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Preys of Two Arboreal Frogs: *Chiromantis rufescens* and *Leptopelis spiritusnoctis* in Okomu National Park, Nigeria

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ABSTRACT: A number of studies on the diets of anurans from Nigeria have been reported, however, there is a paucity of information on the diets of arboreal anuran species. Examination of the stomach contents of two arboreal frogs; *Chiromantis rufescens* and *Leptopelis spiritusnoctis* collected at Okomu National Park in Edo State revealed a total of nine prey taxa. The preys recorded belonged to eight insect orders (Coleoptera 48.98%, Crustacea 1.02%, Dictyoptera 3.06%, Diptera 5.10%, Hymenoptera 19.3%, Isoptera 1.02%, Lepidoptera 2.04% and Orthoptera 18.37%) and a mollusk (Gastropoda 1.02%). Hymenopterans and Coleopterans were the commonest prey taxa categories in *C. rufescens*, 30.77% and 26.92%, respectively while coleopterans (56.94%) and orthopterans (22.22%) were the commonest prey taxa in *L. spiritusnoctis*. The rate of feeding for both species of tree frogs showed no significant differences ($p<0.05$). This study is the first report on the diet of *C. rufescens* and the diversity of prey taxa in the stomachs analysed suggests that this species of arboreal frogs is a not specialist feeder.

Keywords: *Chiromantis rufescens*, *Leptopelis spiritusnoctis*, Okomu National Park, Diet.

Introduction

Anurans are known to primarily feed on a large diversity of invertebrates, and regarding their choice of prey, many species are considered generalists and opportunists. Several factors can influence the diet of anurans including the availability of preys in its habitat. Also crucial in influencing dietary constituents is the preferred natural location of an anuran within its habitat. Strictly aquatic species will majorly feed on aquatic arthropods (Measey, 1998; Bwong and Measey, 2010; Imasuen and Aisien, 2016), while ground dwellers will specialize in crawling, jumping and flying invertebrates. Arboreal species typically will depend on flying and climbing invertebrates for their nutrition (Duellman and Trueb, 1994; Rödel, 2000; Menin *et al*., 2005).

Although there are several studies on the diets of anurans from Nigeria (Luiselli *et al*., 2004; Ogoanah and Uchedike, 2010; Onadeko, 2011; Enabulele and Aisien, 2012; Enabulele and Imasuen, 2012; Imasuen and Enabulele, 2016; Imasuen and Aisien, 2016), few have reported on the diets of arboreal species. Examination of the stomach contents of several arboreal frogs in Nigeria such as: *Leptopelis hyloides*, *L. boulengeri* and *Hyperolius guttulatus* indicated their major preys were coleopterans and orthopterans (Onadeko, 2011; Enabulele and Aisien, 2012).

Chiromantis rufescens (Rhacophoridae) is commonly known as the African foam-nest tree frog because of its characteristic nest which consists of air bubbles wrapped in leaves. Its natural habitats are subtropical or tropical dry forest, dry savanna, moist savanna, subtropical and tropical dry lowland grassland (Schiozt, 1999). *Leptopelis spiritusnoctis* (syn. *Leptopelis Leptopelis hyloides*) is also tropical or sub-tropical dry forests, moist lowland forests, moist savanna, intermittent freshwater marshes and heavily degraded former forests species. It is frequently encountered on elevated position on vegetation (Rödel, 2000; Schiøtz and Rödel, 2004; Rödel, 2007; Rödel *et al*., 2014). The present study is the first report on the prey

constituents in the stomach of the arboreal frog *Chiromantis refescens* while the diet of *Leptopelis spiritusnoctis* is reported for the first time in Okomu National Park, Nigeria.

Materials and methods

The frog species in this study were collected from the Okomu National Park located in Ovia South-West Local Government Area of Edo State, Nigeria. It is situated between latitudes 6°15' North and 6°25' and longitudes 5°9' and 5°23' East. The Park covers a land area of approximately 19,712 hectares and was established in 1985 initially as a wildlife sanctuary and upgraded to the status of a National Park in 1999. The climate is tropical, characterized by wet and dry seasons. The frogs were hand captured in 2012 and 2014 between 19:00 hours and 23:00 hours, based on Acoustic Encounter Survey (AES) and the Visual Encounter Survey (VES) techniques.

