A Survey of Endoparasites of Lizards (*Agama Agama*) in Calabar, Cross River State, Nigeria

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***Abstract*:-A survey of endoparasites of lizards was undertaken in three location in Calabar Municipality to ascertain the infection rate of helminth parasites. Out of the 236 *Agama agama* lizards examined, 176 (72.9%) were infected with helminthes parasites. The lizards in Edim Otop had the highest infection rate of 75 (78.9%) compared to Ikot Ansa and Ekorinim locations. Although male lizards seem to be more infected (51.1%) than the female (48.9%), there was no statistical significant difference ($p > 0.05$) in the infection rate. Of the 481 helminth parasites recovered from the male and female lizards, two nematodes were identified comprising of *Strongyluris brevicaudata* and *Parapharyngodon awokoyai*. The rectum was the most preferred site of infection compared to other organs of the gastrointestinal tract. There was statistical significant difference ($x^2 = 14.9$, df =4, $p < 0.01$) between parasite prevalence and site of recovery. The month of July recorded the highest number of parasites 157 (32.6%), and there was statistical significant diference ($x^2 = 14.1$, df = 3, $p < 0.01$) between the month of lizard collection and the rate of infection. The study revealed that Agama agama lizards in the study area are parasitized by *Strongyluris brevicaudata* and *Parapharyngodon awokoyai*. Further investigation is recommended on the zoonotic implications of these parasites in humans, especially for those communities which still embark on consumption of lizards.**

Keywords: **Endoparasites, Lizards, *Strongyluris brevicaudata, Parapharyngodon awokoyai*, Calabar, Nigeria.**

I. INTRODUCTION

Lizards are found everywhere in many parts of the tropical and subtropical climates of the world because of their body temperature which changes with the environment [1-2]. Agama lizards are always found on walls of buildings basking themselves on sunlight. The lizards commonly found in West Africa and Africa are the Geckos, Agama lizards, Monitor lizard, Chameleons nd Alligator lizard [1, 3]. Geckos are the smallest lizards, which have become established in the vicinity of man in the tropics [1, 3-4]. Lizards are reptiles that belong to the class Reptilia and phylum Chordata [5]. They live on walls and ceiling of buildings and basking themselves on sunlight in the day, feeding on small insects by picking them up at the tip of their sticky tongues [6]. The African Rainbow lizard (*Agama picticauda*) is the only species in the *Agama agama* species group that has extensive African distribution [7-8]. The species exhibits sexual dimorphism with females, immature and subdominant males possessing a uniformly brown-grey body and limbs with olive green spotted heads [7, 9]. Agama lizard lives in groups or colonies [6], and the dominant males are larger than females [10]. The tail is tri-coloured, with bluish-white at the base, an orange middle segment and a black tip [9]. Encounters between males holding adjacent territories involve vigorous bursts of activity involving tail whipping [10]. Like in many lizards, intact tails are important for territory defense and play crucial roles in locomotion and intraspecific social interactions like courtship and mating [11-13]. Tailless individuals or those with malformed tails consequently decline in social status and reproductive fitness as they become competitively inferior and sexually unattractive [10]. Most lizard species are harmless to humans unless cornered [14], which makes it a thing of interest for some to be kept as pets including bearded dragons, iguanas, anoles and geckos[15]. Lizards and other reptiles such as snakes, crocodiles are used for food in some parts of the world [16-17]. For example in Southwest and Southeast part of Nigeria, the clouded–monitor lizard is a source of meat among poor people. During the Nigerian Biafra war, lizard meat especially the broth was consumed with relish as a reliable prophylactic for Kwashiorkor [18]. Reptiles have served as an important source of protein for human populations around the world. Exploitation for food is heaviest in the tropical and sub-tropical regions, but also occurs in temperate areas [16]. Of all reptiles, turtles are the most heavily exploited for human consumption [16]. The skin of many larger lizards such as iguanas, chuckwallas, and monitors is used for leather goods such as handbags, wallets and shoes [17]. Literature review indicated that 81 reptile species are culturally important in Brazil, with 47 (58%) species having multiple uses, 54 being used for medicinal purposes, 38 as food, 28 for ornamental or decorative purposes, 20 used in magic/religious practices, 18 as pets, and 40 are commonly killed when they come into contact with humans [19]. Throughout history human populations in all parts of the world have consumed reptiles as important components of their diets. Among the wide variety of wild reptiles used for food by humans, chelonians (meat and eggs) are probably the most heavily exploited worldwide [19]. *Agama agama* is primarily insectivorous although it is known to eat small mammals, small reptiles, and vegetation such as flowers, grasses and fruits [20]. The diet consists of mainly ants (intermediate host of helminths), grasshoppers, beetles and termites [21], which makes it a veritable natural pest

