Original Research Article

Understanding the Association between Selected *Agama agama* Characteristics and Intestinal Parasitic Infection

Abstract

Lizards (*Agama agama*) are the most widely distributed reptiles and had been reported to serve as transport and reservoir host to several protozoan and helminth parasites. The aim of this study is to determine the association between parasitic infection of *Agama agama* and selected characteristics (age and sex). The observational study was carried out at Otuoke community where 50 *Agama agama* comprising both male and females were randomly obtained. The lizards were sacrificed and their feaces were collected from their intestines and studied in the laboratory for parasite presence using light microscope. The results showed the identification of four parasites in the lizards namely; nematode (*Strongylurisbrevicaudata* and *Parapharyngodoncolonensis*), cestode (*Oochoristica truncate*), trematode (*Mesocoelium monas*) and Conoidasida (*Toxoplasma gondii*). There was no association between age (described as length of the animal) and prevalence of parasitic infection. Also, there was no association between sex and prevalence of the parasitic infection and finally, there was no association between weight and prevalence of the parasitic infection. This study has shown that although parasites are present in *Agama agama*, there was no gender, age and weight variations or dependence of the rate of their infection.

Keywords: *infection, lizard, parasites*

Introduction

Agama, derived from Sranan Tongo meaning "lizard," represents a genus of small-to-moderate-sized, insectivorous Old-World lizards. With at least 37 species distributed across Africa, primarily in sub-Saharan regions, these reptiles vary in size, typically reaching 12 to 30 centimeters when fully grown (Maurice and Robert, 2002). Lizards, one of the most widely distributed reptiles globally, demonstrate remarkable adaptability across various habitats (Robert et al., 2020). However, this study revolves around the Agama agama lizard, a species known to serve as a transport and reservoir host for protozoan and helminth parasites, thereby raising significant concerns (Wekhe and Olayinka, 2009). In Nigeria, comprehensive investigations by Robert et al., 2020, Akinboade and Johnson (2011), and Wekhe and Olayinka (2009) have identified the prevalence of protozoan parasites such as Eimeria oocysts, Plasmodium, and Haemogregarina species, with Eimeria oocysts being the most prevalent (68.7%).

Lizards, owing to their poikilothermic nature, thrive across tropical climates globally, featuring diverse sizes, shapes, and colors. While most lizard species pose no harm to humans, their intriguing characteristics and the threat they pose when cornered have fueled interest in keeping them as pets, including species like bearded dragons, iguanas, anoles, and geckos. In Africa, commonly found lizard species include Geckos, Agama lizards, Chameleons, Monitor lizards, and Alligator lizards.

Beyond their role as fascinating creatures, lizards, including Agama agama, are integral to ecosystem balance, acting as biological controls for insects and arthropod pests (Vasconcelos et al., 2022). However, their insectivorous diet predisposes them to gastrointestinal parasitic infections, some of which have zoonotic implications, threatening human health. The Agamidae family, particularly the Agama agama

species, has emerged as the most prominent among this lizard group, typically native to Western African countries, especially the sub-Saharan region. These sociable lizards live in social groups, with a lead male, around half a dozen females, and subordinate males (Wagner et al., 2009a).

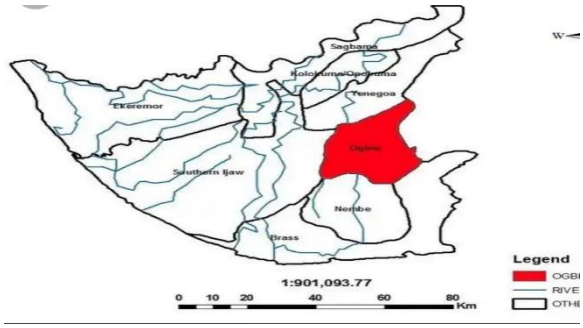
Unfortunately, despite their significant ecological roles, Agama agama lizards have been implicated as transport and reservoir hosts for various protozoan and helminth parasites, some of which can infect humans (zoonotic importance). Human infection risk arises through contact with objects contaminated by infected feces or saliva, inadvertently ingesting parasite eggs. Several studies conducted in Nigeria have reported gastrointestinal parasites in Agama agama lizards, including Ascaris spp., Capillaria spp., and Raillietiella spp., with documented transmission to humans (Adeoye and Ogunbanwo, 2007). Yet, an information gap remains regarding the prevalence of gastrointestinal parasites in Agama agama from Bayelsa State, Nigeria, and their potential transmission risks to both humans and commercial poultry flocks.

