FOOD AND FEEDING HABIT OF AMPHIBIANS AROUND THE FACULTY OF LIFE SCIENCES AND DEPARTMENT OF ANATOMY, WITHIN THE UNIVERSITY OF BENIN

EDO STATE, NIGERIA.

BY

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CERTIFICATION

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DEDICATION

This project report is dedicated to almighty God, my parents; Mr & Mrs Iyase, siblings; Iyase Omoregbe, Iyase Naomi, Iyase Edison, and my friends for their endless support throughout this seminar preparation.

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ABSTRACT

Amphibians play vital roles in our ecosystem as both predator and prey, contributing to insect population control and serving as a bio-indicator of the environmental health. This study was done to examine the food and feeding habits of anurans (*Sclerophyrs maculata, Hoplobatrachus occipitalis,* and *Ptychadena pumilio*) around the Faculty of Life Science towards the Department of Anatomy at the University of Benin, Edo state, Nigeria. A total of 62 specimen were captured and analyzed using the stomach-flushing method to obtain the stomach content and the prey items were identified. The result revealed that the anurans mainly consumed insects in the Order Hymenoptera, which was the most abundant and frequently occurring prey item (73.43%). *Sclerophyrs maculata* had the highest dietary diversity, while *H. occipitalis* showed a preference for Araneae (spiders) and *Ptychadena pumilio* showed the lowest prey diversity probably due to the number of specimens captured. This study provides insight into the adaptability of these

species to their environment, demonstrating their opportunistic feeding habits and the factors influencing their diet. The high consumption of hymenoptera suggests that crawling insects are a readily available and preferred type of food. The presence of empty stomach might indicate low availability of food or fast digestion rate.

CHAPTER ONE

1.1 INTRODUCTION

Amphibians are a class of cold-blooded vertebrates. They were the first vertebrates to transit from water to land, a significant evolutionary step. This happened during the Devonian period, 360 million years ago, this evolutionary breakthrough paved the way for reptiles who eventually became the first successful vertebrates to transition from water to land. Amphibians are considered unsuccessful because they have to alternate life in and out of water (Duellman & Trueb, 1985).

Amphibians possess lungs and gills used for respiration in addition to their permeable skin that allows gaseous exchange, meaning they can absorb oxygen and release carbon dioxide through their skin. Usually found in wet area, shady places or in water bodies (with their nostrils usually above water surface), this helps reduce the loss of moisture from their skin.

They are nocturnal vertebrates because they come out at night when the temperature is low and air is humid. Their distinctive features includes lack of a tail, stocky body, long hind legs, large bulking eyes and wide mouth (Inger & Stuebing, 2005).

Amphibians are a very diverse group of vertebrate, mainly their feeding is opportunistic with food up to gape width being ingested. There is a relationship between the abundance of prey in the environment and in the diet of anurans (Turner 1959, Houston 1973). Amphibians in general are voracious feeders, feeding mainly on insects like beetles, termites, flies, grasshoppers, butterflies, moths, bugs, earwigs, dragonflies and also their larvae, etc. Although insects are their principal diet they can feed also on small mammals, in rare cases small birds, snakes, lizards, other frogs, earthworms, crabs, spiders and in fact any living creature which they can capture and overpower. Some species of frog such as *Rana tigerina* is said to be a regular cannibal and feeds readily on the young of its own species (Chanda 1993).

Amphibians are able to distinguish between different prey types allowing for different degrees of feeding specialization (Freed 1982). Dietary specialization is often associated with morphological, physiological, and behavioral characteristics that facilitate location, identification, capture, ingestion, and digestion of prey items. Anurans are carnivores and their main diet consists of arthropods, parts of plants, fruits accidentally consumed with other food items by adult amphibians (Silva and Britto-Pereira 2006). A relationship between the skull shapes of frogs and their diet was observed, whereby frogs that eat relatively small, slow prey have relatively long jaws and an asymmetrical feeding cycle; time to capture prey is less than the time to bring prey into the mouth. On the other hand, snail-eating frogs have lower jaws with a relatively long distance from the insertion point of the adductor muscle to the jaw articulations (Emerson 1985). Two main diet patterns in anurans were identified and they comprise "ant specialists" eating slow-moving, strongly chitinized arthropods such as ants, termites, and mites, and "non-ant specialists" eating generally more variable and less chitinous arthropods, for example spiders and grasshoppers (Toft 1980a).

Understanding feeding relationships in amphibian communities is of fundamental interest to herpetologists and ecologists because of the pivot role that amphibians may play in aquatic ecosystems (Hirai and Matsui, 1999). Different studies suggest that food is an important factor that explains the structure of anuran communities in different parts of the world (Duellman, 1967, 1978; Inger and Colwell, 1977; Toft and Duellman, 1979, Toft, 1980a). The family Ranidae contains more than 600 species and is distributed worldwide (Duellman and Trueb, 1986). Ranids are considered to be generalist predators (Houston, 1973; Premo and Atomowidjojo,

1987) and to change their diets in response to natural fluctuations of prey availability (Tyler and Hoestenbach, 1979; Hirai and Matsui, 1999). Rana ridibunda is highly riparian, being restricted to aquatic margins and rarely moves far from water ((Basoglu and Özeti, 1973).

1.2 JUSTIFICATION FOR THE STUDY

Amphibians are crucial to our ecosystems as both predator and prey, playing a significant role in controlling the population of insects and maintaining ecological balance. They also act as bio-indicators, reflecting the health of environment due to their sensitivity to changes such as pollution, habitat destruction and climate fluctuations. With the global decline in amphibian populations, understanding their feeding habits is essential for biodiversity conservation and ecological management. This study focuses on the amphibians around the University Of Benin environment, aiming to fill gaps in local ecological knowledge and provide data that could support conservation efforts and enhances awareness of their ecological importance.

1.3 AIM AND OBJECTIVES

The aim of my study is to analyze the diet of the anurans recovered from Faculty of Life Sciences and Department of Anatomy of the University of Benin, Benin City.

