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A review of self-medication and the taxonomy in which zoopharmacognosy is practiced

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ABSTRACT

The practice of medicine has been highly studied and performed by *Homo sapiens* for thousands of years, and due to this the survival of humans has thrived. This brings rise to the question of if animals have developed the same conscious decision making in medicating themselves when sick for their species succession. This paper analyzes the taxonomy that has been observed practicing the intentional alteration of their diet to treat specific health issues throughout their everyday life. Which during these observations it is found that through the use of secondary chemical compounds animals were able to treat and cure a variety of ailments such as: inflammation, parasitic infection, and bacterial infection.

Keywords: *Zoopharmacogonosy, Self-Medication, Taxonomy, Alkaloids, Ailments*

INTRODUCTION

Self-medication, also known as zoopharmacogonosy, is the intentional alteration of an animals' diet to treat their health issues. This has been observed in animals around the world to treat a variety of ailments (Pham-Huy et al. 2008). This can range from health issues as serious as a parasitic and bacterial infections to milder as anti-inflammatory aid to reduce pains associated with their everyday lifestyle. The most difficult challenge in observing self-medication within animals is making the distinction between possible indirect medicinal benefits, derived from secondary compound rich plants that are assumed to be ingested for their nutritional value verses limited, and situation specific ingestion of items that are processed solely for their medicinal properties (Huffman 1997). This review will include an analysis of secondary compounds in plants, what ailments cause these animals to seek medication, and the taxonomic survey over which species are commonly seen participating in this practice.

One of the major secondary compounds commonly used by self-medicating animals are Alkaloids. Alkaloids are a large group of organic compounds that contain nitrogen atoms that are seen within a cyclic structure. Alkaloid's aid through a variety of health-related actions, including anti-inflammatory, anticancer, analgesics, local anesthetic, pain relief, neuropharmacologic, antimicrobial, and antifungal (Parker et al. 2011). Found throughout the plant, including the leaves, stems, roots, and fruits, alkaloids are shown to vary in both quantity and chemical compound structure depending on where they are found within the plant (Huffman 1997). In Huffman's review of animal self-medication, *Careya arborea* and *Dalbergia latifolia* are commonly ingested by a wide range of carnivorous animals including Indian tigers, bears, and jackals (Huffman 1997). All of which have a diet that consists of herbivores or smaller carnivorous prey. *C. arborea* has several pharmacological properties, including anti-inflammatory and analgesic effects which are seen in the alkaloid piperine that is isolated within the bark of the plant containing antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typi*, *Vibrio cholera*, *Shigella dysenteriae*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pneumonia* and *Micrococcus luteus* (Khaliq 2016). Another plant species observed is the *Solanum lycocarpum*, found within the Brazilian savanna, *Solanum lycocarpum* is commonly known as the wolf apple because it makes up over 50% of the Maned wolf's diet (Okba et al. 2018). When observed in animals, *S. lycocarpum* is commonly seen for treating inflammatory disorders but is also observed as antioxidant, anti-inflammatory, and antinociceptive. These medicinal actions in *S. lycocarpum* has been linked to the presence of alkaloids in the fruits, such as solasodine and peiminine, and caffeoylquinic acids (McDowell et al. 2007).

There has been extensive research done over a variety of taxa known to perform self-medication. Studies have identified 46 primate species that self-medicate, and 71 distinct species from seven mammalian orders were also reported (McDowell et al. 2007). While observing these species it was found that Primates had the most reports of self-medication (46 reports), followed by Carnivora (10 reports), Rodentia (5 reports), with the remaining species having very minimal amounts of conclusive data (McDowell, et al. 2007). Reading through several articles, mammals are not the only taxa that have been observed to perform self-medication. Taxonomic groups of insects and birds have been observed practicing this same behavior. Although conclusive data on the total amount of species observed was not found, it is apparent that self-medication is a common defense against parasitic and bacterial infections within these organisms.

