

**TREMATODE PARASITES INFECTION IN *Melanoides tuberculata* FROM RIVER  
SILUKO, OVIA SOUTH WEST LOCAL GOVERNMENT AREA, EDO STATE,  
NIGERIA**

**BY**

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**DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY  
FACULTY OF LIFE SCIENCES  
UNIVERSITY OF BENIN  
BENIN CITY**

**OCTOBER, 2025**

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

**OCTOBER, 2025**

## CERTIFICATION

This is to certify that this work was done by Anthonia Oyindeinyefa ARMSTRONG with matriculation number LSC2205267.

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Dr. (Mrs) O. Edo-Taiwo  
Project Supervisor

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Date

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Prof. (Mrs) I. Tongo  
Head of Department

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Date

## **DEDICATION**

First of all, I want to dedicate this report to God almighty, I also want to dedicate this work to my family for their financial and moral support and for encouraging me throughout the entire duration of my undergraduate program.

## **ACKNOWLEDGEMENT**

The successful completion of this project would not have been possible without the unwavering support of several incredible individuals.

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## ABSTRACT

*Melanooides tuberculata* is a freshwater snail of medical importance and serves as an intermediate host for several parasitic trematodes that affect both humans and animals. The aim of this study was to investigate the prevalence of trematode infections in *M. tuberculata* snails from River Siluko in Ovia South-West Local Government Area, Edo State, Nigeria. A total of 83 snails were collected in two batches: 17 and 66 specimens in May and July, 2025, respectively. All snails were subjected to standard cercarial shedding techniques and examined for the presence of trematode larvae under a dissecting microscope. Thereafter they were crushed and also examined. None of the snails shed cercaria. However, trematode larval stages (redia and furcocercous cercariae) were recovered from two (2.41%) of the snails examined after crushing. Only the snails examined in May were infected while none was infected in July. This finding showed that *M. tuberculata* from River Siluko harbors trematode infections, although at a relatively low prevalence. This indicates the role of *M. tuberculata* as an intermediate host for trematodes infection. The finding provides insight into the potential health risk posed by the aquatic environment of River Siluko. This study contributes to the understanding of the epidemiology of snail-borne trematode infections in the region and offers valuable data that can support public health planning, especially in community like Siluko that relied on water from the river for domestic and recreational activities. There is therefore need for continuous monitoring of freshwater snails parasites infection in the area.

## CHAPTER ONE

### 1.0

### INTRODUCTION

#### 1.1 EVOLUTIONARY HISTORY OF SNAILS

The term snail derived from Old English *snægl*, traced through Proto-Germanic *snagila* and Proto-Indo-European *sneg-*, meaning “to crawl.” Its earliest uses date to around the 15th century, including idiomatic expressions like “snail’s pace.” Snails belong to the Phylum Mollusca, Class Gastropoda, a diverse group distinguished by a muscular foot and, in many cases, a coiled shell. The earliest undisputed gastropods date from the Late Cambrian Period, around 500 million years ago. Their evolutionary journey includes major transitions in anatomy, habitat, and functionality. The evolutionary origins of snails traced back to over 500 million years, placing them among the earliest animals to develop a coiled shell. Fossil records suggest that the earliest gastropods appeared during the late Cambrian period. These primitive marine molluscs, characterized by simple cap-like shells, later underwent torsion, a key evolutionary event that resulted in the asymmetric body structure typical of modern snails (Bandel, 1993).

During the Palaeozoic era, especially the Ordovician period, marine gastropods diversified significantly. Their evolutionary success was closely linked to the development of the protective spiral shell, which enhanced defence against predators and harsh environmental conditions. This spiral coiling evolved independently in several molluscan lineages, suggesting its strong adaptive value (Lindberg *et al.*, 2004). By the Mesozoic era, gastropods had diversified into both marine and non-marine environments. The transition from aquatic to terrestrial habitats marked a significant evolutionary milestone. The development of a lung-like structure (the pallial lung) allowed snails to colonise land. This major physiological

innovation enabled the rise of pulmonate gastropods, which are now dominant in terrestrial ecosystems (Barker, 2001). Snails adapted to terrestrial life by evolving a variety of reproductive and locomotory strategies, including hermaphroditism and mucus-based gliding locomotion. These adaptations allowed them to thrive in environments ranging from tropical forests to arid deserts. Terrestrial snails, particularly those of the subclass Pulmonata, show immense ecological diversity and play essential roles in nutrient recycling and food webs (Ponder and Lindberg, 1997).

Molecular phylogenetics has shed light on the deep evolutionary relationships among gastropods. Studies using mitochondrial DNA sequences have clarified that gastropods are not a monophyletic group, leading to reclassification of several families and the understanding of parallel evolution in shell morphology. This has helped resolve the evolutionary position of various snail groups and clarified their adaptive radiations (Aktipis *et al.*, 2008). In recent years, climate change and habitat fragmentation have highlighted the importance of studying snail evolution from a conservation perspective. Many snail species, particularly endemics with restricted ranges, are highly vulnerable to environmental change. Conservation efforts increasingly rely on evolutionary insights to prioritise protection of genetically distinct lineages and habitats (Lydeard *et al.*, 2004).

## **1.2 BACKGROUND OF THE STUDY**

In Nigeria, gastropods occupy both terrestrial and freshwater habitats where their distribution depends largely on environmental conditions such as humidity, calcium availability, and vegetation cover (Oke & Alohan, 2006). Land snails belonging to the family *Achatinidae*, including *Achatina achatina*, *Archachatina marginata*, *Lissachatina fulica* and *Limicolaria*

spp., are widely distributed across rainforests and agricultural zones, thriving beneath leaf litter, fallen logs, and stones in moist calcium-rich soils (Oke & Alohan, 2006). Freshwater gastropods occur in families such as Thiaridae, Planorbidae, Lymnaeidae, and Ampullariidae, which are well-represented in Nigerian and West African freshwater systems (Koudenoukpo *et al.*, 2020). Gastropods evolved from marine ancestors over 500 million years ago and diversified extensively through adaptive radiation. Terrestrial pulmonates developed vascularized mantle cavities that function as lungs, allowing them to colonize land, while gill-bearing prosobranchs remained aquatic. The evolution of slug-like forms through shell reduction occurred independently several times, highlighting the group's evolutionary plasticity (Ponder & Lindberg, 1997; Pechenik, 2015).

Nigerian land snails flourish in the humid environments of tropical forests, gardens, and farmlands where moisture and calcium-rich soil abound (Oke & Alohan, 2006). Freshwater snails such as *Melanoides tuberculata* inhabit rivers, ponds, gutters, and irrigation canals. In Benue State, Makurdi markets have recorded a high abundance of *M. tuberculata*, indicating its widespread distribution and ecological importance (Omeji, *et al.*, 2017). As ectothermic organisms, snails maintain low metabolic rates and often undergo aestivation during hot or dry periods by sealing their shell aperture with an epiphragm. Pulmonate species respire through lung-like cavities, while prosobranchs retain gills. Their mucus, rich in glycoproteins, assists in locomotion, water retention, and shell repair, which are key adaptations for survival under fluctuating environmental conditions (Pechenik, 2015).

Edible land snails play a significant nutritional role in Nigeria. Studies have shown that snail flesh contains 15–20 % crude protein, low fat, and appreciable mineral levels, making it an important source of nutrition in regions combating malnutrition (Fagbuaro *et al.*, 2006).

Ecologically, gastropods serve as detritivores and herbivores — land species feed on decaying vegetation, fungi, and seedlings, while freshwater species like *M. tuberculata* graze on biofilms and algae, promoting nutrient cycling and decomposition. They also serve as prey for birds, reptiles, and small mammals and as intermediate hosts for parasitic trematodes of medical and veterinary importance (Lydeard *et al.*, 2004). The ecological, nutritional, and evolutionary relevance of gastropods underscores the need for continued study of their biology and distribution in Nigeria and across West Africa.

### **1.3 TAXONOMY**

Snails are invertebrate animals belonging to the phylum *Mollusca*, one of the largest and most morphologically diverse groups in the animal kingdom. Members of this phylum are characterized by a soft, unsegmented body, often protected by a calcareous shell secreted by the mantle. Within this group, snails fall under the class *Gastropoda*, which encompasses the majority of molluscan diversity, including both shelled and shell-less forms such as slugs. Gastropods exhibit a remarkable range of adaptations that have allowed them to occupy marine, freshwater, and terrestrial environments. One of the defining characteristics of the class is the process of torsion which is a unique developmental event in which the visceral mass, mantle, and shell rotate 180 degrees during larval development. This results in the positioning of the mantle cavity and anus above the head region, a distinctive feature that sets gastropods apart from other molluscs (Brusca & Brusca, 1990). The adaptive significance of torsion lies in improved protection of the head and sensory organs and efficient withdrawal into the shell when threatened. The shell itself is generally a single, coiled structure, though its shape, thickness, and orientation vary widely among taxa in response to ecological pressures and evolutionary lineage.

Modern classification of gastropods recognizes several major clades based on molecular and morphological data. These include *Patellogastropoda* (true limpets), *Vetigastropoda*, *Neritimorpha*, *Caenogastropoda*, and *Heterobranchia* (Uribe *et al.*, 2022). Historically, gastropods were divided into prosobranchs, opisthobranchs, and pulmonates based mainly on the position of their gills and mantle cavity, but these groupings have since been revised following phylogenomic analyses. Prosobranchs, which include many aquatic species, are typically gill-bearing and often possess an operculum used to close the shell aperture. Pulmonates, in contrast, have evolved a vascularized mantle cavity that functions as a lung, allowing them to breathe air and thrive in terrestrial and freshwater habitats. Among the pulmonates, the order Stylommatophora encompasses most land snails, while several freshwater genera, such as *Bulinus* and *Biomphalaria*, are of medical importance as intermediate hosts of schistosome parasites. The continued refinement of gastropod taxonomy reflects the integration of molecular sequencing, shell morphology, and reproductive anatomy in determining evolutionary relationships (Lydeard *et al.*, 2004).

Families within the Gastropoda are classified based on both soft-body anatomy and shell characteristics, including shape, coiling pattern, aperture type, and ornamentation. In West Africa, the family *Achatinidae* represents the most prominent group of terrestrial snails, encompassing giant species such as *Achatina achatina*, *Archachatina marginata*, and *Lissachatina fulica*, which are ecologically and economically valuable. These species contribute significantly to nutrient recycling through the breakdown of organic matter and are also harvested as a protein source in many rural communities. In freshwater environments, the family *Planorbidae* (e.g., *Biomphalaria pfeifferi* and *Bulinus globosus*) and the family *Thiaridae* (e.g., *Melanoides tuberculata*) dominate aquatic habitats and play essential roles in

maintaining ecological balance (Lydeard *et al.*, 2004; Uribe *et al.*, 2022). The wide distribution of these species across tropical Africa underlines their adaptability to varying physicochemical conditions, including differences in pH, salinity, and substrate type. Morphological variation within these groups, such as shell ribbing, spire length, and operculum texture, often reflects local environmental selection pressures and feeding strategies, making gastropods excellent indicators of environmental quality and habitat stability.

