

## Research Article

# Helminth fauna and infection intensity of the rainbow lizard (*Agama agama*) in Northwest University Campuses, Kano, Nigeria

Binta Abdullahi Yuguda<sup>1</sup>, Habibu Maaruf Abdu<sup>1</sup>, Mohammad Manjur Shah<sup>1\*</sup>, Zainab Nura Nabegu<sup>2</sup>, Zakiyya Ibrahim Muhammad<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, Northwest University, Kano, Nigeria

<sup>2</sup>Department of Biology, Yusuf Maitama Sule University of Education, Kano

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\*Corresponding author: Mohammad Manjur Shah, E-mail: mmanjurshah@gmail.com

## Abstract

Reptiles play critical ecological roles and are known to harbour diverse parasitic fauna, some with zoonotic implications. This study investigated the ecto-, endo-, and haemoparasites of the rainbow lizard (*Agama agama*) within Northwest University campuses in Kano, Nigeria. Thirty specimens (15 per campus) were examined between June and December 2024 using standard parasitological techniques. The overall infection prevalence was 100%. A total of 486 parasites were recovered, dominated by nematodes (97.9%) and few cestodes (2.1%). Four helminth species were identified: *Strongyluris* sp. (75.31%), *Parapharyngodon* sp. (20.58%), *Thelandros* sp. (2.06%), and *Oochoristica* sp. (2.06%). Lizards from the main campus exhibited a significantly higher mean intensity (24.53±16.50) than those from the city campus (7.87±3.87) ( $p < 0.001$ ). The findings confirm *Agama agama* as a reservoir host for multiple helminths with potential ecological and zoonotic implications.

**Keywords:** *Agama agama*, helminths, nematodes, prevalence, Kano, Nigeria

## Introduction

Parasites represent one of the most ecologically and evolutionarily significant components of biodiversity. They influence the health, population dynamics, and behaviour of their hosts, while simultaneously shaping community structures and trophic interactions in ecosystems (Anderson & Gordon, 2009; Poulin, 2011). Among vertebrates, reptiles occupy a distinctive position due to their wide ecological distribution, poikilothermic physiology, and evolutionary antiquity, all of which make them valuable hosts for a variety of parasitic taxa (Roca *et al.*, 2012). Despite this importance, the parasitological study of reptiles, particularly lizards, remains relatively understudied in Africa when compared to mammals and birds (Bush *et al.*, 1997; Mendoza-Roldan *et al.*, 2021).

Reptiles, including lizards, snakes, and chelonians, host an array of ecto- and endoparasites such as mites, ticks, nematodes, cestodes, trematodes, and protozoa (Jairo *et al.*, 2020; Omonona *et al.*, 2011). These parasites are not only vital for understanding reptilian ecology and evolution but also relevant for zoonotic disease surveillance, since reptiles can serve as reservoirs or mechanical vectors of human pathogens (Mitchell, 2011; Han *et al.*, 2016). In recent years, the popularity of reptiles as pets and their close proximity to humans in peri-domestic environments have renewed interest in their parasitic fauna and its potential health implications (Janssen, 2021; Thompson *et al.*, 2023).

The rainbow lizard, *Agama agama* (Linnaeus, 1758), commonly referred to as the red-headed rock agama, is a diurnal, insectivorous lizard belonging to the family Agamidae. It is widely distributed across sub-Saharan Africa, including Nigeria, and is highly adapted to

human-dominated environments such as walls, fences, and rooftops (Harris, 1964). Males are easily recognizable by their brightly coloured heads and bodies, particularly during the breeding season, while females are duller in appearance (Crews *et al.*, 1983). The species' adaptability to urban and peri-urban areas, coupled with its frequent interactions with human dwellings, presents opportunities for parasite transmission between wildlife and human populations (Adeoye & Ogunbanwo, 2007; Belema *et al.*, 2020).

