Feeding Habits of Two Sympatric Rocket Frogs (Genus Ptychadena) in a Forest Remnant of Southern-Central Ivory Coast, West Africa

Jean Christophe Béhibro Yao N’Gatta Konan1, N’Goran Germain Kouamé2*, Akoua Michèle Kouamé1, Abouo Béatrice Adepo-Gourène1 and Mark-Oliver Rödel1

1Nangui Abrogoua University, Pôle de Recherche en Pêche et Aquaculture, UFR-SN, 02 BP 801, Abidjan 02, Côte d’Ivoire
2Jean Lorougnon Guédé University, UFR-Environnement, Department of Biology and Animal Physiology, Daloa, BP 150, Côte d’Ivoire

Museum of Natural Science, Leibniz Institute for Evolution and Biodiversity Science, Invalidenstrasse 43, 10115 Berlin, Germany

Abstract

The decline of tropical amphibian species calls for studies on their biology and ecology, in order to understand their role in the respective ecosystems. We studied the diet of Ptychadena oxyrhynchus and P. longirostris, two rocket frogs co-occurring along dirt roads with puddles in the Azagny National Park, southern-central Ivory Coast. Stomach contents of 62 individuals of P. oxyrhynchus and 75 specimens of P. longirostris were obtained using the stomach-flushing method. The diet of both species was essentially characterized by various terrestrial invertebrates (predominantly insects) and both species can be considered opportunistic feeders. The presence of tadpoles in the stomach of a female P. longirostris indicates that this species may occasionally prey on aquatic food items as well. The large overlap in prey between both study species can be taken as a hint that competition for food does not play a major role between them. An unexpected observation was the proportion of plant fragments in the diet of our frogs. However, it remains unknown if they devoured plant deliberately or not. Future research should investigate this question.

Keywords: Amphibians; Azagny National Park; Prey composition; Ptychadena longirostris; Ptychadena oxyrhynchus; Upper Guinea

Introduction

Currently, 16 rocket frog species, genus Ptychadena Boulenger, 1917, family Ptychadenidae Dubois, 1987, are known to occur in West Africa [1]. Species of this sub-Saharan genus are widespread in various habitats ranging from different savannahs and grasslands, different forest ecosystems, lowland to mountainous habitats and even occur in urban areas [2-7]. Taxonomic determination of some of these species is sometimes difficult [2,8]. However, up to 14 Ptychadena species have been recorded from Ivory Coast [1].

Ptychadena oxyrhynchus and P. longirostris are two species easily distinguishable from other congeners and both are common in West Africa [2]. Whereas P. oxyrhynchus is predominately a savannah species, P. longirostris is a forest dweller [2,3]. They are widespread in Ivory Coast and meet in the savannah-forest ecotone and in degraded parts of rainforests [2,3,5,9-11]. Both species have been reported to live in sympatry in some forest remnants of south-eastern Ivory Coast [6,12], south-western Ghana [13] and south-western Nigeria [14]. However, despite the numerous publications recording both species [2,13-18] we know only little about their biology. Apart from the reproductive biology, the diet of frogs may help to better understand their biology [19].

Ptychadena oxyrhynchus has been the object of a few ecological studies dealing with reproduction and population dynamics [20], as well as with diet [21]. In contrast, neither data are available for P. longirostris. An area where Ptychadena oxyrhynchus and P. longirostris co-occur is the Azagny National Park (ANP), southern-central Ivory Coast, where the species are found along dirt roads with puddles. We herein compare the prey composition of both species in this secondary rainforest.

Materials and Method

Study site

The Azagny National Park (ANP; 5.15°-5.28° N; 4.78°-4.95° W, 1-100 m a.s.l.) comprises 21,850 ha of coastal rain forest, located in the department of Grand-Lahou, southern-central Ivory Coast (Figure 1). The mean annual temperature is 26°C; the mean annual precipitation is 1,664 mm [22]. The equatorial climate includes a long rainy season from April to mid-July, followed by a short dry season from mid-July to mid-September. A shorter rainy season extends from mid-September to November and the long dry season lasts from December to April. Swamp-forests cover two-thirds of the park. Lauginie [23] provided an overview concerning the vegetation of the ANP.

