Unique Songs of African Wood-Owls (*Strix woodfordii*) in the Democratic Republic of Congo

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Abstract
Statistical analysis of African Wood-Owl *Strix woodfordii* song spectrograms suggest a significantly different song type in Democratic Republic of Congo (DRC), central Africa, than elsewhere in eastern or southern Africa. Songs of DRC owls tend to be consistently shorter in duration and more monotone in overall frequency range. The first note is either absent or is very soft and slightly lower in frequency than the second note in DRC owls, compared with the first note being prominent, loud, and much higher in frequency than the second note in owls found elsewhere. Also, male owls in DRC sing at a higher frequency than do male owls elsewhere. Results from this study should be considered tentative working hypotheses, given the small sample size of song recordings available. Further study is needed to determine consistency of these findings, and the biogeographic scope and behavioral and taxonomic context of any such differences.

Introduction
African Wood-Owls *Strix woodfordii* are common residents of woodlands and forests throughout sub-Saharan Africa including much of the tropical center of the continent (König *et al.* 1999). Their vocalizations are typically described as: a rhythmic "chuckle" sequence of clear hoots, *WHOO-hu*, *WHOO-hu-hu*, *hu-hu* (song); a higher-pitched *eeyow* given by the female, possibly answered by a low gruff *hoo* from the male (calls); and other softer notes and bill-clacking given near the

nest or in alarm (Borrow and Demey 2001, Kemp and Kemp 1998, Maclean 1993, Tarboton and Erasmus 1998). Most references concur that female songs are noticeably higher-pitched than are male songs.

In a study in Kibale National Park, Uganda, Seavy (2004) determined that vocalizations of African Wood-Owls were more numerous during full moons and on clear nights. In Kruger National Park, South Africa, Delport et al. (2002) found that individual African Wood-Owls can be identified reliably by their vocalizations. Along the Limpopo River in South Africa, Kemp and Kemp (1989) used vocalizations of African Wood-Owls to determine density and turnover.

However, geographic differences in African Wood-Owl vocalizations have not been reported except for preliminary observations from central Africa (Marcot 2005). In that paper, it was noted that songs of African Wood-Owls from western Democratic Republic of Congo (DRC) seemed to be shorter in duration and narrower in overall frequency range (more monotone) than songs elsewhere in Africa. In this paper a fuller analysis of the initial study is provided

Study Area

During August-September 2004 and October 2006, I elicited song and call responses from 16 African Wood-Owls in several locations in western DRC, including the areas of Lac Tumba and Salonga National Park. I compared attributes of African Wood-Owl songs from DRC to those I had recorded in Zimbabwe during July 2000, and to African Wood-Owl song recordings provided by other researchers in Kenya (6 songs; D. Ogada, pers. comm.) or from commercially-available CDs of bird sounds from Kenya (1 song; Chappuis 2000) and South Africa (2 songs; Gibbon 1995). I also compared them to the field-note descriptions of songs (not audio-recorded) I heard during May 2002, of 1 African Wood-Owl in southern Malawi (Satemwa Tea Estate, Thyolo Mountain and Escarpment, and Shire Highlands) and 2 African Wood-Owls in eastern Zambia (Lupande Game Management Area and South Luangwa National Park) (Marcot 2004).

Methods

I encountered a total of 16 vocalizing African Wood-Owls in DRC and recorded 15 songs (all males) with a Sony TCS-60DV Cassette-Corder. I transferred these recordings, along with one (a female) I recorded from Zimbabwe and the 9 (6 males, 3 females) from Kenya and South Africa from the other sources, to digital wave format on a PC, for a total of 25 song files.

I first edited each song file and reduced background noise with the program GoldWave (vers. 5.18; GoldWave Inc.), and then I measured 7 time and frequency variables in each song with the program Spectrogram (vers. 14.0; Visualization Software LLC). The variables I measured (after Delport et al. 2002) included: song duration (msec), total frequency range (Hz), maximum overall frequency, differences in maximum frequency between the first and second notes (FI1) and between the third and fourth notes (FI2), and maximum frequencies of the first and third notes (the upper levels of FI1 and FI2; see Fig. 1). I also denoted each song by location (DRC or not DRC) and by sex class. I assumed sex class on the basis of maximum overall frequency. The song samples clearly clustered into two very discrete sets, where maximum overall frequency of the presumed female songs ranged 850-912 Hz, whereas those of the presumed male songs ranged 507-653 Hz.

I used unpaired T-tests with Bonferoni *post hoc* adjustment to evaluate significance ($p<0.05$) of differences of each of the variables between songs from DRC and songs recorded elsewhere, and between sex classes to determine if this was a complicating factor.

