PAPER NAME

Jennifer_Project_work_1-1[1] copy copy.docx

WORD COUNT

12966 Words

CHARACTER COUNT

74504 Characters

PAGE COUNT

66 Pages

FILE SIZE

4.4MB

SUBMISSION DATE

Dec 10, 2025 1:53 PM GMT+1

REPORT DATE

Dec 10, 2025 1:55 PM GMT+1

6% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 5% Internet database
- 2% Publications database
- Crossref database
- 2% Submitted Works database

Excluded from Similarity Report

- Crossref Posted Content database
- Bibliographic material
- Quoted material
- Cited material
- Small Matches (Less then 8 words)

HELMINTH PARASITES OF GECKOS FROM INTERNALLY DISPLACE PERSONS (IDP) CAMP, UHOGUA COMMUNITY, BENIN CITY

BY

IMADE JENNIFER IKPONMWOSA

LSC2205310

DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

October, 2025

HELMINTH PARASITES OF GECKOS FROM INTERNALLY DISPLACE PERSONS (IDP) CAMP, UHOGUA COMMUNITY, BENIN CITY

BY

IMADE JENNIFER IKPONMWOSA

LSC2205310

A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE IN ANIMAL AND ENVIRONMENTAL BIOLOGY (BSCAEB)

October, 2025

CERTIFICATION

This is to certify that this project was carried out by IMADE JENNIFER IKPONMWOSA of the Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City.

____________________________ ___________________

MR. E.O. ALARI DATE

Project Supervisor

___________________________ __________________

PROF. MRS. I. TONGO DATE

Head of Department

DEDICATION

This work is dedicated to God Almighty.

ACKNOWLEDGEMENT

I want to start by appreciating the Management of the University of Benin, Benin City for granting me the opportunity to undertake an undergraduate program in this great institution in order to obtain a B.Sc. degree in Animal and Environmental Biology, Faculty of Life Sciences.

It is with a heart full of gratitude that I genuinely appreciate my Project Supervisor, Mr. E.O. Alari for his assistance, support, guidance and understanding during the course of my project work. My sincerest gratitude goes to Prof. M.S.O. Aisien, the Head of the Laboratory of Parasitological Research, Department of Animal and Environmental Biology, for his support intellectually and morally.

I extend my gratitude to the Head of Department, Animal and Environmental Biology, Prof. Mrs. I. Tongo, for her patience and persistent push for excellence and his words of encouragement.

My warmest regards to my lovely parents, Mr. and Mrs. Imade, who kept supporting me morally and academically in my educational pursuit. Thank you for your financial support and unwavering encouragement. I also appreciate my lovely siblings, for always encouraging me with kind words.

All praises and adoration are due to God Almighty who has brought me this far.

.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

Investigation of wall geckos, caught in IDP Uhogua, Benin City, Edo State for their parasites was undertaken between July and September , 2025. A total of 27 specimens were collected consisting of 20 males and seven females. Two species of geckos were encountered, consisting of *Hemidactylus angulatus* and *Hemidactylus mabouia*. Out of the 27 samples examined, 17 were *H. angulatus* and 10 were *H. mabouia*. Twenty three out of the 27 wall geckos examined were infected with parasites giving an overall prevalence of 85.18%. The parasites recorded included pentastomid;; *Raillietiella* sp. (55.55%), Cestode; O*ochoristica* sp. (7.41%), Nematode; *Parapharyngodon awokoyai* (3.70%) and *Thelandros scleratus* (62.96%). The most encountered parasite was *Thelandros scleratus* while the least encountered was *Parapharyngodon awokoyai*. More males (74.1%) were infected than Females (25.93%). This difference in prevalence values was statistically significant ($p<0.05$). The four parasites recorded in this study have previously been recorded by other researchers in Nigeria.Further study needs to be conducted on the helminth parasites of wall geckos from IDP camp Uhogua in order to unravel other species of wall geckos and helminth parasites infecting them which were not recorded in this study due to small sample size and short duration of study.

Investigation of two species of wall geckos caught in Uhogua, Benin City, Edo State for their parasites was carried out between July and October, 2025. A total of 32 specimens were collected and all were males. Two species of geckos were encountered, consisting of *Hemidactylus angulatus* and *Hemidactylus mabouia.* Out of the 32 samples examined, fifteen were *H. angulatus* and seventeen were *H. mabouia.* Nineteen out of the 32 wall geckos examined were infected with parasites given an overall prevalence of 59.38%. The parasites recorded included; Pentastomid; *Raillietiella sp*. (37.50%), Cestode; *Oochoristica sp.*(15.63%), Trematode; *Paradistomoides*(3.13%) and Nematodes; *Parapharyngodon awokoyai* (15.63%) and *Thelandros scleratus*(28.13%). The most encountered parasite was *Raillietiella sp*. having overall prevalence of 37.50% and mean intensity of 5.67 while the least encountered was *Paradistomoides* having an overall prevalence of 3.13% and mean intensity of 1.00. The difference in prevalence value was statistically significant ($p<0.01$).

All parasites recorded affected both *H. angulatus* and *H. mabouia* except *Oochoristica sp*. and *Paradistomoides* which infected only *H. mabouia*. The parasites recorded in this study have all been previously reported b other researchers from Uhogua and other localities in Edo State.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Geckos are small to medium-sized lizards that belong to the infraorder *Gekkota*, encompassing several families and a wide variety of species distributed globally, particularly in tropical and subtropical environments (Pérez-Higareda *et al.,* 2005). These reptiles are easily recognized by their unique adaptations, such as adhesive toe pads that enable them to climb smooth vertical surfaces, vocal communication in some species, and nocturnal behaviour (Roth *et al.,* 2009). Geckos occupy diverse habitats, ranging from forests and deserts to human dwellings, and they play essential roles in local ecosystems as both predators of insects and prey to larger animals (Pérez-Higareda *et al.,* 2005; King *et al.,* 2009).

Geckos typically measure between 3 cm and 15 cm in total length, including the tail. They possess soft, delicate skin, large expressive eyes, and a sturdy body supported by well-adapted limbs. Their distinctive digits are equipped with specialized adhesive structures that allow them to adhere to smooth surfaces and even navigate ceiling (Meiri, 2019; Russell and Higham, 2009).

Geckos are primarily nocturnal and exhibit behaviours that support survival in low-light environments (Roth *et al.,* 2009). Their toes are lined with microscopic hair-like structures known as *setae*, which create molecular interactions (Van der Waals forces) between the gecko and the climbing surface. This adaptation allows for extraordinary grip on vertical walls and ceilings. (Russell and Higham, 2009).

A gecko's tail serves multiple purposes. It functions as a fat storage organ and plays a defensive role (Higham and Russell, 2012). When threatened by predators, many gecko species can autotomize (shed) their tails to distract the attacker and escape. This detached tail continues to twitch due to a separate nerve mechanism, providing the gecko with a valuable survival advantage. Fortunately, they can regenerate a new tail over time (Miller, 20215).

Unlike many reptiles, geckos have vocal capabilities and communicate through chirps, clicks, and squeaks (Roth *et al.,* 2009). Though they lack eyelids, they keep their eyes clean by licking them. Their night vision is incredibly advanced, with sensitivity that surpasses that of humans many times over. (Roth *et al.*, 2014).

Geckos are members of the kingdom *Animalia*, phylum *Chordata*, class *Reptilia*, and order *Squamata*. Within the infraorder *Gekkota*, they are classified into several families, including Gekkonidae, Eublepharidae, Phyllodactylidae, Diplodactylidae, Sphaerodactylidae, Carphodactylidae, and Pygopodidae (Pyron *et al.,* 2013). These families represent a broad diversity of species adapted to various habitats across the globe. Ecologically, geckos are highly adaptable reptiles that thrive in a wide range of environments such as tropical forests, arid deserts, savannas, and increasingly, urban settlements (Amadi *et al.,* 2020). In human-dominated areas, they are frequently seen clinging to walls and ceilings, especially near sources of artificial light which attract their insect prey. Their diet consists primarily of ants, flies, moths, and cockroaches. As part of the food web, geckos also serve as prey for snakes, birds, and large arachnids, thus playing an important role in maintaining ecological balance within their habitats (Sousa *et al.,* 2017).

Most gecko species reproduce through oviparity, laying one or two hard-shelled eggs at a time. These eggs are usually hidden in protected spaces such as wall crevices or under rocks. The embryos develop within these shells, hatching after an incubation period ranging from 45 to 65 days, depending on environmental conditions. (Chapple and Keogh, 2005; Andrews, 2012)

In some rare cases, geckos exhibit live birth (viviparity), and certain species are capable of asexual reproduction through parthenogenesis. Female geckos can also store sperm in specialized ducts, allowing fertilization to occur long after mating this supports population establishment even in newly colonized areas (Chapple and Keogh, 2005).

During courtship, males may display a range of behaviours including body vibrations, vocalization, and scent marking (Vitt and Caldwell, 2013). Fertilized females produce eggs from each oviduct, and under suitable conditions, the hatchlings grow quickly, reaching sexual maturity within a few months (Chapple *et al.,* 2003).

The life expectancy of geckos varies across species. While some may live only 3 to 5 years in the wild, others, like the leopard gecko (*Eublepharis macularius*), may live up to 15–20 years in captivity under optimal conditions (Brown and Perez, 2007).

Geckos play both beneficial and potentially harmful roles in human society. On the beneficial side, they serve as natural agents of pest control by feeding on various insect pests such as flies, cockroaches, mosquitoes, and moths, particularly in agricultural and urban environments. This predatory behaviour helps to reduce the dependence on chemical insecticides, offering an ecofriendly and sustainable alternative for managing insect populations (Underwood, 2018).

Their presence in residential areas can contribute indirectly to public health by limiting the spread of insect-borne diseases such as malaria, dengue fever, and Zika virus through the reduction of mosquito populations. In traditional medicine practices, especially in parts of Asia, dried gecko extracts have been used in the treatment of ailments such as asthma, skin infections, diabetes, and even certain types of cancer, although scientific validation for such treatments is limited. (Xu *et al.,* 2018; Andrews and Laurance, 2015).

However, geckos may also pose a health risk to humans. They are known carriers of *Salmonella* bacteria, which can be transmitted through their droppings. When humans come into contact with surfaces contaminated by gecko faces, they may be at risk of developing salmonellosis a bacterial infection that affects the gastrointestinal system. As such, while geckos are valuable ecologically, they must be managed carefully in shared environments (Whiley *et al.,* 2017).

A parasite is an organism that lives on or within another living organism, known as the host, from which it derives nutrients and shelter. This relationship typically benefits the parasite while harming the host by draining its energy, impairing its health, and sometimes transmitting diseases. Parasites can affect a wide range of hosts, including humans, animals, and even plants (Combes, 2001; Morand and Krasnov, 2010).

Helminth parasites are a significant concern in reptilian hosts, including geckos, as they can influence the health, growth, behaviour, and survival of these animals. In geckos, helminth infections are often found in the gastrointestinal tract, though they may also affect other organs such as the lungs and liver depending on the parasite species. These parasites can cause malnutrition, lethargy, tissue damage, and even mortality in severe cases. Geckos, particularly those living in close proximity to human dwellings or in captivity, are susceptible to helminth infections due to exposure to contaminated food sources, intermediate hosts, or environments (Rataj *et al*., 2011).

The helminth parasites found in geckos typically belong to three main groups: Trematodes, Cestodes, and Nematodes. Nematodes, such as *Physaloptera* spp., are commonly reported in wild-caught geckos and reside in the stomach and intestines, where they feed on host tissues or pre-digested food, often leading to weight loss and digestive issues (Goldberg and Bursey, 2000). Cestodes, such as *Oochoristica* spp., are flatworms that attach to the intestinal lining using suckers and absorb nutrients, which can lead to nutrient deficiency in the host. Trematodes, although less commonly reported in geckos, may be acquired through ingestion of infected intermediate hosts like insects or snails and can establish in the digestive or hepatic systems of the reptile (Abdu *et al*., 2013). Studies have indicated that environmental conditions, diet, and the availability of intermediate hosts play a key role in the prevalence of helminth infections in gecko populations. Insectivorous feeding habits and exposure to contaminated substrates make geckos especially vulnerable. Moreover, parasitic load is often higher in wild geckos compared to captive ones, though poor hygiene in captivity can also lead to heavy infestations if not managed properly (Upton *et al*., 1992). Helminth infections may also affect the reproductive success and immune competence of geckos, thus influencing population dynamics.

