Not Every Herbalist is Human

How Animals Use Medicinal Plants in the Wild

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Part I: Zoopharmacognosy / Animal Self-Treatment with Medicinal Plants

Animals as diverse as caterpillars, birds, bears, and apes are known to use plants and other natural substances as medicine.

Table 1. Some examples of wild animals with reported self-medication behavior.

Animal species	Source of remedy	Indication
Baboon	*Balonites* spp. fruits	Against schistosomosis
Papio hamadryas *Linnaeus*, 1758		
Chimpanzee	*Aspilia* spp. leaves	It contains antimicrobials that act against fungi and bacteria
Pan troglodytes Blumenbach, 1799		Anti-parasite and for digestive system
	Vernonia spp. leaves	
		Used for intestinal disorders
	Lippea picata leaves	
	Ficus exasperata Vahl. leaves	Anti-microbial (bacteria and fungi)
	Commelina ssp. leaves	Anti-microbial of general use
European starling	Several volatile vegetation	Anti-parasite
Sturnus vulgaris *Linnaeus*, 1758		
Mountain gorilla	*Aframomum angustifolium fruits*	***Antibiotic***
Gorilla gorilla beringei (*Matschie, 1903*)		
Ursina howler monkey	Unknown plants	***Birth control and sex ratio choice***
Alouatta ursine (Humboldt, 1815)		
Reindeer	*Amanita muscaria*	
	(L. ex fr.) Hooker	***Inebriant***
Rangifer tarandus *Linnaeus*, 1758		
Brown bear	*Ligusticum porteri root*	***Against external parasites***
Ursus arctos (*Linnaeus, 1758*)		
Sloth bear	*Madhuca* spp. flowers	Inebriant
Melursus ursinus (*Shaw, 1791*)		

Costa-Netto 2012

Table 1. Some anecdotal evidence for self-medication in animals

Species	Plant specie (Family)	Comments	References
Malay elephant	*Entada schefferi* (Leguminosae):	For stamina before long walk, possible pain killer	Hubback (1941), Janzen (1978)
African elephant	Boraginaceae sp.	Induce labour; used by Kenyan ethnic group to induce labour and abortion. Similar story related to Huffman about observations made in Tanzania	Cowen (1990), MS Kalunde (personal communication)
Indian bison	*Holarrhena antidysenterica* (Apocynaceae)	Bark regularly consumed. Species name suggests anti-dysentaric action	Ogilvie (1929)
Wild Indian boar	*Boerhavia diffusa* (Nyctaginaceae) called pig weed	Roots are selectively eaten by boar and is a traditional Indian anthelmintic	Janzen (1978), Dharmkumarsinhji (1960)
Pigs	*Punicum granatum* (Punicaceae) pomegranate	Root sought after by pigs in Mexico	Janzen (1978), McCann (1932)
		Alkaloid in roots toxic to tapeworms	Caius (1940)
Indian tigers, wild dogs, bears, civets, jackals	*Careya arborea* (Barringtonaeaceae), *Dalbergia latifolia* (Leguminosae) etc.	Fruits of various species eaten by large carnivores. Possibly helps in elimination of parasites ingested along with contents of intestines of herbivore prey	McCann (1932), Burton (1952), Janzen (1978)
South American wolf	*Solanum lycocarpon* (Solanaceae)	Rotting fruit said to be eaten to cure stomach or intestinal upset	DAO Courtnay and GC Kirby (personal communication)
Asiatic two-horned rhinoceros	*Ceriops candoleana* (Rhizophoraceae)	Tannin-rich bark eaten in large amounts enough to turn urine bright orange. Possible use in control of bladder and urinary tract parasites	Hubback (1939)
Black howler monkey, spider monkey		Indigenous peoples living in primate habitats of the Neotropics claim that some monkey species are parasite-free because of the plants they eat	S Vitazkova (personal communication), M Pavelka (personal communication)

Huffman 2003

Concept generally attributed to Dan Janzen’s observations in 1978 of colobus monkey ingestion of anti-parasitic plant remedies.

