"SOUND & VIBRATION IN THE ANIMAL KINGDOM"

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This paper will talk about how sound and vibrations allow animals to communicate, move in space, protect themselves, and heal. My goal is to explore what exists in nature, particularly in the animal kingdom. Everything we want to understand and discover has an answer in nature. Many philosophers and thinkers have observed this truth in the past. The Ancients used the observation of the Cosmos to inspire their philosophies, medicine, and cosmovision. I am personally inspired by the Daoist tradition in Ancient China that was empirically built on the observation and imitation of the laws of the Universe. The Daoists applied the universal principle of "As above, so below. As within, so without" to build their entire philosophy.

Sound is usually associated with the sound that animals make. In the case of the lion or tiger, the roars they create can rattle and paralyze their opponent or victim (animal or human - even trainers who have worked with tigers for years). This phenomenon has been studied by bioacousticians – scientists who study the frequency or pitch, loudness, and duration of animal sounds – and they believe that the infrasound might be the missing link in studying lion or tiger communication. An **infrasound** is a sound that is measured below (infra-) the human audible range. In fact, the specificity of a tiger or lion's roar is that there exist sounds that we can feel, but cannot hear.

We know that humans are generally able to hear frequencies from 20 to about 20,000 hertz, but many animals like tigers, elephants, rhinos and whales can produce sounds below 20 hertz. Infrasounds consist of a very long wave that goes between particles and molecules rather than bouncing off them. High-intensity infrasounds extend in the megahertz range and well beyond but their frequency level is below 20 Hz. The infrasounds can travel long distances: cutting through dense forests, permeating buildings, and even passing through mountains. The lower the frequency, the farther the distance the sound can travel. Sometimes we can hear part of the sound and just sense the infrasound. Sometimes we can only <u>feel</u> the infrasound.

Bioacousticians have found that tigers can create sounds at about 18 hertz and when tigers roar they can create frequencies significantly below this. Hippopotamuses, alligators, and giraffes reportedly use infrasounds to communicate over considerable distances. Sumatran Rhinoceros produce infrasounds as low as 3 Hz with similarities to the song of the humpback whale. Elephants trumpet at 15-35 Hz and as loud as 117 decibels, the sound traveling distances up to six miles. The infrasounds are used to coordinate the movement of herds and allow mating elephants to find each other. Elephants also produce infrasounds that travel through solid ground and are sensed by other herds using their feet, although the herds are separated by hundreds of miles. Elephants have better low-frequency (infrasound) hearing than any other mammal tested so far.

Since all these animals can produce infrasonic sounds, this means they are also sensitive to them. According to zoologists, this sensitivity is helpful for elephants for example, who can be warned of an upcoming earthquake or storm. Birds' sensitivity to infrasound helps them navigate and can also affect their migration process.

Recent research by Jon Hagstrum of the US Geological Survey suggests that homing pigeons use low frequency infrasounds to navigate and migrate. He is using his experience as a geophysicist to question the status quo: For years, biologists have been thinking that homing pigeons (and other birds) used the geomagnetic field to find out where they were relative to where they were heading. Hagstrum realized this was not possible as large numbers of pigeons were getting lost under certain mysterious conditions and were not able to return home at all. He analyzed these conditions and found about infrasounds: The reason why pigeons were being disoriented was due to changes in the weather, specifically winds, as well as changes in the topography: hills, mountains or lakes.

In the 1960s, some students at Cornell did some experiments and showed that pigeons could hear down to .05 Hz, which is very low. That would mean that they can hear earthquakes and they can hear a whole range of sounds that we know nothing about.

In the deep ocean, there are waves called standing waves that are continuously moving. They produce sound in the atmosphere as well as seismic energy because the waves go all the way to the sea floor. That seismic energy moves through the solid earth, comes through to the surface of the earth and moves the surface of the earth, up and down, ever so slightly. We are basically constantly going up and down (a few microns) every six seconds. We cannot sense it at all. But that movement, like the way a stereo speaker moves, oscillates over a large enough area that creates a loud enough sound that pigeons can probably hear.