In Nigeria, the research on helminths infecting geckos is relatively sparse, creating a gap in understanding the local biodiversity and parasitic threats associated with these reptiles. This scarcity of data limits our ability to assess the ecological impacts of helminths in reptilian hosts and the potential risks to other animals or humans who may come into indirect contact with infected geckos (Ajayi and Olayemi, 2015). Moreover, helminth infections can impair the biological fitness of host species, affecting their behaviour, metabolism, and reproductive success. Such disruptions could have cascading effects in local food webs where geckos serve as both predators and prey.

The lack of baseline parasitological data on geckos in this region is a pressing issue. Without empirical evidence on the prevalence, diversity, and intensity of helminth infections in gecko populations, conservation biology, public health policy, and ecosystem management efforts remain compromised (Akani *et al*., 2013). This study aims to bridge that gap by conducting a comprehensive helminthological survey of geckos within a defined geographical location in Nigeria. Doing so is crucial for informing future parasitological surveillance, ecological assessments, and possibly zoonotic disease prevention strategies.

1.2 Aim and objectives of the study

The study was undertaken to explore and document the helminth parasites infecting gecko populations in Uhogua community, Benin City, Edo State.

The specific objectives were to:

1. identify the gecko species present in Uhogua community.
2. investigate the distribution of helminth parasites in the geckos.
3. isolate and identify the helminth parasites infecting geckos in Uhogua community.

4. determine the overall prevalence and mean intensity of helminth infections in the geckos.
5. assess the prevalence and intensity of parasitic infections in relation to the sex of the geckos.

CHAPTER TWO

LITERATURE REVIEW

2.1 Global Distribution of Helminth Parasites in Geckos

Geckos tend to host a wide range of helminth parasites worldwide and various literatures provide evidence of this fact. Records have shown disease-causing parasites in the form of cestodes, trematodes, nematodes, acanthocephalans, and pentastomids. The infections are assumed to have a relationship with one another in terms of ecological factors, food, the habitat, locality area and the predator prey relationship. Local studies have provided valuable details on the assortment, virulence and zoonotic chances of these parasites which have added useful information to the diversity, pathogenicity and zoonotic potential of these protozoans.

Goldberg and Bursey (2000a) carried out research on the tropical house gecko (*Hemidactylus mabouia*) in Argentina in regard to helminth parasites. The sampling was done on walls and ceilings of human habitations in the province Misiones and a total of 30 specimens were collected. Helminth infection prevalence in the dissection conducted was 60%. The prevalent parasite was *Parapharyngodon sceleratus*, a widespread Oxyurid nematode, present in 40% of the samples and then *Oochoristica iguanae* (10%) and *Physaloptera* sp. larvae (10%). Evidence showed that the gecko was exposed to insect vectors as noted by multiple helminths. The study presented the flexibility of *H. mabouia* to urbanized habitats and the ecological consequences of helminth survival in symbiont lizard.

Goldberg and Bursey (2000b) studied helminth parasitism in the Asian house gecko (*Hemidactylus frenatus*) in Queensland, Australia, a species that has achieved success in the establishment of the population in different parts of the Pacific. 72 geckos were sampled in the outer walls of houses and city infrastructures. Helminths in the specimens were observed in 36.1% after the dissection. Recovered helminths were the nematodes, *Spauligodon hemidactylus*, *Physaloptera* sp. and the *Parapharyngodon* sp. Some few cestodes especially

Oochoristica sp. were also noticed. Interestingly, adult geckos were predominantly affected in majority of the infections and it can be assumed that they acquired it cumulatively as they long resided in an environment with infected prey. The research provided valuable information on the biodiversity of malicious geckos as well as the flexibility of the *H. frenatus* to acquire local parasite fauna in the new found habitats.

Goldberg and Bursey (2002) performed thorough research across southern Africa. They studied 107 separate lizards of four gecko species: *Chondrodactylus angulifer*, *Pachydactylus bibronii*, *P. capensis* and *Ptenopus garrulus*. Geckos used in this study were harvested by hand in the course of diurnal and nocturnal field surveys when in many cases they have been found by overturning rocks and debris or by searching homes and natural shelter. According to the researchers, they reported a vastly heterogeneous helminth fauna composed of one cestode (*Oochoristica ubelakeri*) and a range of nematodes (*Maxvachonia dimorpha, Parapharyngodon rotundatus, Skrjabinelazia ornata, Spauligodon petersi, Spauligodon Smithi, and* *Thubunaea fitzsimonsi*. They found out as well a few larvae of an undesignated character as such ascarid larva and cystacanth stages, which spots possible ways of infection that are potential intermediate hosts. The paper highlighted how helminth communities differ even among geckos of neighbouring habitats and that niche and diet are key factors which determine the level of parasitic load.

Bursey and Goldberg (2005) carried out a helminthological survey of the Brazilian tropical gecko *Hemidactylus mabouia* which is distributed widely throughout South America and can be found in human houses. The 40 geckos studied were captured at urban dwellings and vicinity of the Pernambuco State. A total of 45% was found to have helminth infections via dissections. The following nematodes were found; *Parapharyngodon alvarengai*, and *Physaloptera sp*., and the cestode *Oochoristica truncata*. The research offered evidence that the incidence and perpetuation of helminth populations are maintained by urbanized habitats in which geckos readily access infected arthropod prey. In explaining the effect of ecological factors, the authors highlighted the significance of temperature, humidity and density of geckos in determining the prevalence of helminths.

Jones and Pyke (2008) studied the Asian house gecko (*Hemidactylus frenatus*), in Queensland, Australia as a parasitological project. Of 112 specimens taken during a night survey at residential places, the researchers found a prevalence rate of helminth infection of 35.7%. The parasites that were dominant were nematodes which included *Parapharyngodon australis* and *Spauligodon hemidactylus*, with *Physaloptera* larvae sometimes reported. The helminths showed behaviours of site-specific localization in the gastrointestinal tract of the host with *Parapharyngodon* species predominately colonizing the colon and *Spauligodon* colonizing the anterior intestine. The larval forms found ingested by insects implied a close relationship between diet and parasite acquisition. The *H. frenatus* experiment indicated the susceptibility of the helminth community to other geographical areas especially in its transmission to new environments.

In a study conducted in Papua New Guinea by Goldberg *et al.* (2010), 203 geckos from 10 species were examined, among which were *Hemidactylus frenatus*, *Gekko vittatus* and *Lepidodactylus lugubris*. They were all captured by hand when conducting nocturnal searches in forests borders and residential areas. In the cause of the study, they found one trematode (which is a digenean), one cestode and 18 species of nematode, including *Oswaldocruzia*, *Parapharyngodon* and *Spauligod*. They also found one nematode larva which was unidentified which indicated a complex life history. This study highlighted a new record of 31 new hosts as well as 6 new localities for helminth parasites of geckos which indicated that even tropical ecosystems of islands can harbour a great faunal diversity of parasites due to high levels of ecological interactions

In Egypt, Ibrahim and El-Dakhly (2010) investigated the gastrointestinal helminths of *Tarentola annularis* which is a widespread wall gecko that is usually encountered in both households, and countryside settlements. These comprised 75 geckos which were taken in houses and farm storage places at Qena Governorate. It was found out that the total incidence of helminth infections was 45.3%. The dominant helminth species identified included nematodes, e.g. *Parapharyngodon micipsae*, *Spauligodon saxicolae*,n and Physaloptera larvae. Besides, there is the cestode *Oochoristica tarentolae* which was recovered in some few specimens and had been more isolated. The high rate of infection was explained by ascribing the geckos to feeding on insect food sources and their constant exposure to the insect intermediate which included cockroaches and beetles. Ibrahim and El-Dakhly have stressed the ecological role of *T. annularis* as a source of interface and probable conveyor of parasite at home and surrounding environments, thus revealing the crucial role of geckos in zoonotic disease monitoring in arid environments.

In Egypt, a survey reported 100 fan-footed geckos (*Ptyodactylus hasselquistii*) in a helminthological study carried out by Ibrahim and Soliman (2010) sampled in the desert and rocky terrain in the Aswan Governorate. They manually caught the geckos during daytime and evening hours from crevices, walls, and abandoned structures. Overall parasitological examination showed a 46% infection rate. Recovery of helminths fell within the level of *Spauligodon ptyodactyli* (29%), *Skrjabinodon ptyodactyli* (11%), and *Oochoristica maccoyi* (6%). Infections were restrained to the gastrointestinal tract which was based on the state and age of the host organism as well as the surrounding environment. The study emphasized the manner in which even dry settings are capable of maintaining helminths transmission, especially under conditions of mites and insects are the intermediate hosts that are still prevalent. The results are beneficial towards the limited information that exists on gecko-parasite relationships in Africa.

El-Dakhly *et al.* (2013) did a helminthological study on *Hemidactylus turcicus* obtained from different cities and peri-urban vicinities of the Governorate of Qena Egypt. 80 geckos were manually caught on walls, ceiling, and rooftops of buildings and especially at night when the reptiles were very busy in foraging. Analysis carried out highlighted a prevalence of infection amounting to 47.5%. The parasites retrieved involved the nematodes *parapharyngodon micipsae* and *Spauligodon hemidactylus* and the cestode *Oochoristica tuberculata*. Most infections occurred in the intestines, with some parasites being site-specific. The research raised the factor of environmental conditions, diet of the host animal as well as anthropogenic factors potentially having a major effect in parasite diversity and transmission in city reptiles.

A parasitological survey on native geckos of the Northern Territory of Australia was performed by Jones and Reside (2015). They focused on two species (*Gehyra australis* and *Heteronotia binoei*). This covered an attempt to find out how habitat gradients were related to parasitic load from arid scrubland to tropical woodland. They collected 112 geckos by means of a pitfall traps and hand collection during nocturnal transects. They discovered an occurrence of 29% infection of geckos with helminths. The parasites identified were the oxyurid nematode *Pharyngodon australis*, the *strongylid*, *Oxyuris gehyrae* and larval stages of *Mesocestoides* spp. The authors noted that higher infection rates were in regions with a high invertebrate diversity indicating that parasite transmission is particularly determined by the availability of prey and the distribution of the habitat. Their conclusions help to realize the ecological determinants in the helminth infections of gecko populations in the wild.

McAllister and Bursey (2016) examined helminth infection in 136 Mediterranean geckos (*Hemidactylus turcicus*) an invasive species found in some urban, suburban habitats in Texas, USA. They recovered the geckos by hand capturing from walls, fences and near artificial light where they capture bugs. They found 38% infection rate. Known helminths were the trematode *Mesocoelium meggitti*, three cestodes (*Oochoristica ameivae*, *O. scelopori and Mesocestoides* *tetrathyridia*), and nematodes which included *Cosmocercoides variabilis*, *Oswaldocruzia pipiens* and *Parapharyngodon cubensis*. Particularly, larvae of *Physaloptera* were identified, which are normally obtained by means of ingestion of insect which serves as an intermediate host. Quite a number of them were the first host records of H. turcicus, putting an emphasis on the role played by those introduced species in changing parasitic dynamics.

Silva *et al*. (2017) investigated the helminth fauna of two gecko species (*Hemidactylus mabouia* and *Phyllopezus pollicaris*) studied in the state of Sao Paulo, Brazil which is an anthropogenic habitat where these species are commonly found. There were 94 specimens collected in urban and semi-urban regions with the help of active search methods. Results of the study established a total helminth infection prevalence rate of 41%. Among the parasites detected, were nematodes *Physaloptera lutzi, Parapharyngodon bainae,* and *Spauligodon aff. Hemidactylus.* Also discovered from this study was a larval cestode from the genus Mesocestoides. It is crucial to mention that coinfection was prevalent especially among individuals amongst congested insects' population. The helminth range of diversity seemed to be affected by the consistent ecological areas, fauna preferences between the geckos, which enhanced their exposure to intermediate hosts. The results strengthen the notion that city resident geckos are good models in an urban setting that can act as reservoir of a diversity of helminths.

Jones and Mulder (2017) completed a parasitological survey in Quinns hill, Queensland, Australia where a study was carried out on the invasive Asian house gecko (*Hemidactylus frenatus*) in order to test its helminth load and ecological implications. The experiment involved 82 geckos which were gathered from residential areas through glue collecting trials and were caught and collected at night. The infection prevalence obtained by the researchers, amounted to 36.6%. Helminths which were recovered comprised nematodes such as *Parapharyngodon australis*, *Strongyloides* spp., and *Physaloptera* larvae, also recovered was the cestode

Oochoristica novaezealandiae, Notably, the most common parasite was *Parapharyngodon australis* as would be expected. This is what has been reported elsewhere in the Indo-Pacific. The authors were keen on noting that urbanized environments, with abundant insect life and unclean sanitation, added a good deal to the infection rate. In this study, adaptive parasitism of *H. frenatus* is shown with its possible contribution to local distribution of the reptile helminths of introduced and native gecko species.