Captured frogs were euthanized by exposing them to chloroform in a killing jar and the stomach subsequently injected with 5% formalin using a syringe to preserve the stomach content, and transported to the laboratory. Prior to examining the stomach contents, the frogs were identified based on the protocols of Rödel (2000); Frost *et al.* (2006) and Frost (2018). The sex were determined by morphological features or gonads and the snout-vent length (svl) measured in millimeters (mm) using venier calliper. Each frog was dissected and the stomach content emptied into a Petri dish containing distilled water and examined under a dissecting microscope. The stomachs of examined frogs were grouped as either empty, digested contents, identifiable preys or identifiable preys with plant matter.

Taxonomic orders were used for categorizing identified preys following (Maddison and Schulz, 2007). Quantitative analysis of each prey category (P_C) was determined using methods in Ikusemiju and Olaniyan (1977) and Crisp *et al.* (1978), the number of individuals of each prey category in each stomach was expressed as a percentage of the total number of all preys categories in the sampled frog species. Also, the rate of feeding (R_F) was estimated as the percentage of stomach containing food (identifiable preys and digested content) divided by the total number of stomachs examined. Significant difference in the rate of feeding for both species was determined using Chi-square (x^2).

Results

The prey taxa in the stomachs of 297 frogs consisting of 99 *C. rufescens* (91 males and 8 females) and 198 *L. spiritusnoctis* (161 males and 37 females) were examined in the present study. All examined frogs were adults with mean and range of svl as follows: *C. rufescens;* male, 56.02 (48.05-62.00), female, 61.90 (50.20-67.00); *L. spiritusnoctis*: male, 27.08 (21.85-34.25), female, 35.55 (29.96-45.75). Twenty-four (23 males and 1 female) of examined *C. rufescens* and 71 (58 males and 13 females) of *L. spiritusnoctis* had identifiable stomach contents (Fig. 1). Frogs with digested stomach contents which could not be identified were 32 (30 males and 2 females) for *C. rufescens* while the total number for *L. spiritusnoctis* was 70 (60 males and 10 females). Forty-three *C. rufescens* (38 males and 5 females) and 57 (43 males and 14 females) *L. spiritusnoctis* had empty stomachs. Plant materials were recorded in only *C. rufescens* (5 males and 1 female).

A total of 98 identifiable preys belonging to eight insects orders (Coleoptera 48.98%, Crustacea 1.02%, Dictyoptera 3.06%, Diptera 5.10%, Hymenoptera 19.39%, Isoptera 1.02%, Lepidoptera 2.04% and Orthoptera 18.37%) and a mollusk (Gastropoda 1.02%) were recorded in the frogs. Twenty-six prey from seven prey taxa were recorded in *C. rufescens* (Coleoptera 7, Crustacea 1, Dictyoptera 2, Diptera 4, Hymenoptera 8, Lepidoptera 2 and Orthoptera 2). In *L. spiritusnoctis*, more preys (72) were recorded also from seven prey taxa (Coleoptera 41, Dictyoptera 1, Diptera 1, Gastropoda 1, Hymenoptera 11, Isopoda 1 and Orthoptera 16) (Table 1).

Hymenopterans and Coleopterans were the commonest prey taxa category in *C. rufescens* accounting for 30.77% and 26.92% respectively (Table 1). In *L. spiritusnoctis*, Coleopterans accounted for the most common prey taxa (56.94%) followed by Orthoptera (22.22%). The rate of feeding for *C. rufescens* was 53.54% while 65.66% was recorded for *L. spiritusnoctis*. *Chi*-square analysis showed no significant difference in the feeding rate of both species ($p<0.05$).