1.3.1 OBJECTIVES

i. Collection and analysis of the gut content from the frogs and toads captured around the Faculty of Life Science and the Department of Anatomy, within the University of Benin using the stomach-flushing method.
ii. Classifying the diet by identifying the prey and categorizing them into groups.
iii. Understanding the influence of habitat on what frogs eat, from wet or dry places.
iv. Evaluation of different species and their diet difference.

CHAPTER TWO

LITERATURE REVIEW

Amphibians generally are voracious feeder. They take mainly insects like beetles, termites, flies, grasshoppers, butterflies, moths, bugs, earwigs, dragonflies and also their larvae, and so on, they also feed on small mammals, small birds, snakes, other frogs, basically anything they can capture and overpower. Amphibians feeding is heavily influenced by the climatic changes, intraspecific competition, seasonal changes and so on. Amphibians are greatly diversified feeders and this makes them control agents in agricultural areas (Duellman and Trueb, 1994; Attademo *et al*., 2005). The various species of anurans are doing the same kinds of things in all parts of the world. That is, they live in areas characterized by both vegetative cover and open patches (these are often disturbed areas), are generally nocturnal, and feed on ground-dwelling arthropods (Raymond D. Clarke, 2013).

2.1 Method of Stomach Content Collection

In 1974, Raymond D. Clarke examined the stomach content of toads to understand their feeding habits using dissecting method for stomach content extraction. During the summer of 1968, 108 *Bufo woodhousei fowleri* were captured, generally between 19:00-02:00hour EST, in and around New Haven, Conn. Immediately after capture, each individual was anaesthetized with 10% ethanol, and the stomach was injected through the body wall with 10% formalin. The following day the stomachs were removed and stored in 70% ethanol (Ednilza *et al*., 1999; Ogoanah and Uchedike, 2011; Onadeko 2011; Thigpen *et al*., 2016). Each stomach was labeled with a serial number so that the contents could be related to the time of capture, size of toad, sex and location. The toads ranged in snout-vent length from 18.5 to 65 mm

Another method of extraction was used by Noemi Balint *et al*., in 2010 to study the diet of anura Ranidae. It took place on the 23th of May 2009, in Ţicleni, Gorj County, Romania, lying in the Valley of Coiana Stream, being surrounded by Subcarpathian Hills between Jiu and Gilort Rivers (at North), and Getic Heights (at South). The Coiana Stream is the main water flow in the city, which water is not potable and its quality is influenced by the crude oil exploitation. They analyzed 31 individuals of Marsh Frog captured by hand or using nets with handle at daylight. Their stomach contents were obtained using the stomach flushing method (Petrozzi, 2021). The stomach contents were collected immediately after capturing, due to rapid prey digestion in amphibians (Caldwell, 1996). To start stomach flushing the frogs, a spatula or a feather weight forceps was used to gently open the frogs´ mouth. Thereafter, the mouth of the frog was fixed with a finger when inserting a soft, flexible tube attached to a syringe (Mahan and Johnson, 2007). The tube was introduced through the frogs' esophagus into the stomach. Different syringe was used with different size of frogs. The frog was placed on a petri dish. The frog will then throw up and the stomach content was collected. The flushed stomach content was then poured into a petri dish. The method was repeated until only water came out from the frog stomach, typically this was made three to four times. All frogs were released within one hour at their capture site to minimize stress for the animals (Muhamad Affan 2018), no animals were killed or damaged during the stomach-flushing procedure, and all individuals appeared in good conditions when released (Petrozzi *et al*., 2021).

2.2 Food and Feeding Habit in Toads

According to Clarke, all species of the genus Bufo are doing the same thing all around the world. He took out his study during the summer of 1968, 108 *Bufo wood-housei fowleri* were captured, generally between 19:00-02:00hr EST, in and around New Haven, Conn. Stomach content collection was by dissection as seen in Onadeko (2011), Ogoanah (2011) and Thigpen (2016). Each stomach was labeled with a serial number so that the contents could be related to the time of capture, size of toad, sex and location. In this Bufo species, adult beetles and ants were each found in much larger proportions of the stomachs (0.95 and 0.93) than the three next most common prey types: spiders (0.35), harvestmen (0.33) and bugs (0.31). Furthermore, ants and beetles numerically represented 0.808 of all the food items whereas the two next most abundant prey (harvestmen and lepidopterous larvae) represented only 0.968 of all the food items. Although ants formed a greater proportion of the total prey number than beetles (0.484 vs. 0.324), the latter undoubtedly represented a greater proportion of the ingested biomass because of their greater average size. Furthermore, beetles formed a more consistent component of the stomach contents of the Bufo species examined.

In 2003, Jelka *et al*., analyzed prey items in 142 preserved adult specimens which were collected from restricted areas of Mount Avala near Belgrade, Serbia. Prey volume of 142 toad stomachs were counted and observed in 100 stomachs. Most abundant prey were adult coleopterans followed by Diplopoda and Hymenoptera from Serbia. According to their report, the composition of the diets of males and females was not very different. Under the same study, among the European populations of common toads, coleopterans were the dominant prey type in samples from Great Britain, Poland, and central part of Bulgaria. Hymenopterans predominated in samples from Spain, France, Belarus, Hungary, and the eastern part of Bulgaria. This report suggests that the diet of the common toads is defined by the prey availability more than by active choice.

There were no significant differences found between juvenile and adult toads in the research done by Yassir *et al*. (2016). During his research, samples were collected from around ponds in the agricultural lands in Shendi, River Nile State, Sudan, North Africa during dry season (October 2014 – January 2015) and rainy season (August – mid September 2014). Specimens collected from site were transferred immediately to the laboratory and sacrificed using chloroform. During the dry season, 75 toads were captured while in rainy season 78 toads were captured, making it 153 toads in total. Snout vent length was measured and was observed to be a little different dry season between juvenile, males and females. All toads had prey in their stomach and were identified in 10 orders belonging to the phylum Arthropoda.