Almeida *et al*. (2018) investigated the helminth fauna of *Hemidactylus mabouia* in the northeast of Brazil which is a gecko species that is common in urban areas of South America. The scientists gathered 120 specimens from different anthropogenic habitats such as schools, residential and road side walls. Dissection in addition to microscopic analysis indicated an infection rate of 49.2% in the analysis. The found helminths included the nematodes *Physaloptera retusa, Parapharyngodon sceleratus*, and *Oxyuris sp*., and the *Oochoristica eschterus* which was a cestode. It is worth noting that there was a higher helminth load in geckos that were caught from areas that are prone to waste and abundant with insect population. The paper has pointed out that densely populated habitats tend to predispose the geckos to more risks of contracting parasitic infections which could be attributed to high numbers of insect intermediate hosts and the gecko feeding styles. Almeida *et al.,* underlined the opportunity of *H. mabouia* as a health indicator of the manmade ecosystem that is tropical.

The study of Wongsawad *et al.* (2019) introduced an investigation of gastrointestinal helminths in the flat-tailed house gecko (*Hemidactylus platyurus*) in northeastern Thailand which is a specie that is usually found around residential areas. A total of 75 specimens were caught at night from houses and market places by hand capturing method. A total prevalence of helminth infection was reported at 48%. *Skrjabinelazia hoffmanni* and *parapharyngodon spp*. were both recovered as well as larval forms of *physaloptera spp*. All of which were nematodes and several examples of the cestode *Oochoristica sp*. In addition, the study revealed that there is a higher degree of helminth burden in geckos captured near sources of food or refuse areas, which indicate an ecological impact of an urban environment to the cycle of parasite This research made the malleability of the gecko to urban known parasitic cycles and incalculable values of constant supervision in the tropics.

A local study was conducted by El Tayeb *et al.,* (2020) on the white spotted wall gecko (*Tarentola annularis*) in Shendi, Sudan to estimate the prevalence and intensity of helminth in the geckos. The geckos were collected manually in the night by flashlights and hand capture methods along buildings, under stones and in walls which were examples of characteristic microhabitats, where the species is usually found. At the genus level, the researchers identified three nematode species including *Pharyngodon mamillatus*, *Spauligodon brevibursata* as well as an unidentified *Parapharyngodon* sp. The major parasite experienced was the *Pharyngodon mamillatus* with a prevalence rate of nearly 56.3% and a mean intensity that equals to 7.2 worms/ host. In this study, it was noted that adults and male geckos had much higher loads of parasites in them as compared to juveniles and females, pointing out age- and sex-related exposure disparities. The research brings attention to this fact by examining the role of physiological and behavioural characteristics in parasite acquisition.

Ganesh *et al*., (2021) observed helminth infection in the common house gecko (*Hemidactylus frenatus*), a synanthropic species commonly found in human settlement in southern India. The geckos were retained manually at night from residential buildings and specifically where there are light sources that attract the insects prey. 90 geckos were retrieved in total with an overall helminth infection rate of 41.1%. Some of the nematodes they identified were *Parapharyngodon* spp. *Spauligodon* spp. and *Physaloptera* larvae. A single cestode infection was recovered which was *Oochoristica* spp. Interestingly, more than a quarter of the co-infected geckos had nematodes as well as cestodes co-existing in the same host. These results indicate that an urban gecko is constantly being exposed to a wide array of parasites which may perhaps be as a result of opportunistic feeding habits as well as the close associations with insect intermediate hosts. This study is another addition to the knowledge of helminth diversity in reptiles that are sessile in cities of Asia.

2.2 Occurrence of Helminth Parasites in Nigerian Geckos

Helminth parasites in geckos have been recorded more often in Nigeria during the last several decades and particularly after increased concerns have emerged surrounding zoonotic diseases and biodiversity monitoring. The most frequent ones are of the genus *Hemidactylus* which are synanthropic in nature and are usually encountered in or near-town places. They are the draining promisors of surveys. There have been various studies conducted in the ecological zones of Nigeria which have presented great diversity and proliferation of endoparasitic and ectoparasitic helminths, with variable degrees of intensity and species specificity depending on location, climate, host species and sex.

One of the earlier comprehensive studies in Jos was carried out by Ameh *et al.* (2005) in Plateau State. In their study, 70 geckos were hand collected at night from walls and tree trunks where they are most active and easily seen. They analysed the intestinal tracts of the geckos and found a total infection rate of 60%. The study disclosed the occurrence of cestodes (family Proteocephalidae) in 41.4% of the subjects and nematodes (family Pharyngodonidae) in 30%. These results imply excellent host level in which the parasites were usually found in the intestinal tract. The study by Ameh is also pertinent to the present case signalling the contribution of habitats and host feeding habits to the prevalence rates.

Zita *et al.* (2013) carried out a study on 400 wall geckos from Ihiala Local Government Area of Anambra State. Geckos were captured manually from houses and homes during evening surveys with the use of hand capturing method alongside a torchlight. In their study they covered ectoparasites and endoparasites. The specimens had 45% ectoparasitic infestation that consisted of *Ixodes* sp. (61.1%), *Trombicula* sp. (5.6%), *Argasid* sp. (27.8%), and an Unknown species (4.2%). Endoparasitic infection showed a greater diversity containing *Parapharyngodon malplestomi* (33.3%), *Hedruris hanleyae* (23.8%) and *Oochoristica javaensis* (23.8%) and an unknown species (19.1%). The study indicated the importance of close contact of households and environmental sanitation inadequacy as vehicles of infections of parasites.

Chukwu *et al.* (2015) studied the impact of helminth parasites in geckos residing in the Nsukka, Enugu State Nigeria. There were 50 geckos (*Hemidactylus frenatus* and *Hemidactylus turcicus*) which were captured from vegetation and residential buildings with the aid of a torchlight and hand collection method at night hours. The rate of infection was 70%. Parasites that were recovered were *Parapharyngodon* sp. (36%), *Oochoristica truncata* (28 %), *Physaloptera* sp. (20 %) and an unidentified nematode larva (16%). 22% of the samples had mixed infections. The scholars have observed that helminth distributions of certain species were based on the type of habitat and the host diet with geckos found around areas with great insect diversity showing greater infection rate. In the study, it was pointed out that geckos are known to be useful reservoir host and possible sources of zoonotic parasites in peri-domestic spaces.

Along the further south in Uyo and Etinan Local Government Area of Akwa Ibom State, Oboegbulem *et al.* (2016) noted a prevalence of ectoparasites infection to be 55% and endoparasites infection was found to be 65% in the same sample study involving 60 wall geckos. Collecting of the geckos was done manually encompassing nocturnal surveys done through hand catch and sweep nets which was carried out around residential buildings and crevices which were typical gecko habitats. Noteworthy is the most common of these were *Parapharyngodon* sp. (84.6%) and *Oochoristica* sp. (63.3%). A much larger percentage of infected geckos was found to be males (68.9%) than females (18.2%), which was most likely influenced by a behavioural difference such as higher movement, fighting habits where they are provided with an extra contact to the infective forms.

Adeoye and Ogunbanwo (2017) carried out a research work in Ilorin, Kwara State and considered 120 wall geckos (*Hemidactylus frenatus*) both urban house-hold and in market set ups. The geckos were captured manually by hand at night which is their period of greatest activity. Dissection and examination under a microscope confirmed that 52.5% of the geckos were carrying at least one helminth parasite. Specific parasites identified were *Parapharyngodon senegalensis* (29.2%), *Spauligodon hemidactylus* (15.8%) and a third stage larval *Physaloptera* spp. (7.5%). Coinfections were ascertained in 10.8% of the infected hosts. The research explained the high burden of parasite to the high rates of human-gecko contact, lack of sanitation, and insect proliferation of vectors leading to the disease in the sampling locations. Their discovery highlighted the possibility of wall geckos being the carriers of zoonotic helminths in domesticated areas.

In a study, Okafor and Opara (2017) carried out a helminthology survey on wall geckos in Umuahia Abia State involving 35 individual geckos that were manually captured from both indoor and outdoor walls of vegetated surrounding with hand capturing method and with the aid of a torch light at night. Helminth prevalence was seen to be 74.3%. The most occurring parasites found in the study were *Spauligodon hemidactylus* (42.9%), *Ooachristica africana* (25.7%), *Physaloptera retusa* (17.1%) and *Parapharyngodon* spp. (14.3 %). Female geckos (81.8%) had higher cases of infections as compared to male geckos (66.7%). The authors attributed the high levels of prevalence to urban-rural interface which increased accessibility to intermediate hosts and then increases gecko-insect meetings. They concluded that the prevalence rate of helminths in geckos denotes environmental ecology and sanity.

In a study carried out by Akinlolu and Ayodele (2017) about the helminth parasite of geckos in the campus of Obafemi Awolowo University Ile-Ife, in southwestern Nigeria, they studied 30 geckos (*Hemidactylus frenatus* and *H. mabouia*) which were captured by hand from walls of laboratory and residential buildings at night during active searching. Based on the parasitological study, 73.3% of the geckos had at least one helminth parasite. The species that were recovered include: *Raillietiella sp., Oochoristica truncata, Spauligodon oxkutzcabiensis* and *Physaloptera* spp. The parasite which was mostly dominant was *Raillietiella sp.* with a greater infection level in male geckos. The experiment had its focus on the fact that the prevalence and the diversity of the helminths with regard to environmental factors such as the humidity, habitat among others was influenced by degradation of forests, human induced ecological changes and various forms of ecological changes.

The study carried out by Oluwafemi *et al.* (2017) was widely across southwestern Nigeria and targeted two lizard species *Hemidactylus frenatus* (n = 172) and *Mabuya quinquetaeniata* (n = 61). The lizards were caught by a method of hand grabbing and noosing either during the day or evening hours basing on the species and the nature of their activity as well as accessibility of their habitat. They reported high helminth diversity which included three nematodes (*Parapharyngodon* sp., *Spirura* sp. and *Pharyngodon* sp.) a cestode (*Oochoristica truncata*), a pentastomid (*Raillietiella frenatus*), a trematode (*Mesocoelium monas*), a cystacanth of some unidentified acanthocephalan. The overall prevalence level of *H. frenatus* and *M. quinquetaeniata* was 64.0% and 72.1%, respectively. The study highlighted that environmental exposures and diet of the hosts probably influence the helminth heterogeneity and concentration.

Obadiah and Nwogu (2017) explored the gastrointestinal helminth of *Hemidactylus frenatus* in Port Harcourt, Rivers State. During the research, they focused on the parasitic variation and the infection diversity from several parts of the city. 30 geckos were caught using hand nets and torches from wall of residential and commercial buildings. The study revealed a high helminth prevalence rate of 86.7 %. Four species of helminths were identified which include *Oochoristica africana* (cestode), Pentastomid (*Raillietiella sp.*), nematode (*Physaloptera* sp.), and trematode (*Mesocoelium monodi*). The most prevalent parasite was *Oochoristica africana,* with 63.3% of the hosts infected. The research noted the zoonotic potential of gecko-related helminth in high population settings and stressed the focus on regularised community health with regard to domesticated reptilian fauna.

A research study as regards geckos in a parasitological investigation conducted by Ishola *et al.* (2018) surveyed the residential quarters within University of Ilorin, Kwara state. A total of 30 geckos (*Hemidactylus frenatus*) were manually caught when conducting nocturnal surveys via torchlight aided hand capture from building walls and gardening environs. The proportion of the helminth infection as a whole was measured at 76.7%. Helminths identified in the sample were *Oochoristica telfordi* (43.3%; with mean intensity = 3.1), *Spauligodon hemidactylus* (26.7%) and the larvae of *Physaloptera* sp. (13.3%). Coinfection was found in 16.7% of the entire specimens. According to the authors, male geckos had increased rates of infections than the females and this was attributed to paving paths against poor handling of waste that lures insect intermediate hosts.