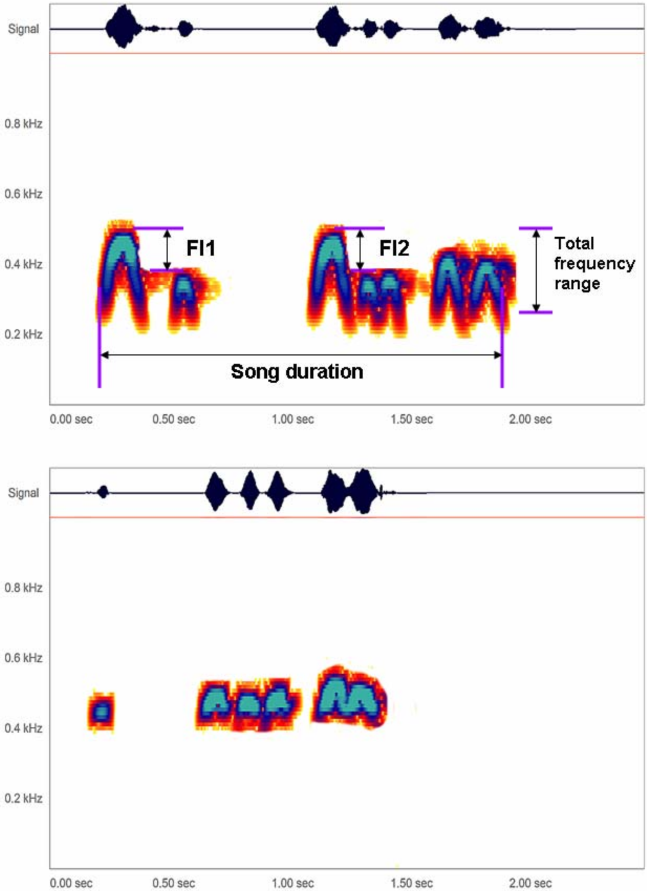

Figure 1: Two examples of male African Wood-Owl songs showing measurements and differences in song types. Top: typical 7-note song from Kenya (Chappuis 2000) showing how the first and third notes are higher in frequency and amplitude than are the other notes. Bottom: typical song recorded from Democratic Republic of Congo, showing how the first note is either missing (as in this example) so that the song consists of 6 notes, or is given as a brief and very soft note slightly *lower* in pitch than the second note.

Results and Discussion

Data on the 25 songs are presented in Table 1.

Scatter plots of the data on the four variables suggested differences between African Wood-Owl songs in DRC and those elsewhere in Africa (Fig. 2). These differences, at least from the song samples analyzed in this study, were confirmed by the statistical analyses. Songs from DRC were significantly shorter in duration (T=15.749, n=25, p=0.001) and covered a narrower overall span of frequencies (T=33.990, n=25, p<0.001) than songs elsewhere in Africa (both sexes combined; differences noted here were even more significant when comparing with only male songs).

The DRC songs also differed significantly by either lacking the initial note or with the initial note being *lower* in pitch than the second note of the song (variable FI1; T=147.240, n=23, P<0.001) and by the third note being only slightly greater in pitch than the fourth note (variable FI2; T=145.114, n=25, p<0.001). In contrast, the typical songs in the sound file samples from outside DRC clearly showed that the first and third notes were considerably higher in pitch than the other notes.

Also, sonograms of African Wood-Owls outside DRC presented by others show clear differences in maximum frequencies among notes in both female and male songs. Sonograms in Kemp and Kemp (1989), Delcourt et al. (2000), and Maclean (1993) suggested approximately 100-200 Hz differences in maximum frequencies of the first and third notes compared with the other notes. I found similar values in male and female songs outside DRC that I analyzed, that averaged 161 Hz and 165 Hz difference in maximum frequencies between first and second notes (FI1) and third and fourth notes (FI2), respectively. These values, however, contrasted significantly with those from DRC songs, viz., differences of -65 Hz and 19 Hz, respectively (the negative value resulting from the fact that, in the DRC songs, the first note was lower than the second note). The difference in the DRC songs was, again, due to those songs being more monotone than the non-DRC songs.

Table 1. Data on African Wood-Owl songs. See Figure 1 and text for explanation of variables.

Sample #	Location	Sex	Song Duration (msec)	Total frequency range (Hz)	FI1 (Hz)	FI2 (Hz)	Highest frequency (Hz)	Source
1	Kenya	M	1697	304	127	127	504	Chappuis 2000
2	Kenya \a	M	1482	289	143	140	552	Ogada, pers. comm.
3	Kenya \a	M	1481	295	126	137	554	Ogada, pers. comm.
4	Kenya \a	M	1693	268	113	141	538	Ogada, pers. comm.
5	Kenya \a	M	1623	225	79	135	510	Ogada, pers. comm.
6	Kenya \a	F	1547	436	230	200	850	Ogada, pers. comm.
7	Kenya \a	F	1568	437	237	200	870	Ogada, pers. comm.
8	S. Africa	F	1508	473	229	245	912	Gibbon 1995
9	S. Africa	M	1460	253	87	113	523	Gibbon 1995
10	DRC	M	1518	146	-46	23	619	This study
11	DRC	M	1483	155	-51	57	653	This study
12	DRC	M	691	154	\b	8	554	This study
13	DRC	M	1171	217	\b	5	563	This study
14	DRC	M	1456	212	-45	8	583	This study
15	DRC	M	1360	237	-59	20	566	This study
16	DRC	M	1328	182	-82	11	568	This study
17	DRC	M	1334	194	-68	26	574	This study
18	DRC	M	1344	197	-82	17	574	This study
19	DRC	M	1326	217	-64	22	591	This study
20	DRC	M	1347	233	-51	14	588	This study
21	DRC	M	1370	200	-85	20	583	This study
22	DRC	M	1345	203	-71	20	583	This study
23	DRC	M	1347	191	-64	20	591	This study
24	DRC	M	1355	197	-79	17	594	This study
25	Zim	F	1792	413	242	213	903	This study

\a Denotes a captive owl, caught after fledging and "speech coached" for 4 years by a pair of African Wood-Owls in Nairobi, and thus not raised in total isolation (D. Ogada, pers. comm.).
\b First notes were missing from these songs, so that variable FI1 could not be measured.

