SOUND ANALYSIS WORKSHOP

PARTICIPATION IN THE CORNELL LABORATORY OF ORNITHOLOGY TRAINING PROGRAMME WITH FUNDNG FROM THE AFRICAN BIRD CLUB

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Background: Sound Analysis Workshop

The Sound Analysis Workshop (SAW) is organised by the 'Bioacoustics Research Program' (BRP) of the Cornell Laboratory of Ornithology (CLO). The SAW is usually a week-long workshop that is conducted at the CLO, in Ithaca, New York, approximately twice a year. The course aims to provide a basic practical understanding of spectrographic analysis along with an introduction to a wide range of techniques used in sound analysis, and an introduction to applications of sound analysis techniques in biological research. The focus is primarily on the use of Raven[1] and XBAT[2] (two software programs developed at BRP) for two types of bioacoustics research – detailed analysis of sounds and large-scale monitoring programmes.

It is not possible to cover all aspects of these topics in detail in one week so each workshop is tailored to best suit the requests of the participants of that particular workshop. Participation is limited to a maximum of ten individuals, and participants come from a wide range of disciplines, with different levels of experience in sound analysis. Application for participation is made several months in advance of the next scheduled workshop. The normal cost of the course is USD 1,300, but a 20% discount is offered to enrolled students (undergraduates, Masters or PhD) making the student fee USD 1,040. Fees provide for five days of instruction, lunch and all required course materials. Participants are encouraged to bring their own recordings for analysis during the workshop. Transportation, lodging and meals other than lunch are the responsibility of the participant. My participation in the September 2009 SAW was facilitated by a workshop scholarship granted by the CLO (allowing access to all the workshop benefits and materials) and a conservation grant by the African Bird Club (covering transportation, accommodation and other logistics).

[1] There is a license fee of USD 800 for commercial research, USD 400 for academic, government, or non-profit research, and USD 100 for students, although there is a discount of 25-90% for users from developing countries.

[2] This is downloadable free of charge from the website, but, it runs in MATLAB, which can be an expensive program to buy. However, many institutes and universities have affordable MATLAB licenses.

Justification for participation

My doctoral research aims to examine the influence of habitat quality on several adaptive behaviours of bird species resident within an Afromontane forest in Nigeria. One of the behaviours being studied is vocalisation – relative to microhabitat and individual fitness. Attending the SAW allowed me understand how vocalisation can be measured and analysed as a qualitative and quantitative parameter. Furthermore, the CLO is at the forefront of bioacoustics research, exemplified by the software developed, as such are the most appropriate institution to approach for training. Lastly, bioacoustics research is a nascent area of indigenous ecological study in Nigeria, if not Africa as a whole.

Workshop programme

The topics covered in the workshop fall into three broad categories: basic principles, applications and hardware techniques (although the latter is covered only briefly).

Basic principles

To be able to use sound analysis tools effectively, it is essential to have a good understanding of the basics of the physics of sound, and of spectrographic analysis. These theoretical concepts were illustrated with Raven and topics included:

- Basic physics of sound: waveforms, factors affecting the speed of sound, harmonics.
- Digital audio: the difference between analogue and digital sound, sampling rates (Nyquist frequency), aliasing, sample size (bit depth).
- Time-domain versus frequency-domain representations of sound: waveforms and spectrograms.
- Spectrograms and the Discrete Fourier Transform (DFT): application of the Fourier Transform to successive short time-slices to represent time-varying spectra.
- Spectrogram parameters: trade-off between time and frequency precision (FFT size, window size and overlap).
- Evaluating recording quality through understanding waveform and spectrographic displays: aliasing and clipping.
- Understanding sound viewing techniques: waveforms, spectrograms and spectral slices.

Applications

The workshop focused on two broad categories of bioacoustics research; detailed analysis and large-scale monitoring programmes. Detailed analysis of specific vocalisations, for instance investigating differences in vocalisations among species or individuals of a species was done with Raven and involved:

- Measurements of different aspects of the acoustic energy in signals of interest (e.g. vocalisations or man-made noise), and choosing the appropriate measures and views (waveform, spectrogram, spectral slice) to use.
- Cross-correlation and how to use this to ascertain degrees of similarity amongst signals of interest.

Large-scale monitoring programmes may involve using recordings that may span many months, where the general aim is counting and/or locating vocalisations or other signals of interest. The tool used to illustrate this was the XBAT program, which is run in a MATLAB environment. The focus was on the automatic detection of desired sounds in long recordings. The XBAT tool makes use of spectrogram patterns (the image of the sound) and has proven to be a valuable tool.

An energy detector is also available in both Raven and XBAT, which detects the bandwidth of the desired sound. Additionally, Raven has an amplitude detector that works in the waveform.

Hardware techniques
The Macaulay Library of the CLO offers a course annually in California which better covers this topic: http://www.birds.cornell.edu/macaulaylibrary/Contribute/soundRecordingWorkshop.html

However, the opportunity was granted for me to undertake a 'crash course' in sound data collection, working with the Macaulay Library staff.

Participants are encouraged to bring their own sound recordings for analyses. My analyses focused on recordings of the Yellow-breasted Boubou, *Laniarius atroflavus*, which were made during the first field season of my research. The use of personal recordings for sound analyses during the workshop allowed a better understanding and appreciation – relative to each participant's research needs.

Outcomes
Though intense, the workshop was a successful learning experience. The limited number of participants enabled the instructors have a personal contact with each participants and the peculiarities of their sound analysis needs.

