

Vocalizations of Male Mantled Howler Monkeys on Ometepe Island, Nicaragua

Matt Artz

**Abstract**

The study aimed to demonstrate the frequency and context of roars, woofs and oodle vocalizations in male Mantled Howler monkeys (*Alouatta palliate*) on Ometepe Island, Nicaragua; so as to compare and contrast the findings with the previous research which was conducted on Barro Colorado Island (BCI), Panama, to elucidate the possible effects that different ecosystems can have on vocalization production. Ometepe is a volcanic island characterized by zones of dry deciduous forest. The specific site of study is a regenerating coffee plantation known as the 'coffee forest', in which the vocalizations of howlers were observed as a function of time, activity and the context in which they were elicited. It was demonstrated that roars displayed the highest rate of occurrence, especially in the early morning in response to the most significant stimulus, intergroup communication, while woofs and oodles both occurred to a similar degree of frequency but differed in the stimulus and as well as the context of elicitation such as to mediate intragroup communication to a higher degree. These findings support previously documented research on the vocalizations of mantled howler monkeys.

**Introduction**

The study aimed to demonstrate the frequency and context of roars, woofs and oodle vocalizations in male Mantled Howler monkeys (*Alouatta palliate*) on Ometepe Island, Nicaragua; so as to compare and contrast the findings with the previous research which was conducted on Barro Colorado Island (BCI), Panama, to elucidate the possible effects that different ecosystems can have on vocalization production.

Ometepe island, Nicaragua (11°40'N and 85°50'W) is a volcanic island located within the southeastern edge of Lake Nicaragua. It is the largest island in the world (276 Km<sup>2</sup>) situated in a fresh water lake, and is characterized by zones of dry deciduous forest, cloud forest, forest-shaded coffee plantations, agricultural fields, and other areas cleared for human use. Human impact has been most severe in the zones between the lake and the foothills of the volcanoes [1]. The climate entails wet and dry seasons which are approximately both six months in duration.

It is estimated that Ometepe island has been separated from the mainland for approximately 10,000 years - which provides a unique opportunity for evolution - however little is known concerning when non-human primates first arrived on the island and the degree to which howling monkey populations on Ometepe differ genetically, behaviorally or ecologically from howling monkey populations in other regions of the Neotropics [1].

Mantled howlers (*A. palliata*) are New World arboreal, diurnal primates that display a low degree of sexual dimorphism, with males averaging 14lbs and females averaging 10lbs. The males are sexually mature on average at the age of 4 and females at 3.5 years of age. They are behavioral folivores which results in a relatively small home range (100m/day) and many hours spent resting per day. Their name stems from their characteristic vocalizations, which are produced by the hyoid bone, which in males is larger, resultantly allowing for greater amplitude, propagation and frequency range (Hz) than females [4].

Mantled howlers live in multi male/female troops, which are unusual in group size (12-20). Juveniles are characteristically evicted from their troop and forced find a new troop to join. This occurs in both sexes however considering the dominance hierarchy differs for males and females howlers the resulting scenarios differ. Both sexes may spend up to a year in solitary, however they differ in that a female when attempting to join a new troop must rise to the top of the dominance hierarchy, anecdotally within a year times or leave and try another troop, whereas a male who does not successfully join a new troop will often live the rest of its life in solitary. This observation appears to again be anecdotal and descriptive in nature due to the inherent difficulties in studying primates across their long life history. This aforementioned dominance hierarchy - in which juvenile eviction is commonplace - creates populations in which less kin are living in troops together, which has the behavioral effect of less intragroup grooming as is seen in other primate species [4].

To be noted when compared to other *Alouatta* species the degree of sexual dimorphism (Ford and Davis, 1992) and hyoid size (Crockett and Eisenberg, 1987) in *A. palliata* are reported to be low, suggesting that factors contributing to reproductive

competition and mate choice in this species may differ significantly from those present in more dimorphic howler species [1].