As an overview, this study focuses on exploring the significance of Agama agama lizards, providing vital insights into their health and potential implications for ecosystems, human health, and the poultry industry. By examining their role as carriers of zoonotic parasites and expanding our understanding of the relationship between these reptiles and various parasites, this study aims to address critical gaps in scientific knowledge, ultimately contributing to the health and well-being of both natural and human environments.

Materials and Methods

Study Area

Otuoke is a suburb in Ogbia local government area of Bayelsa state in the Niger Delta Region of Nigeria. Majority of its inhabitants are farmers and fishermen. Otuoke has the total population of less than 10, 000 (Jibueze, 2015). In Ogbia, the wet season is warm and overcast, the dry season is hot and mostly cloudy, and it is oppressive year-round. Over the course of the year, the temperature typically varies from 71°F to 87°F and is rarely below 64°F or above 90°F. Otuoke is the only community that is connected by road and water in the kingdom, that was why the entire Ogbia community agreed that it be made the centre.



Map 1:showing Ogbia local government area.

Study design

The observational study was conducted on 50 *Agama agama.* These lizards were randomly hand-picked between January to March, 2022 at different locations within the study area. The *Agama agama* was kept in a ventilated container and was

transferred to Biology laboratory in Federal University Otuoke, Bayelsa state for dissection and examination of parasites.

Laboratory Examination for Parasitic Infection

Fifty (50) lizards were euthanized with prepared chloroform, Organ was excised into different petri-dishes containing reptilian saline. The dissecting board, knife, scissors and the picker was disinfected using disinfectant(spirit), and was rinsed under running water so that the parasites will not be killed. The weight of the lizard was taken using digital weighing scale and the length was measured using transparent meter rule, then the lizard was placed on the dissecting board, the lizard was dissected open longitudinally and the intestine was harvested and was excised into different petri dish containing saline solution. The feces were pressed out from the intestine and was introduced into a specimen container, it was emulsified with a saline water, sieved into a container, then introduced into a centrifuge tube, and was centrifuged under 3500rpm for 10minutes. After centrifugation, the precipitate was filtered out from the sediment, the sediment was dropped on a slide with a drop of iodine and was covered with a cover slip, it was then view with microscope under the magnification of X40 for parasitological examination (Hayat et al., 2016; Adedokun et al., 2022; Wokem and Onosakpkonome, 2014; Onosakponome et al., 2021).

Statistical analysis

The proportion was determined for descriptive assessment of the prevalence of the infection based on studied characteristics (length and sex). For inferential statistics, Chi-square was used to determine the association between each of the studied characteristics and parasitic infection prevalence. The test was considered significant at p-value < 0.05.

Results

Parasites identified

A total of five helminth species were recovered from the intestine of the lizard. The helminth parasites found included two species of nematodes: *Strongylurisbrevicaudata, Parapharyngodoncolonensis* was found, one species of cestode: *Oochoristica truncate*, one species of trematode: *Mesocoelium monas* and one species of conoidasida: *Toxoplasma gondii*. The intestinal parasite intensity was very high.

Table 1: Parasites identified

Parasites	**Scientific nomenclature**
Nematode	*Strongylurisbrevicaudata* *Parapharyngodoncolonensis*
Cestode	*Oochoristica truncate*
Trematode	*Mesocoelium monas*
Conoidasida	*Toxoplasma gondii*

A table showing if infection is dependent on sex, here the number of male infected was 18 and prevalence of 90%, while in female 23 was infected with the prevalence of 76.7%.