A parasitological survey was done in Ibadan, Oyo State by Adegbite and Ajayi, (2018) in and around the university hostels and lecture halls involving two gecko species (*Hemidactylus frenatus* and *Hemidactylus turcicus*). The geckos were sampled at night with the help of headlamps and sticky traps and a total amount of 72 geckos were recovered. The identified helminths include *Raillietiella frenatus, Oochoristica africana*., *Parapharyngodon* spp., and *Spauligodon hemidactylus*. The general prevalence rate was 50% with nematodes responsible for 68% of the infections. The study highlighted a higher infection intensity in geckos that were obtained near refuse dumps and open drain and perhaps due to greater insect vectors. There was also seasonal variation that was noted and higher burdens were reported during the wet seasons. According to the study, the quality of microhabitats and anthropogenic did not go unnoticed as it had an effect upon the degree of parasites in the town reptiles.

Ugbomeh and Aisien (2018) carried out an elaborate parasitological scanning of Hemidactylus species in Port-Harcourt, Rivers State, Nigeria. Evening surveys were carried out to capture the geckos by hand from house walls and from vegetable surroundings. From the 25 specimens analysed, there were 19 (76%) that had different helminth parasites. The helminths that were identified were *Parapharyngodon delicatus, Thelandros scleratus, Oochoristica africana* and *Raillietiella sp.*. The most dominant species was *Thelandros scleratus* which was located at the posterior part of the intestine. Co-infection was also evident since the study revealed that 42% of the geckos were also infected indicating complicated epidemiology and host susceptibility in urban places with high population. Researchers identified gecko diet as a significant way that contributes to the infection rates.

Ajayi and Alarape (2018) carried out a parasitological study of helminth in *Hemidactylus mabouia* in Ibadan, Oyo State. 75 geckos were captured manually across ceilings, window sills and walls of residential buildings during night hours. The overall infection rate during the dissections turned out to be 53.3 % with higher prevalence occurring in nematodes. The species that were most dominant include *Parapharyngodon micipsae, Spauligodon hemidactylus* and *Physaloptera* sp., infection of *Oochoristica africana* which is a cestode was also recorded but at a lower prevalence. The infection rate in adult geckos was high as compared with juveniles implying age-dependence. The resilience of *H. mabouia* highlighted in the study is because of ecological related factors and geckos being potential reservoir host for helminth parasite.

In Edo State, Nigeria, Emokpare (2019) evaluated the presence of helminth infection in a number of *Hemidactylus* species which included *H. angulatus, H. mabouia, H. fasciatus, H.*

altuberculatus and one unknown species. Hand sampling was done at night with headlamps and sweep nets to capture geckos from walls, residential compounds and vegetation in which they normally forage. Ten helminth taxa were uncovered when the survey was carried out which include pentastomid (*Raillietiella sp.*), cestode (*Oochoristica* sp.) trematodes (*Mesocoelium monodi, Paradistomoides* sp.), nematodes (*Thelandros scleratus., Parapharyngodon* sp., *Physaloptera* sp., *and Spauligodon* sp.). *Mesocoelium monodi* had the greatest average intensity indicative of heavy parasitic adaptation to the bowel of the host. This was a major research which helped in the comprehension of species-specific parasite and western Nigeria and her ecological patrimony.

Onyekaba and Ezealor (2020) carried out a study into helminth infection in *Hemidactylus frenatus* and *Hemidactylus mabouia* which are usually found slathered on the campus buildings and residential homes in Nsukka, Enugu State. 80 geckos were caught through hand collection and torchlights particularly from walls and ceilings. Among the 80 geckos captured, 47.5% of them were infected with at least one helminth infection. Identified parasites consisted of *Parapharyngodon* spp., *Physaloptera* sp., *Oochoristica* sp. and *Rhaillietiella* spp. It is important to note that *Parapharyngodon* spp. was most frequent especially in *H. frenatus*. The researchers also noted mild bowel inflammation in heavily infected geckos pointing at possible subclinical health effects on the host. Of the findings, the importance of habitat type and feeding ecology was mentioned in determination of parasite transmission dynamics amongst urban-residing geckos In south east Nigeria.

Helminth parasites were investigated in *Hemidactylus mabouia* and *H. frenatus* by Okonkwo and Ezealor (2020) in the southeast of Nigeria. The geckos were captured from school compounds and market buildings by hand which are good locations where these species are usually found. A total of 65 specimen was collected. Seven helminths' taxa were found by post-mortem analysis such as nematodes (*Parapharyngodon* spp., *Thelandros* sp.), trematodes

(*Mesocoelium* spp.) and cestode (*Oochoristica* sp.). *Parapharyngodon* spp. had the highest prevalence (38.4%) and average worms on hosts (4.2). It is notable that the frequency of occurrence of the parasites had correlation with the age of buildings, poor environmental condition where these geckos are found and which are likely to contain a greater number of intermediate hosts such as insects. The study noted that landscape structure and cleanliness influenced the spread of the parasitic infection in the reptile fauna.

Nzegwu and Ezealor (2020) performed a parasitological analysis on *Hemidactylus frenatus* and *H. angulatus* in Enugu state in South eastern Nigeria. The geckos were captured from both rural and peri-urban regions using hand capture practices at the initial hours of nightfall when the geckos were on the move. Out of the 42 geckos that were captured, 33 (78.6%) of them were infected with at least one species of helminth. Findings of the study identified some parasites which included *Spauligodon* sp., *Physaloptera* sp., *Raillietiella* sp., and *Mesocoelium monodi*. *Spauligodon* sp. best documented with the highest prevalence at 47.6% and it was mostly found in the intestinal tract. The authors indicated that human activity and exposure to organic matter nearing a decay stage played strong roles in helminth transmission. The research gave fresh information about the host-parasite ecology and cross-species infection potentials in the future.

Okon and Effanga (2020) examined the helminth parasite of *Hemidactylus angulatus* and *Hemidactylus frenatus* from outdoor environments such as car parks, market stalls, classrooms and residential building in Calabar Cross River State. During the evening hours, 68 geckos were taken by using sweep nets and hand capturing method. The research found out an infection rate of 47.1%. The identified parasites include *Spauligodon hemidactylus*, *Parapharyngodon cubensis* and the cestode, *Oochoristica* sp. Intriguingly enough, the abundance of nematodes was higher among geckos collected from indoor settings probably because of increased concentrations of insect intermediate hosts. The authors also recorded variations in the parasite burden in the two species which implies ecological exposure and species-specific susceptibility. These findings added to the local expertise of the parasite-host relationship and the social health importance of synanthropic geckos.

A helminthological survey of the Hemidactylus species was carried out by Okon and Etim (2020) in Cross River State, Calabar, in focus of determining gastrointestinal parasites and an assessment of infection parameters. Using the manual method, 25 geckos were caught at night from building walls and wooden fences using headlamps and sterile gloves. The dissection and recovery of parasites indicated 84% infection rate. The most dominant were the nematodes especially, *Parapharyngodon* sp. (60%), and *Thelandros scleratus* (40%). Presence of trematodes was also reported but in very little amount, such as *Mesocoelium monodi* (8%). The authors observed a statistically significant difference in the parasite burden between rural and urban samples which implies that regional hygiene and terrestrial arthropod abundance has a parasite transmission effect. This study helped to gradually expand the knowledge of gecko-parasite association in tropical terrestrial habitat.

Omeje *et al.,* (2020) explored the situation of helminth infection in 250 tropical house geckos (*Hemidactylus mabouia*) In Nsukka, Enugu State. Geckos were caught from compounds and market stalls at night with the aid of headlamps and hand capturing method. Screening results showed a 48% infection rate. Helminths detection includes *Spauligodon hemidactylus* (35.6%), *Physaloptera* spp. larva (22.4%), *Oochoristica truncata* (2.9%) and *Parapharyngodon* spp. (15.9%). Mixed infection was 11.2% of the infected samples. The authors highlighted the anthropogenic factors that include open waste disposal and pools of stagnant water sources, which probably contributed to transmission cycles between insect vectors and geckos, which can cause possible health problems to the population.

Ogboh (2021) examined 26 geckos from Temboga, Ikpoba-Okha LGA, Edo State, and reported an overall helminth prevalence of 65%. The geckos were captured using direct hand collection during nighttime hours when the animals were more active on walls and near light sources, which are typical resting and foraging spots. Infection was significantly higher in *H. angulatus* (91%) compared to *H. mabouia* (47%). The helminths identified included *Raillietiella* sp., *Oochoristica* sp., *Pharyngodon* sp., *Thelandros scleratus*, and *Spauligodon* sp. *Raillietiella* sp. was notably dominant (72% in *H. angulatus*, 100% in *H. mabouia*), underscoring its adaptability and possible zoonotic potential.

Inegbedion (2021) carried out a focused study at the Rubber Research Institute of Nigeria in Iyanomo, Edo State, examining 19 geckos (10 males, 9 females). The geckos were collected manually during nocturnal field surveys using torch-assisted hand capture, targeting geckos found on building walls and vegetation in their natural habitat. An astonishing 89.5% overall prevalence was recorded. The dominant helminth was *Raillietiella* sp. (78.9%; mean intensity = 4.9), while *Paradistomoides* sp., *Spauligodon* sp., and *Oochoristica* sp. were each present in 5.3% of samples. The study highlighted variation in prevalence by host sex and species: 90% in *H. angulatus*, 75% in *H. mabouia*, and 100% in an unidentified *Hemidactylus*. The high prevalence was attributed to moist and decaying environments conducive to parasite development.

Ogunleye (2022) conducted a helminthological assessment of gecko populations within the Obafemi Awolowo University campus in Ile-Ife, Osun State. A total of 22 geckos (12 males and 10 females), primarily *Hemidactylus mabouia* and *H. angulatus*, were hand-collected from walls of lecture halls and student hostels during night surveys using flashlights. Dissections revealed an overall helminth prevalence of 81.8%. *Spauligodon* sp. was the most prevalent parasite (68.2%), followed by *Physaloptera* sp. (27.3%) and *Oochoristica* sp. (13.6%). The mean intensity for *Spauligodon* sp. was 3.7, with males harbouring a slightly higher worm burden. The study attributed high infection rates to the abundance of insect intermediate hosts in poorly lit and unsanitary corners of the buildings. It further emphasized the role of human-proximate habitats in facilitating parasite transmission in synanthropic reptiles.

The helminth fauna of Nigerian geckos is characterized by significant taxonomic diversity and regional variation. *Raillietiella*, *Oochoristica*, and *Parapharyngodon* species consistently emerge as dominant taxa across multiple studies. Observed differences in infection rates by host species and sex, as well as across ecological zones, reinforce the importance of environmental and behavioural factors in shaping helminth distribution patterns in Nigerian geckos.

Babatunde *et al*. (2025) investigated the prevalence and intensity of ecto- and gastrointestinal parasites infecting *Hemidactylus frenatus* (wall geckos) in Akure North Local Government Area, Ondo State, Nigeria. A total of 360 geckos were sampled across six communities and examined for parasites using standard parasitological techniques. Overall, 68.9% of H. frenatus were infected with ectoparasites, while 66.4% harboured gastrointestinal parasites. The most prevalent ectoparasite was *Trombicula* sp. (35.8%), and *Parapharyngodon* sp. (37.5%) was the dominant gastrointestinal parasite. *Cryptosporidium* spp. was detected in 6.9% of the geckos using modified Ziehl-Neelsen staining. Ectoparasites were primarily located on the back and limbs, while gastrointestinal parasites were most abundant in the large intestine. Chi-square analysis revealed no statistically significant differences in parasite prevalence across sampling locations and sex ($P > 0.05$). These findings highlight the high parasite burden in H. frenatus and the potential public health risks associated with their close proximity to human dwellings.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Description of Location of Study

This study was carried out in a locality around a poultry farm that is in the peri-urban area of Uhogua in Ovia North-East Local Government Area (LGA) of Benin City, Edo State, Nigeria. This area lies within the tropical rainforest belt in Nigeria and it has two noticeable seasons; the rainy season and the dry season. Its location referred to a semi residential area that was in an infrastructural development stage with simple proximity to farmland, natural vegetation, and a combination of completed and still under construction buildings.

3.2 Sample Collection of Geckos

Specimen collection was done in the months of June and July. The gathering of geckos took place in the active part of the day (starting in the evening up to the night when their activity is most pronounced). A broom was used to lightly knock them off walls into the ground and minimise damage. The geckos were not to be picked up by the tail but by the neck area to avoid the chances of getting injured and losing the tail. In order to avoid suffocation, the collected geckos were initially kept in plastic containers that were under ventilation. Analyses were performed on all specimens within 24 hours of capture.

3.3 Euthanasia of Geckos

The individual geckos were euthanized by inserting into a kill jar containing tissue soaked with chloroform. Exposure was done in 5 minutes approximately. Species of every gecko was identified and noted after euthanasia.