Previous studies across different parts of Nigeria have documented a rich helminth fauna in *A. agama*. For instance, Adeoye and Ogunbanwo (2007) identified *Strongyluris brevicaudata*, *Parapharyngodon awokoyai*, and *Oochoristica agamae* among others from specimens collected in Lagos, reporting an overall prevalence of 100%. Similarly, Omonona *et al.* (2011) reported high infection rates of nematodes (*Strongyluris brevicaudata* and *Thelandros annulatus*) in lizards from Ibadan, while Belema *et al.* (2020) found five species of helminths in specimens from Rivers State, including both nematodes and cestodes. These findings consistently indicate that *A. agama* acts as an important reservoir for helminth parasites in Nigeria.

Despite such reports, data from northern Nigeria, particularly the northwestern ecological zone, remain scarce. The region's climatic conditions, characterized by lower annual rainfall, higher temperatures, and seasonal fluctuations, differ markedly from those of southern Nigeria, potentially influencing the composition and abundance of parasite species (Mbaya *et al.*, 2013). Ecological variations such as vegetation type, soil moisture, and the presence of intermediate hosts (e.g., insects) are known to shape helminth transmission dynamics (Vicente *et al.*, 2020). Hence, establishing baseline data on lizard parasites in this

region is essential for understanding geographical patterns in parasite diversity and prevalence.

## **Materials and methods**

### ***Study area***

The study was carried out within the two campuses of Northwest University, Kano, located in Kano State, Northwestern Nigeria. The university operates two distinct campuses, namely: Main Campus (KofarRuwa, Gwale Local Government Area), and City Campus (Kofar Nassarawa, Kano Municipal Local Government Area). The Main Campus presents a semi-natural, less disturbed environment with open lawns, gardens, and patches of shrub vegetation that favour insect proliferation and lizard habitation. Conversely, the City Campus is highly urbanized, surrounded by paved surfaces, concrete buildings, and limited vegetation. These contrasting ecological features provide distinct environmental contexts for assessing differences in parasitic infections among *Agama agama* populations.

### ***Study design and sampling period***

A comparative cross-sectional survey was conducted between June 2024 and February 2025, covering both the rainy and dry seasons. A total of 30 adult rainbow lizards (*Agama agama*) were sampled (15 from each campus) using random capture methods. Only healthy-looking, active adult lizards were selected to minimize age-related or health-related bias in parasite load (Roca *et al.*, 2012).

### ***Capture and handling of lizards***

Lizards were manually captured by hand early in the morning (07:00-09:00 h) when they were less active due to cooler temperatures. Captured specimens were placed in aerated plastic containers labelled according to sampling location and transported to the Parasite Biodiversity Research Laboratory, Department of Biological Sciences, Northwest University, Kano. Each specimen was euthanized using chloroform vapour in a desiccator following the humane guidelines outlined by Bursey *et al.* (2013).

### ***Examination for ectoparasites***

Before dissection, each euthanized specimen was examined externally for ectoparasites. The head, limbs, ventral and dorsal surfaces, armpits, and tail bases were carefully inspected using a hand lens ( $\times 10$  magnification) and fine-tooth comb (Ozioko *et al.*, 2021). Collected ectoparasites (if any) were preserved in 70% ethanol and later identified under a stereomicroscope following the morphological keys of Fajfer (2012) and Mendoza-Roldan *et al.* (2021).

### ***Examination for haemoparasites***

Approximately 0.5 mL of blood was collected via cardiac puncture using a sterile needle immediately after

euthanasia. Thin and thick blood smears were prepared on clean glass slides, air-dried, and fixed in absolute methanol for 2 minutes. Slides were stained with 10% Giemsa solution for 10 minutes and examined under a light microscope using  $\times 10$  and  $\times 40$  objectives (CDC, 2019). The smears were screened for intraerythrocytic protozoans such as *Plasmodium* spp. and *Haemogregarina* spp. (Mbaya *et al.*, 2013).

### ***Examination for endoparasites***

Each lizard was placed dorsally on a dissection tray and pinned at the limbs. A mid-ventral incision was made from the throat to the cloaca to expose the thoraco-abdominal cavity. The digestive tract (stomach, small intestine, large intestine, rectum) and visceral organs (liver, lungs, heart) were carefully excised and placed in separate Petri dishes containing 0.9% normal saline (Oluwafemi *et al.*, 2017). The contents of each organ were gently teased apart with dissecting needles under a stereomicroscope. The expressed materials were then examined for motile worms. Recovered helminths were counted, sorted by gross morphology, and transferred into labelled vials for preservation and further analysis.

