

**HELMINTHS PARASITES OF *AGAMA AGAMA* LIZARDS FROM INTERNALLY
DISPLACED PERSONS (IDP) CAMP, UHOGUA COMMUNITY,
BENIN CITY, EDO STATE, NIGERIA**

BY

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LSC2103645

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

October, 2025

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**A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF ANIMAL AND
ENVIRONMENTAL BIOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF
BENIN, BENIN CITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE IN ANIMAL AND
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CERTIFICATION

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

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(Head of Department)

DATE

DEDICATION

This work is dedicated to God Almighty who has been my source of strength and providence throughout my academic pursuit. Also, to my lovely and caring mum, Mrs. Christine Ezekiel who always support and encourage me.

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Agama agama

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ABSTRACT

A parasitological study was carried out between May and June 2025, to determine the helminth parasites of *Agama agama* at the Internally Displaced Persons (IDP) Camp located at Uhogua Community, Ovia North-East Local Government Area of Edo State. The lizards were killed by exposure to chloroform, dissected and examined for helminth parasites. A total of 30 lizards were sampled and they were all infected, giving an overall prevalence of 100% and a mean intensity of 24.3 parasites/infected host. The parasites recovered included two nematode species, one species of cestode and a trematode. The nematodes were *Strongyluris brevicaudata* and *Thelandros scleratus*, which were recovered from the large intestine/rectum and a few in the small intestine. The cestode species was *Oochoristica* sp. recovered from the small intestine and *Mesocoelium monodi* represented the trematodes, also from the small intestine. The most prevalent parasite was *Strongyluris brevicaudata* (76.67%), followed by *Oochoristica* sp. (43.33%) and the least prevalent, *Mesocoelium monodi* (10.0%). All the parasites recorded infected both male and female lizards, except *Mesocoelium monodi*, which was only reported in male *Agama* lizards. The difference in prevalence value amongst the helminth parasites reported was statistically significant ($p < 0.05$). More samples need to be examined from Uhogua in order to have more materials for proper identification of the *Oochoristica* sp., as well as to study other parasites that may be present in the study area but were not encountered due to the short duration of this study.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Lizards are seen in most warm places around the world as a result of their nature as poikilotherms (Omonona *et al.*, 2011). They are the most numerous extant species of reptiles, with about 4,470 lizard species (Hallermann *et al.*, 2000). They vary in their sizes, morphologies and colours. They exhibit various means of movement and defence. In Africa, commonly found lizards are the geckos, chameleons, monitor lizards, skinks, alligators, crocodiles and the *Agama* lizards (Branch, 1998). Lizards are diverse and widespread group of reptiles characterized by their distinct morphological features. Such as rounded torso, elevated head, four limbs and long tail. They inhabit various ecosystems, globally from rainforest to deserts and exhibit a wide range of behaviour and adaptation. Lizards are predominantly carnivores, often acting as sit-and-wait predators, and consume a diet mostly of insects and other small invertebrates. Lizards, with their remarkable adaptability and ecological importance, are among the most recognizable reptiles in sub-Saharan Africa. The *Agama* is a typical member of the Agamidae family seen abundantly in Africa, Asia, Australia, and sighted in Southeastern Europe (Spawls *et al.*, 2002). In Nigeria, the *Agama Agama* commonly called the red-headed rock agama, has become a fixture in urban, peri-urban, and rural environments. Their presence is not only a testament to ecological resilience but also to the complex interactions between wildlife, parasites, and human-modified environments. Understanding the helminth parasites associated with *Agama Agama* in such settings carries significant implications not only for the health of the lizards but also for broader ecological balance and potential zoonotic risks to human populations.

Among the diverse array of host species, reptiles often serve as crucial, yet frequently understudied, reservoirs for a wide spectrum of parasitic organisms, particularly helminths. These helminths, including nematodes, cestodes, and trematodes, are integral components of reptilian biology.

1.2 Taxonomy of *Agama* Lizards

The common Agama lizard, *Agama agama*, is a member of the diverse reptilian order Squamata, which encompasses lizards and snakes. This lizard is classified within the family Agamidae (*Agama* or dragon lizards), distinguished by its acrodont dentition, in which teeth are fused to the jawbone apex, many agamids also exhibit robust, keeled scales, such as those seen in *Psammophilus dorsalis* (Cooper *et al.*, 1970). The full taxonomic hierarchy of the study organism is as follows:

- 1 **Kingdom:** Animalia (multicellular eukaryotic organisms)
- 2 **Phylum:** Chordata (animals with a notochord)
- 3 **Class:** Reptilia (cold-blooded vertebrates with scales)
- 4 **Order:** Squamata (scaled reptiles, including lizards and snakes)
- 5 **Family:** Agamidae (Old World lizards, commonly known as agamas)
- 6 **Genus:** *Agama* (a large genus within Agamidae)
- 7 **Species:** *Agama agama*

The species epithet (Linnaeus, 1758) attributes the first formal scientific description of this species to Carl Linnaeus in his monumental work, *Systema Naturae*. This classification underscores the evolutionary relationships of *Agama agama* within the global reptile fauna and provides a foundation for comparative biological studies. The family Agamidae is widely

distributed across Africa and Asia, comprising over 300 species (Stuart-Fox *et al.*, 2003). *Agama Agama* is perhaps the best-known African representative, recognized by its distinctive coloration and social behaviour (Ofori-Boateng *et al.* 2018).

1.3 Biology of Agama Lizards

Agama Agama is arguably one of the most recognizable and abundant lizard species across sub-Saharan Africa, including Nigeria. Its widespread distribution is attributed to its remarkable adaptability to a variety of habitats, ranging from arid savannas to humid forests and highly urbanized environments (Leaché *et al.*, 2013). Understanding its fundamental biological characteristics is paramount to comprehending its role in local ecosystems and its susceptibility to parasitic infections.

1.3.1 Morphology of Agama Lizards

The Agama lizards have dry, horny and overlapping scales. The *Agama* Lizards has the characteristics whitish underside, buff-brown back limbs and tail with a slightly lighter stripes down the middle and six to seven dark patches to the side of this stripe. It has a triangular head which is separated from the trunk by a short neck. The eyes are protected by movable eyelids, a transparent fold of skin called nictitating membrane and a ridge of hard scales. They also have well-developed circular eardrum called Tympanum located behind their eyes. They have terminal mouth with either homodont (equal size of teeth) or heterodont (different in size teeth) dentitions, this dentition can be acrodont, monophyodont, pleurodont and polyphyodonty, depending on the species, (Cooper *et al.*, 1970). *Agama agama* is a medium-sized lizard trong, five-toed limbs. A defining morphological feature is their rough, keeled scales, which provide protection and aid in camouflage on various surfaces.

Perhaps the most striking morphological aspect is their pronounced sexual dimorphism, particularly during the breeding season. Males develop brilliant coloration, typically a vivid orange or reddish head, a bright blue or indigo body, and sometimes a yellow tail (Loveridge, 1937). These vibrant colours are controlled by specialized chromatophores and serve as visual signals in territorial displays and courtship ritual within their complex behavioural. Females and juveniles, in contrast, generally exhibit more subdued, cryptic coloration, often in shades of brown, grey, or olive, sometimes with lighter dorsal stripes or spots (Trape and Mané, 2006). The variations in colour and size are not merely aesthetic; they play critical roles in thermoregulation, predator avoidance, and social communication

1.4 Economic Important of Agama Lizards

While *Agama agama* is not directly exploited for significant economic gain on a large scale, it holds considerable indirect ecological and potentially minor economic importance. As a widespread insectivorous species, these lizards play a crucial role in regulating insect populations, including those considered agricultural pests or disease vectors (e.g., mosquitoes, flies). Their predatory activity contributes to natural pest control, thereby offering an ecosystem service that could potentially reduce reliance on chemical pesticides in agricultural settings (Luiselli *et al.*, 2001).

Furthermore, *Agama agama* serves as a vital component of the food web, acting as a prey item for various predators, including raptors (e.g., kestrels and eagles), snakes, and larger mammalian carnivores (Greig-Smith, 1979). This position within the food chain underscores their importance in maintaining ecosystem balance. In some local contexts, they may also be hunted for subsistence or traditional medicine, although this is generally localized and not a primary driver of their population dynamics. Lastly, their ubiquity and fascinating behaviours make them a common subject of observation and informal study, contributing to broader

ecological understanding and potentially to local ecotourism, albeit on a very small scale. Their health status, as reflected by parasitic loads, can also serve as a bioindicator of environmental quality and potential anthropogenic impacts. By preying on various insects, *Agama agama* contributes to the control of pest populations.

1.5 Helminths in Agama Lizards

Helminths are mostly parasites of vertebrates but could also be found in invertebrates, specifically arthropods and molluscs, which serve as intermediate hosts (Smyth, 1994). Parasites are very important causes of high death rates in wild animal populations (Anderson *et al.*, 1978). Research has shown that Agama lizards harbour a wide range of helminths. Surveys across Nigeria, for example, have identified nematodes such as *Physaloptera*, *Strongyloides*, Oxyurids of the Pharyngodonidae family, Ascaris-like species, and *Rhabdias* (lungworms), as well as cestodes such as *Oochoristica* species, and occasionally trematodes like *Mesocoelium* (Sowemimo, 2008; Omonona, 2011; Ezenwaka *et al.*, 2023). These findings indicate that Agama lizards act as intermediate or definitive hosts depending on the helminth species.