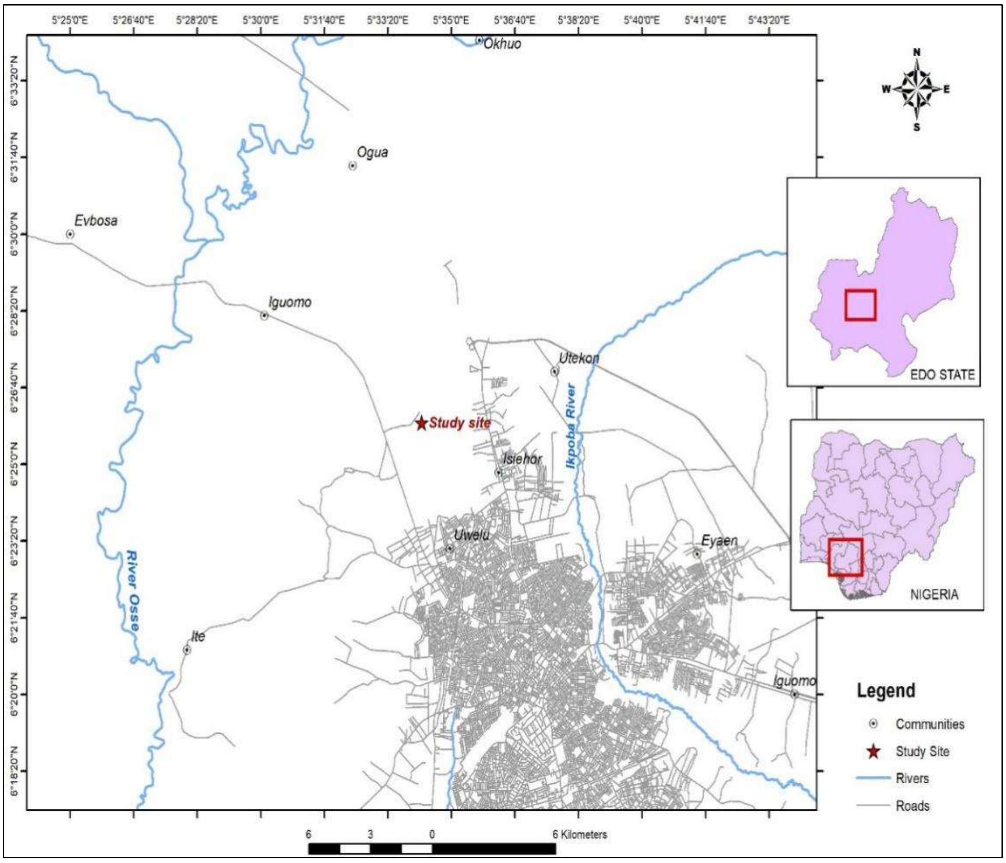

Figure 3.1: Map of Study Area

3.4 Determination of Snout-vent Length

All the gecko specimens were measured in snout-vent length (SVL) with the help of a standard meter rule. These values were documented in an orderly way.

3.5 Analysis and Recovery of Parasites

Just after the euthanasia, the geckos were then dissected in the midline beginning at the throat and down to the abdomen. Internal organs were dissected and put in personalized petri dishes consisting of saline solution of 0.72% salinity. These organs were analysed namely: gastrointestinal tract (oesophagus, stomach, intestines and rectum), lungs, heart, liver and gall bladder. Individual organs were teased out and examined using a dissection microscope to find the parasites. Parasites found were isolated in different petri dishes.

Nematodes and trematodes were washed to clear off tissue debris then fixed in 70% heated ethanol and kept in labelled specimen bottles. With a saline wash, pentastomids were moved to 70% alcohol-saline bottles. Information detailing the host, collection site, date, and organ source of the parasites were labelled on the containers of specimens.

3.6 Identification of Gecko Hosts

The identification of gecko species was conducted with the help of morphological keys and descriptions represented by Trape *et al.* (2012) and Wagnet *et al.* (2014).

3.7 Parasite Identification Protocol

Alcohol-preserved bottles contained the nematodes were opened and the nematodes were taken into plain slides and blotted with tissue. A little lactophenol was then used to clear it and a cover slip added. This treatment increased visibility up to the light microscope.

Cestodes were cleaned, immersed in 5% formal-saline over 48-hours period and stained with acetocarmine. The stain was then followed by dehydration using series of ethanol solutions

(50%, 70%, 90, and absolute) in series followed by clearing with xylene. With Canada balsam, they were permanently mounted and left to dry in an oven during a week.

Specimens of the pentastomids were cleared in lactophenol so as to observe their anterior and their posterior hooks. These morphological traits were used in the identification of species.

3.8 Photography of parasites

A DFRMKU 130-10x22 camera functioning on a trinocular compound microscope was utilized in obtaining digital photomicrographs of the parasites.

3.9 Data Analysis

Raw data were analysed using descriptive statistics to summarize the data. The prevalence was calculated for all data as the number of infected lizards divided by number of examined lizards, and multiplied by 100 to be expressed in percentage. Mean intensity of infection was also calculated as number of a specific parasites collected divided by the number of hosts infected with the specific parasite.

$$\text{Prevalence (\%)} = \frac{\text{Number of infected hosts}}{\text{Name total number of hosts studied}} \times 100$$

The average number of parasites per infected host was also calculated to obtain mean intensity of infection, which was performed in a similar method proposed by Odaibo (2018).

CHAPTER FOUR

RESULTS

4.1 Wall Gecko species investigated for parasites

A total of 27 wall geckos which were caught from IDP camp Uhogua were examined for their parasites.

Out of the 27 specimens examined, twenty (20) were males and seven (7) were females. Two species of *Hemidactylus* were collected: *Hemidactylus angulatus* and *Hemidactylus mabouia*.

The *H. angulatus* (Plate 4.1A) examined consisted of twelve males and four females while the *H. mabouia* (Plate 4.1B) comprised eight males and two females. Three parasites were recovered from the wall geckos examined. They included: a pentastomid (*Raillietella affins*) (Plate 4.2-4.6), a nematode (*Parapharyngodon awokoyai*) (Plate 4.7 A-B) and a cestode (*Oochoristica sp.*) (Plate 4.8 A-C, 4.9 A-C).

Out of the total number of wall geckos examined, 23 were infected. The 23 specimens that were infected, consisted of fourteen *H. angulatus* and nine *H. mabouia*.

Thelandrous scleratus being the parasite with the highest prevalence of 62.96% while other parasites such as *Raillietiella affins, Oochoristica* spp. and *Parapharyngodon awokoyai* had prevalence of 55.55%, 7.41% and 3.79%, respectively.

Amongst the 17 *H. angulatus* examined, fourteen were infected giving a prevalence value of infection of 82.35% and mean intensity of 4.44 parasites per infected host.

Among the 10 *H. mabouia* examined, nine were also infected giving an overall prevalence value of infection of 90% and mean intensity of 3.29 parasites per infected host (Table 4.1)

The parasites and their sites of predilection are presented in Table 4.2. The *Raillietiella* sp. was recovered from the lungs, while *Oochoristica* sp. and *Parapharyngodon awokoyai* were found in the small intestine (Table 4.2).

The parasites recovered in *H. angulatus* were *Raillietiella* sp. (Pentastomida) and *Oochoristica* sp. (Cestoda) which was recovered from the lungs and small intestine respectively. In *H.*

mabouia, the parasites recovered included *Raillietiella* sp. (Pentatomida) from the lungs, *Parapharyngodon awokoyai* (nematoda) and *Oochoristica* sp. (Cestoda) which were both recovered from the small intestine. The prevalence and mean intensity of these parasites in *H. angulatus* and *H. mabouia* are presented in Table 4.4 and 4.5, respectively.

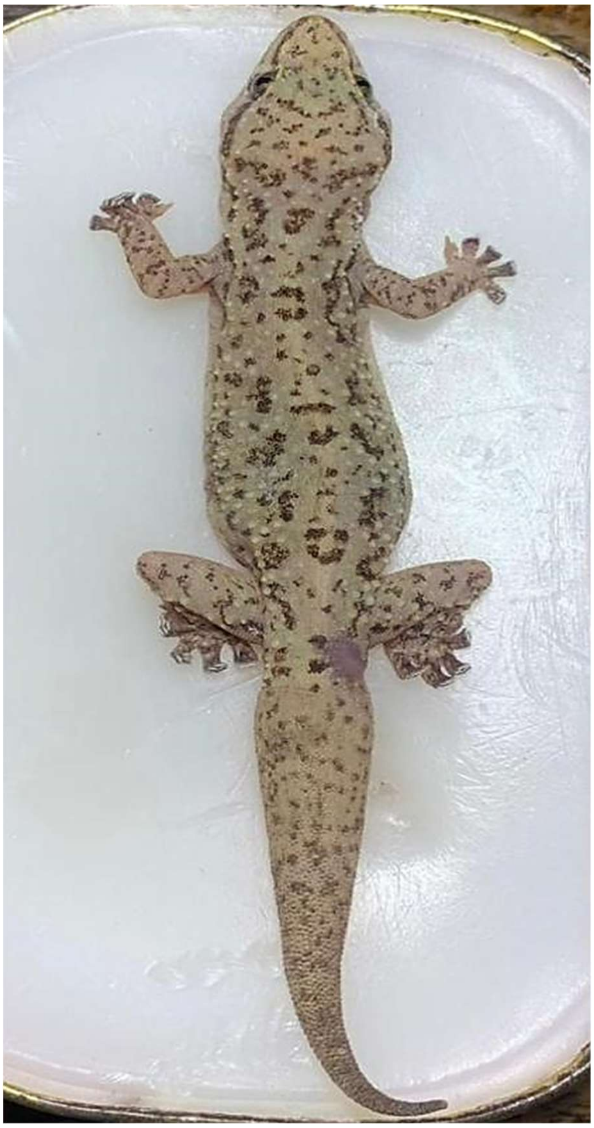

Plate 4.1: *Hemidactylus mabouia* from IDP camp, Uhogua, Benin city

Plate 4.2: *Hemidactylus angulata* from IDP camp, Uhogua, Benin City

Table 4.2: Parasite of *Hemidactylus* spp. from IDP camp, Uhogua, Benin City and their site of predilection

Parasite	Host	Site of Predilection
Cestoda		
Oochoristica spp.	*Hemidactylus angulatus*	Small intestine
Nematoda		
Parapharyngodon awokoyai	*Hemidactylus angulatus*	Large intestine/Rectum
	Hemidactylus mabouia	Large intestine/Rectum
Thelandros scleratus	*Hemidactylus angulatus*	Large intestine/Rectum
	Hemidactylus mabouia	Large intestine/Rectum
Pentastomida		
Raillietiella sp.	*Hemidactylus angulatus*	Lungs
	Hemidactylus mabouia	Lungs

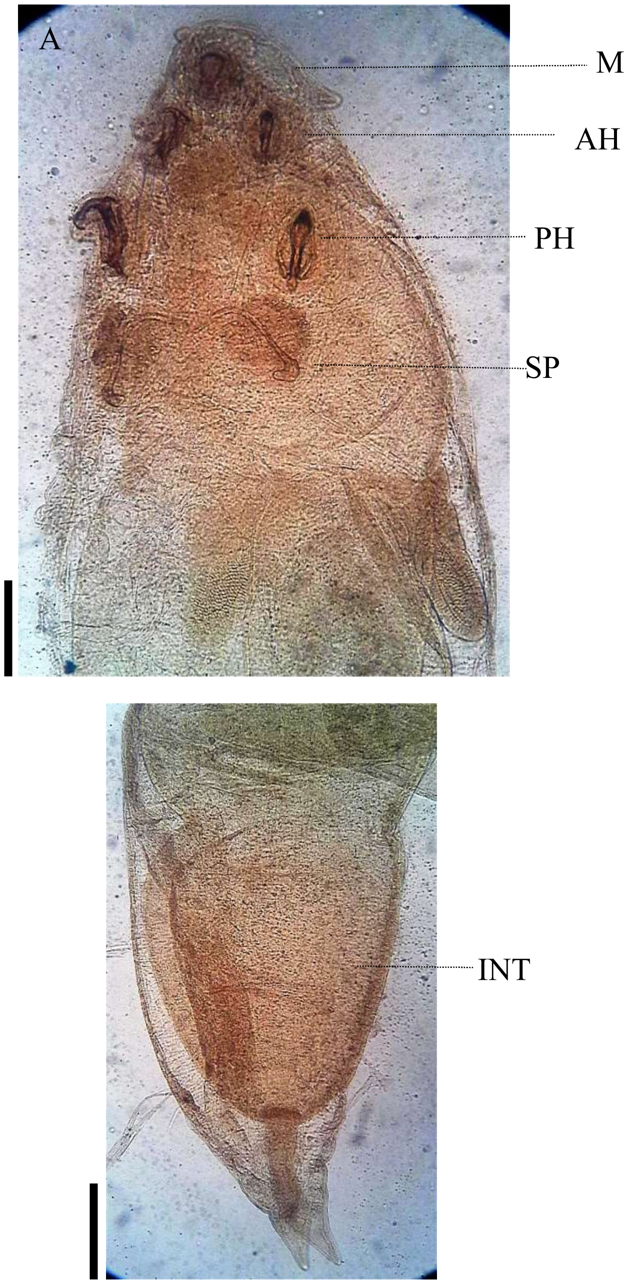

Fig. 4.1 A-B. Male *Raillietiella* sp. infecting *Hemidactylus* spp. from IDP Camp, Uhogua, Benin City. Abbreviations: M, Mouth; AH, Anterior hook; PH, Posterior hook; SP, Spicule; INT, Intestine. Scale bar: A, B = 0.5 mm