Recent molecular studies have reshaped the understanding of gastropod phylogeny. Uribe *et al.* (2022) provided a phylogenomic backbone that confirmed *Patellogastropoda* as the earliest-diverging lineage, forming the sister group to all other gastropods. The clade *Caenogastropoda* was revealed to contain a vast diversity of both marine and freshwater taxa, including many economically important and parasitologically significant species. Moreover, the traditional taxon “Pulmonata” is no longer considered monophyletic; rather, its members are now placed within Heterobranchia, which also includes opisthobranchs and several transitional groups. These phylogenetic advances have brought a clearer understanding of how adaptive features such as air-breathing, shell reduction, and torsion evolved independently multiple times throughout gastropod history. Because of this ongoing refinement, the classification of snails is dynamic, with modern taxonomists preferring clade-based systems (as proposed by Bouchet & Rocroi) instead of strictly Linnaean ranks. Consequently, snail taxonomy not only provides a structural framework for species identification but also serves as a foundation for ecological, evolutionary, and conservation studies in Nigeria and beyond.

## 1.4 BIOLOGY OF SNAILS

Snails are soft-bodied animals belonging to the phylum Mollusca and the class Gastropoda, which is one of the most diverse groups of animals globally. They are most easily recognised by their coiled shell, a muscular foot used for movement, and a head with tentacles. Many also possess a radula, a ribbon-like tongue lined with tiny teeth that is used to scrape or cut food. A distinctive feature of snail development is torsion, a process during which the body twists, causing the anus to lie above the head in adult snails (Pechenik, 2015). There are thousands of snail species that have adapted to life on land, in freshwater, and in the sea. Their shells, composed primarily of calcium carbonate, vary greatly in shape and size depending on the species and their habitat. Land-dwelling snails typically have two pairs of tentacles: the upper pair carries the eyes while the lower pair is used for sensory functions such as touch and smell. The foot, located on the underside of the body, is wide and muscular and secretes mucus that allows the snail to glide smoothly over surfaces. Internally, snails have relatively simple organ systems. Their circulatory system is open which means that their blood, or haemolymph, flows freely around the organs rather than through a closed network of veins. Most land snails breathe using a lung-like cavity while aquatic snails often use gills. Their nervous system consists of small groupings of nerve cells called ganglia connected by nerve cords that coordinate movement and response to stimuli (Hickman *et al* 2006). They also possess a complete digestive system which includes salivary and digestive glands for breaking down food.

Reproduction in snails varies depending on their environment. Many land and freshwater snails are hermaphrodites possessing both male and female reproductive organs yet usually requiring a mate to exchange sperm. In contrast most marine snails have separate sexes.

Fertilization can occur either internally or externally and depending on the species the young may hatch directly as miniature adults or pass through larval stages such as the trochophore or veliger (Pechenik, 2015). Snails have evolved a range of features to survive in diverse habitats. Marine species such as *Littorina littorea* are adapted to life in salty water and can withstand the force of waves. Freshwater snails like *Biomphalaria pfeifferi* are medically important as intermediate hosts in the transmission of schistosomiasis. Terrestrial species such as *Achatina fulica* have become well known for their ability to spread quickly and damage crops particularly in tropical regions (Cowie, 2001). Overall snails are incredibly adaptable animals with a range of biological traits that have enabled them to occupy nearly every environment on Earth from forest floors and gardens to rivers lakes and coastal waters.

## **1.5 ECOLOGY**

Land-snails exhibit remarkable variation in shell size, shape, thickness and ornamentation, reflecting both genetic potential and environmental influence. In environments where humidity is high and calcium availability is good, snails often attain larger shells, while in more arid or resource-limited settings adult sizes tend to be smaller and shells may have reduced aperture area or whorl expansion (Goodfriend, 1986). This morphological plasticity is driven by multiple factors: the need to conserve water, avoid predation, or optimise attachment to substrates under different micro-habitats. Shell shape and height vs. width of the spire or compact vs. elongated form can relate to substrate slope, exposure to wind or sun, or even population density, where higher densities may impose growth limits or energy trade-offs (Goodfriend, 1986).

From the taxonomic perspective, families of land snails such as the Achatinidae in West Africa display variation not only across species but within species across habitats, suggesting local adaptation or phenotypic plasticity. Shells from more forested, moist settings tend to be larger and more robust compared to those from drier agricultural zones or marginal habitats. The book edited by Barker (2001) underscores that shell morphology is shaped by a suite of structural, physiological and behavioural traits: shell thickness relates to predator defence, aperture size to moisture retention, and shell coiling and spire shape to locomotory and habitat constraints. Consequently, analysing shell variation offers insights into how snail populations respond to environmental gradients and selective pressures.

In ecological and evolutionary research, shell morphology serves as a valuable proxy for hypotheses about adaptation, resource allocation and environmental stress. For instance, snails in calcium-poor soils may invest less in shell thickness and orient more energy into reproduction or mobility, while those facing high predation risk may evolve or select thicker, more ornamented shells. Genetic studies indicate a strong hereditary component in size but also reveal that local conditions modulate expression of morphological traits (Goodfriend, 1986). This blend of inherited potential and environmental shaping makes land snail shells effective indicators of habitat quality, climate variability and evolutionary dynamics.

In summary, variation in land snail shell size and morphology is a multifactorial phenomenon combining genetic, ecological and anatomical influences. By studying the patterns of variation across habitats and species, researchers can infer how snails adapt, persist or decline under changing conditions. Such work is not merely descriptive; it informs conservation planning, habitat assessment and the evolutionary biology of invertebrates in general. Shell morphology thus remains a window into the hidden lives of these often-overlooked creatures.

## 1.6 RELEVANCE/IMPORTANCE OF SNAILS

Snails serve an essential function in ecosystems across the globe, primarily as decomposers. By feeding on decaying organic matter such as leaf litter, fungi, and algae, they contribute significantly to nutrient cycling, which improves soil structure and fertility. This process enhances plant growth, supporting biodiversity within terrestrial and aquatic habitats (Barker, 2001). In aquatic systems, particularly freshwater and marine environments, snails act as grazers, controlling algal growth on surfaces and thereby helping to maintain water quality. Their presence is especially important in regulating periphyton biomass, which in turn affects oxygen levels and overall habitat conditions (Lodge *et al.*, 1987). Additionally, snail shells provide microhabitats for small invertebrates once vacated, playing a role in maintaining micro-ecological diversity (Strong *et al.*, 2008). Snails also form an important part of the food web. Many birds, mammals, amphibians, and invertebrates rely on them as a source of protein and calcium. For instance, in some regions, hedgehogs and thrushes have diets that depend heavily on snails (Kerney & Cameron, 1979). In aquatic food chains, fish and waterfowl consume snails, thereby linking lower trophic levels with higher ones (Brown, 1994).

Economically, snails are harvested and farmed for human consumption, particularly in Africa, Asia, and parts of Europe. Species such as *Archachatina marginata* and *Helix aspersa* are considered delicacies and are also valued for their protein-rich content and low fat, which makes them suitable for health-conscious diets (Cobbinah *et al.*, 2008). In addition, snail mucus has drawn significant interest for its pharmaceutical and cosmetic potential, offering wound-healing, anti-ageing, hydrating and regenerative properties for skin care and dermatological applications (Zhu., *et al.*, 2024). In addition, snails are increasingly recognized as bio-indicators of environmental health. Their sensitivity to heavy metals, pesticides, and

other contaminants makes them effective tools for monitoring terrestrial and aquatic pollution. Changes in snail populations, behaviour, or shell morphology can signal ecological disturbances, enabling early intervention in affected ecosystems (Debenay *et al.*, 2002).

## 1.7 LARVAL STAGES OF TREMATODE PARASITES

Trematode transmission typically begins with eggs released by the adult fluke in a definitive host's faeces, urine or sputum; eggs are the first larval stage and their form and hatching biology are adapted for either direct hatching in water or for ingestion by an intermediate host. Most digenetic trematode eggs (for example *Fasciola*, *Clonorchis*, *Opisthorchis*) are operculate that is, they have a lid-like structure that opens during hatching whereas schistosome eggs are non-operculate and instead have a species-specific spine or projection (e.g., lateral or terminal) that is important for identification and pathology (Colley *et al.*, 2014). Egg viability and the timing of hatching are strongly influenced by environmental cues: osmotic shock when eggs pass into freshwater, water temperature, and light all act as triggers for activation and hatching in many species (Jones *et al.*, 2008). Eggs may be embryonated on exit (as in many schistosomes) or require a period of embryonation in the environment before miracidia are ready; this difference changes transmission dynamics because embryonated eggs can hatch immediately on contact with freshwater while unembryonated eggs must first develop (Jones *et al.*, 2008; NCBI/Medical Microbiology). Eggs are not merely passive packets they interact immunologically and mechanically with host tissues during passage from the definitive host, and egg-associated secretions can provoke granulomatous host responses that both aid escape into the environment and contribute to pathology in the host (Jones *et al.*, 2008; Colley *et al.*, 2014).

When a trematode egg hatches it releases the miracidium, a small, usually ciliated free-swimming larva whose primary task is to locate and enter the appropriate first intermediate host (usually a freshwater snail). Miracidia are non-feeding and therefore energetically limited; they rely on stored yolk reserves and must find and penetrate a susceptible snail within a short window (minutes–hours to a few days, depending on species and conditions) to survive and continue the life cycle (Jones *et al.*, 2008; NCBI Bookshelf). Miracidia use multiple sensory cues changes in osmolarity when eggs enter freshwater, light gradients, temperature, and species-specific chemical cues (mucus or other snail exudates) to orient toward and recognise suitable snails (Jones *et al.*, 2008; ScienceDirect topic summary). Upon contact, miracidia attach and penetrate snail tissues by a combination of mechanical action (specialized anterior structures such as the terebratorium) and secreted lytic enzymes that facilitate tissue invasion; once inside, the miracidium rapidly sheds its ciliated epithelium and remodels into a sac-like parthenogenetic stage, the mother sporocyst (Jones *et al.*, 2008; Galaktionov & Dobrovolskij, 2013). The short life span, host-finding behaviour, and physiology of miracidia make them a key bottleneck in transmission small changes in environmental conditions or snail availability can strongly affect infection success.

Following penetration and metamorphosis, the miracidium becomes a mother sporocyst a flattened, sac-like, essentially embryonic/parthenogenetic stage specialized for asexual reproduction rather than feeding or motility. The mother sporocyst functions as a germinal factory: its germinal cells proliferate clonally and give rise to daughter sporocysts (and in some lineages directly to cercariae), enabling rapid intramolluscan amplification of parasite numbers from a single miracidium (Cort, 1954; Ivanchenko *et al.*, 1999). Daughter sporocysts may migrate to preferred tissues in the snail (commonly the hepatopancreas/albumen gland or

gonads in many species) where they continue clonal production of later larval stages; in *Schistosoma* spp., mother to daughter sporocyst development and multiplication typically proceed over days to a few weeks, after which cercarial embryogenesis is completed and cercariae begin to be produced in large numbers (Negrão-Corrêa *et al.*, 2012; Ivanchenko, 1999). Internally, sporocysts manipulate host physiology and immune responses they can modify snail metabolism and modulate haemocyte activity to favour their survival and their tissue distribution and fecundity are central determinants of both cercarial output and snail morbidity. Because sporocysts are the reproductive core of the intramolluscan phase, understanding their timing, reproductive rate, and interaction with snail immune effectors is critical for models of parasite population growth and control strategies.

