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## Croaking's activities of *Amnirana albolabris* (Hallowell, 1856) a frog from Banco National Park (Côte d'Ivoire)

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### Abstract

The croaking activities of *Amnirana albolabris* were studied in Banco National Park from February 2018 to January 2019. The songs were acoustically counted then, eight croaks were recorded in a male using a Techno device and analyzed using the Sounder software 0.9.6. The see wave R package was needed to highlight the graphics in the waveform. In this species, croaking usually begins at 3 p.m. and ends at 9 a.m. The rhythm of croaking activity is early during the heavy rainy season (6 p.m.) and peaks at 9 p.m. during the short dry season and the short rainy season. The peak is reached at 24 hours during the great dry season. The average duration of croaks is  $3.197 \pm 2.32s$ . The recorded average fundamental frequency is  $3960.937 \pm 4133.42$  Hz. The average dominant frequency reaches  $1980.47 \pm 2066.72$  Hz and the recorded average minimum frequency is  $3890.625 \pm 4113.72$  Hz. As for the maximum frequency average, it is  $4007.81 \pm 4154.6$  Hz. The average duration between intervals is  $6.03 \pm 2.25s$  and the notes were repeated in each croaking between 0 and 5 times.

**Keywords:** *Amnirana albolabris*, croaking, frequency, note, interval, Banco National Park

### 1. Introduction

Reproduction is an essential stage in the life cycle of anuran amphibians. It is done in freshwater (pond or river). Generally small males have vocal sacs intended for croaking. They compete with each other vocally to defend the borders between territories [1]. In these animals, croaking is generally related to reproduction [2, 3]. These anurans use these signals during the breeding season to attract mates [4]. Singing stimulates ovulation in females on the one hand and sex hormone production in immature males on the other [5]. Croaking is therefore a hallmark of reproduction in frogs. In addition, the songs of frogs are among the most reliable characteristics for identification [6]. Yet in Côte d'Ivoire, little data is available on the song of frogs. The most recent are those of Soro *et al* [7] whose work focused on the new species *Morerella cyanophthalma* (Hyperoliidae) from the swamp forests of Tanoé Ehy. As for Tohé *et al* [8] they report in a few species of Bufonidae, Ranidae and Hyperoliidae from the Banco National Park fish farm that the peak of song activity is between 9 pm and midnight. However, data on the analysis of songs from these species are still unknown. Also, the present study relating to the enumeration of songs of *Amnirana albolabris* and their analyzes would be a judicious contribution to the study of the ecology of this species of pharmacological interest.

### 2. Materials and methods

#### 2.1 Study site

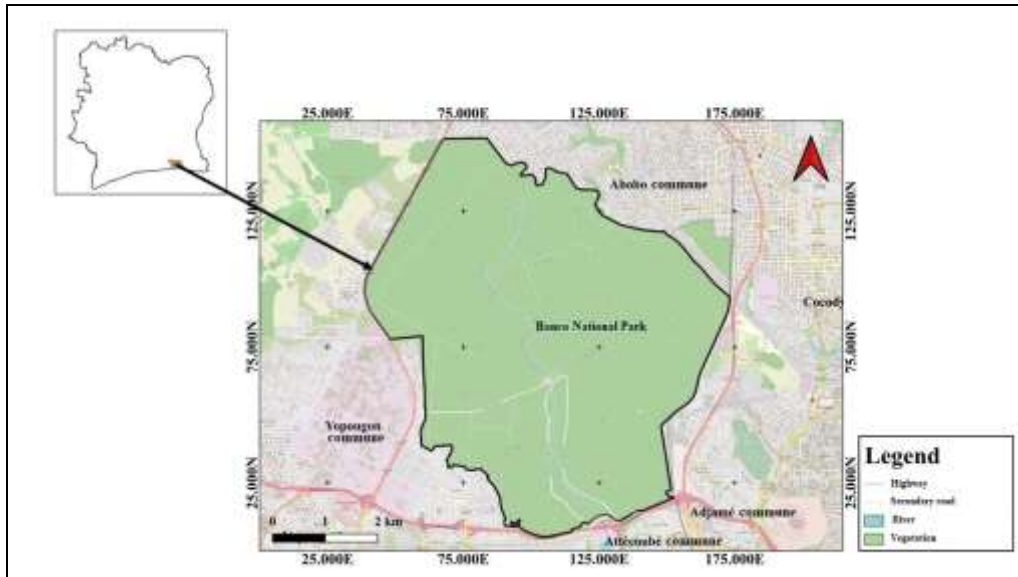
The study was carried out in the Banco National Park located within the vast Abidjan agglomeration between  $5^{\circ} 21'$  and  $5^{\circ} 25'$  North latitude and between  $4^{\circ} 1'$  and  $4^{\circ} 5'$  West longitude with an altitude between 0 and 113 meters [9]. This park is surrounded by the urban areas of the communes of Attécoubé in the South, Yopougon in the South-West, Adjamé in the South-East and that of Abobo in the North (Fig 1). Its area is estimated at 3000 ha [10].

