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CHANGE IN QUALITY OF ENVIRONMENTAL SOUND

IN THE AUTUMN

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Abstract
In rural suburbs, there were, in the past, many birds, insects and other sources of life, particularly near tiny streams. There was pleasure in listening to their singing, and in observing their actions in this natural environment. However this natural environment is changing, and more monotonous scenery is replacing it. Once housing has been developed, and roads constructed, it is difficult for the natural life to continue to live in the new environment. Consequently it is difficult to find the specific kinds of insects that used to inhabit the area. There are very few records of the environmental sound from these earlier times. Even though the environmental sound levels are high, due to their singing, many Japanese enjoy the sound and do not class it as unwanted noise. We show the frequency characteristics of the environmental sound for this measurement period.

1. INTRODUCTION

There are four seasons in Japan. And, the environment sound changes in the season. There are many parks that have lots of trees in a city. However, there are few kinds as compared to a wide variety and number of tree in the suburbs. We feel that the town is not comfortable environment for the bird and the insect. Of course, in the city, people feel each season sensitively from the environmental sound in addition to the temperature and the scenery. In the rainy season, frogs sing. In the summer, cicadas sing aloud. In the early autumn, the insects sing the beautiful chorus. Many Japanese enjoy the sound and do not class it as unwanted noise.

We are interesting in change of the environmental sound by the singing of the insects. We recorded the chorus of *calyptotrypus hibinonis*, that is called aomatsumushi in Japan, in the suburbs in Yokohama from mid-September to beginning of November. The insects begin to sing from the evening and continue to sing until around 3:00. There is a difference from the frequency characteristics between the sound of the insect in the early-evening and in the morning. Moreover in the date, the frequency characteristics are changing. We show the

frequency characteristics of the environmental sound for this measurement period.

2. ON THE MEASUREMENT ENVIRONMENT

As a matter of course, they are living around area across the generations for the most part. Sparrows, bulbuls and crows can be seen in several places. In the tiny stream, killifish, crucians, loaches, tadpoles, diving beetles and some are living. Fireflies can be seen around the spring-fed pond that is about 1 km apart from our house in June.
And, we can hear the continuous chorus of frogs in the rainy season and cicadas in summer time. Chirping of insects that are a grasshopper, a cricket, a bell-ring cricket and some is a popular melody for many Japanese in the early autumn.

Living environment is increasingly apt to go urban. Region richly endowed with nature become narrower. Urbanization affects the environment. As the results, stream dwellers and insect are hard to living in our area. Environmental sound produced by these dwellers is changing from year to year. By housing land development and construction of a road, natural environments are changing and monotonous scenery is spreading out. And we are hard to take a sighting of stream dwellers that are inadaptable for living conditions. Several varieties of dwellers in those days can not be found out or grown downward. Living environment then and the now is very different. About 30 years ago, we could observe and find many birds, insects and dwellers in tiny stream for irrigation and drainage in rural suburb. We had many occasions to enjoy listening their songs and observation actions in natural environments.

As one of evaluations for the developmental observations and environmental preservation in natural environments, we estimate the changes of the environmental sounds as the functions time and day. We focus on singing of insects in early autumn in our living area. Measurements for singing of the insects are carried out for a period of about 60 days. Measurement duration is 3 minute every 30 minute. The observed results of sounds generated by insects in the garden are shown.

3. MEASURING LOCATION

A wide scrub brush and a field are near our house where is located at the end of Yokohama city. District close by the house is agricultural land and quiet area. Size of the garden is about 5m x 10m. Figure 1 shows the picture of the garden. Shear of garden trees and weeds is not done in making and recording measurements.

3.1 Without Singing of Insects

This section describes the sound pressure and spectrum of the observed environmental sound.
In the measured environment sound, the traffic sound, the railroad sound, the voice, the pump sound and the natural sound are mixed. Traffic road runs in front of the garden. Traffic density is about 20 cars/hour. Measuring location is the veranda on the second floor. And, sound pressure meter is set at 3.5 m high from the ground.

We show the environmental sound waves and the frequency characteristics of the environmental sound as a function of time at 8:00 on September 11th in Fig. 2. These noises are propagated from a long distance and are mainly produced by vehicles. A unique sound does not emerge in this area. The pulsing sounds shown in Fig. 2 (a) are generated by the vehicles. In estimating the average power spectral, we calculate the power spectrum of the sounds that is selected from the measured environment sound every 2 sec. by the Hamming window. We don't make the overlap processing by selecting the inter-frame signal. The waveforms of the environment sound in the daytime are different completely every time, but the frequency characteristics are approximately the same. In the frequency band from 0.1 kHz to 1.0 kHz, decay rate of power spectrum levels is 20dB/dec.

