THE FOOD AND FEEDING HABIT OF GROUND DWELLING ANURANS IN OKOMU OIL PALM PLANTATION

IN OVIA SOUTH-WEST L.G.A., EDO STATE, NIGERIA.

BY

BLESSING ONAIWU

MAT. NO LSC1806194

DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY

UNIVERSITY OF BENIN

BENIN CITY.

SEPTEMBER, 2023.

DEDICATION

I dedicate this project to God Almighty for His unending love, grace and favour towards me.

ACKNOWLEDGMENT

With sincere gratitude, I say a big thank you to my project Supervisor, Mrs. H. J. Ozemoka and Prof. M.S.O. Aisien for their assistance, love and guidance during the course of this project. Thank you so much for impacting in me knowledge in my course of study.

Special thanks to the Head of Department, Prof. M.O. Omoigberale for the constant push and reminder that we can do great things, as long as we set our heart to it.

To my course advisor, Dr. C.O. Asemota thank you so much for being my father in school to always guide, direct and correct me.

My sincere gratitude to my project mates, Joy, Isaac, Rachael, Jeff, Emmanuel, Deborah, Peace and Ruben, I love you all.

A big thanks to Christian Fellowship international (CFI) for their teachings which made me better in upholding my values and beliefs as a Christian and for the constant trainings which made me a better leader.

To my wonderful family, thank you for always being my support and motivation.

Above all, my sincere gratitude to God almighty for His unending love, Protection and provision upon my life, the life of my family, my friends and my tutors.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

A one month (August, 2023) study was conducted in Okomu Oil Palm plantation (an altered rainforest habitat) located in Ovia South-West L.G.A., Edo state Nigeria in order to investigate the dietary and feeding habit of the ground dwelling anurans in the study area. The paucity in available information on the food and feeding habit of ground dwelling anurans from the rainforest ecological zone necessitated this study. The specimens were collected at night using the visual and acoustic sampling technique. They were euthanized by exposure to chloroform in a killing jar, injected and fixed with 10% formalin to arrest digestion and preserve stomach content. The gut contents were introduced into properly labeled vials and their prey items fixed in 70% alcohol for microscopic examination and identification. The dietary composition of 28 ground dwelling anurans belonging to 3 families (Bufonidae, Pipidae and Ranidae), 4 genera (*Sclerophrys, Silurana, Ptychadena and Hoplobatrachus*) and 5 species were recorded. The species encountered included: *Sclerophrys maculata*, *Silurana tropicalis*, *Hoplobatrachus occipitalis*, *Ptychadena bibroni* and *Ptychadena longirostris*. A total of 325 prey items belonging to 8 Orders, were recovered from their stomach of which Hymenoptera had the highest abundance of 92.9%, was the most dominant prey item recorded while the least prey item recorded were Dermaptera, Orthoptera and Geophilomorpha which had the lowest abundance of 0.31% each.

All prey items recovered have been previously reported except Earwig insect which belongs to the order Dermaptera.

Common dietary content recovered from both the male and female anurans were Hemiptera and Hymenoptera, while Coleoptera, Polydesmida, Geophilomorpha, Diptera and Orthoptera were recovered only from the male anurans. However Dermaptera was only found in the female anuran. This study concluded that Anurans diet was influenced by the availability of prey items in the habitat and thus they are generalist feeders.

CHAPTER ONE

Introduction

The name Amphibian comes from a Greek word which means “living a double life”. They are members of the class Amphibia, Subphylum Vertebrata, and Phylum Chordata. The life history of anurans is intricately intertwined with their unique adaptations that enable their survival in habitats ranging from aquatic to terrestrial. The adults equipped with limbs (except order Gymnophiona) and lungs are obligate breeders in standing water bodies, where they lay eggs that undergo metamorphosis into aquatic larvae. These larvae serve as free-living embryos and are equipped with specialized aquatic gills that facilitate respiration underwater. Subsequently, as part of their life cycle, these larvae undergo a remarkable transformation into terrestrial lung-breathing adults, thereby equipping them to thrive on land.

They are a diverse group of cold-blooded vertebrates, which includes frogs, toads, salamanders, newts, and caecilians, they are organized into three primary extant taxa: Anurans (comprising frogs and toads), Caudata (which includes salamanders and newts), and Gymnophiona (encompassing limbless caecilians).

Notably, the order Anura is characterized by the presence of limbs, while the Caudata order possesses both limbs and tails. In contrast, the order Gymnophiona consists of species that are limbless and have evolved for a burrowing lifestyle. Amphibians exhibit a global distribution, with notable exceptions being regions such as Antarctica, remote oceanic islands, and extremely arid deserts. It has a remarkable diversity of approximately 8,679 species which highlights the adaptive success of amphibians in various environments Alari (2012).

The spectrum of Anuran species, which consists of frogs and toads, boasts exceptional diversity and global distribution, with the notable exceptions of Polar Regions, specific oceanic islands, and extremely arid deserts. This expansive group comprises over 7,645 species that span across thirty families. Among these, the largest families are Leptodactylidae, Hylidae, and Ranidae. The size range of anuran species is also impressive, spanning from the minuscule 9.8mm American brachycephalids to the substantial 30cm West African goliath frog.

Anurans are adapted to diverse habitats, including aquatic, terrestrial, and arboreal environments. Among these, terrestrial anurans, often referred to as ground-dwelling anurans, are particularly fascinating due to their ability to adapt to a life on land while still retaining a dependence on moisture. These amphibians return to aquatic environments for reproductive purposes and seek refuge in microhabitats like burrows under stones, logs, or abandoned containers, where they can maintain optimal moisture levels. Notable examples of these ground-dwelling species include *Sclerophrys maculata*, *Sclerophys regularis*, *Ptychadena* spp., and *Rana* spp.

The evolutionary pressures that have shaped anurans have endowed them with a set of distinct adaptations, each finely tuned to their specific ecological niche. One such adaptation is their thin and permeable skin, which plays a pivotal role in facilitating essential processes such as gas exchange and water absorption. Intriguingly, some amphibians are armed with skin pigments that possess potent toxic properties, functioning as defense mechanisms against potential predators. In these cases, the most vividly colored individuals often coincide with the most venomous ones, effectively communicating their potential danger.

Amphibians possess well-developed hind limbs for jumping and movement, slightly flattened and webbed toes that enhance stability on uneven surfaces, thicker skin that reduces water loss and provides protection, cryptic coloring for blending into their surroundings, and larger heads for capturing relatively larger prey efficiently. These adaptations collectively equip them as proficient hunters, utilizing their robust limbs for leaping and seizing prey. Their heightened sensory abilities,

including acute hearing and vibration sensitivity, play a role in detecting both predators and potential prey. Visual and auditory cues enable them to perceive movements and sounds in their environment. These adaptations hold particular relevance for terrestrial frogs and contribute to their fitness, resistance to parasites, and overall survival within varying ecological contexts.

Furthermore, the respiration system of anurans involves a dual mechanism: skin respiration during their early stages, which transitions into a combination of lung and skin respiration as they mature. Additionally, the process of metamorphosis, a complex series of developmental changes, guides the transition of aquatic larvae into terrestrial adults. This process frequently involves the growth and development of limbs as well as alterations in body shape. Given their ectothermic nature, anurans rely on external temperatures to regulate their body heat and metabolic activity.

Ground dwelling Anurans exhibit an intriguing inclination towards opportunistic foraging actions. This behavior entails their consumption of an extensive spectrum of invertebrates (without backbones) and vertebrates (with backbones), which includes mollusks, annelids, crustaceans, centipedes, millipedes, arachnids, and insects is proportionate to their own body size (Toft, 1980). While they occasionally ingest plant material, such consumption is generally perceived to be accidental rather than deliberate, as indicated by studies conducted by Kovács *et. al.,* (2007), Solé *et. al.,* (2009); Ogoanah and Uchedike (2011). Nevertheless, it's noteworthy that the presence of plant fragments within frog diet varies among different species, an observation made by Ogoanah and Uchedike (2011), and Luría-Manzano and Ramírez-Bautista (2019). Interestingly, larger anuran species exhibit an even broader dietary range that encompasses small vertebrates such as fish, birds, rodents, and even their fellow frogs. What's particularly captivating is the emergence of distinct dietary patterns within the anuran population.

These patterns manifest as two distinct groups: "ant specialists" and "non-ant specialists." The former group demonstrates a clear preference for consuming chitinous, slow-moving arthropods like ants and mites. On the other hand, the latter group favors larger, more mobile arthropods, including

orthopterans (grasshoppers, crickets, etc.) and sizeable spiders. The driving factors behind these dietary preferences are multifaceted and closely intertwined. They are influenced by a range of elements such as foraging strategies, activity periods (diurnal or nocturnal), defense mechanisms, and even habitat preferences.