#### 2.1 Methodology

The songs of the specimens of *Amnirana albolabris* were recorded at the fish farm (Fig 2) of the Banco National Park. The choice for this site was guided by the criteria of accessibility and the presence of specimens of this species. Four croaking activity rhythms were studied (one rhythm per season). The song count started at 9 a.m. and ended at 6 a.m. the next day.

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**Fig 1:** Geographical position of Banco National Park (Ivory Coast) according to the modified QGIS software.

In addition, eight croaks were recorded between 7 p.m. and 8 p.m. in a male of this species using a Techno Spark4 Air device.

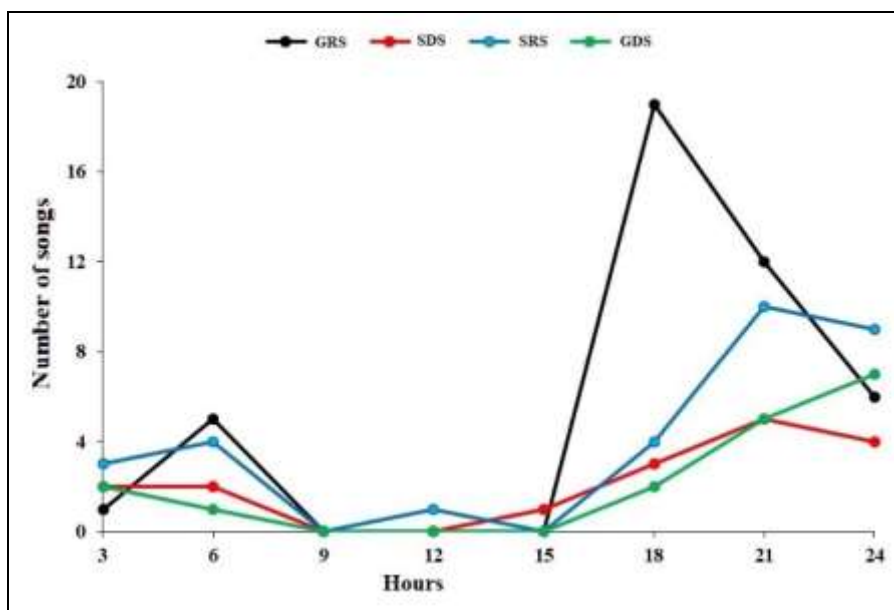
The croaking analysis required the use of the Sounder 0.9.6 software from Gridi-Papp [11] and Köhler *et al* [12]. This software allows highlighting the characteristics of croaking, such as fundamental frequencies (Hz), dominant frequency (Hz), minimum frequency (Hz), maximum frequency (Hz), bandwidth (Hz) and duration croaking. The waveform graphics were obtained using the seawave R package [13].