Petrozzi *et al*. (2021) did their research on the trophic ecology of 2 adult Bufonidae species - African common toad (*Sclerophrys regularis*) and Hallowell's toad (*Sclerophrys maculata*) in urban environments. They studied the food habits of African common toad in Lome (toogo), contonou (benin) and ikeja (Nigeria) and the Hallowell's toad in port harcourt andikeja (both in Nigeria). Sites with similar characteristics were selected during the specimen collection to minimize the effects of local habitat on the diet composition. Collection of stomach content were obtained from individuals found as roadkills and from stomach flushing in night surveys. Collected both in wet season (April – September; 2010-2020) and dry season (October – March; 2010-2020). Sticky traps, sweep-net sampling was used to determine arthropods abundance in Port Harcourt and Cotonou. The food contents of 146 toads including 46 *S. maculata* from Port Harcourt, 33 *S. regularis,* 283 from Cotonou, 13 *S. maculata* and 13 *S. regularis* from Ikeja (all inhabiting the same microhabitat and thus 284 being strictly sympatric) and 41 *S. regularis* from Lomé were examined. Across the 4 cities, Formicidae and Oligochaete were by far the main food items (26.7%), followed by coleopteran adults (15.8%) and coleopteran larva (14.4%); other prey categories were relatively rare. The diet composition of the *S. maculata* and *S. regularis* in Ikeja did not differ significantly and consisted mainly of Formicidea. In both male and female of the 2 species, diet composition was relatively similar in all sites though females had a wider niche breath than male.

2.3 Food and Feeding Habit in Frogs

Toshiaki Hirai in 2004 did his research on the diet composition of *Rana limnocharis* in japan. The study site is a sandbar of the Kizu River, which runs between Kyotanabe City and Jyoyou City, Kyoto Prefecture, Japan. The sandbar is inundated several times within a year, especially during the rainy season (June to mid July) and the typhoon season (late August to September). After inundation, a number of temporal pools emerged near the shore, and foraging frogs were observed around there. Irrespective of species, frogs were captured at night usually for two hours (21:00-23:00hr) because frogs are basically nocturnal predators. In order to examine seasonal variation in diet, samplings were conducted twice a month from June to October 1998. Forced regurgitation with forceps were used for stomach extraction unlike like dissecting (Clarke 1974; Ednilza *et al*., 1999; Ogoanah and Uchedike, 2011; Onadeko 2011; Thigpen *et at*., 2016), this was seen to cause no harm to the frogs because they were seen jumping around in bushes freely after extraction of stomach content. Toshiaki Hirai captured a total of 86 individuals of *Rana limnocharis*, 18 of *R. nigromaculata*, 3 of *R. catesbeiana*, and nine of *Hyla japonica*, 17 adults of *R. limnocharis* had empty stomachs, and 12 juveniles were too small for forced regurgitation of stomach contents, and 1404 identified prey individuals. Collembolans were the most frequent frequently consumed prey, making up 79.8% of the total. By the volume, no sinlge prey dominated but Dermapterans, orthopterans, caterpillars, and earthworms were important contributors. Seasonal variation played a role, as collembolans became most dietary component in late august due to their population explosion in the habitat. Their diet was largely terrestrial with aquatic prey being minor component.

In 2007, Mahan and Johnson studied the diet of gray treefrog (*Hyla versicolor*) in the Baskett Wildlife Research Area in Boone County, Missouri, comparing the diet of frogs captured at the breeding ponds and in the artificial arboreal refugia. They recorded a total of 526 captures of 308 individuals from 13 June until 15 July 2004, of which they stomach-flushed 107 individuals and 76 containing stomach contents. The result showed that hymenopterans (14.2% of stomach content) and beetles (29.6% of stomach content) were the most common prey item, there was no aquatic prey species identified. Their result suggested that treefrogs primarily forage in terrestrial habitats rather than in breeding ponds.

Balint *et at*., in 2010 did there research on on the diet of the *Pelophylax ridibundus* where the most abundant prey item was Heteropteans, Coleopterans, Araneida, Carabida. Their study took place on the 23th of May 2009, in Ţicleni, Gorj County, Romania. Sample collection was done by hand or using nets with handles, at daylight. Thirty one marsh frogs were captured and stomach flushing method was used to obtain stomach content with no stomach being empty. This research confirmed that marsh frogs even when aquatic tend to feed majorly on terrestrial preys.

In 2011, Ogoanah *et al*., did their research on the diet of *Hoplobatrachus occipitalis*, the edible frog. They collected 104 specimens between November 2009 and May 2010 from Benin City to determine the feeding behaviour and food preference of H. occipitalis. Specimens captured were dissected to assess their stomach contents. A total of 701 prey items in 16 prey categories were recorded with 49% empty stomachs most likely due to food availability in the environment. Most prey items were terrestrial invertebrates although two vertebrates – a rodent and an amphibian were also recorded in stomachs of seven *Hoplobatrachus occipitalis* revealing their cannibalistic tendency. The most abundant stomach contents were Trichoptera (50.37%)

and Hymenoptera (21.27%). Although the feeding pattern of *H. occipitalis* is continuous, the large presence of Trichoptera shows it is most active at night.

In 2016, Thigpen *et al*., analyzed stomach contents of 120 Green Tree Frogs, *Hyla cinerea*, collected between May 1956 and October 2014 in Arkansas. Of the 120 stomachs examined, 74 (62%) contained food items of which beetles and arachnids were the predominant prey item. Many stomachs also contained multiple items of animal matter and plant matter and often contained several individuals of each order. Animals were identified in 56 of the stomachs. Plant material was identified in 2 of the 42 stomachs containing vegetable matter; plants may have be ingested during times of low prey abundance as seen by Silva et al. (1989) as a means to supplement the diet. Overall, the diet of Green Tree Frogs in Arkansas is similar to the diets of Green Tree Frogs in other areas. Spiders and beetles were commonly found in frog stomachs in other studies (Haber 1926, Kilby 1945, Freed 1982, Meshaka 2001, and Leavitt and Fitzgerald 2009) and were also a common prey item in this study.