In terms of their hunting strategy, anurans employ a passive sit-and-wait approach to capture prey. This strategy involves the consumption of invertebrates such as arthropods and mollusks, and to a lesser extent, vertebrates including mammals, birds, fish, and other amphibians. Ingested plant material might offer digestive benefits and function as tools to dislodge internal parasites, a phenomenon explored in the work of Anderson *et. al.,* (1999). The dietary composition of these frogs encompasses both terrestrial and aquatic prey, and there are instances of cannibalism.

The composition of anuran diets is influenced by several factors, including habitat type, season, and the age of the frogs. Studies indicated that as frog's age, their dietary preferences can undergo changes. For instance, Blackburn and Moreau (2006) observed a decline in dependency on certain prey types and an increased reliance on others with age. The availability of prey also shapes the diet of predatory frogs, and the size of the frogs can affect their choice of prey, although this effect is more pronounced in semi-arid environments with fewer dietary options Manzano and Bautista (2019). However, there isn't unanimous agreement across studies on whether these changes are consistently present among different frog species Barbosa and Hoyos (2014).

The ecological impact of anurans is of considerable significance within their ecosystems. For instance, the tadpole stage of anurans contributes substantially to water purification by consuming algae, thereby playing a role in maintaining aquatic ecosystems' health. Meanwhile, adult anurans have a critical ecological role in regulating insect populations. This is particularly important because certain insects can serve as vectors for diseases, making the control of these populations vital for preventing disease transmission.

Its impact is particularly evident in the context of West Africa, where their presence significantly contributes to the region's biodiversity. Notable species like the African tree toad, *Kassina fusca*, *Astylosternus occidentalis*, and *Acanthixalus spinosus* underscore their role as essential components of local ecosystems.

Okomu oil palm plantation is a monoculture plantation situated at the Okomu forest reserve. The reserve, characterized by its high rainfall and good vegetation, hosts a variety of amphibian species, including ground-dwelling anurans.

Nigeria is a country which is enriched with a diverse array of anuran species such as *Breviceps gibbosus*, *Arthroleptis variabilis*, *Sclerophrys maculata*, *Sclerophys regularis*, *Ptychadeba* spp., and *Rana* spp., which particularly thrives in tropical rainforest regions like Edo state. Several studies have been conducted by various authors on the food and feeding habit of anurans. These studies centered on specific species of anurans. Petrozzi *et. al*., (2021), Ogoanah and Uchedike (2010) reported on *S. maculata*; Imasuen and Aisien (2019) reported on *S. tropicalis*; Ogaonah *et al.,* (2022) reported on *H. occipitalis*; Ovrawah (2011) reported on *P. bibroni*; (Monye 2011) reported on *P. bibroni* and *P. longirostris*). There is inadequate extensive information available on the dietary and feeding habit of anurans. This thus necessitated this study to be conducted to investigate the food and feeding habit of ground dwelling anurans in Okomu Oil palm plantation.

The aim of these studies is to;

1. Determine the species of ground dwelling Anurans in Oil palm plantation.
2. Investigate the food and feeding habits of Anurans in the study area.
3. Compare result from this study with that previously reported from the rainforest zones by other authors.

CHAPTER TWO

Literature review

The feeding habit as well as the dietary composition of Anurans, have been greatly studied all over the world, giving a detailed insight on the food composition relating to season, availability of prey and locations or environment inhabited by the Anurans.

Hirai *et. al.,* (1999) investigated the feeding habits of the pond frog *Rana nigromaculata* in the rice fields of Kyoto, Japan. The authors reported that *R. nigromaculata* exhibited a diverse dietary preference, consuming a wide array of prey organisms. Pray items of particular significance in the study were arthropods, which constituted the major proportion of both the numerical and volumetric components of the diet of R. nigromaculata. Intriguingly, the frequency of occurrence of the arthropods was influenced by seasonal fluctuations closely aligned with prey availability; this thus suggested that R. nigromaculata exhibited an opportunistic feeding strategy based on the encounter rate with potential prey. The result of the study also shed more light on the interaction between the frog's dietary habits and its body size groups. While there was a certain degree of dietary overlap among three different body-size groups encountered in the study, the evidence suggested limited food resource partitioning among them. It was also inferred from the study that despite the variations in size, the frogs exhibited a relatively weak specialization in terms of their diet preferences.

Hirai and Matsui (2000) examined the diet of *Hyla japonica*, a prolonged breeder, in the reproductive season (early May to late July. A high frequency of empty stomachs and fewer and less stomach contents were observed at the beginning of the breeding season, which they reported that it resulted from energetic constraints associated with reproduction in males. Diverse ground-dwelling invertebrates predominated in the diet, but aquatic organisms were quite few. They reported that the prey recovered consisted of arthropods such as ants, beetles, dipterans, caterpillars, and spiders.

Significant correlations between the diet compositions and prey availability suggested that H. japonica is an opportunistic predator.

Moving from Japan to the rainforests of Brazil, Van Sluys *et. al*., (1998) examined the eating habits and micro habitat use of two Brazilian Amazonian frogs, *Hyla minuto* and *Pseudopaludicula* sp. The authors recorded that both species consumed seven different types of prey. From the study, *H. minuto*, Hemiptera and Aranaea were the most important prey numerically, but spiders constituted the largest prey volume. *Pseudopaludicula* sp. mostly consumed Hemiptera and diptera, with diptera accounting for the majority of the volume (53.8%).

In Northeastern Brazil, Santos *et. al*., (2004) understudied the feeding habits of frogs, including *Leptodactylus natalensis* and *Physalaemus cuvieri*. The studies from Japan to the rainforest of Brazil showcased a diverse diet composition among the studied species. While *L. natalensis* and *P. cuvieri* exhibited higher diet diversity, *Hyla minuta* consumed fewer food items, mainly Insecta and Arachnida. Furthermore, the study observed a preference for certain prey items such as Ascari across various species and this highlighted the influence of ecological niches on diet.

Seasonal dynamics in diet was also investigated by Rodrigues *et. al.,* (2004) in the southern Pantanal region of Brazil. Their research revealed that the diet composition of *Leptodactylus podicipinus* displayed significant variation across the wet and dry seasons. From the study, the author reported that the frog size influenced prey capture and consumption. Larger frogs ingested more preys. The study highlighted the independence between the frogs and the plants they fed on; the diet of the frog was naturally shaped by the planting cycle of the fruit.

Silva *et. al.,* (2006) undertook a 22-month study which involved study 356 *Xenohyla truncata* frogs in Restinga de Maricá, Brazil. From the research, the frogs predominantly consumed fruits. It was reported that the frogs diet was influenced by the availability of fruits in their habitat, an indication that fruit consumption was determined by plant phenology and fruit availability rather than active choice.

Araujo *et. al.,* (2007) investigated the intrapopulation diet variation in the Brazilian Cerrado ecosystem frogs, which included *Leptodactylus fuscus*, *Eleutherodactylus juipoca*, and *Proceratophrys* species. From the studies, it was reported that there was no significant shifts in diet in relations to age or sex, individual-level differences were evident within the species. The authors used the IS index (index of individual specialization) to measure this individual specialization. Interestingly, a negative correlation emerged between the IS index and population niche width, which thus suggested that more generalized populations had greater individual diet variation, which was attributed to trade-offs. Notably, the study was the first to identify individual-level diet variation in a diverse tropical community, challenging the notion that such variation is exclusive to temperate environments driven by competition.

Another study was conducted in Brazil by Forti *et. al.,* (2011) which investigated the feeding habits, foraging behavior, and the influence of habitat, sex, and body size on the diet of *Ameerega braccata*, a relatively unknown *dendrobatid* frog species. The studies was conducted in Chapada dos Guimarães and Cuiabá, Brazil. The primary prey items reported for *A*. *braccata* were ants, termites, and mites, which were obtained through active foraging. Differences in prey consumption were observed between populations from different locations, and the frogs exhibited specialized diets. The females consumed more termites than the males. The body size didn't affect the number of prey categories consumed, it correlated with the abundance and volume of mites consumed. The findings from the studies suggested a narrow dietary niche with a focus on ants, termites, and mites, possibly due to toxic skin alkaloids. Additionally, the variations in diet composition between age classes were noted, which could help reduce competition within the species.

Now moving to other western countries, notable studies have been carried out; Harris *et al*. (1998) studied Northern leopard frogs' invertebrate prey in Northern Ohio. The authors examined stomach contents of adults and juveniles from a restored wetland. The most consumed prey belonged to the order Coleoptera, primarily crawling or fossorial insects. The study suggested that juveniles

exhibited a more diverse diet, which was attributed to habitat differences and local invertebrate abundance.

Blackburn and Moreau (2006) conducted a study which offered insights into the ontogenetic diet changes in *Schoutedenella xenodactyloides*. The findings from the study demonstrated how changes which occur in the frog's diet composition accompanied increase in size. Small frogs predominantly consumed collembolans and mites, while larger frogs transitioned to include a greater proportion of ants in their diet.

