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4pAB3. Acoustic invasion: How invasive species can impact native species acoustic niche?
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The effects of invasive species on native taxa due to direct predation, food and space competition, and disease transmission are well documented. However, the effects of acoustic invaders on animal communication have not been explored. We simulated an invasion of the acoustic niche by exposing calling native male white-banded tree frogs (Hypsiboas albomarginatus, harmonics at 60-1430 Hz and 2720-2780 Hz or 2280-2850 Hz) to recorded calls of the invasive American bullfrog (Lithobates catesbeianus, frequencies from 90 to >4000 Hz) at a non-invaded site in the Brazilian Atlantic Forest. In response, tree frogs immediately shifted calls to significantly higher frequencies. In the post-stimulus period, they continued to use higher frequencies and also decreased signal duration. Tree frogs did not change calling rate or inter-call interval. Acoustic signals are the primary basis of mate selection in many anurans, and such changes could negatively affect the reproductive success of native species. The effects of bullfrog vocalizations on acoustic communities are expected to be especially severe due to their broad frequency band, which masks the calls of multiple species simultaneously. These results show that invasive species could affect native species by interfering in their acoustic niche.

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INTRODUCTION

Alien species have been considered one of the most important causes of species extinctions (Pyšek and Richardson, 2010). Once one alien species is established it could compete, predate and parasite, or become a new potential prey on the native community. A practically unexplored topic is whether an invasion could affect species acoustic niche. If alien plants could completely change an ecosystem in silent, one noise animal has the potential to promote discrete changes in a community by changing the acoustic space.

In this study we tested for immediate changes in advertisement calls from a native anuran response to calls emitted by an invasive species. We simulated the acoustic invasion by presenting advertisement calls of the American bullfrog, *Lithobates catesbeianus*, to a native Atlantic forest species in non-invaded sites. We tested we predicted changes in call rate of the native frog species. We tested for changes in call rate and other gross-temporal calling patterns, and for changes in spectral properties.

MATERIALS AND METHODS

Study Area and Focal Species

The study was conducted at three permanent ponds located in an Atlantic rainforest relict in Serra do Itajaí National Park, municipality of Blumenau, Brazil (27°03' S; 49°05' W), between November/December 2009. *Hypsiboas albomarginatus*, the focal species, occurs in the Atlantic forest and breed in ponds in forest edges (Giaasson and Haddad, 2006). Considering the two harmonics, the lower limit frequency band is about 1061 Hz and the higher limit is 2851 (Giaasson and Haddad, 2006). The alien species, *Lithobates catesbeianus*, is currently widespread in the Atlantic Forest domain (Both et al., 2011). *Lithobates catesbeianus* present a broad band advertisement call (from 90 to > 4000 Hz) with an energy peak concentrated between 200 - 400 Hz in the lower frequency; and a second one between 1000 - 2000 Hz in a broader higher frequency band (Capranica, 1965).

Playback Experiments

We recorded bullfrog calls in invaded sites in south Brazil to verify calling patterns. Males calling alone shows 3-7 consecutive calls, they varied call trains interval from 15 s to several minutes. We chose a representative call train from a single male to build the synthetic stimuli. We built a playback following an A-B-A design: 5-min silence, 5-min stimulus, 5-min silence. The stimulus consisted in 9 trains of five bullfrog advertisement calls (6.6 s) spaced by 30 s interval.

We searched for *Hypsiboas albomarginatus* calling males from 9 p.m. until 0 h. Once a focal males was localized, we set the sound speaker at 1 m distance, at 10 cm high from the water level, and directed to the caller. We waited for 3-5 min to prevent from any interference from the recent movements and then played the A-B-A stimuli. Calls of focal males (N = 10) were recorded with a directional microphone placed at 1 m distance and a digital recorder.

Acoustic Analysis

The 15 min recorded for 10 individuals were reviewed using RavenPro 1.4 (Bioacoustics Research Program, 2011). Sound spectrograms of the calls were constructed using 16 bit resolution, 22 Hz sampling rate, 256 FFT. We displayed and counted the calls emitted in the tree time periods, and calculated the call rate (calls/min). To measure call patterns from single calls, we randomly took 20 calls in each period. For each call we estimated: call duration (s), inter-call interval (the time between the focal call and the following call, s), dominant frequency (Hz), center frequency (Hz), energy (dB) (Chariff, 2011).

Potential differences in call rate, call duration, inter-call interval, frequencies and energy were tested by Anova through randomization testing were the individuals were treated as blocks, and the period, pre - during - post stimulus, was a fixed factor. We used 1000 permutations and pseudo-Fratio statistics as test criteria (Anderson

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1 This study was already published, the complete version is available at http://www.ncbi.nlm.nih.gov/pubmed/22675139
The estimated 30 calling rates and each of the parameters from 600 calls were permuted only within individuals, to remove effects related with individual (e.g. body size) and unknown variation (e.g. temperature, air humidity) and analyze the main effect. With this design we assume the null hypothesis that any call, or call rate presented by a given individual could be emitted in any of the periods of the experiment. We used pairwise contrasts to determine which time periods differed. They were calculated using only the vectors and sample unities of the groups involved in the pair under test, therefore do not require probabilities correction. Analysis were performed in Multiv 2.4.2 (Pillar, 2006).

RESULTS

Bullfrog calls had no effect on tree frog signal rate (F = 0.004, p = 0.968) or inter-call interval (F = 0.004, p = 0.289). Signal duration was affected by the stimulus (F = 0.021, p = 0.002; Fig. 1). It did not differ significantly between pre-stimulus and stimulus periods (F = 0.001, p = 0.522) but was significantly shorter in post-stimulus than pre-stimulus (F = 0.018, p = 0.013) and stimulus periods (F = 0.025, p = 0.002).

Bullfrog calls had a significant effect on the dominant and center frequencies of tree frog calls (F = 0.030, p = 0.001; F = 0.048, p = 0.001, respectively). The dominant frequency increased during the stimulus (F = 0.037, p = 0.001) and then decreased, but remained significantly higher than in the pre-stimulus period (F = 0.021, p = 0.004). The difference between the dominant frequencies of the stimulus and post-stimulus periods was not significant (F = 0.004, p = 0.204). Centre frequencies differed only during the stimulus (F = 0.048, p = 0.001), being significantly different from both the pre- (F = 0.055, p = 0.001) and post-stimulus periods (F = 0.061, p = 0.001).

DISCUSSION

Studies dealing with anthropogenic noise effect in anuran calls observed changes in call rate of the native frog species (Sun and Narins, 2005; Kaiser et al., 2011). Changes in call rate and other gross temporal patterns are also the most common response employed by species when they are exposed to intra- and interspecific signal interference (e.g. Schwartz and Wells, 1983). We expected to find temporal changes in response to bullfrog calls, but individuals only shifted signal frequency. Such altered frequencies could be energetically suboptimal (Bosch and De la Riva, 2004), which might explain the decrease in signal duration after exposure to bullfrog calls. The advertisement call is the primary basis of mate selection (Ryan, 1988), therefore such changes could negatively impact the reproductive success of native species. These results show that invasive species could affect native species by interfering in their acoustic niche.

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REFERENCES


Capranica, R. R. (1968).” The vocal repertoire of the bullfrog (Rana catesbeiana),” Behav 31, 302-324.