control agent. The clouded monitor-lizard serves an important role in insect control in some agricultural areas [17]. The parasitology of Agama lizard is important to aid the diagnosis or prevention of disease [22], in health monitoring. However, the lack of information on most helminthes parasitizing lizards in Africa prevent better understanding of the relationship between these parasites and their hosts in Africa and also, possible host that can harbor species that can potentially infect man [2]. In Nigeria, various studies [23-24], have reported that Lecudina species, a gregarinid protozoan, Eimeria, Plasmodium and Haemogregarina are protozoan parasites of lizards that pose risk to humans, who serve as an intermediate host. Handling faecal contaminated water, dishes and other equipment may also result in accidental transmission. *Capillaria philippinensis* causes human intestinal capillariasis [25]. There have been various studies conducted on the parasites of lizards and other reptiles in various parts of Nigeria and other parts of the world [14, 23, 25]. Man can be infected with *Raillietiella* species by having their hands contaminated from the faeces or saliva of the reptile, and accidentally ingesting the eggs [26]. Usually, there are no clinical signs; however, some people may develop localized inflammation. The larvae can encyst in various tissues, causing abdominal pain, vomiting, constipation, diarrhea, and a tender abdomen [25].Various helminth infection rates have been reported 42.35%, 100%, 86.80%, 64.0% and 72.1%, by [27-30] respectively. However, there is still dearth of information on endoparasites of lizards in some parts of Nigeria as in the study area, which makes understanding of the relationship between these parasites and their hosts difficult. This paper is therefore based on expanding the knowledge of endoparsites of Agama lizards in the study area.

II. MATERIALS AND METHODS

2.1 Study Area

A survey of endoparasites of lizards was undertaken in Calabar municipality to ascertain the infection rate of helminth parasites. Calabar municipality lies between latitude 4^{o} 15^{1} and 5^{o} N and longitude 8^{o} 25^{1} E. In the North, the municipality is bounded by Odukpani Local Government Area, in the North-East by the Great Kwa River. Its Southern shores are bounded by the Calabar River and Calabar South Local Government Area. It is found in the equatorial rainforest belt of Nigeria. It has an area of $142km^2$ and a population of 179392 at 2006 census. It is made up of ten wards. The people's occupation includes trading, farming, and fishing.

2.2 Samples Collection

A total of 236 lizards (*Agama agama*) comprising of 150 males and 86 females were randomly caught by hand from Edim Etop, Ikot Ansa and Ekorinim in Calabar, between the months of April to July 2019. The lizards were kept in ventilated cages and transported to the Biological Science laboratory of the Department of Animal and Environmental Biology, Cross River University of Technology Calabar, for parasitological study.