Figure 1 Picture of a garden.

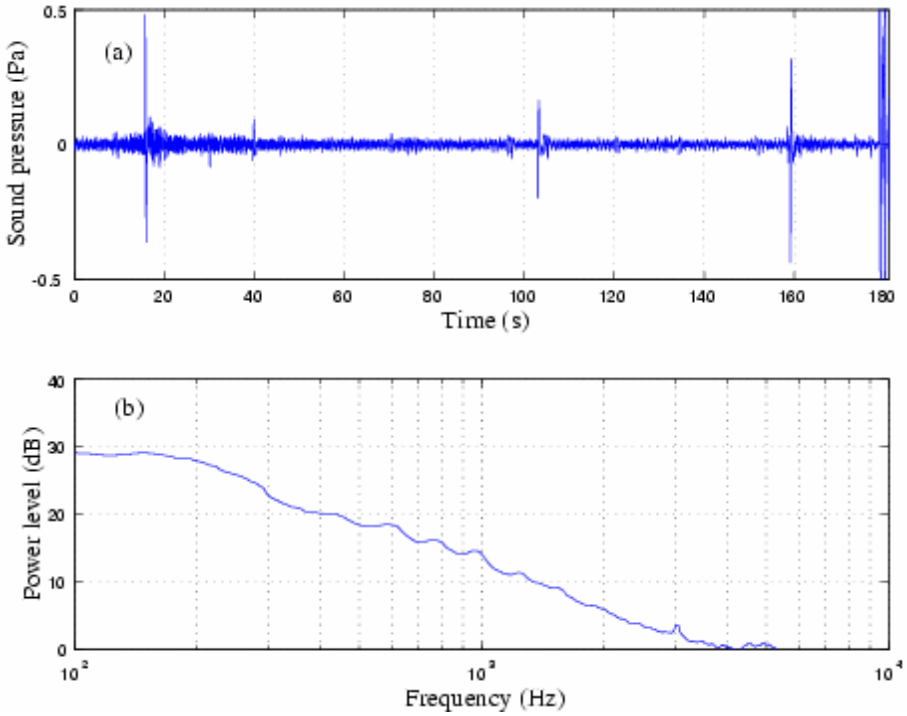

Figure 2 The measured environmental sound and its average power spectrum.
(a) The sound pressure waves measured at 8:00 on September 11th.
(b) Average power spectrum.

3.2 With Singing of Insects

Figure 3 shows the environmental sound waves with chirping of insects that are measured at 19:00-19:03 on September 11th. The magnified four figures for the top figure are shown as function of time. From the bottom figure, the waveform of singing of insects can be seen.

Figure 4 shows the environmental sound waves, sound pressure level and spectrum. The sounds are mainly produced by insects where live in our garden. The insects produce the high power level. The spectrogram of the bottom figure shown in Fig. 3 is distributed in the frequency band from 4500 Hz to 5500 Hz. From the measured frequency characteristics, these insects are mainly the aomatsumushi. Figure 5 shows a picture of the aomatsumushi on a leaf.

Figure 6 shows the equivalent sound level of environmental sound that is measured at each time on September 11th. The highest equivalent sound level occurs at 5:00. It is produced by the rain drops and thunders. And, the ascending-curve of the equivalent sound pressure level in the period between 18:00 and 23:33. It is cause the singing of the insect. Equivalent sound level by the singing of insects is higher than one of traffic noise that mainly is background noise. The aomatsumushi is a nocturnal insect. Peak-hour that shows the maximal sound levels is up to 19:00. And, chirping of insects run for 8 hours. They finish to sing a song up to 4:00 in the early morning.