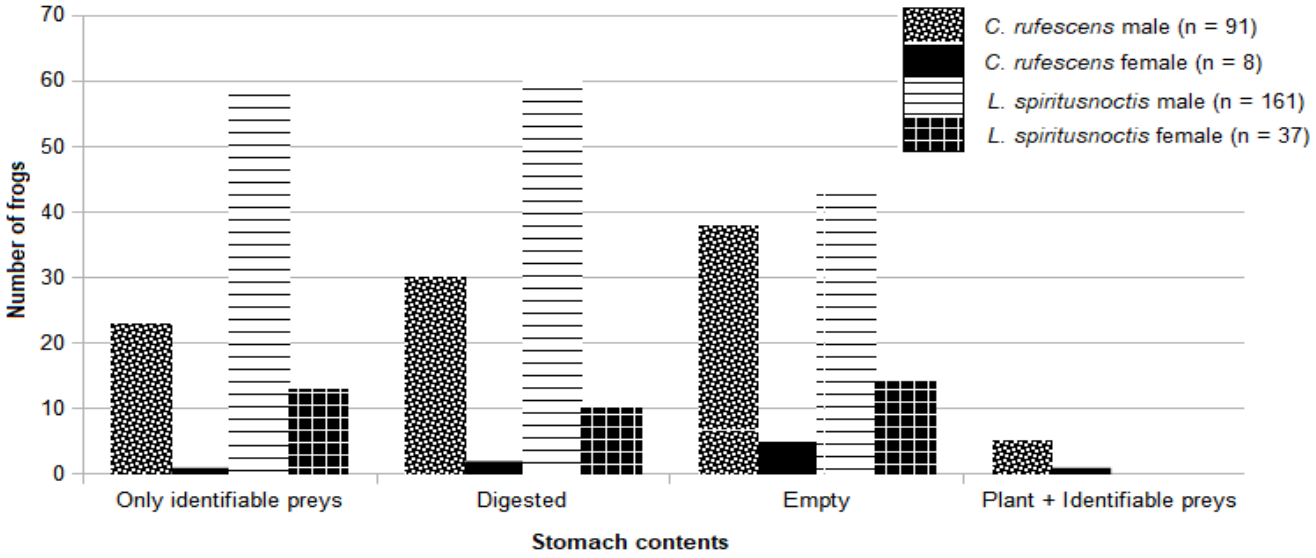

Figure 1: Stomach contents of *Chiromantis rufescens* and *Leptopelis spiritusnoctis* collected in Okomu National Park, Nigeria.

Table 1. Taxonomic categories of preys recorded in the stomachs of *C. rufescens* and *L. spiritusnoctis* collected in Okomu National Park, Nigeria

Prey taxa	***C. rufescens***			***L. spiritusnoctis***			**Total % of prey category**
	Male (n = 91)	**Female (n = 8)**	**% P_C**	**Male (n = 161)**	**Female (n = 37)**	**% P_C**	
Coleoptera	7	0	26.92	26	15	56.94	48.98
Crustacea	1	0	3.85	0	0	0	1.02
Dictyoptera	2	0	7.69	1	0	1.39	3.06
Diptera	4	0	15.38	0	1	1.39	5.10
Gastropoda	0	0	0	1	0	1.39	1.02
Hymenoptera	7	1	30.77	11	0	15.28	19.39
Isoptera	0	0	0	1	0	1.39	1.02
Lepidoptera	2	0	7.69	0	0	0	2.04
Orthoptera	2	0	7.69	16	0	22.22	18.37

% P_c = percentage of prey taxa category in each species of frog

Discussion

The diversity of prey taxa recorded in the stomachs of the two species of frogs in the present study were consistent with previous reports from tree frogs in Nigeria (Luiselli *et al*., 2004; Onadeko, 2011; Enabulele and Aisien, 2012). However, the diversity and quantity of preys consumed by the frogs reported here may have been underestimated due to large percentages of examined stomachs that were empty (*C. rufescens* 43.43%, *L. spiritusnoctis* 28.79%) or had digested contents (*C. rufescens* 32.32%, *L. spiritusnoctis* 35.35%). Enabulele and Aisien (2012) reported a similar range of values (20% empty, 37% digested) stomach contents respectively for *L. hyloides* (*L. spiritusnoctis*) collected in a monoculture plantation sharing boundary with the Okomu National Park.

