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Original Article

A Study on the Risk Analysis of Tiger Cry that Makes Elephants Tremble

Ik-Soo Ahn [1]

[1] *Electronic Information Engineering IT Convergence SoongSil niv*
369, Sangdo-ro Dongjak-gu, Seoul Korea

[1] aisgooman@ssu.ac.kr

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Abstract - *Elephants are often injured or killed while running away after being chased by the cry of a tiger, which is becoming a hot topic. According to the previous experimental papers, it was found that accidents often occur where an elephant, who was not afraid of the cry of a leopard or a puma, hears the cry of a tiger and panics, then falls off a cliff or dies without getting out of the swamp.[1] Then, we investigated what kind of sound components are contained in the Tiger's cry, which frightens the elephants and makes them tremble in fear. We also investigated how different the Tiger's cry was from other feline predators. The experiment was conducted by comparing and analyzing the cries of leopards and pumas among various feline predators with those of tigers. As a result of the analysis, it was found that the low-frequency sound of the 50 Hz band and the intense ultra-low-frequency sound below the human audible band were widely and strongly generated in the cry of a tiger. Suppose the elephant habitat or zoo wants to prevent accidents or stress caused by hearing the tiger cry. In that case, installing a barrier or sound barrier around the elephant habitat is also possible to prevent the powerful low-frequency sound from the Tiger's cry from being transmitted directly.*

Keywords - *Elephant, Tiger cry, Feline, Accidents, Ultra-low-frequency, Sound analysis.*

1. Introduction

It is said that elephants sacrificed by tigers are often found in India. It is said that even adult elephants, grown-up and gigantic, are being chased by the roar of a tiger and stumble or die in an accident. Many feline animals live near the elephant habitat, but they are said to run away in fear of the Tiger's cry. Of course, young elephants are often targeted and sacrificed by various feline predators, but it is not uncommon for adult elephants to be chased and sacrificed.[1] Why are even giant adult elephants being chased and hunted by tigers? It is said that the cause is mostly because the Tiger is the largest among the feline animals and has a frequency that gives fear even to its cry. In addition, the experience the elephant has suffered from the Tiger is also a traumatic experience, making the elephant feel a stronger sense of fear. It is said that the trauma is so strong that the elephant hears the cry of a tiger and is chased by fear, then falls off a cliff or falls into a swamp. Compared to other felines, what are the ingredients in the chirping tiger's cry that terrifies even the largest of the herbivores, the elephant? In this paper, an experiment was conducted to find the cause by analyzing the components of the cry of a tiger and the cry of a leopard and a puma, among other feline predators.[2]

2. Analysis of Elephant Characteristics and Sound Reaction

Elephants are the largest land animals in the world, weighing several tons. There are two main types of elephants: Asian elephants and African elephants. Asian elephants inhabit forests, grasslands, and valleys of India, Southeast Asia, and China and can reach a maximum length of 6.4m and a weight of 5.4t. Its back is arched, and ivory is only found in males. The front paws have five claws, and the hind paws have four claws. African elephants inhabit the southern part of the Sahara Desert in Africa, reaching a maximum length of 7.5 m and a weight of 6.3 tons. The front paws have four claws, and the hind paws have three claws. Elephants have very large ears, but just because they have large ears does not mean they can hear a wide range of sounds. When it's hot, it shakes like a fan to create wind to lower body temperature, and when angry, spread it out to the side to make you look bigger. Of course, they have large ears, so they can play an important role in collecting sound. Elephants Respond to sounds and use mainly low-frequency sounds. Elephants are animals that use infrasound with a frequency lower than the lowest that humans can hear. In addition, elephants form their society by gathering dozens of individuals, and because of their large brains, they are very intelligent and have a surprisingly good memory.

Domesticated elephants, in particular, understand human speech and even play musical instruments. Elephants sometimes communicate colorfully and complexly using infrasound that humans cannot hear. It may also radiate. Elephants communicate by transmitting ultra-low frequencies that their body can feel. It's inaudible to people, but infrasound has a variety of uses in the animal world. When a female elephant seduces a distant male, it emits infrasound because the infrasound has a long wavelength and can be transmitted far away.[3][4][5]