In trematode taxa that produce them (notably many families such as Fasciolidae and Echinostomatidae), the sporocyst lineage gives rise to rediae internally more complex, often motile larval forms that possess rudimentary digestive structures (a pharynx and gut diverticula) and are capable of feeding within the snail. Rediae serve several ecological and developmental functions: they allow intramolluscan dispersal within the body cavity, can consume host tissues (thereby increasing cercarial yield by utilising host resources), and in some cases predate on or outcompete other larval stages (including sporocysts from other trematode species), thereby influencing parasite community outcomes inside the snail (Galaktionov & Dobrovolskij, 2013; Cort, 1954). Because rediae are feeding and mobile, they often support higher rates of cercarial production than the non-feeding sporocyst pathway; however, the redial pathway typically exacts greater pathology on the snail (tissue destruction, reduced fecundity) and can change snail survivorship dynamics (Digenetic Trematodes reviews; Galaktionov & Dobrovolskij, 2013). The presence or absence of rediae in a

trematode's intramolluscan strategy thus has important consequences for transmission ecology, rate of cercarial emergence and the potential for intramolluscan competition between parasite species

Cercariae are the free-swimming, usually tailed larvae produced within daughter sporocysts or rediae and released into the aquatic environment; they are the principal infective dispersal stage for many trematodes. Cercarial morphology is diverse and reflects transmission mode: schistosome cercariae are adapted for active skin penetration (slender bodies and forked tails plus secreted proteolytic enzymes), whereas other cercariae have morphologies adapted to encyst on vegetation, seek and infect second intermediate hosts (fish, crustaceans) or attach to substrates to form metacercariae (Combes *et al.*, 1994; Colley *et al.*, 2014). Cercarial emergence from snails is often rhythmic and light-stimulated, timed to coincide with the activity or water-contact behaviour of the next host (Théron, 2015). A single infected snail can produce thousands of cercariae per day during peak shedding, but individual cercariae are short-lived and vulnerable: longevity in the water is often measured in hours, and infectivity declines rapidly with time and unfavourable temperature or UV exposure (Théron, 2015; Nojima *et al.*, 1982). Cercarial behaviour including vertical migration, phototaxis, and chemotaxis is finely tuned to maximise encounter rates with the appropriate host, making this stage a central focus for both mechanistic studies of transmission and for interventions (for example, predicting peak shedding windows for exposure reduction)

Where a trematode's life cycle includes a second intermediate host or encystment on vegetation/substrates, the metacercaria is the encysted, often quiescent stage that follows the cercarial phase. Cercariae either actively penetrate and encyst within a second host (e.g., fish,

crustaceans) or encyst on plants or other substrates; the resulting metacercariae have a resistant cyst wall and can remain infective for extended periods (days to months, sometimes longer depending on environmental conditions), effectively bridging gaps between cercarial release and ingestion by the definitive host (Hu *et al.*, 2024; Digenetic Trematodes reviews). Metacercariae are epidemiologically important because they are the stage commonly associated with foodborne trematodiasis humans and animals acquire infection by eating raw or undercooked fish, crustaceans, aquatic plants, or other intermediate hosts that harbour metacercariae (Hu *et al.*, 2024; Colley *et al.*, 2014). The physiology of encystment, the resistance of the cyst to desiccation and digestion, and the cues that trigger excystment in the definitive host's gut are all active research areas because they determine metacercarial survival in the environment and hence transmission risk. Management and food-safety interventions therefore commonly target reduction of metacercarial exposure (cooking, freezing, or avoiding raw aquatic foods) as a practical control measure.

The adult trematode is the sexually mature stage that inhabits a definitive host and is responsible for egg production that perpetuates the cycle. Adult flukes are morphologically adapted to their niche: they possess oral and ventral suckers for attachment, tegumental specialisations for nutrient uptake and immune evasion, and reproductive systems capable of producing large numbers of eggs (Colley *et al.*, 2014; Galaktionov & Dobrovolskij, 2013). Adults occupy characteristic anatomical sites that determine disease pathology for example, *Schistosoma mansoni* adults reside in mesenteric veins where egg deposition causes intestinal/hepatic disease, whereas *Fasciola hepatica* adults inhabit the biliary ducts causing fascioliasis (Colley *et al.*, 2014; Digenetic Trematodes). Adult worms can persist for months to years in the definitive host, with chronic infections producing ongoing morbidity; their

fecundity (eggs per female per day) and host-specific biology are therefore crucial parameters in transmission models and control strategies such as mass drug administration. Understanding adult biology (nutrition, reproduction, host immune modulation) is essential both for therapeutics (drug targets) and for predicting how interventions will reduce egg output and downstream infection of intermediate hosts

## **1.8 SNAIL AS INTERMEDIATE HOST OF PARASITES**

Snails' play a critical role as intermediate hosts in the life cycles of several medically and veterinary important parasitic organisms, particularly trematodes (flukes). Among these, schistosomes causative agents of schistosomiasis are the most significant, especially in tropical and subtropical regions. The freshwater snails of the genus *Biomphalaria*, *Bulinus*, and *Oncomelania* serve as obligate intermediate hosts for *Schistosoma mansoni*, *S. haematobium*, and *S. japonicum*, respectively (Rollinson *et al.*, 2010).

The parasitic cycle begins when eggs released from infected humans or animals hatch into miracidia in water. These miracidia actively seek and penetrate a compatible snail host. Inside the snail, the parasite undergoes asexual multiplication and development, producing thousands of cercariae, which are then released into the water. These free-swimming cercariae are infective to the definitive host mostly usually humans, entering the body through intact skin during contact with contaminated water (King *et al.*, 2005). This process illustrates why snail populations are essential in sustaining transmission. Without the intermediate snail host, the trematode life cycle cannot be completed, making snail control a vital aspect of disease management. Moreover, environmental changes such as irrigation schemes, dam construction,

and poor sanitation can increase snail habitats and thus facilitate the spread of parasitic infections (Steinmann *et al.*, 2006).

Besides schistosomes, many other trematodes depend on snails. Species such as *Fasciola hepatica* (liver fluke), affecting livestock and occasionally humans, utilise *Lymnaea* species as intermediate hosts (Mas-Coma *et al.*, 2009). Similarly, *Clonorchis sinensis*, the Chinese liver fluke, uses *Parafossarulus* snails as its first host in East Asian regions (Keiser and Utzinger, 2009). These parasites often follow a complex life cycle involving a second intermediate host, such as fish or aquatic plants, before reaching their final host. Marine and estuarine snails are also involved in parasitic life cycles. For instance, certain species of *Cerithidea* and *Littorina* serve as intermediate hosts for marine trematodes that infect seabirds and fish (Galaktionov and Dobrovolskij, 2013). These interactions, though less medically relevant, have ecological implications, particularly for commercial fisheries and biodiversity. The role of snails in parasitic transmission also underpins their importance in epidemiological surveillance and disease modeling. Molecular tools and ecological mapping helped to identify snail species involved in transmission and their geographic distribution, improving targeted control strategies (Rollinson *et al.*, 2001). Given the global burden of diseases such as schistosomiasis, which affects over 200 million people worldwide, understanding and interrupting the role of snails in these parasitic cycles remains a public health priority (Colley *et al.*, 2014).

## **1.9 JUSTIFICATION**

This study focused on the relationship between freshwater snails and parasitic infections, a major concern in many parts of the world. Snails, especially those in the families of Planorbidae and Lymnaeidae, act as intermediate hosts for parasites that cause disease such as

schistosomiasis and fascioliasis. These diseases affect millions of people, particularly in Africa, Asia, and South America, and mostly impact those living in poor rural communities. In places where access to clean water and sanitation is limited, people are more exposed to environments where infected snails thrive. Therefore, understanding snail's interactions with parasites help reduce the spread of these infections. It also helped in planning proper control strategies like improving sanitation, managing snail habitats, or using molluscicides in a safe way.

Human activities, like farming, dam construction, and irrigation, affect water bodies and make them more suitable for snails. Therefore, parasitic infections are no longer limited to old endemic areas they are thereby spreading to new places. By studying snails, these changes can be monitored and early action taken before outbreaks (Steinmann *et al.*, 2006). Also, by documenting the types of snails found in freshwater bodies and identifying their parasites carrying capacity, useful data to public health and environmental research is contributed. This type of information supports national and global efforts to fight neglected tropical diseases, which the World Health Organization has prioritized in its roadmap for 2021–2030 (WHO, 2020).

### **1.10 AIM AND OBJECTIVES**

The aim of the study was to determine the trematode parasite infection in *Melanooides tuberculata* snails in River Siluko, Ovia South West Local Government Area, Edo State, Nigeria.

The objectives of the study were to:

1. determine the prevalence of parasite infection in *Melanooides tuberculata* from River

Siluko, Ovia South-West LGA, Edo State, Nigeria; and

2. identify the larval stages of trematode parasite infecting *M. tuberculata* from River Siluko, Ovia South-West LGA, Edo State.

## CHAPTER TWO

### 2.0

### LITERATURE REVIEW

Studies on trematodes of freshwater snails date back more than a century, with the role of snails as intermediate hosts first elucidated by Looss (1896) in his work on the life cycle of *Schistosoma* species. Subsequent investigations in the early twentieth century, particularly those of Faust (1920), extended this knowledge to encompass a range of trematodes of both medical and veterinary significance. By the mid-twentieth century, standardized techniques such as cercarial shedding and snail tissue dissection had been widely adopted for the detection of trematode infections in field-collected specimens (Frandsen and Christensen, 1984). In Africa, the detailed taxonomic and epidemiological studies of Brown (1994) and Kristensen (1987) provided essential field guides that improved the accuracy of snail species identification and parasite detection, thereby enhancing disease surveillance. Freshwater snails serve as hosts to several larval stages of trematodes. Infection begins when miracidia penetrate the snail tissues, developing into sporocysts sac-like germinal stages which may subsequently produce rediae, motile worm-like larvae capable of generating cercariae. Cercariae, which are free-swimming and morphologically diverse, represent the most frequently encountered stage in field surveys due to their active emergence from the snail in search of the next host. Accurate identification of cercarial morphotypes remains an integral aspect of parasitological

fieldwork, particularly in the monitoring and control of trematode transmission (Frandsen & Christensen, 1984; Brown, 1994).

## **2.1 PARASITIC INFECTIONS IN SNAILS GLOBALLY**

Biological control strategies had long been explored as alternatives to chemical molluscicides in the fight against schistosomiasis, and in this regard Pointier *et al.* (2000) assessed the potential of *Melanooides tuberculata* as a biological control agent against snail intermediate hosts of *Schistosoma mansoni* in the Caribbean. Their study demonstrated that the introduction of *M. tuberculata*, a highly invasive and competitive thiarid snail, led to significant reductions in the population densities of native planorbid snails, which are the primary vectors of *S. mansoni*. The displacement effect was attributed to the superior reproductive capacity and ecological adaptability of *M. tuberculata*, which allowed it to colonise a wide range of freshwater habitats and outcompete local species. Importantly, the decline in planorbid populations was strongly associated with reduced transmission potential of schistosomiasis in the study areas, thereby highlighting the effectiveness of this approach as a sustainable and environmentally friendly method of disease control. However, the findings also underscored the need for caution, since the widespread establishment of *M. tuberculata* carried possible ecological consequences, such as altered community structure and unintended impacts on non-target species. Overall, this work provided valuable evidence that biological control using invasive snails could play a significant role in schistosomiasis management, while simultaneously raising awareness of the delicate balance between disease control benefits and broader ecological risks (Pointier *et al.*, 2000).

