The Feeding Habits Of The Giant African Bullfrog (Anura: Pyxicephalidae: *Pyxicephalus Adspersus* Tschudi, 1839) Of The Cuvelai Drainage System In Northern Namibia

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Abstract

The recorded diet of the giant African bullfrog *Pyxicephalus adspersus* of the Cuvelai drainage plains (the oshanas) of northern Namibia is presented. Among all the stomach contents; insects accounted for the greatest diversity of the orders recorded. The most abundant prey items to the juvenile frogs come from Orthoptera (20.0%), Lepidoptera (16.0%), Isoptera (15.5%), Coleoptera (12.0%), while to the adult frogs also come from Orthoptera (20.0%) but followed by Coleoptera (11.8%), Odontata (11.0%) and Hemiptera (10.0%) in that hierarchical order. A habit of cannibalism is indicated; tadpoles form the fifth (11.0%) and second (13.1%) most important food item for juvenile and adult frogs, respectively. Diet shift is evident, from ants to tadpoles and beetles as the frogs become larger.

Keywords: giant African bullfrog, Ranidae, *Pyxicephalus adspersus*, feeding habits, diets, Cuvelai, oshanas, Namibia.

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1 Introduction

The giant African bullfrog (Anura: Phyxicephalidae: *Pyxicephalus adspersus* Tschudi, 1839) is also referred to as "African Pyxie Frog" or "Pyxie Frog" or "Giant Pyxie" or "The Giant Bullfrog" or "African Bullfrog" or "African Burrowing Frog". Previously, it was classified under the family Ranidae and the order Salientia (Channing & Griffin, 1993; Griffin, 1997; Conlon et al., 2000; Okeyo, 2004; van der Meijden et al., 2005). According to Passmore & Carruthers (1997), the southern giant African bullfrog belongs to a monotypic genus, with a single species. The giant bullfrog (Fig. 1) is considered the largest in southern Africa, reaching 200 mm in length. If they are threatened or molested, the bullfrogs inflate or swell their bodies enormously to scare off an attacker.

Figure 1: Adult giant African bullfrog (from Okeyo, 2004).

The animal is characterized by a large and stocky body, a massive head with protruding eyes (horizontal eye pupil in adults), extremely big mouth with large tooth-like projections (cusps) on the lower jaw, non-webbed fingers, and a number of longitudinal elevated skin folds which are more prominent in the dorsum of large specimens. Small (under 100 mm) animals are spotted and variable in color and with the dorsum having a streak of single

longitudinal lines running from snout to tail region (see Conradie et al., 2010), while large ones are plain, with a dark-greenish dorsum. More keen and positive identification is recommended; the identification of the frog may involve using over all coloration, adult size, eye to tympanum relationship, eye position and throat coloration (Jeff Kapp, pers. communication).

The giant African bullfrog is distributed widely throughout Southern and Eastern Africa: Namibia, Angola, Botswana, South Africa, Zimbabwe, Zambia, Mozambique, Malawi, Tanzania and Kenya (Channing 1991; Conradie et al., 2010; IUCN, 2011; Fig. 2). It is reported to occur in the central and northern areas of Namibia (Channing 1991; Griffin, 1997); found in considerable numbers in the northern plains, especially during the early times of any rainy season. Here it begins its life as eggs laid in shallow water of the oshanas (in the case of northern Namibia) as well as in ponds, pools, swamps and streams (rivers) with slow moving water. Eggs hatch into tadpoles and after a month or so, they turn into froglings. At the time, the frog appears in various sizes: the subjuveniles and the juveniles, locally known as 'ukadhinahanya' - small ones and adults, locally known as 'namuhogelela' - big ones. They may take about eight years to reach sexual maturity (Yetman et al., 2012). If they are not killed by predators such as snakes or by human beings, the giant African bullfrog can live, inhabiting close proximities with water, or in hibernation (aestivation; Loveridge & Withers, 1981; Withers & Richards, 2005; Yetman & Ferguson, 2011), to a ripe age of about forty (40) years (Yetman et al., 2012). It is understood that they aestivate for much of the year and come to the surface after the first rains to feed and breed.

The aim of this study was to record the feeding habits of the giant African bullfrog of the Cuvelai drainage basin in northern Namibia. Publications on the subject matter and conservation are still scarce (IUCN, 2010). The knowledge of the feeding habits of the frog is important. The information may be useful for the development and formulation of artificial feed for purposes of propagating the giant Africa bullfrog. The propagation would make the delicacy available throughout the year, while reducing the pressure on natural populations, thereby conserving the species.

For purposes of this paper, 'The Cuvelai' covers areas of the regions of northern Namibia studied: Oshikoto, Ohangwena, Oshana and Omusati, formerly known as Owamboland. It is hoped that this article will stimulate interest for the conservation of the African bull frog by improving the knowledge of managers and the local communities.