The life cycles of helminths in Agama lizards are diverse. For nematodes with direct life cycles, such as oxyurids, infection usually occurs through ingestion of embryonated eggs present in contaminated soil or faeces (Chelladurai, 2022). In contrast, *Physaloptera* species require intermediate hosts such as beetles, cockroaches or crickets, which the infected arthropods were consumed by definitive hosts, including reptiles like agamid lizards (King *et al.*, 2016). *Strongyloides* species are particularly important because of their auto-infective ability, which allows them to persist in hosts without environmental stages (Keiser and Nutman, 2004). Cestode like *Oochoristica* species typically rely on beetles, particularly Tenebrionidae, as intermediate hosts before reaching their definitive reptilian hosts. Mackiewicz (1988) This

indirect life cycle emphasizes the ecological link between reptiles and their prey, showing how trophic interactions sustain parasite persistence in natural systems. While trematodes like *Mesocoelium* utilize terrestrial snails as primary intermediate hosts, with insects sometimes acting as secondary intermediate hosts (Thomas, *et al.*, 1965). The prevalent infections vary across studies, but helminth infections are common in Agama populations (Sowemimo *et al.*, 2008) reported that more than 60% of *Agama agama* sampled in southwestern Nigeria were infected with at least one helminth species, with oxyurids being the most prevalent. Similarly, Omonona *et al.*, 2011) found that over half of the lizards examined in Ibadan carried gastrointestinal helminths, most notably *Physaloptera* spp. Recent work (Ezenwaka *et al.*, 2023) reinforced these findings, highlighting high rates of infection among lizards living in human settlements, where environmental contamination and access to intermediate hosts are more frequent.

The impact of helminth infections on their reptilian hosts can range from asymptomatic carriage to significant morbidity and mortality, depending on the parasite burden, the higher internal and external parasite loads exhibit significant reduced heat tolerance, an effect that is reversed by antiparasitic treatment (Bakewell *et al.*, 2025). Heavy parasite loads can lead to reduced feeding, weight loss, organ damage (e.g., enteritis, hepatic lesions), anaemia, impaired reproduction, and increased susceptibility to other diseases or predation (Rataj *et al.*, 2011). Despite the known diversity of helminths in lizards, there remains a significant paucity of data specifically concerning the helminth fauna of *Agama agama* within the highly modified and unique ecological context of an IDP Camp in Uhogua Community, Edo State, Nigeria. This knowledge gap underscores the novelty and critical importance of the proposed research, aiming to provide baseline data on parasite epidemiology in a context influenced by human overcrowding and environmental change.

1.6 Aim of the Study

To determine the helminth parasite infecting *Agama agama* within the Internally Displaced Persons (IDP) Camp, Uhogua Community, Ovia North East, Benin City, Edo State.

1.7 Objectives of the Study

The specific objectives of this study are to:

1. determine the helminth parasites of Agama lizards from IDP Camp, Uhogua Community.
2. identify specific species of helminth parasites infecting Agama lizards in the study area.
3. determine the prevalence and mean intensity of helminth parasites infecting the Agama lizards in IDP Camp, Uhogua Community.

CHAPTER TWO

LITERATURE REVIEW

Numerous works have been done around the world regarding the various helminth parasites of lizards, their prevalence and mean intensity.

2.1 Studied on Helminth Parasites of Lizards Globally

Yildirimhan *et al.* (2005) conducted a parasitological study in Turkey. In 34 *Laudakia caucasia* and 29 *L. stellio* examined, helminths included *Oochoristica tuberculata*, *Spauligodon saxicolae*, *Spauligodon aloisei*, and *Pharyngodon mamillatus*. The study provided detailed prevalence, intensity, and host-specificity data, highlighting shared parasite genera between Turkish and African agamids.

McAllister *et al.* (2011) conducted a comprehensive survey on the endoparasitic fauna of reptiles from the Republic of Namibia, focusing on members of Sauria (lizards) and Ophidia (snakes). A total of 222 reptiles representing 45 species across 11 families and collected from 17 districts were examined, revealing an overall helminth infection prevalence of 15% (33 individuals) (McAllister *et al.*, 2011). Of the infected hosts, 31 were lizards and two were snakes, with several individuals harbouring multiple parasite taxa, including one lizard with five different species. The helminths recorded comprised one cestode species (Family: Linstowiidae), twelve nematode species from six families, and one pentastomid species (Order: Cephalobaenida). The study significantly expanded the known helminthological database for the region, reporting 27 new host records and eight new geographical records for Namibia. These findings highlight both the diversity and host specificity of reptilian helminths in southern Africa, while also underscoring the ecological complexity of host–parasite interactions in arid and semi-arid environments.

McAllister *et al.* (2011) worked not only documents baseline parasitological data but also contributes important biogeographic and biodiversity insights into reptile–helminth associations in a relatively understudied region.

Goldberg and Bursey (2013) examined thirty specimens of *Agama aculeata* from South Africa were tested for helminth. One type of cestode, *Oochoristica truncata* was reported. In spite of their closeness to human habitation and possibly spread of disease to man, very little has been done in Nigeria to study the parasites they carried or to examine their zoonotic potential. Some of the works on *Agama agama* parasite in Nigeria and outside Nigeria that are available in the literature are reviewed below. And three types of nematodes *Abbreviata paradoxa*, *Thubunaea fitzsimonsi* and *Parapharyngodon rotundatus*, were detected. *Oochoristica truncata* had the largest number (808), the highest frequency of 90% and the greatest average of intensity of infection (29.9). *Oochoristica truncata*, *A. paradoxa*, *T. fitzsimonsi*, *P. rotundatus* and *Agama aculeata* were novel hosts records.

Morsy *et al.* (2013a) in Egypt (South Sinai) conducted a parasitological study, where fifty-six *Agama mutabilis* specimens were examined; ten (17.9%) were infected with an anoplocephalid cestode (*Oochoristica mutabilis*). Light and scanning electron microscopy revealed gravid proglottids with uterine capsules filled with oncospheres. The parasite is morphologically distinct from most *Oochoristica* species, closely resembling *O. parvovaria*.

Mosey *et al.* (2013b) described the morphological and morphometric characteristics of *Oochoristica mutabili*. An anoplocephalid cestode infecting the small intestine of the Egyptian changeable Lizard, *Agama mutabilis* in South Senaie by light scanning electron microscopy. This was the first description from this hosts in Egypt. Ten, out of fifty and six (17.9%) of examined specimens were infected with *Oochoristica* spp. Gravid proglottids contained in the uterine capsule containing numerous oncospheres. The described parasite was compared with

different species of the same genus from different hosts and it was found that morphologically the present species was more or less different from the comparable species and the only morphologically similar species was *Oochoristica parvovaria*.

Birlik *et al.* (2018) surveyed gastrointestinal helminths in 72 Valentin's lizards. *Darevskia valentini*; 32 males, 35 females, 5 subadults collected across central and eastern Anatolia (Kayseri, Ardahan, and Van Provinces), reporting infections in 41 hosts an overall prevalence of 56.9% (41/72). The helminth assemblage comprised two cestodes: *Oochoristica tuberculata* and *Mesocestoides* spp. and five nematodes: *Spauligodon aloisei*, *Skrjabinodon alcaraziensis*, *Skrjabinodon medinae*, *Skrjabinelazia hoffmanni*, and *Strongyloides darevskyi*. Notably, *D. valentini* represented a new host record for all taxa recovered, expanding known host ranges in the region, and *S. alcaraziensis* was documented from Turkey for the first time, adding a new national record. The authors also established new locality records (Kayseri, Van, Ardahan) for all helminths reported from *D. valentini*, underscoring how targeted sampling in under-studied Anatolian localities continues to reveal undocumented parasite diversity and host–parasite links in Palearctic lacertids. Collectively, these findings refine the baseline helminth fauna for *D. valentini* and provide a comparative reference for future eco-parasite and biogeographic work on Anatolian *Darevskia* species.

Ocampo-Salinas *et al.* (2021) conducted a parasitological survey on 68 individuals from four lizard species *Aspidoscelis mexicanus*, *Sceloporus horridus*, *Sceloporus ochoterenae*, and *Urosaurus bicarinatus* collected in Santiago Tamazola, Mixteca Region, Oaxaca, Mexico. The study identified one cestode, the tetrathyridium larvae of *Mesocestoides* spp., and two nematodes, *Physaloptera retusa* and *Spauligodon garciaprieto*. Among these, *P. retusa* had the highest prevalence, occurring in 85% of *S. horridus* specimens and present across all four host species, indicating its broad host range. *S. garciaprieto* was the most abundant parasite

recorded (n = 626), particularly in *A. mexicanus*. Most of the helminths were generalists with indirect life cycles, except for *S. garciaprieto*, which may have a different life history. This investigation represents the first record of these helminths in *S. horridus*, *S. ochoterena*, and *U. bicarinatus*, and the first documentation of *Mesocestoides* spp. *tetrathyridia* in Oaxaca State, thereby contributing novel distributional and host data to the helminth fauna of Mexican reptiles.

Sümer *et al.* (2023) examined helminth communities in 38 individuals of Anatolian Rock Lizard (*Anatololacerta anatolica*; Werner, 1902) collected across western Turkish provinces; Aydın, Bursa, Çanakkale, İzmir. The authors identified a diverse parasitic assemblage consisting of one digenean (*Plagiorchis elegans*), one cestode represented by *Mesocestoides* spp. *tetrathyridia*, and four nematode species: *Skrjabinodon medinae*, *Skrjabinelazia hoffmanni*, *Skrjabinelazia taurica*, and *Spauligodon aloisei* the latter three being new host records for *A. anatolica*. This study significantly expands knowledge of the helminth fauna of *A. anatolica* and contributes novel host–parasite association data within Lacertidae in Türkiye.

