Preface

Who is Who in Biocommunication

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"Three things are beyond me: The way of an eagle in the sky … how a snake makes its way over a rock … how a man has his way over a maiden"
Proverbs 30: 18–19

1. Introduction

The concept of biocommunication is very broad and has several meanings: it involves linguistics, cognition, and even outer space, including astrobiology. Biocommunication can also cover molecular genetics, plant physiology (chemotropism), and plant perception. Moreover, the term includes inter-personal exchange of information in various modes.

Biocommunication exists in almost all organisms from bacteria to man. Every organism uses signs of communication to exchange information for purposes of coordination and cooperation. This communication also serves for organization between members of the same, related, or unrelated species. All coordination between cells, organs, and organisms depends on successful biocommunication processes. For example, between single cells we find the chemical attraction between sperm migrating toward an egg within the body or outside in the wet environment. In this respect, diseases in organisms are often the results of disturbed or damaged communication between cells.

In the Bible are a few cases of communication between man and other creatures: such as the conversation of the snake with Eve about eating from the fruit of the Tree of Knowledge in the Garden of Eden (Genesis 3: 1–6), the case of Balaam's ass who spoke to him and complained about his beating her three times (Num. 22: 28–30). It is said that King Solomon was gifted to talk to plants, animals, fowl, creeping things, and fish. Given recent successful attempts to "speak" with primates, and our increasing interest in communicating in some way with animals, these ancient stories show that interest in interspecific biocommunication is thousands of years old.

In our study of biocommunication, we are aiming at more specific types of communication, intraspecific or interspecific, between species of bacteria, fungi, plants, animals, and humans. Communication also incorporates linguistics, sign-mediated interactions following syntactic, pragmatic, and semantic rules. Biocommunication of animals includes vocalizations (as between bird species, canines and others), the use of pheromone production, (between insects or mammals and chemical signals between plants and animals. Animal communication is related to zoosemiotics. Some biocommunication has tentatively been connected to the concept of instincts in insects and animals (Tautz, 2008).

2. Human Communication — the King of Communication

In human beings, we have direct speaking and the senses of vision, hearing, odor, and touching the body as means of communication.

Human's senses are related to links from person to person, such as male–female — including the courtship period — and mankind to their surroundings. The five senses of humankind enable the mastery of humans over other animals. Man is able to communicate with some domestic animals and birds and receive responses from them. For example, the wagoner orders his horses or mules to go forward or to halt. People can command dogs, cats, goats, sheep, or pet birds to perform various actions and they often obey.

In India, street performers with flutes entice cobras to respond to their music (though this is mostly a reaction to movement). On the other hand, we know about communication between man and dolphins, which amazes large crowds of spectators.

3. Biocommunication in Plants

There are plants, such as the orchids, whose flowers mimic others so as to appear as females to their pollinators, so that male insects are happy to land on these flowers, being certain that they are his female; this way pollination and fertilization take place. Other plants can "communicate" with their pollinators through bright colors or pleasant or repulsive odor.

There are chemical signals between plants and animals (such as tannin production by plants to warn away insects). We have heard about chemically mediated communication between plants. Plant physiology covers some processes such as geo- or heliotropism. Some consider plants intelligent (Buhner, 2014). Plants may have perception and are sentient; perhaps they experience pain or pleasure of emotions (Tompkins and Bird, 1973). According to the last two references (popular works), plants have the ability to communicate with humans and other forms of life. Others plants display trembling, moving, and shaking of the whole plant over an insect visit. This is the case of *Mimosa* plants which defend themselves against animals through stimuli responses that rapidly fold its leaves. Still others repulse their plant eating grazers by producing offensive odors or poisonous chemicals to repulse neighboring plants or other predator enemies. The relation between plants and other organisms has been recently published (Seckbach and Dubinsky, 2010).

4. Insects and Animals

Social insects (such as bees, ants, termites, and wasps) use pheromones for communication. We know about the bees' dance (which communicates how to get to flowers). The pollination period is vital for nature and for development of fruit; at this stage plants signal (through their odor, shape and colors) pollinating insects (mainly flying ones) and humming birds to land on their flowers.

Dogs have abilities to smell; this feature has been used by police and armies for their activities. A male dog may appear from several kilometers away during a female's rutting period, a sample of odor communication. On some butterflies their wings mimic the patterns of toxic butterflies to ward off predators.

5. Fowls' Communication

Among the birds are strongly social species; communication among them is seen in a variety of ceremonies, gestures, and specific calls. We recognize vocalization (bird species) and know about pairs of birds (e.g., pigeon couples) — how they divide their functions in the nest, sitting on the eggs and bringing food for the youngsters. There are singing birds learning to sing complicated songs from their parents and even to mimic human voices. Another point is the behavior of the male birds, such as, turkeys or peacocks, to impress the female during the courting period with full-blown colored feathers and special sounds. All their displays are aimed at attracting mates. Among penguins, we find close relations of couples using their voices in communication. They operate with division of duty, in order to protect the huge crowd against the cold polar winds or to warm their eggs. There are the young penguins who find their parents among millions of other members in the surrounding flock by their sounds. Some birds may alert their neighbors against an enemy in the vicinity by making warning sounds.

We'll add a personal story about bird communication. Many years ago, when JS was a tractor driver he was plowing the fields near the Kishon River (northern Israel). The plow exposed and

raised up from the ground a large black snake, which started to wiggle between the freshly lifted soil sections. Suddenly, a carnivorous bird, perhaps a vulture or eagle, landed and started to "deal" with the snake. A few minutes later, the bird lifted up the snake but let it drop from high above, leaving the snake on the ground. Perhaps it proved too heavy. Then the bird flew away and returned with another one [its mate?]. Both of them landed near the prey and together lifted the snake from the ground and flew away with it to have their full meal.

6. General Concepts

In this volume, we describe more specific types of communication. Such exchange of information, and sign-mediated interaction within (intraspecific) or between (interspecific) takes place among species of bacteria, plants, fungi, and animals. Biocommunication means strong interaction via a special "language" used within a species, including that between primates, birds or insects. In most cases, there are chemical molecules (semiochemicals) involved. Biocommunication also occurs between the cells of a developing embryo, as it forms itself.

Biocommunication is expressed in different ways. One may associate it with the concept of symbiosis and organismal language and interaction between species. For example, such communication exists within the soil between roots of higher trees and symbioses with arbuscular mycorrhizal fungi.

The purpose of this book to demonstrate the panoply of biocommunication, interaction, and "language" in the biological world. Such interrelations range from molecules and cells, bacteria, fungi, cyanobacteria, and other organisms as well as from microanimals to mammals.

Topics covered within this book include: molecular biocommunication, superfast evolution via interspecies, bacterial communication, communication languages and agents in biological systems, carnivorous plants and insects, the crosstalk between plants and their symbionts, global communication within the embryo, how

neurons find their target, animal communication under noisy conditions above and below water, chemical communication, sexual communication by pheromones, and artificial communication.

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