In reality animal use of natural medicine has long been observed by indigenous peoples worldwide.

Pharmacognosy: a branch of pharmacology dealing with medicinal substances of biological origin and especially medicinal substances obtained from plants (Merriam-Webster)

In 1991 Richard Wrangham and Eloy Rodríguez coined the term **zoopharmacognosy** to describe self-medication by non-human animals.

This is distinct from ethnoveterinary or traditional veterinary uses of herbs, although one can and should inform the other.

“Not all pharmacists are human.”

Clayton, Wolfe, *The adaptive significance of self-medication*, Trends Ecol Evol. 1993 Feb;8(2):60-3. doi: 10.1016/0169-5347(93)90160-Q.

The pharmaceutical industry is paying close attention.

See for ex.: Berry, J.P. McFerren, M.A. Rodriguez 1995

“Just as modern medicine has benefited from the medicinal practices of indigenous peoples, it can benefit from the medicinal practices of other animals.”

Clayton, Wolfe 1993

“Combined, ethnopharmacology and the emerging field of animal self-medication have the potential to evaluate evolutionary strategies of health maintenance and contribute to the development of biologically sound health care strategies in the 21st Century.”

Cousins, Huffman 2002

Great apes (chimpanzees, bonobos, lowland gorillas) have been documented to have a materia medica of at least 30 plants.

-Biser 1998

Huffman and Cousins list approximately 100 plants in the gorilla diet that have medicinal uses.

-Cousins, Huffman 2002

Mountain gorillas consume *Vernonia adolfi-frederici,* a genus with known benefits for naso-pharyngeal illness and pulmonary infection.

“The cold, wet and windy slopes of the Virunga volcano range is a unique and inhospitable environment for gorillas. Not surprisingly, the apes commonly suffer from coughs, colds, pleurisy, pneumonia and bronchitis.”

Mountain gorillas periodically migrate to high altitude and there consume *Lobelia* and *Senecio spp.*, genera with established respiratory remedies.

Cousins, Huffman 2002

Intelligence or instinct?

In other words, are we all that distinct from other animals?

Mushroom Cultivation:
50 million years old

(by ants and termites – humans a bit more recently…)

The Telegraph HOME | NEWS

Science

Science

Monkeys create stone tools forcing scientists to rethink human evolution

Capuchin stone on stone percussion: the use of a detached flake as an active hammerstone in order to produce quartz dust CREDIT: M.HASLAM

"The researchers believe that the capuchins hammer the stones to extract powdered silicon, an essential trace nutrient, or to remove lichen for a medicinal purpose."

“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****. Capuchin SoS percussion goes a step further, demonstrating that the production of archaeologically identifiable flakes and cores, as currently defined,* ***is no longer unique to the human lineage.”***

Proffitt et al., *Wild monkeys flake stone tools*, Nature (2016) doi:10.1038/nature20112
Published online 19 October 2016

Since then several other species of primates have been discovered using stone tools...

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NewScientist

Some monkeys in Panama may have just stumbled into the Stone Age

LIFE 2 July 2018, updated 6 July 2018

By Colin Barras

The capuchins have been seen using rocks as tools
Description:Barrett et al

Another non-human primate has entered the Stone Age – the fourth type known to have done so. One population of white-faced capuchins living in Panama routinely use stones to smash open nuts and shellfish.

Other nearby populations don't make use of stone tools, which might suggest that primates – perhaps including our ancestors – stumble into the stone age by chance.

Chimpanzees in west Africa, macaques in Thailand and several species of tufted, strongly built capuchin monkeys living in South America use stone tools to access food. Brendan ...

