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CORRELATIONS OF BODY WEIGHT AND SNOUT-VENT LENGTH TO PARASITE BURDEN IN *AGAMA AGAMA* OF OGOLOMA AMA AND OBA AMA, OKRIKA, RIVERS STATE, NIGERIA

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ABSTRACT: *Body size reflects age/maturity in animals and indicates the parasite exposure window of organisms. Larger sized animals tend to harbour higher parasite burden than smaller hosts. Here, we examined correlations of body weight (BW) and snout-vent-length (SVL) of Agama agama to host parasite burden. 151 host specimens were captured using a baited net enclosure in May, 2019, from Ogoloma Ama (n=92) and Oba Ama (n=59) communities in Okrika, Rivers State, Nigeria. They were euthanized in benzocaine, measured and dissected within 24 hours of capture. Parasites recovered were enumerated and fixed in appropriate fixatives; the number of parasites recovered per infected host was recorded as the parasite burden. Pearson correlation was used to test for association between parasite burden of hosts and their body weight and snout-vent length. Mean body weight of hosts was 32.0±15.6g and 30.0±28.8g for specimens from Ogoloma Ama and Oba Ama, respectively, whereas the mean SVL values were 22.6±2.2cm and 21.1±9.4cm, for specimens from Ogoloma Ama and Oba Ama, respectively. A total of 2, 446 parasites were collected. When all hosts were pooled irrespective of gender or location, significant positive correlations were obtained: r = 0.513 for parasite burden and body weight, and r = 0.428 for parasite burden and SVL (p<0.0001). Sample size affected the correlation results as insignificant values were obtained when the test was done by location or gender. We, therefore, conclude that parasite burden in Agama agama was positively correlated with host body size, and significant values were obtained with larger sample size.*

KEYWORDS: Body Size, Helminths, Animal, Parasite Burden, Okrika, Nigeria

INTRODUCTION

Phenotypic traits often have effect on the abundance and impact of parasitic infections on hosts. Studies have shown that parasite prevalence may vary depending on the size of hosts. Kelehear *et al*., (2012) showed that the prevalence of *Raillietiella frenatus* (a pentastome parasite) was higher in *Rhinella marina* (the cane toad) of intermediate body size. They explained it could be linked to acquired immunity which inhibited re-infection of hosts. Generally, larger body size indicates maturity (Windberg *et al*., 1991; Meritt, 2015) and points to the fact that the organisms must have had more exposure to parasites. In larger sized organisms, there are more micro-habitats that could be inhabited by a diverse array of parasites. Hence, higher prevalence and intensity of parasite infections are expected from larger sized hosts over the smaller ones (Van Sluys *et al.*,1994; Poulin, 1997).

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Also, with parasites, their individual body weight is affected by abundance on hosts. Poulin (1999) showed that the body size of helminth endo-parasites of fish was positively correlated with prevalence and negatively with intensity of infection. The author's observation with ecto-parasitic copepods of fish was different. The copepods' body size correlated positively with both prevalence and intensity of infection.

It is reported that parasite burden increases with increasing host size following the inclusion of intermediate hosts in the main diet of the definitive host (Takemoto and Pavanelli, 2000). The aim of this study was to investigate any relationship between the snout-vent length (SVL) and body weight (BW) of *Agama agama* lizards and their parasite burden (defined as the total number of parasites recovered from the hosts). The hypothesis is that larger sized hosts would have higher parasite burden over smaller hosts.

MATERIALS AND METHODS

Geographical Description

Okrika is an island located between Latitudes 4º 35'and 4º 8'N and Longitudes 6º 58' and 7º 15'E in the Okrika Local Government Area of Rivers State, Eastern Niger Delta, Nigeria. It has a tropical climate and the water is estuarine and tidal. In this location, the rainy season is from April to September with a break in August. However, in 2018-2019, rains continued from March until early December. Two locations, Ogoloma Ama and Oba Ama drained by Bonny River, were chosen for the study (Fig. 1).

