Zoopharmacognosy:
Not Every Herbalist is Human

Richard Mandelbaum RH

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I: Animal Self-Treatment with Medicinal Plants

As will be explored below, a growing body of evidence now supports what human beings have observed for millennia: that animals as diverse as caterpillars, birds, bears, and apes are known to use plants and other natural substances as medicine. The diversity of remedies used and the animal species using them, and the purposes of their use (prophylactic therapeutic, and curative) have been well documented.[1,2] While scientific research is expanding quickly in the field, I have identified some inherent biases to date in the published literature, likely because of the relative ease and lower costs of investigating particular subjects: One is that much of the research has been dominated by studies concerning primates as well as domesticated animals over wild ones. Another bias is that studies and research historically have focused on the use by animals of natural antimicrobial, anthelmintic, or anti-parasitic natural remedies. That said, as the body of research grows, this is rapidly changing, and there is more and more evidence of animals' use of natural medicines in the wild and for a wide range of ailments.

Some of the more consistent criticisms of zoopharmacognosy revolve around accusations of *anthropomorphism* – that we are unjustifiably attributing human traits to other species, and the related dualistic (and simplistic) debate of *instinct* versus *intelligence*. It is true that we should guard against interpreting the world through a human lens and assuming that animals (or plants for that matter) that act in a way that is analogous to us are motivated by the same internal processes or intentions. At the same time, it is vital to point out that the opposite bias – what we might call *anthropocentrism* – is widely accepted within the scientific community, often without question or reflection. Indeed, it can be argued from an objective and scientific standpoint that humans and other animals are more alike than distinct – genetically and phylogenically, sharing a commonality of descent, and that the Cartesian biased view that humanity and human behavior are unique is the more unscientific and unfounded starting point to exploring these issues both philosophically and scientifically. Indeed, it was Charles Darwin himself who in his last published work concluded that earthworms clearly demonstrate intelligence.[3] In his second to last book, he reached the same conclusion regarding plants. This will be discussed further below.

While first modern instance of zoopharmacognosy-related research is generally attributed to Dan Janzen's observations in 1978 of colobus monkey ingestion of anti-

parasitic plant remedies[4], it should be noted that **animal use of natural medicine has long been observed by indigenous peoples worldwide.** The term *zoopharmacognosy*, referring to self-medication with naturally occurring remedies by non-human animals, was coined in 1991 by Richard Wrangham and Eloy Rodríguez.[5] It should be noted that zoopharmacognosy is distinct from ethno-veterinary or traditional indigenous veterinary uses of herbs, although one can and should inform the other.

To begin with our closest cousins, great apes including chimpanzees, bonobos, lowland gorillas, and orangutans have all been documented to use botanical and other natural medicines. Gorillas have a working materia medica of at least thirty medicinal plants.[6] Huffman and Cousins list approximately 100 plants in the gorilla diet that have additional medicinal applications.[7] Diane Fossey in her seminal text Gorillas in the Mist documents the coveting by gorillas of a species of reishi mushroom (Ganoderma sp.), long prized as medicine throughout Asia and in modern times throughout much of the West as well. "Still another special food is bracket fungus (*Ganoderma applanatum*), a parasitic tree growth resembling a large solidified mushroom. The shelf-like projection is difficult to break free from the tree; so younger animals often wrap their arms and legs awkwardly around a trunk and content themselves by only gnawing at the delicacy. Older animals who succeed in breaking the fungus loose have been observed carrying it several hundred feet from its source, all the while guarding it possessively from more dominant individuals' attempts to take it away."[8]

As mentioned above, very often in discussing animal use of herbal medicines, one is accused of mistaking instinct for intelligence. While there is certainly a valid and important, and lively, discussion that needs further exploration and investigation regarding instinct vs. intelligence, in reality this dualistic framing is becoming increasingly outdated. For one, there is an implication that humans do not generally act out of instinct as other animal species often do – an assumption and generalization reflecting an unscientific, anthropocentric bias. Secondly, there is an underlying assumption, again anthropocentric in nature, that other animals engage in intelligent action less regularly than humans. This view too is being increasingly overturned as more objective and unbiased research is conducted and published. Let's focus here on the question of whether or not animals exhibit intelligent behavior that includes the use of natural medicines.