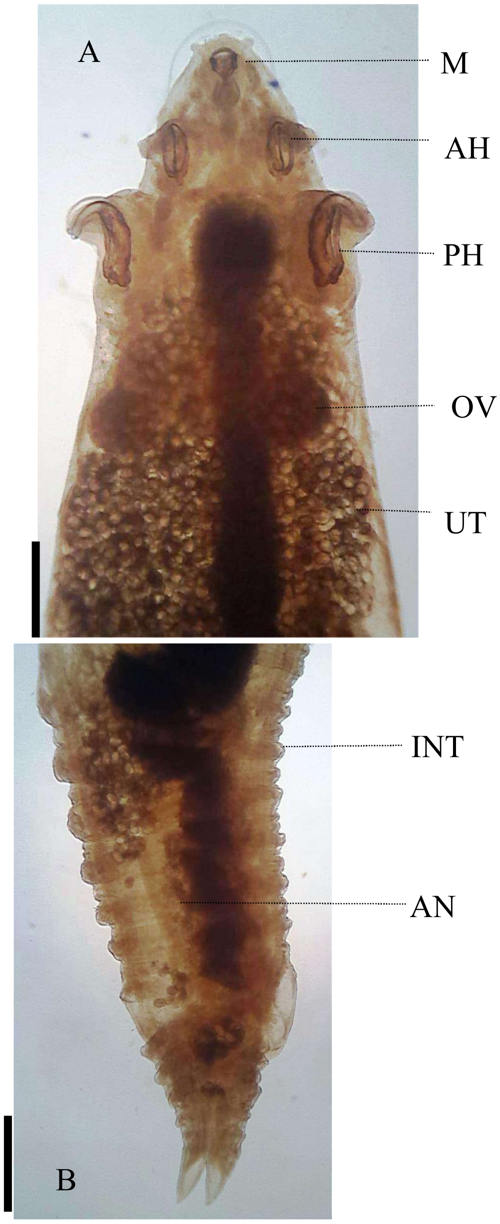

Fig. 4.2 A-B. Female *Raillietiella* sp. infecting *Hemidactylus* spp. from IDP Camp, Uhogua, Benin City. Abbreviations: M, Mouth; AH, Anterior hook; PH, Posterior hook; OV, Ovary; UT, Uterus; INT, Intestine; AN, Annulation. Scale bar: A, B = 0.5 mm

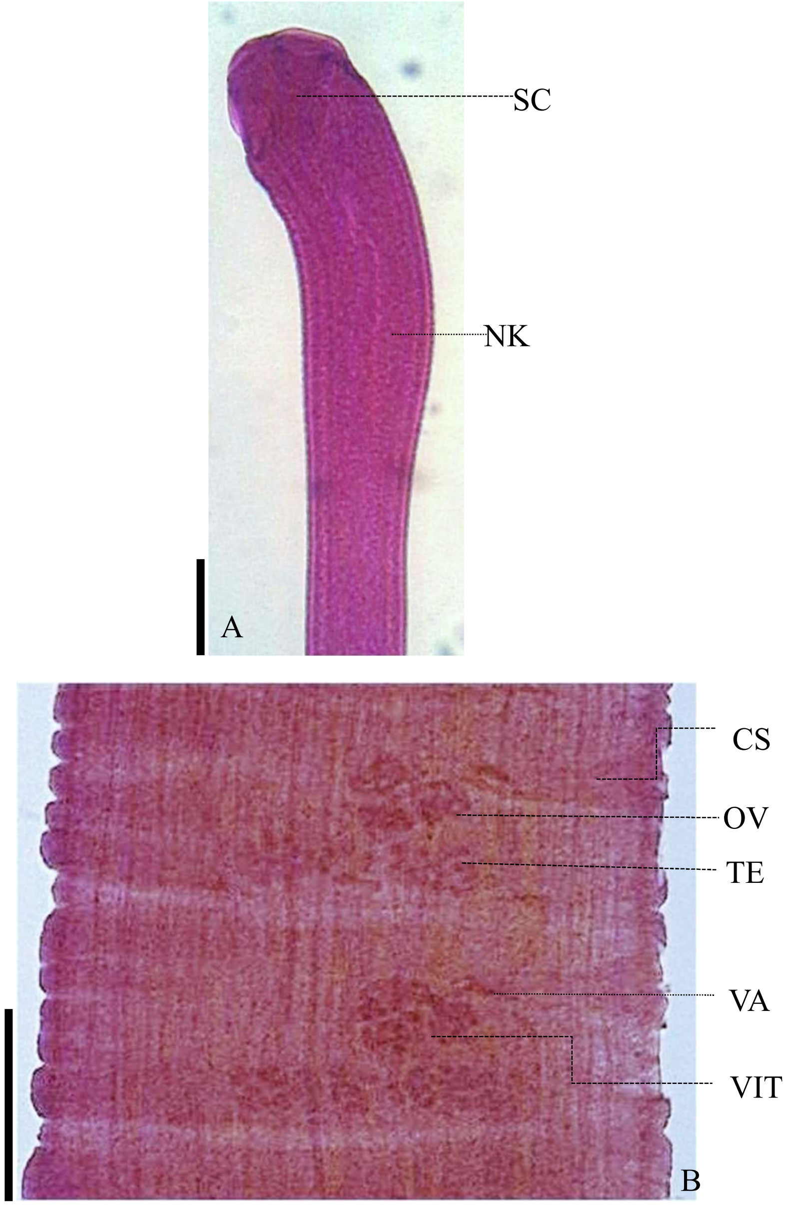

Fig. 4.3 A-B. Pentastomid (*Raillietiella* sp.) infecting *Hemidactylus* spp. from Uhogua, Benin City. *Abbreviations*: SC, Scolex; NK, Neck; CS, Cirrus sac; OV, Ovary; TE, Testes; VA, Vagina; VIT, Vitellarium. Scale bar: A = 0.5 mm; B = 1.0mm

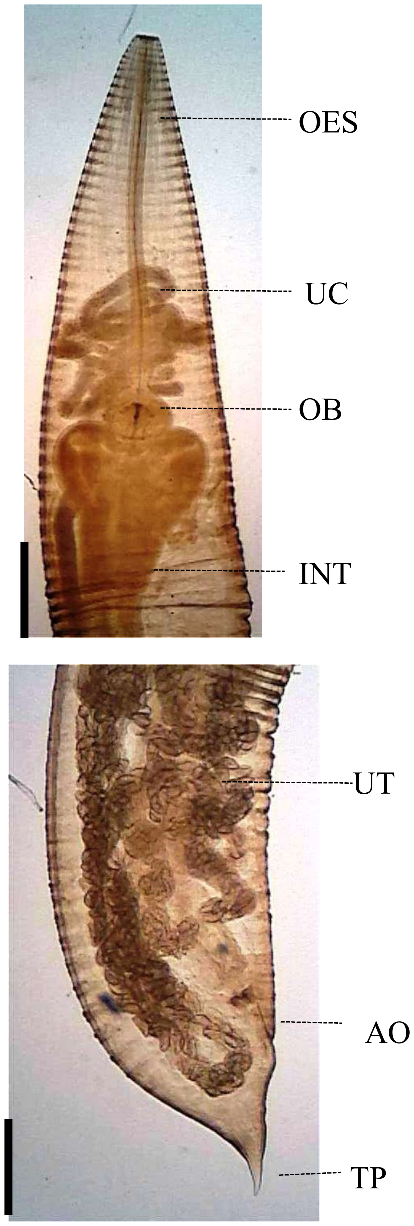

Fig. 4.4 A-B. Female *Thelandros scleratus* infecting *Hemidactylus* sp. from IDP Camp, Uhogua, Benin City. Abbreviations: OES, Oesophagus; OB, Oesophageal bulb; UC, Uterine coil; INT, Intestine; UT, Uterus; AO, Anal opening; TP, Tail process. Scale bar = 0.5 mm

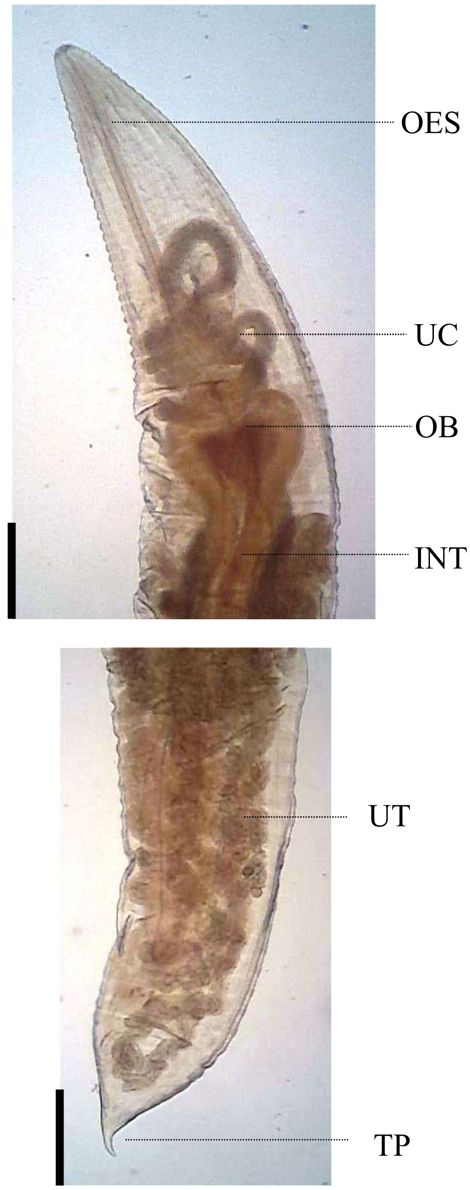

Fig. 4.5 A-B. Female *Paraphayngodon awokoyai* infecting *Hemidactylus* spp. from IDP Camp, Uhogua, Benin City. *Abbreviations*: OES, Oesophagus; UC, Uterine coils; OB, Oesophageal bulb; INT, Intestine; UT, Uterus; TP, Tail process. Scale bar = 0.5 mm

Table 4.2: Overall prevalence of *Hemidactylus* spp. in IDP camp, Uhogua, Benin City

Gecko species	Number examined	Number infected	Prevalence %
Hemidactylus angulatus	17	14	82.55
Hemidactylus mabuoia	10	9	90.00
Total	27	23	85.18

Table 4.3: **Overall Prevalence and mean intensity of helminth Infection in *Hemidactylus* spp. (n=23) from IDP camp Uhogua, Benin City**

Parasite	**Prevalence (%)**	**Number of Host Infected**	**Number of Parasite**	**Mean intensity**
Parapharyngodon awokoyai	3.70	1	2	2.00
Oochoristica sp.	7.41	2	3	1.50
Raillietiella sp.	55.55	15	74	4.93
Thelandros scleratus	62.96	17	49	2.88

Table 4.4: Overall prevalence and mean value of Helminth infection in *H. mabouia* in IDP camp Uhogua, Benin City (n=10)

Parasites	Prevalence (%)	Mean intensity
Prarpharyngodon awokoyai	0.00	0.00
Raillietiella sp.	60.00	7.00
Thelandros sp.	70.00	2.00

Table 4.5: **Overall prevalence and mean value of Helminth infection in *H. angulatus* in IDP camp, Uhogua, Benin City (n=17)**

Parasites	Prevalence (%)	Mean Intensity
Parapharyngodon awokoyai	5.88	2.00
Oochoristica sp.	11.76	1.50
Raillitiella sp.	52.94	4.44
Thelandros scleratus	58.8	3.18

Table 4.6: Prevalence of Parasite in *H. angulata* in IDP Camp, Uhogua, Benin City in relation to sex

Parasite	Male		Female	
	Prevalence (%)	Mean intensity	Prevalence (%)	Mean intensity
Parapharyngodon awokoyai	-	-	33.33	2
Oochoristica sp.	8.33	1.00	33.33	2
Raillietiella sp.	50.00	4.33	60.00	2
Thelandros scleratus	66.66	4.25	33.33	2

Table 4.7: **Prevalence of Parasite in *H. mabouia* in IDP Camp, Uhogua, Benin City in relation to sex**

Parasite	**Male**		**Female**	
	Prevalence (%)	Mean intensity	Prevalence (%)	Mean intensity
Raillietiella sp.	62.5	2.8	50	2.8
Thelandros scleratus	62.5	1.5	100	2.5

CHAPTER FIVE

DISCUSSION

In this study, a total twenty-seven (27) geckos were examined, 20 males and 7 females. The two species of gecko examined were *Hemidactylus angulatus* (17) and *Hemidactylus mabuoia* (10).