Yilmaz and Kutrup (2006) investigated the seasonal changes in the diet of *Rana ridibunda* from the Gorele River in Turkey. From the study, the authors recorded arthropods preys, with insects like beetles, flies, and ants comprising the major prey categories. Importantly, the authors emphasized the correlation between diet composition and prey availability and highlighting the adaptable nature of *R. ridibunda* feeding habits.

Lopez *et. al.,* (2009) conducted a study which explored the dietary composition of the red spotted green frog *Hypsiboas punctatus* in Argentina. From the study, dipterans was the most encountered prey which was followed by Hemipterans, Homopterans, and Coleopterans in the frog's diet. Interestingly, the author reported the study found a high diet similarity between male and female frogs, thus implying a balanced distribution of food resources.

In a study carried out by Ann and Myron (2009) the study reveals that toads derive sustenance from both plant and animal sources in their habitat. They consumed insects found in various environments, primarily hunting at night. Adults feed on insects, grubs, slugs, and worms, while tadpoles fed on plants. As pets, toads can eat fruits and vegetables. Their insect-eating behavior contributes to natural pest control in gardens, thus showcasing their ecological significance.

Lopez *et. al.,* (2009) studied the prey availability's impact on the diet of the red spotted green frog, *Hypsiboas punctatus*, in an Argentine floodplain pond. From the study it was reported that Diptera was the most crucial prey (40.85%), which was followed by Hemiptera (22.07%), primarily

the family Lygaeidae (17.84%), Homoptera (13.62%) and coleoptera (8.45%) also played significant roles, in reflecting their environmental abundance.

In Romania, Balint *et. al.,* (2010) examined the diet of *Pelophylax ridibundus*, showcasing its preference for adult terrestrial arthropod prey. Among invertebrates, Heteroptera, Coleoptera, and Arachnida were particularly notable in the frog's diet.

Studies have also been carried out in African, one of the notable ones is a study carried out in Northern Benin that was conducted by Hirschfeld and Rodel (2011) which aimed at exploring the dietary habits of the African Tiger Frog, *Hoplobhatrachus occipitalis*, in Northern Benin. The researchers used both flushed and collected frogs methods to analyze the frog's stomach contents and found differences in prey categories between the two methods. Despite these differences, the study highlighted that *Hoplobatrachus occipitalis* demonstrates opportunistic foraging behavior, thus being capable of consuming both terrestrial and aquatic preys. The researchers examined 291 frogs in total, with 21% having empty stomachs and identified Coleoptera, Lepidoptera, and Formicidae as prominent prey for flushed frogs, while collected frog stomachs contained Pisces, Coleoptera, and Araneae. Overall, the study emphasized the species' adaptability in its feeding habits and its potential ecological significance in shaping both terrestrial and aquatic food webs.

Many studies in Nigeria have also been done on the dietary habit of ground dwelling anurans, particularly in the Rainforest region of the country. Some of the studies are reviewed as follows; Ogoanah and Uchedike (2010). Conducted a study in Benin City which lasted from November 2009 and May 2010 examined the diets of two frog species, *Hoplobatrachus occipitalis* and *Bufo maculatus*,. A total of 139 specimens were dissected, and their stomach contents were analyzed. Both species exhibited similar dietary preferences, with plant parts, sand grains, Hymenoptera (such as ants), and Coleoptera (beetles) making up significant portions of their diets. Notably, the two species had a perfect niche overlap, sharing common dietary resources. However, an important distinction

was that *H. occipitalis* was cannibalistic, while *B. maculatus* was not. Additionally, the size of the frogs influenced their dietary habits, reflecting the broader prey range of larger frogs.

Okonkwo(2011), Surveyed the food and feeding habits of *Bufo macualtus* in Ogbona and Odighi village in Edo state Nigeria and found out that among the total of twenty-one specimens of *B. maculatus* examined, all have ants(40.28%) as the predominant meal, followed by termites (27.08%) and beetle (15.97%). Other prey includes grasshoppers, woodlouse, spider, cockroaches, earthworm, weevils, and housefly. He concluded that toads are voracious sit and wait feeders, as they sit on wet ground and under wet vegetation to wait for food substances to come across them.

Thirty-six (36) specimens of four *Ptychadena* species, *P. mascereriensis*, *P. poxyrhynchus*, *P. bibroni* and *P. pumilio* at odighi village in Edo State Nigeria were investigated by Ovrawah (2011). He observed difference in their diet relative to season, feeding on varieties of prey like grasshopper, cricket, moth, juvenile frog soil roaches, woodlice, flies, caterpillar, spider, earthworm, snail, beetle and centipede. He concluded them to be generalist feeders

Augustin, (2011) observed the dietary composition of 22 *Hemisus marmoratus* and 36 *Amietophrynus maculates* where were also investigated in Okomu Oil Palm and Rubber Plantation, Edo State, Nigeria. On analysis, a total of nine prey items were recovered. These were: Hymenoptera, Chilopoda, Mollusca, Orthoptera, Isoptera, Diptera, Coleoptera, Plant parts, and Sand grains. In *H. marmoratus*, four prey items consisting of Isoptera (45.45%), Hymenoptera (27.27%), plant parts (9.09%), and sand grains (27.27%) were recovered, while in *A. maculates* seven prey items consisting of: Hymenoptera (82.86%), Coleoptera (65.71%), Diptera (5.71%), Orthoptera (5.71%), Mollusca (2.86%), Chilopoda (2.86%), and plant parts (2.86%) were recovered. Chi - square analysis indicated that there was no significant difference ($P>0.05$) in the food and feeding habits of both species. Based on the prey items recovered from *H. marmoratus*, their feeding habit typically fits into the category described as the sit and wait' feeders, while *A. maculatus* were the 'ant specialist', given the percentage of Hymenopterans (82.86%) recovered.

Mokogwu, (2011) who reported on the food and feeding habits of *Afrixalus dorxalis*, 124 specimens comprising of 101 males and 23 females were examined in Okomu Oil-Palm plantation. On analysis, a total of 31 prey items belonging to four prey taxa were recovered. These included Dipterans, Coleopterans, Hymenopterans and Orthopterans. In male *A. dorsalis*, 26 prey items consisting of Diptera (31.48%), Hymenoptera (12.96%) and Coleoptera (3.70%) were recovered; in female *A. dorsalis*.

The Ptychadena species encountered in the study area include: *P. axyrhynchus*, *P. pumilio*, *P. mascareniensis*, *P. bibroni* and *P. longirostris* Four of these; *P. bibroni P. mascareniensis*, *P. pulio* and *P. longirostris* were recorded in a forest reserve, in Edo State (Monye 2011).

Ogaonah *et. al.,* (2022) in another study focused on examining the dietary patterns of *Hoplobatrachus occipitalis*, a frog species, while considering its prey diversity and preferred prey types based on the frogs' snout-vent lengths (SVLs), which serves as a measure of their age. The researchers collected a total of 392 prey items that belonged to 14 different Orders, seven Classes, and four Phyla of animal kingdom. Additionally, a twig and pebble was also found among the prey items. This diverse range of prey highlights the broad dietary preferences of *H. occipitalis*, reflecting its capacity to consume various types of organisms. The study highlighted a diverse range of broad dietary preference of *H. occipitalis*, thus reflecting its capacity to consume various types of organisms. Small and medium-sized frogs exhibited a statistically significant preference for Hymenopterans (ants) compared to other taxa ($p<0.05$). This suggested that smaller and medium-sized frogs are more likely to target ants as a primary food source. While, the large frogs did not show a specific preference for any particular prey type, thus indicating a more generalized feeding behavior among the larger individuals. Furthermore, the study unveiled interesting differences in prey taxa among the different frog size groups. Among the small frogs, there were significantly fewer prey taxa, and the prey community was less diverse. In contrast, the medium-sized frogs exhibited a greater diversity of prey taxa. Interestingly, the large frogs did not show the same level of

diversity as the medium-sized frogs, indicating a possible saturation point in prey diversity with increasing frog size. The authors also used non parametric estimates to assess the completeness of the prey inventory, which is a measure of how well the researchers sampled the available prey in the frogs' diet. The results indicated that the prey inventory completeness was over 80%, suggesting that the sampling efforts captured a substantial portion of the frogs' diet. This reliability in sampling efforts was further supported by the taxa-accumulation curves, which approached their asymptotic for small and medium-sized frogs. However, the curve for large frogs plateaued at a lower level (53%), indicating that their prey diversity might not have been as comprehensively captured. The authors also reported that there are, the study's findings suggest that there are age-specific differences in the diet of *H. occipitalis*. The observed differences in prey contents, diversity, and preferences among small, medium, and large frogs indicate the influence of ontogenetic changes. These changes might be related to the nutritional requirements of the frogs at different stages of growth, influencing their choices of prey and the extent of their voracity. The study sheds light on the dynamic interplay between predator size, dietary preferences, and ontogenetic changes in the feeding ecology of *H. occipitalis*.