Manta birostris may recognize themselves in mirrors

Ari, C. & D'Agostino, D.P. J Ethol (2016) 34: 167. https://doi.org/10.1007/s10164-016-0462-z

“…Infant apes almost certainly learn about medicinal plants, just as they do about food plants, from their elders…”

Cousins, Huffman 2002

Intelligence

(1) : the ability to learn or understand or to deal with new or trying situations: reason; also: the skilled use of reason

(2) : the ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria (as tests)

Merriam Webster

Bees exhibit intelligence

It has been said that the development of an understanding of zero by society initiated a major intellectual advance in humans, and **we have been thought to be unique in this understanding**. Although recent research has shown that some other vertebrates understand the concept of the “empty set,” Howard *et al.* now show that **an understanding of this concept is present in untrained honey bees** (see the Perspective by Nieder). This finding suggests that such an understanding has evolved independently in distantly related species that deal with complexity in their environments, and that it may be more widespread than previously appreciated.

Howard et al., Numerical ordering of zero in honey bees,
Science 08 Jun 2018: Vol. 360, Issue 6393, pp. 1124-1126

“Each species of flower generates a weak, unique electric field, and a new study shows that bumblebees can actually sense those electric fields using the tiny hairs on their fuzzy little bodies to aid them in identifying the plant.”

-NPR, All Things Considered, May 30, 2016

Zakon, *Electric fields of flowers stimulate the sensory hairs of bumble bees,* PNAS vol. 113 no. 26 7020–7021, doi: 10.1073/pnas.1607426113

Bees can also learn new tasks by observing their sisters

Such “tool use” at one time **was ascribed to humans alone**, but then to primates, next to marine mammals, and later to birds. **Now we recognize that many species have the capacity…**

Such **unprecedented cognitive flexibility** hints that entirely novel behaviors could emerge relatively swiftly in species whose lifestyle demands **advanced learning abilities**, should relevant ecological pressures arise.

Lokoula et al., Bumblebees show cognitive flexibility by improving on an observed complex behavior, *Science* 24 Feb 2017: Vol. 355, Issue 6327, pp. 833-836

Animals from fish (such as cod) to birds to primates have been shown to have ***culture***. And culture is, by definition, malleable.

Macaques at Japan reserve get first alpha female in 70-year history

Yakei took top spot after roughing up Sanchu, the alpha male who had been leader of 'troop B' on the island of Kyushu for five years

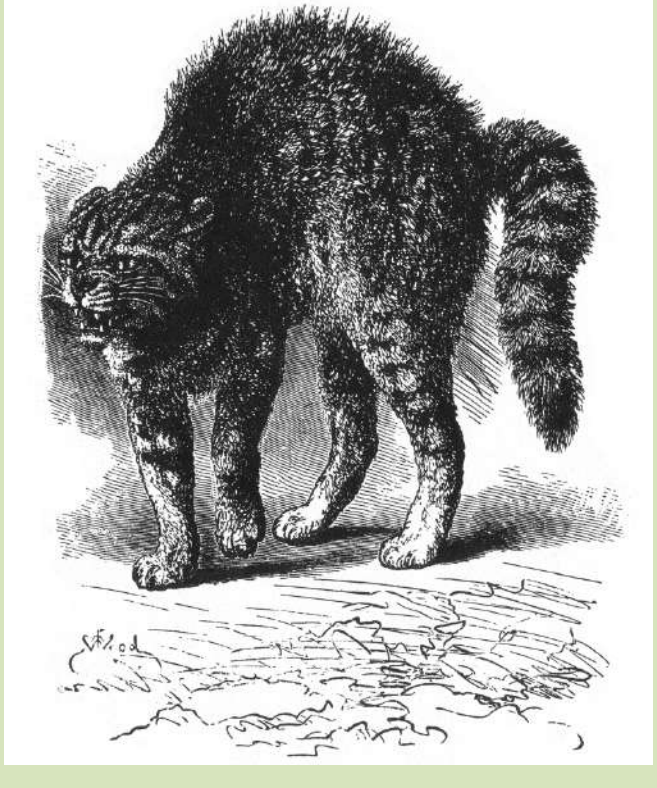
▲ Nine-year-old female known as Yakei, pictured, has become the boss of a 677-strong troop of Japanese macaque monkeys at a nature reserve on the island of Kyushu in Japan. Photograph: Takasakiyama Natural Zoological Garden

In a rarely seen phenomenon in the simian world, a nine-year-old female known as Yakei has become the boss of a 677-strong troop of Japanese macaque monkeys at a nature reserve on the island of Kyushu in Japan.

https://www.theguardian.com/world/2021/aug/03/macaques-at-japan-reserve-get-first-alpha-female-in-70-year-history

But some degree of intelligence appears…a result which has surprised me more than anything else in regard to worms.