3. Analysis of the Cry of Tigers and other Feline Predators

As a research method, we decided to compare the cries of leopards and pumas, which are comparatively comparable in physique to tigers among feline predators, with those of tigers to find out the difference. For comparative analysis, the cries of leopards, pumas, and tigers were collected, and the cries were analyzed using a scientific sound analysis tool. As a tool for cry analysis, Adobe's audition program was used. Each cry was analyzed by dividing it into the time domain, spectrogram, and spectrum analysis. The time-domain graph is a graph that shows the pitch width and volume density of a cry through the time waveform of the sound. The spectrogram graph is a graph that informs the distribution of cry energy by expressing the energy change according to the frequency domain for each time as the brightness of the light. The spectrum graph is a graph that confirms the frequency range of the cry by comparing the decibels for each frequency of the sound. In particular, spectral analysis was performed to compare the cry characteristics of tigers, leopards, and pumas. There are three characteristics of feline calls: the first is a strongly roaring sound, the second is a warning sound, and the third is a growling sound. In this paper, we analyzed the roar crying by classifying it as A, and the wary crying, the growl crying sound as C.[6][7]

3.1. Analysis of Leopard Characteristics and Crying Sound

The leopard is a mammal belonging to the feline family. It mainly lives in the forests of alpine areas and is active after sunset or at dawn. The length of the male is 140-160 cm, the female is about 120 cm, and the shoulder height is 65-70 cm. Males weigh 32-48 kg and females 25-42 kg. The body is long and slender, and the legs are relatively short. The ears are short and round, and they have a long tail, about half the body length. The color of the body's hair is yellow or yellowish-red, and there is a large black ring pattern all over the body. The hairs on the belly and the inside of the legs are white from the lower jaw, and black spots are scattered sporadically. [8]

3.1.1. Time-domain analysis of Leopard cry

The cry of a leopard is distinct from a tiger, even if you listen to it with your ears. The pitch of that cry is much narrower than that of a tiger. The time-domain graph is a graph that examines the waveform shape of a sound component over time and analyzes the sound width and volume of the sound component.

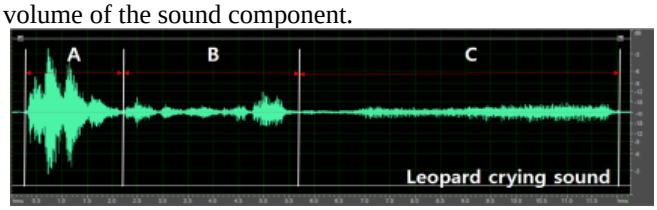


Fig. 1 Time-domain graph of Leopard cry

As shown in the time-domain graph of the leopard roar in Figure 1, in both the roar crying part of A, the wary crying part of B and the growl crying part of C, the sound width and bandwidth and The volume is narrow and weak.[9]

3.1.2. Spectrogram Analysis of Leopard Cry

The leopard cry was analyzed through the spectrogram graph. The spectrogram graph is an analysis method that expresses the energy of a sound in a graph. The shape and characteristics of the leopard cry are different in the order of Apart, the roar crying sound, B wary crying sound, and C growl crying sound. The intensity of the energy is also different. The meaning shown in Figure 2 is that the roar crying sound of the leopard, part A, has the strongest energy in the entire band from the low-frequency region to the high-frequency region, and the wary crying sound of part B has slightly weaker energy than the part A. And the growl crying part C indicates that it has the weakest energy.[10]

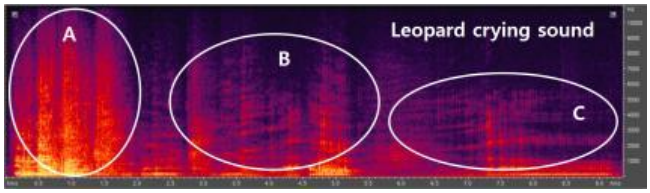


Fig. 2 Spectrogram graph of Leopard cry

3.2. Analysis of Puma Characteristics and Crying Sound

Puma looks like leopards but has no markings on their bodies and long hind legs that allow them to climb mountains. The body length is 1.1~2m, the tail length is 60~78cm, and the weight is 30~103kg. The tail is long in the shape of a round rod, occupying about a third of the total body length. They live mainly in bushes, crevices of rocks, and caves, looking for prey in the mountains. They are mainly nocturnal and rely on sight, hearing, and smell to act. The young males who leave their mothers may roam in groups until they are fully grown.[11]