The previous studies conducted on BCI (Baldwin & Baldwin, 1976) (Altman, 1959, 1966) identified 26 types of vocalizations – most of which are minor or indiscriminant calls – and organized them into 5 groups. Considering the scope of the present study 3 vocalizations will be further elaborated on here, in light of these previous findings. Roars are the loudest of the vocalizations, with the greatest ability to propagate through a forest. They tended to be invoked by important stimulus, such as intergroup communication and predation, and are often produced in chorus – many members join in eliciting this vocalization upon one member starting. These roars are known to often occur where an individual has been foraging/feeding and/or resting, but do also occur during travel. They have also been documented to occur with a high rate of occurrence around the hours of dawn and dusk. Woofs are a type of vocalization which occurs as a result of stimulus deemed less important than that which elicits the roar, and often occurs in accompaniment or after roars. It has also been previously demonstrated that woofs are used for intragroup communication, however to a lesser degree than the oodle, which is often (20-50/day) employed in intragroup communication scenarios [2].

It was predicted that the characteristics of BCI male mantled howler vocalizations would be highly conserved across ecosystems and hence similar on Ometepe, in tonal quality and function. Hence roars will serve as the loudest call which is reserved for the most important of stimuli while, barks and oodles follow progressively. It was also expected that roars occurring around the hours of dawn and dusk would mediate intergroup spacing within the geographic footprint, and that oodles often are produced in social behavioral/communicative circumstance and would be observed frequently. In contrast to the previous findings from BCI it is thought that the mantled howlers of Ometepe will not have calls reserved and elicited by predators, i.e. large birds, due to the apparent lack of capable predators, and that due to habituation would not vocalize in response to human appearance.

## **Methods**

### *Study Site*

The specific site of study on Ometepe is known as the ‘coffee forest’, which is located in the foothills between the lake and the inactive volcano Maderas. It is a regenerating forest of five years, in the primary stage of succession; this is indicated by advantageous colonizing plants such as the Cecropia tree. Prior to regeneration the forest was a coffee plantation measuring approximately 8.4 hectares in size, with its borders delineated by a man-made rock wall. There are observation paths which follow the border inside the wall with seven transects; with six of them running perpendicular to the designated entrance and one running diagonally northeast. To be noted the regenerating flora, hence the forest, extend beyond the rock wall and allow for increased home-range outside of the wall and several troops have been observed traversing this man-made boundary and hence making use of this land for both range and feeding purposes.

### *Study Subjects*

There are an estimated 4-6 troops living in the ‘coffee forest’ – including the land laying outside the rock wall – which are estimated to contain 2-4 adult males and 3-9 adult females per troop as well as several juveniles and often one to several infant(s) [1]. A few solitary individuals have also been observed within the forest.

### *Data Collection*

The study was conducted between the dates of 8/3/05 and 8/7/05 on adult male howlers. Continuous 1 hour focal samples were employed, in which the variables were individual (age/sex), time of day, type of vocalization (call), activity of individual, weather (rain and/or wind) and context. (See Appendix A) Context is a broad based category which sought to encompass or identify whether the call was elicited by intergroup/intragroup howler vocalizations/behavior or if it was a response to intergroup/intragroup howler vocalizations/behavior. (See Appendix A) The time of the day of observations was randomly selected daily, however did span the twelve hour period from 6:30 AM to 6:30 PM. This time period was then sub-divided into three 4