Collectively, these studies enhance our understanding of the diverse dietary habits, interactions in food chains, and adaptability of terrestrial frog species across different ecosystems. They provide insights into how frogs respond to environmental changes, utilize food sources, and impact ecosystems.

From the literature reviewed, little information on recent studies is available on the diet of ground dwelling Anurans in the rain forest region of Nigeria. This thus necessitated this study which was conducted to record the dietary requirements of ground dwelling Anuran in Okomu Oil palm, an altered ecological habitat in Ovia South-West, L.G.A. of Edo state, Nigeria.

CHAPTER THREE

Materials and methods

3.0 Study area

The Okomu Oil-Palm Plantation (fig 1) is located at Okomu-Udo, within the Okomu Forest Reserve in Ovia Southwest Local Government Area of Edo State, Nigeria. It lies between latitude 5°07' and 5°25E and longitude 6°18 and 6°26' N. The area is situated in the deciduous rainforest of Nigeria's vegetation. The specific collection is the natural oil palm site.

The vegetation is typically rainforest, gallery and swamps. The area currently used as a large-scale plantation for cultivating oil palm and rubber. The company is accessible through a network of roads from Benin City. It lies between latitude 5°07' and 5°25' E and longitude 6°18' and 6°26' N. Within the Estate, there exists an extensive earth road network spanning over 270 km.

3.1 Land use and layout

The plantation is laid out in double and single line spacing. The land use for oil-palm is segmented into three sections, the mature area with an area of 8,327 hectares, immature area of about 348 hectares and the nurseries with about 12 hectares, all summing up to 8,687 hectares for the total planted area for oil-palm.

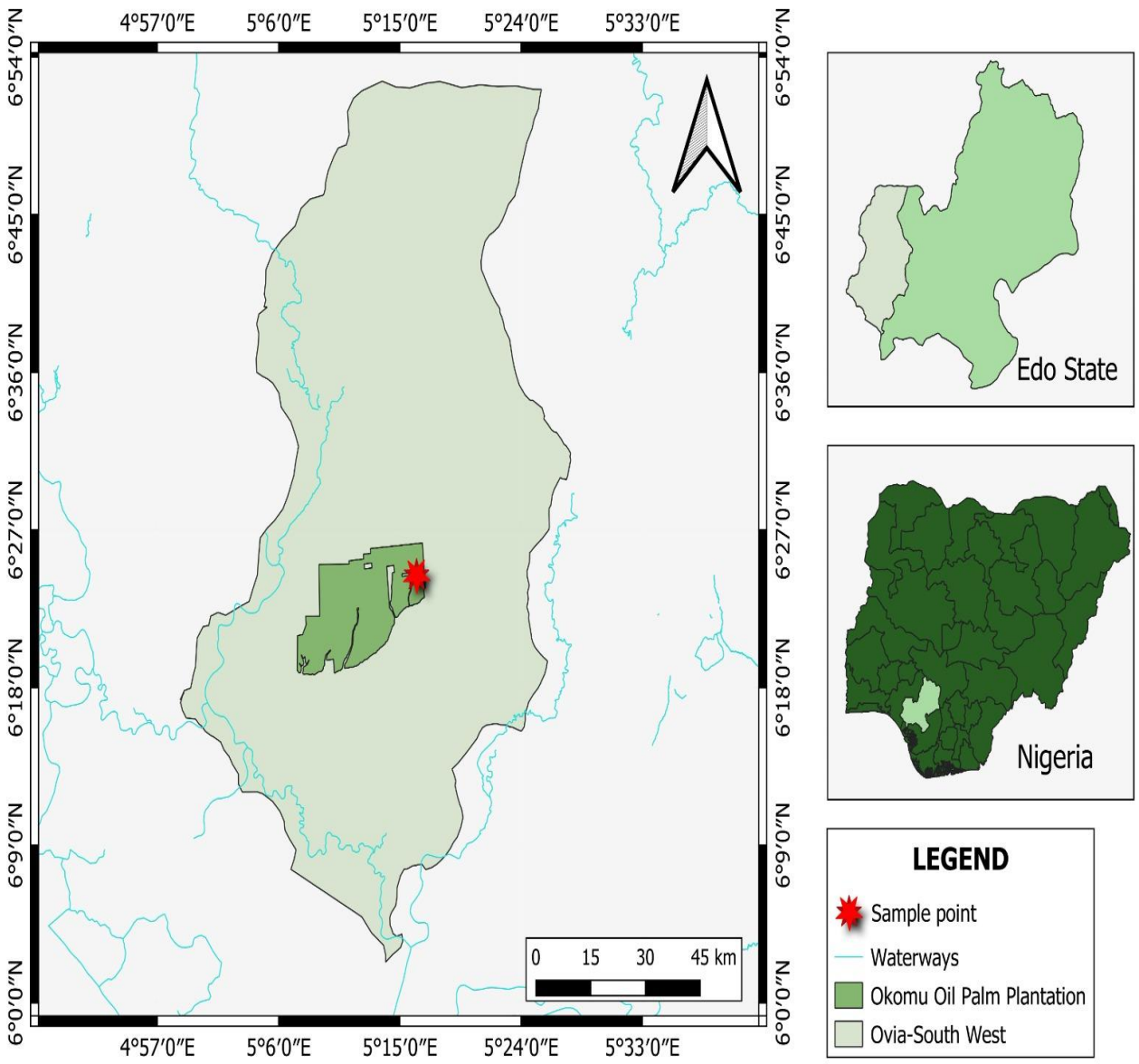

FIGURE 1: Map showing the study area(Okomu Oil palm plantation) at Okomu-Udo in Ovia South West Local government Area of Edo state.

Insert maps: (A) Edo state, (B) Nigeria.

3.2 Collection and sampling technique

The collection methods involved the Acoustic Encounter Survey (AES) and the Visual Encounter Survey (VES) between 7pm to 2am from the month of July to August 2023. Captured toads were placed in a ventilated plastic basket, while frogs were kept in plastic bottles with perforated caps and a small amount of water to prevent drowning and transported to the base camp.

3.3 Euthanizing the anurans

Captured specimens were transported to the base camp where they were euthanized by exposure to chloroform in a killing jar. They were further injected and fixed with 10% formalin to arrest digestion and preserve stomach content. And then stored in a bottle containing 10% formalin.

3.4 IDENTIFICATION AND MEASUREMENT

Anurans were identified according to the protocol of Rodel (2000) which involves the examination of the external morphology (presence of vocal sacs and nuptial spines in males) and gonads. The snout-vent length (SVL) of individuals was measured with veneer caliper.

3.5 Examination and preservation of stomach content

The amphibians were dissected and the stomach was extracted, content were emptied into a Petri dish containing distilled water and examined under a dissecting microscope Pray items in each stomach were identified to different group category as preserved and stored in separate vials containing 70% alcohol.

3.6 Data analysis

The frequency of occurrence for each prey item was calculated using the formula described by Sala and Ballesteros (1997).

Frequency of occurrence$= \frac{Number\ of\ stomachs\ with\ a\ particular\ prey}{Total\ number\ of\ stomachs\ with\ prey} = 100\%$

The rate of feeding activity was estimated acco rding to Sala and Ballesteros (1997) as the percentage of stomach containing food divided by the total number of stomachs examined.

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

Where n is the number of stomach with food while N is the total number of stomach

3.7 Statistical analysis

Chi-square statistical test was undertaken to determine any significant difference in the rate of feeding for both male and female species.

CHAPTER FOUR

4.0 Results

A total of 28 ground dwelling anurans were examined in August 2023 for their dietary and feeding habit. The 28 specimens examined constituted of 24 males and 4 females. The stomach contents of 28 specimens belonging to five different species are listed as follows: *Sclerophrys maculata* (20); *Silurana tropicalis* (1); *Hoplobatrachus occipitalis* (2); *Ptychadena bibroni* (1) and *Ptychadena longirostris* (4) (Table 1) (Plate 1-5). *S. maculata* constituted of 18 males and 2 females; *S. trophicalis* constituted of 1 male; *H. occipitalis* constituted of 2 males*; P. bibroni* constituted of 1 male and *P. longirostris* constituted of 2 males and 2 females. A total of 325 prey items were recovered belonging to 7 different orders; Hymenoptera, Coleoptera, Orthoptera, Diptera, Dermatoptera, Polydesmida, Hemiptera and Geophilomorpha. Ants of different species formed the highest number of food content found in the stomach of the anurans (plate 6-12).