Ajibola *et al*., in 2016 evaluated the food and feeding habit of *Hoplobatrachus occipitalis* in four locations at Obafemi Awolowo University, Ile-Ife. Specimens were collected weekly with the aid of a torch light and dip-net, between the hours of 23:00 and 02:00 GMT; this is the period when the highest activity of the species was observed. Collection was carried out weekly from April to November, 2014. No sampling site was visited more than once in thirty days to avoid stomach flushing the same specimen more than once a month as the specimens were not tagged before being returned to their provenance location. A total of 158 adult frogs were studied, with 92.41% of the specimens containing food in their stomach and 7.59% having empty. A total of 854 prey items were recovered with hymenopterans being the most abundant as seen in the work done by Ogoanah *et al*., 2011, followed by the Phylum Annelida represented by the Order

Oligochaeta (Earthworms) and the Order Isoptera. Other prey included the Order Coleopteran, Order Diptera, Order Hemipteran, Order Lepidoptera and Order Odonatan. The presence of a wide variety of prey items suggests an opportunistic feeding behavior. This frog captures all the moving preys which have a suitable size for consumption (Balint *et al*., 2010).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This study was carried out in the Faculty of Life Sciences towards Anatomy of the University of Benin, Ugbowo Campus, Benin City, Edo State, Nigeria in June, July, September and December, 2024. The area lies between latitude 6^{o}39'71'' and 6^{o}23'49''N and longitude 5^{o}61'53'' and 5^{o}37'24''E. The climate condition is usually tropical and it is divided into two seasons which are wet (March to October) and dry (November to February) with a temperature ranging from 23-30ºC. The area is prominent with grasses, pothole, trees and shrubs.

3.2 Collection of specimens

Anurans were captured and set free after stomach-flushing on site causing no harm to the anurans. Capturing of anurans was done by hand at night between 8pm to 11pm using a flashlight.

3.3 Stomach-flushing; materials and method

The flushing set I used consisted of a container, a syringe (20ml), an infusion tube and a container filled with water from potholes, which I used as a flushing solution. After capturing an anuran, the infusion tube attached to the syringe was used to draw water into the syringe for flushing. The infusion tube was inserted into the mouth of the anuran and pushed deep into the esophagus reaching the stomach. The entire syringe content was flushed into the stomach causing the anuran to regurgitate its undigested food into the container. The stomach content was transferred into a sample bottle that has been labelled for later analysis.

3.3 Prey items Preservation

Little amount of formalin was introduced into the sample bottle with stomach content immediately on site. The 4% of formalin was used in the preservation of the stomach content.

3.4 Specimens identification, measurement and gut content examination

On the field, anurans were identified using protocols of Schiotz (1963) and Rodel (2000). Preserved prey items were put in a petri dish and analyzed under a dissecting microscope.

3.5 Data Analysis

The abundance of various preys was estimated from the stomach contents (percentage of the total number of individual prey/total number of all prey). Frequency of occurrence was determined by dividing the number of stomach that contained a particular prey by the total number of stomach with prey. Thereafter, food groups were classified as constant when extracted from > 50% of stomachs, secondary when present in 25 to 50% of stomachs or accidental when present in < 25% of stomachs (Dajoz, 1983).

Diet diversity was estimated with Shannon–Wiener diversity index (H) (Margurran, 1988).

$$H = \sum_{1=1}^{5} \left[\left(\frac{ni}{n} \right) \ln \left(\frac{ni}{n} \right) \right]$$

Where n*i* is the number of prey category I and N is the total number of prey.

The rate of feeding activity was estimated as the percentage of stomach containing food with respect to the total number of stomachs examined (Sala and Ballesteros, 1997).

$$\text{Rate of feeding activity} = 100n/N$$

Where: n is the number of stomach with food; N is the total number of stomachs examined.

Analysis of variance was used to analyze the differences in the dietary content of *H. occipitalis*, *Sclerophyrs maculata* and *Ptychadena pumilio*

Dietary overlap (DO) index (Pianka, 1976) was used in calculating for checking for dietary overlap between the *H. occipitalis*, *Sclerophyrs maculata* and *Ptychadena pumilio*

$$DO = \sum P_{ij} \sum P_{ik} / \sqrt{\sum P_{ij}^2 \sum P_{ik}^2}$$

where; P_{ij} = proportion of prey category *i* in the diet of predator *j*

P_{ik} = proportion of prey category *i* in the diet of predator *k*.

Dietary overlap values range from 0 to 1, with 0 indicating no overlap and 1 indicating complete overlap.

CHAPTER FOUR

RESULT

During the course of my study a total of sixty two (62) specimens were captured, comprising of; forty four (44) specimens of *Sclerophyrs maculata*, five (5) specimens of *Ptychadena* (*P. oxyrhynchus and P. pumilio;* with only *P. pumilio* having stomach content.) and thirteen (13) specimens of *Hoplobatrachus occipitalis* – and their dietary composition were analyzed. Prey items recovered during this study were identified to their Order level and a total of eleven (11) different Orders and insect parts were seen, and nine (9) stomachs were observed to be empty. A total of 207 consumed prey items were recovered and was grouped into 11 categories. Insect parts was also a part of the stomach content obtained and some stomachs were recorded as empty. One hundred and forty two (142) prey items were recovered from the stomachs of thirty nine (39) specimens of *Sclerophyrs maculata*, three (3) prey items were recovered from the stomachs of five (5) specimens of *Ptychadena pumilio* and twenty three (23) prey items were recovered from the stomachs of thirteen (13) specimens of *Hoplobatrachus occipitalis.*

4.1 DIET COMPOSITION:

Most of the stomach flushed had prey content in it consisting of; insect parts, unidentified insect larvae, various orders under the Class Insecta (Order Coleopteran, Order Dictyoptera, Order Diptera, Order Hemipteran, Order Hymenoptera, Order Isopoda, and Order Orthoptera), one Order from the Class Arachnida (Order Araneae), one Order from Class Amphibian (Order Anura), one Order from Class Diplopoda, and One Order from the Class Gastropoda.