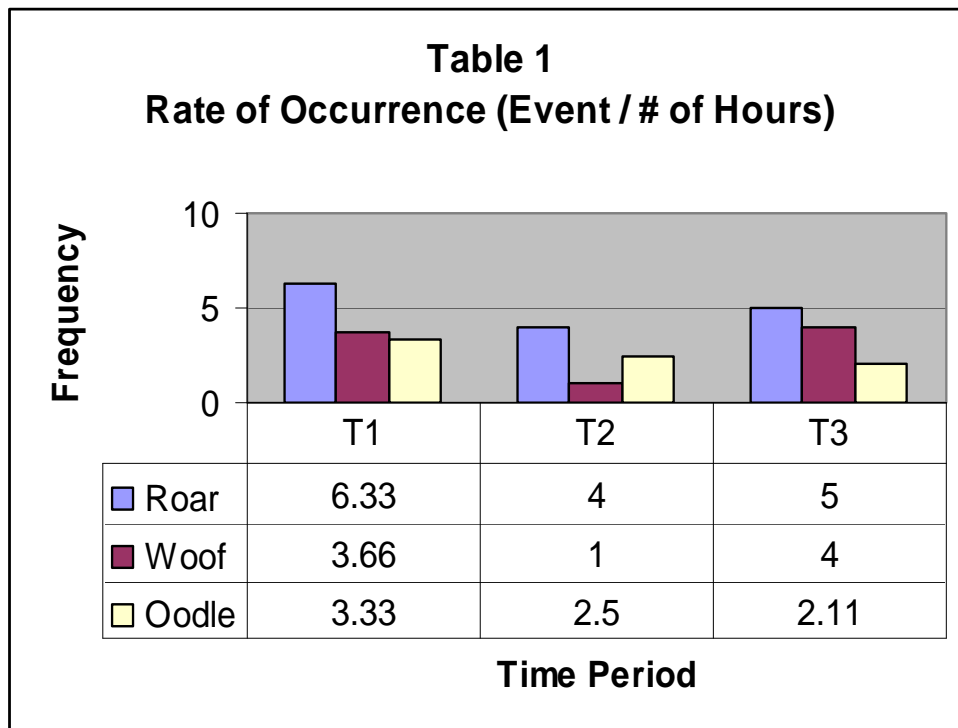
hour chunks; T1 (6:30 – 10:30 AM), T2 (10:30 AM – 3:30 PM) and T3 (3:30 – 6:30 PM). A total of 16 hours were observed in which 199 call/vocalization instances were recorded.

*Data Analysis*

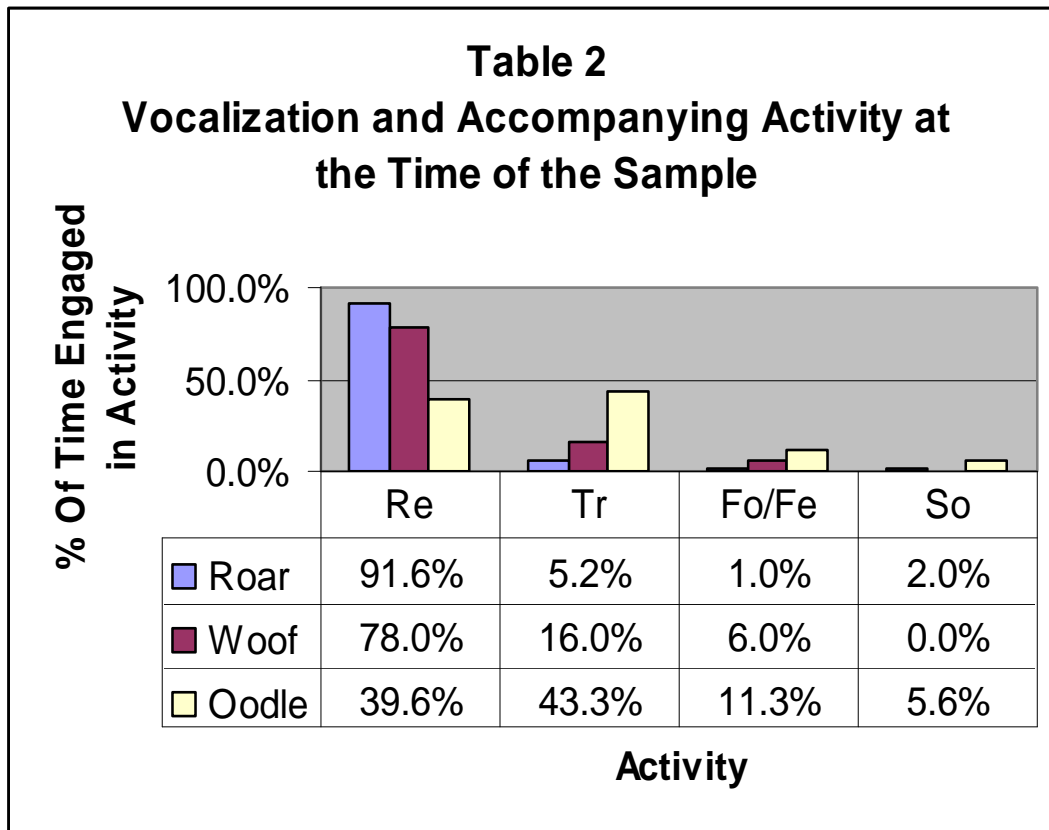
The data analysis in the given study involved statistical analysis of vocalizations in correlation with time period, activity and context. (See Appendix A) A Chi Squared test were performed for all three correlations, in an attempt to show significance of the observed findings.

