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Anthropogenic sounds differentially affect amphibian call rate

Jennifer W.C. Sun [a], Peter M. Narins [b,*]

[a] Department of Organismic Biology, Ecology and Evolution, University of California Los Angeles, 621 Charles E., Young Drive South, Los Angeles, CA 90095, USA
[b] Department of Physiological Science and Department of Organismic Biology, Ecology and Evolution, University of California Los Angeles, 621 Charles E., Young Drive South, Los Angeles, CA 90095, USA

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Abstract

The effects of airplane flyby noise and playbacks of low-frequency motorcycle sounds on calling activity were examined in a mixed-species anuran calling assemblage in central Thailand. In response to these stimuli, three of the most acoustically active pond-edge species (*Microhyla butleri*, *Rana nigrovittata* and *Kaloula pulchra*) significantly decreased their calling rate. Yet under the identical stimulus regime, *Rana taipehensis* consistently increased its calling rate. Moreover, during the occasional natural lulls in the chorus in which males collectively stop calling, resulting in a conspicuous reduction in chorus intensity, calls of *R. taipehensis* would appear to emerge from the background noise. These results suggest that man-made acoustic interference may affect anuran chorus behavior either directly by modulating call rates of the chorus participants or indirectly, by suppressing calling behavior of one set of species which in turn stimulates calling in other species. The results of our playback experiment coupled with the natural calling behavior of these species support the latter hypothesis.

Keywords: Anuran; Acoustic interference; Vocalizations; Frog; Amphibian decline

1. Introduction

The past two decades have seen an emergence of interest and concern in the decline of amphibian populations throughout the world (Barinaga, 1990; Wyman, 1990; Ingram, 1990; Blaustein and Olsen, 1991; Blaustein et al., 1994; Marsh and Trenham, 2001). As a direct result, conservationists have concentrated their attention on such potentially negative effects of human activities on amphibians, as habitat modification and destruction, global climate change and chemical contaminants (Blaustein and Wake, 1990; Phillips, 1990; Wyman, 1990; Pechmann et al., 1991; Fahrig et al., 1995; Laurance, 1996; Vos and Chardon, 1998; Alexander and Eischeid, 2001; Hels and Buchwald, 2001; Blaustein and Kiesecker, 2002). Yet one aspect that is poorly understood is the interaction between man-made sound and amphibian biology. Increased frequency and intensity of sounds produced by airplanes, motorcycles, boats and other vehicles may have deleterious effects on acoustically communicating species. While recent studies have examined the consequences of exogenous sounds on population size and behavior in marine mammals, birds and fish (Richardson et al., 1985; Malme et al., 1988; Richardson and Würsig, 1997; Winker, 2000; Houser, 2001; Perry et al., 2002; Wilson and Dill, 2002; Slabbekoorn and Peet, 2003), very few have explored the effects of man-made acoustical disturbances on amphibians (Barrass, 1985).

This study was motivated by a series of observations of calling behavior in an Old World tropical frog community. At the pond-edge, males of *Rana taipehensis* would exhibit conspicuous vocal sac movements, yet no calls appeared to be emitted. It was not until several other syntopic species drastically reduced their calling rate in response to an airplane flying overhead, that *R. taipehensis* produced a series of rapid, squeak-like calls audible to the human ear.

* Corresponding author. Tel.: +1-310-825-0265; fax: +1-310-206-3987.
E-mail address: pnarins@ucla.edu (P.M. Narins).

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The aim of our experiments was to demonstrate the differential effects of anthropogenic sounds on calling rate, and to predict the potential impact they may have on the survival and reproductive success of a multi-species frog community. Because it is well-established that individual reproductive success is directly proportional to calling effort in numerous frog species (e.g., Whitney and Krebs, 1975; Davies and Halliday, 1977; Ryan, 1980; Gerhardt, 1982; Halliday, 1983; Sullivan, 1983; Arak, 1983, 1988; Wells and Schwartz, 1984; Robertson, 1986: Schwartz, 1986; Klump and Gerhardt, 1987; Dyson et al., 1992; Witte et al., 2001), we deduce that anthropogenic sounds that affect calling rate may impact fitness by altering reproductive behavior in this species.

