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New record of a savannah frog, *Amnirana galamensis* (Anura: Ranidae), in a West Africa evergreen forest (Ivory Coast)

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Abstract

This study aimed to confirm the presence of *Amnirana galamensis* in the Taï National Park (a west Africa evergreen forest), and to collect additional data on ecology and morphology of these frogs. The study was carried out over a period from March 26 to April 14 2020. A population of 33 specimens of *A. galamensis* was found in the North of Taï National Park: six females and three males were captured; four frogs were observed and 20 calls were recorded. The snout-urostyle-lengths of *A. galamensis* 's males ranged between 45-52 mm, those of females ranged between 53-57 mm. The survey area was characterized by the presence of bamboos, grasses, household garbage, damaged canoes, houses, potato fields. The presence of *A. galamensis* in this area of this park brings a clear indication of the advanced degradation of some habitats of this protected area located in forest block in southwestern Ivory coast.

Keywords: anurans, Ranidae, degraded habitats, ivory coast, evergreen forest

Introduction

Amnirana galamensis is a specie of the anuran amphibians of the Ranidae family. It is found in several sub-Saharan African countries such as Benin, Burkina Faso, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Ivory Coast, Eritrea, Ethiopia, Gambia, Ghana, Guinea-Bissau, Kenya, Malawi, Mali, Mozambique, Nigeria, Senegal, Sierra Leone, Somalia, Tanzania, Uganda, Zambia ^[1, 2]. This frog is considered with less Concern according to the IUCN Red List of Threatened Species ^[2]. It is a highly aquatic specie in savannah areas, where it lives in and around permanent lakes, small rivers, ponds and swamps. It also survives in modified habitats. *Amnirana galamensis* is usually found in permanent water bodies, but if these dry up, it hides in sheltered areas and termite mounds. It breeds in still water lakes, ponds and swamps ^[2, 3].

In Ivory Coast, *A. galamensis* has been observed in the Lamto Reserve ^[4,5], Comoé National Park ^[3], Mont Sangbé National Park ^[6], Marahoué National Park ^[7], and an urban area in Daloa ^[8]. These types of localities are located in the savannah areas of the country. No studies have detected a population of *A. galamensis* in the rainforest of the south and south-west. Furthermore, *A. galamensis* is unknown from the Taï National Park, an evergreen forest environment in the southwestern Ivory Coast. Thus, this study aimed to confirm the presence of the *A. galamensis* population in the Taï National Park, and to collect additional data on the abundance, morphology and habitat of this frog.

Material and Methods

Study area

The study took place in the Taï National Park (Figure 1) located in the southwestern part of Ivory Coast, between Cavally and Sassandra rivers, in a quadrilateral formed by the towns of Guiglo, Buyo, San Pedro and Tabou. It lies between 05°08' and 06°24' north latitude and 06°47' and 07°25' west longitude ^[9]. The climate of the Taï National Park is that of the southwestern part of the country, it is sub-equatorial with four seasons: a large rainy season (from mid-March to July), a small rainy season (September-October), a large dry season (from November to mid-March) and a small dry season (August). The average annual rainfall is 1,800 mm. It ranges from 1,700 mm in the north to 2,200 mm in the south of the park ^[10]. The monthly average temperature varies from 24 to 28 °C ^[11].

The average relative humidity is always high every month. It varies between 85 to 90% under the forest cover and can often reach 100% during the night^[12]. Harmattan is irregular and very little felt; one to two weeks at most between December and January^[13]. The Taï National Park constitutes the western part of the large Guinean-Congolese floristic region of dense evergreen humid forests or rainforests^[14]. The flora of TNP is

very rich with 1350 plant species, 80 of which are endemic and 26 are on the IUCN Red List^[15]. In terms of fauna, the 536,000 hectares of the park contain about 145 species of mammals corresponding to 93% of the mammal species of the West Guinean forest zone^[16], 234 species of birds, 60 species of fish and 42 species of snakes. This fauna also includes 56 species of amphibians^[17].