Table 1: Ground dwelling anurans from Okomu Oil Plam Plantation sampled

SPECIES	**OCCURANCE(N)**	**ABUNDANCE (%)**
S. maculata	20	71.43
S. trophicalis	1	3.57
H. occipitalis	2	7.14
P. bibroni	1	3.57
P. longirostris	4	14.29

Plate 1: Dorsal view of *Ptychadena longirostris*

Plate 2: Dorsal view of *Ptychadena bibroni*

Plate 3: Dorsal view of *Hoplobatrachus occipitalis*

Plate 4: Dorsal view of *Silurana tropicalis*

Plate 5: Dorsal view of *Sclerophrys maculata*

4.1 Relative abundance of prey items

A total of 303 Ants (Hymenoptera) were found with a relative abundance of 92.9% being the most abundant food substance, of which 302 was found in *S. maculata* and 1 in *H. occipitalis.* Bugs (Hemiptera) of different species had the second highest abundance with a frequency of 2.77 %. Beetles (Coleoptera) were next with a relative abundance of 1.85% (Table 2). These three proved to be the most available food items to the anurans examined. Blackfly (Diptera) and Millipede (Polydesmida) both had a relative abundance of 0.62 % while Grasshopper(Orthoptera), Earwig (Dermaptera) and Soil Centipedes (Geophilomorpha) each had prevalence abundance of 0.31% and they both constituted the least available food content. Table 3 showed the numerical representation of the relative abundance of prey items. The relative abundance in this study was used to show the availability of food in the Anuran habitat in accordance to their feeding habit. These are represented graphically (Figure 2).

4.2 Relative frequency of prey items

The relative frequency of prey items represents the rate of preference of a particular food to the Anuran. This is represented graphically in figure 3. It was calculated and the following result was obtained. Ants (Hymenoptera) had a relative frequency of 75%; Bugs (Hemiptera) had a relative frequency of 25%. Both were the most preferred food Item. Beetles (Coleoptera); Blackfly(Diptera) and juvenile Centipede(diptera) were all next on the preference list and each had the relative frequency 7.14% . Grasshopper (Orthoptera); Earwig (Dermaptera) and Millipede (Geophilomorpha) each had a relative frequency of 3.57% (Table 3).

Table 2: Diet of Anurans showing the occurrence of prey items in the stomach

1			**ANURANS**	*3*	*3*
PREY ITEMS **ORDER**	*S. maculata*	*S. trophicalis*	*H. occipitalis*	*P. bibroni*	*P. longirostris*
Hymenoptera	302		1		
Coleoptera	6				
Orthoptera	-		1		
Diptera	2				
Dermatoptera	1				
Polydesmida	2				
Hemiptera	9				
Geophilomorpha	1				

Table 3: Prey order of prey items recovered from Okomu oil palm plantation, showing percentage abundance and frequency

PREY ORDER	RELATIVE ABUNDANCE	RELATIVE FREQUENCY
Hymenoptera	92.9%	75.00%
Coleoptera	1.85%	7.14%
Orthoptera	0.31%	3.57%
Diptera	0.62%	7.14%
Dermatoptera	0.31%	3.57%
Polydesmida	0.62%	7.14%
Hemiptera	2.77%	25.00%
Geophilomorpha	0.31%	3.57%

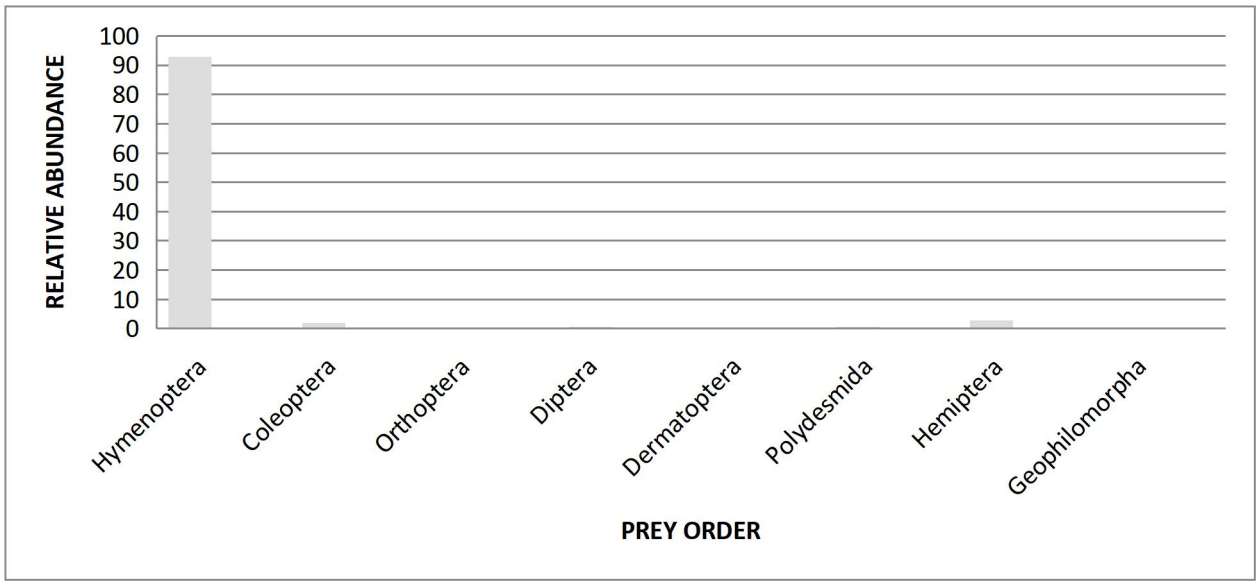

Figure 2: Relative abundance or prey items

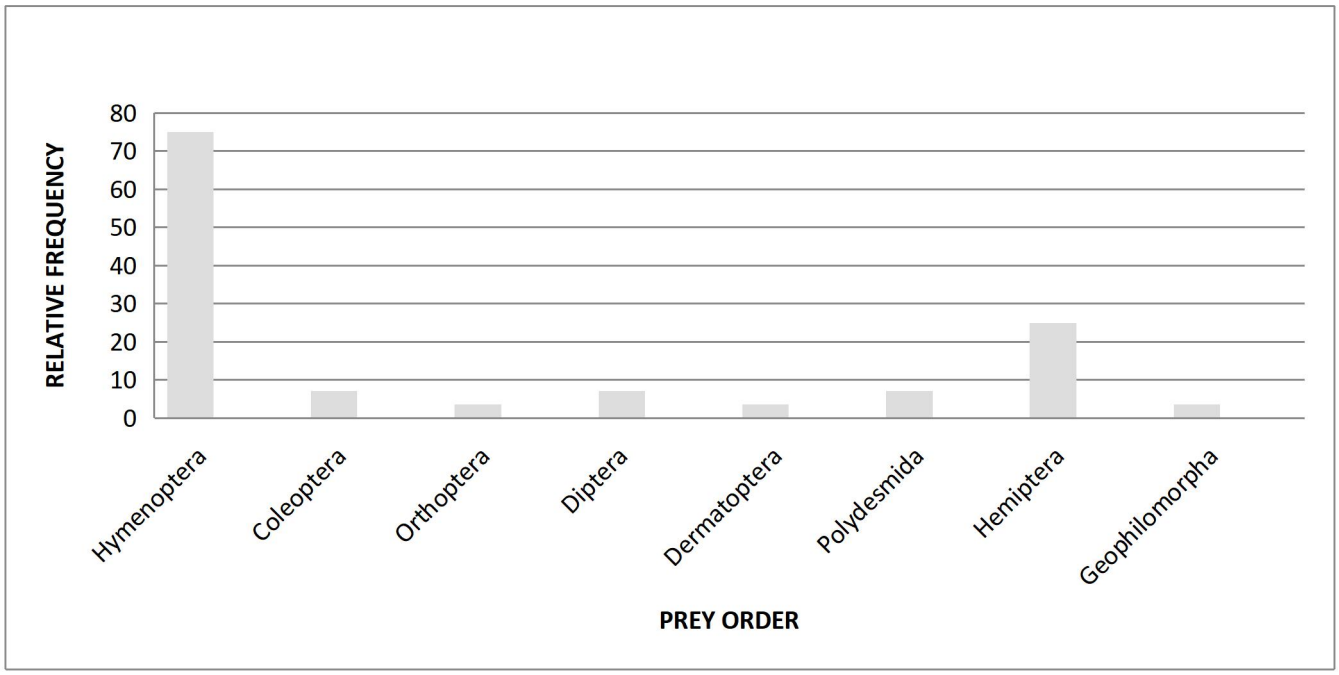

Figure 3: Relative frequency of prey occurrence

4.4 Relative abundance and frequency of prey items in relation to sex of the anurans

In this study, the 28 specimens examined comprised of 24 males and 4 females. Out of the 24 males, 21 (87.5%) had prey items recovered from them, while 4 had empty stomachs (Table 4) Two out of the Four females examined had prey items (50%) in their stomach content, while the other 2 had empty stomachs (Table 5). Both Hemenoptera and Hemiptera were recorded in both male and female Anurans species. However, Coleoptera, Polydesmida, Geophilomorpha and Diptera were not recorded in the female, though it was recorded in the males. However, Dermaptera was present in the female specimen, while it was absent in the male. The narrow prey diversity discovered in female anurans could be attributed to the low amount /number of Female anurans encountered in this work.