Karamian *et al.* (2011) conducted a detailed parasitological and molecular investigation in Khuzestan Province, southwestern Iran, during 2009–2010. They collected over 3,800 freshwater snails, including *Lymnaea gedrosiana*, *Radix auricularia*, *Melanooides tuberculata*, *Melanopsis* sp., and *Physa acuta*, and performed cercarial shedding assays to screen for trematode infections. Only two *M. tuberculata* specimens shed ocellate furcocercariae belonging to the Schistosomatidae family. Subsequent sequencing of the Internal Transcribed Spacer (ITS) region revealed an unknown schistosome species closely related to the Gigantobilharzia–Dendritobilharzia clade. The authors concluded that this represented one of the first molecular characterizations of schistosome cercariae in *M. tuberculata*, emphasising the snail’s invasive ecology and its potential role in human cercarial dermatitis. Moreover, the study demonstrated the crucial importance of combining molecular diagnostics with conventional parasitological methods to uncover emerging zoonotic trematode threats.

In 2010, Zhou *et al.* conducted a study in Shanghai, China on the effects of low temperature on the schistosome-transmitting snail *Oncomelania hupensis* and the implications of global climate change, the causative agent of schistosomiasis, a disease of substantial public health concern in China and other parts of East Asia. This area had the ecological and climatic implications largely considered endemic for schistosomiasis in the country. The researchers sought to determine how winter cold tolerance in this amphibious snail influenced the distribution of the species and, by extension, the future epidemiology of schistosomiasis under the context of global climate change. This was a ground of enquiry given the ongoing debates on how climate warming may alter the distribution of disease vectors and intermediate hosts. The authors were particularly interested in the northward limits of *O. hupensis* distribution. These limits had historically been constrained by winter severity, as survival through sub-zero

temperatures was a key determinant of snail populations' persistence in the environment. The researchers compared the tolerance of "dry" and "wet" snails to sub-zero conditions. Among the results reported was the crystallization temperature (T<sub>c</sub>) of the snails. Dry snails had a mean crystallization temperature of  $-12.79 \pm 1.17^{\circ}\text{C}$ , while wet snails recorded a much higher T<sub>c</sub> of  $-5.36 \pm 2.11^{\circ}\text{C}$ . This clearly demonstrated that dry snails were able to supercool more effectively, avoiding the formation of internal ice and thus resisting freezing at much lower temperatures. According to the authors, this difference between dry and wet states was practically important, because it indicated the snail's ability to survive winter depended significantly on whether it is exposed to water or dry environments at the onset of cold conditions. The authors concluded that as winters become milder under global warming, *O. hupensis* was able to survive in regions that were previously too cold to permit its overwintering. This ecological shift allowed for the potential expansion of *S. japonicum* transmission into new geographical areas. Consequently, there was a rise in the burden of schistosomiasis in China, not because of changes in human behaviour or parasite biology, but because the intermediate host may expand its distribution range. This underscored the importance of integrating ecological and climatic factors into public health strategies for disease control. (Zhou *et al.* (2010))

### **2.1.1 TERRESTRIAL SNAILS**

Cowie (2001) examined the role of terrestrial snails in the transmission of parasitic infections in Hawaii, with emphasis on *Achatina fulica*, a widespread invasive species. The investigation demonstrated that this giant African land snail serves as a major intermediate host of *Angiostrongylus cantonensis*, the rat lungworm, which is an important zoonotic parasite affecting both rodents and humans. The findings indicated that infection prevalence was

particularly high among snail populations in tropical environments, underscoring the ecological significance of *A. fulica* in sustaining the transmission cycle of the parasite. Cowie highlighted the serious public health risk associated with the presence of *A. fulica*, especially in regions where human populations frequently come into contact with contaminated snails or their mucus trails. This work remains a foundational reference in understanding the epidemiological importance of terrestrial snails in parasite transmission dynamics.

Kim *et al.* (2014) published a study on the gastropod hosts of *Angiostrongylus cantonensis*, the rat lungworm. The research team included Hayes, Yeung, and Cowie, who are based at the University of Hawaii at Mānoa and the Bishop Museum. They have considerable experience in the study of invasive molluscs and parasitic diseases, which placed them in a strong position to explore the relationships between gastropods and the spread of this medically important parasite. The aim of the study was to assess the diversity of snail and slug species that can serve as hosts of *A. cantonensis* across the world, with particular attention given to the Hawaiian Islands. The rat lungworm is a parasitic nematode of rats, but gastropods act as intermediate hosts and transmit the parasite when consumed. In humans, infection can cause eosinophilic meningitis, a severe neurological illness. Hawaii has experienced repeated cases of this disease, which made it a relevant focus for this work. The study reported a striking level of host diversity. Globally, more than 120 species of terrestrial and freshwater gastropods were identified as natural or experimental hosts of *A. cantonensis*. This finding demonstrated the parasite's adaptability and its ability to use a wide variety of molluscan species to complete its life cycle. Such flexibility helps to explain the successful spread of the parasite across different continents. The results from Hawaii were of particular interest. The authors recorded at least 37 gastropod species that hosted *A. cantonensis* on the islands. These

included both native species and non-native species such as the giant African land snail (*Achatina fulica*) and the semi-slug (*Parmarion martensi*). The latter was highlighted as a particularly important host because of its high infection rates and its tendency to occur near human habitation. This combination of ecological traits makes it a strong contributor to the transmission cycle in Hawaii. The authors concluded that the extensive host range of *A. cantonensis* poses a major challenge for public health. Where a parasite depends on only one or two host species, control efforts can sometimes be targeted effectively. By contrast, the rat lungworm is sustained by a very broad range of gastropods, which makes eradication or even local control extremely difficult. The situation is further complicated by the role of invasive snails and slugs, which are spread through trade and human activity, and by the potential effects of climate change in altering distributions of both gastropods and the parasite. They provided a comprehensive global account of the many gastropod hosts of *A. cantonensis*. By combining a worldwide perspective with detailed observations from Hawaii, they showed that the parasite's transmission is reinforced by ecological diversity. Their work demonstrated the importance of considering multiple host species when assessing the risks of rat lungworm disease and underscored the complex challenges involved in its control.

Meffowoet *et al.* (2020) conducted a detailed investigation into the infestation rate of African giant snails (*Achatina fulica* and *Archachatina marginata*) by parasites during the rainy season across three localities in Cameroon. The study revealed the presence of various parasitic forms, including nematodes and trematodes, indicating that these edible snails can act as reservoirs for zoonotic parasites capable of transmission to humans. Given that these snail species are widely consumed as a nutritious and economically valuable food source, the findings highlight a significant public health concern. The researchers emphasized that poor

hygiene, inadequate handling, and insufficient cooking of snails could facilitate the spread of foodborne parasitic infections. Consequently, they advocated for proper sanitation, thorough cooking, and regular monitoring of edible snail populations to minimize infection risks. This study underlines the need for balancing the nutritional and cultural importance of snail consumption with effective preventive measures to safeguard human health. Overall, Meffowoet and colleagues' work demonstrates how environmental conditions and human practices can interact to increase the parasitic burden in edible snail species.

### **2.1.2 FRESHWATER SNAILS**

Pan (1965) during a laboratory experiment investigated the interaction of *Biomphalaria glabrata* snails with *Schistosoma mansoni*, focusing on compatibility, infection dynamics, and the developmental stages inside the snail. Pan exposed groups of snails to *S. mansoni* miracidia and recorded the infection rate. The results recorded a high infection success rate of about 60–80%, which depended on factors such as snail age, parasite strain, and number of miracidia used. The study found that once infected, the snails developed sporocysts and furcocercous cercariae, which confirmed successful parasite development. However, Pan also noted that not all infected snails produced cercariae, and that some infections were incomplete or aborted. The study showed that *B. glabrata* was a highly compatible host for *S. mansoni*, and snail–parasite compatibility was influenced by both environmental and biological factors.

Yousif *et al.* (1993) examined the ecology of *Biomphalaria alexandrina*, the principal snail vector of *Schistosoma mansoni* in Egypt, with emphasis on its distribution and seasonal dynamics within irrigation systems. Their study revealed that snail populations exhibited two marked annual peaks, one in spring (April–May) and another in late autumn (November–

December), while densities declined sharply during the hottest summer months and immediately after winter canal drawdown. These fluctuations were closely linked to hydrological and climatic conditions such as water temperature, flow regulation, and habitat availability, which directly influenced snail survival and reproduction. The authors further observed spatial variation in snail density, with certain canal sections serving as persistent hotspots that could sustain higher transmission potential. Importantly, periods of peak snail abundance coincided with favourable conditions for cercarial shedding, highlighting critical windows of increased schistosomiasis risk. The study concluded that effective control of schistosomiasis in Egypt requires interventions timed to these seasonal peaks, alongside targeted monitoring of ecological hotspots and integration of irrigation management with public-health measures.

Mubila and Rollinson (2002) carried out a comprehensive study on snail and parasite compatibility, and prevalence of *Schistosoma haematobium* on the shores of Lake Kariba, Zambia, as well as in Lake Bangweulu and Lusaka. Their aim was to evaluate how *Bulinus globosus* from different sites responded to miracidia from various *S. haematobium* strains and to determine how environmental and host factors influenced infection success. Out of the 2,184 *B. globosus* exposed to the miracidia of *S. haematobium* in the laboratory, 265 infected with an overall infection prevalence of 12.1%. The cercariae released were furcocercous, characteristic of *S. haematobium*. Infections were confirmed microscopically through the presence of sporocysts and cercarial shedding. The authors noted that environmental factors such as temperature, water flow, vegetation cover, and frequency of human water contact influenced both snail density and infection rates.

In 2003, Chimbari *et al.* examined the relationship between snail hosts and the transmission of *Schistosoma haematobium* on the shores of a freshwater lake in Africa. The research team, made up of Mubila, Rollinson, and Stothard, all of whom are recognized contributors to schistosomiasis research, set out to evaluate the compatibility between the parasite and local snail populations and to assess the prevalence of infection in the region. The study revealed that compatibility between *S. haematobium* and freshwater snails, particularly *Bulinus* species, was not uniform. Some snail populations were highly compatible and supported active shedding of cercariae, which meant they played a central role in maintaining the parasite's transmission cycle. Other populations were less suitable as hosts, displaying much lower levels of compatibility and contributing less to ongoing transmission. This variability highlighted that even within the same geographical setting, snail populations may differ in their role in the epidemiology of schistosomiasis. In terms of infection rates, prevalence was found to be particularly high along certain parts of the lakeshore. Human communities that relied on lake water for daily activities were at significant risk due to the combination of high-water contact and the presence of compatible snail hosts. However, prevalence was not evenly distributed across the study area. Some sections of the lake had lower levels of infection, which could be attributed to both reduced snail compatibility and differences in patterns of human water use. The authors concluded that snail–parasite compatibility is a critical factor shaping the distribution and intensity of schistosomiasis transmission. They emphasised that control measures need to be adapted to local ecological conditions. In areas where snail populations are highly compatible with the parasite, interventions such as snail control or sanitation improvements are essential to reduce transmission. In other areas where compatibility is limited, the epidemiological importance may be lower, and resources could be

directed differently. Overall, this work demonstrated the value of examining host biology alongside human epidemiological data. By showing that not all snail populations contribute equally to transmission, the study provided important evidence for tailoring schistosomiasis control strategies to local realities, thereby making interventions more effective and sustainable.