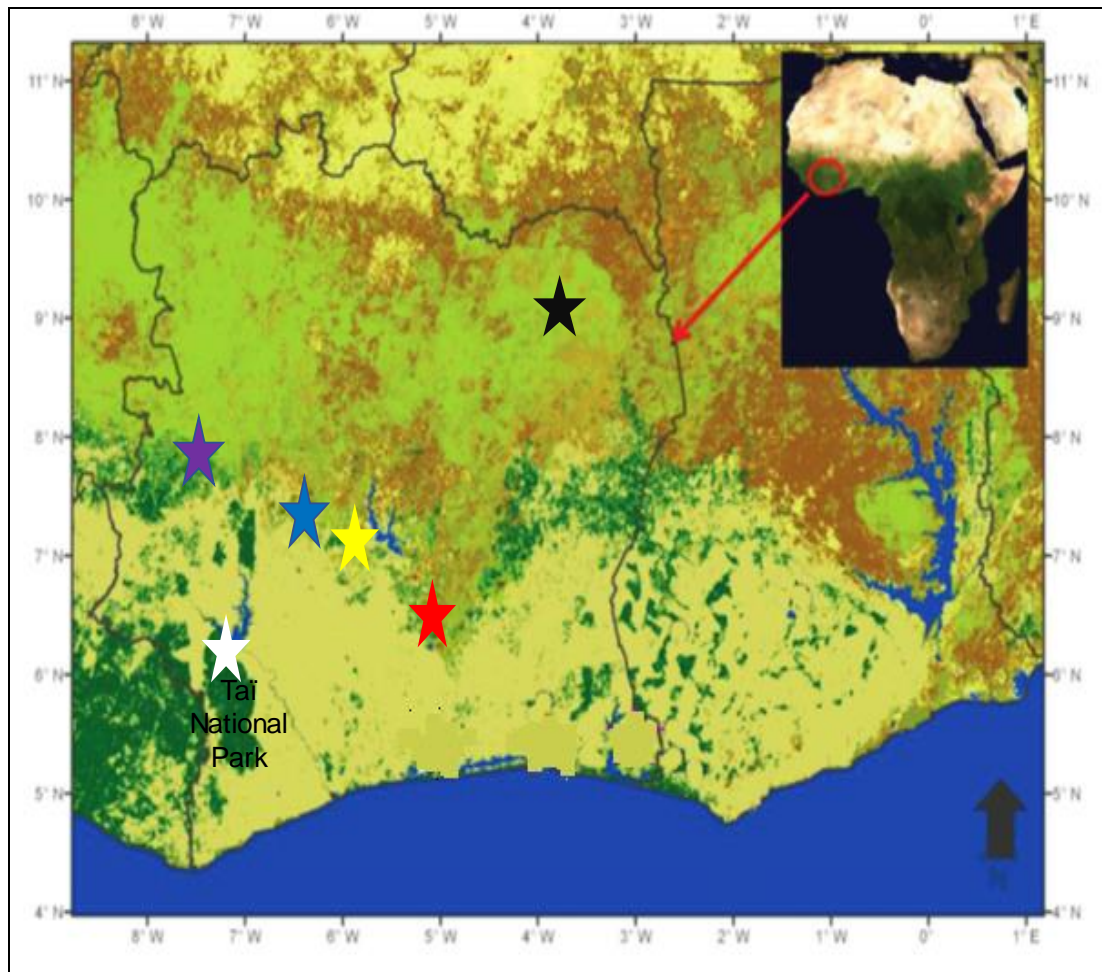


Fig 1: Geographical position of all six known localities (stars) of *Amnirana galamensis* in Ivory Coast. The Lamto Reserve (red); the Marahoué National Park (yellow); the Daloa city (blue); the Mont Sangbé National Park (purple); the Comoé National Park (black) and the Taï National Park (white). Adapted from^[18].

Fieldwork

The study was carried in the rainy season from 26th March to 14th April, 2020. The fieldwork was carried out by one person (KHO). A GPS (Global Positioning System) device (Garmin 60 CSx) was used to record geographical positions. The sampling included acoustic and visual encounter surveys during day and night, which consisted in identifying the specimens of *A. galamensis* present in a fishermen's camp near one of the dead branches of Buyo Lake located the north of the Taï National Park. All available habitats were examined.

