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

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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*; *P. 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 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

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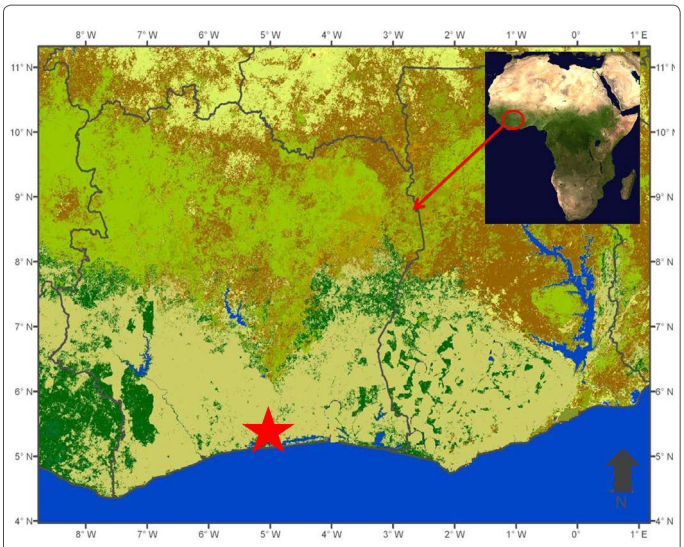

Figure 1: Geographical position of the Azagny National Park (red star) in southern-central Ivory Coast. The inset figure indicates the position of Ivory Coast on the African continent. The dark green areas represent original forest cover. Modified from Arinor et al. [24].

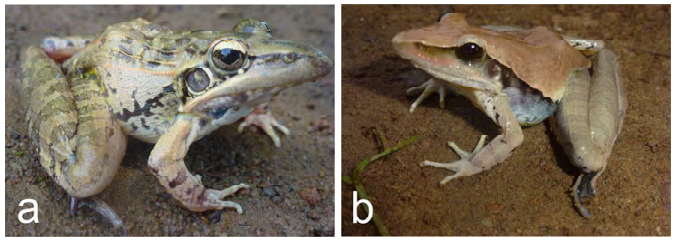

Figure 2: *Ptychadena oxyrhynchus* (a) and *P. longirostris* (b) from Azagny National Park.

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 Cλ 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.

Cλ would be 0 if the prey composition in both species was entirely different; Cλ would be 1 if the prey of both species was identical. A Cλ 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, Isoptera, 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

	Ptychadena oxyrhynchus				*Ptychadena longirostris*			
	♂ (N=25)		♀ (N=37)		♂ (N=60)		♀ (N=15)	
Prey category	n	s	n	s	n	s	n	s
Annelida	-	-	-	-	0	0	2	2
Arachnida	4	2	15	7	43	24	0	0
Blattodae	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	5	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).

	Ptychadena oxyrhynchus		*Ptychadena longirotris*	
	♂ (N=25)	♀ (N=37)	♂ (N=60)	♀ (N=15)
Prey category	Fi%	Fi%	Fi%	Fi%
Annelida	-	-	0	13.3
Arachnida	8	18.9	40	0
Blattodea	52	5.4	25	0
Coleoptera	20	18.9	8.3	20
Hymenoptera	36	5.4	30	13.3
Insect larvae	48	29.7	8.3	0
Isopoda	-	-	5	6.7
Isoptera	-	-	13.3	0
Lepidoptera	12	5.4	5	33.3
Orthoptera	52	21.6	33.3	26.7
Other prey	8	5.4	13.3	0
Plant fragments	20	2.7	8.3	20
Tadpole	-	-	0	6.7

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

(grasshoppers), insect larvae and hymenopterans (predominantly ants) while males of this species mainly preyed on insect larvae, grasshoppers, beetles 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.

The prey composition did not significantly overlap between *P. oxyrhynchus* and *P. longirostris* (Cλ=0.78). However, the index of shared prey between males and females was significantly different in *P. oxyrhynchus* (Cλ=0.52) and in *P. longirostris* was (Cλ=0.091).

Discussion

Not surprisingly the diet of *P. oxyrhynchus* and *P. longirostris* in ANP mainly consisted of arthropods (predominantly diverse insect orders). This is consistent with the diet of other congeners in Ivory Coast, e.g. *P. mascareniensis* and *P. pumilio* [37]. In contrast to our data, the diet of *P. oxyrhynchus* from a forest-savannah ecotone in central Ivory Coast was less diverse and mainly consisted of spiders and orthopterans [21]. These differences might be due to differing prey availability and/or other environmental conditions [37,38].

The large prey overlap between both Ptychadena species in ANP may be taken as a hint that competition for food does not play a major role between these two anurans. A similar observation for two sympatric forest frogs from the genus Phrynobatrachus has been reported in swampy parts of an Ivorian eastern forest remnant [39]. However, the values of Cλ beneath the threshold of 0.6 indicate that some intraspecific competitions for food could occur between males and females of respective species.