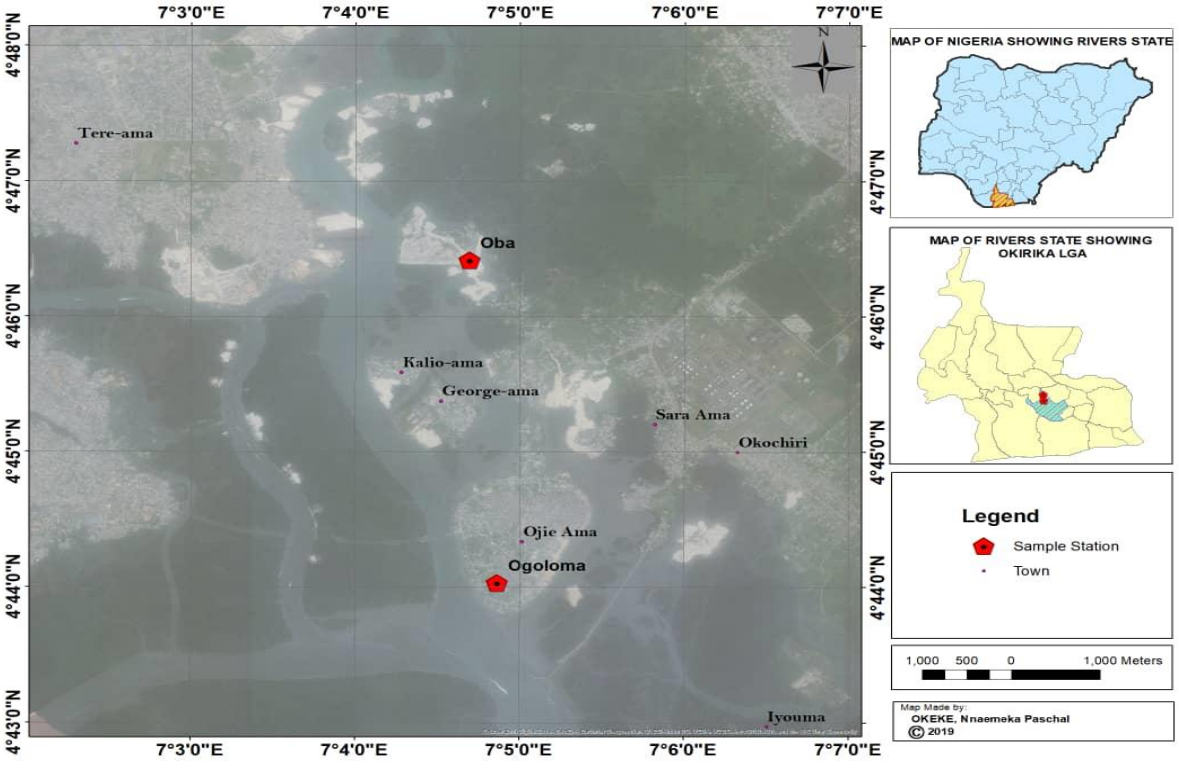

Fig. 1: Map of Study Area Showing Sample Stations

Sample Collection and Examination

One hundred and fifty-one (151) lizards (*Agama agama*) comprising 54 males and 97 females were randomly captured between February and May 2019. Specimens were transported to the Parasitology and Entomology Laboratory, Rivers State University, in buckets covered with nets to allow ventilation. They were euthanized in benzocaine and dissected within 24 hours of capture. Each individual lizard was weighed with Adams electronic weighing balance (model AQP 1600). The Snout vent length (SVL) was measured using a measuring board and a transparent meter rule. Host gender was determined by examining their external and internal structures.

Each specimen was dissected and the gastrointestinal tract (GIT) removed from the viscera. The body cavity and sections of the GIT were properly examined for parasites in Petri dishes containing 0.72% saline solution.

Parasites recovered were counted and fixed in appropriate reagents following Amuzie and Aisien (2018) and identified to possible taxonomic levels with the aid of a compound microscope (Model: National Motic A07270) according to protocols of Yamaguti (1961) and Schmidt (1986). The number of parasites recovered per infected host was recorded as the parasite burden.

Statistical Analysis

Pearson correlation was used to test for association between parasite burden of hosts and their body weight and snout-vent length. Significant differences were tested using Tukey Kramer test. These analyses were done using JMP-SAS package.

RESULTS

Fifty-nine (59) Agama lizards were captured from Oba Ama (21 males and 38 females) and ninety-two (92) from Ogoloma Ama (34 males and 58 females), totaling 151. Lizards from Ogoloma Ama had mean body weight and snout-vent length of 32.0±15.60g and 22.6±2.19cm, respectively. Those from Oba Ama had mean body weight and SVL of 30.0±28.81g and 21.2±9.41cm, respectively. The range and mean of the morphometric characters of both sexes investigated from both locations is presented in Table 1.