Frogs were searched in the park for 20 days, every day for seven hours (06 - 10 am and 6 - 9 pm). After frogs were captured, they were measured and their sex was determined. Morphometric measures were taken by one person with a dial calliper (accuracy ± 0.5 mm). The list of morphological characters that were measured on frogs was snout-urostyle-length (SUL), head width measured directly behind the eyes (HW), head length (HL), femur length (FL), tibia length (TL), foot length including longest toe (FTL), horizontal eye diameter (ED), interorbital distance (IOD), distance from

anterior corner of the eye to the snout tip (ES), horizontal tympanum-diameter (TD), and inter-nostril distance (IND). Measurements are given in mm, and were presented as means with standard deviations ($\bar{x} \pm sd$). Other characters were recorded, including the color pattern. Three specimens were kept for further study; all other specimens were released at the place where they were captured. Vouchers were preserved in 70% ethanol. They are deposited in the working collection of KHO at the Laboratory of Biology and Tropical Ecology of Jean Lorougnon Guédé University form Daloa (Ivory Coast).

Acoustic analysis

Calls (n=5) were recorded with a Samsung recorder (DUOS, 44.1 kHz sample ratio, 16 bits resolution, FFT length = 256) and analysed with the software Soundruler 0.9.6^[19, 20]. The call characteristics such as fundamental frequency (Hz), dominant frequency (Hz), minimum and maximum frequency (Hz), overall frequency bandwidth (Hz), and call duration (s) were measured. Values are presented as mean \pm standard deviation ($\pm SD$). Sonogram and waveform were prepared using the seewave R package^[21].

Statistical analysis

The non-parametric Mann-Whitney test was used to compare the size between females and males of *A. galamensis*. This test was carried out using the STATISTICA 7.1 software.

Results

A. galamensis were found only in the habitat of high anthropogenic pressure, at one site (06°14'12.7"N - 007°11'04.3"W). This site was characterized by very high fishing activities. It is dominated by an abundance of grass and garbage. A total of 33 frogs were inventoried: six females and three males were captured, four frogs were observed and 20 calls were recorded. All the frogs were found in the morning between 6 - 10 am and at night between 6 - 9 pm GMT during the whole study period. Frogs captured were found hidden under grass and in the garbage at the lakeshore (Figure 2).



Fig. 2: Habitat of *A. galamensis* in Tai National Park.

They also appeared to be camouflaged in hollows in the ground. Overall, the site had no canopy and was close to fishermen's dwellings. Some stands of mango trees, bamboo and potato fields were also observed on the site. Other anuran species have been found in this part of the forest: *Ptychadena mascareniensis* (Duméril and Bibron, 1841), *Hyperolius concolor* (Halowell, 1844), *Sclerophrys maculata* (Halowell, 1844), *Afrivalus dorsalis* (Peters, 1975), *Sclerophrys regularis* (Reuss, 1833), *Phrynobatrachus latifrons* (Ahl 1924), *Hoplobatrachus occipitalis* (Gunther, 1858), *Phrynobatrachus plicatus* (Gunther, 1858) and *Ptychadena pumilio* (Boulenger, 1920). A call recording further indicated the presence of a species of the genus *Kassina*. However, we could not detect this species visually and could not be identified.

The results of the morphological measurements of the frogs are summarized in Table 1. The snout-urostyle-lengths of males ranged between 45-52 mm, those of females ranged between 53-57 mm. Thus, males and females of *A. galamensis* differed in size but not significantly ($p = 1,000$; $n = 9$). However, males were smaller than females.

The description of the specimens of *A. galamensis* collected from the TNP showed that the basic body color of the frogs was dark brown and was relatively uniform showing just several paler yellow spots in the anal region and on the thighs.

A pale yellow or pale orange stripe runs from the nostril across the eyelid and along the dorsolateral ridge the body end.

Table 1: Morphometric measures of three males and six females of *Amnirana galamensis* from Tai National Park.

