marine transgressions, which impacted evolutionary radiations, according to molecular phylogenetic analyses and fossil calibrations (Frontier in Environmental Research, 2022; PLOS One, 2016).

1.2 TAXONOMY OF SNAILS

Snails are invertebrate animals that belong to the Phylum Mollusca and the Class Gastropoda, which is the largest class within the Mollusca. Most medically important freshwater snails that act as intermediate hosts for parasitic trematodes belong to the subclass Pulmonata, which includes air-breathing snails, and the order Basommatophora.

Taxonomic Classification:

Kingdom: Animalia

Phylum: Mollusca

Class: Gastropoda

Subclass: Pulmonata

Order: Basommatophora

Families:

Planorbidae e.g. *Biomphalaria* spp.

Lymnaeidae e.g. *Lymnaea* spp.

Thiaridae e.g. *Melanoides* spp.

Examples of medically important snail hosts:

Biomphalariapfeifferi: Intermediate host of *Schistosoma mansoni* (WHO, 2023; Brown, 1994).

Bulinusglobous: Intermediate host of *Schistosoma haematobium* (Rollinson *et al.*, 2001; WHO, 2023).

1.3 BIOLOGY AND MORPHOLOGY OF SNAILS

The Shell

The thick, coiled shell of the snail is made of calcium carbonate and acts as a barrier to keep out predators and environmental dangers. A characteristic of gastropods is their spiral shell shape, which offers strength and compactness. Snails develop shells throughout their lives by producing new material at the shell's aperture. The size, shape, and color of shells vary depending on the species and location (Barnes *et al.*,2004).

Head-Foot

Snails belong to the class Gastropoda, meaning “stomach foot.” The “head-foot” region comprises a muscular foot used for locomotion, allowing snails to glide over surfaces by ciliary movement and mucus secretion. The head features sensory tentacles; typically, two pairs are present in most land snails. The upper pair possesses eyes at their tips or bases, used for light detection and basic vision (Barnes *et al.*, 2001).

Mantle Cavity

The mantle cavity is a significant morphological feature located between the body and shell. It houses respiratory organs: either gills (ctenidia) in aquatic snails or a vascularized lung in terrestrial species (pulmonates). This adaptation allows snails to efficiently exchange gases in their respective environments (Pechenik, 2015).

Radula

The radula is a chitinous, tongue-like structure covered with rows of tiny teeth. It is used primarily to scrape or cut food, allowing snails to feed on a variety of materials, including algae, plant matter, and detritus. The radula's morphology varies greatly among species, correlating with diet (Hickman, *et al.* 2001).

Hermaphroditic Reproductive Organs

Many freshwater snails, especially those in the Pulmonata group, are hermaphroditic—possessing both male and female reproductive organs within a single individual. This reproductive strategy enhances their ability to colonize new or isolated habitats, since any two individuals can mate. Some species can even self-fertilize in the absence of mates (Dillon, 2000).

1.4 ECOLOGY OF SNAILS

Freshwater snails are very adaptable invertebrates that may live in a variety of damp or aquatic settings, including rivers, ponds, lakes, rice paddies, irrigation canals, marshes, and even temporary pools. Their ecological distribution is regulated by both abiotic and biotic variables, making them important biomarkers of freshwater ecosystem health (Brown, 1994).

Habitat Preferences

Snails prefer slow-moving or stationary water bodies with plenty of aquatic vegetation, which serves as both food and protection from predators. The amount of calcium, which they need for shell growth, also regulates their dispersion (Appleton, 2003).

Feeding Habits

Snails are detritivores and grazers that consume algae, biofilms, decaying plant materials, and microbes. Their feeding promotes nutrient recycling and biofilm control in freshwater habitats (Barker, 2001).

Environmental Factors

Environmental factors that have a significant impact on freshwater snail population density and reproductive success include:

a. temperature: Higher temperatures can speed up parasite development while also accelerating metabolism and reproduction.

b. Water hardness and pH: These factors have an impact on shell survival and formation.

c. Aquatic vegetation: Offers food and shelter.

d. Water flow: Strong currents may cause snail populations to decline, whereas moderate flow promotes oxygenation (Sturrock, 1993).

Human-caused Factors

Snail multiplication is frequently facilitated by human activities such as dam construction, urban wastewater discharge, rice farming, and irrigation expansion. By extending the ecological range of host snails, these efforts inadvertently contribute to the development of parasitic illnesses (WHO, 2023; Steinmann *et al*. 2006).

1.5 LIFE CYCLE

Egg Stage: Depending on the species, snails deposit their eggs in gelatinous masses on soil, vegetation, or submerged surfaces. Typically, eggs are protected by a gelly-like sac. Young snails hatch after an incubation period of roughly 7 to 14 days. As their initial feeding source, hatchings frequently eat their eggshell and even other snail eggs (Vedantu, 2025).

Juvenile Stage: Hatchings are smaller than adults and create their shells as they grow. Before they reach full size, juveniles may go through multiple juvenile Stages and engage in active feeding. Juvenile Stage growth rates and duration differ depending on the species and environment. For example, before becoming adults, juvenile of the African giant snail (*Achatinafulica*) go through three juvenile Substages over a period of weeks, during which they build shell rings (Roobak *et al*. 2018).

Adult Stage: Depending on the species and habitat, adult snails usually attain sexual maturity in a few months to a year or so. The cycle is completed when adult procreate and lay eggs (FAO, 1998).

1.6 RELEVANCE/IMPORTANCE OF SNAILS

Edible Resource and Aquaculture: Certain species of snails, such as the African giant snail, are widely farmed for food. Snail farming is a profitable agribusiness, offering high nutritional value (rich in protein, low in fat, and containing minerals like calcium and iron), and thus contributes to household income and food security in many regions, especially in Africa.

Waste Recycling: Snails can recycle organic waste by converting it into valuable nutrients, making them beneficial in sustainable food and feed production systems.

Medical Importance

a. Vectors for Disease: Aquatic snails act as intermediate hosts for several parasitic flatworms responsible for diseases such as *schistosomiasis* and fascioliasis. These diseases significantly impact human and animal health, leading to chronic illness and organ damage in some cases.

b. Pharmaceutical Potential: Marine snails (e.g., cone snails) produce bioactive compounds like conotoxins, which have potent analgesic effects and are under investigation as new classes of painkillers and other drugs due to their unique neuroactive properties.

c. Traditional and Modern Uses: Snail slime is utilized in traditional medicine for its anti-inflammatory, antioxidant, and skin-healing properties and is included in various cosmetics and therapeutic applications.

Research Models

a. Neurobiology and Toxicology: Snails, particularly species like *Lymnaeastagnalis*and marine cone snails, are widely used as model organisms in neuroscience and toxicological research. Their relatively simple and accessible nervous systems allow detailed study of neuronal function, learning, memory, and the effects of toxins. Insights from snail research have contributed to understanding aging, memory loss, neurodegenerative diseases (such as Parkinson's and Alzheimer's), and environmental toxicity.

b. Genetic and Biomedical Studies: The genetic and physiological similarities of certain neurobiological processes between snails and higher organisms make them valuable in translational research and in the identification of novel therapeutic targets.

1.7 SNAILS AS INTERMEDIATE HOSTS

Snails play a critical role as intermediate hosts in the life cycles of many trematode (fluke) parasites, particularly those causing significant human and veterinary diseases. In this role, the snail harbors larval stages of the parasites, allowing them to undergo asexual reproduction and development before becoming infectious to the definitive host (typically humans or animals).When eggs of trematodes such as *Schistosoma* spp. or *Fasciola hepatica* are released into freshwater environments through the feces or urine of infected hosts, they hatch into miracidia. These miracidia actively seek and penetrate suitable snail hosts. Inside the snail, they develop into sporocysts, then into rediae (in some species), and finally produce cercariae—the free-swimming larval stage that exits the snail to infect the next host (WHO, 2023; Rollinson *et al.*, 2001).

Examples:

Biomphalaria and *Bulinus* snails are intermediate hosts for *Schistosoma mansoni* and *Schistosoma haematobium*, respectively.