In *Sclerrophyrs maculata* which had the largest number of specimens and highest number of stomach content, the prey individuals were represented in 4 Classes; Class Arachnida, Class Insecta, Class Gastropoda and Class Diplopoda. There were evident insect parts also found when I was analyzing their stomach content. Orders like; Order Diptera, and Order Anura were not represented in the *Sclerophyrs maculata* specimens captured during my study.

The *Hoplobatrachus occipitalis* had a total of twenty three (23) prey items which were gotten from 11 stomachs because two specimen's stomachs were empty. The Classes represented in the diet of *Hoplobatrachus occipitalis* were Class Arachnida, Class Amphibian, and Class Insecta (Order Coleoptera, Order Diptera, Order Hemiptera, Order Hymenoptera, and Order Orthoptera). There were also insect parts found in *H. occiptalis* just like in *Sclerophyrs maculata*.

Ptychadena pumilio had the lowest amount of specimens hence their prey items were small. The total amount of prey items collect from the ptychadena captured were only three, falling under the Class Insecta; Order Isopoda, and Orthoptera – insect parts were also found.

4.1.1a Abundance of prey items in *Ptychadena pumilio*

Prey items distribution *in Ptychadena pumilio* are evenly distributed in all Orders and insect part – these Orders are Order Isopoda, Order Orthoptera and unidentifiable insect parts were also evident (0.48%).

4.1.1b Abundance of prey items in *Hoplobatrachus occipitalis*

The most abundant Order in diet of the *H. occipitalis* is the Order Hymenoptera which took up 4.83% of the overall stomach content, was found across 5 stomachs of captured prey.

4.1.1c Abundance of prey items in *Sclerophyrs maculata*

The most abundant in *S. maculata* is also the Hymenoptera, taking up 68.60% of stomach content, was observed in twenty nine (29) stomachs of these *S. maculata*.

4.1.2 Overall abundance of prey items

Overall abundance of prey items indicated that the most abundant prey item belonged to the order Hymenoptera (73.43%), while the least represented orders were; Dictoptera, and Diptera; and Class Diplopoda and Class Gastropoda, all 0.48%.

Table 1: Distribution of prey items in specimens and diversity indices

Host (n=62)	**Number of specimens**	**Number of specimens with content**	**Percentage composition (%)**	**Total number of prey items**	**MI ± SE**	**Range**
Sclerophyrs maculate	44	39	88.64	181	4.64 ± 0.67	1 – 21
Hoplobatrachus occipitalis	13	11	84.62	23	2.09 ± 0.17	1 – 3
Ptychadena pumilio	5	3	60.00	3	1.00 ± 0.00	1 – 1
Total	62	53	85.48	207	7.73 ± 0.84	
Shannon-wiener index	0.41					
Evenne index	0.37					

Plate 1: Picture showing *Sclerophyrs maculata*

Source: Iwinosa (2024)

Plate 2: Picture showing *Ptychadena sp.*

Source: Iwinosa (2024)

Plate 3: Picture of a *Hoplobatrachus occipita*

Soure: Iwinosa (2024)

Table 2: Abundance of prey items in the sampled specimens

Host species	**Class**	**Order**	**Number of specimens**	**Frequency**	**% abundance**
Ptychadena pumilio	Insecta	Isopoda	1	1	0.48
		Orthoptera	1	1	0.48
	insect parts		1	1	0.48
Hoplobatrachus occipitalis	Arachnida	Araneae	3	5	2.42
	Insecta	Coleoptera	1	2	0.97
		Diptera	1	1	0.48
		Hemiptera	1	2	0.97
		Hymenoptera	5	10	4.83
		Orthoptera	1	1	0.48
	Amphibians	Anura	1	1	0.48
	insect parts		1	1	0.48
Sclerophyrs maculata	Arachnida	Araneae	2	2	0.97
	Diplopoda		1	1	0.48

	Insecta	Coleoptera	5	6	2.90
		Dictyoptera	1	1	0.48
		Hemiptera	2	6	2.90
		Hymenoptera	29	142	68.60
		Isopoda	5	8	3.86
		insect larvae	1	1	0.48
		Orthoptera	2	3	1.45
	Unidentified Insect larvae		1	1	0.48
	Insect parts		9	9	4.35
TOTAL				207	99.50

Table 3: Overall abundance of prey items in sampled specimens

Class	**Order**	**Frequency of prey item**	**Percentage of abundance (%)**
Amphibia	Anura	1	0.48
Arachnida	Araneae	7	3.38
Diplopoda		1	0.48

Gastropoda		1	0.48
Insecta	Coleoptera	8	3.86
	Dictyoptera	1	0.48
	Diptera	1	0.48
	Hemiptera	8	3.86
	Hymenoptera	152	73.43
	Isopoda	9	4.35
	Orthoptera	5	2.42
Unidentified Insect larvae		1	0.48
Insect parts		11	5.31
TOTAL		207	99.49

4.2 Frequency of occurrence of prey items

The prey items found in the stomach of *Ptychadena pumilio* are all distributed equally, each order of the class insecta having one prey item each and unidentifiable insect parts – with a frequency of 0.33 for each prey order.

In *Hoplobatrachus occipitalis*, the most frequent prey item is the Araneae with a frequency of 0.27. The least frequent prey items were Anura, Coleoptera, Hemiptera, Diptera, Orthoptera, and Hymenoptera having 0.09 frequency each.