Table 2: Overall prevalence of infection based on sex

Sex	No. examined	No. Infected (%)	χ^2	p-value
Male	20	18 (90)		
Female	30	23 (76.7)		
Total	50	41(82)	1.445	0.229

The table showing if infection is dependent on age (described in size), here 13 small *Agama agama*were infected with the prevalence of 72.2% while 15 adult were infected with the prevalence of 46.9%. There was no significant association (p-value = 0.083) between size and prevalence. There was no significant association (p-value = 0.229) between sex and prevalence. (Should be moved above table 2)

Table 3: Prevalence of infection based on size

Size	No. examined	No. Infected %	χ^2	p-value
Small	18	13 (72.22)		
Adult	32	15 (46.88)		
Total	50	28(56)	3.004	0.083

The table below showing if infection is dependent on weight, here 11 *Agama agama weighing* ≥25g were infected with the prevalence of 50%; 8 *Agama agama weighing between* 25-35g were infected with the prevalence of 75%; and 11 *Agama agama weighing* ≥36g were infected with the prevalence of 55%. There was no significant association (p-value = 0.472) between weight and prevalence.

Table 4: prevalence of infection based on weight

Weight (g)	no. examined	No. infected(%)	χ^2	p-value
≥25	22	11(50)		
26-35	8	6(75)		
≥36	20	11(55)	1.502	0.472

Discussion

The result of my study showed a prevalence of 28% in Agama agama from Otuoke community, in Ogbia local government area, Bayelsa state, Nigeria. The parasites isolated from *Agama agama* were *Toxoplasma gondii,Strongylurisbrevicaudata, Mesocoelium monas, Oochoristica truncate, Parapharyngodoncolonensis*. Of the five parasite species recovered, nematodes, especially *S. brevicaudata* and *P. colonensis* were the most prevalent. No acanthocephalan was discovered during the course of study. In an investigation of reptile species by Borkovcova and Kopriva (2005), of the five parasites found, nematodes occurred most often, followed by trematodes and cestodes; no acanthocephalans were also detected. High diversity in helminth infra-communities was shown to be due to the large size, wide ranging plant diet and exposure to helminthes with direct life cycles (Martin et al., 2005). Helminth

acquisition thus appears to be related with the diet of saurian reptiles (Sanchis et al., 2000).

According to my findings of this study, male lizards, being the more active sex, had a higher level of prevalence of infection than female lizards. Similar studies in lizards (Uller and Olsson 2003) and other organisms have found that males are more susceptible to parasite's infection probably due to the immune suppressive effects of testosterone, at least during the reproductive period (Roberts et al., 2004). Early in the mating period, males maintain high levels of testosterone hormone (Tokarz, 2008), which makes them more aggressive, thus more able to obtain and maintain a territory. In pregnant females, the development of eggs requires a great amount of energy and metabolites, which could not be allocated to defense against parasites. Therefore, both sexes seem to invest more in reproduction than in defense against parasites (Amo et al., 2005). Cestodes tend to block the already narrow intestine due to their length, thus reducing the carrying capacity of the intestine of the lizards; hence, low worm burden of cestodes.

Size of lizard was used as a direct measurement of age. From my findings, adult lizards were the most parasitized. This agrees with the findings of Ribas et al. (1995) and (Amo et al., 2005), where prevalence of infection by helminthes was positively correlated with the adult size of the lizards they studied. Adults were expected to be more infected because they occupy, more frequently, the more favorable places such as basking spots or refuges, and they interact more with other adults, exposing them to vectors and also because older lizards supposedly had more time/probability to get contact with the parasites, compared to the youngs. On the other hand, younger ones are often limited to suboptimal areas by dominant older male lizards. Ribas et al., (1995) also showed that the total mass of nematodes increased significantly with lizard body size. Results also imply that there is no immunity to infection as they grow older. However, infection rate was not significantly influenced by host body size in an investigation of a partenogenetic whiptail lizard (Cnemidophorusnativo) (Menezeset al., 2004).(There is some irrelevance regarding size between discussion and result. Please check)Generally, life span of lizards is between five to 20 years. There was no significant difference in their mean intensities. This suggests that the amount of rainfall plays a role in determining the presence and number of parasite transmission stages or encysted forms (in parasites with a direct life cycle), or its vector (in parasites with an indirect life cycle), within the habitat of the host. The months of May, June and July fall within the wet season in Nigeria. The breeding season of *A. agama* is all year-round in rainforest belt, but in drier savanna regions, breeding season coincides with the rainy season (Enge et al., 2004). During this study, the heaviest rain was experienced in the month of May, and the lowest in June. Raillietiella sp. was observed to have high intensity in May in both sexes, which reduced by June to increase again in July to its highest peak in males, but further reduced in the females.(Data is unclear. Please check for months and also species mentioned)These differences in intensity could be explained by observing the structure of the egg, which is covered by two distinct transparent and inelastic membranes, 115 X 88 microns, making them weather-tolerant (Hallmann and Griebeler, 2015). On the other hand, *P. colonensis* had a steady decrease in prevalence across the three months. *S. brevicaudata* had its highest mean discussion in the month of July, and generally had relatively high prevalence across the three months. These parasites seem to have been better adapted to the seasons and are not affected by type of season. Eggs of *S. brevicaudata* are thick-shelled, containing embryos at deposition (Seguel et al., 2022). There were no monthly differences in the prevalence of infection

