

# RELATION OF CALLING QUALITY IN MALE *DENDROBATES PUMILIO* TO TERRITORY QUALITY

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*Abstract:* Vocalizations are frequently costly but can increase fitness through defense of mates and territory. The ability of organisms to adequately defend or establish these territories may depend on their ability to vocalize. I tested relationships between calling and territory quality in *Dendrobates pumilio*. The hypothesis was that males who called for longer periods of time and with higher frequency would hold better territories. In fact, leaf litter depth on the territory was positively correlated with the 2<sup>nd</sup> axis of a principal components analysis of calling patterns. Results also indicated a negative correlation between calling quality and the duration of second calls. Litter depth might affect territory quality by providing oviposition sites, by providing habitat for ants on which the frogs prey; or it might be correlated with something else that is directly important to the frogs. In any case, leaf litter depth is linked to frog calling, and may be linked to frog fitness as well.

*KEYWORDS:* Strawberry poison dart frogs, frog vocalization, La Selva Costa Rica

## INTRODUCTION

Vocalizations are important for communication in many organisms, e.g., to protect resources and attract mates. Vocalization is energetically costly, and variation in strength and quality of vocalization can be due to variation in the resources an individual has access too, or to their body size. It may also be due to variation in abiotic factors such as rainfall, soil moisture or types which may create less or more optimal conditions for calling.

*Dendrobates pumilio*, the Strawberry Poison Dart Frog, is a classic example of this use for vocalization. *D. pumilio* males use vocalization to attract females with

which to mate and to protect their territory from other males. *D. pumilio* females are attracted to males who can call with the most endurance (Heike, 2003), which suggests there may be a correlation between calling quality (as defined by endurance and frequency) and territory quality. Some variables contributing to territory quality for male *D. pumilio* may be the amount of leaf litter (which can provide oviposition sites and perhaps habitat for their ant prey), and the amount of bromeliads that can provide phytotelmata for tadpoles. Presence of adequate perches for males to call from (0-2 m from ground) as well as the presence of a food source (small ants and termites) may also be important

factors of territory quality. I hypothesized that males with high quality territories would need to call more vigorously to adequately defend their territory than males with low quality territory. This was inseparable from the related idea that males who can call better will be able to establish and hold better territories. Alternatively, males with poor territories may have higher quality calls to remain sexually competitive with males in high quality territories. Finally, there may be no relationship between calling quality and territory quality, and the establishment of territory may depend more upon physical displays and interactions (Janzen 1983) than on calling quality.

## METHODS

I collected data from 0800 on February 18<sup>th</sup> to 1100 on February 20<sup>th</sup> 2008 in Heredia, Costa Rica. I marked and collected data from 13 territories along Sendero Tres Rios (0 - 600m), Sendero Sura (0 - 350m) and within the Arboleda at La Selva. After I identified male *Dendrobates pumilio* by their calls, I located and marked male *D. pumilio* positions and territories (estimated as a circle with a 4m radius around the frogs' locations). I then evaluated Male *D. pumilio* calls by measuring call length, the resting time between calls, and the frequency of calls (amount of individual chirps per 10

seconds). I took these measurements over two days from 0600-1100 to control for the diurnal patterns in frog calls. I evaluated male territory quality by counting calling perches (logs or horizontal structures 0 - 2m off of the ground), the number of bromeliads, leaf litter depth at 3 points within the territory, and the abundance of ants within the territory (evaluated with pitfall and sticky traps). I analyzed the data by running a Principle Components Analysis on the variables that make up call quality (call duration, frequency, and proportion of time calling, for 1<sup>st</sup> and 2<sup>nd</sup> calls). I then evaluated alternative models to predict call quality (1<sup>st</sup> two axes of PCA) based upon independent measurements of territory quality.

## RESULTS

The number of small ants and termites captured by my sticky traps and pitfall traps was negligible in all sites; so I had to omit direct measures of food abundance from my analyses. There was no relationship between any measures of habitat quality and the 1<sup>st</sup> PCA axis of frog calling ( $F < 2.5$ ,  $df = 4, 7$ ,  $P > 0.13$ ). However, the 2<sup>nd</sup> PCA axis of frog calling was significantly positively related to leaf litter depth (Fig. 1,  $r^2 = 0.61$ ,  $F = 5.79$ ,  $df = 1, 7$ ,  $P = .047$ ). The factor loadings for PCA-2 for duration of calls 1 and 2, frequency of calls 1 and 2, and

proportion of time spent calling, were 0.685, -0.489, -0.264, 0.471 and 0.0173, respectively.

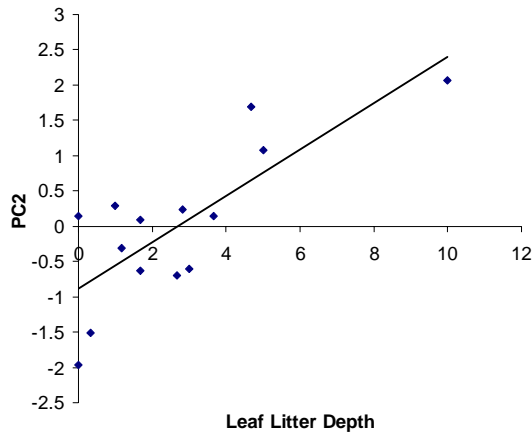


Figure 1: Regression of leaf litter depth vs PCA2 (descriptor of calling quality of male *Dendrobates pumilio*, Data from La Selva Research Station, Heredia, Costa Rica.  $r^2$  value = .61

## DISCUSSION

Results partially supported the hypothesis that territory quality (Fig. 1) positively related to calling quality. This could either be because males who call better can hold better territories, or that males who hold better territories must call more to defend their desirable territories. Further study on *D. pumilio* would be required to separate these possibilities.

My interpretations are based on the assumption that leaf litter depth is related to territory quality. I support this assumption based on two possible mechanisms. The litter

may be important for oviposition sites (Janzen, 1983). Also, leaf litter depth can be related to the abundance of arthropods (Lieberman, 1982), especially ants, which are the primary food resource of *D. pumilio*. Food provides energy for mating and, in the case of *D. pumilio*, calling for mates. Chow et al. (2005) found correlations between leaf litter depth and the abundance of *D. pumilio* supporting my assumption of the importance of leaf litter in territory quality. Conte et al. (2000), who also studied territoriality in *D. pumilio*, suggest that reproductive resources do not influence territory selection of male poison dart frogs. However, their measurement of bromeliads related to the reproductive resources used by females, while the process of oviposition, directed by males (Janzen, 1983), is related to the leaf litter in an area.

The positive correlation between PC2 (calling quality) and duration of call suggests that duration of call 1 is an important factor of calling quality. This is consistent with reports that selection of males by females is largely based upon call endurance (Heike, 2003). The negative correlation between PC2 and the duration of call 2 may reflect the energetic expense of calling (better callers use more energy on the first call and have less to devote to their second call, shortening its duration).

Vocalization by Strawberry Poison-Dart frogs, like that of many other territorial species, is apparently related to the quality of territories that they hold, and is presumably a partial determinant of their fitness.

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