Lymnaea spp. snails are intermediate hosts for *Fasciola* hepatica, which causes liver fluke infections in humans and livestock. The transmission and prevalence of these diseases are heavily dependent on the presence, abundance, and infection status of snails in the environment. Consequently, controlling snail populations is a major strategy for interrupting the transmission of these parasitic diseases.

1.8 Lifecycle/Larval Stage of Trematode

The trematode lifecycle is a complex process involving multiple hosts and distinct larval stages. It typically begins with an egg that hatches into a free-swimming larva, which then undergoes asexual reproduction within intermediate hosts before maturing into the adult form in a definitive host. Most trematodes, also known as flukes, have a three-host lifecycle.

1.8.1 Egg: Eggs are released into the environment. Depending on the species, they may hatch in water or be ingested by a host.

1.8.2 Miracidium: The miracidium is the first larval stage, hatching from the egg. It's a free-swimming, ciliated larva that must quickly find and penetrate a specific snail host. It doesn't feed and has a short lifespan of a few hours to a day, so it relies on its cilia and sensory organs to locate its target (Roberts *et al*., 2009)

1.8.3 Sporocyst: Once inside the snail, the miracidium transforms into a sporocyst. This sac-like stage lacks a digestive system and absorbs nutrients directly from the snail's tissues. The sporocyst undergoes extensive asexual reproduction, producing either a new generation of sporocysts (daughter sporocysts) or the next larval stage, the rediae (Garcia and Bruckner, 2001).

1.8.4 Redia: The redia emerges from the sporocyst. It's a more developed larva with a mouth and a simple gut, allowing it to actively feed on the snail's tissues, including other parasites. Like the sporocyst, the redia also reproduces asexually, generating either more rediae or the next stage, the cercariae (Roberts *et al.* 2009).

1.8.5 Cercaria: The cercaria is a free-swimming, tailed larva that emerges from the snail. Its form is tailored for finding the next host. They can have a variety of tail shapes for propulsion in water and are equipped with suckers and penetration glands to infect a second intermediate host. In some species, like *Schistosoma*, the cercaria directly penetrates the skin of the definitive host (humans) (Garcia and Bruckner, 2001).

1.8.6 Metacercaria: When the cercaria finds and infects a second intermediate host, it loses its tail and encysts within the host's tissues, forming a metacercaria. This is the dormant, infective stage for the definitive host. The hard cyst wall protects the parasite until the infected host is consumed. Upon ingestion, the metacercariaencysts in the definitive host's intestine and matures into the adult fluke (Roberts *et al*. 2009).

1.8.7 Adult Fluke: The final larval stage is ingested by the definitive host, where it matures into an adult and reproduces sexually.

1.9 JUSTIFICATION OF THE STUDY

Parasitic infections in snails are a critical link in the transmission of several human and animal diseases, particularly those caused by trematodes such as *Schistosoma* and *Fasciola* species. These diseases are endemic in many tropical and subtropical regions, including parts of sub-Saharan Africa, due in part to the widespread distribution of infected freshwater snails (WHO, 2023; Chitsulo *et al*. 2000).The justification for this study lies in the urgent need to understand the parasitic dynamics within snail populations. By identifying infected snail species and their distribution, we gain valuable insight into local transmission patterns. Such information is essential for designing evidence-based snail control strategies, such as mollusciciding, environmental management, or biological control, which ultimately help reduce the disease burden (Rollinson *et* *al.*, 2001).Additionally, climate change, water resource development (e.g., dams, irrigation), and urban expansion have created favorable habitats for snails, increasing human contact with infected waters (Steinmann *et al.*, 2006). Thus, targeted surveillance and snail population monitoring become crucial.

1.10 Aim and Objectives

The aim of this study was to investigate the prevalence of parasitic infection in *Melanoides tuberculanta* from Iguedo Community in Ovia South West LGA, Edo State, Nigeria.

The objectives of the study were to;

1. determine the prevalence of parasitic infections in *Melanoides tuberculata* from Iguedo River; and
2. determine the type of the parasite species infecting *Melanoides tuberculata* from Iguedo River.

CHAPTER TWO

2.0 LITERATURE REVIEW

Snails, terrestrial, freshwater, or marine, play great roles in the life cycles of many parasites, especially trematodes, nematodes, and other helminths. Globally, research on parasitic infections in snails has been carried out across diverse habitats, revealing their significance in disease ecology. In Nigeria, also, snail-borne parasites are important both medically and ecologically. Review on global and Nigerian literature on parasitic infections in snails, from recent studies to show patterns, gaps, and implications, was carried out in this chapter.

2.1 Global Parasites Infection in Snails

Globally, parasitic infections in snails show a complex lifecycle of many parasites, with some having serious veterinary and public health consequences.

2.1.1 TERRESTRIAL SNAILS

In 2022, Silvana *et al*. carried out a comprehensive review on the parasitic infection of terrestrial gastropods by medically important nematodes in Brazil**.** The researchers analyzed results from parasitological testing of terrestrial mollusk samples submitted to the Brazilian National Reference Laboratory for Schistosomiasis and Malacology (LRNEM) between 2008 and 2021. A total of 1,919 service orders were registered during this period, comprising 19,758 snail and slug specimens collected from 23 out of 26 Brazilian states, including the Federal District. Out of these, 16,750 specimens were successfully examined for nematode infections, as some specimens had died prior to arrival and could not be tested. The study investigated multiple mollusk species, including *Achatina fulica*, *Bulimulus tenuissimus*, *Bradybaena similaris*, *Sarasinula linguaeformis*, *Leptinaria unilamellata*, *Subulina octona*, *Cyclodontina fasciata*, *Megalobulimus dryades*, *Diplosolenodes occidentalis*, *Ovachlamys fulgens*, and *Succinea meridionalis*, among others. *A. fulica* accounted for the majority of specimens examined (14,887), followed by *B. tenuissimus, B. similaris,* and *S. linguaeformis*. The parasitological analysis revealed the presence of larval forms of nematodes, particularly *Aelurostrongylus abstrusus*, as well as free-living nematode forms, in 952 positive samples (46.34%). *Angiostrongylus cantonensis* was recovered from 252 service orders, with the majority (95.24%) obtained from *A. fulica*. Overall, *A. cantonensis* was detected in five species and one genus, including *S. linguaeformis* (7.41%), *B. similaris* (8.82%), *Subulina octona* (11.11%), *Sarasinula* sp. (5.00%), and *C. fasciata* (14.29%). For *A. fulica*, the detection of *A. cantonensis* represented 15.51% of all samples examined in this species (n = 240/1,547). Additionally, *A. abstrusus* was identified in 145 service orders and was consistently recorded throughout the study period. A notable rise in positive cases of *A. cantonensis* was observed after 2013, coinciding with the adoption of molecular diagnostic techniques at the LRNEM. The study concluded that terrestrial mollusks, particularly *A. fulica*, played an important role in the transmission of medically significant nematodes (*A. cantonensis* and *A. abstrusus*) in Brazil. The interaction between mollusks and nematodes highlights the epidemiological importance of monitoring these parasites. The authors emphasized the necessity for continued studies, improved diagnostic approaches, and the implementation of preventive and control measures, especially in urban areas where synanthropic and exotic mollusks were commonly found.

Earlier evidence by Thiengo *et al*. (2007) had already established the first confirmed record of *A. cantonensis* in *A. fulica* in Brazil. This landmark study was significant in linking the invasive spread of *A. fulica* with zoonotic transmission risks. While Thiengo's findings were primarily confirmatory, the broader survey by Silvana *et al*. (2022) expanded on this by quantifying infection prevalence across multiple mollusk species and highlighting the broader public health implications at a national scale. Rodrigues *et al*. (2020) further advanced this understanding within Rio de Janeiro State, where 14 mollusk species were surveyed, including *A. fulica, Bradybaena similaris*, and *Sarasinula linguaeformis*. Their findings revealed that 8.8% of mollusks were naturally infected with *A. cantonensis*. Although this prevalence was lower than the national figures reported by Silvana *et al*. (2022), the detection of infections across multiple host species reinforced the broad ecological role of terrestrial snails in sustaining transmission cycles. Moreover, *A. fulica* was detected in 22 municipalities, underscoring its dominance as an invasive host and vector in the region.

