DIETS OF *Hemisus mamoratus* AND *Leptopelis hyloides* (ORDER ANURA) FROM MONOCULTURE PLANTATIONS IN SOUTHERN NIGERIA

ENABULELE, E.E. and **AISIEN, M.S.O.***
Laboratory of Parasitology Research, Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, P.M.B. 1154, Benin City, Nigeria

*Corresponding author: *msoaisien@hotmail.com*

Abstract

The stomachs of 73 anurans, consisting of 22 *Hemisus marmoratus* and 51 *Leptopelis hyloides* from two monoculture plantations (oil palm and rubber), respectively, in Okomu-Udo, Edo State, were examined for their dietary constituents. The diets of the two frog consisted mainly of insects belonging to the orders Coleoptera, Orthoptera, Hymenoptera, Isoptera and Diptera. Other items recovered, which may be incidental intakes were sand grains and plant materials. Hymenopterans and isopterans were the food items recorded in *H. marmoratus* with percentage frequencies of occurrence 1.55% and 98.45%, respectively. Food items recovered from *L. hyloides* were Hymenoptera (22.73%), Coleoptera (65.91%), Diptera (2.27%) and Orthoptera (9.09%) with coleopterans having the highest percentage frequency of 68.18%. Although there were differences in the feeding rates of *H. marmoratus* (31.82%) and *L. hyloides* (43.14%), the difference was not statistically significant ($p>0.05$). The restricted diets of these frogs, which differed from those of their counterparts collected from natural forests, may have been influenced by the food items available in their respective monoculture habitats. While *H. marmoratus* may be classified a specialist feeder, *L. hyloides* is a generalist.

Keywords: anurans, *H. marmoratus*, *L. hyloides*, diet, monoculture plantations, southern Nigeria.

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Introduction

Conventionally, anurans are regarded as generalist feeders and exhibit foraging behaviours. Toft (1980, 1981) identified two main diet patterns in tropical anurans: "ant specialists" that feed on mainly slow moving arthropods and the "non-specialists" that eat larger and more mobile arthropods. Most of the diet that have been reported from anurans consist of invertebrates, including molluscs, annelids, centipedes, millipedes, arachnids, crustaceans and particularly, insects (Duellman and Trueb, 1986; Lima and Magnusson, 1998; Van Sluys and Rocha, 1998; Anderson *et al* 1999). Small vertebrates may occasionally be consumed by carnivorous and larger frogs (Duellman and Trueb, 1986; Crump, 1992).

Studies have suggested that some species show some degree of diet specialization which may be are intrinsically linked to foraging strategies (sit-and-wait or active searching), nocturnal or diurnal feeding, the nature of defence mechanisms, habitat type and the seasonal availability of food (Toft, 1980, 1981; Duellman and Trueb, 1986; Simon and Toft, 1991; Lima and Magnusson, 1998).

Studies on the food and feeding habits of anurans have been conducted in many countries worldwide. Literature on investigations from Africa is growing with works such as those of Inger and Marx (1961); Hughes (1979); Blackburn and Moreau (2006); Kouame *et al*

(2008); Hirschfeld and Rödel (2011), providing useful information. In Nigeria, Luiselli *et al* (2004) and very recently, Ogoanah and Uchedike (2010) and Onadeko (2011) have undertaken some studies.

According to Rödel (2000), the shovel nose frog *Hemisus marmoratus* mainly inhabits savannas, but it is also found in gallery and island forests. This frog has been recorded in forest locations in Nigeria (Aisien *et al* 2001). *Leptopelis hyloides* (syn. *Leptopelis spiritusnoctis*) inhabits sub-tropical or tropical dry forests, moist lowland forests, moist savanna, intermittent freshwater marshes and heavily degraded former forests (Schiøtz and Rödel, 2004). *Hemisus marmoratus* is predominantly subterranean while *L. hyloides* is rarely found on the ground but always climb to elevated position on vegetation (Rödel, 2000).

In this study, we examined the diets of *H. marmoratus* and *L. hyloides* that were collected from a rubber and an oil palm plantations, respectively. The aim of this paper is to; (1) determine their most important dietary items, (2) ascertain if they are specialized or generalized regarding their prey selection and 3) determine if habitat type has effect on the diet of these frogs.

Figure 1: Location of Okomu Oil Palm and Rubber plantations.