Table 4: Diet of male Anurans showing its prey content

S/N	SPECIES	STOMACH CONTENTET
1	*Sclerophrys maculata*	9 Hymenoptera, 2 Coleoptera
2	*Sclerophrys maculata*	5 Hymenoptera
3	*Sclerophrys maculata*	1 Hymenoptera
4	*Sclerophrys maculata*	31 Hymenoptera
5	*Sclerophrys maculata*	2 Hymenoptera
6	*Sclerophrys maculata*	22 Hymenoptera
7	*Sclerophrys maculata*	1 Hymenoptera
8	*Sclerophrys maculata*	17 Hymenoptera, 4 Coleoptera, 1 Polydesmida, 1 Geophilomorpha
9	*Sclerophrys maculata*	18 Hymenoptera , 1
10	*Sclerophrys maculata*	20 Hymenoptera, 3 Hemiptera, 1 Polydesmida
11	*Sclerophrys maculata*	11 Hymenoptera, 1 hemiptera
12	*Sclerophrys maculata*	33 Hymenoptera
13	*Sclerophrys maculata*	47 Hymenoptera, 1 Hemiptera
14	*Sclerophrys maculata*	13 Hymenoptera, 3 Hemiptera
15	*Sclerophrys maculata*	21 Hymenoptera,2 Hemiptera, 1 Diptera
16	*Sclerophrys maculata*	4 Hymenoptera
17	*Sclerophrys maculata*	9 Hymenoptera
18	*Sclerophrys maculata*	20 Hymenoptera, 1 Diptera larvae
19	*Silorana trophicalis*	Empty
20	*Hoplobatrachus occipitalis*	Empty
21	*Hoplobatrachus occipitalis*	1 Hymenoptera, 1 Orthoptera
22	*Ptychadena bibroni*	Empty
23	*Ptychadena longirostris*	Empty
24	*Ptychadena longirostris*	Empty

Table 5: Diet of female Anurans showing its prey content

S/N	SPECIES	STOMACH CONTENTET
1	*Sclerophrys maculata*	2 Hemiptera, 1 Hymenoptera, 1 Dermaptera
2	*Sclerophrys maculata*	15 Hymenoptera, 1 Hemiptera,
3	*Ptychadena longirostris*	Empty
4	*Ptychadena longirostris*	Empty

4.5 Rate of feeding

The Anurans had a percentage rate of feeding of 75% which resulted from 21 out of 28 stomach of Anurans had food. This showed that they are good eaters and consumed a lot of food especially in *S. maculata.* Seventeen of the stomach had partially digested food content. Four of the stomachs were undigested, while none were completely digested. There was no record of cannibalism or plant feeding during the course of this study.

Rate of feeding= 75%

Plate 6: representatives of the food content of *S. maculata* 17) containing 1 Hemiptera, 1 Diptera and 3 Hymenoptera.

Plate 7: Representative of the food content of *S. maculata* (5) containing different species of partially digested Hymenoptera.

Plate 8: Representative of the food content of *S. maculata* (9) containing Geophilomorpha, Coleoptera, Hymenoptera and partially digested Geophilomorpha.

Plate 9: Representative of the food content of *S. maculata* (10) containing Coleoptera, Polydesmida and Hymenoptera.

Plate 10: Representative of the food content of *S. maculata* (15) containing Hymenoptera and Dermaptera(Earwig).

Plate 11: Representative of the food content of *S. maculata (2*0) containing Hymenoptera and Diptera Larvae.

Plate 12: Representative of the food content of *H. occipitalis* (15) containing partially digested Orthoptera and Hymenoptera.

CHAPTER FIVE

Discussion

A total of 5 species of anurans were recorded in this study namely: *Sclerophrys maculata*, *Silurana tropicalis*, *Hoplobatrachus occipitalis*, *Ptychadena bibroni* and *Ptychadena longirostris*. All the anurans recorded in this study, have been reported by other authors from previous studies from the rainforest zone (Aisien *et. al.,* (2009), Imasuen *et. al.,* (2012), Imasuen and Aisien(2015)). In the savannah zone (Aisien *et.al*.,(2003), Ozemoka and Aisien(2020), Ozemoka and Aisien(2021)).From mangrove rainforest zone (Aisien *et. al*., (2015), Aisien *et. al.,* (2021)) This is a more extensive study on food and feeding habits of ground dwelling anurans when compared with previous studies. *S. maculate* dietary investigation have been reported by Petrozzi *et. al*., (2021) and Ogoanah and Uchedike (2010); *S. tropicalis* dietary investigation was reported by Imasuen and Aisien (2019); *H. occipitalis* dietary investigation have also been reported by Ogaonah *et. al.,* (2022); *P. bibroni* dietary investigation have been reported by Ovrawah (2011); *P. bibroni* and *P. longirostris* dietary investigation have been also reported by Monye (2011).

A total of 28 species were examined for their stomach content, comprising of 24 males and 4 females of which 21 were *S. maculata,* 1 was *S. trophicalis*, 2 were *H. occipitalis* 1 was *P. bibroni* and 4 were *P. longirostris* which were all captured in the Okomu Oil palm plantation (appendix). This showed that they were more male specimens than female specimens readily available. This is in agreement with the studies conducted by Mokogwu, (2011) in which he reported that out of the 124 specimens collected, males comprised of 101 while females were 23 of the total specimens. This could be attributed to the fact that both studies were carried out at the peak of the wet season, which is the most suitable time for breeding among Anurans, and so male specimens were more readily available, easily located and captured due to their mating calls.

The stomach contents were examined, Out of which only 21 were with prey items, while the remaining 7 were empty. Out of the 21 stomachs with prey items, 18 were partially digested while 3

were undigested. 8 different prey categories were recorded; Hymenoptera, Coleoptera, Orthoptera, Diptera, Dermaptera, Polydesmida, Hemiptera and Geoph ilomorpha. This is in close conformity with the study conducted by Augustine (2011) who recorded 7 prey orders; Hymenoptera, Chilopoda, Mollusca, Orthoptera, Isoptera, Diptera and Coleoptera.

Among the prey item recorded in this study, Hymenoptera, Coleoptera, Diptera and Orthoptera were reported by Augustin (2011). Polydesmida, Hemiptera, Dermapter and Geophilomorpha were not reported in his study. However he reported Mollusca, Chilopoda and Isoptera which was not reported in this study. In the study conducted by Ovrawah (2011) prey items belonging to 9 orders were reported: Orthoptera, Lepidoptera, Blattodea, Diptera, Araneida, Opisthopora, Mollusca, Coleoptera and Geophilomorpha, of which Orthoptera, Diptera, Coleoptera and Geophilomorpha. However Blattodea, Araneida, Opisthopora and Mollusca were not reported in this study. Mokogwu, (2011) who investigated the food and feeding habits of *Afrixalus dorxalis* in Okomu Oil palm plantation, reported that a total of 31 prey items belonging to the order Hymenoptera, Orthoptera, Diptera and Coleoptera were recovered which is in close conformity with this study. In the study conducted by Okonkwo(2011) where he reported on the food and feeding habits of *S. maculata* in Ogbona and Odighi village in Edo state Nigeria, reported that among the total of twenty-one specimens of *S. maculata* examined, all had Hymenoptera, Diptera, Blattodea, and Coleoptera as prey item of which Hymenoptera, Diptera and Coleoptera were recorded in this study.

From the 8 different prey item order recorded in this study, Hymenoptera had 92.9% abundance which was the most diverse, indicating that the anurans exhibited a narrow diversity of prey items. This is in accordance with the studies conducted by Ogaonah *et. al.,* (2022) in which Hymenoptera had the highest diversity and abundance of prey items. They also recorded Coleoptera, Diptera, Polydesmida, Orthoptera and Hemiptera in their report. However contrary to the study, they recorded Opisthophora, Lepidoptera, Odonata, Isopoda and Anura adult and tadpole, which was not recorded in this study. It is assumed that the prey consumption is affected by the availability of prey item in

the habitat. This is in accordance to the studies conducted by Toft (1981, 1995) Ogaonah *et. al.,* (2022) in which they recorded that the consumption of Anurans prey is directly proportional to their availability in the environment which could explain the large occurrence of Hymenoptera in their diets.

Contrary to the study by Mokogwu (2011), in which he reported Diptera (31.48%) to have the highest abundance of prey item while Hymenoptera (12.96%) and Coleoptera (3.70%)) were among prey items with low abundance, this study recorded Diptera (0.62%) to be among prey items with the lowest abundance. This may be attributed to the probability of high availability of Diptera, compared to Hymenoptera in the habitat. This is further supported by the study carried out by Lopez *et. al.* (2009) in which they recorded Diptera (40.85%) to have the highest abundance compared to other prey items Hemiptera (22.07%), Lygaeidae (17.84%), Homoptera (13.62%) and Coleoptera (8.45%). Hemiptera had the second highest prey abundance followed by Coleoptera and then Diptera, Polydesmida, Dermaptera, Orthoptera and the finally Geophilomorpha.