Target species

Ptychadena oxyrhynchus is medium-sized and has extremely robust and long hind legs [2]. The basic dorsal color is beige with an olive tinge; the top of the snout is usually lighter colored. The dorsal ridges are well-defined (Figure 2a). Ptychadena longirostris (Figure 2b), likewise have very pointed heads, and long hind limbs. Their bright brown to sometimes yellowish dorsal coloration may be uniform or showing an ill-defined darker pattern. In contrast to P. oxyrhynchus the dorsal ridges are less well-defined [2,3].

In ANP, P. oxyrhynchus and Ptychadena longirostris co-occur along dirt roads with numerous temporary water bodies, i.e., puddles of different size.

Prey analyses

Frogs were captured from 28 April to 4 November 2015 with a

*Corresponding author: N’Goran Germain Kouamé, Jean Lorougnon Guédé University, UFR-Environnement, Department of Biology and Animal Physiology, Daloa, BP 150, Côte d’Ivoire; Tel: +22570228455; E-mail: ngoran_kouame@yahoo.fr

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dip-net along the dirt road puddles, between 22:30-00:30 h GMT. Detailed information concerning anuran survey methods in ANP are provided by Kouamé et al. [25] and Konan et al. [26]. After capture, frogs were sexed and their Snout-Urostyle-Length (SUL) measured with a dial caliper (accuracy ± 0.5 mm). Stomach contents of adult individuals were recorded by stomach flushing into a fine-meshed net [27,28], from which prey items were recovered with forceps, preserved in 70% ethanol and thereafter analyzed in the laboratory with the aid of a dissecting microscope. Frogs were released at their sites of capture. Invertebrates were determined to order level in insects, as insect larvae, spiders (Arachnida), woodlice (Isopoda), earthworms (Annelida) and unidentified preys (other prey) [29-31]. Further prey items were tadpoles and plants fragments. We determined and counted the prey items for each individual. For a quantitative analysis of the frogs’ diets, we counted the number of individuals that contained one type of prey and calculated the frequency of occurrence (Fi) of the different prey categories as the percentage of individuals containing a particular type of prey using the following formula [32,33]: Fi=100ni/n, where Fi= frequency of occurrence of the i food item in the sample, ni= number of individuals in which the i item was found, and n= total number of individuals with food in the sample.

The index of shared prey CA according to Morisita [34] modified from Horn [35] was used to calculate the prey overlap between P. oxyrhynchus and P. longirostris:

Where: S=the total number of prey items; xi= the proportion of prey i consumed by the species x; yi= the proportion of prey i consumed by the species y.

Ca would be 0 if the prey composition in both species was entirely different; Ca would be 1 if the prey of both species was identical. A Ca value smaller than 0.6 represents a significantly different trophic niche [36]. Other tests were performed with Statistica Version 7.1.

Results

We captured 77 P. oxyrhynchus and 88 P. longirostris. Fifteen P. oxyrhynchus (19.5%) and 13 P. longirostris (14.8%) had empty stomachs. Prey items were obtained from 62 P. oxyrhynchus (males: N=25; females: N=37) and 75 P. longirostris (males: N=60; females: N=15; Table 1).

SUL in male P. oxyrhynchus ranged between 46.0 and 60.9 mm (mean ± sd: 53.4 ± 4.3 mm), while females’ SUL varied from 58.0 to 65.1 mm (62.1 ± 2.3 mm). Respective SUL values in P. longirostris males was 37.6 to 48.7 mm (45.7 ± 2.4 mm), in females 54.0 to 58.5 mm (56.1 ± 1.6 mm). The pairwise comparisons with Bonferroni adjusted p-values showed that females of P. oxyrhynchus were significantly larger than those of conspecific males (p<0.001), males of P. longirostris (p<0.001), and female P. longirostris (p<0.001). Male P. oxyrhynchus also differed in size from male (p<0.001) and female P. longirostris (p=0.025). Female P. longirostris were significantly larger than conspecific males (p<0.001).

We identified nine prey categories consumed by P. oxyrhynchus and 13 in P. longirostris (Table 1). Male and female P. oxyrhynchus consumed prey items of the same categories. In contrast we found worms and a tadpole only in female P. longirostris, while only males consumed arachnids.