Material and methods

The anurans investigated were collected from Okomu Oil Palm and Rubber Company (Latitude 5˚07′ and 5˚25 E and Longitude 6º 18′ and 6º 26′ N) located at Okomu-Udo, within the Okomu Forest Reserve in Edo State, southern Nigeria (Figure 1). Edo State has a tropical climate characterized by two distinct conditions of wet and dry seasons, with an average annual rainfall of 250 cm near the coastal areas and 150 cm in the extreme northern part of the state.

Amphibians were collected between the months of May and July 2011 between 19:00 hours and 23:00 hours, applying the Acoustic Encounter Survey (AES) and the Visual Encounter Survey (VES) techniques. Sampling was done by four individuals for two man hours each in the rubber and oil palm plantation, respectively, over two nights on each visit. Captured anurans were transported to the base camp in plastic bottles with perforated caps and containing little quantity of water to keep them moist. The captured anurans were euthanized by exposing them to chloroform in a killing jar. Thereafter, 5% formalin was injected with a syringe into their stomachs to preserve the stomach content, and the whole animal stored in a jar containing 5% formalin.

Prior to examining the stomach contents, the amphibians were washed free of the preservative and identification was done based on the protocols of Rodel (2000); Frost *et al* (2006) and Frost (2007). The animals were sexed and the snout-vent length (SVL) was measured with the aid of a venier calliper. The amphibians were thereafter dissected and the stomach content emptied into a Petri dish containing distilled water. The contents were examined under a dissecting microscope (Nikon SMZ 645 Dissecting Microscope) at X10 magnification. The stomach were grouped as empty or with diet (either as identifiable items or digested content). The food items in the stomachs were categorized as insect preys and other materials (plant and sand grains). Insect preys were classified in categories representing taxonomic orders following (Maddison and Schulz, 2007) and then stored in separate vials containing 70% alcohol.

The frequency of occurrence for each prey item was calculated as number of stomachs with a particular prey divided by total number of stomachs with prey while the rate of feeding was estimated as the percentage of stomach containing food divided by the total number of stomachs examined (Sala and Ballesteros, 1997). *Chi*-square ($\div^2$) statistical test was used to determine any significant difference in the rate of feeding for both species.

Result

The stomach contents of 73 anurans consisting of 22 *H. marmoratus* (14 males and 08 females) and 51 *L. hyloides* (41 males and 10 females) were examined during this study. The mean and standard deviation of the snout vent length (svl) of the frogs were as follows: *H. marmoratus* (male, 29.32 ± 1.53; female, 31.03 ± 2.58); *L. hyloides* (male, 27.10 ± 1.57; female, 32.47 ± 4.62).

Seven (31.82%) of the examined *H. marmoratus* and 22 (43.14%) of *L. hyloides* had identifiable stomach contents, respectively. Nineteen (37.25%) *L. hyloides* had digested stomach contents which could not be identified while eleven (50%) and 10 (19.61%) empty stomachs were recorded for *H. marmoratus* and *L. hyloides*, respectively. Sand grains and plant materials were recorded in three stomachs (13.64%) and one stomach (4.55%) of *H. mamoratus* (Table 1).

Table 1: Stomach contents of anurans from Okomu Oil Palm and Rubber Plantations in Edo State, Nigeria.

Stomach contents	Anurans	
	***H. marmoratus* (*n*=22)**	***L. hyloides* (*n*=51)**
Identifiable items (insects)	07	22
Digested food	00	19
Plant material	01	00
Sand grains	03	00
Empty stomach	11	10

Table 2: Percentage frequencies (%FO) of prey items in anurans from Okomu Oil Palm and Rubber Plantations.

Food item	Anurans			
	H. marmoratus		***L. hyloides***	
	No of prey items	**% FO**	**No of prey items**	**% FO**
Diptera	00	0.00	01 (2.27%)	4.55
Coleoptera	00	0.00	29 (65.91%)	68.18
Hymenoptera	05 (1.55%)	42.86	10 (22.73%)	13.64
Isoptera	317 (98.45%)	71.43	00	0.00
Orthoptera	00	0.00	04 (9.09%)	18.18
Total	322		44	

The identifiable food items recorded in the stomach of the frogs belonged to the class Insecta and comprised of six orders which included Hymenoptera, Isoptera, Diptera, Coleoptera, Hymenoptera and Orthoptera (Table 2).