**Results**

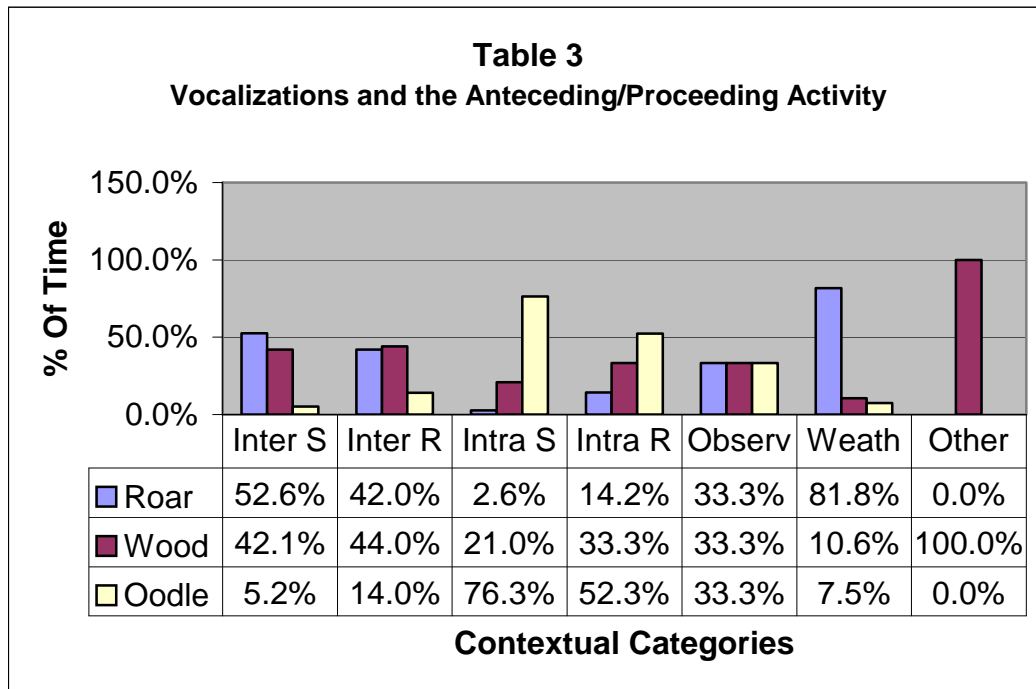
Male mantled howlers were observed during the three time periods (T1, T2 & T3) and it was demonstrated that vocalizations occurred most frequently around the hours of dawn/dusk, hence the hierarchal order of these time periods are as follows: T1, T3 & T2, with T1 having the highest rate of occurrence and T2 the lowest. A trend of roars occurring most frequently was also found across all three time periods. (See Table 1) The chi squared test was calculated with 5 degrees of freedom and returned a value of 2.84 which is not significant.