In Table 2 we summarize the percentage of the different prey categories (Fi%) consumed by both species. Insects represented the bulk of both species’ diet. Insect categories were represented by Blattodea, Coleoptera, Hymenoptera, and Insect larvae, Isopoda, Lepidoptera and Orthoptera. Five prey categories (coleopterans, hymenopterans, lepidopterans, orthopterans and plant fragments) dominated the diet of all frogs (Tables 1 and 2). Female P. oxyrhynchus mainly fed on small cockroaches (growing up to 2 cm in length), orthopterans

Table 1: Number of prey items (n) in specimens (s) of Ptychadena oxyrhynchus and Ptychadena longirostris (N=sample size).

| Prey category      | P. oxyrhynchus | P. longirostris |
|--------------------|----------------|-----------------|
|                    | N=25           | N=37            |
|                    | n   s  n   s | n   s  n   s   |
| Annelida           | -   -   0   2 | 0   2  0   2   |
| Arachnida          | 4   2  15   7 | 43  24  24   0  |
| Blattodea          | 39  13  6   2 | 27  15  0   0   |
| Coleoptera         | 10  5   9   7 | 7   5  3   3   |
| Hymenoptera        | 19  9   6   2 | 54  18  2   2   |
| Insect larvae      | 14 12  16   11| 11  5   0   0   |
| Isopoda            | -   -   -   - | 6   3  3   1   |
| Isoptera           | -   -   -   - | 23  8  0   0   |
| Lepidoptera        | 4   3   4   2 | 3   3  3   5   |
| Orthoptera         | 25  13  17   8| 24  20  6   4   |
| Other prey         | 2   2   2   2 | 8   8  0   0   |
| Plant fragments    | 5   5   1   1 | 5   5  3   3   |
| Tadpole            | -   -   -   - | 0   0  1   1   |

Table 1: Number of prey items (n) in specimens (s) of Ptychadena oxyrhynchus and Ptychadena longirostris (N= samplesize).
The prey composition did not significantly overlap between *P. oxyrhynchus* and *P. longirostris* (CA=0.78). However, the index of shared prey between males and females was significantly different in *P. oxyrhynchus* (CA=0.52) and in *P. longirostris* was (CA=0.091).

**Discussion**

Not surprisingly the diet of *P. oxyrhynchus* and *P. longirostris* in ANP mainly consisted of arthropods (predominantly insects and spiders) and plant fragments. Female *P. longirostris* mainly fed on butterflies, grasshoppers, beetles, and plant fragments; the dominant prey of males consisted of spiders, grasshoppers, ants and cockroaches.

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**Table 2:** Frequency of prey categories consumed by female and male *Phrynobatrachus oxyrhynchus* and *P. longirostris* in ANP (N=sample size).

| Prey category | *P. oxyrhynchus* | *P. longirostris* |
|---------------|-----------------|------------------|
|               | ♂ (N=25)        | ♀ (N=37)         | ♂ (N=60) | ♀ (N=15) |
| Annelida      |                |                  | 0        | 13.3     |
| Arachnida     | 0.0            | 8.5              | 0        | 13.3     |
| Blattodea     | 0.0            | 8.5              | 0        | 13.3     |
| Coleoptera    | 0.0            | 8.5              | 0        | 13.3     |
| Hymenoptera   | 0.0            | 8.5              | 0        | 13.3     |
| Insect larvae | 0.0            | 8.5              | 0        | 13.3     |
| Isopoda       | 0.0            | 8.5              | 0        | 13.3     |
| Isoptera      | 0.0            | 8.5              | 0        | 13.3     |
| Lepidoptera   | 0.0            | 8.5              | 0        | 13.3     |
| Orthoptera    | 0.0            | 8.5              | 0        | 13.3     |
| Other prey    | 0.0            | 8.5              | 0        | 13.3     |
| Plant fragments | 0.0          | 8.5              | 0        | 13.3     |
| Tadpole       | 0.0            | 8.5              | 0        | 13.3     |

An unexpected observation was the proportion of plant fragments in the diet of our studied frogs. Although the ingestion of plants is commonly reported in many anuran species [37,39,42-44], it is still unknown if frogs devour plant deliberately or not. Future research should investigate this question.

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