Toledo *et al.* (2012) reviewed the role of freshwater snails as intermediate hosts of trematodes in Southeast Asia, an area where parasitic diseases remain a major public health issue. Their work brought together evidence on the wide range of snail species that maintain transmission cycles, with a focus on groups like *Biomphalaria*, *Bulinus*, *Oncomelania*, and *Lymnaea*, which are all linked to important human infections such as schistosomiasis, fascioliasis, and paragonimiasis. The authors pointed out that the distribution of these snails is strongly influenced by local ecology, including river systems, rice fields, ponds, and irrigation networks, which provide habitats that favour both the snails and their parasites. They also stressed that infection prevalence varied between regions and species, showing that some snails acted as key reservoirs while others played only minor roles. Seasonal conditions, especially rainfall and flooding, were shown to boost transmission by increasing snail populations and contact between humans and infested water. Importantly, the study highlighted that Southeast Asia's high biodiversity means a greater variety of snail hosts and trematode species compared to many other regions, making control more complex. The authors concluded that effective strategies against trematode diseases in the region must consider the ecology of snails just as much as human behaviour, since breaking transmission depends on targeting both parasite and host in their shared environments.

### **2.1.3 MARINE/ESTUARINE SNAILS**

Curtis (2002) carried out a detailed investigation into the ecology of larval trematodes within three species of marine gastropods, aiming to understand how host biology and environmental conditions influence parasite communities. The work showed that these snails acted as crucial first intermediate hosts, harbouring a range of trematode larvae that played a central role in connecting different parts of the marine food web. Infection levels were not evenly distributed, with clear differences observed between the three gastropod species, reflecting variations in their life spans, population density, feeding behaviour and habitat preferences. The study also reported strong seasonal patterns, with higher infection rates during periods when definitive hosts such as fish and shorebirds were more abundant, reinforcing the idea that parasite transmission is shaped by the presence and movements of higher-level hosts. Another important observation was that infections tended to be aggregated, with a small proportion of snails carrying heavy parasite burdens while many remained uninfected, a distribution pattern that pointed to the influence of ecological hotspots where host and parasite interactions overlapped most intensely. Curtis highlighted that these infections had both ecological and evolutionary implications, as trematodes could reduce the fitness of their snail hosts while also affecting predator-prey relationships by altering snail survival and behaviour. The broader significance of the work lay in showing that larval trematodes are not just incidental organisms within snails but active players in marine ecosystems, influencing community structure, energy transfer and overall ecological stability. The study concluded that the diversity and prevalence of larval trematodes are tightly linked to the biology of their gastropod hosts and the wider dynamics of their coastal environment, making them valuable indicators of ecosystem health and change.

Bartoli and Gibson (2007) provided a wide-ranging overview of the life cycles of digenean trematodes found in lagoons along the northern coast of the western Mediterranean, drawing on years of observations across different host species and ecological settings. Their study revealed that these lagoons supported a striking variety of digenean parasites, with gastropod hosts playing a central role in harbouring the larval stages, while fish and birds frequently acted as later hosts in the cycle. The authors showed how parasite diversity in these systems was closely tied to the ecological richness of the lagoons themselves, which combine marine and freshwater influences to create a unique environment for transmission. A key point in their work was the balance between parasites with strict host specificity, which were adapted to a single snail species, and others that could infect a broader range of hosts, reflecting different survival strategies shaped by evolutionary pressures. Seasonal and environmental factors, such as temperature, salinity, and the arrival of migratory birds, also had a major influence on infection levels, demonstrating how dynamic these systems are. By linking parasite life cycles to the ecological features of the lagoons, the authors highlighted how local habitat differences, such as shallow muddy areas rich in snails or fish nurseries, could become focal points of transmission. Their overall conclusion was that digenean trematodes in Mediterranean lagoons are not only ecologically diverse but also important for maintaining the balance of these ecosystems, regulating host populations and acting as indicators of environmental change, with the added implication that human activity or climate shifts could significantly alter these delicate parasite–host relationships.

Lafferty and Kuris (2009) explored how parasites shape the structure and stability of food webs, focusing particularly on the way they can reduce ecological robustness by being highly vulnerable to secondary extinctions. Using the case of an invasive estuarine snail, the authors

demonstrated that parasites, despite being small and often overlooked, play a critical role in linking multiple species together and therefore make food webs more interconnected but also more fragile. Their findings showed that when host species decline or disappear, parasites are often lost as well, which can trigger further imbalances in the ecosystem and weaken overall resilience. The invasive snail provided a clear example, as it altered the local food web and disrupted established host–parasite relationships, leading to losses in parasitic diversity that would otherwise help regulate populations and maintain ecological balance. This work highlighted how parasites contribute to energy flow and species interactions at many levels of the food web, but at the same time revealed that their dependence on hosts makes them especially sensitive to environmental change and species loss. The authors concluded that understanding parasites is essential to fully grasping how ecosystems function, and they warned that ignoring their role risks overlooking key processes that determine how resilient or fragile a community might be in the face of disturbances such as biological invasions or habitat alteration.

## **2.2 PARASITIC INFECTIONS IN SNAIL SPECIES IN NIGERIA**

Freshwater wetlands in the Niger Delta are well known for their ecological richness, but they also serve as breeding grounds for parasites of public health concern. In a study carried out in Uruan communities, the freshwater snail *Melanoides tuberculata* was examined and found to harbour several zoonotic helminths capable of transmission to both humans and animals. The presence of these parasites highlighted the close interaction between the local environment, human activity, and the persistence of infection cycles in rural communities where water contact is frequent. The findings revealed that *M. tuberculata* was not just a passive component of the wetland ecosystem but an active link in maintaining zoonotic helminths,

which can complicate control efforts in endemic regions. By drawing attention to the risks posed by snail hosts in these wetlands, the study underscored the importance of continuous monitoring and the need for health education among local populations who depend heavily on the water bodies for daily use. These insights provided a clearer understanding of how environmental reservoirs support the persistence of parasitic infections in the Niger Delta (Ebenso and Ekpenyong (2015)).

The detection of *Schistosoma haematobium* in *Melanooides tuberculata* populations from Plateau State, Nigeria, provided important new insights into the transmission dynamics of urinary schistosomiasis in the country. This discovery was made through molecular techniques, which allowed the authors to confirm with precision that the species, not usually considered a classical host, was indeed harbouring the parasite. The significance of this finding cannot be overstated, because *M. tuberculata* is both widely distributed across Nigeria and adaptable to diverse freshwater habitats, particularly those linked to human activity such as rivers, ponds, and irrigation channels. Its involvement as an intermediate host means that communities living around these water bodies may face an additional risk of infection beyond that posed by the more familiar *Bulinus* species traditionally associated with *S. haematobium*. Another key contribution of the study was its demonstration that conventional field-based malacological surveys are limited, since they rely heavily on cercarial shedding and morphology, which can easily overlook cryptic infections. By applying molecular tools, the authors revealed a more complex picture of snail–parasite relationships, one that suggests schistosomiasis control programmes must broaden their scope when assessing potential transmission routes. The implications of these results are far-reaching, as they indicate that the disease may persist in unexpected ecological niches, making eradication more challenging if

only a narrow range of host snails is considered. Moreover, *M. tuberculata* is known for its invasive tendencies and ability to colonise new environments, raising the possibility that its role in schistosomiasis transmission could expand over time if not carefully monitored. The authors argued that a better understanding of local snail ecology, backed by molecular confirmation of infections, is essential for designing sustainable control strategies that account for all possible vectors of transmission. Taken together, the study enriched the knowledge of schistosomiasis epidemiology in Nigeria, highlighted the limitations of relying on classical malacological methods alone, and urged the incorporation of molecular diagnostics into routine surveillance. This broader perspective underscored the need for integrated interventions that address not just the human dimension of infection but also the overlooked ecological contributors that sustain the parasite, as shown by Adubi *et al.* (2022).

The morphometric variations and abundance of *Melanooides tuberculata* in freshwater ecosystems have continued to draw the attention of researchers due to the species' ecological adaptability and its role in parasitic transmission. In Makurdi, Nigeria, investigations revealed significant differences in shell morphology and population density of this snail species, underscoring the influence of environmental factors such as water quality, substrate type, and food availability on their growth and distribution. The study highlighted that the morphological variations observed in *M. tuberculata* could serve as useful biological indicators of habitat conditions while also pointing to the potential implications for the spread of snail-borne parasitic diseases, given the species' role as an intermediate host. The abundance patterns recorded suggested that local environmental conditions directly affect the snail's population dynamics, which may in turn influence disease prevalence in the area. These findings emphasize the importance of continuous monitoring of snail populations in

freshwater systems, particularly in regions where human and animal health could be affected by zoonotic parasites, as documented by Omeji et al. (2017).

Oloyede *et al.* (2016) carried out a detailed study on the assessment of water quality and the distribution of freshwater snails in Eleyele Dam, Ibadan, Nigeria, with the aim of understanding how environmental conditions influence snail populations and the risks they pose. Their findings revealed that physicochemical parameters such as temperature, pH, dissolved oxygen, conductivity, and nutrient concentrations played a significant role in determining both the abundance and diversity of snail species in the dam. Areas rich in organic matter and aquatic vegetation were identified as hotspots for snail proliferation, providing both shelter and food sources through algal and detritus accumulation. Of particular concern was the dominance of snail species that serve as intermediate hosts for trematodes, especially schistosomes, thereby linking snail ecology directly to the epidemiology of water-borne diseases in the community. Given that Eleyele Dam serves as a major source of water for domestic use, fishing, irrigation, and other socio-economic activities in Ibadan, the presence of these medically important snails species highlights a critical public health challenge. The authors stressed the need for routine monitoring and ecological management of freshwater bodies, emphasising that combining snail distribution data with water quality indices could serve as an early warning system for potential outbreaks of snail-borne diseases. They further recommended improved sanitation, regulation of human-water contact activities, and community awareness as vital steps towards reducing transmission risks. In a broader sense, their study contributes to the growing evidence that links environmental health with disease ecology in Nigeria, echoing similar reports from other freshwater systems across the

country where water quality has been shown to shape snail abundance and, in turn, the dynamics of parasitic transmission.

### **2.2.1 TERRESTRIAL SNAILS**

Awharitoma and Edo-Taiwo (2012) investigated the occurrence of *Rhabditis axei*, a nematode parasite of the Oxyuridae family, in terrestrial snails from southern Nigeria, thereby drawing attention to an often-overlooked dimension of snail–parasite interactions. They reported that a significant proportion of the snails examined were infected with *R. axei*, a parasite of both veterinary and medical concern, since it had been linked to infections in animals and, in rare cases, humans. Their study revealed that infection rates varied across snail species and locations, suggesting that both host factors and environmental conditions influenced parasite transmission. By demonstrating that terrestrial snails could act as reservoirs of *R. axei*, the authors widened the discussion on snail-borne diseases beyond the usual aquatic systems, pointing to risks in agricultural and domestic contexts. Their findings indicated that terrestrial snails could also serve as sentinel organisms for monitoring nematode spread in the region. Overall, the study highlighted the importance of recognising land snails not only as part of local food and ecological systems but also as potential contributors to disease transmission dynamics in southern Nigeria.