C. Darwin, On the Formation of Vegetable Mould Through the Actions of Earthworms, 1881



THE

EXPRESSION OF THE EMOTIONS

IN

MAN AND ANIMALS.

By CHARLES DARWIN, M.A., F.R.S., &c.

WITH PHOTOGRAPHIC AND OTHER ILLUSTRATIONS.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1872.

The right of Translation is reserved.

Social learning about foods and foraging has been observed and documented in many animals including deer, sheep, moose, cats, and even some insects.

Young animals will even eat less nutritious foods if their mothers have taught them to:

- Kittens eating bananas and mashed potatoes rather than meat (Wyrwicka 1978)
- Goats and blackbrush (*Coleogyne ramosissima*) preference over nutritious alfalfa (Howery, Provenza, Burrit 2010)

“…Evolutionary processes could provide selective pressure for herbivores that feed in large, mixed-generation groups to rely on social learning, where foraging information is passed from experienced to inexperienced foragers. Recent research suggests that the mother may greatly influence her offsprings' dietary habits.”

-Frederick D Provenza and D F Balph. "Diet learning by domestic ruminants: Theory, evidence and practical implications" Applied Animal Behaviour Science Vol. 18 Iss. 3-4 (1987)

Birds

“In choice experiments, starlings employed olfaction to select nest herbs, using innate information and ***experience acquired as nestlings*** *to identify odours.”*

Gwinner 2012

Not all Dancers are Human: *meet Snowball the Cockatoo*

Keehn et al., Spontaneity and diversity of movement to music are not uniquely human, Current Biology, VOLUME 29, ISSUE 13, PR621-R622, JULY 08, 2019

Organoleptic Skills

Animals (including humans) can in some cases infer the nutritional, toxic, and potentially medicinal activity of a plant.

“Rangeland herbivores are remarkably adept at selecting plants that meet their nutritional needs while largely avoiding plants that do not. The fact that animals preferentially select plant species that are more nutritious than what is available, on average, is strong evidence that animals are able to somehow detect nutrient and toxin levels in plants as they change across space and time.”

-Provenza

“First, early experience matters, especially with mother. Second, animals can remember what they learned early in life for at least 5 years.”

Howery, Provenza, Burrit, 2010

Lambs Can Determine Which Remedy They Need

Frederick D Provenza, Juan J Villalba and Ryan Shaw. "Sheep self-medicate when challenged with illness-inducing foods" Animal Behaviour Vol. 71 Iss. 5 (2006)

Non-herbal remedies: 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 (Bolton et al. 1998)

Costa-Netto 2012

Chimps increase their consumption of rolled whole leaves during tapeworm infestations.

Richard W. Wrangham, Relationship of chimpanzee leaf-swallowing to a tapeworm infection, American Journal of Primatology
Volume 37, Issue 4, pages 297–303, 1995

Chimps roll and swallow whole Aspilia leaves to treat roundworm, a learned behavior.

“Because chimps swallow Aspilia leaves whole, the ‘chewing’ or surface rupture, occurs during digestion, presumably enabling the body to extract just the right amount of thiarurbrine-A for use as an antibiotic or antiparasitic agent... Whole leaves removed intact from chimpanzee dung show significantly lower levels of this compound than do uneaten leaves.”

Rodriguez & Wrangham 1993

Gall wasps benefit from high tannin content of oak leaves to ward off parasitic or microbial illness. Wasps have higher survival rates when growing in proximity to high-tannin content leaves over low-tannin content leaves.

Clayton, Wolfe 1993

Honey Bees

“Hence, forager honey bees apparently spend a considerable portion of their life span learning and improving their foraging skills.”