My analysis of the *L. atroflavus* sound allows a general description of the bandwidth (1,000-3,000 Hz), duration (0.5 sec) and pattern of this call (see Fig. 1 for the waveform and spectrogram view of the recording, and Fig. 2 for the spectrogram view of a single call – examples of some outputs from the Raven program). Presently, more records of the *L. atroflavus* sounds are being made during my ongoing second field season.

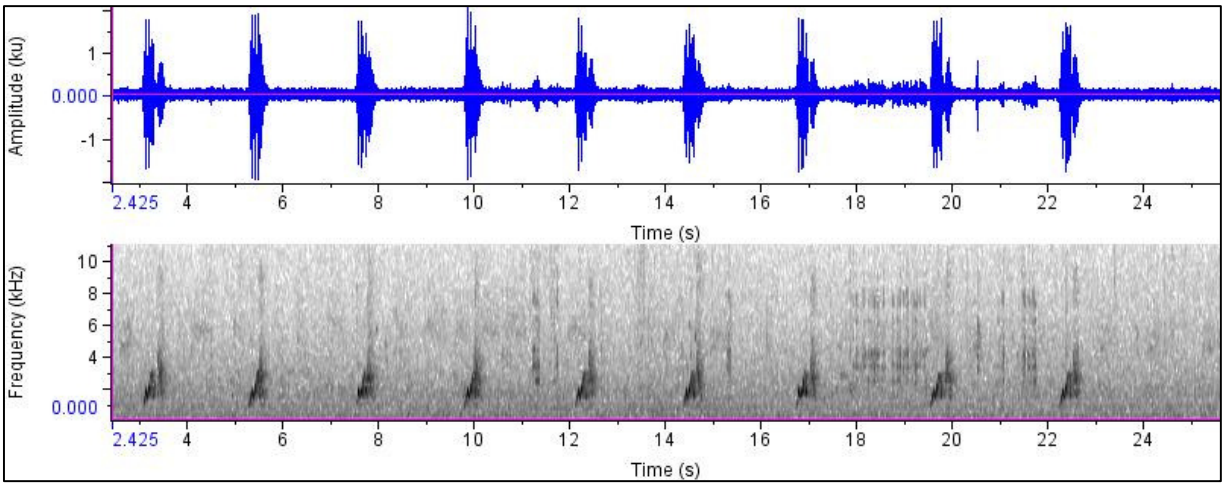

Figure 1: A waveform (top; Amplitude against Time) and spectrogram (bottom; Frequency against Time) view of field records of the *L. atroflavus*, duet. However, note that the abnormality at the 18th second of the recording is from a rattle in the casing of the recording unit, and is not part of the call.

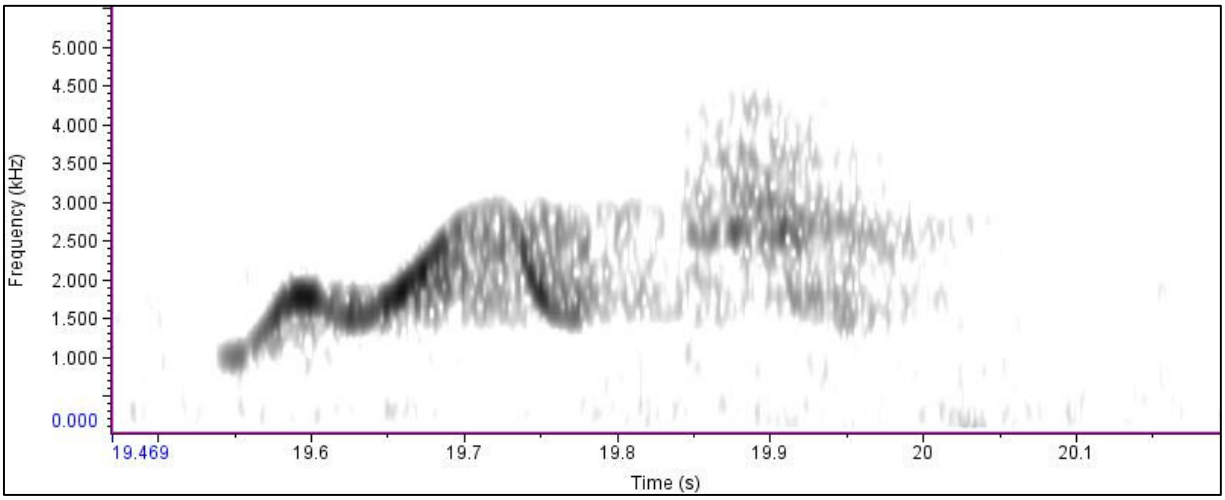

Figure 2: Spectrogram view of a single call of the *L. atroflavus*, duet structure showing the undulating male call (19.5-19.8 sec) and the 'clicked' response of the female (19.8-20 sec).

A Raven licence was purchased for USD 40, which was the discounted price for a Nigerian student working in Nigeria. An equipment loan was also secured, with the support of the Macaulay Library, which provided a Marantz PMB 661 digital recording unit, a Sennheiser MKH 60 P48 shotgun microphone, and all necessary accessories for me to use during my second field season. The set of aforementioned equipment is to be returned at the end of the field season. The sounds recorded using the equipment will be archived in the Macaulay Library, which contains the largest collection of animal sounds in the world, but will be available to other researchers. The catalogue of my sound records can also be cited in publications, which will grant more credence to my research and publications. Contributions will also be made to the African Bird Club sound collection.

My sincere appreciation goes to Stephanie Tyler, John Caddick and all other members of the African Bird Club staff, as well as Dr. Leventis, for his generous support. I am also thankful for the opportunity and support given to me by the members of staff of both the Bioacoustics Research Program and the Macaulay Library of the Cornell Laboratory of Ornithology.