Beyond South America, similar patterns have been reported in Asia. Lv *et al*. (2009) documented natural infections of wild *A. fulica* with *A. cantonensis* in China. Crucially, these infections were directly linked to outbreaks of eosinophilic meningitis in humans, thereby establishing a clear epidemiological connection between invasive snail populations and human disease. Comparable to the Brazilian data, this study demonstrated that *A. fulica* is a critical host species wherever it becomes established. In South Korea, Kim *et al*. (2014) extended the scope of investigation by showing that terrestrial mollusks can harbor more than one zoonotic nematode. Their study found that land snails and slugs were infected with both *A. cantonensis* and *Parastrongylus costaricensis*. This finding significantly broadens the public health implications, suggesting that terrestrial snails are not restricted to transmitting a single parasite but may serve as intermediate hosts for multiple nematode species simultaneously.

African studies provide additional evidence of the epidemiological importance of terrestrial snails. Otarigho and Morenikeji (2012) examined *Achatina achatina* and *A. fulica* in Nigeria, reporting variable infection rates across sites. Parasitic larvae, including larval strongylids, were detected in edible snails, raising dual concerns of zoonotic transmission and foodborne infection, given the widespread consumption of snails in West Africa. Similarly, Akinwale *et al*. (2015) documented the presence of nematode larvae of medical importance in terrestrial snails from rural and peri-urban Nigerian communities. They stressed the importance of routine surveillance, particularly in regions where snail harvesting and consumption form an integral part of cultural practices.

Taken together, these studies reveal a consistent global pattern: invasive and synanthropic terrestrial snails, particularly *A. fulica*, are repeatedly implicated as important hosts for zoonotic nematodes. While prevalence rates vary depending on geography, host species, and diagnostic methods, the recurrent identification of *A. cantonensis* in Brazil, China, and Korea, alongside the detection of other zoonotic nematodes in Africa, underscores the worldwide public health risk posed by snail-borne infections. These findings reinforce the need for continuous monitoring, integrated snail control strategies, and widespread community education to mitigate the risks associated with terrestrial snail–nematode interactions.

2.1.2 Freshwater Snails

A study was carried out by Mohammad on The parasitic fauna of freshwater snails in central Iraq in 2015. He conducted a year-long survey; seven species of freshwater snails were collected monthly from local irrigation channels in central Iraq. *Melanopsis praemorsa*, *Melanoides tuberculata*, *Radix* sp. *Bellamya bengalensis*, *Physella acuta*, *Theodoxus jordani*and *Gyraulus huwaizahensis* were examined for the natural parasitic infection in central Iraq. The findings indicated that *Melanoides tuberculata* was a significant host, with an infection rate of 32.9%, shedding echinostome-type cercariae. Interestingly, the closely related thiarid snail, *Melanopsis praemorsa*, exhibited an even higher infection prevalence of 57.4% and hosted four different types of cercariae. *Radix* sp. with rate of 16.4%, *B. bengalensis* with rate of 8.2% and finally *Physellaacuta* with rate of 0.34%. No cercariae were shed from *T. jordani* and *G. huwaizahensis*. Although he examined 4 freshwater snail Species in Al-Husseinia creek, Kerbala Province, middle of Iraq, he got cercariae from *M. nodosa* (*praemorsa*) only with Infection rate of 27.98%. He concluded that thiarid snails are the dominant intermediate hosts for trematodes in the region's aquatic ecosystems and that host specificity and suitability can lead to vastly different infection dynamics even among co-occurring snail species.

Providing a broader continental perspective, the review by Allan *et al*. (2020) on the work of the Schistosomiasis Consortium for Operational Research and Evaluation (SCORE) program highlighted a renewed interest in snail-focused interventions. The SCORE program investigated several snail-related control strategies across Africa. These included xeno monitoring (the use of molecular techniques to detect parasite DNA in snails, including prepatent infections), focal mollusciciding with niclosamide in Zanzibar and Côte d'Ivoire, and explorations of biological control using native river prawns and the invasive Louisiana crayfish. A key takeaway from the SCORE program's snail-related work is that while traditional methods like cercarial shedding can detect transmission, they often miss the large burden of pre-patent infections, which can be revealed by molecular tools like PCR. This confirms that snail infection rates are often much higher than previously thought, reinforcing the importance of snail surveillance and control in the push towards schistosomiasis elimination.

A study on the spatial and seasonal distribution, abundance, and infection rates of human schistosomiasis intermediate host snails and interactions with other freshwater snails, water physicochemical parameters, and climatic factors was carried out by Nwonko *et al*. They carried out a longitudinal malacology survey at seventy-nine sites in seven districts in KwaZulu-Natal province between September 2020 and August 2021. A total of 15,756 snails were collected during the study period. Eight Freshwater snails were found: *Bulinusglobosus* (n= 13Providing a broader continental perspective, the review by Allan *et al*. (2020) on the work of the Schistosomiasis Consortium for Operational Research and Evaluation (SCORE) program highlighted a renewed interest in snail-focused interventions. The SCORE program investigated several snail-related control strategies across Africa. These included xenomonitoring (the use of molecular techniques to detect parasite DNA in snails, including prepatent infections), focal mollusciciding with niclosamide in Zanzibar and Côte d'Ivoire, and explorations of biological control using native river prawns and the invasive Louisiana crayfish. A key takeaway from the SCORE program's snail-related work is that while traditional methods like cercarial shedding can detect transmission, they often miss the large burden of prepatent infections, which can be revealed by molecular tools like PCR. This confirms that snail infection rates are often much higher than previously thought, reinforcing the importance of snail surveillance and control in the push towards schistosomiasis elimination.96), *Biomphalariapfeiferi* (n= 1130), *LymnaeaNatalensis* (n= 1195), *Bulinustropicus* (n= 1722), *Bulinusforskalii* (n= 195), *Tarebiagranifera* (n= 8078), *Physaacuta* (n= 1579), and *Bivalves* (n= 461). The infection rates of *B. globosus* and *B. pfeiferi*are 3.5% And 0.9%, respectively. In the study, rainfall, pH, type of habitats, other freshwater snails and seasons influenced the distribution, abundance, and infection rates of human *schistosomiasis* intermediate host snails (*p-value*< 0.05). The fndings provided useful information which can be adopted in designing and andimplementing snail control strategies as part of *schistosomiasis* control in the study area.

2.1.3 Marine Snails

Marine snails (class Gastropoda) constitute an ecologically and economically important group of mollusks inhabiting oceans and estuarine ecosystems worldwide. They serve as grazers, scavengers, and prey for a wide range of marine organisms, thus playing critical roles in the balance of marine food webs (Strong *et al*., 2017). However, beyond their ecological importance, marine snails are known to act as intermediate or definitive hosts for several parasites, particularly trematodes and nematodes, which may have significant consequences for biodiversity, aquaculture, and human health.

Parasitic infections in marine snails are well-documented, especially trematode infections. Trematodes (class Digenea) require mollusks, particularly gastropods, as their first intermediate hosts in complex life cycles that may involve fish, crustaceans, birds, or mammals (Cribb *et al*., 2001). Infected marine snails often display castration, morphological changes, and behavioral modifications due to parasite-induced pathology, which may have cascading ecological effects on host populations and community structures (Koprivnikar and Poulin, 2012). For instance, *Cerithidea cingulata* and *Pirenella conica*, two estuarine marine snails from Asia, have been reported to host trematodes of medical and veterinary importance such as *Heterophyidae* and *Opisthorchiidae*, which cause foodborne zoonoses in humans consuming raw or undercooked fish (Chontananarth and Wongsawad, 2013).

Globally, several studies have highlighted the diversity of trematode infections in marine snails. In New Zealand, Poulin and Mouritsen (2006) reported high infection rates of intertidal snails, particularly *Zeacumantus subcarinatus*, by multiple trematode species, showing how parasite prevalence can shape snail population dynamics. Similarly, in the Persian Gulf and Gulf of Oman, *Cerithidea cingulata* was identified as a host for trematodes such as *Heterophyes heterophyes* and *Stictodora spp.*, both of which are known to infect humans (Dobaradaran *et al*., 2016). Studies in Brazil have also identified trematodes infecting marine snails such as *Littoraria angulifera*, with implications for both wildlife health and the potential transmission of zoonotic parasites (Carmo and Cohen, 1993).