-Reuven Dukas, P.Kirk Visscher , Lifetime learning by foraging honey bees, Animal Behaviour, Volume 48, Issue 5, November 1994, Pages 1007–1012

Honeybees utilize propolis, with a strong antimicrobial activity, making up for a reduced immune response in comparison to other bees.

“Immune responses are costly, suggesting that animals should not use or evolve immunity when they do not need it. Animal medication provides an alternative to cellular and humoral immune responses and may thus result in a reduction or loss of such immune responses.“

De Roode et al. 2013

Bees ingest nicotine to ward off parasitic infection

“…when infected, bumblebees use a nectar alkaloid, slowing the progression of the infection …”

Baracchi, **Behavioural evidence for self-medication in bumblebees?** Version 3. F1000Res. 2015; 4: 73. Published online 2015 Oct 29. doi: 10.12688/f1000research.6262.3

Antimicrobial Nesting Materials

- Many birds will include fresh plant material in their nests high in aromatic, antiseptic compounds, including:
  - wild carrot (*Daucus carota*) leaves, yarrow (*Achillea millefolium*), goutweed (*Aegopodium podagaria*), hogweed (*Heracleum sphondylium*), elder (*Sambucus niger*), cow parsley (*Anthriscus sylvestris*) and white willow (*Salix alba*).
- House sparrows and finches have been observed incorporating cigarette butts into their nests in urban areas, reducing their pest and parasite load.
- Ants will place antimicrobial conifer resin in nests.
- Fruit flies lay eggs in high ethanol foods when wasps are present

Only male European starlings bring green vegetation into nest – this may help to attract partners.

Clayton, Wolfe, 1993

“Male European starlings (Sturnus vulgaris) use odorous herbs as green nest material. They show these plants to females to catch their attention before they incorporate them into their nests. Nestlings reared in nests containing herbs carry fewer bacteria, have higher haematocrit levels and more basophile leucocytes, and have a higher fledging weight than those reared in nests without herbs.”

Gwinner 2012

Table 1 An overview of experimental studies in natural populations of three species of birds that test the effects of green plant material in nests on parasite/pathogen communities and condition and survival of nestlings and adult birds

Plants preferentially selected by birds in the study population	Plants tested by experimenter	Description of GM manipulation	Targeted parasites and pathogens	Observed effects on parasites and pathogens	Observed effects on nestlings	Ref.[a]
European Starling (*Sturnus vulgaris*)						
Agrimonia paraflora, Daucus carota, Achillea millefolium, Lamium purpureum, Solidago rugosa (from Clark and Mason, 1985)	*Daucus carota*	GM-treated and control nests: all GM removed on daily basis throughout the nest-building stage, only GM-treated nests: supplementation on days 10 and 5 pre- and 1, 7 and 13 post- hatching with 5 g of *D. carota*	*Omithonsyssus sylvianum*	Reduced number of mites in GM-treated nests over the whole nestling period, no difference in the rate of population growth	Higher levels of blood hemoglobin in GM-treated nests, no effect on nestling growth, fledging body mass and feather development	1
Achillea millefolium, Daucus carota, Solidago pp., *Barbarea vulgaris, Glechoma hederacae, Erigeron* sp.,	The mix of naturally supplied plants	Two types of nests: unmanipulated and with GM removed from the nest after the clutch completion	*Omithonsyssus sylvianum*	No effect	No effect on hatching and fledging success, body mass, fat scores, tarsus length, haematocrit level, postfledging survival	2
Achillea millefolia, Salix alba, Ajuga reptans, Heracleum sphondylium, Sambucus niger, Evonymus europaea, Anthriscus sylvestris, Galeobdolon luteum, Galium sp., *Rhamnus cathartica, Aegopodium podagraria, Glecoma hederacea*	*Aegopodium podagraria, Heracleum sphondylium, Sambucus niger, Anthriscus sylvestris, Achillea millefolia, Salix alba*	Two types of artificial nests: herb-treated nests: 60 g of dry grass mix and 40 g of preferred plants in the mix reflecting the composition and plant proportional usage; Control nests: 60 g of dry grass and 40 g of fresh grass of the same species. Natural nest was replaced with an artificial one after the clutch completion.	*Dermanyssus gallinae* *Ceratophyllus gallinae* Mallophaga	No effect on the number of mites, fleas and lice	Herb-treated nests: higher nestling body mass, haematocrit level, recruitment rate, number of basophils, lower number of lymphocytes No effect: hatching and fledging success, cell-mediated immune response, buffy coat layer, the number of heterophils and eosinophils	3
			Dermanyssus gallinae	No effect	Higher fledgling body mass	4
			cultivable bacteria sampled from nestling's belly	Reduction of bacteria load, but only in late nests		