The study by Igbiosa *et al.* (2016) explored the parasites harboured by edible land snails in Edo State, Nigeria, with an emphasis on the potential public health consequences of consuming these snails. Their investigation revealed a wide range of helminth parasites infecting the snails, many of which are zoonotic and capable of being transmitted to humans either through direct handling or the consumption of undercooked snail meat. The findings were significant given the cultural and economic importance of land snails as a delicacy and

source of protein in many Nigerian communities, where they are often prepared and sold with little awareness of the associated health risks. The study highlighted that infection prevalence varied across different snail species and collection sites, with environmental conditions such as humidity, vegetation cover, and soil type influencing both snail distribution and parasite load. This pattern suggested that ecological factors not only shape the abundance of land snails but also determine their potential as reservoirs of infection. Importantly, the detection of parasites with known pathogenicity in humans underscored the urgent need for public education on proper snail handling, thorough cooking, and improved sanitation in snail harvesting areas. The authors argued that overlooking these risks could contribute to the spread of parasitic diseases in rural and peri-urban communities, particularly where snail consumption is high and access to healthcare is limited. By linking parasitology with public health awareness, the study shed light on an often-neglected pathway of disease transmission in Nigeria, urging both researchers and policymakers to take a proactive approach in addressing snail-borne zoonoses. The work of Igbinosa et al. ultimately emphasised that while edible land snails remain a valued food resource, their role as vectors of infection cannot be ignored if community health is to be safeguarded.

Onyishi *et al.* (2018) investigated the prevalence of helminth infections among terrestrial snails collected from both agricultural and domestic environments across urban and rural zones of Enugu State, Nigeria. A total of 618 snails belonging to seven species *Achatina achatina*, *A. belteata*, *A. degneri*, *Limicolaria aurora*, *L. flammea*, *Lamellaxis gracilis*, and *Orthalicus* sp. were examined. The study revealed a high overall infection rate of 62.8%, with *A. achatina* exhibiting the highest prevalence (76.4%). The recovered helminth parasites included species of *Cosmocercoides*, *Capillaria*, and *Philonema*, all of which are known to

have medical or veterinary relevance. The findings highlight the role of terrestrial snails as reservoirs for helminth transmission within semi-urban agricultural communities. The authors concluded that snail farming and human health may be at risk, particularly when these snails are consumed raw or insufficiently cooked; thereby underscoring the need for public health awareness and proper snail handling practices (Onyishi *et al.*, 2018).

### **2.2.2 FRESHWATER SNAILS**

Ecological studies by Ofoezie (1999) investigated freshwater snail vectors of schistosomiasis across south-western Nigeria, with emphasis on their field distribution, abundance, and association with environmental variables. The researcher found that snail species were most abundant in anthropogenic water bodies, including irrigation sites and domestic ponds, where favourable physicochemical conditions promoted survival and breeding. Their findings demonstrated that ecological factors such as water flow, vegetation, and substrate type significantly influenced snail population dynamics. The study concluded that the persistence of schistosomiasis transmission in the region was closely tied to environmental modifications that enhanced snail habitats.

Okafor and Obiezue (2004) conducted a malacological survey of freshwater snails in the Anambra River Basin, Anambra State, Nigeria, to determine the distribution, ecology, and infection rates of medically important snails. Out of the 4000 snails they examined, only 250 (6.3%) shed cercaria. Snails were collected from 13 sites across the basin, including Otuocha, Aguleri, Omor, Ayamelum, Nsugbe, Ifite Ogwari, Nteje, Anaku, Igbariam, Okija, Awka-Etiti, Agulu Lake, and Nando, covering rivers, streams, and a natural lake. In total, they recorded 17 snail species which includes five pulmonates (*Bulinus globosus*, *B. forskalii*, *B. truncatus*, *Lymnaea natalensis*, and *Biomphalaria pfeifferi*) and 12 prosobranchs (*Melanoides*

*tuberculata*, *Lanistes varicus*, *Pila ovata*, *Potadoma moerchi*, *Cleopatra bulimoides*, *Gabbiella senaariensis*, *Bellamyia unicolor*, *Viviparus contectus*, *Thiaropsis granifera*, *Turitella* sp., *Potadoma freethi*, and *P. freethi* var. *minor*). The dominant species were *B. globosus*, *L. varicus*, *P. ovata*, and *M. tuberculata*. *Bulinus* species serves as the main intermediate hosts of schistosome parasites. Infection was more common during the rainy season, when water levels and vegetation were high, and was influenced by water quality parameters such as pH, calcium, dissolved oxygen, and conductivity. Their findings revealed the presence of *Biomphalaria*, *Bulinus*, *Lymnaea*, and *Melanooides* species across sampled sites. Although infection prevalence among the snails was not reported, both *Bulinus* and *Biomphalaria* were recognized as potential vectors of schistosomiasis, thereby highlighting their public health significance. The study underscored the importance of sustained ecological monitoring of the basin, given that the occurrence of these vector snails represents a latent risk for disease transmission in the region.

Salawu and Odaibo (2012) carried out a preliminary ecological study on *Bulinus jousseaumei* in a rural Nigerian community that was endemic for schistosomiasis, and their findings added to existing knowledge on the ecology of freshwater snails that served as intermediate hosts of schistosome parasites. They observed that the abundance and distribution of *B. jousseaumei* were closely linked to environmental conditions such as water levels, vegetation cover, and seasonal changes. The species was found to be not only present but well established in the community, which confirmed its potential role in sustaining local schistosomiasis transmission. The authors also stressed that ecological observations of this kind were crucial for understanding how snail populations adapted to their habitats and how such adaptations contributed to the persistence of disease transmission in rural areas. Their study further

showed that monitoring snail ecology had direct public health relevance, since the stability and survival of snail populations influenced the transmission cycle of schistosomiasis. Although the research was described as preliminary, it provided a solid foundation for future investigations by highlighting the significance of *B. jousseaumei*, a species less studied compared to other *Bulinus* hosts in Nigeria. In conclusion, their findings reinforced the view that snail ecology and disease epidemiology were deeply connected, and they emphasised the importance of regular surveillance and targeted control strategies in rural communities where water contact was frequent and the burden of schistosomiasis remained high.

Akinwale *et al.* (2015) carried out a study on the molecular characterisation of *Bulinus* snails, which serve as intermediate hosts of schistosomes, in Ogun State, South-Western Nigeria. A total of 149 *Bulinus* snails were collected from rivers in Yewa North Local Government Area in the State. Four species namely, *Bulinus globosus*, *B. forskalii*, *B. camerunensis*, and *B. senegalensis* were identified using molecular techniques (PCR and DNA sequencing). Out of all the snails examined, 52 (34.9%) were infected with *Schistosoma haematobium*, the trematode parasite responsible for urinary schistosomiasis. The authors noted that the high infection rate was due to the dominance of *B. globosus* in the area, favourable ecological conditions, and the frequent human–water contact, which encouraged transmission.

### **2.2.3 MARINE/ESTUARINE SNAILS**

Brackish water ecosystems served as vital habitats for gastropod species that frequently acted as intermediate hosts for trematodes, and within this context Awharitoma and Aisien (2011) investigated *Tympanotonus fuscatus*, the brackish water periwinkle from the Niger Delta, Nigeria, to determine its role in trematode transmission. Their study revealed the presence of diverse larval trematodes including xiphidiocercariae, echinostome, gymnocephalous, and

furcocercous cercariae, which confirmed *T. fuscatus* as an important first intermediate host supporting the life cycles of multiple trematode species and maintaining parasite biodiversity in estuarine habitats. A key finding of their work was the observation of seasonal variation in infection prevalence, with higher rates occurring during the wet season, a pattern that suggested environmental conditions such as rainfall, salinity, and water level fluctuations strongly influenced both snail infection and parasite transmission success. These results carried important public health and ecological implications since periwinkles are widely harvested for food in the region, raising concerns about exposure risks to human and animal populations dependent on brackish water systems. By establishing baseline data on cercarial diversity and linking infection dynamics to seasonal ecological changes, the study not only provided new insights into host–parasite interactions in estuarine ecosystems but also highlighted the need for continuous snail surveillance and ecological monitoring to guide control strategies for trematode-related diseases in endemic areas (Awharitoma & Aisien, 2011).

## **CHAPTER THREE**

### **3.0 MATERIALS AND METHODS**

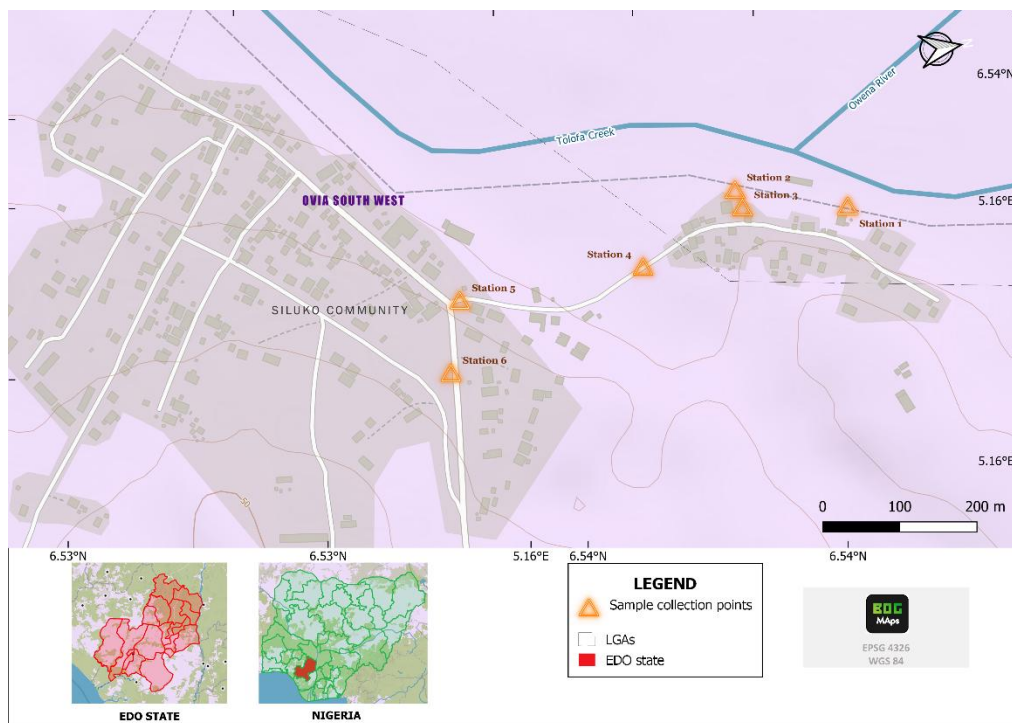
#### **3.1 STUDY AREA**

This study was conducted at River Siluko, Ovia South-West Local Government Area (LGA), Edo State, Nigeria in May and July, 2025. The area lies between latitude 6°32'365''N and longitude 5°09'559''E (Fig. 3.1). Siluko is a populated community in Ovia South-West LGA, Edo State, in Nigeria's South-South region. It lies about 56 km northwest of Benin City (straight-line distance). Elevation is approximately 21 m above sea level, though some sources estimate about 50–51 m (Oboh and Agbala, 2017). The people of this community are majorly into farming, fishing and selling of wood. Activities occurring in the river include domestic (clothes and plates washing) and recreational (swimming). The sampling location is presented in Plate 3.1.