3.2.1. Time-domain analysis of Puma cry

Pumas are similar in size to leopards, but their calls are less frightening than leopards' calls. As shown in the time domain graph of the puma cry in Figure 3 below, the sound width of the puma's cry seems to be expressed wider than that of the leopard, but in terms of density, it shows a spread

rather than condensed waveform. Part A in Fig. 3 is the roaring sound of a puma. Compared with part A of the time domain graph of the leopard's cry in Fig. 1, the width of the sound width or the density of the waveform is not so strong, and it is not a threatening cry. Part B in Fig. 3 is the wary crying of the puma, and compared to the growl crying of the leopard in part C in Figure 1, the sound width appears to be wider, but the density and condensing power of the sound seem weak. Part C in Fig. 3 is the puma's growl, and it can be seen that it is short and weak compared to the growl of a leopard in Fig. 1, as it appears short and weak on the graph.[12]

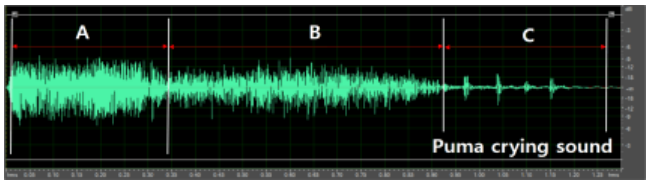


Fig. 3 Time-domain graph of Puma cry

3.2.2. Spectrogram Analysis of Puma Cry

The energy characteristics between the frequency domains for each crying characteristic of the puma's cry were analyzed through spectrogram analysis. Figure 4 The spectrogram graph of the puma's cry shows the energy distribution by dividing the puma's cry into A roar crying sound section, B wary crying section, and C growl crying section. As shown in the spectrogram graph of the puma cry in Figure 6, strong energy is expressed in the low-frequency part of A roar crying sound, B wary crying sound, and C growl crying sound.[13]

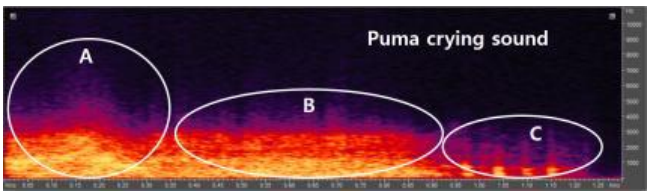


Fig. 4 Spectrogram graph of Puma cry

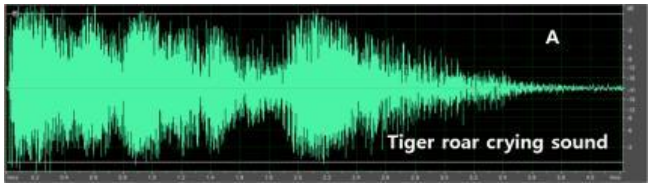
As shown in the spectrogram graph of the puma cry in Fig. 4, the puma's cry forms a fundamental sound frequency with a lower frequency than that of the leopard's cry. The puma's cry has energy evenly over the entire frequency band. Still, it is not threatening overall because stronger energy is concentrated only in the low-frequency region than the leopard's cry. Of course, the puma's cry is also analyzed to be incomparably weaker than that of a tiger in terms of overall sound width and volume.[14][15][16]

3.3. Tiger cry analysis

The Tiger is the largest of all the extant felines, with an overall length of approximately 2.2 m to 3.4 m, with males weighing 100 to 360 kg and females weighing 70 to 200 kg. Tigers are mostly solitary and prey on hoofed animals. The cry of a tiger is unique. When a tiger, the highest predator, is angry, its roaring cry makes the prey animals of the lower food chain tremble. The fact that prey animals are terrified of hearing the infrasound of a tiger's cry has not been clarified scientifically. Still, the characteristics of the low-frequency sound are transmitted throughout the body, and the body can feel the sound. It is reasonably accepted that the fear of tigers terrifies them. The cry of a tiger is similar to that of a lion, but there are some differences. The sound of a lion's roar is a bit dull, and the roar of a tiger seems sharper and more aggressive.[17][18]

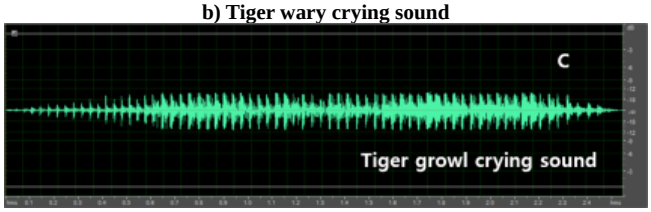
3.3.1. Time-domain analysis of Tiger cry