Ofori *et al.* (2023) examined the gastrointestinal helminths and Gram[−]negative bacteria of the West African rainbow lizard (*Agama picticauda*) in urban and suburban sites in Accra, Ghana. They recorded an overall helminth prevalence of 71.9%, comprising *Ascaris*, *Enterobius*, *Pharyngodon* and *Oxyurid* spp. Spatial and seasonal differences were evident: *Ascaris* and *Pharyngodon* were more common in suburban populations during the wet season, while *Ascaris* and *Enterobius* were more prevalent in urban sites. Six Gram[−]negative bacterial genera were detected *Escherichia* (86.5%), *Enterobacter* (75.7%), *Proteus* (67.6%), *Shigella* (40.5%), *Klebsiella* (21.6%) and *Salmonella* (16.2%) with *Escherichia* and *Proteus* more frequent in suburban lizards during the wet season. Several of these, including *Ascaris*, *Enterobius*, *Shigella* and *Salmonella*, are recognised human pathogens, indicating zoonotic

potential. The study highlights how anthropogenic habitat modification and seasonal factors influence reptile–pathogen associations and provides valuable baseline data for urban wildlife disease monitoring.

Kirillov *et al.* (2025) offer a comprehensive analysis of helminth diversity in reptiles across eight administrative provinces of the Middle Volga region, leveraging an extensive dataset of 8,576 georeferenced helminth occurrence records collected between 1996 and 2024 and archived via GBIF. The study spans nine reptile species including: *Natrix natrix*, *N. tessellata*, *Vipera berus*, *V. renardi*, *Coronella austriaca*, *Lacerta agilis*, *Zootoca vivipara*, *Anguis colchica*, and *Eremias arguta* and reports a total of 45 parasitic worm species: 21 trematodes, 16 nematodes, 4 cestodes, and 4 acanthocephalans (Kirillov *et al.*, 2025). Notably, helminth richness varied greatly among hosts: *Natrix natrix* exhibited the highest diversity (26 species), followed by *Lacerta agilis* (21), *N. tessellata* (16), and *V. berus* (15), whereas *Anguis colchica* (8), *Z. vivipara* (7), *V. renardi* (6), *C. austriaca* (5), and *E. arguta* (3) were comparatively less diverse. The helminth community composition reflects a predominance of *Palearctic* taxa (25 species), complemented by *Holarctic* (8), European-only (7), and cosmopolitan (5) species. Importantly, three species with medical and veterinary importance were identified as causative agents of potentially dangerous helminthiases. Despite the comprehensiveness of this dataset, the authors emphasize that overall helminth diversity in the Middle Volga remains lower than that documented in some other European contexts, suggesting that further regional sampling may uncover additional host–parasite associations. This study thus establishes a critical baseline for future parasitological and biogeographical investigations of reptile-associated helminths in the Volga basin region.

2.2 Studied on Helminth Parasites of Lizards in Nigeria

Parasitological studies on helminths parasites of lizards especially the rainbow Lizard (*Agama agama*) have also been conducted over the years in various parts of Nigeria. Some of the studies are as follows:

Adeoye and Ogunbanwo (2005), at Oyingbo Lagos, Nigeria, examined 310 Lizards specimens. 124 males and 186 females were examined and out of the 124 males 121 (97.6%) of males infected, while for female out of 186 females 175 (94.1%) were infected with the Helminths parasite. Seven helminth species were recorded in the study, which includes four nematode species: *Strongyluris brevicaudata* were present in 82.3% of the specimens, *Oxyuris* spp. were present in 1.6%, *Capillaria* spp. were present in 8.4%, and *Parapharyngodon awokoyai* were present in 74.5%. There was also one cestode species, *Oochoristica agamae* present in 74.22%, one trematode species, *Mesocoelium monas* present in 1.6%. and *Pentastomids*, *Raillietiella* spp. 10.3%. The rectum contained four of the seven parasite species. There were significant references in the interaction between the parasite and the organs, in which they were found ($p < 0.05$). Overall parasite intensity was highest in the rectum.

Studies on the helminth fauna of reptiles have revealed that *Agama agama* serves as a significant host of intestinal parasites in Nigeria. Adeoye and Ogunbanwo (2007) investigated 310 specimens of *A. agama* collected in Lagos, Nigeria, and reported a diverse assemblage of helminths comprising nematodes, cestodes, trematodes, and pentastomids. The most prevalent parasites were nematodes, with *Strongyluris brevicaudata* (82.3%) and *Parapharyngodon awokoyai* (74.5%) dominating the infections, followed by *Capillaria* spp. (8.4%) and *Oxyuris* spp. (1.61%). Other taxa included the cestode *Oochoristica agamae* (7.4%), the trematode *Mesocoelium monas* (1.61%), and the pentastomid, *Raillietiella* spp. (10.3%). Notably, *Raillietiella* spp. and *Capillaria* spp. are of zoonotic concern, as they can cause localized

inflammation and intestinal infections in humans. Infection dynamics varied with host biology and season; larger adults harboured more parasites, and males showed both a higher prevalence (97.6%) and greater intensity than females (94.1%). Parasite burden was highest in the rectum, followed by the intestine, a difference that was statistically significant. Seasonal fluctuations were also evident, with *P. awokoyai* peaking in May, *S. brevicaudata* in June, and other species reaching maximum prevalence in July. These findings highlight the ecological complexity of host–parasite interactions in urban lizard populations and emphasize the potential public health relevance of helminths harboured by *A. agama*.

Parasitological investigations on *Agama agama* have revealed significant gastrointestinal helminth infections across different ecological zones in Nigeria. In a study conducted in Ibadan, Oyo State, Omonona, Adedokun, and Adekoya-Gafaar (2011) examined 60 *Agama agama* with snout–vent lengths ranging from 22.9 cm to 37.5 cm, collected from five local government areas. The authors reported two nematode species, *Strongyluris brevicaudata* and *Thelandros annulatus*, as the predominant parasites. Infection was ubiquitous, with all lizards examined harbouring at least one of these nematodes. Prevalence varied by locality, with *S. brevicaudata* being most common in Ibadan South East (87.5%), while *T. annulatus* reached its highest prevalence in Ibadan North (75.86%). Sex-related differences were also observed, as female lizards showed higher infection intensity in Ibadan North (51.72%), Ibadan South East (54.68%), and Ibadan North West (53.57%), whereas males exhibited higher prevalence in Ibadan North East (48.44%) and Ibadan South West (49.15%). Overall, *S. brevicaudata* was more widely distributed than *T. annulatus* across the study area. The findings underscore the heavy burden of gastrointestinal helminths among *Agama agama* in southwestern Nigeria and highlight ecological and host-related variations in parasite distribution.

Parasitic infections in reptiles, particularly lizards, are of significant epidemiological importance as they may act as reservoirs or intermediate hosts for parasites that can affect other vertebrates, including humans. In a comprehensive parasitological survey carried out by Mbaya, Luka, and Adamu (2013) in Maiduguri, Borno State, Nigeria, investigated the prevalence of endoparasites, ectoparasites, and haemoparasites in *Agama agama*, a lizard species commonly found in urban and peri-urban environments. The study examined 100 lizards, consisting of 44 males and 56 females, further categorized into 20 juveniles and 80 adults. Results revealed a striking 100% prevalence of endoparasitic infections, underscoring the widespread distribution of gastrointestinal helminths in this lizard population. Two nematode species were identified: *Trichuris* spp., which accounted for 70% of infections, and *Ascaris* spp., detected in 30% of the lizards. The authors noted that the ubiquity of endoparasites in these reptiles may be attributed to their feeding habits and environmental exposure, especially since *Agama agama* thrives in human dwellings where sanitary conditions are often poor. Interestingly, no ectoparasites were detected in any of the lizards examined. This finding diverges from previous studies in other reptiles, where ectoparasites such as mites and ticks are commonly reported. The absence of ectoparasites could be linked to the specific ecological conditions in Maiduguri or the particular behaviour and microhabitat preferences of *Agama agama*, which may limit exposure to external parasites. However, the lack of ectoparasites does not diminish the epidemiological importance of this species, as high burdens of endo- and haemoparasites were observed. Haemoparasitic infections were recorded in 36% of the lizards, with slight differences between sexes. Male lizards had a higher infection rate (20 out of 44; 55.6%) compared to females (16 out of 56; 44.4%), but this difference was statistically insignificant ($P > 0.05$) (Mbaya *et al.* , 2013). Age, however, was a significant factor: adults exhibited a markedly higher prevalence of haemoparasites (86.1%) than juveniles (13.9%) ($P < 0.05$), suggesting that cumulative exposure over time and behavioural differences

between age groups may influence infection risk. Three genera of haemoparasites were identified: *Plasmodium spp.* (47.2%), *Haemoproteus spp.* (30.6%), and *Leucocytozoon spp.* (22.2%). These findings demonstrate that *Agama agama* is a natural host for multiple blood parasites, some of which are of medical and veterinary importance. For instance, *Plasmodium spp.* are well-known agents of malaria in reptiles and other vertebrates, while *Haemoproteus* and *Leucocytozoon* species are common avian haemoparasites that can cross ecological boundaries.

Nwadike and Ilozumba (2015) conducted a parasitological survey to determine the prevalence of the helminthiasis of a rainbow Lizard (*Agama agama*) in Nsugbe Anambra State, Nigeria. A total of 250 Lizards consisting of 90 females and 160 males as well as 191 adults and 59 juveniles, were manually captured at night at their roosting location and then killed. Using chloroform within airtight jars. The Oesophagus, stomach, intestine, rectum, lungs, liver and body cavity of the Lizards were examined for the helminths. Four species of helminths namely: *Strongyluris brevicaudata*, *Parapharyngodon awokoyai*, *Foleyella candezei* (Nematoda) and *Oochoristica truncata*, (Cestoda) were recovered from infected Lizards. Two hundred and seventeen (217) (86.80%) of the lizards harboured helminths. One hundred thirty and nine (139) (86.88 %) of male Lizards and 78 (86.67%) of females were infected. While 182 (95.29%) and 35 (59.32%) of adults and juveniles Lizards respectively were infected. *Strongyluris brevicaudata* had the prevalence of 85.60%, followed by *Parapharyngodon awokoyai* (55.60%), *Oochoristica truncata* (6.80%), *Foleyella candezei* (2.00%). Prevalence, abundance, mean abundance, mean intensity of infections did not differ significantly ($p=0.05$) with sex of Lizard but all differed significantly with age of hosts ($p=0.05$).