**Fig 2:** View of the Banco National Park fish farm.

### 3. Results

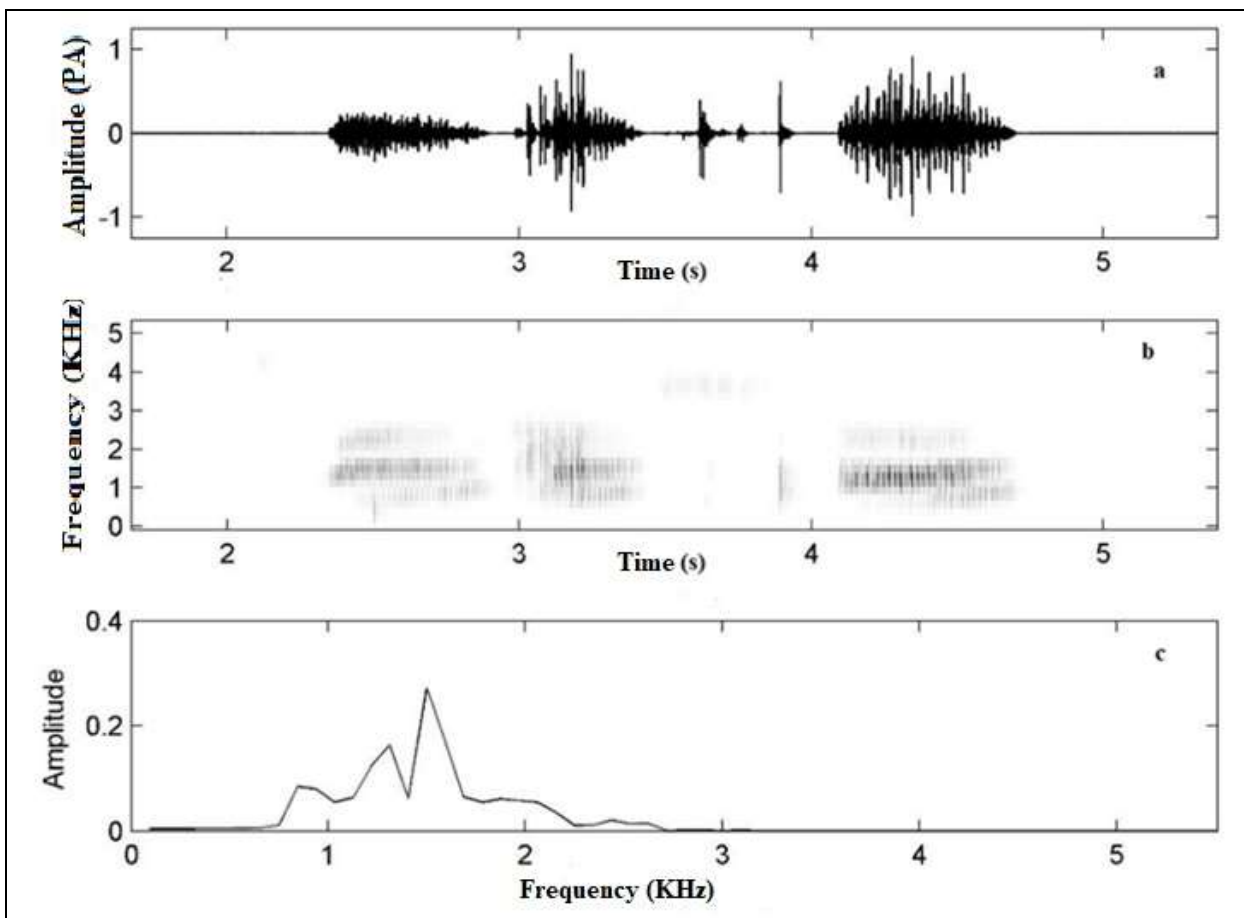
The Fig 3 illustrates four rhythms of croaking activity (one rhythm per season) in *Amnirana albolabris* at the Banco National Park fish farm. In this species, croaking activity usually begins after 3 p.m. and ends at 9 a.m. The peak of the songs is early during the great rainy season (18 hours). In contrast, activity peaks at 9 p.m. during the short rainy season and the short dry season and at 24 hours for the long dry season. The singing activity is very low between 9 a.m. and 3 p.m. A few sporadic chants are heard at 12 noon only during the short rainy season.



**Fig 3:** Daily activity of *Amnirana albolabris* croaking at the fish farm in Banco National Park: GRS= Great Rainy Season; SDS = Small Dry Season; SRS = Small Rainy Season; GDS = Great Dry Season.

The sinogram indicative of the croaking of *Amnirana albolabris* shows an oscillogram in waveform (Fig4a), a

sonogram (Fig 4b) and an amplitude spectrogram (Fig 4c).



**Fig 4:** Sinogram of the croaking of *Amnirana albolabris* from banco national park: (a) = oscillogram in wave form; (b) = sonogram; (c) = amplitude spectrogram

The pulse frequencies were recorded during the eight croakings in a male of *Amnirana albolabris* from Banco National Park (Table I).

Eight (08) vocalizations were recorded between 7 p.m. and 8 p.m. The average duration of the recorded croakings is  $3.197375 \pm 2.32s$  in an interval of 0.676 to 5.86s. In addition, the duration (in seconds) of the recorded croaking differs from one croaking to another. However, the lowest durations were recorded on the eighth croaking ( $0.676 \pm 0.48s$ ) followed by the fifth ( $0.789 \pm 0.56s$ ) and third ( $0.788 \pm 0.56s$ ). In contrast, the most extended durations were observed on the fourth croaking ( $5.86 \pm 4.14s$ ) followed by the second ( $5.747 \pm 4.06s$ ) and the seventh croaking ( $5.522 \pm$

3.90s).