When vocalizations were analyzed as a function of individual's activity it was found that the activity state of resting provided the highest rate of occurrence for vocalizations; of which roars were the most frequent. Sequentially following rest are travel, foraging/feeding and then social. (See Table 2) The chi squared test was calculated with 6 degrees of freedom and returned a value of 50.91 which is significant.



In correlating the vocalizations with the variables of context it was found that roars were most commonly invoked by wind and as a means of initiating intergroup communication. Barks most frequently occurred in response to intergroup vocalizations, where as oodles showed the highest correlation for both initiating and responding to intragroup communications. To be noted all three of the vocalizations displayed the same rate of occurrence in response to observer/human presence. (See Table 3) The chi squared test was calculated with 9 degrees of freedom and returned a value of 113.62 which is significant.



## Discussion

### *Calls in Time – Rate of Occurrence (Event/# Hours)*

It was demonstrated that the frequency of calls elicited in the time periods follow the order of T1, T3 & T2. This appears to indicate that more calls are elicited around the hours of dawn/dusk as previously indicated by (Baldwin & Baldwin, 1976). Specifically the highest rate of occurrence (T1), as well as (T3 – though slightly lesser in rate of occurrence) is indicative of intergroup spacing mediation as previously demonstrated (Whitehead, 1987). The Baldwin study also cited shorter bouts woofs as following roars

in the early morning which is indicated in the fact that roars occurred most frequently in T1 followed by woofs (Table 1). To be noted in this study the bulk of the observation hours occurred in the A.M. so a rate (event/# hours) was calculated which effectively compensated for the unequal distribution of observation time. The results of this calculation are displayed in table 1 as opposed to percentage of the total occurrences (instances of vocalization). The low occurrence of all vocalizations in the T2 period can be attributed to the midday period on vocal inactivity as previously demonstrated (Figure 1, Baldwin & Baldwin, 1976). It is also noteworthy to indicate that the high rate of roars may be skewed by the invoking of wind – which will be further elaborated on shortly.

Oodles were expected to occur with a higher frequency (20-50/day) as occurred in the Baldwin study of 76'. The lack of a high rate of occurrence for this call may have been a result of researcher error, unequal distribution of observation hours or a lack of clear identification of all vocalizations due to the 'grading' effect, also noted by Baldwin. Grading is what occurs when one vocalization fades out into another. The previous research employed recording techniques for optimal identification of calls, and the lack there of so stated equipment in this current study may have been a disabling factor in differentiating between vocalizations involved in 'grading'.

#### *Activity of sampled individuals at the time of vocalizations*

When vocalizations were analyzed in light of an individual's activity it was demonstrated that the majority of calls occurred while an individual is resting, as previously demonstrated by (Baldwin & Baldwin, 1976). This is not to say the individual was sleeping/napping, simply that they were stationary at the time of vocal elicitation. It is also shown that roars occurred more frequently in all activity categories except in travel, for which oodles displayed the highest percentage followed by woofs and then roars. This pattern fits with the previous data in that roars are reserved for the most important stimulus and oodles for the least. Compounding this, woofs and especially oodles have been shown to mediate intragroup activity by serving as a means of communication within troops. Having stated that it was thought that oodles and woofs would have been associated with social behavior to a higher degree, but this was probably skewed by relatively few observations (4) of social behavior. This may have

been caused by either researcher error/subjectivity and/or the unequal distribution of observation hours. When looking at the findings for foraging/feeding they seem to parallel earlier studies in that oodles mark the highest rate of occurrence, which again is elicited for intragroup communication (Baldwin & Baldwin, 1976)

