

BRIEF REPORTS

Acoustic Structure of Long Calls in Free-Ranging Groups of Golden Lion Tamarians, *Leontopithecus rosalia*

MONIQUE HALLOY AND DEVRA G. KLEIMAN
Department of Zoological Research, National Zoological Park, Smithsonian Institution,
Washington, D.C.

Like many other callitrichids, golden lion tamarians, *Leontopithecus rosalia*, emit Long Calls. Recordings of four free-ranging groups were made to explore different types of Long Calls. Three Long Call types were identified acoustically, and analyzed sonographically. The calls usually started with an introductory syllable (a chirp, a trill, or a whine) which was followed by either one, two, or three different phrases in a fixed sequential order. Each of the three phrases was unique and contained a typical number of syllables of characteristic shape, frequencies, and durations. Possible functions of these calls are discussed. © 1994 Wiley-Liss, Inc.

Key words: golden lion tamarians, *Leontopithecus rosalia*, Long Calls, acoustic structure

INTRODUCTION

Long Calls are loud, long, and highly conspicuous vocalizations [Snowdon et al., 1983], common in forest-dwelling primates of the New and the Old World [Cleveland & Snowdon, 1982; Gautier & Gautier-Hion, 1977; Waser, 1977]. They often have a complex structure composed of several phrases, each phrase having a different number of syllables [Cleveland & Snowdon, 1982; Snowdon et al., 1983]. Three Long Call types have been described in the saddle-backed tamarin, *Saguinus oedipus oedipus* [McConnell & Snowdon, 1986; Snowdon et al., 1983]. The golden lion tamarin, *Leontopithecus rosalia*, an endangered Neotropical primate from Southeastern Brazil, is a diurnal, frugivore-insectivore that forages both in second-growth lowland and upland forest, and in primary swamp forest [Dietz et al., in press]. Social groups tend to be monogamous, composed of a breeding male and female and their offspring from several litters [Baker et al., in press]. Groups are territorial, and have regular, highly vocal encounters with neighbors [Peres, 1989]. As the group travels through the forest, individuals also maintain contact by vocalizing. Thus, like other forest-dwelling primates, the golden lion tamarin repertoire contains a set of very conspicuous loud vocalizations, termed Long Calls. Different authors have described the golden lion tamarin Long Call to some extent, but they did not distinguish more than one Long Call type

Received for publication January 10, 1993; revision accepted October 3, 1993.

Address reprint requests to Monique Halloy, Department of Psychology, 307 Austin Peay Building, University of Tennessee, Knoxville, TN 37996-0900.

[Epile, 1968; McLanahan & Green, 1977; Snowdon et al., 1986]. The purpose of our study was to characterize Long Call types in this primate by an analysis of their acoustic structure, and to develop hypotheses for testing concerning their potential functions.

METHODS

Subjects and Sites

Four family groups of free-ranging golden lion tamarins were observed, three of them in or near the Pogo das Antas Reserve (approximately 80 km northeast of Rio de Janeiro, Brazil) and the fourth in a patch of deciduous temperate woodland within the National Zoological Park, Washington, D.C. Of the three groups observed in Brazil, two contained wild-born animals native to the area ("Segunda Agua" and "Tres Machos") and the third contained captive-born animals from the Riverbanks Zoo, South Carolina, which had been reintroduced to Brazil two months prior to observations [Kleiman et al., 1986]. The National Zoo group, originally from Brandywine Zoo, Delaware, contained captive-born tamarins re-leased on zoo grounds as a public exhibit. Observations began four months after their release.

The tamarins from Riverbanks and those at the National Zoo were provided with a nest box located about 10 m high on a tree trunk and provisioned with food (fruits, Marmoset Science Diet, occasionally eggs, crickets, and mealworms). They also foraged for natural foods and often captured and ate insects [Beck et al., 1991]. Although habituated to humans, and free to range, interactions with people were discouraged.

Individuals were dye marked for identification. Observation time for the four groups totaled 137 h; for the Riverbanks, Segunda Agua, and Tres Machos groups, observations occurred during a one week period in November 1987 (n = 37 h), and for the Brandywine/National Zoo group, during a five week period in September and October 1987 (n = 100 h).

Analysis of Long Call Acoustic Structure

A UHER 4200 Report Monitor with a Dan Gibson parabolic reflector and microphone (model 200 E.P.M.) was used to record the Long Calls at the National Zoo. While parabolic reflectors are known to be subject to a low-frequency roll-off, this was not judged to be a problem, since the critical frequency for the reflector was about 1.5 kHz, whereas the lowest recorded frequency in our study was 4 kHz. A Sony Walkman Professional Recorder (WM-D6C) with a Sennheiser directional microphone (K3U and ME80 head) was used to record Long Calls in Brazil. A Real Time Sound Spectrum Analyzer (Uniscan II, model 4600) was employed for the sonographic analyses.