A total of 322 food items belonging to the orders Hymenoptera (1.55%) and Isoptera (98.45%) were recorded in the diets of *H. marmoratus* while 44, comprising of Diptera (2.27%), Coleoptera (65.91%), Hymenoptera (22.73%) and Orthoptera (9.09%) were recovered from *L. hyloides* (Table 2).

The percentage frequency of food item occurrence in *H. marmoratus* was Hymenoptera (42.86%) and Isoptera (71.43%). In *L. hyloides*, Diptera accounted for 4.55% while 68.18%, 13.64% and 18.18% were recorded for Coleoptera, Hymenoptera and Orthoptera, respectively (Table 2). Hymenopterans were a common diet in both anurans accounting for 42.86% in *H. marmoratus* and 13.64% in *L. hyloides*. Isoptera occurred more (71.43%) in *H. marmoratus* while Coleoptera (68.18%) was the most occurring item in the diet of *L. hyloides*.

The rate of feeding in *H. marmoratus* was determined to be 31.82% while 43.14% was recorded for *L. hyloides*. *Chi*-square analysis showed no significant difference in the feeding rate of both species ($p>0.05$).

Discussion

Analysis of the diet composition of *H. marmoratus* and *L. hyloides* revealed little diversity in terms of the food items consumed by the two frogs. Only five food items (Hymenoptera, Orthoptera, Isoptera, Diptera and Coloeptera) constituted the diets of the two frogs in these plantations (Table 2). This is in sharp contrast to their counterparts collected from natural forests in south-western Nigeria, where *H. marmoratus* consumed seven identifiable food items and *L. hyloides* five (Onadeko, 2011). The restricted diets of these frogs in

the respective monoculture plantations from which they were collected, is most likely a reflection of the food items available in the plantations rather than a selective mode of feeding. Amphibians and their preys thrive better in moist and humid environments, such as are provided by closed forest canopy and undergrowth. The situation is different in the oil palm and rubber plantations, where the foliage characteristics allows greater light and heat penetration, resulting in lower relative humidity, which is less conducive for vertebrates and invertebrates alike. The altered nature of the plantations in comparison to natural forests may be responsible for the absence of other preys recorded by Onadeko (2011).

Although a total of 322 prey items were recorded for *H. marmoratus*, they were restricted to the orders Hymenoptera (1.55%) and Isoptera (98.45%). This finding is in agreement with Wells (2007) who observed ants and termites as the main prey items in *H. marmoratus*. This narrow range of food items in their diet suggests that these frogs are specialist feeders (Toft, 1980). When our findings are compared with those of Onadeko (2011), this categorization appears untenable, because, in addition to isopterans and hymenopterans, Onadeko (2011) also recovered coleopterans, dipterans, isopods and annelids from the stomachs of *H. marmoratus*. The range of prey items found by Onadeko (2011) would better describe these frogs as generalist feeders. The differences in the dietary components of *H. marmoratus* caught in our study and those examined by Onadeko (2011) must be a factor of the habitats from which these frogs were collected. While Onadeko collected frog samples from a rainforest habitat, frogs for this study were collected from a rubber plantation, an agriculturally altered environment. This alteration in the habitat of *H. marmoratus* in Okomu, which replaced a natural forest with a monoculture plantation (rubber trees), may have affected prey abundance and availability in the plantation (Mahan and Johnson, 2007) and consequently their abundance in the diet of the frogs (Turner, 1959; Houston, 1973).

Other stomach contents recorded in *M. marmoratus* in this study (plant materials and sand grains) were also reported by Onadeko (2011) along with detritus. While consumption of plant materials has been reported in several studies on anuran diet, plants are not considered an important resource in their diet. As some authors (Korschgen and Moyle 1955; Linzey, 1967; Hedeen, 1972; Mahan and Johnson, 2007) have suggested, we are also of the view that ingestion of plant parts by these frogs is incidental. Anderson *et al* (1999) was however of the opinion that ingested plant materials helped in the elimination of parasites, and also provided roughage to assist in grinding up of arthropod exoskeletons.