Parasitic infections in marine snails are not restricted to trematodes alone. Nematode larvae, cestodes, and protozoans have also been found in various snail species. For example, marine snails belonging to the family Littorinidae are known to harbor protozoan parasites such as *Perkinsus spp.*, which are important pathogens in mollusks and may impact shellfish aquaculture (Villalba *et al*., 2004). Additionally, marine snails can act as hosts for *Angiostrongylus cantonensis* (rat lungworm), a zoonotic nematode of considerable public health concern, though its prevalence is better documented in terrestrial and freshwater snails. Nonetheless, the potential for marine snails to harbor such parasites in coastal regions with human interaction remains a concern (Prociv and Turner, 2018).

The ecological consequences of parasitic infections in marine snails are significant. Heavy infections can lead to parasitic castration, where the reproductive capacity of the snail is entirely diverted towards supporting parasite development (Lafferty, 1993). This can reduce snail recruitment, alter population dynamics, and influence the community structure of intertidal ecosystems. Furthermore, the high prevalence of trematode infections in marine snails has been linked to habitat features such as bird migration routes, since seabirds often act as definitive hosts in the parasite life cycle (Mouritsen and Poulin, 2002). For instance, in Danish coastal waters, intertidal snails such as *Hydrobia ulvae* showed high infection rates with trematodes due to the presence of migratory shorebirds (Køie, 1992).

From a public health perspective, the role of marine snails in the transmission of foodborne trematodiases is increasingly recognized. In Southeast Asia, infections such as heterophyiasis and opisthorchiasis have been linked to consumption of raw or insufficiently cooked seafood carrying infective larval stages (metacercariae) originating from trematode-infected snails (Sripa *et al*., 2010). While freshwater snails are the most notorious vectors of schistosomiasis, marine and brackish water snails significantly contribute to other neglected tropical diseases that remain endemic in coastal regions of Asia, Africa, and South America.

2.2 Parasitic Infection in Nigeria Snails Species

2.2.1 Terrestrial Snails

In 2016, Igbinosa *et al*. conducted a study on the parasites of edible land snails in Edo State, Nigeria.A total of 272 snails were examined across four major towns which include Benin, Uromi, Ekpoma, and Auchi during the dry and rainy seasons. The species examined included *Achatina achatina, Achatina fulica, Archachatina marginata, Limicolaria aurora, Limicolaria flammea, and Limicolariaopsis* sp. The internal organs and feces of the snails were examined for parasites.More than half of the snails collected during the rainy season tested positive for at least one parasite species. *Limicolariopsis* sp. was restricted to Ekpoma, while the other species were collected across all study sites. Four different parasites were identified in the snails. Notably, motile larvae of *Strongyloides stercoralis* were observed in all positive organs, with 65% being L2 larvae, 20% L1, and 15% L3. Sporocysts o*f Fasciola gigantica* and *Schistosoma mansoni* were detected in the intestine. Among the parasites, *S. stercoralis* was the most frequently isolated, which the researchers attributed to its abundance in soil and its ability to locate snail hosts via chemical cues (Safer *et al*., 2007).The study confirmed the role of land snails as intermediate hosts for several parasites, with *Strongyloides stercoralis* being the most prevalent. The findings highlighted the public health risk of consuming undercooked snails, since transmission of these parasites could negatively impact both human and animal health.

In 2023, Okwa *et al*. (2023**)** investigated the prevalence and diversity of parasites in edible land snails across selected locations in Nigeria. The findings revealed that 36 of the examined land snails were infected with parasites**,** with 66.7% of infections recorded in reared snails and 33.3% in wild snails. Three parasite species were identified: *Strongyloides stercoralis* larvae, which were the most prevalent (38.9%), followed by *Angiostrongylus cantonensis* (22.2%) and *Dicrocoelium dendriticum* (5.6%). Among the snail species examined, *Archachatina marginata* exhibited the highest infection rate (50%), harboring more parasites in both the slime and intestinal tract compared to other species. Conversely, *A. fulica* showed the lowest infection rate at 16.7%. The study also noted that more parasites were found in the slime (66.7%) than in the intestine (33.3%). Further analysis revealed that 58.3% of reared snails and 83.3% of wild snails had parasites in their slime, while 41.7% of reared snails and 16.7% of wild snails had parasites in their intestine. These results underscore the potential public health risk associated with consuming raw or undercooked snail meat, as parasite transmission may occur through direct contact with contaminated slime or ingestion of infected tissues (Okwa *et al*., 2023).

Building on these insights, Mbah *et al*. (2022) examined the parasitic profile of five species of terrestrial *Achatina* snails *A. achatina*, *A. fulica*, *A. marginata*, *Achatina* sp., and *Archachatina* sp. in Cross River State, Nigeria. A total of 200 snails were collected from local markets and farmlands, with their internal organs and hemolymph screened for helminths and protozoans. The study reported an overall prevalence of 42.5%**,** identifying *Strongyloides stercoralis* (28.5%) and *Aelurostrongylus abstrusus* (15.0%) as the dominant nematodes, along with trematode sporocysts resembling *Fasciola hepatica*. The highest infection rate was found in *A. fulica* (52%), attributed to its invasive nature and foraging habits in contaminated environments. The study highlighted the zoonotic potential of these parasites, stressing that consumption of inadequately cooked snails or contact with their slime could facilitate parasite transmission to humans. Public awareness campaigns promoting hygienic handling and thorough cooking of snail meat were recommended to mitigate infection risks (Mbah *et al*., 2022).

Similarly, in Lagos Metropolis**,** Afolabi *et al*. (2023) conducted a study to assess the parasitic fauna of edible land snails sold in open markets. A total of 180 snails, predominantly *A. fulica* and *A. marginata*, were examined, revealing an overall prevalence of 38%**.** Detected parasites included *Strongyloides* larvae (18%) and *Capillaria* spp. ova (12%), as well as protozoan cysts of *Entamoeba* species in fecal samples. Seasonal variations were observed, with higher infection rates during the wet season, which the researchers associated with flooding and poor sanitation conditions that favor parasite development and transmission. The authors emphasized the need for veterinary inspection of market-sourced snails to prevent foodborne parasitosis and reduce health risks among urban consumers (Afolabi *et al*., 2023).

In Akure Metropolis, Ondo State**,** Awosolu *et al*. (2021) investigated *Archachatina marginata* as an intermediate host for intestinal parasites. Out of 120 snails examined, 45% were found to harbor parasites**,** with nematodes—specifically *Strongyloides* and *Ascaris lumbricoides* larvae—constituting 30%, and trematodes accounting for 15% of infections. The study highlighted the role of *A. marginata* in maintaining zoonotic transmission cycles in peri-urban areas where human and livestock waste frequently contaminate snail habitats. The researchers proposed the use of eco-friendly molluscicides and improved sanitation to control infection spread and reduce exposure risk (Awosolu *et al*., 2021).

Collectively, these studies highlight the significant epidemiological role of terrestrial snails in Nigeria as reservoirs and intermediate hosts for a wide range of parasitic organisms. Across different regions, *Strongyloides stercoralis* consistently emerged as the most prevalent parasite species, reflecting its wide ecological adaptability. Environmental conditions such as seasonality, sanitation level, and habitat type greatly influence infection dynamics in snail populations. The findings underscore the importance of public health interventions**,** including improved sanitation, health education, and food safety practices, to curb the transmission of snail-borne parasitic infections. Proper handling, thorough cooking of snail meat, and routine monitoring of snail farms and market supplies remain crucial preventive measures against zoonotic parasitoses in Nigeria.