We use the following terminology: a "Syllable" is the basic element of a call [e.g., Snowdon & Hodun, 1985] and corresponds to a single continuous tracing of any distinct frequency on a spectrogram (see Fig. 1). It has been called "note" [Haimoff, 1984; Mitani & Marler, 1989], "unit" [Struhsaker, 1967], and "pulse" [Oates & Trocco, 1983]. A "Phrase" is composed of any number of consecutive similarly shaped syllables [also called "figure" by Haimoff, 1984]. Statistical analyses were performed using SAS for mainframe computers (SAS Institute Inc., Cary, NC). We used the General Linear Models (GLM) procedure to determine significant differences between acoustic parameters, such as between durations, or between frequencies. Random subsamples of these parameters were showed them to be normally distributed. All calls with clear sonograms were evaluated statistically (184 Long Calls).

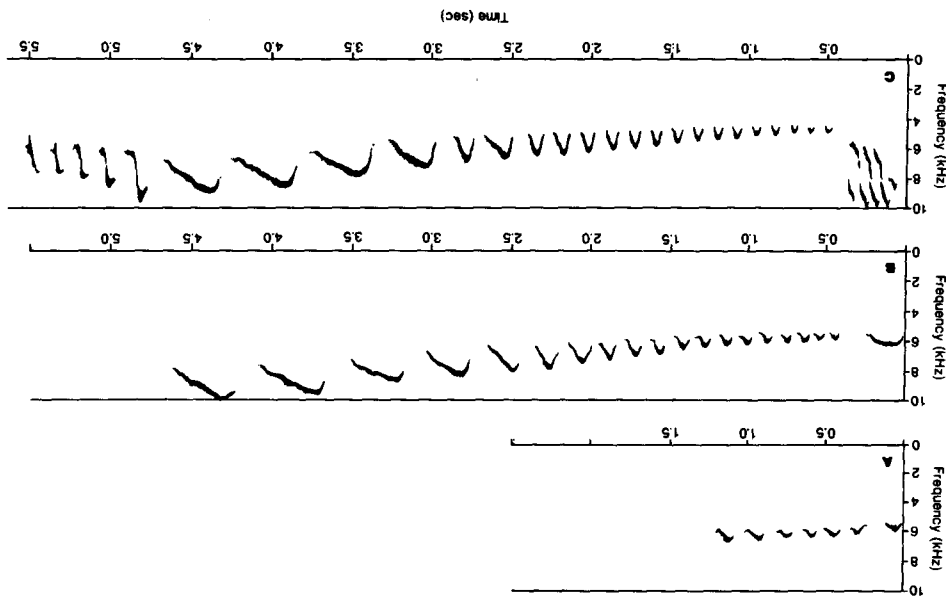


Fig. 1. Sonogram of each of the three Long Call types recorded in golden lion tamarins, *Leontopithecus rosalia*: one-phrase Long Call preceded by a chirp (A), two-phrase Long Call preceded by a whine (B), and three-phrase Long Call preceded by a trill (C). The chirp, whine, and trill can precede any of the three Long Call types.

The one-phrase Long Call is composed of an Introductory Syllable and Phrase I (Fig. 1 and Table II), the latter being characterized by a varying number of chevron-shaped syllables [referred to as wah-wah notes by McLanahan and Green, 1977].

The two-phrase Long Call consists of an Introductory Syllable followed by Phrases I and II (Fig. 1 and Table II). Phrase II includes fewer syllables than Phrase I, with a flatter, longer shape, and was referred to as a descending whine by McLanahan and Green [1977]: it is slightly more modulated and higher pitched than the whine emitted as an Introductory Syllable.

The three-phrase Long Call is formed by the Introductory Syllable, Phrases I, II, and III (Fig. 1 and Table II). Phrase III has a varying number of hook-shaped syllables, called clucks by McLanahan and Green [1977].

The duration of Phrase I (wah-wah) was significantly shorter in the one-phrase Long Call compared to Phrase I in the other two types of Long Calls ($F_{(2,181)} = 15.04, P = 0.0001$). Phrase II (descending whine) of the two-phrase Long Call was significantly shorter than Phrase II of the three-phrase Long Call ($F_{(1,164)} = 85.30, P = 0.0001$) (Table II).

Phrase I started at a significantly higher frequency in the one- and two-phrase Long Calls than Phrase I in the three-phrase Long Call ($F_{(2,181)} = 31.14, P = 0.0001$) (Table II). Phrase II also started at a significantly higher frequency in the two-phrase Long Call than Phrase II in the three-phrase Long Call ($F_{(1,164)} = 32.37, P = 0.0001$) (Table II). The logarithms of the slopes for Phrases I and II were not significantly different across the three types of calls (Table II).