### **Preservation and processing of parasites**

#### ***Nematodes***

Nematodes were killed in hot 0.9% saline, rinsed, and fixed in 70% ethanol. Specimens were then dehydrated through graded ethanol series (70%, 80%, 90%, 100%) for 10-15 minutes each, transferred to glycerine-alcohol, and stored in a desiccator for 1-2 weeks to allow slow evaporation (Gupta *et al.*, 2009). Cleared nematodes were mounted in anhydrous glycerine and sealed with DPX.

#### ***Cestodes***

Cestodes were fixed in Alcohol-Formol-Acetic acid (AFA), washed in distilled water, dehydrated through ascending ethanol series, and stained with Borax carmine for 12-18 hours. Stained worms were differentiated in acid-alcohol, dehydrated, cleared in xylene, and mounted in Canada balsam (Sepulveda & Kinsella, 2013).

### ***Identification of parasites***

Parasites were identified morphologically using diagnostic features such as body size, shape, presence or absence of suckers or hooks, tail morphology, and cuticular ornamentation. Reference identification keys and taxonomic descriptions were consulted from Babero and Okpala (1962), Adamson (1981), Bursey *et al.* (2013) and Vicente *et al.* (2020). Identification was performed under a compound microscope equipped with an ocular micrometer for morphometric measurements.

### ***Statistical analysis***

Descriptive statistics were employed to calculate Prevalence (%) and Mean intensity. A two-sample t-test

**Table 1:** Prevalence and intensity of helminth infection in *Agama agama* by location

Campus	No. examined	No. infected	Prevalence (%)	Total parasites	Mean intensity ( $\pm$ SD)
Main Campus	15	15	100	368	24.53 $\pm$ 16.50
City Campus	15	15	100	118	7.87 $\pm$ 3.87
Total/Mean	30	30	100	486	16.20 $\pm$ 11.30

$t=4.53, p<0.001$  (significant difference between campuses)

was used to assess differences in mean parasite intensity between the Main and City Campuses. The Chi-square ( $\chi^2$ ) test was used to determine differences in parasite species distribution across host populations. All analyses were performed using SPSS version 25.0 (IBM Corp., 2017) at a 95% confidence level ( $\alpha=0.05$ ).

### Ethical considerations

This research was reviewed and approved by the Research Ethics Committee, Northwest University, Kano. All procedures adhered to the guidelines for the Care and Use of Laboratory Animals in Research (National Research Council, 2011). Efforts were made to minimize animal suffering and to use the smallest number of specimens necessary to achieve statistical reliability.

### Results

All 30 *Agama agama* individuals examined from the two campuses of Northwest University, Kano, were found to harbour one or more helminth species, yielding an overall infection prevalence of 100%. A total of 486 individual helminths were recovered from the sampled hosts. Of these, 368 (75.7%) originated from specimens captured at the Main Campus, whereas 118 (24.3%) were from the City Campus (Table 1). The mean intensity of infection was 16.2 $\pm$ 11.3 parasites per host, though this varied significantly between the two campuses. The Main Campus recorded a mean intensity of 24.53 $\pm$ 16.50 parasites per host, while the City Campus recorded 7.87 $\pm$ 3.87. Statistical comparison using a two-sample *t*-test revealed a significant difference in parasite intensity between the two campuses ( $t=4.53, p<0.001$ ).

Four helminth species were identified from the gastrointestinal tracts of *A. agama* (Table 3). These comprised three nematode species and one cestode species, representing two classes and four genera. The nematodes accounted for the vast majority of parasites recovered (97.9%), while the cestodes constituted only 2.1% of the total count. The identified nematodes included *Strongyluris* sp., *Parapharyngodon* sp., and *Thelandros* sp., whereas the only cestode recovered was *Oochoristica* sp. (Table 2). Among these, *Strongyluris* sp. was the most dominant, representing 75.31% of all helminths recovered. *Parapharyngodon* sp. followed with 20.58%, while *Thelandros* sp. and *Oochoristica* sp. were least represented, each contributing 2.06% of the total count (Figures 2-13).