The oil palm plantation, though a monoculture plantation, has a rich supply of palm fruits, which gives it the capacity to support a large variety of invertebrate fauna. This perhaps explains why the insect fauna of this habitat is only marginally different from those encountered by Onadeko (2011) in the natural forest. Except for arachnids, which was reported as part of the diet of *L. hyloides* by Onadeko (2011), in the natural forest, the insect fauna of both habitats were the same and the percentage frequencies comparable. Although fewer prey items (44) were recovered from the stomachs of the *L. hyloides* examined, there was greater variety in the dietary components of this frog. The frog consumed dipterans, coleopterans, hymenopterans and orthopterans (Table 2). This array of dietary components found in the stomachs of the *L. hyloides* fits it as a generalist feeder. Unlike *H. marmoratus* where hymenopterans and isopterans were the predominant food items, coleopterans (68.18%) and orthopterans (18.18%) formed the bulk of the diet of *L. hyloides* examined in this study.

Leptopelis hyloides is arboreal and forage for food mainly at night. It is obvious from the percentage frequency occurrence, that these insects (coleopterans and orthopterans), form the bulk of the preys available at these locations and at night when these frogs forage for food. Onadeko (2011) also observed a similar trend in the tree frogs (*L. hyloides*, *L. boulengeri* and *Hyperolius guttulatus* studied in south-western Nigeria. *Leptopelis hyloides* examined in this study did not have Isopterans as part of their food. This finding is in agreement with that of Onadeko (2011), who also observed the absence of these insects in the diets of the *L. hyloides* and other tree frogs studied in south-western Nigeria. While hymenopterans had lower occurrence (13.64%) in the diet of *L. hyloides* studied at Okomu, these insects had high occurrence in the diet of tree frogs in south-western Nigeria. Onadeko (2011) attributed this to the fact that these insects either inhabit arboreal habitats like the tree frogs, or forage there for food at night and are thereby encountered and consumed by the frogs (Duellman *et al* 1986; Duellmann, 1993; Wells, 2007).

Plant materials and sand grains, which formed part of the stomach contents of *H. mamoratus* was not recovered from the stomachs *L. hyloides*. In view of arboreal habitat of *L. hyloides*, there is little or no opportunity of sand grains mixing with the food of these frogs. Furthermore, the absence of plant materials in their stomachs, further buttresses the assertion that the ingestion of plant materials by amphibians, is purely incidental.

The feeding rate of *H. marmoratus* was determined

to be 31.82% while 43.14% was recorded for *L. hyloides*. *Chi*-square analysis showed that there was no significant difference in the feeding rate of both species (p>0.05).

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References

Aisien, S.O., Ugbo, A.D., Ilavbare, A.N. and Ogunbor, O. 2001. Endoparasites of amphibians from south-western Nigeria. *Acta Parasitol. 46(4):* 299-305.

Anderson, A.M., Haukos, D.A. and Anderson, J.T. 1999. Diet composition of three anurans from the Playa wetlands of north-west Texas. *Copeia 2:* 515-520.

Blackburn, D.C. and Moreau, C.S. 2006. Ontogenic diet change in the arthroleptid frog *Schoutedenella xenodactyloides*. *J. Herpetol. 40:* 388-394.

Crump, M.L. 1992. Cannibalism in Amphibians. In*:* Elgar, M. A. and Crespi, B.J. Eds. Cannibalism:In *Ecology and evolution among diverse taxa*. Oxford University Press, pp. 256-276.

Duellman, W.E. and Trueb, L. 1986. *The Biology of Amphibians*. McGraw-Hill, New York, 670pp.

Frost, D.R., Grant, T., Faivovich, J., Bain, R.H., Haas, A., Haddad, C.F.B., De Sa, R.O., Channing, J.A., Wilkinson, M., Donellan, S.C., Raxworthy, C.J., Cambell, J.A., Blotto, B.L., Molar, P., Drewes, R.A., Nussbaum, R.A., Lynch, J.D., Green, D.M. and Wheeler, W.C. 2006. The amphibian tree of life. *B. Am. Mus. Nat. Hist. 297:* 1-370.

Frost, D.R. 2007. Amphibian Species of the World: An Online Reference. Version 5.0 (last enquiry: 13 May 2007) http://research.amnh.org/herpetology/amphibia/index.html.

American Museum of Natural History, New York, US.Hedeen, S.E. 1972. Food and feeding behaviour of the mink frog, *Rana septentrionalis* Baird, in Minnesota. *Am. Midl. Nat. 88:* 291-300.