DISCUSSION

Three Long Call types composed of one, two, or three phrases were acoustically and sonographically distinguishable within the golden lion tamarins' vocal reper-

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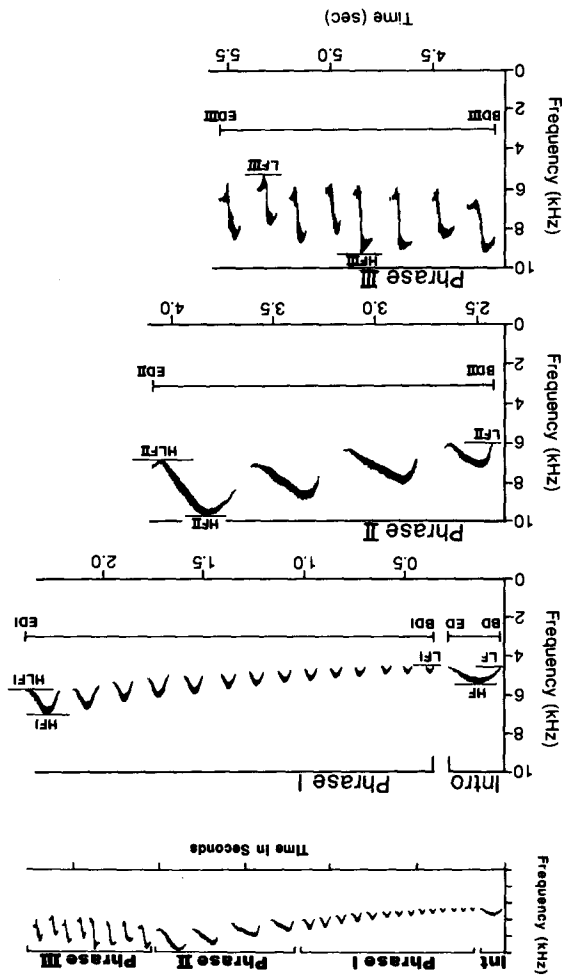


Fig. 2. Sonogram of a golden lion tamarin three-phrase Long Call, followed by an analysis of each part with the corresponding measurements used to determine the 23 acoustic parameters: Introductory Syllable (here, a whine with Phrases I (wah-wahs), II (descending whines), and III (clucks); BD, beginning duration; ED, end duration; LF, lowest frequency; HF, highest frequency; HLF, high-low frequency.

In this species, as well as in other forest-dwelling primates (Cleveland & Snowdon, 1982; Snowdon et al., 1983), each type of Long Call had a particular set of features defined by the type and number of syllables, number of phrases, and the durations and frequencies of each phrase (Table II). Snowdon et al. [1986] described only one type of Long Call in golden lion tamarins which, by its characteristics, would correspond to our two-phrase Long Call. McLanahan and Green [1977] described Long Calls which included calls that did not end with clucks (two-phrase Long Call) and those that did (three-phrase Long Call). We preferred to separate these two types of calls, because a statistical analysis of their acoustic parameters showed significant differences in the frequencies at which Phrases I (wah-wah) and II (descending whine) started (both lower in the three-phrase Long Call), and in the duration of Phrase II (longer in the three-phrase Long Call) (Table II). The contexts were also different (see further).

communication, both within and between groups. We suggest that this call likely functions to indicate the location of group members that are isolated or have strayed. It also possibly serves as an indicator of the group's location to other tamarin groups. This call may be analogous to the Short Call and Long Soft Call in the saddle-backed tamarin [Moody & Menzel, 1976] and the Quiet Long Call in the cotton-top tamarin [Snowdon et al., 1983], all of which function to restore contact with group members.

The three-phrase Long Call (wah-wah, descending whine, and clucks) is also very loud, and is primarily used in group encounters when the tamarins are in visual contact. Individuals appear to be highly aroused: piloerection and frequent back and forth jumping are observed. We hypothesize that this Long Call promotes group spacing and helps in the establishment and/or control of territorial boundaries. A similar function was observed for the Long Loud Call of the saddle-backed tamarin [Moody & Menzel, 1976] and for the Normal Long Call of the cotton-top tamarin [Snowdon et al., 1983; McConnell & Snowdon, 1986].

CONCLUSIONS

Three types of Long Calls were readily distinguishable by ear in golden lion tamarins, and their acoustic structure was analyzed. The three types had either one, two, or three phrases, each phrase having a characteristic number of syllables with particular shape, frequencies, and durations. Each type of call is associated with a different context, and a possible function is suggested.

ACKNOWLEDGMENTS

We are grateful to A. J. Baker, K. Derrickson, J. Dietz, E. Morton, R. Barquez, L. C. Driekamer, P. Feinsinger, and anonymous reviewers for comments on drafts of this manuscript; to K. Derrickson, J. Ballou, D. Boness, and C. Grosse for statistical and other advice; and to A. J. Baker, J. Dietz, and B. Retberg-Beck for information on tamarin group identities. We thank John Anderson for the figures. Many FONZ (Friends of the National Zoo) Volunteers provided invaluable help as did research staff of the Golden Lion Tamarin Conservation Program in Brazil. Finally, we thank supporting institutions including IBAMA, Smithsonian Institution, do Desenvolvimento Florestal (IBDF), FONZ, Smithsonian International Environmental Sciences Program, World Wildlife Fund-US, National Geographic Society, and Wildlife Preservation Trust International. A FONZ Project Aide grant supported M. H. The National Zoological Park is a signatory to the International Cooperative Research and Management Agreement for the endangered golden lion tamarin.

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