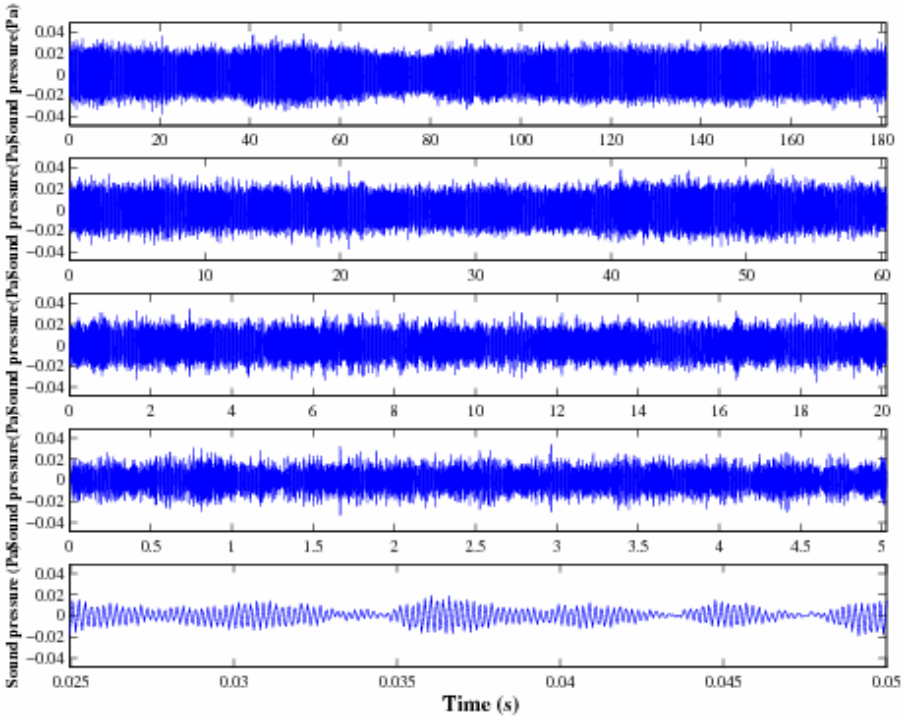

Figure 3 The environmental sound waves with chirping of insects that are measured at time from 19:00 to 19:03 on September 11th. Top-bottom: The magnified four figures for the top figure are shown as function of time.

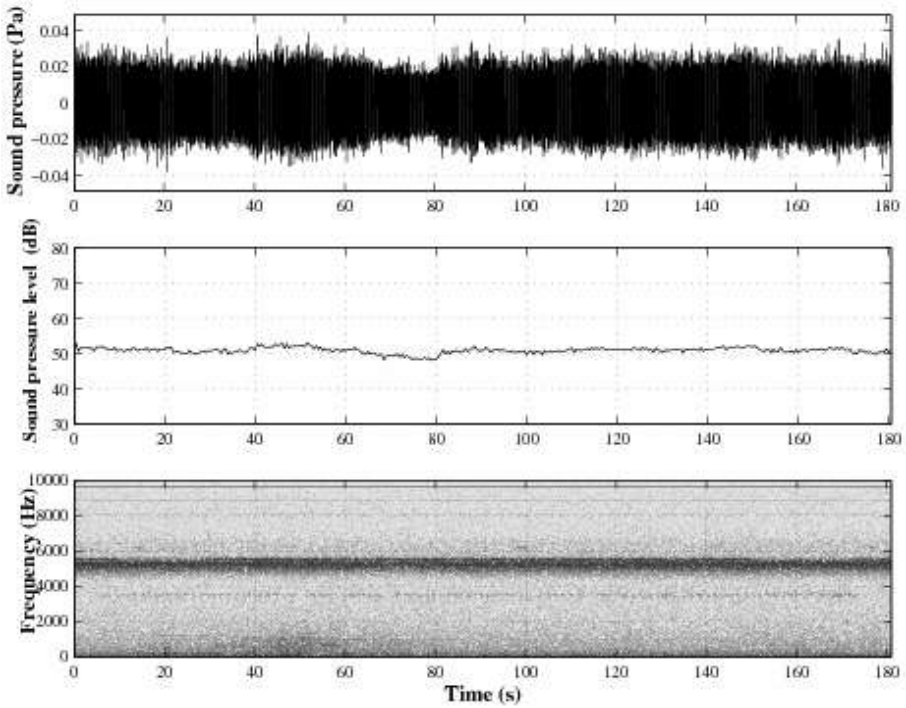

Figure 4 Measured the environmental sound waves, sound pressure level and spectrum. Measuring time: from 19:00 to 19:03 on September 11th.

Figure 5 Aomatsumushi on the leaf.