This showed that Anurans preferred Arthropods as their prey item and this result is in accordance with the reports by Toft, 1980, Van and Rocha (1998), and Kiesecker *et. al.,* (1999) which stated that Aquatic and terrestrial insects have been reported to be the most preferential anuran prey item in most studies conducted over the years.

The rate of frequency (Table 3) of the food substance calculated, indicated that the studied Anurans preferred Hymenoptera as their prey item with a frequency of 75.00%, Followed by Hemiptera which had a frequency of 25.00% compared to other prey items such as Coleoptera, Diptera, and Polydesmida which had a frequency of 7.14% frequency each, and Dermaptera, Orthoptera and Geophilomorpha which had a frequency of 3.57% each, being the least preferred prey items. This is in accordance with the investigation carried out by Okonkwo(2011) where he surveyed on the food and feeding habit of *Sclerophrys macualta.* He reported Hymenoptera as the most preferred prey item with a frequency of 40.28% compared to other prey item such as Blattodea

which had a frequency of 27.08% and Coleoptera with a frequency of 15.97%. However the frequency of Hymenoptera (75%) in this study was high compared the frequency of Hymenoptera (40.28%) recorded in his studies. In agreement to this, the frequency of Hymenoptera (75.00%) was incredibly high when compared to the frequency (12.96%) reported by Mokogwu (2011).

The rate of feeding was calculated to be 75%. The anurans all fed on moving arthropods which suggested that they were all active foragers (feeds on anything that moves and that can fit into its mouth). According to this study, *S. maculata* is considered the most active foraging predator and thus more efficient in the capture of prey. This is due to the fact that no empty stomach was recorded for the studied *S. maculata.* All species of anurans studied fed on arthropods and this confirmed that they do not show variation in their diets and there is high tendency of competition among the species for prey items. The altered environment prevalent in the plantation may also have influenced the abundance and variety of arthropods in the habitat.

It is noteworthy that variations in the diet of the studied anuran specimens varied within a narrow limit when compared to previous studies conducted. In this study, all prey items recovered were arthropods which indicated a narrow dietary preference and is contrary to other studies reported by other authors that indicated that anurans had a broad dietary preference. Ovrawah (2011) whose record was from a natural environment reported that Ptychadena species fed on a wide variety of preys such as Annalids, Arthropods, Amphibians, Molluscs that was comprised of grasshopper cricket moth, juvenile frog soil roaches woodlice, flies, caterpillar spider, earthworm, snail, beetle and centipede. Also Onyinyechi (2014), who studied the food and feeding of *S. tropicalis* recorded that the prey item belonged to four prey taxa; Oligochaete, Nematoda, Hymenoptera and Cestoda. Plants parts and baits were also recovered. Ogoanah and Uchedike(2011) examined the stomach content of *H. occipitalis* and recorded prey items that consisted of terrestrial invertebrates and two vertebrates – a rodent and an amphibian. In addition, Yilmax nd Kutrup (2006), who reported on *Rana ridibunda* at Gorele River Giresun of Turkey, recorded they consumed mostly arthropod prey

as well as some prey items belonging to Mollusca, Nematoda and Annelida. This confirmed the claim that in an altered habitat Anurans species feeds on what is available and not prey selective. This differences in variations can be attributed to certain factors such as: Short duration of study as this study was conducted within the short duration of one month (August), compared to the study conducted by Ogoanah and Uchedike (2011) which spanned for 7 months (November 2009 to May 2010). Site location and time of specimen collection could also be a factor as in their study, samples were collected both night and day from different site location. This study is contrary as specimens were only collected at night from a single location. Season of specimen collection could also be a factor as this study was carried out only at the peak of the raining season, which is contrary to the studies conducted by Ogoanah and Uchedike(2011), Ovrawah (2011) and Onyinyech(2014) whose study spanned from several months in both the raining and dry season.

We can conclude that the prey availability affected the dietary preference of the anurans. This is in agreement with the study conducted by Turner (1959) and Houston (1973) who reported a relationship between the abundance of prey in the environment and in the diet of Anurans. They reported that Anuran species feeding seems related to the food available in the environment, where by all the species showed a predominance of insect diet, with Hymenoptera (Ant) having more percentage than the other prey, which was the most abundant prey item in the study.

The study of Anurans is very important, as the study of the dietary composition has of a lot of benefit to man and his environment. The food of anurans includes a large number of invertebrates and occasionally smaller vertebrate species so these frogs have an important role as regulators of the density of prey species. Paunovic *et. al.,* (2010) reported that with the knowledge of the type of insects that is mostly consumed by Anuran species, Anurans can be used as pest control agent on farmlands that is infested with the species of arthropods. This is a way of substituting chemicals that can reduce soil fertility and damage crops Ogoanah and Uchedike (2010). Also a good understanding of the food and feeding habits of amphibians in general and Anuran species in

particular will help in their culture which is one of the ways of conserving amphibian which are currently faced with decline and extinction.

Variations in the diet of the studied anuran specimens varied within a narrow limit when compared to previous studies conducted and this may be due to morphological, behavioral, environmental or physiological characteristics of both predator and prey (Simon and Toft, 1991). Data on the diet of Anurans are therefore useful in detecting these variations both in natural and altered habitats and are also useful for future references. Inclusively, much work has not been done on the diet of *Sclerophrys maculata* in an altered habitat. This work would be among the few report on the food and feeding habit of Anuran species, having *S. maculata* in Okomu Oil-Palm Plantation in Edo State.

REFERENCE

Aigbe.M. E. (2011).Dietary constituents of leptopelis hyloides in okomu oil plantation in ovia south, Benin City, Nigeria. B.Sc Thesis. University of Benin. Page1-37p

Aisien, S. O., Ajakaiye, F. B., and Braimoh, K.(2003). Helminth. Parasites of anurans from the savannah mosaic zone of south-western Nigeria. *Acta Parasitologica*, *1*(48).

Aisien, M. S. O., Ogoannah, S.O. and Imasuen, A. A. (2009). Helminth parasites of amphibians from a rainforest reserve in southwestern Nigeria. *African Zoology*, **44**(1), 1-7.

Aisien, M. S. O., Uwagbae, M., Edo-Taiwo, O., Imasuen, A. A., and Ovwah, E. (2015). Pattern of parasitic infections in anurans from a mangrove community of the Niger Delta, Nigeria. *Zoologist (The)*, ***13***, 50-55.

Aisien, M. S., Edo-Taiwo, O., and Imasuen, A. A. (2021). Ecological scenarios and parasite diversity in anurans of West Africa: a review. *Diversity*, ***13***(6), 223.

Alari, E. (2010)Amphibian biodiversity in urbanized and peri-urban areas in Ugbowo and environs, Benin City, Nigeria. B.Sc Thesis, University of Benin. Page56p.

Araújo, M. S., dos Reis, S. F., Giaretta, A. A., Machado, G., and Bolnick, D. I. (2007). Intrapopulation diet variation in four frogs (Leptodactylidae) of the Brazilian Savannah. *Copeia*, **2007**(4), 855-865.

Augustin R .C (2011). Dietary composition of Hemisus marmoratus and Amietophrynus maculatus in okomu oil palm plantation: an altered forest habitat in ovia south, Benin City,Nigeria. B.Sc. Thesis. University of Benin. Page 1-30p.

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.

Blackburn, D. C., and Moreau, C. S. (2006). Ontogenetic diet change in the arthroleptid frog Schoutedenella xenodactyloides. *Journal of Herpetology*, **40**(3), 388-394.

Da Silva, E. T., Dos Reis, E. P., Feio, R. N., and Ribeiro Filho, O. P. (2009). Diet of the invasive frog Lithobates catesbeianus (shaw, 1802)(anura: raniDae) in viçosa, Minas gerais state, Brazil. *South American Journal of herpetology*, ***4***(3), 286- 294.

Forti, L. R., Tissiani, A. S. O., Mott, T., & Strüssmann, C. (2011). Diet of Ameerega braccata (Steindachner, 1864)(Anura: Dendrobatidae) from Chapada dos Guimarães and Cuiabá, Mato Grosso State, Brazil. *Brazilian Journal of Biology*, **71**, 189-196.

Gray, M. J., Smith, L. M., and Brenes, R. (2004). Effects of agricultural cultivation on demographics of Southern High Plains Amphibians. *Conservation Biology*, ***18***(5), 1368-1377.

Harris, M. L., Bishop, C. A., Struger, J., Ripley, B., and Bogart, J. P. (1998). The functional integrity of northern leopard frog (Rana pipiens) and green frog (Rana clamitans) populations in orchard wetlands. II. Effects of pesticides and eutrophic conditions on early life stage development. Environmental Toxicology and Chemistry: *An International Journal*, **17**(7), 1351-1363.

Hirai, T., and Matsui, M. (1999). Feeding habits of the pond frog, Rana nigromaculata, inhabiting rice fields in Kyoto, Japan. *Copeia*, 940-947.

Hirai, T., and Matsui, M. (2000). Feeding habits of the Japanese tree frog, Hyla japonica, in the reproductive season. *Zoological Science*, **17**(7), 977-982.