To analyze the Tiger's cry in more detail, A roar crying sound, B wary crying sound, and C growl crying sound were analyzed separately. First of all, if you look at the time domain graph of the Tiger's cry, you can see that the waveform itself is expressed intensely and magnificently, even at a glance. [19]



a) Tiger roar crying sound

b) Tiger wary crying sound



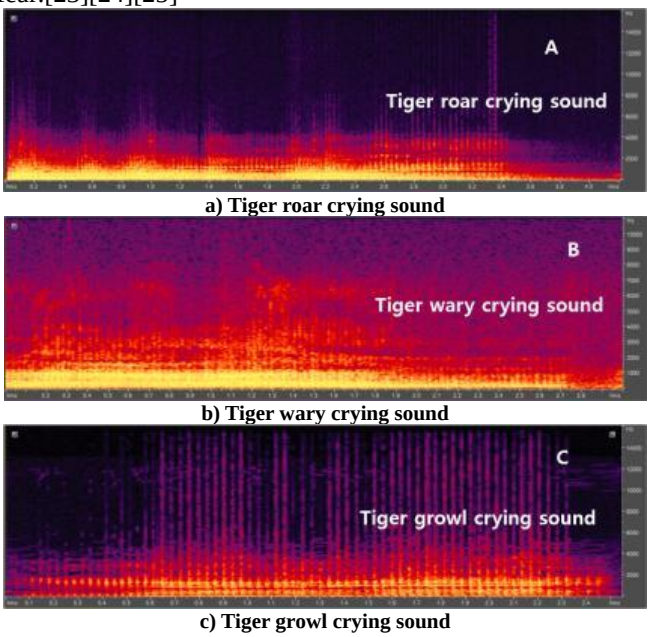
c) Tiger growl crying sound

Fig. 5 Time-domain graph of tiger cry

Figure 5 is a time-domain graph divided and analyzed according to the characteristics of the tiger cry. "a" is a time-domain graph for the roar crying sound of a tiger, with a large pitch and intense volume. "b" is a time-domain graph for the wary crying sound of a tiger, showing a graph in which the sound width is wide. Still, the density is dispersed. "c" is a time-domain graph of the growl crying sound of a tiger, in which intense and condensed waveforms are repeatedly expressed. Their meanings are that the tiger cry characteristic is to subdue the baseline by roaring with an intense, condensed roar to the opponent, frighten them with a dispersed, distracted roar, and immobilize them with a low, uniform growl.[20][21][22]

3.3.2 Spectrogram Analysis of Tiger Cry

The sound energy of the Tiger's cry was confirmed through the spectrogram graph of the Tiger's cry. To analyze the energy of the Tiger's cry, the spectrogram graph was extracted by classifying it into A's Tiger's roar crying sound, B's wary crying sound, and C's growl crying sound. First of all, it can be seen that A's Tiger's roar crying sound is emitting strong energy centered on low-frequency sounds as if it were a sound that subdues the opponent. The roaring sound of a tiger resonating with a strong roar is expressed so strongly that it cannot be compared with the roar of other feline predators. It can be seen that the strong sound energy distributed over the entire band based on the strong low-frequency sound is shown in B's Tiger's wary crying sound. Such sound energy is judged to be sufficient to frighten the prey. The roaring sound of a tiger's growl crying sound in C shows sound energy as if the sound of a large marble rolling on a floor with strong resonance is regularly expressed. This sound energy is considered to be a sound that makes the prey tremble in tension and gradually maximizes the sense of fear.[23][24][25]



a) Tiger roar crying sound

b) Tiger wary crying sound

c) Tiger growl crying sound

Fig. 6 Spectrogram graph of Tiger cry

Although the energy of the Tiger's roar crying sound is strong, the energy contained in the entire frequency of the wary crying sound and the intense threat of a growl crying sound have more than enough sound energy to make the elephant tremble. Among them, the low growl crying sound of the Tiger, which is part C, is the condensed low-frequency and ultra-low-frequency cry that seems to roll over and over, and it seems to be transmitted to the elephant most threateningly.[26]

4. Comparison of tiger cry and feline predator cry

The spectrum was analyzed to compare the cry of the Tiger, the top predator among feline predators, and the cry of leopard and puma, which belong to the second-highest predator class, with each other. Felines predators make a cry to mark their territory, and the components of the cry show various frequency ranges. In particular, it is known that the frequency region that makes the prey tremble among the sound components is mainly the low-frequency region of 100 Hz or less. The audible frequency band that humans can hear is a frequency sound between 20Hz and 20,000Hz. Among them, sounds less than 20 Hz are inaudible sounds that humans cannot hear, are called infrasound, and are strongly included in the cries of felines.

