环境噪声对临安和阜阳两地白头鹎鸣声频率的影响

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摘要: 为了解环境噪声对白头鹎鸣声频率的影响，在浙江临安和安徽阜阳两地分别对白头鹎在高低噪声水平环境中的鸣声做了研究。把用数码录音机记录到的鸣声输入计算机，利用计算机声谱分析系统进行分析，再对每一鸣声的每个音节的主频进行检验。结果显示: 高噪声水平区和低噪声水平区相比，在两地白头鹎每一鸣声的各音节主频中，最低和最高主频以及第1、第2音节的主频都有显著提高; 在阜阳第3音节的主频也有显著提高。这表明白头鹎可以通过提高声音频率来避免环境噪声对鸣声的影响，从而保证噪声环境中声信息的有效传递; 而噪声对各音节的不同影响也表明，同一鸣句的各音节，对于噪声通讯中的信息识别，具有不同的地位。

关键词: 白头鹎; 噪声; 鸣声; 主频

Effects of Ambient Noise on the Vocal Frequency of Chinese Bulbuls Pycnonotus sinensis in Lin’an and Fuyang City

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Abstract: The study of the ambient noise’s effect on the vocal frequency of Chinese Bulbuls Pycnonotus sinensis was carried out in two cities Lin’an and Fuyang in China. Based on the noise level 55 dB the samples of each city were divided into two groups of high noise level and low noise level HN and LN. The records of songs were inputted into the computer and then the data of principal frequency of each syllable were gotten through fast Fourier transform using a computerized analysis system. The statistical analyses of each syllable’s PF of the songs were carried out with Mann-Whitney U test to determine differences between HN and LN of each city. The results showed that the minimum PF maximum PF the first syllable S1 and the second syllable S2 of every song had significant differences between HN and LN in two cities. In Fuyang the third syllable S3 had significant difference because of geographic diversity. In contrast HN with LN the minimum PF maximum PF and the PF of S1 and S2 increased significantly in the high noise level environment. This means that Chinese Bulbuls may avoid the interference of ambient noise with a higher pitch to communicate effectively and the difference of ambient noise’s effects on each syllable principal frequency shows that each syllable has different status in communication in noisy environment.

Key words: Chinese Bulbul Pycnonotus sinensis Noise Song Principal frequency
When the noise level is within the frequency range of the bird's call, it can most effectively cause the bird to increase its vocal intensity. The nightingale (Luscinia megarhynchos) can adjust its vocal intensity based on the masking noise level. In a continuous background noise, the little penguin (Eudyptula minor) identifies its parents based on the frequency, not the amplitude (62.7%).

In a noisy environment, the great tit (Parus major) uses high-frequency sounds to effectively communicate (97%). Its calls have a higher minimum frequency, which reduces the masking effect of low-frequency noise (200). When the noise level is within the frequency range of the bird's call, it can most effectively cause the bird to increase its vocal intensity. The nightingale (Luscinia megarhynchos) can adjust its vocal intensity based on the masking noise level. In a continuous background noise, the little penguin (Eudyptula minor) identifies its parents based on the frequency, not the amplitude (62.7%).

White-crested laughingthrush (Garrulax leucolophus) is widely distributed in southeastern China, is one of the most common resident birds, and is often active in grasslands, town parks, gardens, and nearby villages. Its breeding season is noted for its complex and varied song, while the territorial call is clear, loud, and distinctive (200). Different regions of the white-crested laughingthrush have different phrases, with variations in duration, frequency range, and spectral characteristics (50). In this paper, we attempt to explore the changes in the white-crested laughingthrush's call in two environments with different noise levels, from an acoustic perspective, to study the effects of environmental changes on birds, and the adaptability of birds, providing a basis for research.

### Methods

From 9/2002 to 8/2003, the study was conducted in Lin'an, Zhejiang Province and Fuyang, Anhui Province. The high-noise area (CD) was mainly set in the side roads of urban roads and courtyards in the city; the low-noise area (9D) was set in villages around the city at a distance of about 15 km. The sampling sites in Fuyang were mainly set in the city's parks, side roads of urban roads and nearby residential areas; the sampling was set in villages around the city at a distance of about 15 km.

Noise measurements were made using the E5476A sound level meter (sensitivity: frequency range: 20 Hz to 12 kHz). According to the 'Method for Measuring Urban Environmental Noise' (GB3096-93), the sound level meter was set to "A" and "C" modes. Recording was conducted without rain or strong winds, and each data point was recorded at a distance of 5 m from the ground for 1 second, then repeating the same process in four directions. The main noise sources were identified and recorded using sound recording equipment. The noise spectrum was analyzed through a computer.

Bird calls were recorded using the Sony MZ-R909 (sampling frequency: frequency range: 20 Hz to 20 kHz, ±3 dB). Analysis was conducted using the computer sound spectrum analysis system, with each individual's call analyzed using narrowband analysis and frequency domain analysis. Each call was divided into 512 points and repeatedly analyzed using fast Fourier transform (FFT), with statistical analysis performed using SPSS.