2.2.2. Freshwater Snails

Around September 2018 and October 2019, Naphtali S.R. *et al*. conducted a study on the population dynamics, ecology, and infection rate of freshwater snails in northern Nigeria.The study was carried out in Kiri Dam and Shelleng water bodies. Monthly variations of physicochemical parameters—including dissolved oxygen, alkalinity, pH, conductivity, temperature, transparency, and depth—were measured. Snails were collected monthly and examined for cercariae shedding in the research laboratory using a dissecting microscope. A total of 769 snails were examined, belonging to five species: *Melanoides tuberculata, Bulinus globosus, Bulinus truncatus, Bulinus forskalii,* and *Biomphala riapfeifferi.* The overall infection rate was 24.5%. Among the species, *B. truncatus* had the highest infection (64.4%), followed by *B.* globosus (42.4%), while *B. forskalii* recorded the lowest (4.1%).Seasonal variations were observed: the highest snail abundance occurred in June (20.5%), followed by May (13.5%) and July (13.4%), while the lowest was in December (2.5%). *B. truncatus* showed the highest abundance across several months (up to 52.6%), followed by *B. globosus*, while *M. tuberculata* had the least abundance (1.4%).Physicochemical analysis revealed a significant relationship ($p<0.05$) between snail abundance and alkalinity, dissolved oxygen, pH, and temperature, but no significant relationship with turbidity and conductivity. The ecological ranges observed were: alkalinity (4.6–11.3 mg/L), dissolved oxygen (5.1–16 mg/L), and pH (2.0–7.9), which aligned with previous studies (Gabriel *et al*., 2014; Obande *et al*., 2012; Usman *et al*., 2017).The study concluded that physicochemical parameters strongly influence freshwater snail population dynamics and infection rates, with Bulinus species being the most abundant and infected. The abundance of intermediate host snails and their infection with cercariae suggest an increased risk of schistosomiasis transmission in the area. The findings also emphasized the role of ecological factors and local socio-cultural practices in promoting the persistence and spread of snail-borne diseases.

Aisen *et al*. (2025) carried out a study on freshwater snails in *schistosoma* endemic communities. Ovia South-West Local Government Area of Edo State in Nigeria. A year-long freshwater snail survey was conducted in seven localities (Aden, Igbogor, Ikoha, Okopon, Okponha, Siluko, and Ugbogui) in Ovia South-West to determine the snail diversity and identify species that are intermediate hosts for schistosomiasis. A total of 468 snails, representing species in four genera (*Bulinus*, *Lanistes*, *Melanoides*, and *Radix*) were collected. five snails, B. *forskalii*, *B. globosus*, *B. truncatus*, L. *varicus*, and *M. tuberculata*. A snail, *Radix*, could not be identified at the species level. *Melanoides tuberculata* was the most abundant snail and the only species identified in all sampled locations (n = 284, 60.68%). The next abundant species was *Radix* sp. (n = 106, 22.65%), followed by *B. globosus* (n = 42, 8.97%). The least abundant snail was *B. truncatus* (n = 5, 1.07%). At Siluko, all species of snails were present, and only *M. tuberculata* in Ugbogui. All species of snail was seen in both dry and wet seasons, 297 snails were collected in the wet season and in the dry season 171snails were collected. Similar snail diversity occurred in each sampling location in both seasons, with more individuals of each species collected during the wet season. The only infected snail was a single Radix sp. in Siluko that shed *brevifurcate-apharyngeate distome furcocercariae***.** All other snail species were uninfected. The study revealed the first time in Edo State, snail vectors of *schistosomiasis* were reported but were uninfected with *Schistosoma* parasite. The *brevifurcate-apharyngeate distome furcocercariae* from the Radix sp. Had conspicuous eye spots that suggest it is not a *Schistosoma* sp.

2.2.3 Marine Snails

Marine and brackish water snails play an important ecological and epidemiological role as intermediate hosts for trematodes and other parasitic organisms in aquatic environments. In

Nigeria, several studies have documented the prevalence and diversity of parasitic infections in marine snail species, particularly in the Niger Delta and other coastal regions.

In 2011, Awharitoma and Aisien (2011) conducted an extensive investigation on larval trematodes occurring in the brackish water periwinkle *Tympanotonus fuscatus* from the Niger Delta, Nigeria. A total of 4,429 snails were examined across six water bodies, namely Elume River, Sapele River, Warri River, Koko River, Escravos River, and Ilaje River. The study focused on *T. fuscatus* and *Potadoma moerchi*, where the internal body parts were dissected and examined under a microscope in normal saline for parasitic stages. The overall prevalence of trematode infections was reported as 4.18%, corresponding to 185 infected snails. Interestingly, infections were observed only in *T. fuscatus*, while *P. moerchi* showed no infection.

Site-specific infection rates revealed variations across the sampled rivers: 15.7% in Koko River, 4.9% in Sapele River, 4.8% in Warri River, 3.4% in Escravos River, 2.8% in Elume River, and 1.3% in Ilaje River. The study identified four cercarial morphotypes: gymnocephalous (widespread in five locations), xiphidiocercariae (indicative of *Microphallus* species), furcocercous (found in four sites), and echinostome (restricted to Sapele River with a prevalence of 3.1%). The researchers also observed rediae and sporocysts. Experimental observations revealed that echinostome cercariae encysted and produced juvenile echinostomatid worms within one week at 37°C, while gymnocephalous metacercariae developed into unidentified juveniles after seven weeks but failed to infect ducklings. Among the identified parasites, gymnocephalous cercariae were the most frequently encountered, which was attributed to the favorable environmental conditions in brackish waters that support the life cycle of trematodes. This study thus confirmed *T. fuscatus* as a significant intermediate host for multiple trematode species and highlighted the potential ecological and public health impacts of such infections (Awharitoma and Aisien, 2011).

Building on these findings, Oriakpono and Jaja (2022) investigated heavy metal concentrations and associated parasitic infections in the periwinkle *T. fuscatus* from the Warri River, Nigeria. A total of 120 snails were collected between January and March, and their internal tissues, along with detected parasites, were analyzed for heavy metal content. The study reported an infection rate of 8.3% (10 infected snails), distributed as 2% in January, 3.3% in February, and 3.3% in March. The parasites identified included nematodes and cercariae. Remarkably, the researchers observed higher bioaccumulation of certain heavy metals such as cadmium (0.03–0.49 mg/kg) in the parasites than in their snail hosts, while lead, copper, and manganese were more concentrated in uninfected snails. They attributed the increased susceptibility of the snails to parasitic infections to pollution-induced immunosuppression, suggesting a link between environmental contamination and parasitism. The findings also raised concerns about public health risks, as some metal concentrations exceeded permissible limits, posing potential dangers to consumers of *T. fuscatus* harvested from polluted environments.

More recently, Elegbede *et al*. (2023) carried out a nutritional and biochemical analysis of the gastropods *Pachymelania aurita* and *Tympanotonus fuscatus* sold in local markets within Calabar, Cross River State, Nigeria. Although the primary focus was on proximate composition, mineral content, carotenoid levels, and trypsin inhibitor activity, the study also raised concerns about possible contamination and parasitic infections in these commonly consumed species. The researchers emphasized that high consumption rates of these gastropods in the Niger Delta region could expose consumers to undetected parasites and toxins. They referenced previous incidental reports that found helminth infections in less than 5% of similar gastropod samples from estuarine environments. *P. aurita* demonstrated higher mineral content compared to *T. fuscatus*, but was also associated with potential bioaccumulation risks. The study concluded with a strong recommendation for adequate thermal processing (cooking) and routine parasitological screening to mitigate zoonotic risks associated with the consumption of brackish water snails.

Collectively, these studies underscore the significance of marine and brackish snails such as *T. fuscatus* and *P. aurita* as intermediate hosts for trematodes and other parasites in Nigeria. Reported prevalence rates across different studies ranged from 1% to 16%, reflecting the influence of environmental factors such as pollution, salinity, and hydrological conditions on infection dynamics. The reviewed studies also highlight the public health implications of consuming inadequately processed gastropods from contaminated aquatic environments. Therefore, stringent environmental management, pollution control, and public awareness on proper handling and cooking practices are essential in minimizing the transmission of snail-borne parasitic infections to humans and livestock in coastal communities.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was carried out in Iguedo, a rural community located in Ovia South-West Local Government Area, Edo State, Nigeria. The community lies within the humid tropical rainforest belt of Southern Nigeria and is characterized by rich biodiversity and extensive freshwater systems. Iguedo village covers an approximate area of 2,803 km². The snails were collected from Iguedo River (06.7170°N, 005.3696°E), which serves as a primary source of drinking, washing, and bathing water for the inhabitants. Human activities such as laundry, bathing, and fishing often take place along the river banks, thereby increasing the potential risk of transmission of water-borne parasitic diseases.