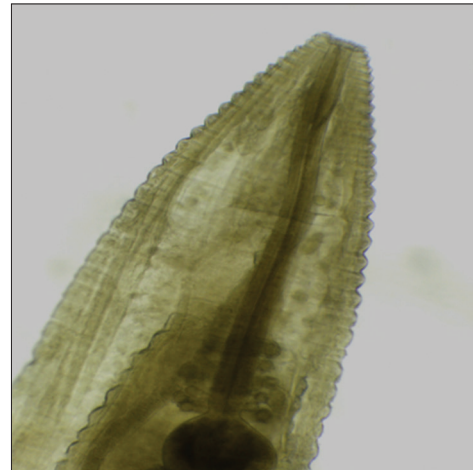
A Chi-square ( $\chi^2$ ) analysis revealed a significant variation in species distribution among recovered helminths ( $\chi^2=345.12, p<0.001$ ), confirming that *Strongyluris* sp. was disproportionately more abundant than other taxa.

**Table 2:** Helminth species composition in *Agama agama* from both campuses

Parasite type	Genus/Species	Total number recovered	Relative abundance (%)
Nematode	<i>Strongyluris</i> sp.	366	75.31
Nematode	<i>Parapharyngodon</i> sp.	100	20.58
Nematode	<i>Thelandros</i> sp.	10	2.06
Cestode	<i>Oochoristica</i> sp.	10	2.06
Total	—	486	100

**Table 3:** Distribution of helminths within the digestive tract of *A. agama*

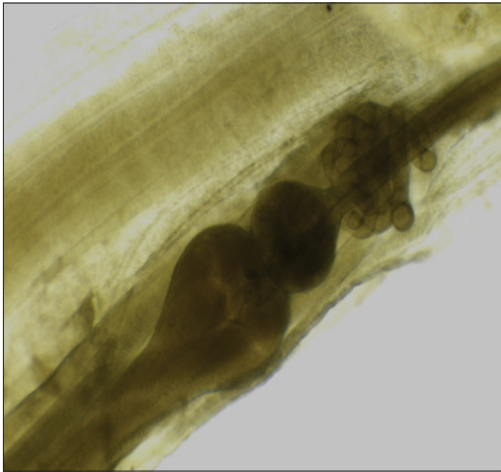
Organ/Segment	Parasite species detected	Number (%)
Small intestine	<i>Strongyluris</i> sp., <i>Parapharyngodon</i> sp.	61 (12.5%)
Large intestine	<i>Strongyluris</i> sp., <i>Parapharyngodon</i> sp., <i>Oochoristica</i> sp.	120 (24.7%)
Rectum	<i>Strongyluris</i> sp., <i>Parapharyngodon</i> sp., <i>Thelandros</i> sp.	305 (62.8%)
Stomach	None	0 (0%)
Total	—	486 (100%)

**Figure 1:** Mouthpart and annulations in *Parapharyngodon* sp.

All helminths were confined to the alimentary canal, with no parasites observed in the lungs, liver, or heart. The rectum harboured the greatest number of parasites, accounting for 62.8% of the total count, followed by the large intestine (24.7%), and small intestine (12.5%) (Figure 1). No helminths were found in the stomachs of the examined specimens.

### Identified parasites

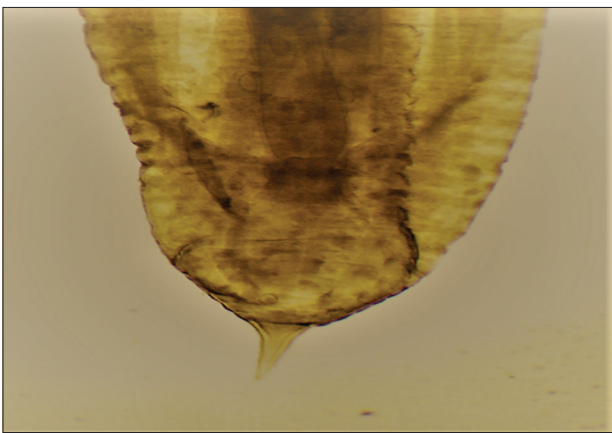
No ectoparasites (ticks, mites, or lice) were detected on any of the examined *A. agama* specimens, despite thorough inspection of skin folds, tail bases, and axillary regions.