Tree frogs typically spend most of their time above ground and are generally opportunistic sit-and-wait feeders, relying more on preys that wander towards them (Toft, 1980; 1981). Prey availability influenced by environmental factors in a particular habitat can also determine the dietary composition in frogs (Lima and Moreira, 1993). However, the proportions

of empty or digested stomach contents commonly recorded for non-arboreal frogs is usually less (Ogoanah and Uchedike, 2010; Enabulele and Imasuen, 2012; Imasuen and Enabulele, 2016; Imasuen and Aisien, 2016), this may be influenced by the active feeding and foraging habits of most non-arboreal frog species.

The limited numbers of female *C. rufescens* and *L. spiritusnoctis* stomachs examined was insufficient to allow comparative determination of feeding rate based on the sex of the frogs. This is usually as a result of the commonly used acoustic encounter survey sampling techniques which is often biased to capturing males who make advertisement calls and are easily located (Rödel, 2000). However, studies on frog diets that have compared feeding rates based on sex have not shown significant difference (Hirai and Matsui, 2000; Attademo *et al*., 2007). However, the energetic constraints associated with male reproductive behavior rather than the scarcity of prey may be responsible for high percentages of empty stomach commonly observed (Hirai and Matsui, 2000).

Analysis of the prey taxa in the stomach of *C. rufescens* show they consume a variety of insects (Coleoptera, Crustacea, Dictyoptera, Diptera, Hymenoptera, Lepidoptera and Orthoptera) which suggests that they are not specialist feeders (Toft, 1980). Hymenopterans and Coleopterans formed the bulk of prey taxa recorded (30.77% and 26.92% respectively). Generally, Hymenopterans are the most commonly reported preys of anurans because they are readily available and easy to prey on in most habitat (Toft, 1980; 1981). Plant remains was among the stomach contents recorded in only 6 of the 99 *C. rufescens* examined and none in *L. spiritusnoctis*.

The occurrence of plant remains in the stomachs of several anuran species has been reported (Mahan and Johnson, 2007; Almeida-Santos *et al.*, 2011; Onadeko, 2011; Enabulele and Aisien, 2012) including in the aquatic frog *Silurana tropicalis* (Imasuen and Aisien, 2016). Ingestion of plant by anurans is considered accidental during feeding on preys (Van Sluys *et al.*, 2001) and appears to be the case for *C. rufescens* in this study. However, intentional ingestion of plant material has been reported for *Xenohyla truncata* (Silva *et al.*, 1989; Silva and Brito-Pereira, 2006). Also, Anderson *et al.* (1999) has suggested ingestion of plant materials provides roughage to assist in grinding up of arthropod exoskeletons.

More diversity of prey taxa were recorded in *L. spiritusnoctis* from this study in comparison to the reports by Onadeko (2011) and Enabulele and Aisien (2012). However, four of the prey taxa (Dictyoptera, Diptera, Gastropoda and Isopoda) reported here in *L. spiritusnoctis* only accounted for 1.39% respectively of the prey taxa recorded and may have been opportunistic prey items. Coleopterans appears to be the preferred diet of *L. spiritusnoctis*, as was previously observed by Onadeko (2011) and Enabulele and Aisien (2012) and accounted for 56.94% of preys recorded in the present study.

Analysis of the stomach content of some pipid and non-pipid anurans have revealed a tendency toward cannibalism (D'Cruze and Sahel, 2005; Ogoanna and Uchiedike, 2010; Bwong and Measey, 2010; Enabulele and Imasuen, 2012; Imasuen and Aisien, 2016). However, there is no report on this phenomenon among the tree frogs. Although the size of the anurans reported to exhibit cannibalism are larger in comparison to most tree frogs, the arboreal behaviour of frogs may be a limiting factor. The rate of feeding for both species of tree frogs examined in the present study showed no significant differences ($p<0.05$).

In summary, based on the diversity of prey taxa in the stomachs of the analysed *C. rufescens*, this first report on the diet of this species of arboreal frogs suggests they are not specialist feeders. Also, the diet composition of *L. spiritusnoctis* confirms that they are generalist species. More research work is advocated in this area of study in order to expand knowledge in the maintenance requirements of the frogs in captivity.

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