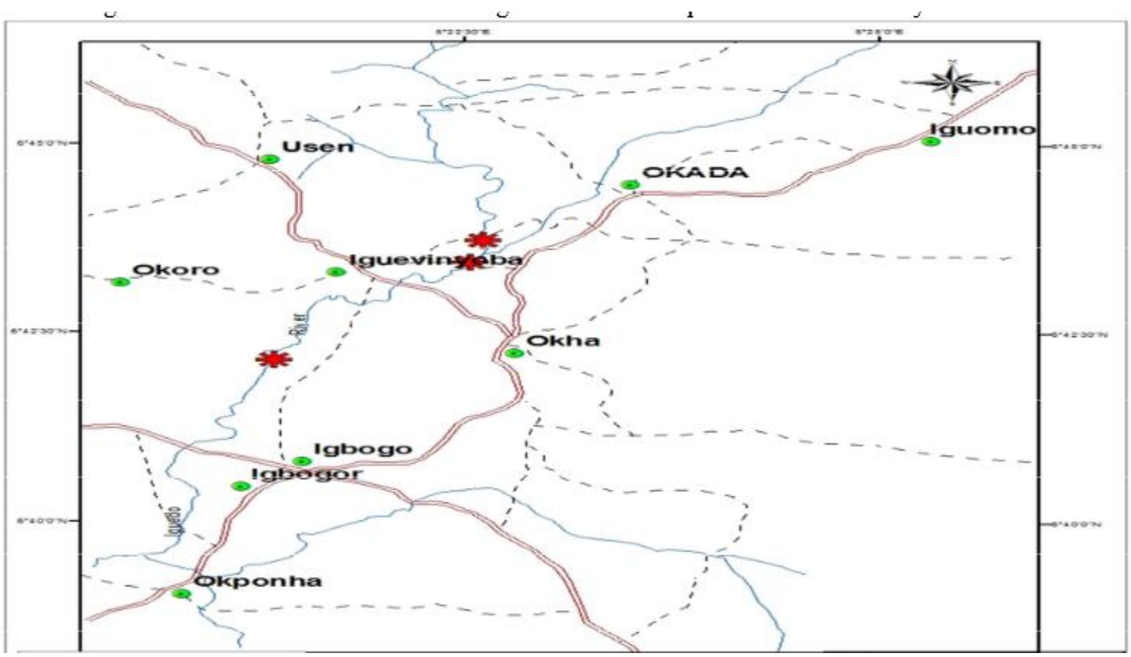


Figure 3.1: Map of the Study Area

3.2 Vegetation and Climate

Iguedo, being part of the southern region of Nigeria, experiences a typically humid tropical climate. The area is marked by high rainfall ranging from 1,500 mm to 2,500 mm annually, high humidity often above 70%, and consistently warm temperatures that range between 25°C and 33°C throughout the year. The vegetation in Iguedo is predominantly a mixture of coastal mangroves and freshwater swamp forests near the riverbanks, gradually transitioning inland to dense tropical rainforest. However, agricultural practices, logging, and settlement expansion have led to noticeable modification of the natural vegetation. The favorable climatic conditions, abundant rainfall, and lush vegetation provide an ideal ecological environment for freshwater snails, including *Melanoides tuberculata*, which serves as an important intermediate host for various parasitic infections.

3.3 Snail Sampling

Different sampling techniques were employed to collect *Melanoides tuberculata* from Iguedo River. Snails were collected between the hours of 9:00 am and 12:00 noon, a period considered optimal since snails are usually more active during early morning hours. Sampling was carried out systematically along the edges of the river, on submerged wood, among aquatic vegetation, and within the river sediment. The collection tools included plastic containers, scooping nets, hand gloves, and protective boots. Collected snails were thoroughly washed with river water to remove attached debris and mud. Each batch of snails was placed into separate, well-labeled plastic containers containing river water and some aquatic leaves to mimic their natural environment. The containers were covered with perforated lids to allow aeration and prevent escape of snails. The samples were then transported to the Public Health and Veterinary Parasitology Laboratory, University of Benin, for further examination.

Plate 3.1: Sampling Location Point One at Iguedo River

Plate 3.2: Sampling Location Point Two at Iguedo River

Plate 3.3: Sampling Location Point Three at Iguedo River

Plate 3.4: Sampling Location Point Four at Iguedo River

3.4 Identification and Photography of Snails

In the laboratory, snails were identified and classified based on their external morphological features. Identification criteria included shell size, shape, color, the number of whorls, and the direction of shell coiling. *Melanoides tuberculata* was identified by its distinct elongated, turret-shaped shell with multiple whorls. For proper documentation, high-resolution photographs of each snail species were taken using a digital camera, ensuring clear dorsal and lateral views to enhance recognition and record-keeping.

3.5 Snail Examination for Parasite Infection

Each snail was subjected to parasitological examination using both cercarial shedding and visceral dissection techniques Snails were individually placed in sterile Petri dishes containing clean, dechlorinated water and exposed to a bright light source for about two hours to stimulate shedding of cercariae. After exposure, the Petri dishes were examined microscopically for the presence of free-swimming cercariae. This procedure was repeated daily for five consecutive days to increase detection chances. Snails that did not shed cercariae were dissected to examine internal organs. The foot of each snail was carefully separated from the visceral mass, and the visceral tissue was placed in a Petri dish containing 0.75% normal saline solution. The tissues were teased apart and examined under a dissecting microscope for larval stages such as sporocysts, rediae, and encysted cercariae. In cases where sporocysts were detected, they were gently pressed between two glass slides to release the developing cercariae for proper observation.

3.6 Identification, Photography and Processing of Parasites

Parasites recovered were identified based on standard morphological criteria such as body size, tail structure, and general body features. Cercariae were observed under the compound microscope, and representative stages were photographed using a microscope-mounted digital camera for documentation. To preserve the specimens, some parasites were fixed in 5% formal saline solution in well-labeled bottles, while others were preserved in 96% ethanol and stored in Eppendorf tubes. Preserved samples were refrigerated at 4°C until further processing and taxonomic confirmation.

3.7 Data Analysis

Prevalence of parasite infection was calculated as percentage of infected snails divided by the total number of snails examined.

CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence of Trematode infection in *Melanoides tuberculata* from Iguedo River Ovia South-West LGA, Edo State

One hundred and twenty-three *Melanoides tuberculata* (Plate 4.1) from Iguedo River in Ovia South-West Local Government Area, Edo State were examined for parasitic infection. One hundred and thirteen snails were examined during the month of May while 10 were examined in July. None of the snail shed cercaria after exposure to light while infection of trematode larval parasites was recorded in four after crushing with an overall prevalence of 3.25%. Infection was only recorded in May.

The cerceriae recovered from the infected snails were released after slight pressure was applied on the rediae mounted on the microscope slide (Plate 4.3). The larval stages of trematode parasites recovered were rediae (Plate 4.2) and three cercaria types including Cercariaeum cercariae (Plate 4.4), Echinostome cercaria (Plate 4.5) and Gymnocephalous cercaria (Plate 4.6). In the month of July, no infection was recorded in the 10 *Melanoides tuberculata* examined.