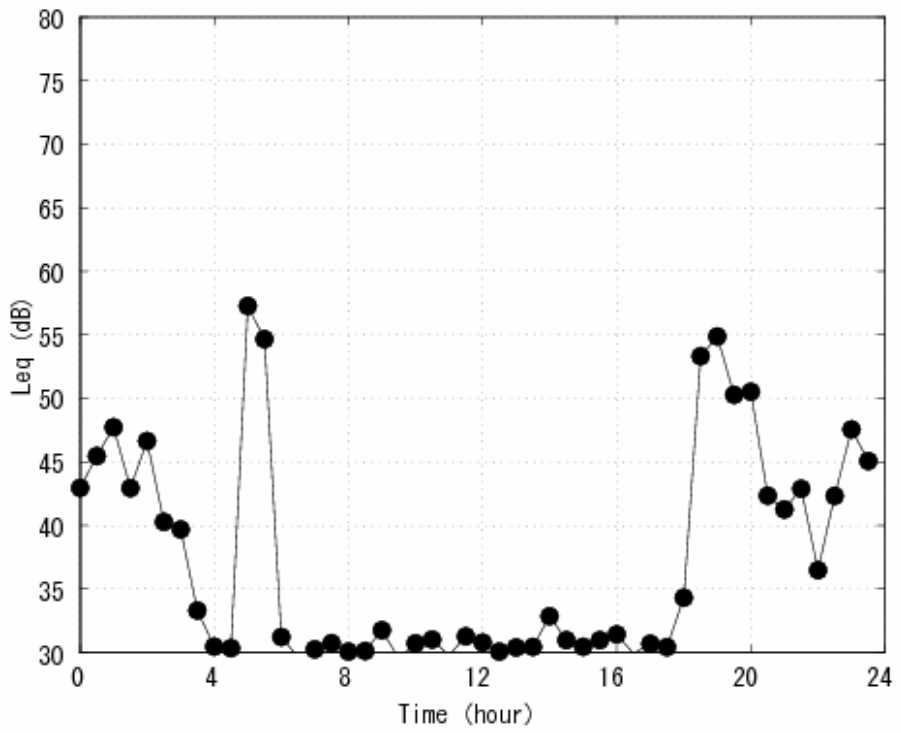

Figure 6 Equivalent sound levels. Measuring date: September 11th

7. The CHANGE AS A FUNCTION OF TIME

In the frequency characteristics, the frequency of the local peak spectrum is up to 5 kHz. The spectrum characteristics of the environmental sound from 16:00 to 23:00 on September 11th are shown in Fig.7. In the results measured at 16:00 and 17:00, power spectrum of singing of insects is over the frequency range from 4 kHz to 7 kHz. And, the bandwidth is broad. However, at the measuring time at 16:00 or later, the sound power concentrates in frequency band between 5 kHz and 5.5 kHz.

The measuring hour of the highest levels in the frequency characteristics is 19:00. It becomes low in turn in 20:00, 21:00, 22:00, 18:00, 17:00 and 16:00. The tendency of this level variation of the characteristic of the environment sound continues until the middle in October. After, equivalent sound level becomes low gradually. While keeping the time tendency of the levels, beginning time of singing shifts to the earlier hour.

8. The CHANGE AS A FUNCTION OF DAY

From 16:00 to 23:00 every one hour on October 15th, the spectrum characteristic of the frequency band between 1 kHz and 10 kHz is shown in Fig.8. The environmental sound in the measuring time between 16:00 and 17:00 was not produced by the insects. The insects begin to sing at 18:00. Compare with the measured results on September 11th, the difference of level variation is a few as a function of the time.

Next, compare the frequency response of the environmental sound, we know that the local

peak frequency is 4.93 kHz at 18:00. And, the local peak frequency is 4.25 kHz at 19:00. After this, the peak frequency changed to 4.80 kHz, 4.73 kHz, 4.58 kHz and 4.58 kHz at the measuring hour.

The main energy band of the frequency characteristics changes to the low frequency. The spectrum characteristics of the measured environmental sound on November 1st are shown in Fig.9. The local peak frequency is 3.85 kHz at 18:00. The time which could be observed is from 22:00 to 23:00. The frequencies of high levels are 3.92 kHz and 3.80 kHz, respectively. The local peak frequency is shifting to the frequency which is lower than the results of the other date. For late autumn, the frequency of the environmental sound generated by the insect is changing into the low frequency band.

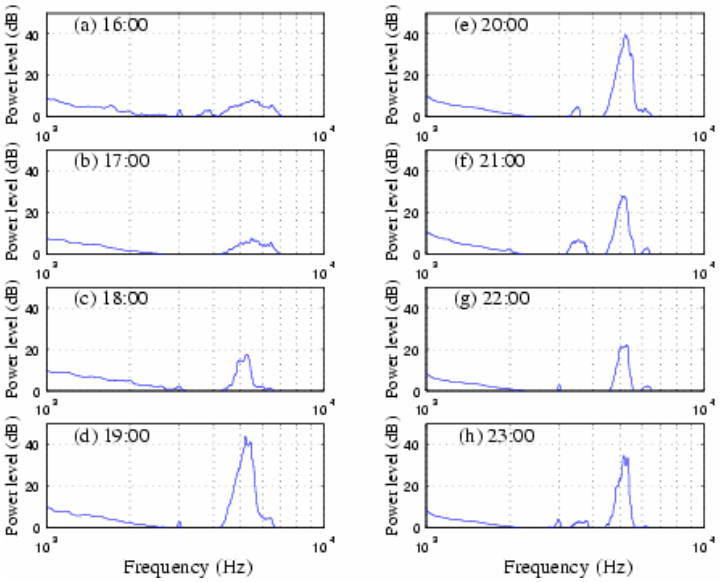

Figure 7 Average power spectrum of the environmental sound.
(a) - (h): 16:00 - 23:00 on September 11th