In *Sclerophyrs maculata*, the most frequent prey item across the stomach of the captured specimens was Hymenoptera with a frequency of 0.74 – Hymenoptera was present in 29 stomach contents of the specimens. The least frequent ones were Class Diplopoda, Class Gastropoda and Order Dictyoptera which frequency were 0.03.

4.2.1 Overall frequency of prey items

The most frequent prey item found during my study was Hymenoptera, occurring in thirty four (34) out of the fifty three (53) stomachs with content with a frequency score of 0.64, while the least frequent prey item were Class Diplopoda, Class Gastropoda and Order; Anura, Diptera, Dictyoptera, and insect larvae, with a frequency score of 0.02 each (Table 4.5).

Table 4: Frequency distribution of prey items

Host	**Class**	**Order**	**Number of stomach**	**Frequency**
Ptychadena pumilio. (n=3)	Insecta	Isopoda	1	0.33
		Orthoptera	1	0.33
		insect part	1	0.33
Hoplobatrachus occipitalis (n=11)	Arachnida	Araneae	3	0.27
	Amphibia	Anura	1	0.09
	Insecta	Coleoptera	1	0.09
		Diptera	1	0.09

		Hemiptera	1	0.09
		Hymenoptera	1	0.09
		Orthoptera	1	0.09
Sclerophyrs maculata (n=39)	Arachnida	Araneae	2	0.05
	Diplopoda		1	0.03
	Gastropoda		1	0.03
	Insecta	Coleoptera	5	0.13
		Dictyoptera	1	0.03
		Hemiptera	2	0.05
		Hymenoptera	29	0.74
		Isoptera	5	0.13
		Orthoptera	2	0.05
	Insect parts		9	0.23
	Unidentified Insect larvae		1	0.03

Table 5: Frequency distribution of prey items (Total number of stomachs with food = 53)

Class	**Order**	**Number of stomach recovered**	**Frequency**

Amphibia	Anura	1	0.02
Arachnida	Araneae	5	0.09
Diplopoda		1	0.02
Gastropoda		1	0.02
Insecta	Dictyoptera	1	0.02
	Diptera	1	0.02
	Coleoptera	5	0.09
	Hemiptera	3	0.06
	Hymenoptera	34	0.64
	Isopoda	6	0.11
	Orthoptera	4	0.08
insect part		11	0.21
Unidentified insect larvae		1	0.02

4.3 Food groups

In *Ptychadena pumilio* all species had an equal percentage of 33.33% which is considered to be in a secondary food group.

In *Hoplobatrachus occipitalis*, the highest food group is the secondary food group and the only order of this secondary food group is araneae with 27.27%. The other prey items fell under the accidental group.

In *Sclerophyrs maculata*, the highest food group is the constant food group seen in the Hymenoptera with a percentage of 74.35% and every other prey item fell under the accidental food group.

Table 6: Food groups across each species

Host	**Category**	**Order**	**Percentage (%)**
Ptychadena pumilio. (n=3)	Secondary	Isopoda	33.33
	Secondary	Orthoptera	33.33
	Secondary	unidentified insect part	33.33
Hoplobatrachus occipitalis (n=11)	Secondary	Araneae	27.27
	Accidental	Anura	9.09
	Accidental	Coleoptera	9.09
	Accidental	Diptera	9.09
	Accidental	Hemiptera	9.09
	Secondary	Hymenoptera	45.45
	Accidental	orthoptera	9.09
	Accidental	unidentified insect part	9.09
Sclerophyrs maculata (n=39)	Accidental	Araneae	5.12
	Accidental	Dictyoptera	2.56
	Accidental	Coleoptera	12.82

	Accidental	Hemiptera	5.12
	Constant	Hymenoptera	74.35
	Accidental	Isopoda	12.82
	Accidental	Orthoptera	5.12
	Accidental	Diplopoda	2.56
	Accidental	Gastropoda	2.56
	Accidental	unidentifiable insect larvae	2.56
	Accidental	unidentifiable insect part	23.07

4.3.1 Overall food groups

During my study, the overall highest food group is the accidental group seen in all orders except the Order Hymenoptera which had a percentage of 64.15%, hence making a constant food group for these species.

T1able 7: Overall food group

Category	**Order**	**Percentage (%)**
Accidental	Anura	1.88
	Araneae	9.43
	Spirostreptida	1.88
	Stylommatophora	1.88
	Coleoptera	1.88

	Dictyoptera	1.88
	Diptera	1.88
	Hemiptera	5.66
	Isopoda	11.32
	Orthoptera	7.54
	insect part	20.75
	Unidentified insect larvae	1.88
Constant	Hymenoptera	64.15

4.4 Rate of Feeding Activities

Rate of feeding activity was highest in *Sclerophyrs maculata* with 88.64%, followed by *Hoplobatrachus occipitalis* with 84.62% and *Ptychadena pumilio* with 60.0% (Table 10). The rate of feeding is directly proportional to the number of stomachs with food content. The smaller the number with food content, the lower the rate of feeding. The higher the number with food content, the higher the rate of feeding.

4.4.1 Overall rate of Feeding Activities

Overall, the rate of feeding in this study is 85.48% with fifty-three (53) out of the sixty two (62) stomachs examined having food content.

Table 8**: Rate of feeding activities**

Figure 6: A chart showing the overall food group

Host species	**Rate of feeding activity (%)**
Sclerophyrs maculate	88.64
Hoplobatrachus occipitalis	84.62
Ptychadena pumilio	60.00

Table 9: Distribution of prey items across the stomachs of *Ptychadena pumilio, Sclerophyrs maculata* and *Hoplobatrachus occipitalis*.

Prey items	***Sclerophyrs maculata***	***Hoplobatrachus occipitalis***	***Ptychadena pumilio***
Anura	-	+	-
Araneae	+	+	-
Spirostreptida	+	-	-
Stylommatophora	+	-	-
Coleoptera	+	+	-
Dictyoptera	+	-	-
Diptera	-	+	-
Hemiptera	+	+	-
Hymenoptera	+	+	-
Isopoda	+	-	+

Orthoptera	+	+	+
Unidentified Insect larvae	+	-	-
Insect parts	+	+	+

The '+' sign indicates that the prey item is present in the specimens stomach while '-' sign indicates the absence of the prey item in question.