in adults examined by Amo et al. (1995). They suggested that infections occurred early in the breeding season, when lizards were more active.

References

1. Maurice, B. and Robert, B. (2002). "Agama". *International Wildlife Encyclopedia* (3rd ed.). New York: Marshall Cavendish Corp. p. 30. https://eol.org/pages/815935/articles#cite_note-6 Accessed October 26, 2023
2. Robert, B., Amadi, N., Amuzie, C. C. and Ugbomeh, A. P. (2020). Endo-Helminth Fauna of the Rainbow Lizard (Agama Agama). *Journal La Lifesci*, *1*(5), 22-34. https://doi.org/10.37899/journallalifesci.v1i5.244
3. Wekhe, S. N. and Olayinka, F. O. (2009). The role of Agama agama in thetransmission of coccidiosis in poultry. *Nigeria Veterinary Journal*, 20: 34-36.
4. Akinboade, O. and Johnson, A. (2011). Effect of Temperature on the Oviposition Capacity of Engorged Adult Females and Hatchability of Eggs of Dog Ticks: Rhipicephalussanguineus and Heamaphysalisleachileachi (Acari: Ixodidae). *African Journal Biomedical Research*. 14.
5. Vasconcelos, S., Pina, S., Herrera, J. M., Silva, B., Sousa, P., Porto, M., Melguizo-Ruiz, N., Jiménez-Navarro, G., Ferreira, S., Moreira, F., Heleno, R., Jonsson, M. and Beja, P. (2022). Canopy arthropod declines along a gradient of olive farming intensification. *Scientific Reports*, 12(1), 17273. doi: 10.1038/s41598-022-21480-1.
6. Wagner, P., Wilms, T., Bauer, A. and Böhme, W. (2009a): Studies on African Agama V. On the origin of Lacerta agama Linnaeus, 1758 (Squamata: Agamidae). *Bonner ZoologischeBeiträge,* 56 (4), 215–223
7. Adeoye, G. O. and Ogunbanwo, O. O. (2007). Helminth parasites of the African lizard Agama agama (Squamata: Agamidae), in Lagos, Nigeria. *Revista de Biología Tropical*, 55(2), 417-25. doi: 10.15517/rbt.v55i2.6021.
8. Jibueze, J. (2015). Otuoke…Where there is no opposition. *The Nation*. https://thenationonlineng.net/otuoke-where-there-is-no-opposition/ Accessed October 26, 2023
9. Hayat, Z. M., Kumar, P. D., Hamida, K., Muhammad, R., Riadul, M. H., Ehteshamul, I., Hafij Al, M., Shafiqul, M., Islam, Khan, I., Digbijoy, D. Md, I. (2016). Time-Temperature Model for Bacterial and Parasitic Annihilation from Cow Dung and Human Faecal Sludge: A Forthcoming Bio-Fertilizer. *Researchgate*. Doi. :10.4172/2155-9597.1000284.
10. Adedokun, A. A., Onosakponome, E. O. and Abah A. E. (2020) Intestinal Parasites and Salmonella typhi Infection among Food-handlers in Port Harcourt Metropolis. *Nigeria Journal of Advances in Medicine and Medical Research*, 32(18), 1-9. https//doi.org/10.9734/JAMMR/2020/v32i18306491
11. Wokem, G. N and Onosakpkonome, E. O (2014). Soil transmitted Helminthes nSapele Local Government, Delta State. *Nigerian Journal of Parasitology*, 35(1-2) 143-148
12. Onosakponome, E. O., Adedokun, A. A. and Nyenke, C. U. (2021). Comparative Study of the Incidence of Co-Infection of Soil Transmitted Helminths and Helicobacter pylori among Women of Reproductive Age and School Aged Children Living in Slum Settlements in Rivers State. *Journal of Advances in Medicine and Medical Research*, 33(24), 60-69 https//doi.org/ 10.9734/JAMMR/2021/v33i2431224