There are several types of ailments that affect these animals, causing them to seek out specific remedies to heal themselves. These ailments range from bacterial infections, inflammation within the muscle systems, and parasitic infection. Amongst these, parasitic infections are the most studied when it comes to animals seeking specific chemical compounds. A parasite is an organism that infects and lives off a host organism, surviving off the food from the host or the host itself (Okba et al. 2018). Due to this infection the animals can be observed while infected to alter their behavior and change diet selection. For example, woolly bear caterpillars have been observed specifically due to their body's response to a lethal endoparasite known as tachinid flies. In Singer, Mace, and Bernays experiment it is tested and shown that the ingestion of plant toxins known as pyrrolizidine alkaloids improve the survival of all parasitized caterpillars (Raga et al. 2009). Yet although it is beneficial to have these pyrrolizidine alkaloids when the caterpillar is infected with the parasite, the study showed that the caterpillars that were not parasitized had a decrease in survival. Bacterial infections can be a burden to not only one individual animal but can affect a whole group of animals that live within close proximities (Pereira et al. 2018). Having as minimal of an effect from bacterial infections can be the difference in prosperity or failure. This has been observed throughout colonies of honeybees, *Apis mellifera*, will increase their overall collection of resin from a variety of plant species. The collection of resin that is returned to the hive plays a large roll in in the overall decrease in colony bacterial loads which reduces the overall investment in immune function (Pereira et al. 2018). Inflammation of the muscular system can be very painful and cause discomfort to these animals as they migrate and forage. Consuming plants that contain specific secondary compounds such as alkaloids can act as an anti-inflammatory and is a common practice that is observed (Glander et al. 1994) For example, Malaysian Elephants, *Elephas maximus*, will specifically eat *Entada schefferi*, this plant is commonly used for stamina before a long migratory walk (Glander et al. 1994). The Malaysian Elephant will consume this plant in attempt to aid in pain relieve through the strenuous activity of migration. In relation to this there have been other parts of the animal kingdom that have been noticed to perform the process of self-medication through their selection of diet depending on their infection or sickness.

Research done on the African elephant, *Loxodonta*, has concluded when pregnant, the African elephant will seek out Boraginaceae, a species of plant which is commonly seen for the induction of labor (Inglis-Arkell 2014). Although it is not sought out in a manner of illness it is important to take notice of the animals being self-aware and medicating themselves in the attempt of being able to birth their calf for that cycle of pregnancy. Not only is this consumed by elephants to begin the induction of labor, but Kenyan groups will use this same plant to induce labor and in some fatal cases, when taken in a substantial amount can result in an aborted fetus.

An approach that is commonly seen within predators is the seeking out of alkaloids within the roots of plants to aid in the elimination of parasites such as tapeworms due to the toxicity of the root. This is practiced by the Indian tiger but has also been observed in many other predators. This is due to the medicinal properties that come along with the ingestion of these plants (Lozano 1998). The consumption of *Careya arborea* and *Dalbergia latifolia* is commonly practiced due to both plants containing alkaloids that aid with parasitic infections (Huffman 1997). Fruits are also commonly consumed by large carnivores to aid in the elimination of parasites that could have been ingested while consuming the intestinal tract of their prey. South American wolves have been observed to seek out *Solanum lycocarpon*, also known as the wolf apple, within rotting fruit salads in the attempting to cure stomach pains or possible parasitic infection within their intestinal tract that could be causing them discomfort (Okba et al. 2018).

Studies have also been conducted over African great apes, and the actions of the consumption of specific plants that provide absolutely zero nutritional value to them at all. African great apes' diet is supplemented by that of fruits, yet it is also seen to eat insects, small mammals, and even sometimes birds (Masi et al. 2012). Due to the phylogenetic closeness, humans and chimpanzees will have a similar selection in some of the same plants when displaying similar symptoms of illness (Huffman 1997). Chimpanzees and Great African apes with parasitic worms within their intestinal tract, will practice what is known as leaf-swallowing which is a behavior that is very rarely been observed within healthy chimps (Huffman 1997). The leaves of *Aspilia* plants function medicinally by dislodging parasites from the gut (Raga et al. 2009).

Geophagy has been a practice that has been studied while observing primates and other species of animals (Krishnamani and Mahaney 2000). Geophagy is known as the practice of eating earth, especially the consuming of chalk or clay within regions of the world who experience famine. This practice does not occur by humans but often other animal species the clay is consumed as a buffer. It can be used for anti-diarrheal properties and the elimination of bitter taste, stomach aches, and vomiting which are seen to come from the consumption of an immense number of foods that are high in secondary compounds (Huffman 1997).

Difficulty lies within this study when attempting to distinguish exactly why an animal may consume or alter their original diet; through observation of the species that have self-medicated it can be concluded that this behavior is considered to be from a higher level of thinking and is being seen across a larger

number of species. Due to the animal being self-aware of their health and having disorder to their physical state it is astonishing to evaluate that their mental capacity has adapted to this essential form of survival. A beneficial area to further investigate for future research of this topic would be observing marine life and if it is apparent that aquatic animals have also developed the self-awareness to seek medication. I feel there is minimal research over this due to the difficulty of being able to follow and track aquatic animals. Yet if studies began within a small reef through observation a conclusion can be made if the marine animal puts forth extra effort to locate and consume specific foods in times of illness.

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