Hirschfeld, M. and Rödel, M.-O. 2011. The diet of the African Tiger frog, *Hoplobatrachus occipitalis*, in Northern Benin. *Salamandra 47(3):*125-132.

Houston, W.W.K. 1973. The food of the common frog, *Rana temporaria*, on high moorland in northern England. *J. Zool. 171:* 153-165.

Hughes, B. 1979. Feeding habits of the frog *Aubria subsigillata* in Ghana. *BIFAN 41:*654-663.

Inger, R. and Marx, H. 1961. Food of amphibians. De Wit, M.G.E (ed): *Exploration du Parc National de I'Umpemba*. Institut des Parc Nationaux du Congo et du Ruanda-Urundi, Bruxells, pp. 3-36.

Korschgen, L.J. and Moyle, D.L. 1955. Food habits of the bullfrog in central Missouri farm ponds. *Am. Midl. Nat. 54:* 332-341.

Kouame, N.G., Tohe, B., Assemian, N.E., Gourene, G. and Rödel, M.-O. 2008. Prey composition of two syntopic *Phrynobatrachus* species in the swamp forest of Banco National Park, Ivory Coast. *Salamandra 44*: 177-186.

Lima, A.P. and Magnusson, W. E. 1998. Partitioning seasonal time: Interactions among size, foraging activity and diet in leaf-litter frogs. *Oecologia 116:* 259-266.

Linzey, D.W. 1967. Food of the leopard frog *Rana pipiens*, in central New York. *Herpetologica 23:* 11-17.

Luiselli, L., Bikikoro, L., Odegbune, E., Wariboko, S.M., Rugiero, L., Akani, G.C. and Politano, E. 2004. Feeding relationships between sympatric Afrotropical tree frogs (genus *Hyperolius*): The effects of predator body size and season. *Anim. Biol. 54(3):* 293-302.

Maddison, D.R. and Schulz, K.S. 2007. *The Tree of Life Web Project*. Available at http://tolweb.org.

Mahan, R.D. and Johnson, J.R. 200). Diet of the Gray Treefrog (*Hyla versicolor*) in relation to foraging site location, *J. Herpetol. 41:* 16-23.

Ogoanah, S.O. and Uchedike, E. 2010. Diet of two anurans *Hoplobatrachus occipitalis* and *Bufo maculatus*, in Benin City, Nigeria: *Biosci. Res. Commun. 22:* 189- 196.

Onadeko, A.B. 2011. Food and feeding habits of some species in south-western Nigeria. *The Zoologist 9:* 57-69.

Rodel, M.O. 2000. *Herpetofauna of West Africa, Volume 1. Amphibians of the West African Savanna*. Edition Chimaira, Frankfurt, Germany, 332p.

Sala, E. and Ballesteros, E. 1997. Partitioning of space and food resources by three fish of the genus *Diplodus* (Sparidae) in a Mediterranean rocky infralittoral ecosystem. *Marine Ecology Programme Services 152:* 273-283.

Schiøtz, A. and Rödel, M.-O. 2004. *Leptopelis spiritusnoctis.* In : IUCN 2011. IUCN Red list of threatened species. Version 2011.2.

Simon, M.P. and Toft, C.A. 1991. Diet specialization in small vertebrates: mite eating in frogs. *Oikos 61:* 263-278.

Toft, C.A. 1980. Feeding ecology of thirteen synoptic species of anurans in a seasonal tropical environment. *Oecologia 45:* 131-141.

Toft, C.A. 1981. Feeding ecology of Panamanian litter anurans: patterns in diet and foraging mode. *J. Herpetol. 15:* 39-144.

Turner, F.B. 1959. An analysis of the feeding habits of *Rana p. pretiosa* in Yellowstone Park, Wyoming. *Am.. Midl. Nat. 61:* 403-413.

Van Sluys, M. and Rocha, C.F.D. 1998. Feeding habits and microhabitat utilization by two syntopic Brazilian Amazonian frogs (*Hyla minuta* and *Pseudopaludicola* sp. (Gr. *Falcipes*). *Rev. Bras. Biol. 58:* 559-562.

Wells, K.D. 2007. *The Ecology and Behaviour of Amphibians*. University of Chicago Press, 1148p.

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