4.5 Dietary overlap

Across the three species observed during this study the only prey item found in all is from the Order Orthoptera. Four prey items (Order; Coleoptera, Araneae, Hemipteran and Hymenoptera) were found across two species, *Sclerophyrs maculata* and *Hoplobatrachus occipitalis* while one prey item was seen in only *Sclerophyrs maculata* and *Ptychadena pumilio*, Order Isopoda. Hence, the dietary over between *Ptychadena pumilio* is zero (0), *Sclerophyrs maculata* is one (1.0) and *Hoplobatrachus occipitalis* is one (1.0).

Table 10: Dietary overlap in the prey items of *Sclerophyrs maculata, H. occipitalis* and *Ptychadena pumilio*

Comparative host species	**DO Score**
Sclerophyrs maculate	1.00
Hoplobatrachus occipitalis	1.00
Ptychadena pumilio	0.00

CHAPTER 5

DISCUSSION

The food and feeding habit of anurans have been studied previously by several researchers. During the course of my study, the collection of my specimen took place from the month of; June, July, September and December – September, considered the start of dry season. The sampling carried out in the faculty of life science towards the faculty of life science resulted to 62 anurans captured. For these specimens captured, stomach flushing was used to acquire the stomach content and the prey items collected from the stomach content was a total of two hundred and seven (207); three (3) in *ptychadena pumilio*, twenty three (23) in *H. occipitalis* and a hundred and eighty one (181) in *Sclerophyrs maculata*. The difference in the stomach content of the captured specimens might be attributed to a number of factors including; number of specimens captured, the method of acquiring food 'the sit-and-wait' (Onadeko 2011; Ogoanah et al., 2011). Another factor may be the time interval between when specimens were caught and when the digestive system was flushed for prey items, and if the specimen had not consumed any food at the time of capture. More *Sclerophyrs maculata* were captured followed by the *H. occipitalis* and the least is *Ptychadena pumilio*. Noticeable differences were observed in the feeding habit of these specimens where *Sclerophyrs maculata* preferred Hymenoptera and *Hoplobatrachus occipitalis* preferred Araneae and these two orders were not observed in the stomach of *Ptychadena pumilio*. Most anuran species are sit-and-wait predators that consume relatively large preys such as large coleopterans, orthoptera, and dictopterans (Hickman et al, 2001). Their feed consists mainly of insects and other member of the phylum Arthropoda. Most species are generalist or opportunistic feeders that take prey roughly in proportion to their abundance in the habitat (Houston, 1973; Blackith and Speight, 1974). Results from the examination of prey items abundance in the overall stomach was highest in Hymenoptera, having the highest percentage with 73.43%. The least prey item abundance were observed in Anura, Spirostreptida, Stylommatophora, Dictyoptera, Diptera, and insect part, all with a percentage of 0.48%. As a result of the sit-and-wait attitude in these species, some species may have waited for a long duration of time to capture prey that may not even be readily available. This may have contributed to the empty stomach observed during this study (Onadeko 2011). The presence of a wide variety of prey items in *Sclerophyrs maculata* suggests an opportunistic feeding behavior. This frog captures all the moving preys with a suitable size for consumption (Balint et al., 2010). Some stomachs in *Sclerophyrs maculata* and *H. occipitalis* contained multiple prey items of animal matters. This is similar to the reports of Thigpen *et al*. (2016).

In *Ptychadena pumilio,* there was no most or least abundant prey items because the only prey items recovered were Isopoda and Orthoptera both with a percentage of 0.48%. Isopoda (3.86%)

and Orthoptera (1.45%) were recorded in *Sclerophyrs maculata*, other prey items were Araneae, Hymenoptera, Coleopteran, Dictyoptera, Spirostreptida, Stylommatophora, Hemipteran, and insect larvae (0.97%, 68.60%, 2.90%, 0.48%, 0.48%, 0.48%, 2.90% and 0.48%; respectively), making Hymenoptera the most abundant and followed by Isopoda then Coleoptera and Hemipteran, and the least abundant were, Dictyoptera, Spirostreptida, Stylommatophora, and insect larvae. In *H. occipitalis*, the most abundant prery item is Hymenoptera (4.83%), followed by Araneae (2.42%), Coleopteran and Hemipteran both with a percentage of 0.97% - the least abundant were Anura and Diptera both with 0.48%. Overall, the most abundant prey item was Hymenoptera (73.43%). This is similar to the report of Hirai and Matsui (2000), Ajibola *et al*. (2016) and Sulieman *et al*. (2016), but contrast with the report of Cicek and Mermer (2006), where Coleoptera were the most abundant prey items. Also, this contrast with the reports of Ogoanah and Uchedike (2011), where Trichoptera and Orthoptera where the respective most abundant prey items in their report. However, the position of Hymenoptera as a top prey item which basically comprises ants could be as a result of their ease of consumption being creeping insects, which makes them within reach of the frogs and they are readily available in the environment where these frogs forage (Maneyro and da Rosa, 2004). In some other studies where they were not the most abundant, they were the second most abundant (Ogoanah and Uchedike, 2011).

The most frequent identifiable prey item in *Ptychadena pumilio* was both Isopoda and Orthoptera both with a frequency of 0.33. That of *H. occipitalis* was Araneae with s frequency of 0.27% while *Sclerophrys maculata* was Hymenoptera (0.74). However, the overall most frequent prey item was Hymenoptera having a frequency of 0.64. This is consistent with the reports of

Sulieman *et al*. (2016), but contrast with the report of Cicek and Mermer (2006) where Coleoptera was the most frequent prey item.