One by one in recent years, the supposedly unique traits that define human evolution and intelligence have been shown to be shared by other species. Crows, ravens, and other birds make and use tools.[9] Described in a paradigm-shifting study reported in the journal Nature in 2016, capuchin monkeys are now known to create stone tools (emphasis added): "The capuchin data add support to **an ongoing paradigm shift** in our understanding of stone tool production and the uniqueness of hominin technology. Within the last decade, studies have shown that **the use and intentional production of sharp-edged flakes is not necessarily tied to the genus Homo."**[10]

In another example, while the invention of agriculture is often seen as a uniquely human behavior, over forty species of both ants and termites have been cultivating fungus for food for tens of millions of years, long before humans evolved as a species. "The combination of climate control and careful husbandry of the fungus by the termites is comparable to the methods of industrial mushroom cultivation by humans."[11]

If we define intelligence as the capacity to learn, reason, adapt and modify behavior, and apply new knowledge, then we see clearly that this can be applied to animal use of natural medicines. Social learning, in particular learning from the animal's mother or other elders, about foods and foraging has been observed and documented in many animals including primates, deer, sheep, moose, cats, and even some insects, and it is logical to think such transfer of knowledge would be similar for the use of medicinal plants.[12] As Cousins and Huffman write, "…infant apes almost certainly learn about medicinal plants, just as they do about food plants, from their elders…"[7] Young animals will even eat less nutritious foods if their mothers have taught them to, defying or overriding any "instinctual" attraction to more beneficial foods.[12,13,14]

There is a strong and sound foundation of evidence published in the scientific literature that animals are adept not only at identifying plants and food and medicine, but also at learning and adopting new uses for plants. For instance, Provensa, Villalba, and Shaw showed that lambs can determine which remedy they need for a given ailment.[15] Birds such as starlings as well as insects, including honey bees, are known to acquire knowledge throughout their lives regarding plants that provide potential food and medicine. In other words, they learn.[16, 17]

Animals' use of natural remedies has also been shown to include non-botanical sources, such as the ingestion of clay, otherwise known as *geophagy*. "Macaws, parrots, tapirs, forest elephants, colobus monkeys, mountain gorillas, chimpanzees, as well as many human beings seek out and eat clay, which absorbs intestinal bacteria and their toxins and alleviates stomach upset and diarrhea."[1]

As mentioned above, much of the research has historically focused on antimicrobial, anthelmintic, and anti-parasitic botanical remedies. Examples include the use of *Boerhaavia diffusa* by wild boars, and the use of *Vernonia amygdalina* by chimpanzees.[4, 2] When chimpanzees in Kibale National Park in Uganda consume *Aspilia spp.* to treat roundworm, they ingest it in a form – whole, rolled leaves – that is not only distinct from any consumption of plants for food, but that also maximizes the bioavailability and efficacy of the relevant medicinal compounds such as thiarurbrine-A.[5]

Many animals also make use of topical application of medicine. Apes, monkeys, and other primates will rub their fur with plant material, or in some cases, insects that are high in antimicrobial constituents. Plants observed include species of *Citrus, Clematis,* and *Piper*. Capuchin monkeys will rub millipedes into their fur.[6]

Orangutans in Borneo fur-rub with *Commelina sp.***,** used locally by people as a topical remedy for muscular pain, soreness, and swelling.[18] Many species of nesting birds will also gather specific plant material for incorporation into their nests for their antimicrobial, anti-parasitic, and antiseptic benefits.[16]

In another example from the insect world, a species of woolly bear caterpillar (*Grammia incorrupta*) intentionally consumes plants high in pyrrolizidine alkaloids when they are infected with endoparasites (tachinid flies), which in turn increases their survival. Healthy caterpillars do not consume these plants. Revelations about insect learned behavior are particularly significant in overturning previous assumptions that such small, short-lived animals would not exhibit such behavior. As reported by the authors of that study (emphasis added), **"This case challenges the conventional view that self-medication behavior is restricted to animals with advanced cognitive abilities, such as primates**, and empowers the science of self-medication by placing it in the domain of adaptive plasticity theory."[19]

Lastly, there is small but growing evidence that some animals may address their reproductive health through the use of botanical remedies, including birth control (for instance among howler monkeys in Central America)[20] and during pregnancy, birth and delivery. In one example, pregnant elephants in East Africa have been observed walking up to 17 miles at the end of their pregnancy to ingest a small tree that is used among women in Kenya to induce labor.[6]

II: The Animal Origins of Herbal Medicine

Within the fields of herbal medicine and ethnobotany it is often asked how early humans discovered and developed the safe and effective use of botanical remedies. There is evidence dating back at least 50,000 years of Neanderthal usage of chamomile and yarrow.[21] Trial and error seems unlikely to explain the sophisticated systems of medicine and vast knowledge and wisdom held by indigenous cultures throughout the world. The framing of the question itself reveals certain biases and assumptions in our thinking. For one, we cannot ignore the fact that the Animal and Plant Kingdoms have co-evolved mutualistically for millions of years, and the use of plants as both food and medicine predates the evolutionary arrival of hominids. In other words, **human beings did not acquire knowledge of botanical medicine after having become human; we became human already having accumulated much of this knowledge.**