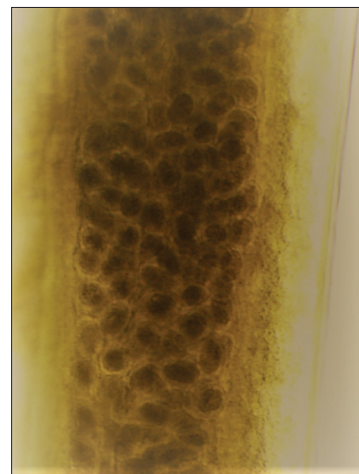
**Figure 2:** Coiled uterus of *Parapharyngodon* sp.



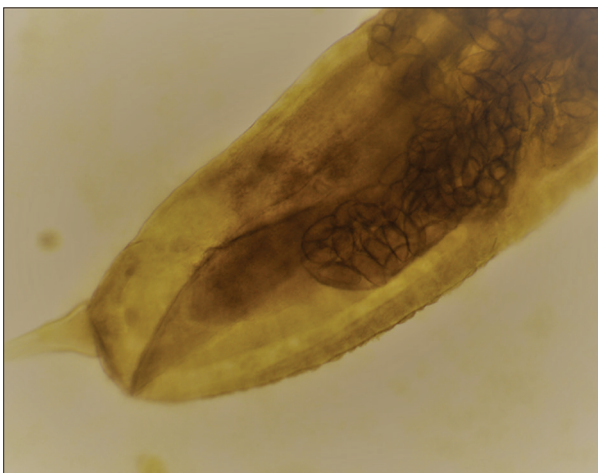
**Figure 5:** Mouthpart of *Strongyluris* sp. (Anterior end).



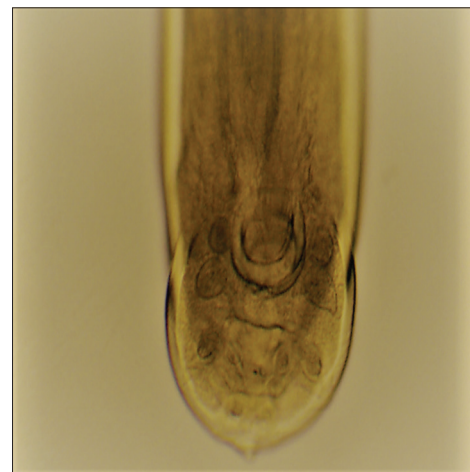
**Figure 3:** Conical tail in *Parapharyngodon* sp.



**Figure 6:** Gravid female *Strongyluris* sp.



**Figure 4:** Gravid female in *Strongyluris* sp.



**Figure 7:** Tail of *Strongyluris* sp. (posterior end)

Similarly, all blood smears were negative for haemoparasites such as *Plasmodium* spp. and *Haemogregarina* spp.

## Discussion

The present study revealed a 100% helminth infection rate among *Agama agama* within Northwest University, Kano, indicating that parasitism is a common feature of this species in northern Nigeria. Similar findings have been reported across the country, confirming *A. agama* as a natural reservoir for gastrointestinal helminths (Adeoye &

Ogunbanwo, 2007; Sowemimo & Oluwafemi, 2017). The predominance of nematodes, particularly *Strongyluris* sp. and *Parapharyngodon* sp., agrees with earlier studies from Lagos, Ibadan, and Rivers State (Omonona *et al.*, 2011; Belema *et al.*, 2020), suggesting strong host–parasite adaptation and a direct life cycle that promotes efficient transmission.