2.3 Laboratory examination of lizard samples

The lizards were euthanatized with formaldehyde in desiccators. Each lizard was dissected open longitudinally and the digestive tracts comprising the stomach, intestine, caecum, rectum, were removed and placed in different Petri-dishes containing physiological saline (0.86%). Other organs comprising the heart, liver and lungs were also removed, separated, and put into separate petri-dishes containing physiological saline. Each organ was cut open longitudinally and the contents expressed in a Petri-dish containing physiological saline. The contents were then examined closely under a dissecting microscope. The helminths observed were removed and sorted according to their kind, washed in saline to remove adhering debris, counted, fixed and mounted according to standard techniques (Roca ,1985). Results were analysed using the Chi-Square Test to find out the significance of the different associations observed.

III. RESULTS

Out of 236 *Agama agama* lizards examined 176 (72.9%) were infected with helminth parasites. Edim Otop had the highest 75 (78.9%) infection rate, followed by Ikot Ansa 56 (74.7%) and 45 (68.2%) in Ekorinim. (Table 1).

Table 1. Illustrates number of infected lizard Agama agama in the sampled area

Location	Total Lizards examined	Total lizard infected (%)	Percentage (%)
Ikot Ansa	75	56	74.7
Edim Otop	95	75	78.9
Ekorinim	66	45	68.2
Total	236	176	72.9

Table 2 illustrates parasite infection of male and female lizards *Agama agama*. A total of 159 (33.0%), 160 (33.3%) and 162 (33.7%) were recovered from the male and female lizards in Ikot Ansa, Edim Otop and Ekorinim respectively. The prevalence of helminth parasites recorded in the female lizards at Ikot Ansa, Edim Otop and Ekorinim were 50.3%, 47.5% and 48.8% respectively. Similarly, prevalence of helminth parasites in male lizard was 49.7%, 52.5%, and 51.2% at Ikot Ansa, Edim Otop and Ekorinim respectively. Although the male lizard seem to be more infected (51.1%) than the female (48.9%), there was no statistical significant differtence ($x^2 = 6.1$, df = 4, $p > 0.05$) in the infection rate (Table 2).

Table 2. Illustrates the parasite infection of male and female lizards Agama agama

Location	No of parasites in female	No of parasites in male	Total number of parasites	Female (%)	Male (%)
Ikot Ansa	80	79	159	50.3	49.7
Edim Otop	76	84	160	47.5	52.5
Ekorinim	79	83	162	48.8	51.2

($x^2 = 6.1$, df = 4, $p > 0.05$)

Table 3 illustrates prevalence of helminth parasites and site of recovery in *A. agama*. Of the 481 helminth parasites recovered from the male and female lizards, only two nematodes were found, comprising *Strongyluris brevicaudata* and *Parapharyngodon awokoyai*. Out of the 481 parasites recovered 289 (60.0%) were *S. brevicaudata* and 192 (39.9%) *P. awokoyai*. The proportion of parasite distribution was 114 (23.7%), 17 (3.5%), 135 (28.1%), 37 (&.7%), and 178 (37.0%) in the stomach, lung, intestine, liver and rectum of *A. agama* respectively. The predilection site of *S. brevicaudata* was highest in all but one site, the liver. Also *P. awokoyai* was lowest in all sites except the liver. The rectum had higher preference for helminths with *S. brevicaudata* recording 112 (62.9%) compared with 66 (37.1%) recorded by *P. awokoyai. S. brevicaudata* was more abundant across the different sections of the digestive tract 289 (60.0%) than *P. awokoyai* with 192 (39.9%). There was statistical significant difference ($x^2 = 14.9$, df = 4, $p < 0.01$) between parasite prevalence and site of recovery (Table 3).