Morphological characters	Males (n=3)				Females (n=6)			
	Mean	sd	Min	Max	Mean	sd	Min	Max
SUL	47.7	0.7	45	52	55	1.7	53	57
FL	16	0.9	15.5	17	18.3	0.6	17.5	19
TL	24.2	1.6	23	26	27.7	1.2	26.5	29.5
HW	16.3	0.6	16	17	19.6	0.5	19	20
HL	14.2	0.8	13.5	14	16.9	0.9	16	18
FTL	35.8	2.7	34	39	40.5	0.5	40	41
IOD	2.7	0.3	2.5	3	3.5	0.5	3	4
ED	2.5	0	2.5	2.5	3.5	0.4	3.5	4
ES	9.8	0.3	9.5	10	11.4	0.5	11	12
TD	2.5	0.4	2.1	3	2.6	0.7	2	3.5
IND	1.3	0.2	1.1	1.5	2.2	0.2	2	2.5

The flanks show the same color on the back, bearing several flat yellowish warts with dark borders. The upper lips were white and the iris was orange. The feet and arms were light colored. The venter was whitish to light gray, with only the lateral region of the belly and hind limbs being mottled with dark. The part of the snout between the above-mentioned lines and the tympana was dark brown. The snout was moderately pointed. The tympanum was clearly visible. The males of *Amnirana galamensis* possessed a pair of vocal sacs. The toes and fingers had no discs (Figure 3).

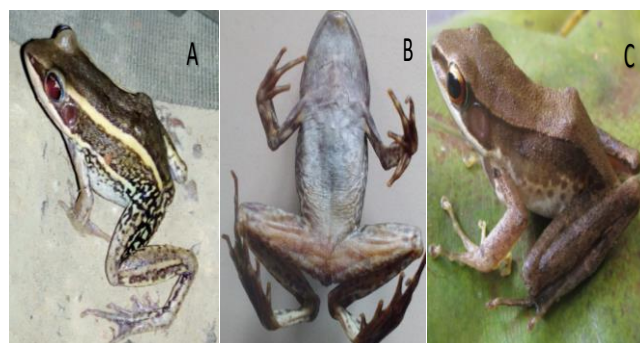


Fig 3: Pictures of *Amnirana galamensis* (A: side view; B: ventral view) and *Amnirana albolabris* (C: side view) from Tai National Park. (Photos by Oussou, 2020). Specimen (B) comes from the preservation of alcohol.

Seven advertisement calls were recorded from one male. Notes within each call were repeated between 1–3 times (Figure 4). Calls were short with a mean duration of 0.353 ± 0.088 s (range = 0.19–0.444 s, $N = 7$). Intervals between call durations averaged 3.645 ± 2.78 s (range = 1.056–8.952 s, $N = 6$). Intervals between notes within each call were 0.0065 ± 0.004 s (range = 0.0014–0.016 s, $N = 14$). The mean fundamental frequency was 997.77 ± 35.43 Hz (range = 984.37 – 1078.12 Hz, $N = 7$), while the dominant frequency reached 1995.53 ± 70.87 Hz (range = 1968.75 – 2156.25 Hz, $N = 7$). Whereas the maximum frequency intensity was at 2049.11 ± 100.22 Hz (range = 1968.75 – 2156.25 Hz, $N = 7$), the minimum frequency intensity, in contrast, averaged 1888.39 ± 100.22 Hz (range = 1781.25 – 1968.75 Hz, $N = 7$).