A parasitological survey was carried out in two locations. Ibadan and Ile-Ife, South- West Nigeria by Sowemimo and Oluwanifemi (2015). A total of 133 Lizards (*Agama agama*)

specimens was examined (67 from Ibadan and 66 from Ile-Ife) and helminths was found to be 100% prevalence. A total of five helminths were recovered comprising three nematodes, one cestode and one trematode. The Nematodes recovered were include; *Strongyluris brevicaudata* with a prevalence of 92.5%, *Parapharyngodon* spp. has a prevalence of 89.5% and unidentified nematode with a prevalence of 0.8%. The cestode and trematode recovered were *Oochoristica truncata* and *Mesocoelium monas* with a prevalence of 56.4% and 1.5%, respectively. Both *Strongyluris brevicaudata* and *Oochoristica truncata* were recovered from the intestine/ rectum of the Lizards (*Agama agama*) while *Parapharyngodon* spp. and *Mesocoelium monas* were recovered from rectum only and unidentified nematode was recovered from the small intestine of the Lizards. No parasite was found in lungs and stomach.

Helminth fauna in West African agamid lizards exhibits remarkable diversity and prevalence across regions, reinforcing their ecological and epidemiological significance. In a survey spanning February to October 2015 across *Agama agama* populations in Ile-Ife and Ibadan, southwestern Nigeria, Sowemimo and Oluwafemi (2017) examined 133 lizards and found a striking 100% infection prevalence, identifying five helminth species: three nematodes *Strongyluris brevicaudata* (92.5%), *Parapharyngodon* spp. (89.5%), and an unidentified nematode (0.8%) as well as the cestode *Oochoristica truncata* (56.4%) and the trematode *Mesocoelium monas* (1.5%). The study revealed that *S. brevicaudata* was the most frequently encountered parasite in both regions, with worm burden (infection intensity) highest in the rectum and positively correlated with the lizard's body size suggesting larger individuals are more susceptible to heavier infections. Importantly, multiple infections were the most common scenario, occurring in 81.2% of lizards, although none of the identified parasites are known to infect humans. This work provides valuable baseline metrics for helminth diversity and

infection dynamics in West African lizards and underscores the influence of host morphology and geographic setting on parasite burdens.

Lawal *et al.*, (2017) investigated the prevalence of gastrointestinal parasites in *Agama agama* lizards trapped within and around commercial poultry pens in six Local Government Areas of Gombe State, Nigeria, between February and December 2017. A total of 200 euthanized lizards were examined, with overall parasite prevalence recorded at 77.0%. Nematode infections were dominant (58.0%), represented by *Strongyluris* spp. (25.5%), *Trichuris* spp. (13.5%), *Oxyuris* spp. (8.0%), *Ascaris* spp. (5.5%), *Heterakis* spp. (4.0%) and *Capillaria* spp. (1.5%). Coccidian protozoa were detected in 19.0% of samples, with *Eimeria* and *Isospora* each occurring at 1.5% prevalence. The prevalence of infection was significantly higher during the rainy season compared to the dry season ($p < 0.0001$), and male lizards exhibited a slightly higher helminth infection rate (19.4%) than females (18.5%) ($p < 0.05$). The authors noted that some identified genera (*Ascaris*, *Capillaria*, *Heterakis*) have zoonotic or veterinary importance, indicating potential cross-transmission between lizards, poultry, and humans. They recommended molecular characterization of the parasites and implementation of strict biosecurity measures around poultry facilities to reduce transmission risks.

The helminth parasites of Agama Lizards from Urban and pre-urban locations in Benin City and environs were investigated by Aghedo (2019). The study was conducted in three locations: Ugbowo campus of the University of Benin, Imafidon Street in Ekosodin and Uhogua community all in the Ovia North East Local Government area of Edo State, Nigeria. The investigator collected and examined 40 Lizards. There were 10 species of helminths were recovered, which comprised five nematodes: *Thelandros scleratus*, *Parapharyngodon awokoyai*, *Ampliacaceum* spp., *Strongyluris brevicaudata* and one unidentified Oxyurid nematodes. Three cestode species were also discovered, one from each location: *Oochoristica*

agamae as well as other two cestode species that were suspected to be a new species. It was recorded in the study that *S. brevicaudata* was the most prevalent parasite (95%) followed by *P. awoyai* (50%) and *T. scleratus* (10%). While among the cestode *O. agamae* had the highest prevalence. Male Lizard (97.6%) had a slightly higher prevalence than the female (94.1%) of the specimens.

Robert *et al.* (2020) carried out a parasitological study between February and May 2019 to assess the prevalence and intensity of helminth infections in the rainbow lizard (*Agama agama*) in Okrika, Rivers State, Nigeria. A total of 151 specimens (93 males and 75 females) were examined from two sampling stations, Ogoloma-Ama and Oba-Ama, after chloroform anaesthesia and dissection of visceral organs. Five helminth species were recovered, comprising nematodes (*Strongyluris brevicaudata*, *Parapharyngodon awokoyai*, and encysted Ascaridida larvae), cestodes (*Oochoristica* spp.), and trematodes (*Mesocoelium* spp.). Overall prevalence was high, with 123 lizards (82%) infected. Prevalence varied by locality, with 76.3% infection in Oba-Ama and 84.8% in Ogoloma-Ama. Males exhibited significantly higher infection levels (93%) compared with females (75%) ($p < 0.05$), suggesting that behavioural or ecological differences between sexes may influence parasite exposure. Among the parasites, *S. brevicaudata* and *P. awokoyai* were the most common, while *Mesocoelium* spp. and *Oochoristica* spp. were found in lower numbers, including some unidentified species, highlighting the diversity of helminths within this host population. The results demonstrate that *A. agama* serves as an important host for multiple helminth taxa in southern Nigeria, with infection patterns shaped by location and sex. The study also emphasized that the simple local netting system used for capture was both effective and efficient, providing a replicable method for field parasitological surveys. These findings expand knowledge on helminth ecology in

Nigerian agamid lizards and underline their potential relevance in zoonotic transmission pathways.

Robert *et al.* (2020) carried out a parasitological survey on the prevalence and intensity of parasitic helminths of Lizards from two Local Government area (Ogolo-Ama and Oba-Amawere), from River State Nigeria. A total of 152 specimens, 59 Lizards from Ogoloma-Ama and 92 Lizards from Oba-Amawere were taken in to examination by the researchers. Those from Oba-Amawere had 21 males and 38 females while those from Ogoloma-Ama were 34 males and 58 females. A total of 123 (82%) Lizards were infected. Out of 59 Lizards that were examined from Oba-Amawere, 45 (76.3%) were infected, while 74 (84.8%) of the 92 Lizards caught from Ogoloma-Ama were infected. Helminths parasite of five species was recorded in the study. The parasitic helminths recovered were nematodes: *Strongyluris brevicaudata*, *Parapharyngodon awokoyai* and encysted Ascaridida larvae, cestodes (*Oochoristica* spp.), and trematodes (*Mesocoelium* spp.). Nematodes were recorded as the most prevalent parasites than both cestodes and trematodes. Infection was high in male than in female. For instance, in hosts from Ogoloma-Ama, nematodes infected 94% of the male host and 79% of the female hosts. Similarly, higher prevalence of infection was recorded in hosts from Ogoloma-Ama. Nematodes infected 91% of the male host and 71% of the females hosts in Oba-Ama.

Eziegbemhin (2021) investigated the Helminth parasites in *Agama agama* lizards from a poultry farm from Uhogua Community, Benin City, Edo State, the investigator examined 15 specimens out of 15 Lizards collected 3 were males and 12 were females. Helminths parasites of seven species were recovered. Overall prevalence of parasites was 100%. Three cestodes *Oochoristica* spp. were recovered and four Nematodes species: *Thelandros scleratus*, *Parapharyngodon awokoyai*, *Thelandros* spp. and *Strongyluris brevicaudata*. Nematodes were

the most prevalent about 93%: male (100%) and females (91.6%). *Strongyluris brevicaudata* was the most prevalent (80%) followed by *Thelandros* spp. (33.3%).

A study of helminths parasite of reptile in Igarra Community, Edo state, Nigeria was conducted by Aghimien (2022). A total of 23 Lizards (*Agama agama*) and two Geckos (*Hemidatylys angulatus* and *Hemidatylys mabouia*) was caught and examined for helminth parasites. The overall prevalence of parasite infection in *Agama agama*, *Hemidatylys angulatus* and *Hemidatylys mabouia* were 82.6%, 100% and 100% respectively. A parasite recovered from *Agama agama* were one Pentastomida [*Raillietiela affinis* (8.7)]; one cestode [*Oochoristica* spp (34.8)]; three nematodes [*Strongyluris brevicaudata* (73.9), *Ascaridida* spp. (4.3), *Thelandros scleratus* (8.7)] and one trematode [*Mesocilum* spp. (4.3)]. The parasite recovered from the *Hemidatylys angulatus* and *Hemidatylys mabouia* were *Strongyluris brevicaudata* and *Raillietiela affinis*, respectively.

Edede (2022) conducted a study to determine the prevalence of helminth parasite infections in *Agama agama*. Captured in Okhumwun, Edo State. A total of nine (9) lizards were examined during the survey, and the results revealed an overall prevalence of 100%, indicating that all sampled individuals harboured at least one helminth parasite (Edede, 2022). The identified helminths comprised both nematodes and cestodes. Among the nematodes, *Thelandros scleratus* was the most prevalent, infecting 88.9% of the lizards examined, followed by *Strongyluris brevicaudata* with a prevalence of 33.3%. In addition, a cestode species, *Oochoristica* spp., was recovered with a prevalence of 22.2%. The high infection rate recorded in this study suggests that *A. agama* serves as a suitable host for a wide range of gastrointestinal helminths and may act as an ecological reservoir that sustains transmission cycles in the environment.