#### **3.2 TOPOGRAPHY AND GEOLOGY**

Siluko Community is situated within the Southern Sedimentary Basin, specifically within the Benin Formation, which is predominantly composed of over 90% massive, porous coarse sands inter-bedded with thick layers of clay and shale that enhance groundwater retention. The

surface soils are typically reddish clayey sands, often enriched with iron or resulting from tropical weathering. Basement depth indicates a relatively flat relief in this sedimentary region, with contour variations ranging from 500 to 1900 meters. However, its shallow elevation approximately 21 to 51 meters above sea level place it close to the uppermost geological layers.



**Fig 3.1: Map of Study Area the Sampled Location at River Siluko, Ovia South West, Edo State, Nigeria**



**Plate 3.1: Hedges of River Siluko where *Melanoides tuberculata* were collected**

### **3.3 VEGETATION AND CLIMATE**

The climate condition of the study area is usually that of a tropical rainforest. It is divided into two seasons which are the wet seasons characterized by a period of prolonged rainfall (April to October) and dry season (November to March) with a temperature ranging from 25-30°C. Annual rainfall ranged between 1,500 mm and 2,500 mm. The vegetation comprises predominantly of shrubs like *Alchornea cordifolia*, *Abelmoschus esculentus* {Okra}, *Dialium guineense* (Black velvet) and *Elaeis guineensis* (African oil palm).

### **3.4 SNAIL SAMPLING**

Snail samples [*Melanoides tuberculata* (Red-rimmed melania)], were collected in May and July, 2025. Collections were carried out in the early hours of the day, between 9:00 a.m. and 12:00 p.m., from freshwater environments such as riverbanks and ponds. Adult snails were handpicked (Brown, 1994) while juvenile snails were collected using sediment washing and sieving methods (De Kock and Wolmarans, 1998) (Plates 3.1 and 3.2). The samples were then

transferred into 250 ml plastic containers with perforated lid and a little quantity of freshwater was added to keep the snails alive. They were thereafter transported to the laboratory of Public Health and Veterinary Parasitology for further investigation. In the field, the snails were rinsed thoroughly with clean water to remove debris and mud, and then held for at least 24 hours to allow clearance of gut contents such as waste products before further examination.

### **3.5 IDENTIFICATION AND PHOTOGRAPHY OF SNAILS**

The identification of snail samples collected for this study was based on external morphological characteristics and standard identification keys. The snails exhibited key diagnostic features consistent with *Melanooides tuberculata*, including elongated, turreted shells with 8–15 sharply pointed whorls, prominent spiral ridges, and surface tubercles. The shell coloration ranged from light brown to reddish, often with dark spiral bands, and the operculum was thin and horn-like, which are characteristic of prosobranch snails in the family Thiariidae. These morphological features were cross-checked using dichotomous identification keys provided by Brown and Kristensen (1993), which confirmed the identity of the specimens as *Melanooides tuberculata*.



**Plate 3.2: Collection of snails using sediment washing and sieving methods**

### **3.6 SNAIL EXAMINATION FOR PARASITE INFECTION**

The shedding method was first implemented in this study, a non-destructive method for examining snail samples (Frandsen and Christensen, 1984). Each snail was placed in a petri dish containing a small volume of water and exposed to light for several hours to induce the emergence of cercariae. The petri dishes were then examined under a dissecting microscope. This procedure was repeated for four days. When the snails failed to shed cercariae, the crushing method systematically described in snail-parasite (Barbosa, 1992), was then adopted for the detection of non-shedding larval trematodes such as sporocysts, rediae, and encysted cercariae in *Melanooides tuberculata*. Using a blunt forcep or a small hammer to gently break

the shell, and the internal tissues were placed in a petri dish and teased with a dissecting needle to release cercaria from the tissue of the snail.

### **3.7 IDENTIFICATION, PHOTOGRAPHY AND PROCESSING OF PARASITES**

Parasites obtained from infected snails were identified using morphological characteristics under light microscopy, following standard taxonomic keys (Frandsen and Christensen, 1984). A compound microscope fitted with a digital camera was used to capture high-resolution images of cercariae and other larval stages. The cercariae were then preserved in 96% ethanol and 5% formal saline to maintain their structural integrity for subsequent morphological and molecular studies.

### **3.8 DATA ANALYSIS**

In this study, both descriptive and inferential methods were applied to analyze infection patterns. Descriptive statistics such as mean, range, and standard deviation were used to summarize snail sizes and parasite counts, while prevalence, intensity, and abundance indices provided a clear overview of infection levels within the population. To test whether infection prevalence differed significantly across groups of snails, chi-square tests were employed. In addition, comparisons of parasite counts across snail samples or collection sites were carried out using ANOVA. These statistical approaches were chosen because they allow both a descriptive presentation and hypothesis testing, ensuring a clear interpretation of infection dynamics in the study population.

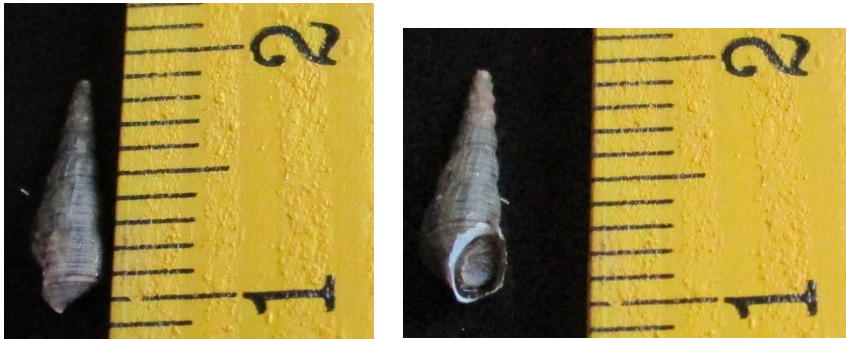
## CHAPTER FOUR

### 4.0

### RESULT

#### 4.1 Overall Prevalence and Type of Trematode Larval Stages in *Melanooides tuberculata* from Siluko River, Ovia South-West LGA, Edo State, Nigeria

A total of eighty-three (83) *Melanooides tuberculata* (Plate 4.1) were examined in this study, comprising of 17 snails in May and 66 snails in July, 2025. None of the snails shed cercaria when exposed to light. Only two (02) of the snails examined in May were found to be infected with larval stages of trematode parasites after crushing with an overall prevalence of 2.41% parasite infection and a prevalence of 11.76% in the month of May. There was no parasitic infection recorded in the July collection. The larval stages identified in the infected snails were redia (Plate 4.2) and furcocercous cercariae (Plate 4.3).



**Plate 4.1: *Melanoides tuberculata* (Red-rimmed melania)  
(A, Dorsal view; B, Ventral view)**



**Plate 4.2: Redia**



**Plate 4.3: Furcocercous cercaria**

#### **4.2 Morphometric of *Melanoides tuberculata* from Siluko River, Ovia South-West LGA, Edo State, Nigeria**

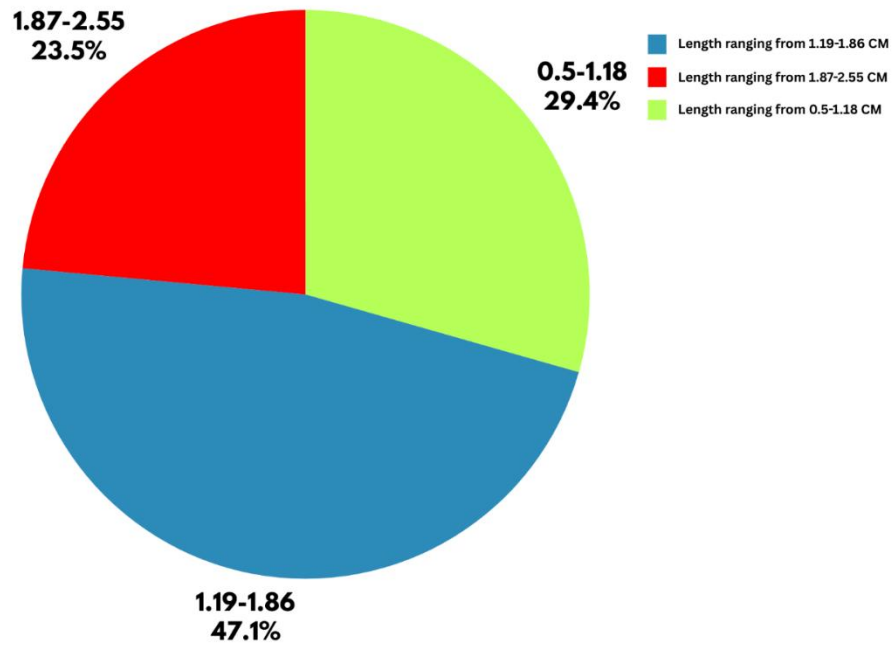
The shell length range of *Melanoides tuberculata* encountered during this study was 0.8 – 2.3 cm with a mean of  $1.52 \pm 0.36$  while the diameter was 0.2 – 0.9 cm (mean  $0.50 \pm 0.14$ ). In May, the shell length range was 0.8 – 2.3 cm (mean  $1.44 \pm 0.42$ ) with diameter of 0.2 – 0.7 cm (mean  $0.47 \pm 0.16$ ). The mean shell length of snails collected in May was  $1.47 \pm 0.44$  cm.

In July, the shell length range was 0.7 – 2.3 cm ( $1.54 \pm 0.34$ ) and diameter of 0.3 – 0.9 cm (mean  $0.51 \pm 0.13$ ). Statistical analysis revealed that there was no significant difference in length ( $F = 1.109$ ,  $p = 0.295$ ) or diameter ( $F = 1.409$ ,  $p = 0.239$ ) between the two months (Table 4.1). The length ranges of May and July from 0.5 to 2.55cm and it is shown in Figures 4.1 and 4.2, respectively. Figure 4.3 presents the mean morphometric and prevalence of parasite infection in *M. tuberculata* from River Siluko.