### Results

#### Environmental Noise Impact on the White-crested Laughingthrush in Lin'an

In Lin'an, the white-crested laughingthrush's territorial call is characterized by a complex and varied song, while the territorial call is clear, loud, and distinctive (200). Different regions of the white-crested laughingthrush have different phrases, with variations in duration, frequency range, and spectral characteristics (50). In this paper, we attempt to explore the changes in the white-crested laughingthrush's call in two environments with different noise levels, from an acoustic perspective, to study the effects of environmental changes on birds, and the adaptability of birds, providing a basis for research.

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检验  U = 66.3 P = 0.001

2.2

2.2.1

Table 1  Characteristics of principal frequencies of Pycnonotus sinensis
territory songs in high and low noisy localities in Lin’an City
Zhejiang Province

<table>
<thead>
<tr>
<th></th>
<th>Minimum PF</th>
<th>Maximum PF</th>
<th>Syllable</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2 213 ± 203</td>
<td>2 932 ± 223</td>
<td>2 629 ± 309</td>
</tr>
<tr>
<td>II</td>
<td>2 629 ± 268</td>
<td>2 346 ± 121*</td>
<td>2 346 ± 121*</td>
</tr>
<tr>
<td>III</td>
<td>2 932 ± 303</td>
<td>2 644 ± 151</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>2 932 ± 303</td>
<td>2 571 ± 98</td>
<td></td>
</tr>
</tbody>
</table>

No. of samples  30    12

表 1.4  对应表 1.2

Table 2  Characteristics of principal frequencies of Pycnonotus sinensis
territory songs in high and low noisy localities in Fuyang City
Anhui Province

<table>
<thead>
<tr>
<th></th>
<th>Minimum PF</th>
<th>Maximum PF</th>
<th>Syllable</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1 846 ± 238</td>
<td>2 758 ± 227</td>
<td>2 403 ± 245</td>
</tr>
<tr>
<td>II</td>
<td>1 851 ± 235</td>
<td>2 026 ± 150*</td>
<td>2 026 ± 150*</td>
</tr>
<tr>
<td>III</td>
<td>2 629 ± 248</td>
<td>2 396 ± 119*</td>
<td>2 396 ± 119*</td>
</tr>
<tr>
<td>IV</td>
<td>2 403 ± 245</td>
<td>2 673 ± 163*</td>
<td>2 673 ± 163*</td>
</tr>
<tr>
<td>V</td>
<td>2 589 ± 262</td>
<td>2 744 ± 334</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>2 484 ± 188</td>
<td>2 434 ± 117</td>
<td></td>
</tr>
</tbody>
</table>

No. of samples  20    15

* P = 0.002

1.2.4  检验  U = 58.5 P < 0.001

3
图1 浙江临安和安徽阜阳白头鹎领域鸣声的时域波形图、频谱图和第音节的频谱图

以用于个体识别的声音特征，应定位于低频部分（1-6 kHz）。但是，当有背景噪声存在，特别是噪声的频率在鸣声的频率范围内，就会产生掩蔽效应。提高鸣声的频率，与环境噪声的频率不重叠，就能避免低频噪声对鸣声的掩蔽作用。另外，从对人的听觉研究结果看，人耳对高频音，特别是A G H E I J的声音敏感，对低频音不敏感（K*0$ (2 *6，!CCL）。也就是说，同样的强度，高频音相对于人的听觉，其响度比低频音要高。这意味着，在一定的频率范围内，提高声音的频率，可以提高声音的响度，有利于信息的传递。我们推测白头鹎提高鸣声的频率，以避免噪声的掩蔽影响和提高声音响度，从而保证噪声环境中声信息的有效传递。

在自然合唱的背景噪声中，当信噪比（噪声较小）时，鸣声接听者热带蛙（+"," *./-##-0&-）的雌性个体更偏好较低频率的雄蛙鸣声；在信噪比为（中等程度噪声）时，雌蛙不能从各种频率鸣声中识别雄性；在信噪比为（噪声较大）时，则偏好接近种群典型频率的鸣声。即使雌蛙能够发现雄蛙，适度水平的自然背景声音也会降低雌蛙辨别雄蛙鸣声的能力；而在高背景声音下，雌蛙则不能辨别低频鸣声（K-66(.'*0 K#P）。

Fig.1 Time waveforms and the second syllable’s frequency spectrums of Pycnonotus sinensis territory songs in Lin’an and Fuyang City

PF " Principal frequency

" de la Torre & Snowdon 2002
Langemann 1998 Slabbe koorn & Peet 2003
2 ~ 5 kHz W Wang et al. 1997 Wollerman & Wi-
节。说明噪声对同一鸣句各音节的影响不同，同时

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