Figure 2: The giant African bullfrog distribution (from IUCN, 2011).

2 Materials and Methods

The study involved frog collection for purposes of feeding ecology. To study the feeding habits, juveniles were separated from adults according to size and skin colour. Juveniles (under 100 mm; 0 to <50 grams) animals were spotted and variable in colour and with the dorsum having a streak of single longitudinal line running from snout to tail region (Conradie et al., 2010). The adult animal (over 100 mm; 150 to <200 grams) were plain, with a darkish-greenish dorsum and characterized by a large and stocky body, a massive head with protruding eyes (horizontal eye pupil in adults), extremely big mouth with large tooth-like projections (cusps) on the lower jaw, non-webbed fingers, and a number of longitudinal elevated skin folds which were more prominent in the dorsum of large specimens. More keen and positive identification is recommended; the identification of the frog may involve using over all coloration, adult size, eye to tympanum relationship, eye position and throat coloration (Jeff Kapp, per. communication).

Frogs were collected from the water ponds along the oshanas during rainy season and juveniles preserved in whole in 10% formaldehyde and brought to the laboratory at the University of Namibia, Windhoek. Immediately after capture of large frogs, stomachs were eviscerated in the field and also preserved in the same concentration of formaldehyde solution. Formaldehyde is carcinogenic, so precaution was applied to avoid skin contact and direct inhalation. Running water was passed through specimens in the laboratory for a period of at least 24 hours; handling was done using gloves. The specimens were blotted with paper towel to remove excess water before weighing.

Dissection was done by cutting on the ventral side with forceps and scissors to make slits. Frog stomachs were blotted and weighed. Food contents from each stomach were removed and preserved in 5% alcohol solution for analysis. Food contents were observed under both dissecting and compound microscopes; food items were identified as much as possible to order level, using field guides (e.g. Gerber & Gabriel, 2002; USEPA, 2011); help for further identification of contents came from staff at the National Museums of Namibia and Department of Biological Sciences, University of Namibia. The abundance of the most important food items were analyzed using a modified standard techniques of 'points method' (Hynes, 1950; Marrero & Lopez-Rojas, 1995). Test statistics (SPSS 10.0) was applied to determine whether there is a correlation between food quantity and frog weight, in order to indicate a shift in specific diet. The correlation coefficients show that there is a significant association if values are between -1 and +1, when performed at 95% confidence level.

3 Results and Discussion

Feeding ecology: Five most important food items for the juvenile frogs come from Orthoptera (20.0%), Lepidoptera (16.0%), Isoptera (15.5%), Coleoptera (12.0%) and tadpoles (11.0%), in that hierarchical order (Table 1) - the latter indicating a habit of cannibalism. Five most important food items to the adult frogs also come from Orthoptera (20.0%) but followed by, Tadpoles (13.05%), Coleoptera (11.8%), Odontata (11.0%) and Hemiptera (10.0%) in that order. Stomachs from juvenile and adult frogs also contained well digested, thus, unidentified contents of 2.0% and 12.0%, respectively (Table 1).

Table 1: The most important food items eaten by juvenile and adult giant African bullfrog from water pools (the oshanas), northern Namibia.

Food item (Taxon)	Juveniles (%)	Adults (%)
Orthoptera	20.00	20.00
Hemiptera	5.00	10.00
Coleoptera	12.00	11.80
Diptera	2.50	0.24
Lepidoptera	16.00	5.03
Hymenoptera	2.45	0.95
Odontata	8.00	11.00
Isoptera	15.50	2.75
Crustecea	0.87	3.15
Gastropoda	0.25	2.26
Zoogoptera	3.50	0.34
Monoptera	0.50	1.13
Arthropoda	0.43	6.30
Tadpoles	11.00	13.05
Unidentified	2.00	12.00
TOTAL	100.00	100.00

Diet shifts: Food items eaten by the giant African bullfrog are mainly insects. The diet consists of mainly ants (especially from the family Foramicidae), eaten at all stages of life; the diet also involved a variety of beetles (especially from the order Coleoptera) (Fig. 3). Correlation between food quantity and frog weight classes indicates a shift in specific diet. For example, while the small frogs (0 to <50 grams) and the large frogs (150 to <200 grams) take a rather equal amount of ants, more and more tadpoles and beetles are taken as the frogs become larger (Fig. 3).