Dubiec, Góüdü, Mazgajski, *Green plant material in avian nests*, AVIAN BIOLOGY RESEARCH 6 (2), 133–146, 2013

Table 1. Contd

Plants preferentially selected by birds in the study population	Plants tested by experimenter	Description of GM manipulation	Targeted parasites and pathogens	Observed effects on parasites and pathogens	Observed effects on nestlings	Ref.[a]
GM from herbs, bushes and trees, no species identification available	The mix of plants reflecting the average species composition	GM-nest: supplementation with the average mass and species composition found per nestbox in a given day, control nests: unmanipulated, GM-devoid nests: GM removed; manipulation of GM every second day till egg laying in one of the boxes in the set	*Dermanyssus gallinae*	No effect on the abundance	No effect on clutch size, number of fledglings and nestling body mass	5
Blue Tit (*Cyanistes caeruleus*)						
Lavandula stoechas, *Achillea ligustica*, *Helichrysum italicum*, *Mentha suaveolens*, *Pulicaria odora*, *Calamintha nepeta*, *Foeniculum* sp., *Melissa officinalis*, *Lamium bifidum*, *Teucrium scorodonia* (from Petit et al., 2002)	*Lavandula stoechas*; *Helichrysum italicum*	GM-nests: 1 g of fresh GM, control nests: 1 g of fresh moss supplemented 3 days before hatching and then daily from day 2–3 post-hatching until day 14–15 post-hatching; before deposition of GM or moss all detectable GM placed by either Blue Tit females or the experimenter during previous days was removed	Blow fly (*Protocalliphora*) larvae (second and third stage) and pupae	No effect on blow fly infestation intensity	No effect on nestling size, haematocrit and survival	6
			Cultivable bacteria sampled from nestling and adult birds' flanks including feathers	Reduced bacterial richness on nestlings, reduced bacterial densities on nestlings under high, but not low blow fly infestation, no effects on bacterial richness and density on adults		7
	Lavandula stoechas, *Achillea ligustica*, *Helichrysum italicum*, *Pulicaria odora*, *Calamintha nepeta*	Unmanipulated and enlarged broods were randomly assigned to either aromatic (1 g of fresh leaves of five plant species) or control (1 g of fresh moss placed every 2nd day from day 5 to day 14–15 post-hatching) treatment, all nests had blow fly larvae removed throughout the nestling period to minimize phenotypic variation among nestlings associated with variation in blow fly infestation intensity	Not studied	Not studied	Positive effect on: nestling mass in enlarged broods, on feather development both in control and enlarged broods (but only in one of the two study years), haematocrit in control and enlarged broods; no effect on body size	8

Dubiec, Góüdü, Mazgajski, *Green plant material in avian nests*, AVIAN BIOLOGY RESEARCH 6 (2), 133–146, 2013

Topical Uses of Herbs: Fur Rubbing

- 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*: Citrus, Clematis, Piper spp.*
- Capuchin monkeys rub millipedes into their fur.