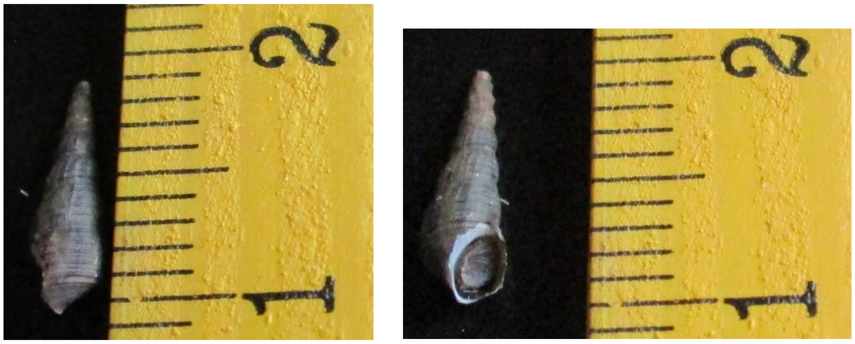


Plate 4.1: *Melanoides tuberculata* (Red-rimmed melania) from Iguedo River, Ovia South-West LGA, Edo State, Nigeria
(A, Dorsal view; B, Ventral view)

Plate 4.2: Redia

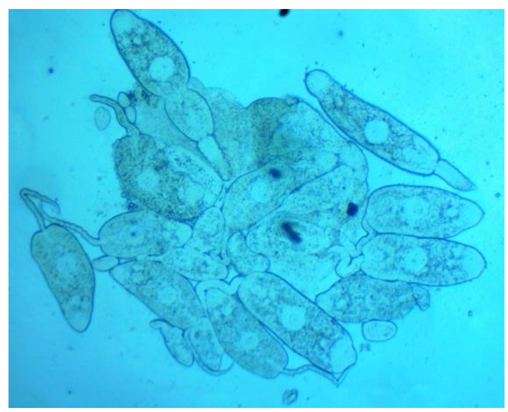


Plate 4.3: Emerging cercariae from Redia

Plate 4.4: Cercariaeum cercariae

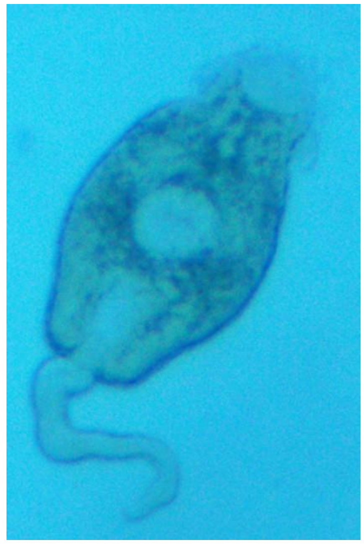


Plate 4.5: Echinostome cercaria

Plate 4.6: Gymnocephalous cercaria

4.2 Morphometric of Melanoides tuberculata

The summary of the morphometric of *M. tuberculata* is presented in Table 4.1, Figure 4.1 and 4.2. The snail had a shell length range of 1.1 cm - 3.9 cm while the diameter was 0.6 – 1.9 cm. A large number (15) of snails measured 3.0 cm. Similarly, 21 snails also measured 1.3 cm in diameter. One snail each had a length of 3.9, 3.8, 2.4, 1.9, 1.6 and 1.1 while a diameter of 1.9 and 0.7 cm each were also recorded individual snail.

Table: Summary of Morphometrics analysis of *Melanoides tuberculata* from Iguedo River, Ovia South-West LGA, Edo State, Nigeria

Number of snail	Length (cm)	Diameter
1	3.9	1.9
1	3.8	0.7
1	2.4	-
1	1.9	-
1	1.6	-
1	1.1	-
2	3.5	1.6
2	1.7	0.6
2	1.5	-
2	1.4	-
3	1.8	1.8
3	-	0.8
4	2.5	-
4	2.1	-
5	-	1.7
6	2.3	-
7	3.2	-
7	2.2	-
8.	3.1	0.9
8	2.9	-
8	2.6	-
9	3.3	-
9	2.7	-
10	2.8	-
10	2.0	-
13	-	1.2
14	-	1.5
14	-	1.0
15	3.0	-
17	-	1.4
19	-	1.1
21	-	1.3
Mean	2.64878	1.244715
Standard Error	0.049741	0.023037
Standard Deviation	0.551654	0.255498
Median	2.8	1.3
Minimum	1.1	0.6
Maximum	3.9	1.9
Sum	325.8	153.1
Count	123	123

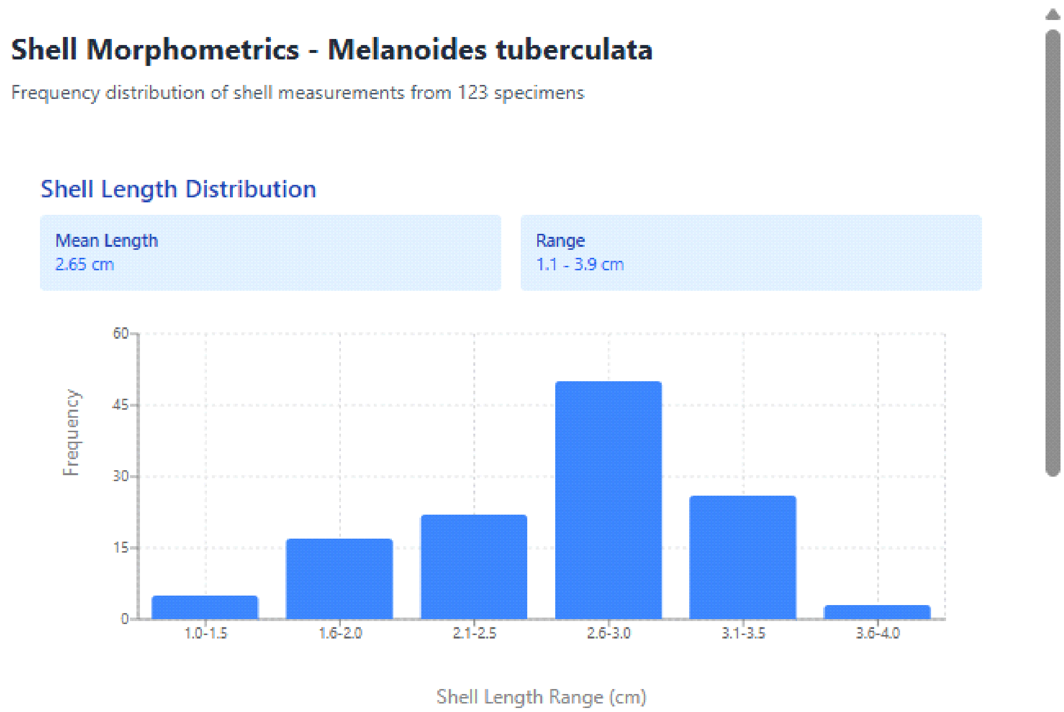
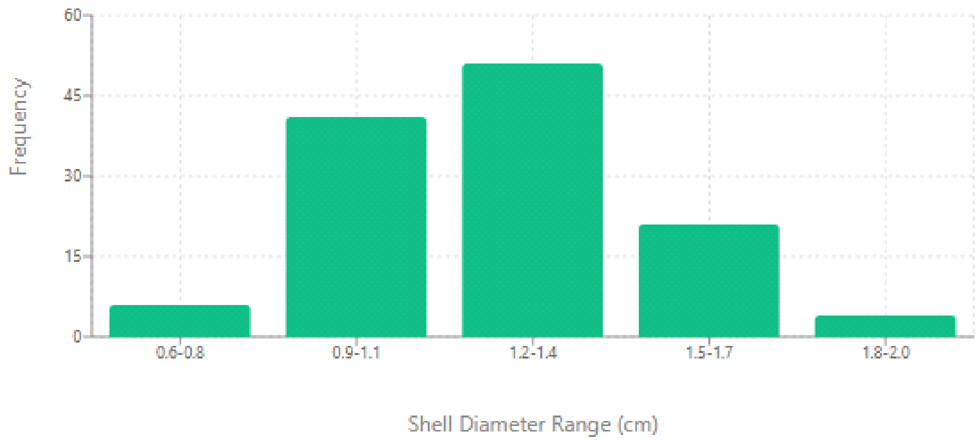


Fig. 4.1: Shell Length of *Melanoides tuberculanta*

Shell Diameter Distribution

Mean Diameter
1.24 cm

Range
0.6 - 1.9 cm



Summary Statistics

Sample Size: 123 specimens of *Melanoides tuberculata*
Shell Length: Mean = 2.65 cm, Range = 1.1-3.9 cm
Shell Diameter: Mean = 1.24 cm, Range = 0.6-1.9 cm

Distribution Pattern: Both length and diameter show approximately normal distributions, with the majority of specimens falling in the middle size ranges.

Fig. 4.2: Shell Diameter of *Melanoides tuberculanta*

CHAPTER FIVE

5.0 DISCUSSION

Melanoides tuberculata is a freshwater snail of the family Thiaridae that has gained global attention due to its role as an intermediate host for a wide range of trematode parasites of medical and veterinary importance. This snail has been implicated in the transmission of heterophyid trematodes such as *Haplorchis pumilio*, *Centrocestus formosanus*, and *Clonorchis sinensis*, which are associated with fish-borne zoonoses in humans and animals (Appleton and Miranda, 2015; Chai and Jung, 2017). Its ecological adaptability, parthenogenetic reproduction, and tolerance to diverse environmental conditions make it a successful invasive species capable of sustaining parasite life cycles across tropical and subtropical regions (Pointier, 1999).