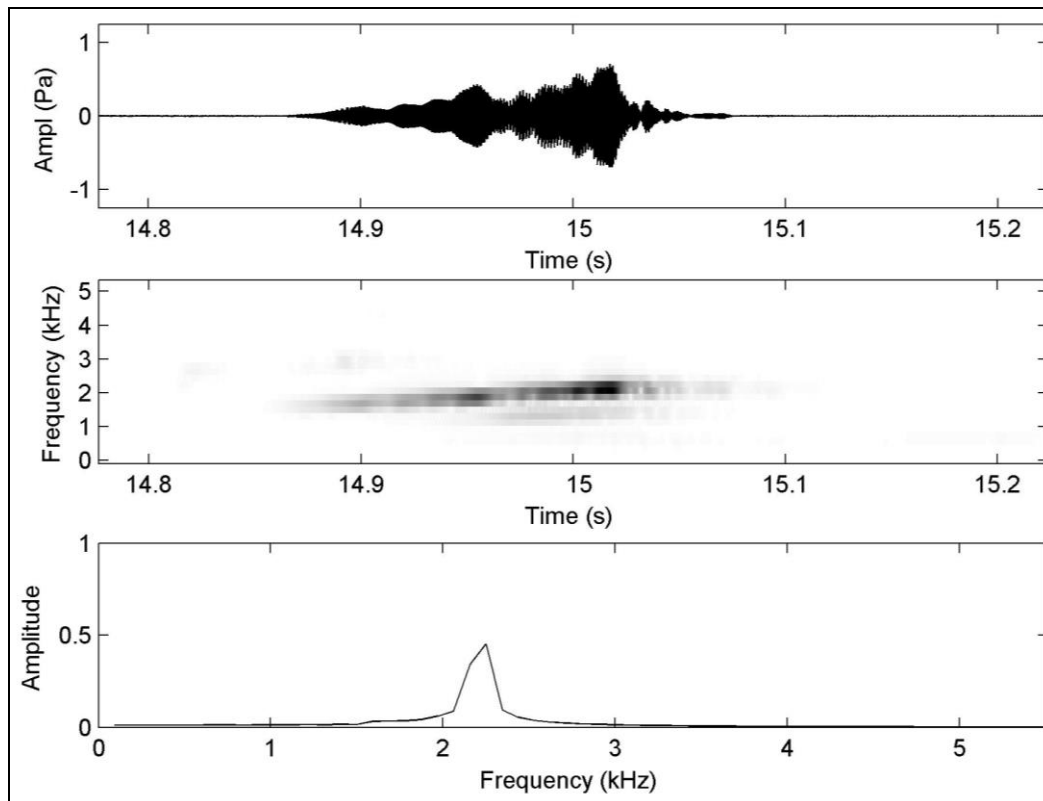


Fig 4: Waveform (above), sonogram (middle) and power-spectrogram (below) of the advertisement call of a male *Amnirana galamensis* from Taï National Park, Ivory Coast.

Discussion

The presence of *A. galamensis* has, so far, been confirmed only in five localities: the savannahs habitats of central, central-western and northern regions of Ivory Coast^[3, 4, 6, 7, 8]. Several studies have been carried out in forest habitats from Ivory Coast, for example in classified forests of Haute Dodo and Cavally in the south-western^[22] and Banco National Park in the south-eastern^[23]. But none of them have revealed the presence of *A. galamensis* in these ecosystems. Our survey confirmed the presence of the species in the Taï National Park, an evergreen forest, in the south-west of the Ivory coast, that is not likely to harbour *A. galamensis*. According to^[3], this species is a savannah frog. At TNP, we recorded only 33 specimens during the 20 days of the survey. The size of this population therefore seems high for a species that does not have a range in a forest area. No specimens of *A. galamensis* were recorded before among the amphibian species according to studies by^[17, 24, 25] conducted at the TNP. Indeed, these studies had been monitored at several permanent sites near the town of Taï (west of the park) between 1999 and 2002. Frog habitat in the TNP was characterized by dwellings, fishing equipment (nets, dugout canoes, etc...), the strong presence of grasses, bamboo and household garbage near a lake. Similar habitats were reported in an urban area of Daloa where a few individuals of *A. galamensis* were observed on a site with grasses, bamboos, buildings and ornamental plants near a permanent pond^[8].

In TNP, *A. galamensis* may be confused with the species *A. albolabris*, which lives in forests^[26]. Furthermore, although these two species are morphologically similar, the dorsal-lateral yellow band in *A. galamensis* makes it easy to identify this frog species (cf. figure 3).

Measurements of the population of *A. galamensis* from TNP would be slightly smaller than those reported by^[3] who reported that a male of 77.4 mm in length was found in

Comoé National Park and the largest female measured 62 mm. These morphological differences could be said to be biologically irrelevant. However, the *A. galamensis* population of TNP is morphologically closer to the population of these species in savannah areas.

Conclusion

At the end of the study, we will consider our new data as the best known of *A. galamensis*, a record in the south-west forest of Ivory Coast. However, we don't know if the specie is found somewhere in another forest area from Ivory Coast, but it is highly probable given the strong anthropogenic pressure on the forests of this country. Furthermore, our data show that *A. galamensis* is capable of living in degraded forests close to watercourses. However, given the apparent abundance of the *A. galamensis* population in TNP (33 frogs recorded during 140 person-hours of research), it is therefore important to urge the protection and conservation of the park, as the presence of such species gives a clear indication of the advanced degradation of certain habitats of the park.

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