From a qualitative point of view, males and females of *P. oxyrhynchus* consumed similar prey, whereas in *P. longirostris* some differences in prey consumptions were found between sexes. In Malagasy *P. mascareniensis* the diet between males and females was similar [40], but it differed between sexes in Ivory Coast [37]. The later observation was attributed to a significant sexual dimorphism, with females being much larger than males. Regardless of sex the generalistic [41,42] diet of *P. oxyrhynchus* and *P. longirostris* was essentially characterized by terrestrial invertebrates (Tables 1 and 2), being in accordance with the terrestrial life of both species. However, the presence of a strictly aquatic prey, i.e., tadpoles, in the prey of a female *P. longirostris* indicates that this species also feeds in water. Many tadpoles are usually found in the road puddles, where they surface from time to time to breathe atmospheric oxygen. As only one *P. longirostris* specimen has fed on them, this seems to be a rather infrequent prey. The prey spectrum of *P. longirostris* indicates that this species is an opportunistic feeder. The fact that females did not consume isopterans (and spiders) and preyed on much less hymenopterans than conspecific males could be due to either their low number (N=15), which was four times inferior than captured males (N=60), or the significantly different trophic niche of both sexes (Cλ=0.091).

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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References

1. Frost DR (2015) Amphibian species of the World: an online reference. Version 6.0 (last checked on 18 December, 2015).
2. Rödel MO (2000) Herpetofauna of West Africa. Vol. 1 Amphibians of the West African savannah. Frankfurt/Main (Edition Chimaira) pp 332.
3. Rödel MO, Spieler M (2000) Trilingual keys to the savannah-anurans of the Comoé National Park, Ivory Coast. Stuttgarter Beiträge zur Naturkunde, Serie A 620: 1-31.
4. Rödel MO, Krätz D, Ernst R (2002) The tadpole of Ptychadena aequiplicata (Werner, 1898) with the description of a new reproductive mode for the genus (Amphibia, Anura, Ranidae). Alytes 2: 1-12.
5. Rödel MO, Ernst R (2003) The amphibians of Marahoué and Mont Péko National Parks, Ivory Coast. Herpetozoa 16: 23-29.
6. Kouamé NG, Konan JCBYN, Adepo-Gourène AB, Gourène G, Rödel MO (2014) The amphibians of the Yakassé-Mé village forest, a threatened rainforest of south-eastern Ivory Coast. Herpetology Notes 7: 657-665.
7. Kouamé NG, Ofori-Boateng C, Adum GB, Gourène G, Rödel MO (2015) The anuran fauna of a West African urban area. Amphibian and Reptile Conservation 9: 1-14.
8. Rödel MO, Branch WR (2002) Herpetological survey of the Haute Dodo and Cavally forests, western Ivory Coast, Part I: Amphibians. Salamandra 38: 213-232.
9. Lamotte M (1967) Les batraciens de la région de Gpakobo (Côte d'Ivoire). Bulletin de l'Institut Fondamental d'Afrique Noire, Série A 29: 218-294.
10. Rödel MO (2003) The amphibians of Mont Sangbé National Park, Ivory Coast. Salamandra 39: 91-110.
11. Assemian NE, Kouamé NG, Tohé B, Gourène G, Rödel MO (2006) The anurans of the Banco National Park, Côte d'Ivoire, a threatened West African rainforest. Salamandra 42: 41-51.
12. Kpan TF, Adeba PJ, Kouamé NG, Koné I, Kouassi KP et al. (2014) The anuran fauna of a Volunteer Nature Reserve: the Tanoé-Ehy Swamp Forests, south-eastern Ivory Coast, West Africa. Zoosystematics and Evolution 90: 261-270.
13. Rödel MO, Gil M, Agyei AC, Leaché AD, Diaz RE, et al. (2005) The amphibians of the forested parts of south-western Ghana. Salamandra 41: 107-127.
14. Onadeko AB, Rödel MO (2008) Anuran surveys in south-western Nigeria. Salamandra 44: 153-167.
15. Nago SGA, Grell O, Sinsin B, Rödel MO (2006) The amphibian fauna of Pendjari National Park and surroundings, northern Benin. Salamandra 42: 93-108.

16. Hillers A, Rödel MO (2007) The amphibians of three national forests in Liberia, West Africa Salamandra 43: 1-10.

17. Hillers A, Loua NS, Rödel MO (2008) A preliminary assessment of the amphibians of the Fouta Djallon, Guinea, West Africa. Salamandra 44: 113-122.

18. Hillers A, Boateng CO, Segniagbeto GH, Agyei AC, Rödel MO (2009) Assessment of the amphibians in the forests of southern Ghana and western Togo. Zoosystematics and Evolution 85: 127-141.

19. Parker ML, Goldstein MI (2004) Diet of the Rio Grande leopard frog (Rana berlandieri) in Texas. Journal of Herpetology 38: 127-130.

20. Barbault R, Trefaut Rodriguez M (1978) Observation sur la reproduction et la dynamique des populations de quelques anoures tropicaux I. *Ptychadena maccarthyensis* et *Ptychadena oxyrhynchus*. Terre Vie 32: 441-452.

21. Barbault R (1974) Le régime alimentaire des amphibiens de la savane de Lamto (Côte d'Ivoire). Bulletin de l'Institut Fondamental d'Afrique Noire Série A 36: 952-972.