Ezenwaka (2023) conducted observational research at Otuoke Community in Ogba Local Government area of Bayelsa State, Nigeria. Where 50 *Agama agama* consisting both male and female were randomly selected. The Lizards were euthanized and examined for parasite, the finding revealed four parasites namely: nematodes (*Strongyluris brevicaudata* and *Parapharyngodon colonensis*), cestode (*Oochoristica truncata*) and trematodes (*Mesocoelium monas*). There was no relationship between age (measured as length of the animal) and frequency of the parasitic infection. Likewise, there was no relationship between sex and the frequency of the parasitic infection and finally there was no relationship between weight and frequency of the parasitic infection. This research has demonstrated that, although parasites are present in *Agama agama*, but there was no gender, Age and weight differences or influence of the rate of their infection. Conoidasida (*Toxoplasma gondii*) was also reported by the author.

The diversity and prevalence of helminth parasites in Agama lizards vary across different geographical locations. This variation is evident in the various studies conducted in different locations both within and outside Nigeria. Compared with that in the Uhogua Community, located in Ovia North-East, Benin City, Edo State. All the examined Agama lizards were found to be infected with helminths, specifically nematodes and cestodes, with 100% infection rate for these two groups. However, there were no cases of other helminth parasites such as trematodes and pentastomids recorded in the studied carried out in Uhogua Community by Eziegbemhin (2021), Aghedo (2019), and Edede (2022), which were conducted in Okhumwun, also within Ovia North-East, Benin City. These studies collectively highlight the geographical influence on helminth parasite diversity and prevalence in Agama lizard populations.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Description of the Study Area

The study was carried out at the Internally Displaced Persons (IDP) Camp located in Uhogua Community, Ovia North-East Local Government Area, Benin City, Edo State, Nigeria. The camp lies within the tropical rainforest zone of Southern Nigeria, which is well known for its rich biodiversity and favourable climatic conditions that support a wide variety of plant and animal life. The climate of the area is typically humid, with two major seasons: a wet season and a dry season. The wet season usually spans from March to October, while the dry season extends from November to March. The region receives an annual rainfall of approximately 2,000–2,500 mm, which ensures lush vegetation for most of the year. Average daily temperatures range between 25–32°C, creating a warm environment that encourages the survival and reproduction of many organisms, including reptiles such as lizards. The IDP Camp itself is a semi-urban settlement designed to accommodate a crowd. It contains residential quarters, Primary and Secondary classrooms, worship centres, and other basic facilities. In addition to human dwellings, the camp also has adjoining farmlands, gardens, and open fields that contains patches of coarse grasses, tree-studded grasslands, and bushes dominated by tall trees, which offer shade and cover. The presence of food resources, both natural (insects, plants) and artificial (human waste and leftovers), also supports the abundance of lizards within and around the camp.

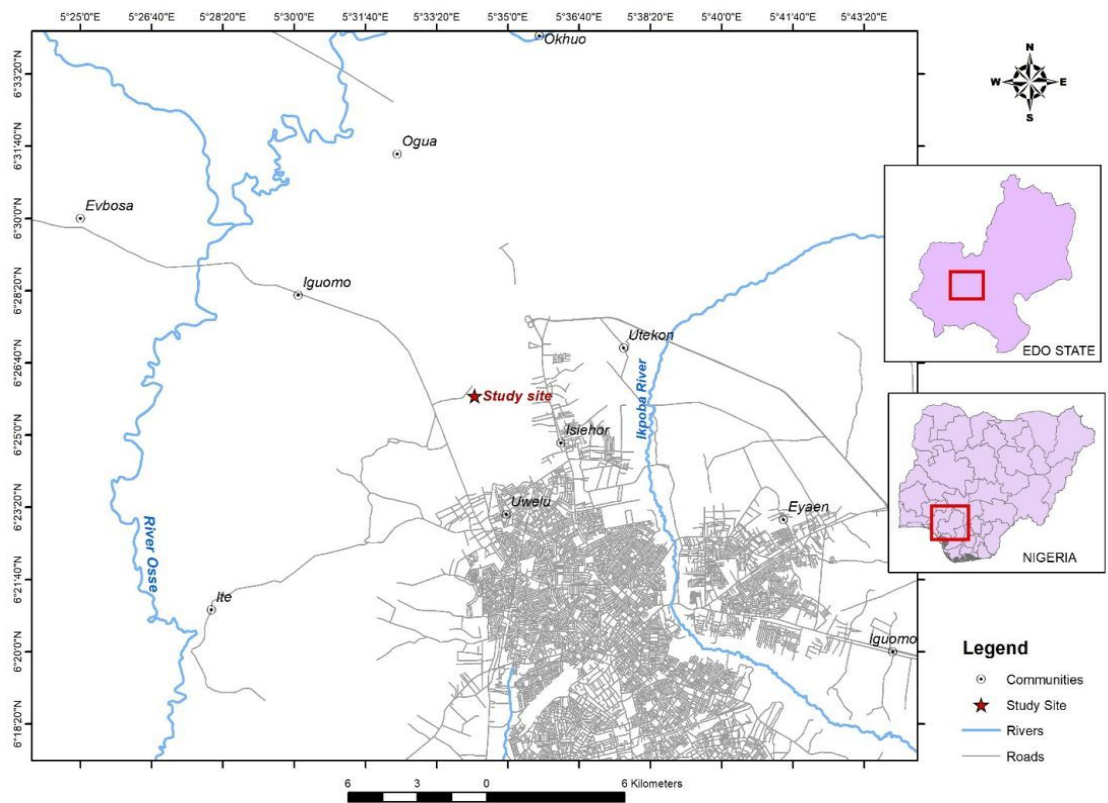


Fig 3.1: Map of the study area, showing sample sites

The camp is enclosed by a short perimeter wall and beyond this wall lies an area of luxuriant secondary forest, which further enriches the ecological diversity of the environment. This forest serves as an additional habitat for biodiversity, allowing free movement of reptiles and other animals between the camp and the surrounding natural vegetation. The mixture of human settlement and the rangeland create a mosaic of habitats that provide shelter, breeding grounds, and feeding opportunities for lizards and other fauna, making the IDP Camp at Uhogua an ideal location for the study.

The IDP Camp in Uhogua community is located within the Latitude and Longitude of 6° 25' 53.5" N, 5° 34' 10.6" E

3.2 Collection of lizards for helminth infection

The collection of lizard samples took place between May and June 2025. Sampling took place at different areas, such as the roof of a building, between blocks, and on top of a wall. The sampling time was either at night (between 7:00pm - 10pm) or early in the morning at 6:00am, when the lizards were still less active. The collection was done by hand catching collection method (holding the lizards on their dorsal part to prevent any harm from their self-defence bite) and by shoving them with a broom for those on top of a wall). And these were done with caution to avoid causing them injuries and even killing them. They were collected and temporary stored in a perforated plastic container which allow air flow into it, to prevent suffocation. The samples then were transported to the Laboratory of Parasitological Research in the Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City, Edo State, for dissection and examination for helminth parasites. The lizards were identified using the keys of Trape *et al.* (2012).

3.3 Preparation of parasites for identification

The lizards were anaesthetised by exposure to chloroform vapor in an airtight container (killing jar) for at least 5 minutes. Following euthanasia, the sex of the lizards was identified, each specimen snout–vent length was also measured with the aid of measuring tape and recorded before dissection. Dissection was carried out on a dissecting board using sterilized dissection tools such as scissors, forceps, and scalpels. A mid-ventral incision was made to open the body cavity. This incision extended from the throat region down to the cloaca to allow for the proper exposure of the internal organs. The digestive tract was carefully removed and separated into distinct sections: the oesophagus/stomach, liver/gall bladder, lungs, small intestine, large intestine/rectum. Each section was placed individually in clean Petri dishes containing normal saline solution to keep the tissues moist and viable for examination. Each portion of the organs were then slit open longitudinally with the aid of fine dissecting scissors and gently examined under a dissecting microscope. The saline solution made of 0.72% NaCl in the Petri dishes helped to dislodge mucus and debris, making it easier to observe parasites that might be attached to the intestinal wall or free-floating in the lumen. Any helminth parasites observed were carefully removed using fine forceps or a puncture pipette to avoid breakage or loss of important body parts. Recovered worms were immediately washed in a normal saline solution (0.72% NaCl) to remove any adhering mucus and tissue debris. This washing step ensured that the parasites were clean and suitable for subsequent preservation and identification. To prevent mixing of samples, parasites collected from each organ of each lizard were kept separately in well-labelled containers.

For preservation, nematodes and cestodes were handled differently. Nematodes and cestodes were first straightened by gently immersing them in heated 70% alcohol, which prevented them from coiling or folding, thus preserving their morphological features for easier identification.

After straightening, the parasites were transferred into freshly prepared 70% alcohol for long-term preservation. Specimens were then stored appropriately: nematodes were placed in well-labelled glass specimen bottles, while cestodes were stored in labelled plastic containers to avoid damage.

3.4 Parasite Identification

Parasite identification was carried out using a compound light microscope under different magnifications. Morphological features such as the shape of the body, presence or absence of hooks or suckers, structure of the cuticle, and reproductive organs were used in classification. Identification was done with reference to standard parasitological keys and manuals (Soulsby, 1982; Schmidt and Roberts, 2009).

3.5 Photography of host and parasites

Photomicrographs of the parasites were taken using an Imaging Source microscope digital camera, DFK MKU 130-10 × 22 attached to a binocular microscope.

3.6 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. Chi-square test was also carried out to compare the prevalence and mean intensity of helminth infection in the lizards with a p-value of 0.05.