Food items eaten by the giant African bullfrogs of all sizes range from as tiny as ants to beetles and tadpoles, in the plains (oshanas) of northern Namibia. Conradie et al. (2010)

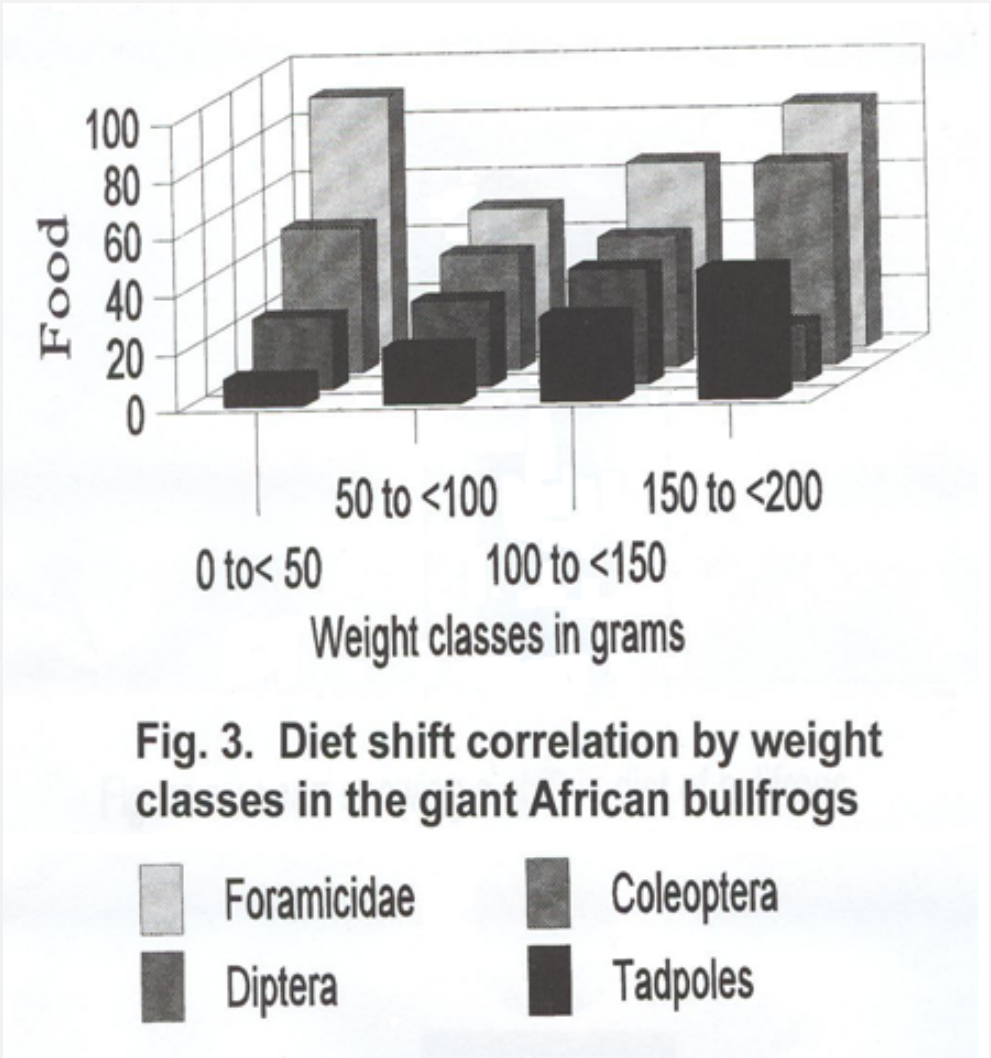

Figure 3: Diet shift correlation by weight classes in the giant African bull frogs.

studying the diet of metamorphosed giant African bullfrogs from a semi-aquatic habitat in the Karoo, South Africa, reported that all stomachs contained insects, accounting for the greatest prey diversity, with Coleopterans (11 families) dominating the 29 insect families recorded. There was growth increase by the metamorphosed giant African bullfrogs during the first nine months of feeding the insects, suggesting some nutritional gain. Alternatively, the frog may behave opportunistically at metamorphosis, feeding selectively on easy to access and available ants during certain seasons in the semi arid Karoo. In the Karoo, various types of ants come out above the ground when the season warms up in the summer times (per. observation). The variety of food sizes may suggest that the bull frog seems to eat anything that fits in its mouth or anything it can overpower. The diet tends to be mainly carnivorous. The diet of the bullfrog also includes large items as, fishlings, rodents (such as rats and mice), earth and butter worms, crickets, grasshoppers, lizards and small birds and other frogs (Polis & Myers, 1985). The diet taken may correlate with skull shape in frogs (Emerson, 1985). In the oshanas, less tadpoles and beetles are consumed by the juvenile frogs compared to the adult frogs. Sometimes large frogs become cannibalistic and feed on small frogs. According to Bolker et al. (2008), diseases may play selective force precluding cannibalism in nature; obviously the populations sampled in this study are on the high side of cannibalism.

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