The two species of gecko (*Hemidactylus angulatus* and *Hemidactylus mabouia*) encountered in this study was in conformity with the report of Inegbedion (2021), Ogboh (2021), Eyamekware (2022), Adewoye (2024), and Mkpanam (2025), who all encountered *Hemidactylus angulatus* and *Hemidactylus maboui*a from Ohogua, Iyanomo, Temboga, Ekosodin, Uhogua and Osasogie communities, respectively.

Four parasite species were recovered in this study (*Railietella sp.., Paraphayrngodon awokoyai, Thelandros scleratus* and *Oochoristica* sp.) as against seven parasite species (*Parapharyngodon* sp*., Spirura* sp. and *Pharyngodon* sp., one cestode, *Oochoristica truncata*, one trematode*, Mesocoelium monas*, one pentastomid, *Raillietiella frenatus* and cystacanth of an unidentified species of Acanthocephala) recovered from a study in Ile-Ife and Ibadan by Oluwafemi *et al*. (2017) on *Hemidactylus frenatus* and *Mabuya quinquetaeniata*.

High parasite prevalence was recorded with male over female in this study similar to findings done by Babatunde *et al*. (2025) on *H. frenatus*. The result from the study by Babatunde *et al*. (2025) showed that the overall prevalence in Akure LGA, Ondo State was higher in male (70%) compared to female (66%). This was likely due to increased exposure from active behaviours like hunting and mating. This supports the idea that behavioural differences, more than immune function, drive parasite transmission. However, it contrasts with the study by Ajala (2015) that investigated *Hemidactylus brookii angulatus* in western Nigeria and recorded high prevalence of parasite in female than in male. The prevalence for female and male was 42.45% and 20.27%, respectively. This difference in result might be accounted for the number of the individual sex sample examined difference, female (45) and male (15).

In the course of this study, a total of four parasite species were recovered, including one Pentastomida (*Raillietiella* sp.), one Cestode (*Oochoristica* sp.) and two Nematodes (*Parapharyngodon awokoyai* and *Thelandros scleratus*). These are parasites that have also been reported by other authors including Emokpare (2019), Ekata (2021) and Ogboh (2021).

This most prevalent parasite examined in both species of geckos during this study was the nematode, *Thelandros scleratus*. The parasite, had an overall prevalence value of 62.96% and a mean intensity value of 2.88. The prevalence of *Thelandros scleratus* in this study corresponds to similar findings by various authors in Nigeria. For instance, Ugbomeh and Aisien (2018) carried out an elaborate parasitological scanning of Hemidactylus species in Port-Harcourt, Rivers State, Nigeria. The most dominant species reported from the study was *Thelandros scleratus* which was located at the posterior part of the intestine of the geckos examined.

The least prevalent parasite species in this study was the nematode, *Parapharyngodon awokoyai* with an overall prevalence value of 3.70% and a mean intensity of 2.00.

In the course of this study, the overall prevalence value of helminth infections in *Hemidactylus angulatus* was 82.35% while that of *Hemidactylus mabouia* was 90.00%. The study reported that prevalence in *H. angulatus* was lower than that of *H. mabouia*. This clearly opposes the reports of Ogboh (2021), and Eyamekware (2022), which reported *H. angulatus* to have a higher prevalence (80%) than *H. mabouia* (58.82%)

Thelandros scleratus, which was the most dominant parasite, was recovered from both *H. angulatus* and *H. mabouia.* The parasite *Thelandros scleratus* was the most prevalent parasite found in *H. mabouia* where it had a prevalence value of 70.00% and mean value of 2.00. and in *H. angulatus,* having a prevalence value of 58.8% and a mean intensity value of 3.18.

Raillietiella sp. also infected both *Hemidactylus angulatus* and *Hemidactylus mabouia* with prevalence values of 52.94% and 60%, and mean intensity values of 4.44 and 7.00 respectively. This parasite was also reported by Akinlolu and Ayodele (2017), Ugbomeh and Aisien (2018).

Prarpharyngodon awokoyai was also found during the examination of *H. angulatus* but was absent in *Hemidactylus mabouia* with a prevalence value of 5.88% and mean value of 2.00. *Parpharyngodon awokoyai* represents the parasite species with the least prevalence in *Hemidactylus angulatus.*

Oochoristica sp. was found only in *H. angulatus* with a prevalence value of 11.76% and mean intensity value of 1.50. It has been reported by Inegbedion (2021) from Iyanomo, Ogboh (2021) from Temboga, Emokpare (2019) from Ugbowo, as well as by a few other authors.

In this study, the male geckos were recorded to have a higher overall prevalence of parasite infections than the female. The prevalence value for the males was 74.07% while for females, the prevalence value was 18.5%. In *Hemidactylus angulatus,* the most prevalent parasite species in males was *Thelandros scleratus* with a prevalence value of 66.66% and a mean intensity value of 4.25, while the least prevalent was *Parapharyngodon awokoyai,* with a prevalence value and mean intensity of 0. In the female species of *H. angulatus*, *Raillietella sp* was the most dominant parasite with a prevalent value and mean intensity value of 60.00% and 2 respectively. The least prevalent parasites were *Parapharyngodon awokoyai,* *Thelandros scleratus* and *Oochoristica* sp., each of which had equal prevalence values of 33.33% and mean intensity values of 2.

In the male *Hemidactylus mabouia, Raillietiella* sp and *Thelandros scleratus* both had equal prevalence with prevalence values of 62.5% but with varying mean intensity values of 2.8 and 1.5 respectively. In the females, the most prevalent parasite species was *Thelandros scleratus,* having a prevalent value of 100% and mean intensity value of 2.5, while the least prevalent parasite species was *Raillietella* sp. with a prevalent value of 50% and mean intensity value of 28.

Four helminth parasites were recorded in this study namely: *Raillietella* sp., *Parapharyngodon awokoyai, Thelandros scleratus* and *Oochoristica* sp. Only two (*Raillietiella* sp. and *Thelandros scleratus*) were found to infect both species of wall geckos (*Hemidactylus angulatus and Hemidactylus mabouia*), while two (*Oochoristica* sp. and *Parapharyngodon awokoyai.*) were specific to only *Hemidactylus angulatus.* The gecko species encountered in this study have been previously reported by other authors in Nigeria. This study covered infections in both male and female species and recorded 85.18% prevalence. More sample needs to be collected from IDP camp, Uhogua over a long period of 12 to 18 months in order to encounter other wall gecko species and parasites which may not have been recorded in this study due to small sample size and short duration of study.

5.1 Conclusion

In conclusion, two species of *Hemidactylus* examined in this study (*H. angulatus* and *H. mabuioa*) have been reported by other authors for their helminth parasites. Only two nematode species, *P. awokoyai* and *T. scleratus*, one cestode, *Oochoristica* sp. and one pentastomid, *Raillietiella* sp. were reported in this study.

REFERENCES

Abdu, P. A., Lawal, A. I., and Adamu, A. Y. (2013). Helminths of some reptiles from Zaria, Nigeria. *Nigerian Journal of Parasitology,* **34(**2): 153–157.

Adegbite, O. R., and Ajayi, A. F. (2018). A survey of helminth parasites of *Hemidactylus* species in a university environment in Ibadan, Nigeria. *Nigerian Journal of Helminthology*, **32**(2): 101–107.

Adeoye, G. O., and Ogunbanwo, S. T. (2017). Helminthic burden in common house geckos (*Hemidactylus frenatus*) in Ilorin, Kwara State, Nigeria. *Nigerian Journal of Parasitology,* **38**(2): 221–226.

Ajala, O. O. (2015). The occurrence of Pharyngodon mamillatus (Linstow, 1897) (Oxyuroidea, Pharyngodonidae) in a tropical wall gecko. International Journal of Applied and Natural Sciences, **4**, 47-50.

Ajayi, A. O., and Alarape, S. A. (2018). Helminth fauna of *Hemidactylus mabouia* in urban habitats of Ibadan, southwestern Nigeria. *African Journal of Herpetology*, **67**(2): 101–108.

Ajayi, O. O., and Olayemi, I. K. (2015). Helminth parasites of some lizards in Ilorin, Nigeria. *Nigerian Journal of Parasitology*, **36**(2): 215–220.

Akani, G. C., Luiselli, L., and Amuzie, C. C. (2013). Ecological patterns of parasite infestation in lizard communities from disturbed and undisturbed forests in the Niger Delta (Nigeria). *Acta Herpetologica*, 8(1): 111–120.

Akinlolu, A. A., and Ayodele, I. A. (2017). Helminth fauna of wall geckos (*Hemidactylus* spp.) in a university environment in southwestern Nigeria. *Journal of Helminthology and Ecology*, **38**(2): 45–52.

Almeida, W. O., Vasconcellos, A., Lopes, S. G., and Santos, E. M. (2018). Helminth parasites of the tropical house gecko (*Hemidactylus mabouia*) in urban habitats of northeastern Brazil. *Journal of Helminthology*, **92**(1): 64–69.

Amadi, N., Gladstone, G. C., Wala, C., Vignoli, L., Ugbomeh, A., Dendi, D., and Luiselli, L. (2020). Habitat use and food habitats of a gecko population in a West African suburban area. *European Journal of Ecology*, **6**(1): 1–12.

Andrews, K. M., and Laurance, W. F. (2015). The importance of small predators in vector-borne disease control: a case study of geckos. *Ecology and Health*, **9**(4): 1232–1241.

Andrews, R. M. (2012). Water vapor permeability of the rigid-shelled gecko egg. *Journal of Experimental Zoology Part A: Ecological Genetics and Physiology*, **317**(5): 258–267.

Autumn, K., Liang, Y. A., Hsieh, S. T., Zesch, W., Chan, W. P., Kenny, T. W., Fearing, R., and Full, R. J. (2002). Adhesive force of a single gecko foot-hair. *Nature*, **405**(6787): 681–685.

Babatunde, O. S., Olusi, T. A., Simon-Oke, I. A., David, M., Adejoh, B., & Olonisakin, A. A. (2025). Prevalence of Ecto-and Gastrointestinal Parasites of Hemidactylus frenatus (Schlegel) in Akure North Local Government Area of Ondo State, Nigeria. *J. Appl. Life Sci. Int.* ***28** (3): 44*, *53*.

Bauer, A. M. (2013). Geckos: The animal answer guide. *Johns Hopkins University Press*.

Brown, R., and Perez, L. (2007). Captive longevity and factors influencing lifespan in leopard geckos (*Eublepharis macularius*). *Journal of Herpetological Medicine and Surgery*, **17**(4): 187–192.

Bursey, C. R., and Goldberg, S. R. (2005). Gastrointestinal helminths of *Hemidactylus mabouia* (Sauria: Gekkonidae) from Brazil. *Comparative Parasitology*, **72**(2): 201–206.

Chapple, D. G., and Keogh, J. S. (2005). Reproductive ecology of the eastern mouse-tailed gecko (*Diplodactylus tessellatus*) in arid Australia. *Herpetologica*, **61**(4): 345–360.

Chapple, D. G., Keogh, J. S., and Bull, C. M. (2003). Flexibility of reproductive traits with latitude: evidence across the native range of *Tiliqua rugosa*. *Journal of Zoology*, **259**(3): 345–355.