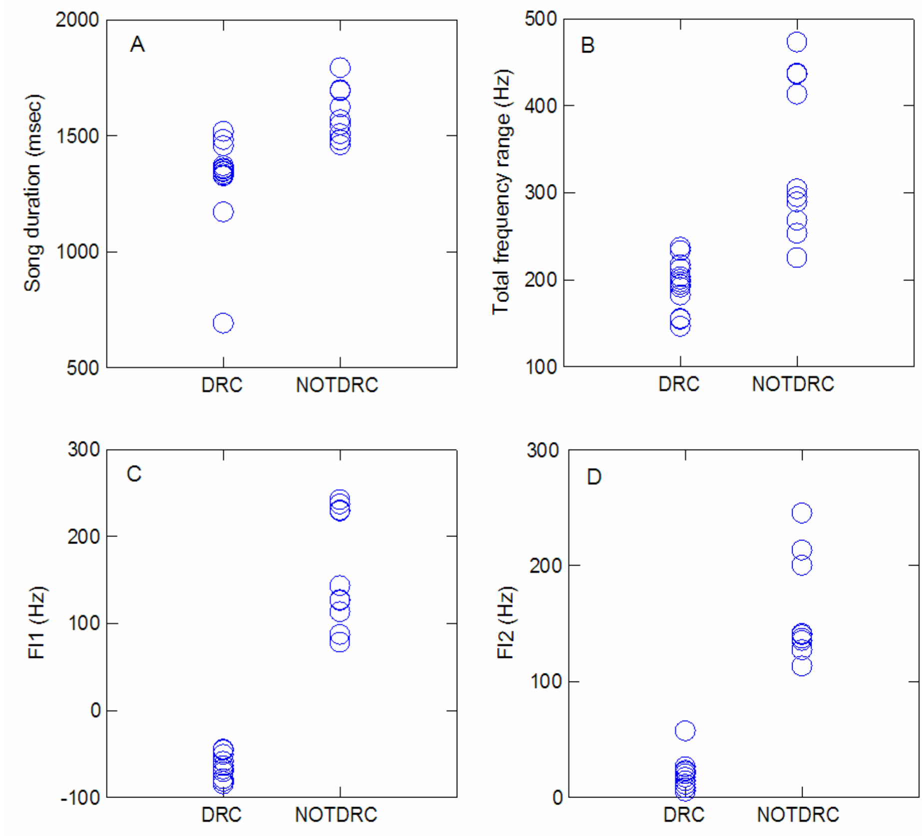

Figure 2: Scatter plots of four variables (see Fig. 1) in songs of African Wood-Owls in Democratic Republic of Congo (DRC) and elsewhere in Africa (NOTDRC, both sexes). See Table 1 for data values.

The more monotone characteristic of the DRC songs seemed to be a consistent characteristic there. All of the African Wood-Owls I called in and heard in DRC, including those I did not audio-record, sounded similarly "flat" in frequency range, lacking the same "chuckle" or bouncing-ball effect heard elsewhere in Africa.

As for overall song pitch, the (presumed) male songs in DRC ranged significantly ($T=23.662$, $n=21$, $P<0.001$) higher in pitch (mean +/- 1SD of highest frequency = 586 +/- 24 Hz) than did male songs elsewhere (530 +/-20 Hz) (although both sets of songs were significantly lower in pitch than the obviously different female songs). Whether this is an artifact of my small sample size, or if DRC males consistently sing slightly higher in pitch than they do elsewhere, needs further study.

My results were likely not an artifact of time. Delport *et al.* (2002) reported long-term constancy (up to 12 years) in the characteristics of individual African Wood-Owl songs. Kemp and Kemp (1989) also reported consistency of vocalizations over successive nights and years.

The song differences in DRC owls that I previously suggested (Marcot 2005) seem to be borne out by statistical analysis. However, given the small sample size of available recordings, these findings should be considered tentative working hypotheses. More recording samples are needed to determine if my findings constitute a consistent pattern throughout the local African Wood-Owl population, and if differences also exist in their other types of vocalizations. Also needed are further samples in other parts of DRC and central Africa to determine geographically where and over what cline these vocalization differences occur and if they are a function of any biogeographic isolating effect of range or habitat interruption. More important may be behavioral studies to determine if age class and breeding status of singing African Wood-Owls affect these song characteristics. Finally, whether the differences I have noted suggest a unique taxonomic entity at least in DRC needs corroboration from comparative genetic and behavioral studies.

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