2. Methods

2.1. Study area and focal species

This study was conducted in a small semi-permanent pond located in a semi-evergreen rainforest in Khao Yai National Park, Thailand (14°24′N, 101°22′E, altitude 765 m) from 13 to 22 May 2001. Located about 20 m from a park road, the study site was populated by several species of frogs and toads actively calling at the start of the breeding season. Exogenous sounds, specifically engine noises produced by airplane flyovers, passing motorcycles and automobiles were quite evident at the study site.

At the start of this study, the pond was approximately 15 m long by 10 m wide. Temperatures ranged from 22.5 to 25.5 °C, and relative humidity varied between 85% and 100% throughout the study period. All measurements were taken between 19:30 and 23:30 h when calling was most active.

Rana taipehensis, the focal species of this study, is a small, conspicuous ranid frog present in high densities at the study site. Males call from the pond-edge and are characterized by a snout-vent length of less than 30 mm and the lack of distinct stripes on the inner side of the latero-dorsal folds on the back (Ohler and Mallick, 2002). Both color morphs (green and brown) were actively calling at this site. Like other ranid frogs, this locally abundant species is threatened by the overuse of agricultural pesticides in Asia. Declining numbers have resulted in them being reclassified as "vulnerable" and "threatened" in Taiwan and Hong Kong, respectively (Dahmer et al., 2001).

2.2. Field recordings and playbacks

We recorded calling activity of *R. taipehensis* and several other syntopic frog species before (Fig. 1(a)), during (Fig. 1(b) and (c)) and after lulls in background noise-evoked by airplane overflights and playbacks of motorcycle engine noise. Vocalizations were recorded with an audiocassette recorder (Sony TC-D5M) and directional microphone (Sennheiser ME88) equipped with a windscreen placed within 50 cm of a calling male.

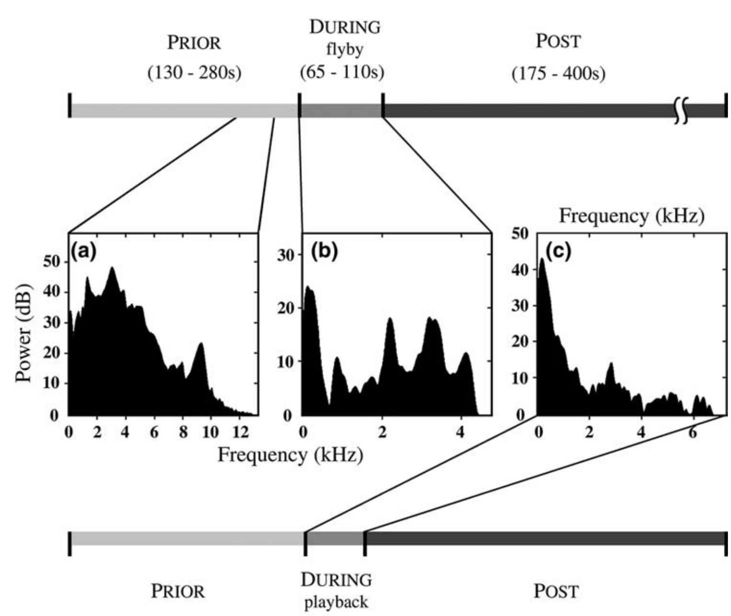

Fig. 1. Observation period prior, during and post-airplane overflight (top time line) and motorcycle stimulus (bottom time line); recording time given in seconds. The power spectra (a) of the ambient noise at the pond prior to flyby, (b) during flyby and (c) of the motorcycle engine noise stimulus are shown. The ambient noise power spectra for the post-stimulus periods (data not shown) are similar to those in (a).