Table 1: Summary of Some Morphometric Characters of the Rainbow Lizard, *Agama agama*, of Ogoloma Ama and Oba Ama, Okrika, Rivers State, Nigeria

Location		Ogoloma Ama		Oba Ama	
Sex		Female	Male	Female	Male
SVL (cm)	Min.	10.0	20.0	7.8	19.0
	Max.	28.4	32.0	30.0	30.0
	Mean	20.6±1.77	26.5±2.44	18.0±6.57	26.8±4.00
BW (g)	Min.	10.0	25.0	6.0	11.0
	Max.	44.0	75.0	54.0	84.0
	Mean	22.0±5.40	51.0±16.67	20.0±8.70	48.2±23.40

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From the examined lizards, 123 were infected accounting for a total burden of 82%. The parasites recovered were cestodes (*Oochoristica sp*.), trematodes (*Mesocoelium spp*.) and nematodes (encysted *Ascaridida* larva, *Parapharyngodon awokoyai* and *Strongyluris brevicaudata*). A total of 2,446 parasites were recovered from all infected hosts: 788 parasites from Oba Ama and 1, 658 from Ogoloma Ama giving a parasite intensity of 13.36 and 18.02, respectively (Table 2). There was no difference between the parasite burden of both locations ($t_1 = 2.7682$, $p = 0.0983$) as shown in Fig. 2.

Table 2: Number and Parasitic Burden of Lizards (*Agama agama*) from Oba Ama and Ogoloma Ama, Okrika LGA, Rivers State

Parameters	Station	
	Oba	Ogoloma
No of Lizards	59	92
Number of Infected Hosts	45	78
Parasite Load	788	1658
Mean Parasite Intensity	13.36±16.2	18.02±17.2

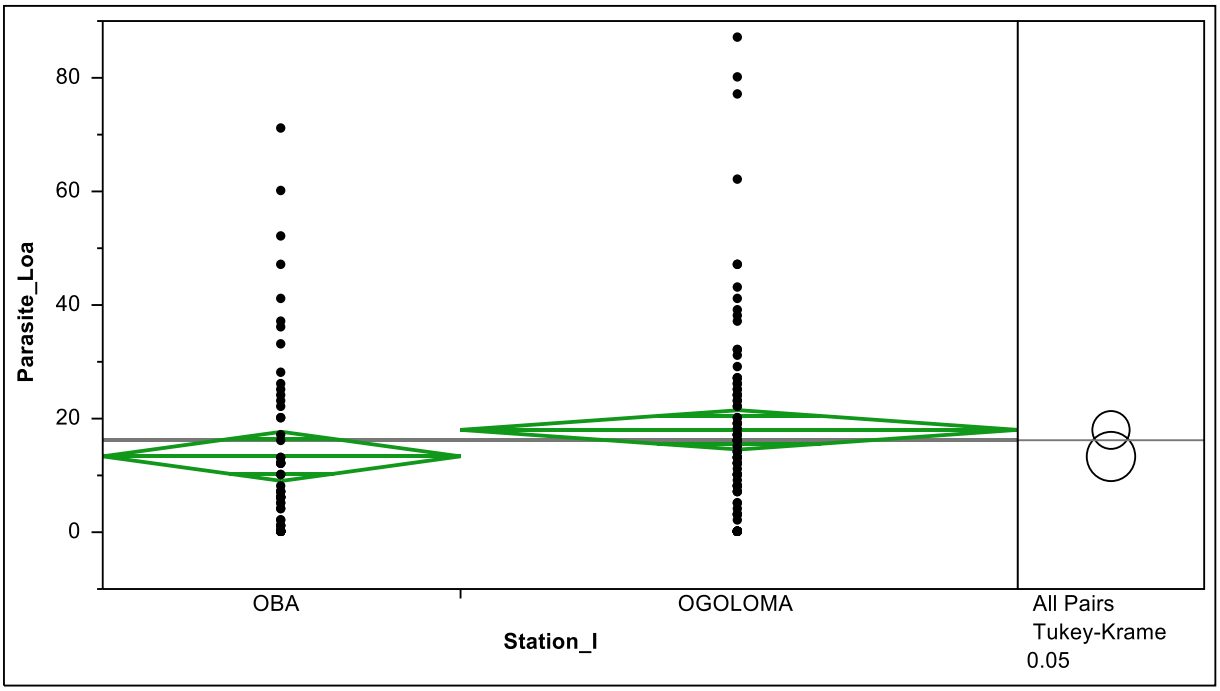

Fig. 2: Test of Significance of Parasite Load in Agama Lizards of Oba and Ogoloma, Okrika, Rivers State, Nigeria

Pearson correlations were used to test for significant associations between parasite burden and morphometric measurements (body weight [BW] and snout-vent length [SVL]) of the specimens from both locations. When all hosts were pooled irrespective of location and gender, a correlation coefficient of 0.51 was obtained between parasite burden and body weight and 0.43 for parasite burden and snout-vent-length (SVL) of the hosts. Both values were different at $p < 0.0001$.