22. Eldin M (1971) Le climat. In: Le Milieu Naturel de la Côte d'Ivoire, p. 73-108, Avenard JM, Eldin M, Girard G, Sircoulon J, Touchebeuf P, et al. Eds, Paris, ORSTOM.

23. Lauginie F (2007) Conservation de la nature et aires protégées en Côte d'Ivoire. Abidjan (Editions CEDA/NEI et Afrique Nature).

24. Arinor O, Ramos Pere JJ, Kalogirou V, Bontemps S, Defourny P et al. (2012) Global Land Cover Map for 2009 (GlobCover 2009). European Space Agency and Université Catholique de Louvain.

25. Kouamé AM, Kouamé NG, Konan JCBYN, Adepo-Gourène AB, Rödel MO (2015) Contributions to the reproductive biology and behaviour of the dotted reed frog, *Hyperolius guttulatus*, in southern-central Ivory Coast, West Africa. Herpetology Notes 8: 633-641.

26. Konan JCBYN, Kouamé NG, Kouamé AM, Adepo-Gourène AB, Rödel MO (2016) New data from *Morerella cyanophthalma* (Anura: Hyperoliidae) in Azagny National Park, southern-central Ivory Coast. Herpetology Notes 9: 59-65.

27. Joly P (1987) Le régime alimentaire des amphibiens: méthodes d'études. Alytes 6: 11-17.

28. Solé M, Beckmann O, Pelz B, Kwet A, Engels W (2005) Diet analysis by stomach-flushing in amphibians: an improved protocol evaluated in a case study on the Araucaria Plateau, Brazil. Studies on Neotropical Fauna and Environment 40: 23-28.

29. Delvare G, Aberlenc H (1989) Les insectes d'Afrique et d'Amérique tropicale. Clés pour la reconnaissance des familles. CIRAD-PRIFAS, Montpellier.

30. Dierl W, Ring W (1992) Guide des insectes: description, habitat, moeurs. Paris (Edition Delachaux et Niestlé).

31. Tachet H, Richoux P, Bournaud M, Usseglo-Polatera P (2003) Invertébrés d'eau douce: systématique, biologie, écologie. Paris (Editions du Centre National de la Recherche Scientifique).

32. Rosecchi E, Nouaze Y (1987) Comparaison de cinq indices utilisés dans l'analyse des contenus stomacaux. Revue des Travaux de l'Institut des Pêches Maritimes 49: 111-123.

33. Gray AE, Mulligan TJ, Hannah RW (1997) Food habits, occurrence, and population structure of the bat ray, Myliobatis californica. Environmental Biology of Fishes 49: 227-238.

34. Morisita M (1959) Measuring of interspecific association and similarity between communities. Memories of the Faculty of Sciences Kyushu University, Serie E 3: 65-80.

35. Horn HS (1966) Measurement of overlap in comparative ecological studies. The American Naturalist 100: 419-424.

36. Zaret TM, Rand AS (1971) Competition in tropical stream fishes: Support for the competitive exclusive principle. Ecology 52: 336-342.

37. Tohé B, Kouamé NG, Assemian NE, Gourène G (2015) Diet of two sympatric rocket frogs (Amphibia, Anura, Ptychadenidae: Ptychadena) in the disturbed parts of a West African rainforest. International Journal of Innovative Science, Engineering and Technology 2: 444-459.

38. Inger R, Marx H (1961) The food of amphibians. In: Mission de Witte GF: Exploration du Parc National de l'Upemba, Institut des parcs nationaux du Congo et du Ruanda-Urundi, Fascicule 64: 1-86.

39. Kouamé NG, Tohé B, Assemian NE, Gourène G, and Rödel MO (2008) Prey composition of two syntopic Phrynobatrachus species in the swamp forest of Banco National Park, Ivory Coast. Salamandra 44: 177-186.

40. Fatroandrianjafinonjasolomiovazo TNL, Rasoamampionona NR, Vieites DR, Vences V (2011) Diet of the Mascarene grass frog, *Ptychadena mascareniensis*, in Madagascar. Malagasy Nature 5: 68-74.

41. Santos EM, Almeida AV, Vasconcelos SD (2004) Feeding habits of six anuran (Amphibia: Anura) species in a rainforest fragment in Northeastern Brazil. Iheringia Série Zoologia 94: 433-438.

42. Camera BF, Krinski D, Calvo IA (2014) Diet of the Neotropical frog *Leptodactylus mystaceus* (Anura: Leptodactylidae). Herpetology Notes 7: 31-36.

43. Da Silva HR, De Britto-Pereira MC (2006) How much fruit do fruit-eating frogs eat? An investigation on the diet of *Xenohyla truncata* (Lissamphibia: Anura: Hylidae). Journal of Zoology 270: 692-698.

44. Sabagh LT, Carvalho-e-Silva AMPT, Rocha CFD (2012) Diet of the toad *Rhinella icterica* (Anura: Bufonidae) from Atlantic Forest Highlands of southeastern Brazil. Biota Neotropica 12: 1-5.