Like we said before: the lower the frequency, the longer the wave length. Which means that birds and pigeons can hear sounds that come off the ocean, produced by standing waves that are about .2 Hz. They are able to follow these signals from the earth and the ocean to travel to a specific area and come back to their home.

The bar-tailed godwit is another bird which is also interesting to mention: It travels from Alaska to New Zealand, non-stop and in only five days. This bird flies in a straight line but only when the weather conditions are optimal on the entire route of its future trip, which is quite fascinating. This bird is using infrasounds to check on the weather conditions. We know that sound depends on wind and temperature, so sound basically depends on weather. The bird is listening to these signals, it has developed an ability to listen to these signals and interpret them to tell what the weather is. Its survival depends on it. If it had to fight a headwind or a storm during its trip, it would not make it. It has to know what the weather is, and it does.

As many scientists are now agreeing, there is a high probability that other animals like sea turtles, whales, and all of the animals that travel very far distances on Earth are actually using this same technology: using the sounds/noises and infrasounds that exist on earth and in the atmosphere to navigate with.

If we take a closer look at whales: Many researchers have suggested that whales use sonars but it was not clear in which way. A **sonar** "is a method or a device for detecting and locating objects especially underwater by means of sound waves sent out to be reflected by the objects." (Merriam-Webster)

For decades, scientists have stated that whales' songs were basically songs used for reproductive purposes, always created by males. But a paper written by Eduardo Mercado makes the hypothesizes that the humpbacks whales may use their songs for long-range sonar as a way to explore their world. His idea is that the whales are singing to perform a type of auditory scene analysis. It's the singing whale, not the listening whale who is doing most of the analysis. The goal is still mainly reproductive but the song in this case "is like a searchlight that informs singers about the presence of other whales, the direction those whales might be heading and whether or not the singer might be able to catch up to them." This is such an interesting hypothesis and if correct, this model should change the direction of how we understand and study whales.

The technique of using reflected sound to locate objects is called **"echolocation"**, which is a two-part process: the animal makes a sound, and the animal listens to the rebounding sound waves to identify where items are located. This allows the animals to move around in pitch darkness, so they can navigate, hunt, identify friends and enemies, and avoid obstacles. Other animals using a sonar are bats, dolphins and shrews.

Lastly, I would like to talk about the fabulous bees. Bees generate sound not only through movement of their wings but also with their thoracic muscles. Although they use these muscles to move their wings, they can uncouple their wings to produce heat and generate acoustic signals - so they can hum without flying or moving their wings, a feature known in bees but not in other insects.

Honey bees produce many frequencies of vibration and sound – from less than 10 to more than 1000 Hz. So far it has been shown that they can detect sound frequencies up to about 500 Hz. In 1974, the Russian researchers Eskov and Sapozhnikov found that bees generate electromagnetic signals with a modulation frequency between 180 and 250 Hz when they do their communications dances.

According to Professor James Nieh: "Stingless bees are an excellent model for the evolution of animal language because they possess the widest diversity of species and communication strategies, including the ability to acoustically encode the distance and height of food sources." The sounds the bees create are part of a very complex language that we are only starting to uncover.

It was also fascinating to discover Valerie Solheim's work about the sounds of beehives. She has recorded the sounds of the hives at different stages throughout the year and witnessed how the bees actually form a super being, with a "hive consciousness", which sounds are able to create coherence and healing for other hives as well as for humans.

To conclude this paper, I will share that during this research I have realized once again and to a deeper level, how little we know about the Universe, nature, animals and specifically

about Sound. There is still much to be (re-)discovered. Science alone will not be able to do it. It is crucial that we keep documenting ourselves, sharing knowledge and information to create bridges between the scientific world and the spiritual world(s). When we understand our environment better, we will respect it more thus naturally spreading healing, wellbeing and peace.

This is my wish.

Joyah