*Vocalizations and the antecedent/proceeding activity*

This study demonstrated that roars occur most frequently in response to strong gusts of wind and as a means of initiating intergroup communication. The initiation of intergroup communication is thought to be used to mediate intergroup spacing (Whitehead, 1987). It should be stated that due to the topographical nature of Ometepe island and the prevailing patterns of the S.E. & N.E. trade winds which bombard Nicaragua on both coasts during the summer months (summer in the eyes of the Northern Hemisphere) the observations of the previous study may have been affected. This is stated because the variable wind, elicited the highest rate of occurrence for vocalizations, which effectively may have skewed the results in terms of wind response and resultantly intergroup communication. Intergroup communication may be skewed because as stated by Baldwin, wind invokes roars but roars invoked intergroup communication (Inter S & Inter R), hence the high occurrence of wind on Ometepe may skew both observations.

Having stated that it is interesting to note that woofs were observed to have a higher rate of occurrence than roars in terms of intergroup response (Inter R), but again this may be skewed. When analyzing the data for intragroup communication it is clear that oodles occurred more frequently than either roars or woofs, which correlates with Baldwin 76'. Also occurring in accordance with this previous data is the fact that woofs follow oodles in use for intragroup communication, and that a very small percentage of this intragroup communication was a function of roars.

The other two contextual categories, observer and other make only a small percentage of the observed and recorded vocalizations. Three calls were recorded in response to the observer, with an equal distribution in terms of vocalization type. This contradicted the prediction –insignificantly as a result of low n value - that howlers of Ometepe are habituated to humans and hence would not vocalize at them. The two occurrences of vocalizations in the ‘other’ category were in response to a ‘hammering’

noise originating from outside the rock wall boundary of the forest and the response of woofs fit within the paradigm of the previous data (Baldwin & Baldwin, 1976) in that the woof vocalization is often emitted to stimulus of intermediate importance – in terms of the three vocalizations of current concern.

#### *Anecdotal / Ad-lib Observations*

It was observed that mantled howlers of Ometepe responded only to wind of significant speed. The actual wind speed or direction was not recorded however it is thought that minor gusts or not enough of a stimulus to invoke a response. It was also observed auditorally from a distance that roars and barks were elicited in response to earthquakes/tremors as occurred on 8/3/05.

#### *Future Research*

Future research will aim to observe the vocalizations of male mantled howler monkeys on Ometepe island in a more evenly distributed fashion throughout the day. It is also desired to observe vocalization duration, number of syllables produced, grading and intragroup accompaniment. Recording equipment in which the vocalizations could be recorded and spectrally analyzed would be optimal. This would allow for a visual analysis of tone, frequency (Hz) and amplitude. Tone is of interest because it was observed and previously noted (Baldwin & Baldwin, 1976) that some calls such as the roar can occur in more than one modal tone, ‘aw’ and ‘oh’. Recording the vocalizations would also allow for playback experiments in which the properties of the vocalizations could be manipulated such as frequency (Hz), duration, tempo, amplitude, distance as a function of reverberation (Whitehead, 1987), and group participation as a function of chorus.

A greater understanding of the troops within the forest would also be desirable. This would entail the identification of home range, troop size as well as mixing/non-mixing characteristics of the troops (Baldwin & Baldwin, 1976). Then the distance between troops as well as orientation of vocalization emittance could be observed and evaluated to provide a better understanding of intergroup communication.

## Appendix A

Individual – Age/Sex

Time – T1, T2, T3

T1 = 6:30 – 10:30 AM

T2 = 10:30 AM – 2:30 PM

T3 = 2:30 – 6:30 PM

Vocalization (call) – Roar, Woof, Oodle (Baldwin & Baldwin, 1976)

Activity

Re - Resting

Tr - Travel

Fo/Fe - Foraging or Feeding

So -Social behavior

Context

Inter S - Initiation of intergroup communication

Inter R - Response to intergroup communication

Intra S - Initiation of intragroup communication

Inter R - Response to intragroup communication

Obsv - Response to initial appearance of a human observer (researcher)

Weath - Response to wind or rain

Other - Vocalization initiated by any other stimulus

### Work Cited

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