Table 3. Illustrates prevalence of parasite species and site of recovery in *Agama agama*

Species of parasite	Site of recovery					
	Stomach	Lung	Intestine	Liver	Rectum	Total infection
Strongyluris brevicaudata	69 (60.5)	10 (58.8)	83 (61.5)	15 (40.5)	112 (62.9)	289 (60.0)
Parapharyngodon awokoyai	45 (39.5)	7 (41.2)	52 (38.5)	22 (59.5)	66 (37.1)	192 (39.9)
Total	114 (23.7)	17 (3.5)	35 (28.1)	37 (7.7)	178 (37.0)	481 (100)

($x^2 = 14.9$, df = 4, $p < 0.01$)

Table 4 illustrates prevalence of helminth parasites in male and female lizards in relation to month of infection. Of the 481 helminth parasites recovered from the study area, 115 (23.9%), 123 (25.6%) 86 (17.9%), and 157 (32.6%) were recovered in April, May, June and July respectively. The month of July recorded the highest number of parasites 157 (32.6%) made up of 75 (47.8%) female and 82 (52.2%) male lizards. The least number of parasites 86 (17.9%) were recovered in the month of June. There was statistical significant difference ($x^2 = 14.1$, df = 3, $p < 0.01$) between the month of lizard collection and the infection rate of male and female lizards. (Table 4). Plate 1 shows the anterior end of *P. awokoyai* recovered from A. agama in the study area. This portion of the parasite revealed the long oesophagus which terminates on the oeophageal bulb. The posterior section of *P. awokoyai* is shown on Plate 2. Plate 3 shows a single *image* of *S. brevicaudata*. The abundance of *S. brevicaudata* in the rectum of the lizard A. agama is shown on Plate 4. Over 70 *S. brevicaudata* were recovered in this site.

Table 4.Illustrates prevalence of helminth parasites in male and female lizards in relation to month of infection

Month	Female lizard	Prevalence (%)	Male lizard	Prevalence (%)	Total
April	42	36.5	73	63.5	115 (23.9)
May	54	43.9	69	56.1	123 (25.6)
June	35	40.7	51	59.3	86 (17.9)
July	75	47.8	82	52.2	157(32.6)
Total	206	42.8	275	57.2	481 (100)

($x^2 = 14.1$, df = 3, $p < 0.01$)