CHAPTER FOUR

RESULTS

4.1 Helminth Parasites of Agama Lizards from Uhogua Community and their sites of infections

A total of thirty (30) specimens of *Agama agama* were captured from the Internally Displaced Persons (IDP) Camp in Uhogua Community, Edo State, and examined for helminth parasites. Out of these, nine (9) were males and twenty-one (21) were females. Morphometric measurements taken from the specimens revealed that the Snout-to-Vent Length (SVL) of all the lizards ranged from 6.50 cm to 14.30 cm, with a mean value of 10.40 cm. The SVL of the males ranged from 12.00 cm to 14.30 cm, with an average of 13.15 cm, while that of the females ranged from 6.50 cm to 12.00 cm, with a mean value of 9.25 cm. These observations indicate that, on average, the male lizards were larger in size than their female counterparts, which is consistent with the general pattern of sexual dimorphism reported in many agamid species.

Following the examination for the helminth parasite, a total of 857 helminth parasites were recovered from the digestive tracts of the thirty lizards examined. Table 4.1 shows the parasites recovered belong to three major taxonomic groups: Cestoda, Trematoda, and Nematoda. Specifically, four helminth species were identified, comprising one cestode, one trematode, and two nematodes. The cestode identified was *Oochoristica* sp. (Plate 4.2), which is a common intestinal parasite of reptiles, particularly lizards. It was found in the small intestine of the examined specimens. The trematode recovered was *Mesocoelium monodi* (Plate 4.3), which was also found in the small intestine. This fluke species has been previously reported in various amphibians and reptiles in West Africa. While the two nematode species identified were *Strongyluris brevicaudata* (Plate 4.4) and *Thelandros scleratus* (Plate 4.5). *Strongyluris*

brevicaudata was found in the large intestine. This species has been widely reported in different species of agamid lizards and is recognized for its characteristic elongated body and sharply pointed tail. *Thelandros scleratus*, on the other hand, was also localized mainly in the large intestine.

4.2 Overall Prevalence and Mean Intensity of Helminth Parasites of Agama Lizards from Uhogua Community

The findings revealed a 100% overall prevalence, indicating that all the examined lizards were infected with one or more helminth parasite species. Four helminth taxa which were recovered, representing cestodes, trematodes and nematodes, with varying rates of occurrence and infection intensities. The cestode *Oochoristica* sp. recorded a prevalence of 43.33% and a mean intensity of 9.00 ± 10.77 . Among the nematode species, *Strongyluris brevicaudata* exhibited the highest prevalence rate (76.67%) and a mean intensity of 20.00 ± 27.19 making it the most dominant and successful parasite in colonizing the lizard hosts. Another nematode species, *Thelandros scleratus*, had a prevalence of 23.33% and a mean intensity of 6.57 ± 2.57 . Although *T. scleratus* was less prevalent than *S. brevicaudata*, its presence indicates some level of diversity among the nematode fauna infecting the lizards. The trematode, *Mesocoelium monodi* showed the lowest prevalence (10.0%), but recorded a relatively high mean intensity (40.67 ± 21.78). This suggests that although few lizards were infected, those that harboured the parasite carried a heavy worm burden. The overall prevalence and mean intensity of the parasite were represented in Table 4.2.

Statistically, there was a significant difference ($p < .05$) in the prevalence and mean intensity of helminth infection between the helminth parasite species reported in this study.



Plate. 4.1A-B. *Agama* lizards from Uhogua. A. Male *Agama agama*; B. Female *Agama agama*

Table 4.1 Parasites of Agama Lizards from Uhogua and their sites of infection

Host	Parasite	Site of infection
Agama agama	Cestode	
	<i>Oochoristica</i> sp.	Small intestine
	Nematode	
	<i>Parapharyngodon awokoyai</i>	Large intestine
	<i>Strongyluris brevicaudata</i>	Small intestine/Large intestine
	Trematode	
<i>Mesocoelium monodi</i>	Small intestine	

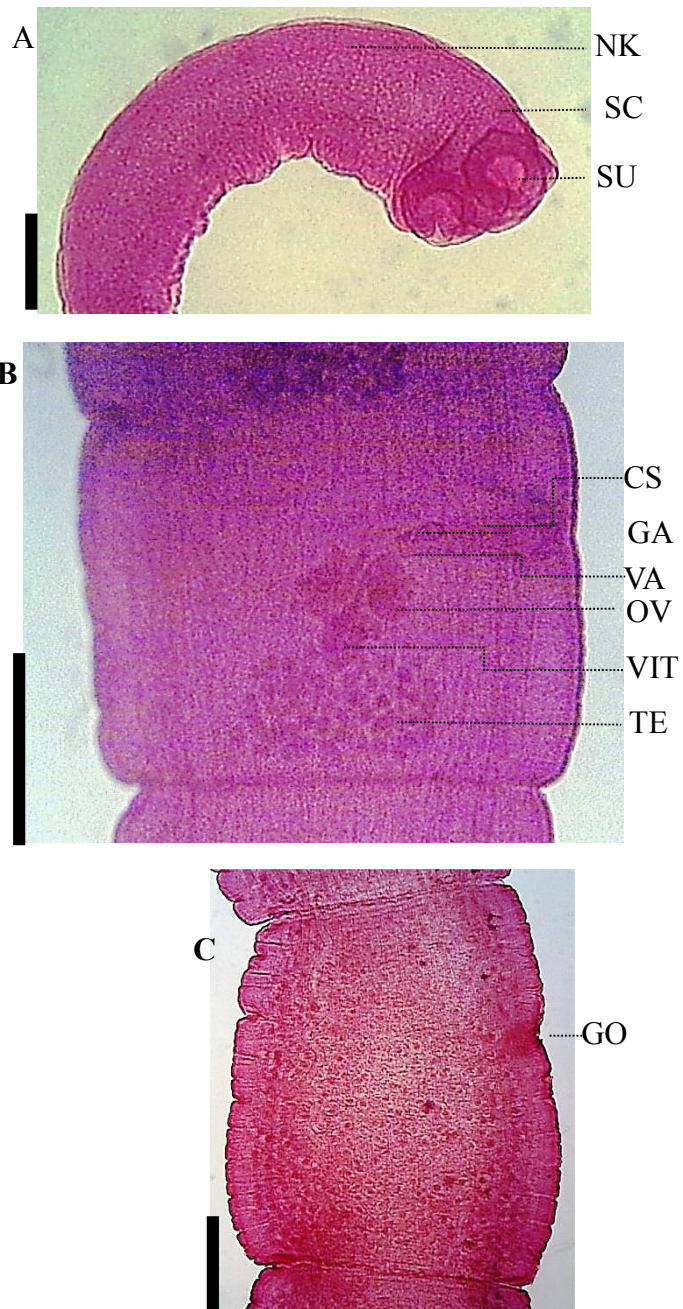


Fig. 4.1 A-C. *Oochoristica* sp. infecting *Agama agama* from the IDP Camp, Uhogua, Benin City. A, Scolex; B, Mature proglottid; C, Gravid proglottid; Abbreviations: NK, Neck; SC, Scolex; SU, Sucker; CS, Cirrus sac; GA, Genital atrium; VA, Vagina; OV, Ovary; VIT, Vitellatium; TE, Testes; GO, Genital opening. Scale bar: A, C = 0.1 mm; B = 0.5 mm

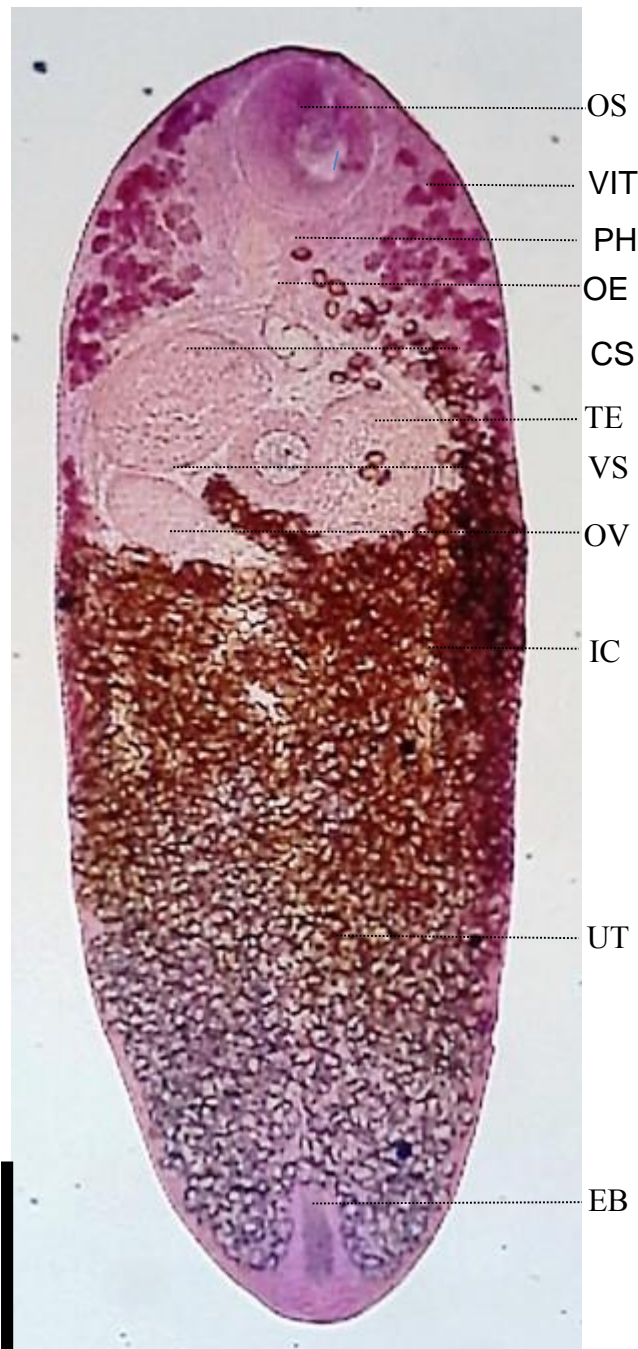


Fig. 4.2. *Mesocoelium monodi* infecting *Agama agama* at the IDP Camp, Uhogua, Benin City. Abbreviations: OS, Oral sucker; VIT, Vitellaria; PH, Pharynx; OES, Oesophagus; CS, Cirrus sac; TE, Testis; VS, Ventral sucker; OV, Ovary; IC, Intestinal caecum; UT, Uterus; EB, Excretory bladder. Scale bar: 1.0 mm