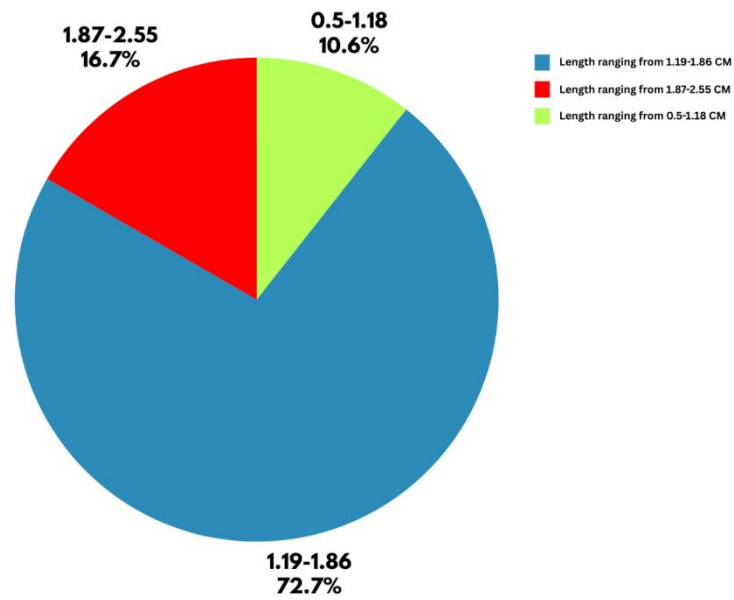
**Table 4.1: F-value and P-value of Length and Diameter of *M. tuberculata* from River Siluko**

<b>Variable</b>	<b>F-value</b>	<b>p-value</b>
Length	1.109	P>0.05
Diameter	1.409	P>0.05

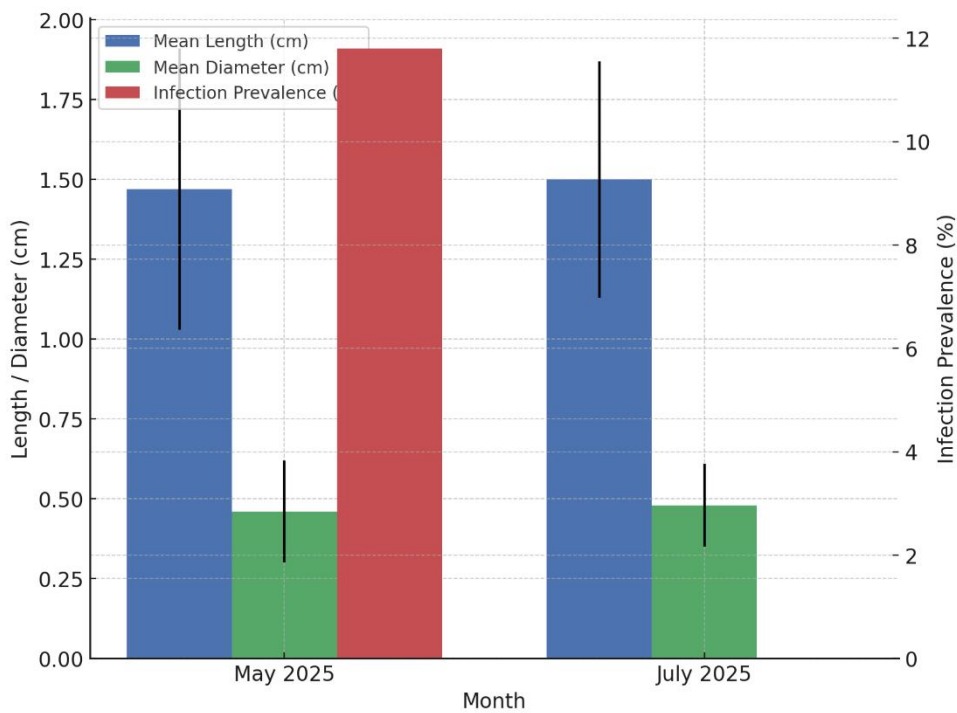
P<0.05 (Significantly difference); P>0.05 (Non Significantly difference)



**Figure 4.1: Size Distribution in *M. tuberculata* Samples Collected in May 2025 from River Siluko**



**Figure 4.2: Size Distribution in *M. tuberculata* Sample Collected in July 2025 from River Siluko**



**Figure 4.3: Mean Morphometric and Prevalence of Parasite Infection in *M. tuberculata* from River Siluko**

### 4.3 Morphometric of Trematode Larvae infecting *Melanoides tuberculata* from Siluko River, Ovia South-West LGA, Edo State, Nigeria

Morphometric analysis was carried out under  $\times 4$  magnification and revealed distinct structural differences between the two furcocercous cercariae (Table 4). Both cercariae exhibited the characteristic furcocercous tail (Plate 4.2) confirming their classification as furcocercous cercariae. In Cercaria 1, the head was relatively short and broad, with a length of 9.5 units and width of 6.0 units, while the tail measured 9.5 units long but only 1.5 units wide, ending in a bifurcation with the longest branch measuring 8.0 units. Cercaria 2, however, displayed a more elongated head with a length of 15.0 units and a narrower width of 5.0 units, while its tail measured 10.0 units long and 2.0 units wide, with a bifurcated branch length of 9.0 units.

**Table 4.2: Morphometric features of Trematode Larvae (Furcocercous cercaria)**

Morphometric Feature	Cercaria 1 ( $\times 4$ )	Cercaria 2 ( $\times 4$ )
Length of head	9.5	15.0
Width of head	6.0	5.0
Length of tail	9.5	10.0
Width of tail	1.5	2.0
Length of longest bifurcated tail	8.0	9.0

## CHAPTER FIVE

### 5.0

### DISCUSSION

This study investigated the parasitic infections in the freshwater snail, *Melanoides tuberculata* from Siluko River, Ovia South-West LGA, Edo State, Nigeria. It is noteworthy that the snail did not shed cercaria when exposed to light source but infection was observed after crushing. This is in conformity with the report of Pan (1965) who noted that not all infected snails produced cercariae, and that some infections were incomplete or aborted.

A low prevalence (2.41%) of trematode larval parasite infection was recorded in the infected snails examined in this study when compared to the account of Ebenso and Ekpenyong (2015) who reported prevalence of 5.03% larval trematodes infection from *M. tuberculata* investigated from selected wetlands in the Niger Delta region (Akwa Ibom State) of Nigeria. Only one type of cercaria (furcocercous) and redia were recovered in the snails from River Siluko, whereas these authors identified different cercaria forms including furcocercous, echinostome, xiphidiocercous, and monostome cercariae, as well as sporocysts, all associated with helminths of zoonotic potential. In the study furcocercous cercariae were the most abundant, an indication of the active transmission of schistosome-related trematodes within the region. Infection rates were shown to fluctuate with season and habitat type, being higher during the rainy season, when water levels and human-water contact were greatest. These variations between the two studies could be attributed to ecological and habitat differences. Ebenso and Ekpenyong (2015) worked in wetlands of the Niger Delta, characterized by stagnant, nutrient-rich, and highly contaminated waters, which provided ideal conditions for parasite proliferation and snail-parasite contact, leading to their higher prevalence. In contrast, River Siluko is a flowing freshwater ecosystem, where water current speed and reduced

organic load might limit survival of miracidia and infection success. Moreover, their detection of greater diversity of cercarial types suggests that the wetlands support multiple trematode species and definitive hosts, whereas the limited diversity in this study where only redia and furcocercous cercariae were encountered may reflect lower host-parasite interaction in the riverine environment. Mubila and Rollinson (2002) reported higher prevalence (12.1%) of parasite infection during a laboratory exposure of the miracidium of *Schistosoma haematobium* to *Bulinus globosus* snail from shores of Lake Kariba, Zambia, and Lake Bangweulu and Lusaka. The cercariae released/shed by the infected snails were furcocercous, characteristic of *S. haematobium*. According to the authors environmental factors such as temperature, water flow, vegetation cover, and frequency of human water contact influenced both snail density and infection rates. Similarly, furcocercous cercariae were also recovered from *M. tuberculata* at River Siluko. Negrão-Corrêa *et al.* (2012) noted that snail's internal defense system, particularly hemocytes and soluble hemolymph factors, recognized and destroyed many sporocysts before they could develop further; that the ability of snail to resist trematodes infection depended on how strongly its hemocytes attached to and encapsulated the sporocysts, with resistant snail strains displaying stronger immune reactions. This probably explains the low infection prevalence (2.41%) observed in this study, as many of the miracidia might have been destroyed by the snail's immune system before reaching the cercarial stage.

However, the observed prevalence in this study is higher when compared to that of Karamian *et al.* (2011) who reported lower prevalence ( $\approx 0.1\%$ ) of parasite trematode larva from *Melanoides tuberculata* during a parasitological and molecular study of aquatic snails from water sources (canals, rivers and swamps) in southwestern Iran. Of the five snail species (*M.*

*tuberculata*, *Lymnaea gedrosiana*, *Radix auricularia*, *Melanopsis* sp., and *Physa acuta*), only *M. tuberculata* was infected with ocellate furcocercous cercariae (Family Schistosomatidae). Molecular sequencing showed that these cercariae belonged to a previously unknown schistosome closely related to the Gigantobilharzia–Dendritobilharzia clade. The observed prevalence in *M. tuberculata* was extremely low, an indication that infection was rare in this snail species in the region. Furcocercous cercaria was similarly recovered in this study from *M. tuberculata*. The lower prevalence could be attributed to the arid/semi-arid nature of southwestern Iran and irrespective of the numerous water sources sampled only *M. tuberculata* was infected. The higher prevalence recorded in Siluko could be a reflection of more favourable environmental conditions, higher human or animal water contact. Najet *et al.* (2014) also recorded lower prevalence of 1.4% in *M. tuberculata* collected from the irrigation system of Ain Soltan’s oasis, south-west Tunisia. However, the furcocercous cercariae identified in the snails from Siluko River was also reported by the authors. According to the authors, the identified furcocercous cercariae were morphologically consistent with the descriptions of *Centrocestus formosanus* (a fish gill trematode of medical and veterinary concern) from Taiwan, Mexico, and Hawaii. The findings confirmed the role of *M. tuberculata* as first intermediate host in the parasite’s life cycle. The lower prevalence of larval infection reported in Tunisia may be linked to the cooler, arid climatic conditions and the artificial irrigation environment, which offered fewer definitive hosts compared to the more humid and natural Siluko River ecosystem where human, animal, and agricultural interactions are frequent. Hence, while both studies revealed the medical significance of *M. tuberculata* as an intermediate host, environmental, ecological, and host-parasite diversity factors accounted for the observed differences in infection rates. According to Hu *et al* (2024)

trematodes parasites distribution and transmission are common due to the presence of freshwater habitats and frequent water contact which make transmission easier and that infection rates in snails and fish varied widely from less than 1% in some areas to over 30% in others. The authors further explained that infection levels depended on factors like temperature, water quality, sanitation, and the level of human activity near water.

### **5.1. RECOMMENDATION**

Regular surveillance of freshwater snail populations to detect changes in infection prevalence and provide early warning of potential outbreaks is of utmost importance. Community health education and interventions in endemic regions and understudied regions are also essential. Local populations need to be sensitized on the risks of handling or consuming snails and of prolonged contact with infested water bodies. Simple preventive measures such as proper cooking of snails, reduced water contact, and better hygiene can significantly lower exposure. Improved sanitation, particularly the safe disposal of human and animal waste, is equally important, since contaminated water sources directly support parasite transmission. Further research using molecular diagnostic tools is recommended, as these methods provide more accurate results than traditional microscopy. Finally, integrated approaches that combine monitoring, sanitation, education, and possibly biological control remain the most effective way of reducing the risk of snail-borne diseases in endemic communities.

### **5.2. CONCLUSION**

Though, low prevalence of trematode parasite larval stages were recorded in the *Melanoides tuberculata* snails from Siluko River, it nevertheless, confirmed the possibility of *M. tuberculata* to serve as potential intermediate host of parasites that could probably be of medical or veterinary significance in the study area. Regardless of the low parasite prevalence,

transmission is possible under favorable conditions, particularly in rural communities where there is frequent contact with water for domestic, agricultural, and recreational purposes. It strengthens the evidence that snail populations across Nigeria waters continue to play a role in sustaining parasite transmission cycles, and it underscores the importance of routine monitoring of freshwater snails, as infection rates may fluctuate over time and rise under more favourable environmental conditions.

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