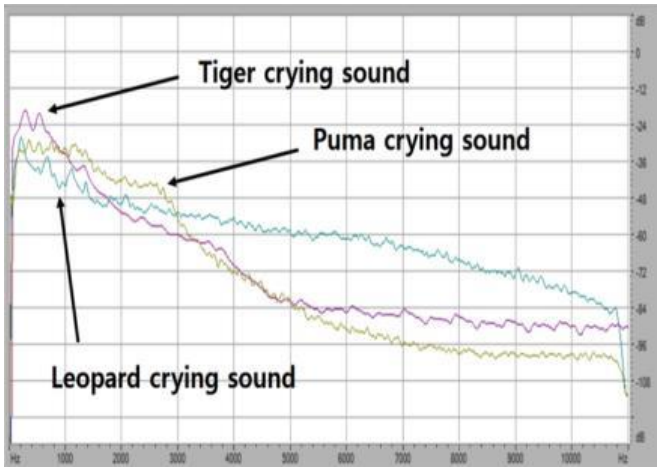


Fig. 7 Comparison spectrum graph of Tiger, leopard, and puma cry

In addition, it is said that the powerful infrasound of felines makes the prey tremble in fear, making it appear frozen on the spot. Among them, a more powerful ultra-low-frequency sound is formed in the cry of a tiger, which makes not only the relatively large prey such as bison, hippopotamus, and rhinoceros but also the elephant, the largest animal on land, tremble. There is a lot of information that we have witnessed many cases where an adult elephant heard a leopard or a cougar's cry and fought back by screaming, but when it heard a tiger's cry, it ran away without any reason. Figure 9 is a spectrum graph comparing the differences between the cry of a tiger and that of other feline predators, such as leopards and pumas. The comparative spectrum graph of the cry of Tiger, leopard, and puma in Fig. 7 shows the characteristics of cry sound components through the difference in decibels for each frequency contained in the cry of each feline predator. The graph shows that the graph of relatively high decibels in the low-frequency region, which is characteristic of felines, is common for the feline predator animals. The low-frequency part of the Tiger's cry has very strong sound characteristics. The Tiger's cry, which has strong condensing power in the

low-frequency and ultra-low-frequency region, will contain a power that is not found in the cry of leopards and pumas. In particular, for an elephant that detects and utilizes low-frequency sounds well, the Tiger's cry with strong low-frequency sounds will be enough to feel dangerous. Although leopards and pumas have a cool, alert cry in the entire frequency range, they do not pose a significant threat to the elephant, a large animal sensitive to low-frequency sounds. However, the Tiger's cry, which resonates strongly with its entire body, is enough to make the elephant sense danger and run away in a hurry. The energy of such a tiger's cry will be why the elephant tries to fight the cry of a leopard or a cougar with its cry but becomes even more frightened by the Tiger's cry and has no choice but to run away.[27][28]

5. Conclusion

It can be concluded that elephants run away. After all, they feel threatened by the Tiger's cries because they are sensitive to low-frequency sounds, and tigers have attacked them in the past. In particular, the tiger's cry produces a stronger ultra-low-frequency sound than that of other feline animals, so it has a greater effect on the elephant. And because it remembers the trauma of being attacked by a tiger, a powerful predator with a maximum length of more than 3 meters and a weight of more than 300 kg, it makes the elephant tremble in fear. The cry of a tiger emits strong sound energy of less than 20Hz in the low-frequency band, so it can be seen that it stimulates the most sensitive part of the elephant's audible range. In particular, elephants are sensitive to low-frequency sounds because they are large and absorb the sounds of the ground with their whole body. Among them, the Tiger's roaring sound conveyed the fear to the elephant even more. If there is a wildlife safari or zoo to protect elephants, appropriate measures should be taken. Because the wild safari is vast, it is impossible to install sound barriers that can block the low-frequency sound of the Tiger's cry. It will have to be prevented. If it is a small zoo, it is necessary to find an effective way to place the elephant house away from the tiger house and install a soundproof wall toward the tiger house so that the elephants do not get stressed by hearing the Tiger's cries.[29][30]

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