Plate 1 showing the anterior portion of *Parapharyngodon awokoyai* x40

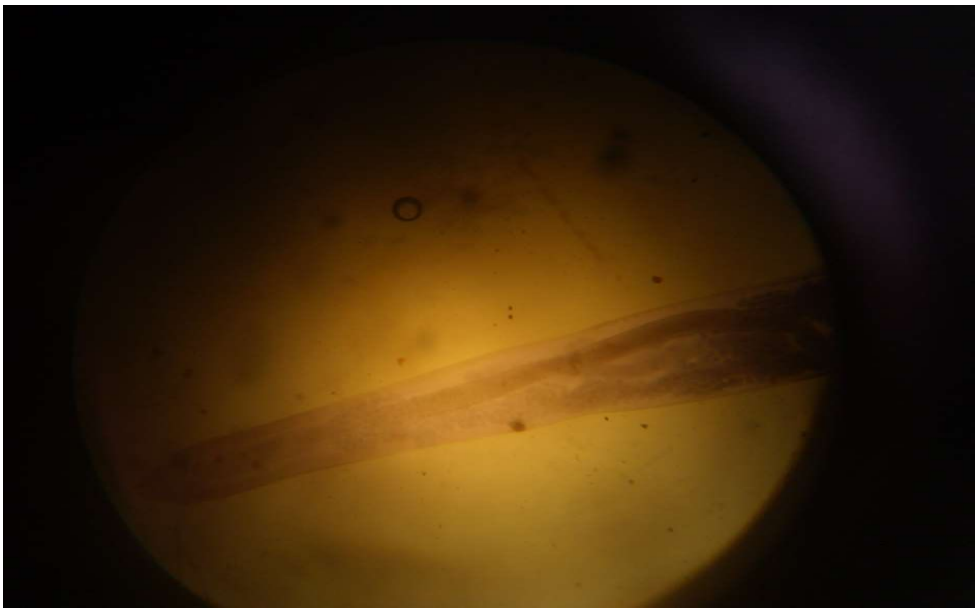

Plate 2 showing the posterior end of *Parapharyngodon awokoyai* x40

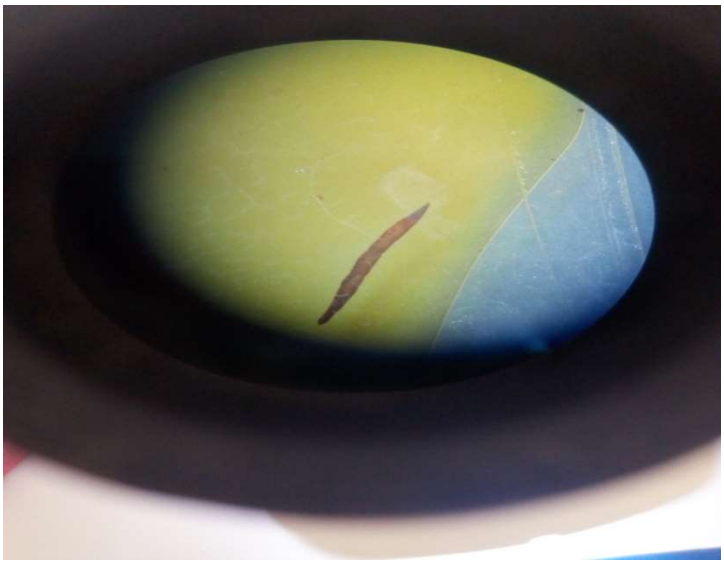

Plate 3. A single *Strongyluris brevicaudata*

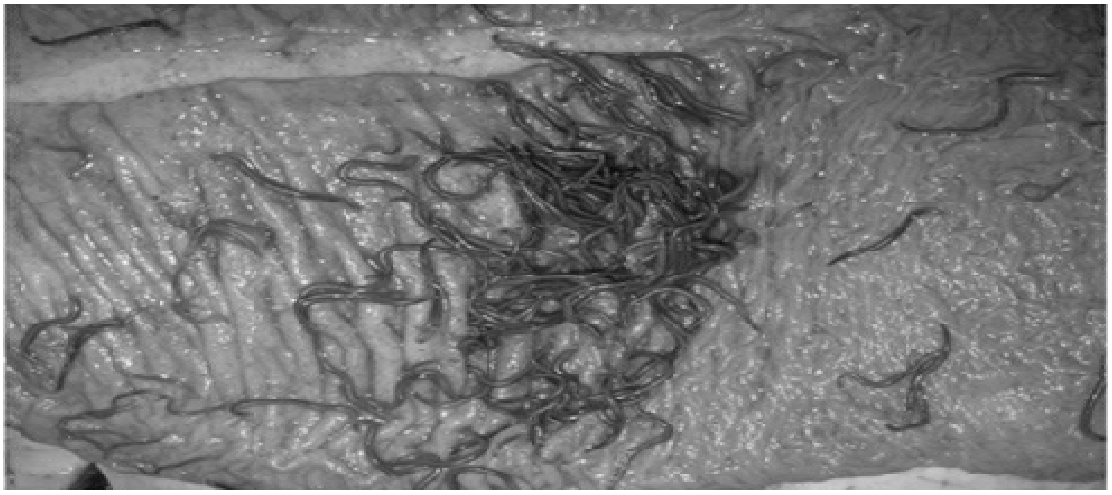

Plate 4. Numerous *Strongyluris brevicaudata* from the rectum.