Relative to the frequency of the pulses, the recorded average fundamental frequency is  $3960.937 \pm 4133.42$  Hz while the average dominant frequency reaches  $1980.47 \pm 2066.72$  Hz. The recorded average minimum frequency intensity is  $3890.625 \pm 4113.72$  Hz while the average maximum frequency intensity reaches  $4007.81 \pm 4154.6$  Hz. The highest dominant frequency ( $11531.25$  Hz) was reached during the second croaking. As for the lowest dominant frequency ( $1406.25$  Hz), it was recorded during croakings four and six. On the other hand, the strongest fundamental frequency ( $5765.625$  Hz) was observed during the second vocalization and the weakest ( $703.125$  Hz) during croakings four and six.

**Table I:** Pulse frequencies of eight croakings of *Amnirana albolabris* from Banco National Park D F = Dominant frequency, F.F = Fundamental frequency, Mini. F = Minimum frequency; Max. F = Maximum frequency

Croaking	Pulse frequencies (Hz)				
	Duration	D. F	F. F	Mini. F	Max. F
1	$3,718 \pm 2,63$	1968,75	984,375	1968,75	1968,75
2	$5,747 \pm 4,06$	11531,25	5765,625	11343,75	11531,25
3	$0,788 \pm 0,56$	1968,75	984,375	1968,75	1968,75
4	$5,86 \pm 4,14$	1406,25	703,125	1406,25	1406,25
5	$0,789 \pm 0,56$	2156,25	1078,125	1968,75	2156,25
6	$2,479 \pm 1,75$	1406,25	703,125	1218,75	1593,75
7	$5,522 \pm 3,90$	9656,25	4828,125	9656,25	9843,75
8	$0,676 \pm 0,48$	1593,75	796,875	1593,75	1593,75

Table II summarizes the duration of the intervals and amplitudes of the peaks in *Amnirana albolabris* from the Banco National Park.

The average time between intervals recorded is  $6.03 \pm 2.25$ s. In addition, the longest duration ( $8.71 \pm 6.16$ s) was observed between interval [5 - 6] followed by the interval [4 - 5] with a duration of  $8.34 \pm 5.89$ s. As for the shorter times, they are noted between the intervals [2 - 3] and [1 - 2] with the

respective values of  $3.61 \pm 2.55$ s and  $3.76 \pm 2.66$ s. Regarding the amplitude, the strongest (0.1025 Hz) was recorded between the intervals [6 - 7] with a peak lasting about 49.62s while the weakest amplitude (0.0002 Hz) was observed recorded between interval

[4 - 5] showing a peak that lasts 32.70s. Note, however, that the 0.0054 Hz peak corresponds to the interval [7 - 8] has the longest duration (60.95s).

**Table II:** Variations in the intervals between croaks and their amplitudes in *Amnirana albolabris* from Banco National Park.

Interval	Duration (s)	Parameters	
		Peak amplitude (Hz)	Peak duration (s)
[1 - 2]	$3,76 \pm 2,66$	0,0042	8,53
[2 - 3]	$3,61 \pm 2,55$	0,0003	14,95
[3 - 4]	$5,86 \pm 4,14$	0,0127	21,04
[4 - 5]	$8,34 \pm 5,89$	0,0002	32,70
[5 - 6]	$8,71 \pm 6,16$	0,0456	41,63
[6 - 7]	$4,13 \pm 2,92$	0,1025	49,62
[7 - 8]	$7,81 \pm 5,52$	0,0054	60,95

The notes and the intervals between the notes obtained between the eight croakings of *Amnirana albolabris* are summarized in Table III

A total of 17 intervals were obtained between 24 notes out of the 8 croakings. The notes were repeated in each croaking between 0 and 5 times. The average duration between note intervals is  $0.49 \pm 0.43$ s with an amplitude and peak of average values of 0.18Hz and 29.92s, respectively.

The intervals between the notes of croakings 2 and 4 are the most abundant (4 intervals each), while only one interval was obtained in notes two (02) coming from croakings 5 and 6. On the other hand, no note was accepted at croaking 3. The longest duration between note intervals is  $1.272 \pm 0.9$  s with an amplitude of 0.26 Hz, which lasts about 52.09 s. As for the most petite period between note intervals, it is  $0.01 \pm 0.01$ s and has a peak amplitude of 0.19Hz over a duration of 61.29 s.