Parasitic infections in *M. tuberculata* are of particular epidemiological importance because the cercariae released from infected snails can infect fish, amphibians, and even humans who consume undercooked or raw fish harboring metacercariae (Sripa *et al*., 2010). Globally, prevalence of infection in *M. tuberculata* varies widely, ranging from less than 5% in some African habitats to more than 40% in parts of Southeast Asia (Oladejo and Ofoezie, 2006; Chontananarth and Wongsawad, 2013). These variations reflect local ecological conditions, the presence of definitive hosts, and seasonal factors that influence parasite transmission. In Nigeria, studies have documented the presence of larval trematodes in *M. tuberculata*, raising concerns about their potential role in maintaining zoonotic disease cycles in freshwater ecosystems (Ofoezie, 2002; Ugbomoiko *et al*., 2010).

This study investigated the prevalence of trematode infections in *Melanoides tuberculata* collected from the Iguedo River, Ovia South-West LGA, Edo State, Nigeria. The results revealed an overall trematode infection prevalence of 3.25%, with infections recorded only in May, while no infection was detected in July. The absence of infection in July may be linked to environmental variations such as changes in rainfall, water flow, and dissolved oxygen, which influence both snail survival and parasite development (Appleton and Miranda, 2015), which may reduce cercarial shedding or snail susceptibility (Woolhouse and Chandiwana, 1990). Previous reports in West Africa have shown that snail infection rates fluctuate seasonally, with higher prevalence often observed in periods following rainfall due to increased availability of definitive hosts and aquatic vegetation (Opisa *et al.*, 2011). Thus, the temporal variation in Iguedo River highlights the dynamic nature of trematode-snail interactions.

The parasites recovered were larval stages of trematode namely; rediae, and three cercariae types (Cercariaeum, Echinostome and Gymnocephalous). Cercariaeum cercaria has no tail, develop in rediae, encyst in snails, and produced by species of the families Monorchiidae (intestinal parasites of fish) and Cyclocoelidae (parasites of the respiratory tract of birds). Of no economic importance. It is produced by species of the snail genera *Biomphalaria*, *Gabbiella* and *Lymnaea*. Echinostome cercaria has unforked tail, ventral sucker on mid-ventral surface of body, oral sucker without a stylet but surrounded by a spiny collar, numerous cystogenous glands in the body, and no eyespots. Develop in rediae. Encyst in invertebrates, fish and amphibians. It is produced by species of the family Echinostomatidae (intestinal parasites of birds, reptiles and mammals). Some species may be of some economic importance; produced by species of the snail genera *Biomphalari, Bulinus, Ceratophallus, Gyraulus, Lentorbis, Lymnaea, Pila* and *Segmentorbis*. Gymnocephalous cercariae also possess unforked tail, ventral sucker on mid-ventral surface of body, neither stylet nor spiny collar present; no eyespots, and numerous cystogenous glands in body. Develop in rediae. Encyst on external substrates. Produced by species of the family Fasciolidae (intestinal and liver parasites in herbivorous mammals) and by species of numerous other families. Species of the family Fasciolidae are of great veterinary importance; produced by species of the genera *Biomphalaria. Bulinus. Ceratophallus. Gabbiella. Gyraulus. Lymnaea* and *Melanoides.*

The detection of rediae and diverse types of cercariae in the infected snails aligned with the life cycle of digenetic trematodes, where rediae are larval stages that produce cercariae, the infective stage for the next host (Esch *et al*., 2001). However, the low prevalence of trematode larvae infection in the infected snails (3.25%) probably indicated a limited parasite load in the study area, which might reflect a low density of definitive hosts or environmental conditions unfavorable for parasite transmission. This finding contrasts with studies in endemic areas, such as those by Frandsen (1979), who reported higher cercarial outputs in *Biomphalaria* snails in schistosomiasis-endemic regions of East Africa. The variation underscores the importance of site-specific ecological factors in shaping parasite prevalence.

The low prevalence of trematode infection (3.25%) observed in this study reflects a relatively reduced transmission in the Iguedo Community during the study period. Several ecological and epidemiological studies have shown that the prevalence of trematode infections in freshwater snails varies widely depending on environmental conditions, host-parasite interactions, and seasonality (Chontananarth and Wongsawad, 2013; Ukong *et al*., 2017).

Contrary to the low prevalence recorded in this study, Pointier *et al*. (1993) reported a prevalence of 15–20% in some South American rivers where *M. tuberculata* serves as a key intermediate host for heterophyid trematodes. Owojori *et al*. (2006) reported a trematode prevalence of 12.5% from

Bulinus globosus in Ogun State, Nigeria which is significantly higher than the findings in this study. The difference may be attributed to variations in snail species, as *B. globosus* is a known primary intermediate host for schistosomes, whereas *M. tuberculata* is less commonly associated with trematode infections, particularly in Nigeria (Pointier, 1999). Dung *et al*. (2010) also reported a higher prevalence of trematode infections (8.7%), particularly with *Paragonimus* and *Clonorchis* species from *M. tuberculata* in Vietnam. This discrepancy could be due to differences in ecological conditions. According to these authors Vietnamese study sites were known for high trematode transmission because of the human and animal activities which is contrary to the situation in Iguedo River where low anthropogenic contamination or fewer definitive hosts (e.g., mammals or birds) were observed. Similarly, in Thailand and Laos, Sripa *et al*. (2010) reported an infection prevalence of *M. tuberculata* by heterophyid trematodes that exceeded 40% in highly endemic regions. Within Nigeria, prevalence levels vary, with some studies recording between 2–10% in southern rivers (Oladejo and Ofoezie, 2006; Ugbomoiko *et al*., 2010). These differences highlight the role of local ecological conditions, human behavior, and host availability in shaping transmission patterns.

In contrast, a study by Pinto and de Melo (2011) in Brazil found that *M. tuberculata* in polluted water bodies had smaller shell sizes (1.0–2.5 cm), possibly due to environmental stress. The larger shell sizes (length, 1.1 cm - 3.9 cm; diameter, 0.6 – 1.9 cm) observed in this study suggest that the Iguedo River provides relatively favorable conditions for snail growth, potentially due to low pollution levels or abundant food resources. However, the lack of correlation between snail size and infection status in this study contrasts with findings by Curtis and Hubbard (1990), who reported that larger snails were more likely to be infected due to prolonged exposure to parasites.

RECOMMENDATIONS

In light of the findings from this study, which revealed the prevalence of trematode infections in *Melanoides tuberculata* from Iguedo Community, it becomes imperative to suggest measures aimed at reducing the risk of transmission and safeguarding public health. The following recommendations are therefore proposed:

1. **Public Health Education:** Community members in Iguedo and surrounding areas should be sensitized on the health risks associated with contact or consumption of water sources harboring infected *Melanoides tuberculata*.
2. **Regular Surveillance of Snail Populations:** Environmental health authorities should institute routine monitoring of freshwater snails to detect trematode infections early and provide data for effective disease control strategies.
3. **Environmental Management:** Measures such as proper sanitation, improved waste disposal, and reduction of organic pollution in rivers should be prioritized to limit snail breeding grounds.
4. **Access to Safe Water:** Provision of clean and treated water sources should be encouraged to reduce dependence on potentially contaminated river water for domestic use.
5. **Further Research:** More studies should be conducted to identify the specific trematode species infecting *Melanoides tuberculata,* as well as the seasonal variation in prevalence, to guide targeted interventions.
6. **Policy and Control Programs:** Government and health agencies should adopt snail control initiatives and implement policies that promote safe water practices, in line with integrated disease management approaches.

CONCLUSION

The present findings demonstrate that *Melanoides tuberculata* in Iguedo River harbor trematode infections at a low prevalence (3.25%). Although the observed infection rate is relatively low, the presence of these trematode stages indicates a potential reservoir for zoonotic transmission. Regular monitoring of snail populations, coupled with environmental management and community awareness, is recommended to mitigate the risk of snail-borne parasitic infections in Ovia South-West Local Government Area.

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