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. *Journal of Zoology*, **171**(2), 153-165.

Imasuen, A. A., Ozemoka, H. J., and Aisien, M. S. (2012). Anurans as intermediate and paratenic hosts of helminth infections in the rainforest and derived savanna biotopes of southern Nigeria. *International Journal of Zoology*, *2012*.

Imasuen, A. A., and Aisien, M. S. O. (2015). Helminth parasites of Silurana tropicalis from the Okomu National Park, Edo State, Nigeria. *Nigerian Journal of Parasitology*, ***36***(1), 61-66.

Imasuen, A. A., and Aisien, M. O. (2019). Diets of Silurana tropicalis from two rainforest habitats in Edo State, Nigeria. *NISEB Journal*, ***16***(4).

Kiesecker, J. M., Chivers, D. P., Marco, A., Quilchano, C., Anderson, M. T., and Blaustein, A. R. (1999). Identification of a disturbance signal in larval red- legged frogs, Rana aurora. *Animal Behaviour*, **57**(6), 1295-1300.

López, J. A., Scarabotti, P. A., Medrano, M. C., and Ghirardi, R. (2009). Is the red spotted green frog Hypsiboas punctatus (Anura: Hylidae) selecting its preys?: The importance of prey availability. *Revista de biologia tropical*, **57**(3), 847-857.

Mokogwuo.A.A. (2011)Food and feeding habits of Afrixalus dorsalis in Okomu Oil Palm Plantation:An Altered Forest Habitat Edo State, Nigeria.B.sc Thesis, University Of Benin.37p

Monye, N. D. (2011). Food And Feeding Habits Of Ptychadena Species In Okomu Oil Palm And Rubber Plantation (An Altered Forest Habitat) In Ovia South, Edo State, Department of Animal and Environmental Biology University of Benin, Benin city. 41pp

Ogoanah, S. O., and Uchedike, E. (2010). Diet of two anurans (Hoplobatrachus occipitalis and Bufo maculatus) in Benin City, Nigeria. *Bio Res Comm*, ***22***(4), 189-198.

Ogoanah, O. S., and Uchedike, E. (2011). Diet and feeding behavior of the edible frog Hoplobatrachus occipitalis (Amphibia: Anura). *African Scientist*, ***12***(4), 209-213.

Ogoanah, S., Egbon, I. N., and Alegbe, S. (2022). The gut content of Hoplobatrachus occipitalis (anura: dicroglossidae) provides an inkling of its age-modulated voracity, prey diversity and choices. *Animal Research International*, **19**(3), 4661-4672.

Okonkwo, K. U. (2011). Food and feeding habits of toad(Bufo maculatus) collected from Ogbona and Odighi villages in Edo state, Nigeria. Bsc thesis. Animal and Environmental Biology, University of Benin. 1-45pp.

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

Onyinyechi, D.I.(2014).). Food And Feeding Habits Of Ptychadena Species In Okomu National park, A protected rainforest habitat in Ovia Southwest local government, Edo State. Bsc thesis, Animal and environmental Biology, University of Benin.

Ovrawah, E.E. (2011). Food and feeding habits of Ptychaden species at Odighi Village in Edo state, Nigeria. Bsc thesis, Animal and environmental Biology, University of Benin.

Ozemoka, H. J., and Aisien, M. S. O. (2020). Digenetic trematodes infecting anurans from a derived savanna biotope in Edo State, Nigeria. *Nigerian Journal of Parasitology*, ***41***(2).

Ozemoka, H. J., and Aisien, M. S. O. (2021). Parasitic nematode infections of anurans from a derived savanna biotope in edo state, nigeria. *African Journal of Health, Safety and Environment*, ***2***(2), 166-182.

Paunović, A., Bjelić-Čabrilo, O., and Šimić, S. (2010). The diet of water frogs (Pelophylax esculentus' complex') from the Petrovaradinski Rit marsh (Serbia). *Archives of Biological Sciences*, ***62***(3), 797-806.

Petrozzi, F., Akani, G. C., Eniang, E. A., Ajong, S. N., Funk, S. M., Fa, J. E., ... and Luiselli, L. (2021). Generalist, selective or 'mixed'foragers? Feeding strategies of two tropical toads across suburban habitats. *Journal of Zoology*, ***315***(4), 288-300.

Rodrigues, D. D. J., Uetanabaro, M., and Prado, C. P. (2004). Seasonal and ontogenetic variation in diet composition of Leptodactylus podicipinus (Anura, Leptodactylidae) in the southern Pantanal, Brazil. *Revista Española de Herpetología*, **18**, 19-28.

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

Toft, C. A. (1980). Seasonal variation in populations of Panamanian litter frogs and their prey: a comparison of wetter and drier sites. *Oecologia*, ***47***, 34-38.

Toft, C. A. (1981). Feeding ecology of Panamanian litter anurans: patterns in diet and foraging mode. *Journal of herpetology,* 139-144.

Toft, C. A. (1995). Evolution of diet specialization in poison-dart frogs (Dendrobatidae). *Herpetologica*, 202-216.

Turner, F. B. (1959). An analysis of the feeding habits of Rana p. pretiosa in Yellowstone Park, Wyoming. *The American Midland Naturalist*, ***61***(2), 403- 413.

Van Sluys, M., and Rocha, C. D. (1998). Feeding habits and microhabitat utilization by two syntopic Brazilian Amazonian frogs (Hyla minuta and Pseudopaludicula sp.(gr. falcipes). *Revista Brasileira de Biologia*, ***58***, 559-562.

Yilmaz, Z. C., and Kutrup, B. (2006). Seasonal changes in the diet of Rana ridibunda Pallas, 1771 (Anura: Ranidae) from the Gorele River, Giresun, Turkey. *In Proceedings of the 13th Congress of the Societas Europaea Herpetologica.* **201**,204.

APPENDIX

S/N	SPECIES	SVL(mm)	SEX	STOMACH CONTENTET	DEGREE OF DIGESTION
1	*Sclerophrys maculata*	5.1	MALE	9 Hymenoptera, 2 Coleoptera	Partially digested
2	*Sclerophrys maculata*	4.9	MALE	5 Hymenoptera	Undigested
3	*Sclerophrys maculata*	5	MALE	1 Hymenoptera	Partially digested
4	*Sclerophrys maculata*	4.6	MALE	31 Hymenoptera	Undigested
5	*Sclerophrys maculata*	4.4	MALE	2 Hymenoptera	Partially digested
6	*Sclerophrys maculata*	4.7	MALE	22 Hymenoptera	Undigested
7	*Sclerophrys maculata*	4.7	MALE	1 Hymenoptera	Partially digested
8	*Sclerophrys maculata*	5.1	MALE	17 Hymenoptera, 4 Coleoptera, 1 Polydesmida, 1 Geophilomorpha	Partially digested
9	*Sclerophrys maculata*	5.1	MALE	18 Hymenoptera , 1	Partially digested
10	*Sclerophrys maculata*	4.8	MALE	20 Hymenoptera, 3 Hemiptera, 1 Polydesmida	Partially digested

11	*Sclerophrys maculata*	4.9	MALE	11 Hymenoptera, 1 hemiptera	Partially digested
12	*Sclerophrys maculata*	4.7	MALE	33 Hymenoptera	Partially digested
13	*Sclerophrys maculata*	4.8	MALE	47 Hymenoptera, 1 Hemiptera	Partially digested
14	*Sclerophrys maculata*	4.8	MALE	13 Hymenoptera, 3 Hemiptera	Partially digested
15	*Sclerophrys maculata*	4.5	FEMALE	2 Hemiptera, 1 Hymenoptera, 1 Dermaptera	Partially digested
16	*Sclerophrys maculata*	5	FEMALE	15 Hymenoptera, 1 Hemiptera,	Partially digested
17	*Sclerophrys maculata*	4.8	MALE	21 Hymenoptera,2 Hemiptera, 1 Diptera	Partially digested
18	*Sclerophrys maculata*	4.6	MALE	4 Hymenoptera	Partially digested
19	*Sclerophrys maculata*	5.1	MALE	9 Hymenoptera	Partially digested
20	*Sclerophrys maculata*	4.6	MALE	20 Hymenoptera, 1 Diptera larvae	Partially digested
21	*Silorana trophicalis*	4.7	MALE	Empty	Empty
22	*Hoplobatrachus occipitalis*	5.4	MALE	Empty	Empty

23	*Hoplobatrachus occipitalis*	5.4	MALE	1 Hymenoptera, 1 Orthoptera	Partially digested
24	*Ptychadena bibroni*	4.5	MALE	Empty	Empty
25	*Ptychadena longirostris*	4.6	MALE	Empty	Empty
26	*Ptychadena longirostris*	5.3	FEMALE	Empty	Empty
27	*Ptychadena longirostris*	5.5	MALE	Empty	Empty
28	*Ptychadena longirostris*	6	FEMALE	Empty	