Some of this knowledge derived from direct, intuitive, organoleptic assessments of the plants; some no doubt from deeper "listening" to the plants themselves, as cultures around the world attest to. Legends from Brazil, ancient Greece, and India all depict people learning from animals such as lizards or birds observed using herbs when bitten by snakes – herbs now used in local herbalism for that purpose.[1] More recently in Western European culture, notable 16th century figures such as Erasmus and Brunfels observed animals using herbal medicines: birds curing constipation with bay leaves, toads applying plantain to snakebites.[22] In addition, several historical

accounts and origin legends exist of humans first learning of the medicinal properties of plants by observing animals' usage of those plants. Cultures around the world attribute their acquisition of herbal remedies to animals, in particular sacred plants; this includes coffee in Ethiopia (from observing goats), iboga in Africa (from observing gorillas), ayahuasca in South America (from observing jaguars), and osha in the Western United States (from observing bears).

To further describe the relationship between *Ligusticum porteri,* known as osha or bear root, and the grizzly bear in western North America, bears will seek out and dig up the root, chewing it carefully and mixing it with their saliva to then rub methodically into their paws and fur. By legend osha is a medicine bestowed to people as a gift from the bear.[23] Osha is an important herbal remedy used today by modern and indigenous herbalists alike (and must be protected due to its scarcity in the wild). The example of gorillas and iboga is described in more detail below.

It has been written that "Not all pharmacists are human."[24] I would expand and amend that somewhat to state: **Not all herbalists are human.**

Science is now confirming (with a substantial lag time due to historical biases of human predominance) what people have known all along: "that humans watching the behaviour of sick animals discovered the medicinal properties of many plants early on in our history."[2] In other words, we owe much of our knowledge of medicinal plants, and as a derivative pharmaceutical medicine, to animals. The pharmaceutical industry is paying close attention to this, now recognizing zoopharmacognosy as a reliable and potential source of "prospecting" for new pharmaceuticals.[25, 26] In the past and into the present this same industry has engaged in highly exploitative bio-piracy practices, co-opting indigenous wisdom in similar fashion.

Zoopharmacognosy can serve to remind us of who we are, what we have lost, and what we can regain.

In the words of Eloy Rodriguez (personal correspondence), "There is no question in my mind that the detection of metabolites that "medicate" probably ***goes back to the origin of life itself,*** with bacteria either deterred by bitter compounds or attracted to compounds produced by other microbes that in turn were essential for survival and reproduction. The co-evolution of natural products and prokaryotes was and is driven by natural selection and the co-evolution of early herbivores, especially mammals and their utilization of primitive gymnosperms and later angiosperms as medications."

III: The Use of Natural Psychoactive Substances by Animals

Anyone who has observed cats interact with catnip – not just how they respond to catnip when handed to them but also how they are attracted to the plant growing in a garden or in the wild - are familiar with how animals clearly seek out mind-altering substances. In addition to ingestion of plants for therapeutic or curative purposes, it

is now well-documented both anecdotally and increasingly in the scientific literature that a wide range of animals, from insects to primates, deliberately ingest psychoactive plants and fungi. This includes, for example, plants and mushrooms with known hallucinogenic, stimulant, and/or narcotic effects.

The use of *Coffea* (coffee) by goats in Africa and *Banisteriopsis* by jaguars in South America, has been mentioned above. Many other examples abound. Gorillas have been repeatedly observed harvesting and ingesting Iboga, *Tabernanthe iboga*. Iboga is a rainforest shrub, high in psychoactive alkaloids used widely in central and Western Africa for ritual and spiritual purposes, as well as medicinal applications. Gorillas also frequently seek out both coffee and chocolate.[7] Being 98% genetically identical to our gorilla cousins, perhaps we ought not to be surprised.

In other examples, bighorn sheep in Canada will scrape psychoactive lichen off rocks, water buffalo in Asia eat opium poppies; "cattle, horses, deer, elk, and antelope in the American West eat locoweed, which sometimes disorients the animals so much, they walk off a cliff or up to a predator. Dogs in Australia's Northern Territory and elsewhere lick hallucinogenic toxins off the skin of cane toads."[26] In an opium factory in India, monkeys have become a ubiquitous presence, getting drugged off the factory waste.[27] In Tasmania wallabies became a nuisance repeatedly breaking into legal opium poppy fields and consuming the crop. According to the Attorney General of Tasmania at the time, "We have a problem with wallabies entering poppy fields, getting as high as a kite and going around in circles. Then they crash."[28]

Alcohol consumption is widespread among animals. This involves mainly naturally occurring alcohol and thus seems to be a completely natural process, but there are also many incidences of animals consuming alcohol produced by human beings. And while no doubt this is in some cases accidental, there is much evidence for occasional, or for some species, regular *deliberate* alcohol consumption.