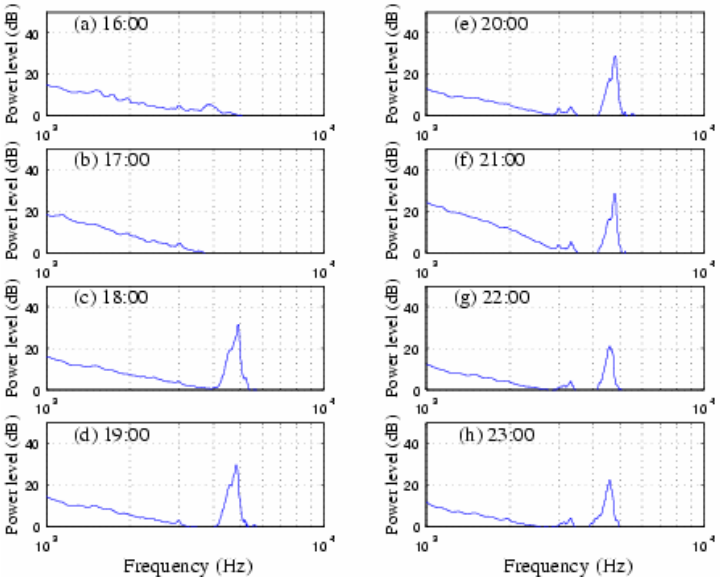

Figure 8 Average power spectrum of the environmental sound.
(a) - (h): Measuring time: 16:00 - 23:00 on October 10th.

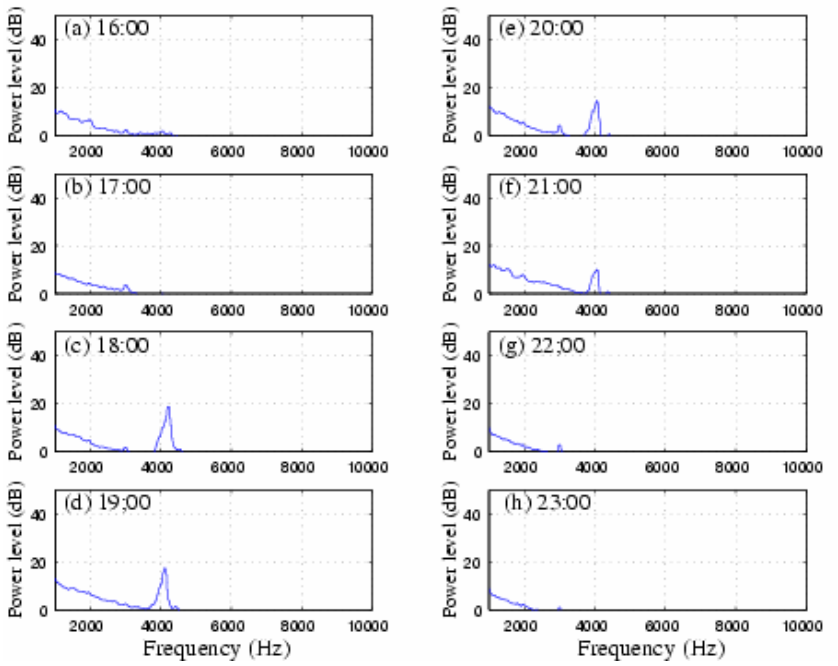

Figure 9 Average power spectrum of the environmental sound.
(a) - (h): Measuring time: 16:00 - 23:00 on November 1st.

9. CONCLUSIONS

For many Japanese, the singing of the insect is one of the familiar sounds like the natural sound. There are many persons who have the insects in a cage from these earlier times. In China, people have two insects in sculpting beautiful box and enjoy the singing. We show the analysis of the sound generated by the insects in our garden. The frequency characteristics of the singing of the insect changed in the singing time. From measured results, we know the change of the sound quality of environmental sound from the early autumn to the late autumn.

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