Gender differences (Table 3) were significant at 0.35 between parasite burden and SVL and 0.44 for parasite burden and body weight of the female hosts. In males it was 0.20 for parasite burden and SVL, and 0.33 for parasite burden and body weight. The association between parasite burden and body weight was significant at $P < 0.05$ but that between parasite burden and SVL was not significant ($p = 0.05$).

Table 3: Gender Related Correlation Coefficients Between Parasite Burden and Body Weight and SVL of All Hosts Pooled from both Locations

A. Female hosts

Variable	by Variable	Correlation coefficient (r)	P-value
Parasite burden	SVL	0.3455	0.0006*
Parasite burden	BW (g)	0.4398	<.0001*

B. Male hosts

Variable	by Variable	Correlation coefficient (r)	P-value
Parasite burden	SVL	0.2024	0.1383
Parasite burden	BW (g)	0.3270	0.0148*

All hosts where computed for in view of location and gender (Table 4). In Ogoloma Ama, the correlation coefficients obtained between SVL and parasite burden, and body weight and parasite burden of female hosts were 0.16 and 0.08, respectively. Both values were not significantly different and those obtained for the male counterparts (0.42 and 0.09) were not also different.

Table 4: Gender and location related correlation coefficient between parasite burden and snout vent length and body weight of hosts, Ogoloma Ama

Females

Variable	by Variable	Correlation coefficient (r)	P-value
Parasite_burden	SVL(cm)	0.1870	0.1599
Parasite_burden	WT (g)	0.2283	0.0848

Males

Variable	by Variable	Correlation coefficient (r)	P-value
Parasite_burden	SVL(cm)	0.1423	0.4219
Parasite_burden	WT (g)	0.2939	0.0916

In Oba Ama, correlation coefficients of 0.46 and 0.66 were obtained for the associations between parasite burden and SVL; parasite burden and body weights of female hosts (Table 5). These values were statistically significant at P<0.001. A correlation coefficient of 0.35 was obtained for the association between parasite burden and SVL, and 0.40 for parasite burden and body weight of the male hosts; these were not significant at P<0.001.

Table 5: Gender and Location Related Correlation Coefficient between Parasite Burden and Snout Vent Length and Body Weight of Hosts, Oba Ama

Females

Variable	by Variable	Correlation coefficient (r)	P-value
Parasite_burden	SVL(cm)	0.4636	0.0034*
Parasite_burden	WT (g)	0.6647	<.0001*

Males

Variable	by Variable	Correlation coefficient (r)	P-value
Parasite_burden	SVL(cm)	0.3478	0.1223
Parasite_burden	WT (g)	0.4043	0.0691

DISCUSSION

Results from this study indicated significant positive correlations between parasite burden and the morphometric characters examined. Adeoye and Ogunbanwo (2007) also reported that parasite burden increased with the body weight in agamid lizards. In wild birds, Chu *et al*. (2019) found that both prevalence and mean intensity of chewing lice was positively correlated with host body mass.

Several studies, especially on fish specimens, have reported positive correlations between parasite burden/prevalence with host size (Machado *et al*., 1994; Chapman *et al*., 2000; Morand and Guegan, 2000; Poulin, 2000). This observation is linked with the change in diet of animal hosts as they advance to adults which is more likely to include parasite intermediate hosts (Takemoto and Pavanelli, 2000). In another vein, larger size often indicates older age which points to greater chances of encounter with parasites.

In some other studies, parasite burden/prevalence was found to increase with increasing host size until a certain climax size was reached (Obiekezie *et al*., 1988; Roubal, 1990; Chapman *et al*.,

2000). Development of host immune responses and, in some cases, loss of parasites with increasing age have been implicated (Kelehear *et al*., 2012).

Significant positive correlations were obtained when larger sample sizes were tested, for instance, when either all hosts were pooled irrespective of gender or when all of each gender from both locations were pooled. When the correlation coefficients were computed by location, the values were not significant for both sexes from Ogoloma Ama; and significant only for female hosts from Oba Ama. Therefore, it is presumed that sample size may affect tests of correlation between parasite burden and host body size (Shaw *et al*., 2018).

CONCLUSION AND RECOMMENDATIONS

The parasite burden of the rainbow lizard, *Agama agama*, correlated positively with host body weight and snout vent length which means that larger sized specimens had higher parasite burden than smaller ones. Sample size was found to affect the results.

Due to dearth of recent studies on the rainbow lizard, we recommend more studies on the species, including those on the influence of host characteristics on parasite prevalence and mean intensity.

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