Chukwu, O. O., Eze, N. C., and Ugwu, M. C. (2015). Survey of helminth parasites in geckos (*Hemidactylus* spp.) from Nsukka, Enugu State, Nigeria. *Animal Research International,* **12**(3): 2253–2259.

Combes, C. (2001). *Parasitism: The ecology and evolution of intimate interactions*. University of Chicago Press.

Djomnang, N. A. L., Chahdini, G. A., Wabo, P. J., & Mpoame, M. (2016). Occurrence of ticks and gastrointestinal helminths in the house gecko (Hemidactylus spp.) from Dschang in Cameroon. *International Journal of Fauna and Biological Studies*, ***3***(1), 117-120.

El-Dakhly, K. M., El-Nahass, E., and Mahdy, O. A. (2013). Helminth parasites of the Mediterranean house gecko (*Hemidactylus turcicus*) in Qena, Upper Egypt. *Journal of Advanced Veterinary Research*, **3**(2): 84–89.

Ganesh, S. R., Gowri Shankar, A., and Balan, S. (2021). Helminth parasites of the common house gecko *Hemidactylus frenatus* (Reptilia: Gekkonidae) from southern India. *Journal of Helminthology*, **9**(5): 54-88.

Goldberg, S. R., and Bursey, C. R. (2000). Helminths of the house gecko, *Hemidactylus frenatus* (Gekkonidae), from Papua New Guinea and the Philippines. *Journal of the Helminthological Society of Washington,* **67(**1): 64–66.

Goldberg, S. R., and Bursey, C. R. (2001). Helminths of the Mediterranean house gecko, *Hemidactylus turcicus* (Gekkonidae), from Florida. *Journal of Parasitology*, **87**(3): 674–675.

Han, D., Zhou, K., and Bauer, A. M. (2004). Phylogenetic relationships among gekkotan lizards inferred from c-mos nuclear DNA sequences and a new classification of the Gekkota. *Biological Journal of the Linnean Society*, **83**(3): 353–364.

Higham, T. E., and Russell, A. P. (2012). Flip, flop and fly: modulated motor control and highly variable movement patterns of autotomized gecko tails. *Biology Letters*. **67(**1): 64–66.

Ibrahim, M. M., and El-Dakhly, K. H. (2010). Gastrointestinal helminths of the common wall gecko (*Tarentola annularis*) in Qena, Egypt. *Veterinary Parasitology*, **173**(1–2): 135–139.

Ibrahim, M. M., and Soliman, M. F. M. (2010). Helminth parasites of the fan-footed gecko (*Ptyodactylus hasselquistii*) from Egypt. *Journal of Helminthology*, **84**(2): 157–162.

Ishola, A. I., Yakubu, D. P., and Saka, Y. M. (2018). Helminth parasites of *Hemidactylus frenatus* in urban residential zones of Ilorin, Nigeria. *Nigerian Journal of Parasitology,* **39**(1): 87–91.

Jones, H. I., and Pyke, G. H. (2008). Parasites and exotic invasive amphibians and reptiles: A case study of helminth communities in *Hemidactylus frenatus*. *International Journal for Parasitology*, **38**(8–9): 879–890

Jones, H. I., and Reside, A. E. (2015). Helminth parasites in two species of Australian geckos across a habitat gradient. *Australian Journal of Zoology*, **63**(5): 367–374.

Jones, L. P., and Mulder, E. (2017). Helminth parasites of the Asian house gecko (*Hemidactylus frenatus*) in Queensland, Australia. *Australian Journal of Zoology*, **65**(2): 142–150.

King, R. B., and Hines, R. L. (2009). Feeding ecology of geckos: Patterns and generalizations. *Herpetological Review*, **40**(2): 123–134.

Meiri, S. (2019). Body size of lizards is related to climatic variability. *Global Ecology and Biogeography*, **28**(2): 229–241.

Miller, A. K. (2015). Relative apportioning of resources to the body and regenerating tail in juvenile leopard geckos maintained on different dietary rations. *Physiological and Biochemical Zoology*, **88**(3): 252–261.

Morand, S., and Krasnov, B. R. (2010). *The biogeography of host–parasite interactions*. Oxford University Press.

Nurhidayat, L. (2025). Tail regeneration in the Tokay Gecko (*Gekko gecko*). *BMC Biology*, 23(1), Article 211.

Nzegwu, C.I. and Ezealor, A.U. (2020). Gastrointestinal helminths of house geckos (*Hemidactylus* spp.) in southeastern Nigeria: Infection patterns and environmental influences. *Nigerian Journal of Parasitology*, **41**(1): 72–79.

Obadiah, S.O. and Nwogu, C.O. (2017). Prevalence and diversity of gastrointestinal helminths in the common house gecko (*Hemidactylus frenatus*) in Port Harcourt, Nigeria. *Journal of Parasitology and Vector Biology*, **9**(4): 34–41.

Ogunleye, A. D. (2022). Prevalence and diversity of helminths in *Hemidactylus* species from an academic environment in southwestern Nigeria. *Nigerian Journal of Parasitology*, **43**(2): 114–121.

Okafor, F. C., and Opara, K. N. (2017). Helminth parasites of wall geckos (*Hemidactylus* spp.) in Umuahia, Nigeria. *Nigerian Journal of Parasitology,* **38**(1): 45–50. Okon, A.E. and Effanga, E.E. (2020). Helminth Parasites of Urban Geckos (*Hemidactylus* spp.) in Calabar, Nigeria. *Nigerian Journal of Parasitology*, **41**(1): 43–49.

Okon, E.A. and Etim, E.O. (2020). Helminth parasites of *Hemidactylus* species in Calabar, Nigeria: A study of urban ecological influence. *Nigerian Journal of Helminthology*, **12**(1): 45–52.

Okonkwo, I.F. and Ezealor, A.U. (2020). Urban habitat influence on helminth parasites in *Hemidactylus* spp. in southeastern Nigeria. *Tropical Journal of Parasitology and Public Health*, **28**(1): 53–60.

Omeje, V.O., Okonkwo, C.C. and Eze, J.I. (2020). Prevalence and diversity of gastrointestinal helminths in *Hemidactylus mabouia* from Nsukka, Nigeria. *Helminthologia,* **57**(4): 319–324.

Onyekaba, C.C. and Ezealor, A.U. (2020). Helminth parasites of two gecko species (*Hemidactylus frenatus* and *H. mabouia*) in Nsukka, Nigeria. *Nigerian Journal of Parasitology*, **41**(1): 65–72.

Pelegrin, N., Costa, T.M. and Netto, A. (2013). Gastrointestinal parasites of lizards from a tropical forest in Brazil. *Brazilian Journal of Biology,* **73**(2): 351–358.

Pérez-Higareda, G., Smith, H. M., and Smith, R. B. (2005). Composition and ecological distribution of herpetofauna in Veracruz, Mexico. *Bulletin of the Maryland Herpetological Society*, **41**(3): 125–160.

Pyron, R. A., Burbrink, F. T., and Wiens, J. J. (2013). A phylogeny and revised classification of Squamata, including 4,161 species of lizards and snakes. *BMC Evolutionary Biology*, **13**(1): 93.

Ramesh, M., and Vijayalakshmi, C. (2012). Survey of helminth parasites of the common house gecko, *Hemidactylus frenatus*, in Tirupati, Andhra Pradesh, India. *Journal of Parasitic Diseases*, **36**(1): 28–31.

Rataj, A. V., Lindtner-Knific, R., Dovč, A., and Vlahović, K. (2011). Parasites in pet reptiles. *Acta Veterinaria Scandinavica,* **53**(1): 33-56.

Roth, L. S. V., Kelber, A., and Ghosh, S. (2009). Geckos see in color at night. *Science*, **325**(5938): 585–585.

Roth, L. S. V., Lundström, L., Kelber, A., Kröger, R. H. H., and Unsbo, P. (2014). The pupils and optical systems of gecko eyes. *Journal of Vision*, **9**(3): 1–11.

Russell, A. P., and Higham, T. E. (2009). Gecko adhesion: Mechanisms and applications. *Integrative and Comparative Biology*, **49**(3): 354–366.

Silva, R. J., Teles, R. C., and Melo, F. T. (2017). Helminth parasites of urban geckos *Hemidactylus mabouia* and *Phyllopezus pollicaris* (Squamata: Gekkonidae, Phyllodactylidae) in southeastern Brazil. *Brazilian Journal of Biology*, **77**(1): 71–77.

Sousa, J. G., Teixeira, A. A., Teles, D. A., Araujo-Filho, J. A., and Ávila, R. W. (2017). Feeding ecology of two sympatric geckos in an urban area of Northeastern Brazil. *Acta Herpetologica*, **12**(1): 49–54.

Ugbomeh, A. P., and Aisien, M. S. O. (2018). Gastrointestinal helminths of *Hemidactylus* species in an urban area of southern Nigeria. *Nigerian Journal of Parasitology*, **39**(1): 60–67.

Underwood, G. (2018). The ecological role of geckos in tropical human environments. *Tropical Ecology*, **59**(1): 74–85.

Upton, S. J., Freed, P. S., and Freed, A. N. (1992). Helminth parasites of *Sceloporus grammicus* (Sauria: Phrynosomatidae) from Mexico. *Journal of the Helminthological Society of Washington,* **59**(1): 7–10

Vitt, L. J., and Caldwell, J. P. (2013). *Herpetology: An introductory biology of amphibians and reptiles* (4th ed.). Academic Press.

Whiley, H., Ross, K., and Bentham, R. (2017). *Salmonella* presence in domestic reptilian pets: risk factors and control. *International Journal of Environmental Research and Public Health*, **14**(5): 485.

Wongsawad, C., Wongsawad, P., and Srita, W. (2019). Gastrointestinal helminths of *Hemidactylus platyurus* (Gekkonidae) in northeastern Thailand. *The Journal of Tropical Medicine and Parasitology*, **42**(1): 45–51.

Xu, X., Liu, H., Zhou, Y., and Yang, Q. (2018). Review of traditional uses of gecko in Chinese folk medicine and its pharmacological effectiveness. *Journal of Ethnopharmacology*, **12**(3): 219–227.

6% Overall Similarity

Top sources found in the following databases:

- 5% Internet database
- 2% Publications database
- Crossref database
- 2% Submitted Works database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	hal.science	Internet	1%
2	grossarchive.com	Internet	<1%
3	researchcub.info	Internet	<1%
4	bioone.org	Internet	<1%
5	veterinaryworld.org	Internet	<1%
6	Farhana Muznebin, Shanzida Islam, Benzir Binte Lotif. "Prevalence and...	Crossref	<1%
7	mafiadoc.com	Internet	<1%
8	CVC Nigeria Consortium on 2015-11-09	Submitted works	<1%
9	sua.ac.tz	Internet	<1%

10	worldwidescience.org Internet	<1%
11	E. O. Alari, A. P. Ugbomeh, A. O. Awharitoma, E. E. Enabulele, M.S.O. Ai... Crossref	<1%
12	Ibrahim Babangida University on 2017-10-10 Submitted works	<1%
13	University of Stellenbosch, South Africa on 2017-10-13 Submitted works	<1%
14	coursehero.com Internet	<1%
15	sciendo.com Internet	<1%
16	reference.com Internet	<1%
17	scribd.com Internet	<1%
18	freeprojectmaterials.com Internet	<1%
19	"Archaeology", Abstracts in Anthropology, 2005 Crossref	<1%
20	Abigail A. Imasuen, Habibat J. Ozemoka, Martins S. O. Aisien. "Anuran... Crossref	<1%
21	CVC Nigeria Consortium on 2015-09-09 Submitted works	<1%

22	Upper Iowa University on 2015-04-30 Submitted works	<1%
23	K. A. Hanley, D. M. Vollmer, T. J. Case. "The distribution and prevalenc... Crossref	<1%
24	ir-library.ku.ac.ke Internet	<1%
25	vdoc.pub Internet	<1%
26	modishproject.com Internet	<1%
27	science.gov Internet	<1%
28	A. O. Bamidele, Y. E. Olutunji. "Abundance and Morphometric Study of ... Crossref	<1%
29	K.M. Campião. "Helminth parasites of Leptodactylus podicipinus (Anu... Crossref	<1%
30	University of Lincoln on 2025-10-09 Submitted works	<1%
31	archive.org Internet	<1%
32	bioscientistjournal.com Internet	<1%
33	core-cms.prod.aop.cambridge.org Internet	<1%

34	journals.lww.com Internet	<1%
35	repository.au-ibar.org Internet	<1%
36	coalitionbrewing.com Internet	<1%
37	projectreserve.com Internet	<1%
38	unn.edu.ng Internet	<1%