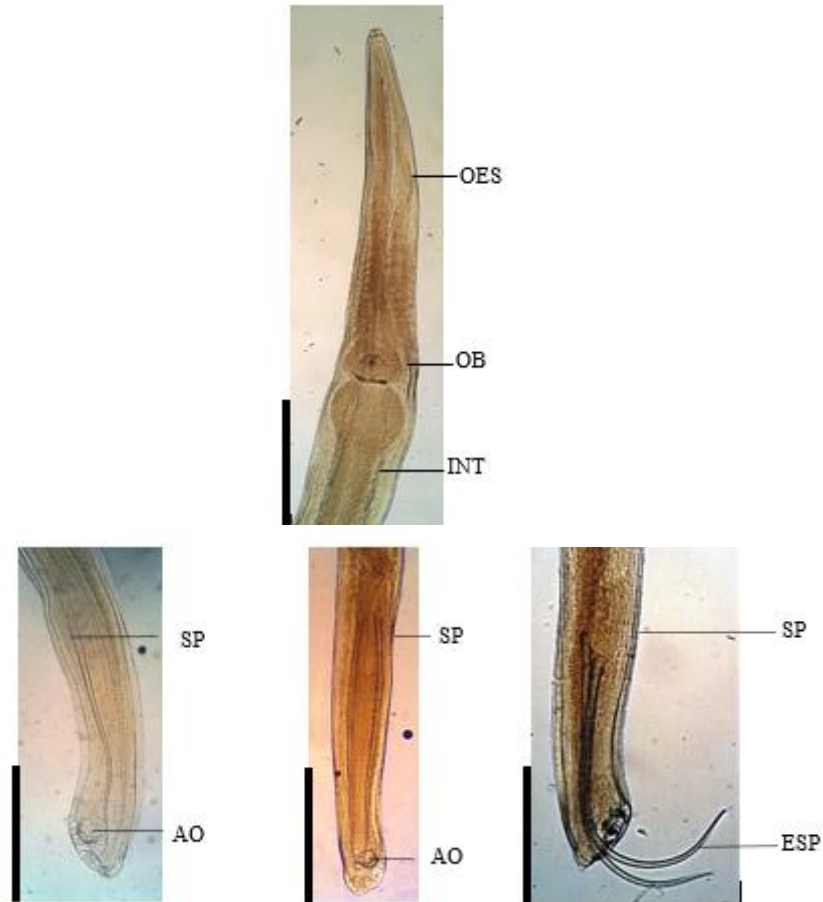


Fig. 4.3 A-D. *Strongyluris brevicaudata* infecting *Agama agama* from the IDP Camp, Uhogua, Benin City. A, Anterior end of male; B, Side view, posterior end of male, C, Ventral view of posterior end of male; D, Side view, posterior end of male with extruded spicules. Abbreviations: OES, Oesophagus; OB, Oesophageal bulb; INT, Intestine; SP, Spicule; AO, Anal opening; ESP, Extruded spicule. Scale bar: A, B, C = 1.0 mm

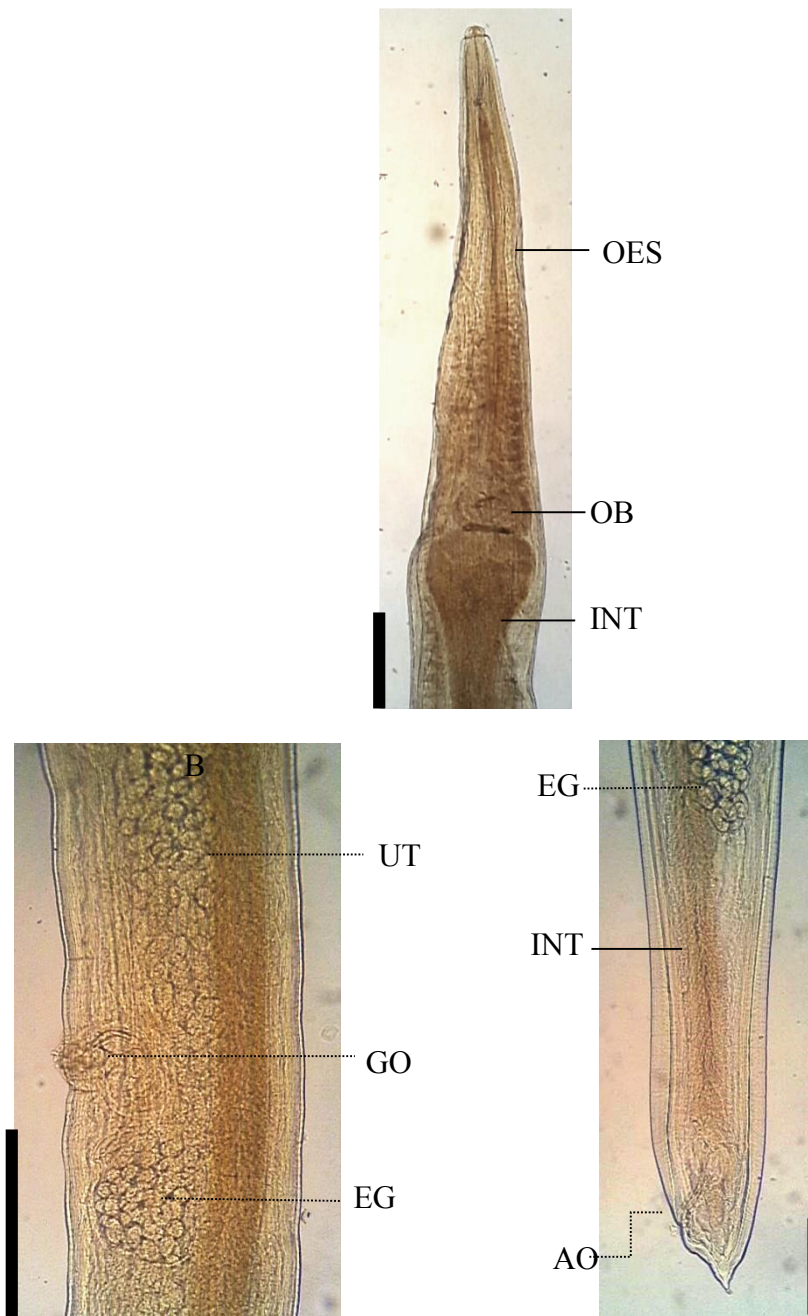


Fig. 4.4 A-C. Female of *Strongyluris brevicaudata* infecting *Agama agama* from IDP Camp, Uhogua, Benin City. A, Anterior end of female; B. Uterine portion showing genital opening; C, Posterior end of female. Abbreviations: OES, Oesophagus; OB, Oesophageal bulb; INT, Intestine; EG, Eggs; UT, Uterus; GO, Genital opening; AO, Anal opening.

Scale bar: A,C = 0.5mm, B = 1.0 mm

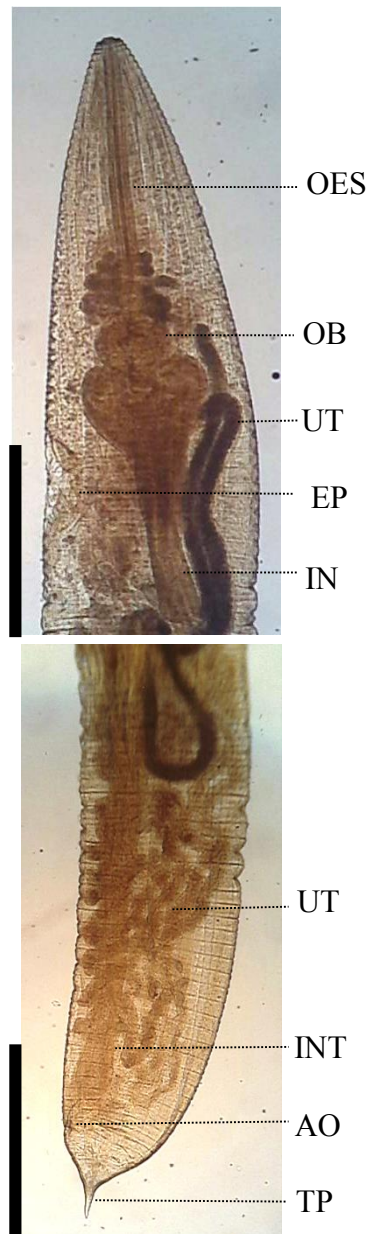


Fig. 4.5 A-B. *parapharygodon awokoyai* infecting *Agama agama* from IDP Camp, Uhogua, Benin City. A, Anterior end of female; B, Posterior end of female. Abbreviations: OES, Oesophagus; OB, Oesophageal bulb; UT, Uterus; EP, Excretory pore; INT, Intestine; AO, An opening; TP, Tail process. Scale bar: A, B = 1.0 mm

4.3 Overall Prevalence and Mean Intensity of the Parasites in Agama Lizards from Uhogua Based on Sex

All the males and female Agama lizards examined were infected with helminth parasite species with an overall prevalence of 100.0% for males and females.