Gochman, Brown, and Dominy have documented alcohol consumption of naturally occurring alcohol among both the aye-aye (*Daubentonia madagascariensis*) of Madagascar and the slow loris (*Nycticebus coucang*) of southeast Asia, the latter in particular almost certainly becoming inebriated quite deliberately.[30] A study published in PLOS-ONE in 2014 showed that inebriated birds "slur" their songs.[31] Elk in Sweden are known to commonly get drunk from over-ripe apples in the Autumn, occasionally causing mischief for their human neighbors.[32] Honey bees seem to be affected cognitively and physically by ethanol in similar ways as humans, and are known to seek out alcohol for deliberate consumption. Like humans, honey bees also demonstrate self-administration of ethanol and exhibit preferences for commercially available alcoholic beverages.[33]

We might ask ourselves: Why would animals seek out alcohol, opium, and other psychoactive drugs? Alternately, we could ask, why wouldn't they, given how closely

related to us they are biologically and how widespread this behavior is among our own species?

Biologists and zoologists have observed that frugivorous (fruit-eating) animals will generally avoid consuming rotting fruits, but they will make an exception for fruits that are high in ethanol as opposed to harmful bacterial or fungal decay. Dr. Robert Dudley and others theorize that this attraction to ethanol may be of evolutionary benefit to humans and animals in guiding us to ripe fruit that had not been colonized by any deleterious microbes. As summarized by Katherine Milton, (emphasis added) "**ethanol plumes from ripening fruits may have served for millions of years to guide primates to ripening fruit crops** and also served as an appetite stimulus and welcome source of dietary calories…Just as we speak today of diabetes running wild in human populations due to excessive caloric intake, so might we speak of ethanol running wild in human populations due to unlimited access to beverage ethanol and the tendency of many to drink to excess. **Thus, biologically-based behaviors that might have served positive functions for pre-human, fruit-eating ancestors, could, under present-day environmental conditions, prove highly maladaptive."**[34]

There are repeated well-documented, even video-recorded episodes of elephants in India becoming drunk (the intentionality being a hot topic for debate) and subsequently causing serious property damage to local villages. One hypothetical explanation for this behavior is that the animals are responding to a loss of habitat with destructive and self-destructive behavior not so distinct from how humans respond to intense stressors. In the words of Dr. Barbara Natterson-Horowitz, "That animals also suffer from addiction; that receptors for intoxicants exist in all kinds of creatures, some dating back millions of years; that these receptors facilitate many life-affirming behaviors in animals and at least some in humans; and that the endocrine and central nervous systems are regulating many of our behaviors—can help us reconceive of human addiction in a more expansive and destigmatizing way. **What some see as a personal failing is not unique, not uniquely human, and not uniquely applicable to our times**."[26]

Laying aside our biases that the use of psychoactive substances is distinctly human, we can broaden our understanding not only of other animals, not only of ourselves, but also of the plants themselves. Until recently it had been assumed that plants in general would not produce caffeine in their nectar, as the bitter taste would deter pollinators seeking a sweet flavor. Again, an assumption was accepted in a long-standing way, therefore reducing the likelihood of identifying counter-examples, thus perpetuating the original assumption (if we assume we will not find something, we do not bother looking). In 2013 it was discovered that caffeine production in flower nectar is much more widespread than previously believed, in particular in the genus *Citrus*.[35] It turns out that not only does the caffeine *not* deter honeybees, it in fact seems to attract them further, enhancing short-term memory and perhaps (speculatively) through the mechanism of addiction. Perhaps the bees simply enjoy the experience and want to seek it out again, as we do.

Conclusion

The sophistication of animal behavior, both in the wild and under domestication, has been long undervalued and under-studied. Animals display an intelligent wisdom, and we owe our knowledge of medicinal plants and other remedies in large part to animals. This gap in our knowledge base has extended to interactions between animals and plants, and the uses of plants by animals for the purposes of self-medication. The Animal and Plant Kingdoms have co-evolved for millions of years, and the use of plants as both food and medicine predates the evolutionary arrival of hominids. Many if not most; of the traits that we consider unique or particularly human in character turn out to be widespread in the animal kingdom. The study of zoopharmacognosy has the potential, like the study of the microbiome, or the search for extraterrestrial life, to shift our cultural paradigms of who and what we are, and to enable further steps in the evolution of our knowledge.

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