V. DISCUSSION

This study has implicated lizards from the three locations surveyed in Calabar Municipality as carriers of nematode parasites. An overall 72.9% prevalence of helminth infection was recorded among lizards. This finding is higher than 42.35% and 55.0% reported by [27] in Poland and [29] in Turkey respectively, but lower than 100% and 86.80% recorded by [2] in Ile-Ife, Nigeria, and [30] in Anambra, Nigeria, respectively. This study revealed that the most abundant helminth parasite recovered from Agama agama lizard was nematodes. This finding corroborate the reports of earlier researchers in various parts of the world like [1-2, 30-34], who reported nematode abundance of 3, 3, 3, 2, 6, 2, and 5 in Ile-Ife, Anambra, Libya, Egypt, Namibia, Ibadan and Egypt respectively. In this study, the most frequently encountered parasite was *Strongyluris bevicaudata* with a prevalence range of 60.0%. This finding is in consonance with the report of [30] who recorded the highest prevalence of 85.6% for *S. brevicaudata*. The most frequently double infection observed in this study was the combination of *S. brevicaudata* and *Parapharyngodon awokoyai* with a prevalence of 37.0%. This finding is similar to that of [2, 30].

From the analysis of the result, the difference between intensity of infection and prevalence between male and female lizards seem to be very negligible. Although the male lizard seem to have a higher level of intensity of infection than the female counterpart, the difference was not statistically significant between intensity of infection and sex. This finding supports earlier reports by [31, 35]. Investigation by [36] pointed out that males are more susceptible to parasite's infection probably due to the immune suppressive effects of testosterone, at least during the reproductive period. However, it was observed that the presence of testosterone in males before mating and the amount of energy required by

females during egg development are to drive their reproductive activity and not against parasite infection. Similar observations have been reported by some investigators [37-38].

In this study, the rectum was most infected with the highest parasite intensity of 89.0., than other sites of gastrointestinal tract. Over seventy species of *S. brevicaudata* were recovered in the rectum. Such finding has been reported by [2, 25]. These researchers argued that the rectum being filled with undigested food serves as a convenient habitat for high number of nematodes, since these parasites seek parts of their host organ which provide maximum nutritional value. It was observed that the two recovered parasites, *S. brevicaudata* and *P. awokoyai,* preferred more alkaline environment of the rectum and intestine than the acidic stomach. This finding is in line with the report of [25]. There was statistical significant difference between species recovered and the organ infected. This could be interpreted as parasites being organ specific and therefore determine their distribution.

There was significant difference in the infection rate of male and female lizards in relation to the four months (April to July) of investigation. This finding indicates that the rainfall has great influence on the number of parasites transmitted within each month, which is similar to previous recorded observation [25]. In the study area, like other tropical rainforest belt, *Agama agama* reproduces during the wet season although they are capable of reproducing nearly year round in areas of consistent rainfall as earlier reported [39]. *A. agama* is a thermo-regulated embryo species resulting in all males at twenty-nine degree Celsius and all females at twenty-six to twenty-seven degree Celsius [40]. A. agama breeding occurs during the rainy season in the study area (April to October) when there is increasing temperature required by the eggs for hatching and availability of more food required by the hatchlings [21, 41]. The intensity and prevalence of parasites in male and female lizards was highest in July, when rainfall has increased tremendously. This finding is in contrast with that of [25], but in line with the report of [41]. The recovered image of *P. awokoyai* in this study is shown in Plates 1 and 2, while *S. brevicaudata* in Plates 3 and 4. The anterior portion of *P. awokoyai* in Plate 1 revealed the long oesophagus which terminates on the oeophageal bulb. The posterior section of *P. awokoyai* is shown on Plate 2. In Plate 3 the single *image* of *S. brevicaudata* revealed tapering both ends of the parasite, while Plate 4 exhibits its numerous infection in the rectum. Over 70 *S. brevicaudata* were recovered in this site.

In conclusion, this study has provided compelling evidence that lizards in the study area are parasitized by two nematodes *S. brevicaudata* and *P. awokoyai*. Male lizards seem to be more infected than female lizards, while the lizards from Edim Otop were the most infected. The rectum was the most infected organ in the studied lizards. Further investigation is recommended on the zoonotic implications of these parasites, especially for communities that still embark on the consumption of this reptile.

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CONFLICT OF INTEREST

Author declared no conflict of interest since no organization funded this investigation.

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