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 sing 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 ± 2.32s. The recorded average fundamental frequency is 3960.937 ± 4133.42 Hz. The average dominant frequency reaches 1980.47 ± 2066.72 Hz and the recorded average minimum frequency is 3890.625 ± 4133.72 Hz. As for the frequency maximum average, it is 4007.81 ± 4154.6 Hz. The average duration between intervals is 6.03 ± 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 fresh water (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 Tohè 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 in 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 ° 21’ and 5 ° 25’ North latitude and between 4 ° 1 and 4 ° 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, Adjâmé 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 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.
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 to highlight 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 seewave R package [13].

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 1: Geographical position of Banco National Park (Ivory Coast) according to the modified QGIS software.](image1)

![Fig 2: View of the Banco National Park fish farm.](image2)

![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.](image3)
The sinogram indicative of the croaking of *Amnirana albolabris* shows an oscillogram in wave form (Fig 4a), a sonogram (Fig 4b) and amplitude spectrogram (Fig 4c).

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 ± 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 ± 0.48s) followed by the fifth (0.789 ± 0.56s) and third (0.788 ± 0.56s). In contrast, the longest durations were observed on the fourth croaking (5.86 ± 4.14s) followed by the second (5.747 ± 4.06s) and the seventh croaking (5.522 ± 3.90s).

Relative to the frequency of the pulses, the recorded average fundamental frequency is 3960.937 ± 4133.42 Hz while the average dominant frequency reaches 1980.47 ± 2066.72 Hz. The recorded average minimum frequency intensity is 3890.625 ± 4113.72 Hz while the average maximum frequency intensity reaches 4007.81 ± 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 1: Pulse frequencies of eight croakings of *Amnirana albolabris* from Banco National Park

| Croaking | Duration | D. F  | F. F  | Mini. F | Max. F |
|----------|----------|-------|-------|---------|--------|
| 1        | 3.718 ± 2.63 | 1968.75 | 984.375 | 1968.75 | 1968.75 |
| 2        | 5.747 ± 4.06 | 11531.25 | 5765.625 | 11343.75 | 11351.25 |
| 3        | 0.788 ± 0.56 | 1968.75 | 984.375 | 1968.75 | 1968.75 |
| 4        | 5.86 ± 4.14 | 1406.25 | 703.125 | 1406.25 | 1406.25 |
| 5        | 0.789 ± 0.56 | 2156.25 | 1078.125 | 1968.75 | 2156.25 |
| 6        | 2.479 ± 1.75 | 1406.25 | 703.125 | 1218.75 | 1593.75 |
| 7        | 5.522 ± 3.90 | 9656.25 | 4828.125 | 9656.25 | 9843.75 |
| 8        | 0.676 ± 0.48 | 1593.75 | 796.875 | 1593.75 | 1593.75 |
Table II summarizes the durations 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 ± 2.25s. In addition, the longest duration (8.71 ± 6.16s) was observed between interval [5 - 6] followed by interval [4 - 5] with a duration of 8.34 ± 5.89s. As for the shorter times, they are noted between the intervals [2 - 3] and [1 - 2] with the respective values 3.61 ± 2.55s and 3.76 ± 2.66s. Regarding the amplitude, the strongest (0.1025 Hz) was recorded between the interval [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 it is the 0.0054 Hz peak corresponding to the interval [7 - 8] that 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) | Peak amplitude (Hz) | Peak duration (s) |
|----------|--------------|---------------------|------------------|
| [1 – 2]  | 3.76 ± 2.66  | 0.0042              | 8.53             |
| [2 - 3]  | 3.61 ± 2.55  | 0.0003              | 14.95            |
| [3 - 4]  | 5.86 ± 4.14  | 0.0127              | 21.04            |
| [4 - 5]  | 8.34 ± 5.89  | 0.0002              | 32.70            |
| [5 - 6]  | 8.71 ± 6.16  | 0.0456              | 41.63            |
| [6 - 7]  | 4.13 ± 2.92  | 0.1025              | 49.62            |
| [7 - 8]  | 7.81 ± 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 ± 0.43s with an amplitude and peak of average values of 0.18Hz and 29.92s, respectively.

### 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         | 3     | [1 - 2]        | 0.12 ± 0.1   | 0.039               | 2.875            |
| 5         | 3     | [2 - 3]        | 0.69 ± 0.5   | 0.713               | 3.892            |
|           | 5     | [1 - 2]        | 0.32 ± 0.2   | 0.014               | 8.924            |
| 2         | 3     | [3 - 4]        | 0.47 ± 0.3   | 0.017               | 10.244           |
| 3         | 0     | 0              |              | 0                   | 11.989           |
| 4         | 5     | [1 - 2]        | 0.39 ± 0.3   | 0.018               | 23.109           |
| 5         | 3     | [2 - 3]        | 0.21 ± 0.1   | 0.031               | 23.538           |
|           | 3     | [3 - 4]        | 0.32 ± 0.2   | 0.031               | 24.103           |
| 7         | 2     | [1 - 2]        | 0.12 ± 0.1   | 0.155               | 34.764           |
| 6         | 2     | [1 - 2]        | 0.61 ± 0.4   | 0.021               | 44.161           |
| 7         | 3     | [1 - 2]        | 1.05 ± 0.7   | 0.080               | 50.935           |
| 8         | 4     | [2 - 3]        | 1.27 ± 0.9   | 0.260               | 52.089           |
|           | 4     | [3 - 4]        | 0.07 ± 0.1   | 0.998               | 61.254           |

### 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 [14] noted that low temperatures and high relative humidity in the air are favorable for the activities of Buitonidae, Ranididae and Hyperoliidae 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 [15 - 8].

Moreover Spieler and Linsenmair [16] 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 [2] and Heyer et al [3] noted that the song activity of frogs is linked to reproduction. Also, nocturnal croaking suggests in this species that amplexus phenomena occur mainly at night. This has already been reported by Tohé et al [8] 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 ± 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 ± 0.43 s. The recorded average fundamental frequency is 3960.937 ± 4133.42 Hz. Thus, the recorded average dominant frequency is 1980.47 ± 2066.72 Hz. In addition, the average minimum and maximum frequencies with respective values 3890.625 ± 4113.72 Hz and 4007.81 ± 4154.6 Hz were recorded. In Côte d'Ivoire to date, the only bibliographic data available to us is that of Soro et al.  in the male of Morerella cyanophthalma (tree frog) from the forests of Tanoé-Ely. These authors recorded 5 croakings in a male. The average duration between croakings is 1.18 ± 0.60 s. The notes were repeated between 2 and 8 times. The average of the fundamental frequency is 1266.1 ± 38.5 Hz and that of the dominant frequency is 2532.3 ± 77.0 Hz. As for the maximum and minimum frequencies, the recorded values are respectively 2601.2 ± 94.3Hz and 2428.9 ± 94.3 Hz. These differences could be explained by the fact that each species of frog has a specific song which allows them to be identified. Incidentally on this subject, Rödel et al. report that, the songs of frogs are among the most reliable characters for identification.

5. Conclusion
Amnirana albolabris is a very active frog species during the first half of the night. 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.

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