**Table III:** variation of the intervals between the notes in *Amnirana albolabris* from the banco national park.

Croakings	Notes	Notes intervals	Duration (s)	Peak amplitude (Hz)	Peak duration (s)
		[1 - 2]	$0,12 \pm 0,1$	0,039	2,875
1	3	[2 - 3]	$0,69 \pm 0,5$	0,713	3,892
		[1 - 2]	$0,32 \pm 0,2$	0,014	8,924
	5	[2 - 3]	$0,23 \pm 0,2$	0,021	9,718
2		[3 - 4]	$0,47 \pm 0,3$	0,017	10,244
		[4 - 5]	$1,20 \pm 0,8$	0,039	11,989
3	0	0	0	0	0
4		[1 - 2]	$0,39 \pm 0,3$	0,018	23,109
	5	[2 - 3]	$0,21 \pm 0,1$	0,031	23,538
		[3 - 4]	$0,32 \pm 0,2$	0,031	24,103
		[4 - 5]	$1,18 \pm 0,8$	0,033	24,584
5	2	[1 - 2]	$0,12 \pm 0,1$	0,155	34,764
6	2	[1 - 2]	$0,61 \pm 0,4$	0,021	44,161
7		[1 - 2]	$1,05 \pm 0,7$	0,080	50,935
	3	[2 - 3]	$1,27 \pm 0,9$	0,260	52,089
8		[1 - 2]	$0,02 \pm 0,0$	0,422	61,217
	4	[2 - 3]	$0,07 \pm 0,1$	0,998	61,254
		[3 - 4]	$0,01 \pm 0,0$	0,186	61,299

#### 4. Discussion

The song activities of *Amnirana albolabris* recorded at the Banco National Park fish farm indicate that males of this species mainly sing at night with a peak in croaking at 9 p.m. This singing activity is very slow during the day. This high nighttime activity could be attributed to the relative humidity of the air, which is optimal (85%) at 9 p.m. on the fish farm. Indeed, Gibbons and Semlitsch<sup>[14]</sup> noted that low temperatures and high relative humidity in the air are favorable for the activities of Bufonidae, Ranidea and Hyperoliidea all night until dawn. High daytime temperatures and the resulting low humidity are believed to be the main causes of the drop, or even the stopping of song activity<sup>[15 - 8]</sup>.

Moreover Spieler and Linsenmair<sup>[16]</sup> reported in Comoé National Park that frogs are only active at night because of the relatively low temperatures observed during this period. From sunrise to sunset, the frogs take refuge in their hiding places. On the other hand, Wells<sup>[2]</sup> and Heyer *et al*<sup>[3]</sup> noted that the song activity of frogs is linked to reproduction. Also, nocturnal croaking suggests that amplexus phenomena occur mainly at night in this species. This has already been reported by Tohé *et al.*<sup>[8]</sup> in frogs from the Banco National Park fish farm.

Regarding croaking, eight (08) vocalizations were recorded in *Amnirana albolabris* between 7 p.m. and 8 p.m. The mean duration between croakings recorded was  $3.197375 \pm 2.32$  s



with a mean interval of 0.676 to 5.86 s. 24 notes were also recorded in the eight croakings. The notes were repeated in each croaking between 0 and 5 times. The average time between note intervals is  $0.49 \pm 0.43$  s. The recorded average fundamental frequency is  $3960.937 \pm 4133.42$  Hz. Thus, the recorded average dominant frequency is  $1980.47 \pm 2066.72$  Hz. In addition, the average minimum and maximum frequencies with respective values  $3890.625 \pm 4113.72$  Hz and  $4007.81 \pm 4154.6$  Hz were recorded. In Côte d'Ivoire to date, the only bibliographic data available to us is that of Soro *et al* <sup>[7]</sup> in the male of *Morerella cyanophthalma* (tree frog) from the forests of Tanoé-Ehy. These authors recorded 5 croakings in a male. The average duration between croakings is  $1.18 \pm 0.60$  s. The notes were repeated between 2 and 8 times. The average of the fundamental frequency is  $1266.1 \pm 38.5$  Hz and that of the dominant frequency is  $2532.3 \pm 77.0$  Hz. As for the maximum and minimum frequencies, the recorded values are respectively  $2601.2 \pm 94.3$  Hz and  $2428.9 \pm 94.3$  Hz. These differences could be explained by the fact that each frog species has a specific song that allows them to be identified. Incidentally on this subject, Rödel *et al.* <sup>[6]</sup> report that frogs' songs are among the most reliable characters for identification.

## 5. Conclusion

*Ammirana albolabris* is a very active frog species during the night's first half. In addition, the croakings rhythm is earlier during the rainy season than during the dry season. Song analyses showed that this frog species has a specific croak that distinguishes it from other frogs.

## 6. Acknowledgment

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