  -Biser 1998 (and many others)

“Anting” among birds and mammals

- Observed in over 200 species
- Many species of birds and some mammals will lie on ant nests or rub crushed ants on their plumage or fur
- Formic acid inhibits lice and other parasites

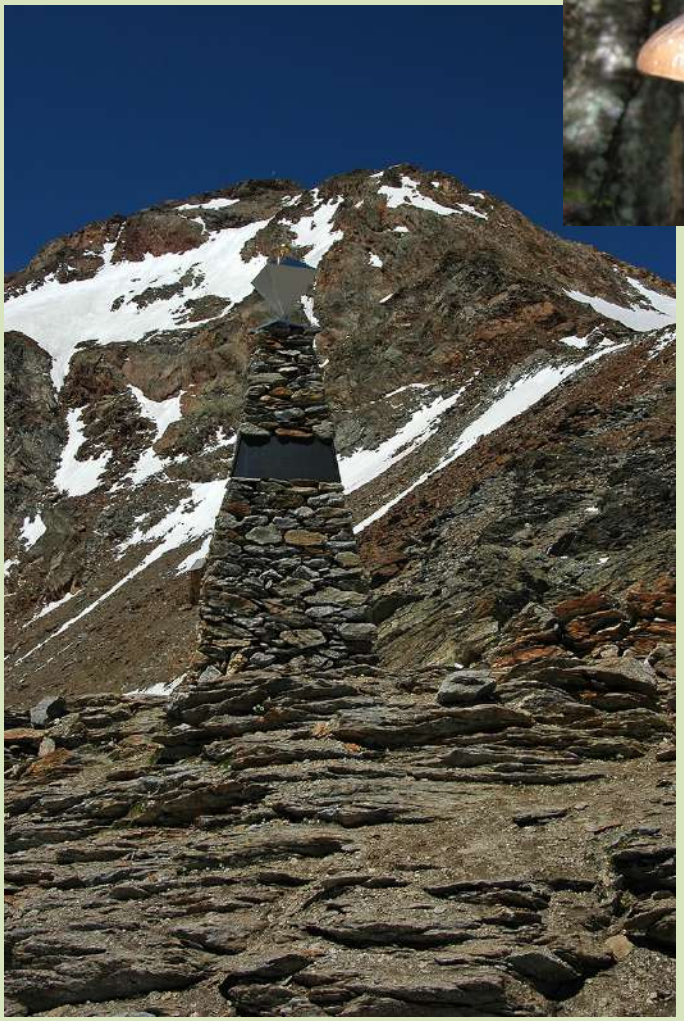
Clayton, Wolfe 1993

Orangutans in Borneo fur-rub with *Commelina*, used locally by people as a topical remedy for muscular pain, soreness, and swelling.

Morrogh-Bernard, 2009

Fig. 1 Species of *Commelina* used for fur-rubbing.

Part II: The Animal Origins of Herbal Medicine



Ötzi

50,000 year old Neanderthal evidence

We can never know for sure why yarrow and camomile were ingested at El Sidron, but we propose that the evidence for self-medication offers the most convincing behavioural context.

Hardy, Buckley, & Huffman, 2013

If Herbal Medicine is our *Original Medicine*, How did it Originate?

- Trial and error
- Direct communication
- Observing animals
- Is the question the right one? Are the answers mutually exclusive?
- What bias is inherent in this framing? *Questioning the unspoken premise.*

The Harvest

Chickadees can recall the location of *tens of thousands* of cached seeds

Sonnenberg et al., Natural Selection and Spatial Cognition in Wild Food-Caching Mountain Chickadees, Current Biology, VOLUME 29, ISSUE 4, P670-676.E3, FEBRUARY 18, 2019

Meanwhile on Fiji ants farm diverse crops for food and housing

Ants in the genus Philidris conduct…gardening activities in six different species of epiphytic plants, often simultaneously. Specifically, they not only manage growing conditions but also disperse and plant seeds and pollinate flowers.