Table 4.4 shows that among the four parasite species recorded, *Strongyluris brevicaudata* showed the highest prevalence in both sexes, with 88.89 % in males and 90.48 % in females. The mean intensity of this parasite was also relatively high, measuring 36.00 ± 42.75 in males and 15.26 ± 17.17 in females. *Oochoristica* sp. had a moderate prevalence, recorded at 33.33 % in males and 47.62 % in females. However, the mean intensity was higher in females (10.70 ± 11.77) compared to males (3.33 ± 3.21), suggesting that females carried a heavier parasite burden for this species. For *Parapharyngodon awokoyai*, the prevalence was higher in males (44.44 %) than in females (14.29 %), but females exhibited a slightly higher mean intensity (8.67 ± 2.08) compared to males (5.00 ± 1.63). *Mesocoelium monodi* was detected only in male lizards, with a prevalence of 33.33 % and a mean intensity of 47.33 ± 21.78 , indicating a heavy parasite load in the infected males.

Statistically, there was a significant difference ($p < 0.05$) in the prevalence and mean intensity of helminth infection between the helminth parasite species amongst the male Agama lizards, but significant difference was only observed for prevalence amongst the female Agama lizards reported in this study.

Table 4.2 Overall prevalence and mean intensity of helminth parasite infection in Agama Lizards

Parasite	Prevalence (%)	Mean intensity (M ± SD)
<i>Oochoristica</i> sp.	43.33	9.00 ± 10.77
<i>Strongyluris brevicaudata</i>	76.67	20.00 ± 27.19
<i>Parapharyngodon awokoyai</i>	23.33	6.57 ± 2.57
<i>Mesocoelium monodi</i>	10.00	40.67 ± 21.78
χ^2	66.791	37.857
p-value	0.000*	0.000*

* significant difference; M – Mean; SD – Standard deviation; χ^2 – Chi-square value;
p-value – Probability value

Table 4.3: Overall prevalence of helminth parasite infection in Agama Lizards based on sex

Parasite	Male		Female	
	Prevalence (%)	Mean intensity (M ± SD)	Prevalence (%)	Mean intensity (M ± SD)
<i>Oochoristica</i> sp.	33.33	3.33 ± 3.21	47.62	10.70 ± 11.77
<i>Strongyluris brevicaudata</i>	88.89	36.00 ± 42.75	90.48	15.26 ± 17.17
<i>Parapharyngodon awokoyai</i>	44.44	5.00 ± 1.63	14.29	8.67 ± 2.08
<i>Mesocoelium monodi</i>	33.33	47.33 ± 21.78	-	-
χ^2	15.266	64.560	57.211	1.600
p-value	0.000*	0.000*	0.000*	0.449

* significant difference; M – Mean; SD – Standard deviation; χ^2 – Chi-square value;

p-value – Probability value

CHAPTER FIVE

DISCUSSION

This study investigated the prevalence and mean intensity of helminth parasites infecting *Agama agama* collected from the IDP Camp in Uhogua Community, Edo State, Nigeria. The findings revealed a 100% overall prevalence of helminth infection among the examined lizards. All 30 individuals harboured at least one or more helminth species. This high prevalence aligns closely with previous studies conducted in various parts of Nigeria and West Africa. For instance, Sowemimo and Oluwanfemi (2015) reported a prevalence of 96.7% in Ile-Ife, while Adeoye and Ogunbanwo (2005) recorded a prevalence of 92.3% in southwestern Nigeria. Similarly, Eziegbemhin *et al.* (2021) reported an infection rate of 100% in Benin City, which is geographically close to Uhogua. These similarities in prevalence values suggest that helminth infection is almost ubiquitous among *Agama agama* populations in southern Nigeria. The consistently high prevalence may be attributed to their terrestrial behaviour, feeding habits, and exposure to contaminated substrates, which increase their chances of encountering infective parasite stages (Leung, 2019).

The most prevalent parasite in this study was the nematode *Strongyluris brevicaudata*, with an overall prevalence of 76.67% and a mean intensity of 20.00 ± 27.19 . This value is slightly higher than the prevalence of 68.5% reported by Adeoye and Ogunbanwo (2005) and 71.4% reported by Sowemimo and Oluwanfemi (2015). Eziegbemhin *et al.* (2021) also found *S. brevicaudata* as the dominant species in Benin City, with a prevalence of 83.3% and mean intensity of 21.6. This confirms that *S. brevicaudata* is a common and successful parasite of *Agama agama* in Nigeria. The high intensity observed in this study may be influenced by the

warm, humid environment in Uhogua, which favours the survival and transmission of nematode eggs and larvae in the soil (Frank, 1981; Leung, 2019).

The cestode *Oochoristica* sp. was the second most prevalent parasite in this study, with a prevalence of 43.33% and a mean intensity of 9.00 ± 10.77 . This finding is consistent with reports by Aghedo (2019) and Aghimien (2022), who recorded prevalence rates of 41.0% and 46.7%, respectively. Adeoye and Ogunbanwo (2005) recorded a slightly lower prevalence of 36.4%, while Nwadike and Ilozumba (2015b) found a higher prevalence of 50.0% in southeastern Nigeria. These values show some variation between locations, which may reflect differences in the availability of intermediate hosts (such as arthropods) required for the transmission of *Oochoristica* sp. (Leung, 2019). The mean intensity recorded in this study (9.00 ± 10.77) is relatively higher than some previous findings, suggesting favourable local conditions for the completion of the parasite's life cycle.

The trematode *Mesocoelium monodi* recorded the lowest prevalence (10.0%) but had the highest mean intensity (40.67 ± 21.78) among all parasites recovered. A similar low prevalence of this trematode has been reported in other regions: Aghimien (2022) observed a prevalence of 13.3%, and Aghedo (2019) recorded 11.0%, but their mean intensities (35.0 and 31.7, respectively) were slightly lower than the value observed in Uhogua Community. The high intensity despite low prevalence suggests that infection occurs infrequently, but once the parasite establishes in a host, it reproduces in large numbers. Trematode infections are often influenced by environmental factors such as the presence of suitable snail intermediate hosts and water bodies, which are necessary for their life cycle (Frank, 1981; Leung, 2019).

The nematode *Parapharyngodon awokoyai* exhibited a prevalence of 23.33% and a mean intensity of 6.57 in this study. This is comparable to the 20.0% prevalence reported by Adeoye and Ogunbanwo (2005) and slightly higher than the 18.3% observed by Nwadike and Ilozumba

(2015b). Aghedo (2019) reported a prevalence of 27.0%, indicating some geographical variation. These differences could be due to environmental conditions, seasonal fluctuations, or differences in the feeding behaviour of the host populations. *Parapharyngodon awokoyai* are transmitted through direct ingestion of infective eggs, and their prevalence is often influenced by environmental contamination and host density (Leung, 2019).

A comparison between male and female lizards revealed interesting patterns. Males exhibited higher prevalence for *Parapharyngodon awokoyai* (40.44%). Also, only males were infected with *Mesocoelium monodi* (33.33%). Females had slightly higher prevalence of *Oochoristica* sp. (47.62%) and *Strongyluris brevicaudata* (90.48%). Similar sex-related differences have been observed in other studies. Sowemimo and Oluwanfemi (2015) and Nwadike and Ilozumba (2015a) both reported that females often carry heavier burdens of *Oochoristica* sp., possibly due to lower mobility and higher exposure to contaminated feeding grounds. Conversely, males may be more exposed to *Parapharyngodon awokoyai* and trematodes due to territorial behaviour, larger body size, and wider movement range (Frank, 1981). The high mean intensity of *Mesocoelium monodi* in males (40.67) compared to its absence in females suggests a sex-biased exposure pattern.

The observed differences in prevalence and intensity across parasite species and sexes could be linked to several factors, including host size, feeding ecology, parasite transmission strategies, and environmental conditions. Larger male lizards may provide a more favourable habitat for parasites, which can lead to higher parasite loads (Leung, 2019). Additionally, the tropical climate of Uhogua, which includes warm temperatures and seasonal rainfall, provides optimal conditions for parasite eggs and larvae to survive and remain infective in the environment, thereby enhancing transmission potential. In overall, the prevalence values recorded in this study are comparable to or slightly higher than those reported in other regions

of Nigeria. The mean intensity of some species, especially *S. brevicaudata* and *M. monodi*, were also higher, which may indicate a particularly favourable environment for parasite survival and transmission in Uhogua. The findings underscore the ecological importance of helminth parasites in natural reptile populations and highlight the role of environmental and host-related factors in shaping infection patterns.

RECOMMENDATION

1. Regular parasitological investigations should be carried out on *Agama agama* and other reptiles in Uhogua Community to monitor the prevalence and distribution of helminth parasites within the environment.
2. Further studies should be conducted using larger sample sizes and across different geographical locations to provide more comprehensive information on helminth infections of *Agama agama* in Nigeria.
3. Advanced diagnostic and molecular identification techniques should be adopted in future research to ensure accurate identification of parasite species, especially those identified only at the genus level.
4. Studies should also focus on the influence of factors such as sex, age, seasons, and habitat on the prevalence and intensity of helminth infections among reptiles.
5. More research should be carried out on the effects of helminth infections on the physiology, growth, reproduction and survival of *Agama agama* in order to determine the pathological and ecological significance of the parasites.

CONCLUSION

This study revealed a 100% overall prevalence of helminth infection among *Agama agama* from Uhogua Community, indicating that all examined individuals were infected with one or more parasite species. Four helminth species were identified: *Strongyluris brevicaudata*, *Oochoristica* sp., *Parapharyngodon awokoyai*, and *Mesocoelium monodi*. Among these, *S.*

brevicaudata was the most dominant and widely distributed parasite, showing the highest prevalence and mean intensity, while *M. monodi* occurred least frequently but with a high worm burden in infected hosts. Female lizards generally harboured more parasites than males, though certain species, such as *M. monodi*, were restricted to males as in this study. These findings suggest that helminth infection is widespread among *Agama agama* in the study area and that both host sex and parasite species influence infection intensity and distribution.

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