13. Borkovcová, M. and Kopriva, J. K. (2005). Parasitic helminths of reptiles (Reptilia) in South Moravia (Czech Republic). *Parasitology research*, 95. 77-8. Doi. :10.1007/s00436-004-1258-6.
14. Martin, J. E., Llorente, G. A., Roca, V., Carretero, M. A., Montori, A., Santos, X. and Romeu, R. (2005). Relationship between diet and helminths in Gallotiacaesaris (Sauria: Lacertidae). *Zoology*, 108, (2), 121-130. https://doi.org/10.1016/j.zool.2005.03.002.
15. Sanchis, V., J.M. Roig, M.A. Carretero, V. Roca and G.A. Llorente, (2000). *Host-parasite relationships of Zootoca vivipara* (Sauria: Lacertidae) in the Pyrenees (North Spain). Folia Parasitology, 47: 118-122.
16. Uller, T. and Olsson, M. (2003). Prenatal exposure to testosterone increases ectoparasite susceptibility in the common lizard (Lacerta vivipara). Proc Roy. Soc. London, 270: 1867-1870.
17. Roberts, M. L., Buchanan, K. L. and Evans, M. R. (2004). Testing the immunocompetence handicap hypothesis: a review of the evidence. *Animal Behaviour*, 68,227–239. doi:10.1016/j.anbehav.2004.05.001
18. Tokarz, R. R. (2008). "Males Distinguish between Former Female Residents of Their Territories and Unfamiliar, Nonresident Females as Preferred Mating Partners in the Lizard Anolissagrei," *Journal of Herpetology*, 42(2), 260-264. https://doi.org/10.1670/07-1931.1
19. Amo, L., Fargallo, J. A., Martinez-Padilla, J., Millan, L. P., and J. Martin, J. (2005). *Prevalence and intensity of blood and intestinal parasites in a field population of a mediterranean lizard (Lacerta lipid)*.Parasitology Resources, 96: 413-417.
20. Ribas, S. C., Rocha, C. F.D., Teixeira-Filho, C. F.D., and Vicente, J. (1995). Helminths (Nematoda) of the lizard Cnemidophorusocellifer (Sauria: Teiidae): Assessing the effect of rainfall, Body size and sex in the nematode infection rates. *Ciência&Cultura*, 47, 88-91
21. Menezes, V. A., Carlos F. D. Rocha, and Dutra, G. F. (2004). Reproductive Ecology of the Parthenogenetic Whiptail Lizard Cnemidophorus nativo in a Brazilian Restinga Habitat. *Journal of Herpetology*, *38*(2), 280–282. http://www.jstor.org/stable/1566226
22. Enge, K. M., Krysko, K. L., and Talley, B. L. (2004). Distribution and Ecology of the Introduced African Rainbow Lizard, Agama Agama Africana (Sauria: Agamidae), In Florida. *Florida Scientist*, *67*(4), 303–310. Http://Www.Jstor.Org/Stable/24321176
23. Hallmann, K. and Griebeler, E. M. (2015). Eggshell Types and Their Evolutionary Correlation with Life-History Strategies in Squamates. *PLoS One*, 10(9), e0138785. doi: 10.1371/journal.pone.0138785.
24. Seguel, M. E., Ramírez-Rivera, S., Concha, F., Espinoza, M., and Hernández, S. (2022). Predation and epibiosis on egg capsules of the Shorttailfanskate, Sympterygiabrevicaudata. *Journal of Marine Biology and Oceanography*, 57 (Special), 20–28. https://doi.org/10.22370/rbmo.2022.57.Especial.3314