Infection intensity differed significantly between campuses, with lizards from the vegetated Main Campus



Figure 8: Tail of *Strongyluris* sp. with papillae



Figure 11: *Oochoristica* sp. anterior end



Figure 9: Tail of *Strongyluris* sp. (posterior end view)

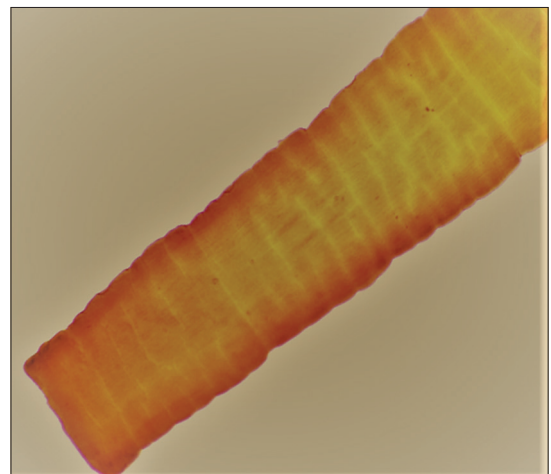


Figure 12: Proglottid of *Oochoristica* sp.

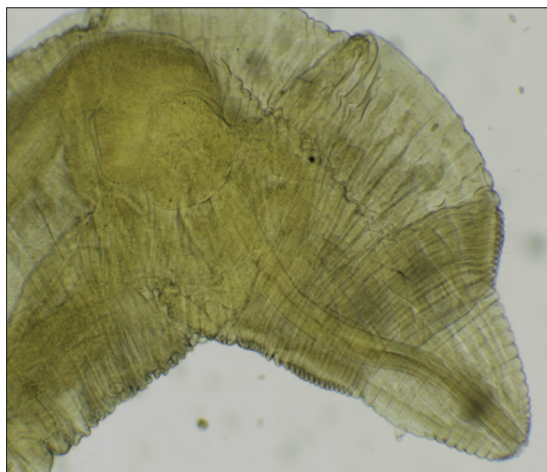


Figure 10: *Thelandros* sp.

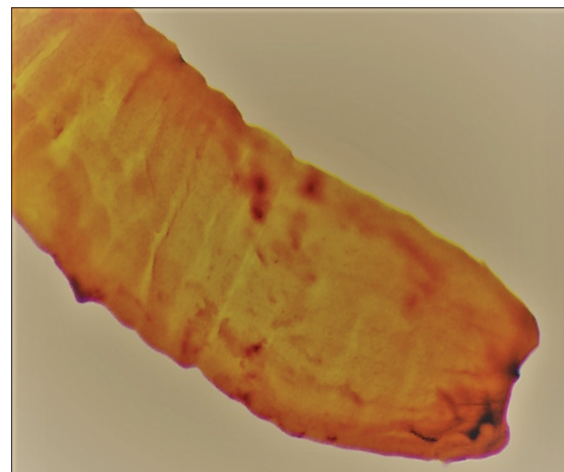


Figure 13: Tail *Oochoristica* sp. (posterior end)

harbouring more parasites than those from the urbanized City Campus. This spatial variation may be attributed to ecological differences; greater vegetation, soil moisture, and insect availability in the Main Campus likely favour parasite survival and exposure. Urban habitats, on the other hand, tend to be hotter and less humid, conditions that reduce infective-stage persistence (French *et al.*, 2018).

The confinement of helminths to the lower intestine and rectum mirrors the niche preferences of *Strongyluris* and *Parapharyngodon*, which thrive in the posterior gut due to optimal nutrient conditions and slower food transit (Babero & Okpala, 1962). The absence of ectoparasites and haemoparasites may be linked to seasonal factors, limited vector presence, or periodic molting that removes external parasites (Arnold, 1986). However, while none of the

detected helminths are known to be zoonotic, the proximity of *A. agama* to human dwellings raises potential concerns about environmental contamination. Parasite eggs shed in lizard faeces could indirectly affect domestic animals or humans through mechanical transmission by insects.

## Conclusion

In conclusion, this study confirms *A. agama* as a robust host for nematodes and highlights the influence of habitat on parasite intensity rather than prevalence. The findings emphasize the need for continued parasitological monitoring of reptiles in urban ecosystems and molecular identification of helminths to better assess their ecological and public health significance.

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