In *Ptychadena pumilio*, the highest food group was secondary with both Isopoda and Orthoptera were both with 33.33%, while *H. occipitalis* and *Sclerophyrs maculata* had the accidental group as their highest food group, both having their majority food group less than 25%. However, the overall highest food group across the three *specimens* was accidental group, with only Hymenoptera food group being constant with 64.15% of all the stomach with food and the highest among the prey items. This contradicts the report by Ogoanah and Uchedike (2011) where they had secondary group representing Hymenoptera along with plant parts constituted the highest food group.

There was only one prey item reported across the three species of the stomach, the Orthoptera and insect parts, signifying the dietary overlap. However, this narrative could have be altered if the species were not collected in close proximity and the prey items far supersede the number of frogs that feed on them, which is often the case.

CONCLUSION

During my study, the dominant group of prey items was insects with 88.88% and was recovered from both *Sclerophyrs maculata* and *H. occipitalis*. *Sclerophyrs maculata* accounted for the species with the most diverse prey items (9). The overall most abundant prey item was Hymenoptera, as well as the most frequent prey item. Although *S. maculata* recorded a constant prey item (Hymenoptera), the highest food group overall was accidental, represented by every other prey item. There were dietary overlaps between *H. occipitalis* and *S. maculata* (1.0).

REFERENCE

Balint, N., Indrei, C, Ianc, R. and Ursuţ, A. 2010. On The Diet of the *Pelophylax ridibundus* (Anura, Ranidae) in Ţicleni, Romania. South Western Journal of Horticulture, Biology and Environment 1 (1): 57-66. Bwong, B. A. and Measey, G. J. 2

Basoglu, M. and Özeti, N. 1973. Türkiye amfibileri, E.Ü. Fen Fakültesi, Kitaplar Serisi No: 151, Bornova, Izmir.

Blackith, R.M. and Speight, M.C.D. 1974. Food and feeding habits of the frog *Rana temporaria* in the west of Ireland. J. Zool., Lond. 172: 67-79.

Caldwell, J. P. (1996): The evolution of myrmecophagy and its correlates in poison frogs (Family Dendrobatidae). Journal of Zoology 240: 75-101.

Chanda S. K. 1993, Food And Feeding Habits Of Some Amphibian Species Of Northeast India. Rec. zool. Surv. India, 93 (1-2) : 15-29.

Clarke, R.D. 1974. Food habits of toads, genus Bufo (Amphibia: Bufonidae). American Midland Naturalist 91:140–147.

Duellman W. E. and L. Trueb. 1986. Biology of Amphibians. McGraw-Hill (USA). Food and Feeding; 229-238.

Emerson, S. B. (1985). Skull shape in frogs—correlations with diet. Herpetologica, 41, 177–88.

Freed, A. N. (1982). A treefrog's menu: selection for an evening's meal. Oecologia, 53, 20–6.

Hirai T (2004) Diet composition of introduced bullfrog, Rana catesbeiana, in the Mizorogaike Pond of Kyoto, Japan. Ecological Research 19, 375–380.

Houston, W. W. K. (1973): Food of Common Frog, *Rana temporaria*, on High Moorland in Northern England. Journal of Zoology 171: 153-165.

Inger, R.F. & Stuebing, R.B. (2005). A Field Guide to the Frogs of Borneo (second edition). Natural History Publication (Borneo), Kota Kinabalu. 133pp.

Kilby JD. 1945. A biological analysis on the food and feeding habits of two frogs, *Hyla cinerea* and *Rana pipiens sphenocephala*. Quarterly Journal of the Florida Academy of Sciences 8: 71- 104.

Ogoanah, S. O. and Uchedike, E. 2011. Diet and feeding behaviour of the edible frog Hoplobatrachus occipitalis (Amphibia: Anura)African Scientist 12: 4

Onadeko, A. B., Egonmwan, R. I. and Saliu, J. K. 2011. Edible Amphibian Species: Local Knowledge of their Consumption in Southwest Nigeria and their Nutritional Value. West African Journal of Applied Ecology 19: 67-76.

Petrozzi, F, Akani, GC, Eniang, EA, Ajong, SN, Funk, SM, Fa, JE, Amadi, N, Dendi, D and Luiselli, L (2021) Generalist, selective or 'mixed' foragers? Feeding strategies of two tropical toads across suburban habitats. Journal of Zoology, 315 (4). pp. 288-300. ISSN 0952-8369

Pianka, E. R. (1976). Dietary overlap index in predator-prey interactions.

Premo, D.B. and Atmowidjojo, A.H. 1987, Dietary patterns of the crab eating frog Rana cancrivora in west Java. Herpetologica 43: 1-6

Rödel, M. O. 2000. Herpetofauna of West Africa. Vol. I. Amphibians of the West African Savanna. Edition Chimaira, Frankfurt, Germany. 335.

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 Progress Series 152: 273-283.

Schiotz, A. 1963. The Amphibians of Nigeria. Videnskabelige Meddelelser fra Dansk naturhistorisk Forening 101.

Silva, H. R. and Britto-Pereira, M. C. (2006). How much fruit do fruit-eating frogs eat? An investigation on the diet of *Xenohyla truncata* (Lissamphibia: Anura: Hylidae). Journal of Zoology, 270, 692–8.

Thigpen, C. S., H. Dodson, and S. E. Trauth. "Food Habits of green frogs (Hyla cinera) from Arkansas". Journal of the Arkansas Academy of Science 70 (1): Article 38.

Toft, C. A. (1980a). Feeding ecology of thirteen syntopic species of anurans in a seasonal tropical environment. Oecologia, 45, 131–41.

Turner, F. B. (1959): An analysis of the feeding habits of Rana p. pretiosa in Yellowstone Park, Wyoming. American Midland Naturalist. 61: 403-413

Tyler, J.D. and Hoestenbach Jr., R.D. 1979. Differences in food of bullfrogs (Rana catesbeiana) from pond and stream habitats in southwestern Oklahoma. Southwest. Nat. 24: 33-38