Science 25 Nov 2016: Ants Farming Plants, Vol. 354, Issue 6315, pp.1017 1018
DOI:10.1126/science.354.6315.1017-d

The [*Philidris nagasau*] ants cultivate the [coffee] seedling for weeks, even though it is initially of no direct benefit to them. Only after three to five months can they finally move in to their new and aromatic abode. To ensure the botanical house turns out as planned, the ants take it in turns to guard the seedling and fertilize it with dung and urine.

https://www.dw.com/en/ant-species-cultivates-coffee-for-accommodation/a-36477533

Origin of Herbal Remedies:
Humans Learning from Other Animals

Cultures around the world attribute their acquisition of herbal remedies to animals, in particular ***sacred plants****.*

“According to Brunfels (1532), the leaves of Laurus nobilis are used by pigeons and chickens to cure constipation. Noordhuis (2005) reported that Erasmus (1466-1536) observed a toad, who, after he was bitten by a spider, took instantly a leaf of Plantago.”

Khan et al., 2014

“There is ample evidence that man globally has discovered the effects of drug plants by observing the behavior of animals.”

Siegel, 1979; Huffman, 2001

“It is also likely that humans watching the behaviour of sick animals discovered the medicinal properties of many plants early on in our history.”

Huffman, 2001

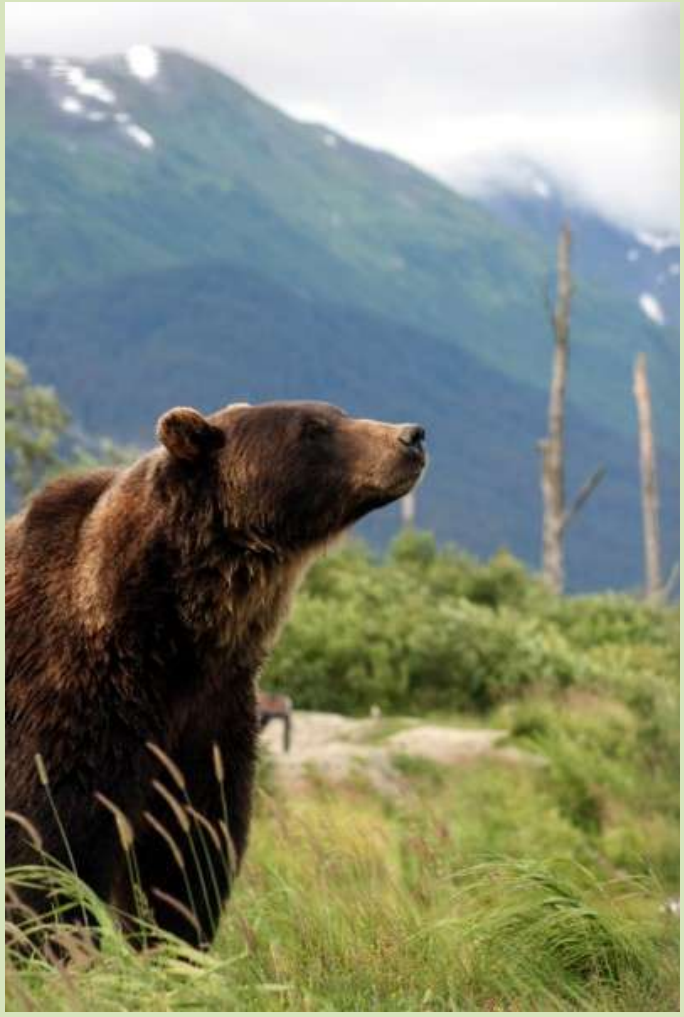
Anti-parasitic, Anthelmintic, Antimicrobial Activity

- Chimps use *Vernonia amygdalina* – bitter leaf
  African tribes also use extracts from the plant's bark, stems, roots, seeds and leaves to treat a variety of human ailments.

  Huffman, Seifu 1989
- Indian wild boars selectively dig and eat the roots of pigweed (*Boerhaavia diffusa*), which humans use as an anthelmintic.

Janzen 1978

Ligusticum porteri
Bear-root; osha



Ligusticum porteri
Bear-root; osha

“…the bear, a generous divine being in their tradition, gave them osha a gift – a medicinal plant of great importance” (Andrews, 2005). Sigstedt argues that “the Native Americans were such excellent scientific observers that they were aware that the bear was using the plant, and they were probably scientifically accurate when they included these observations in their stories”.

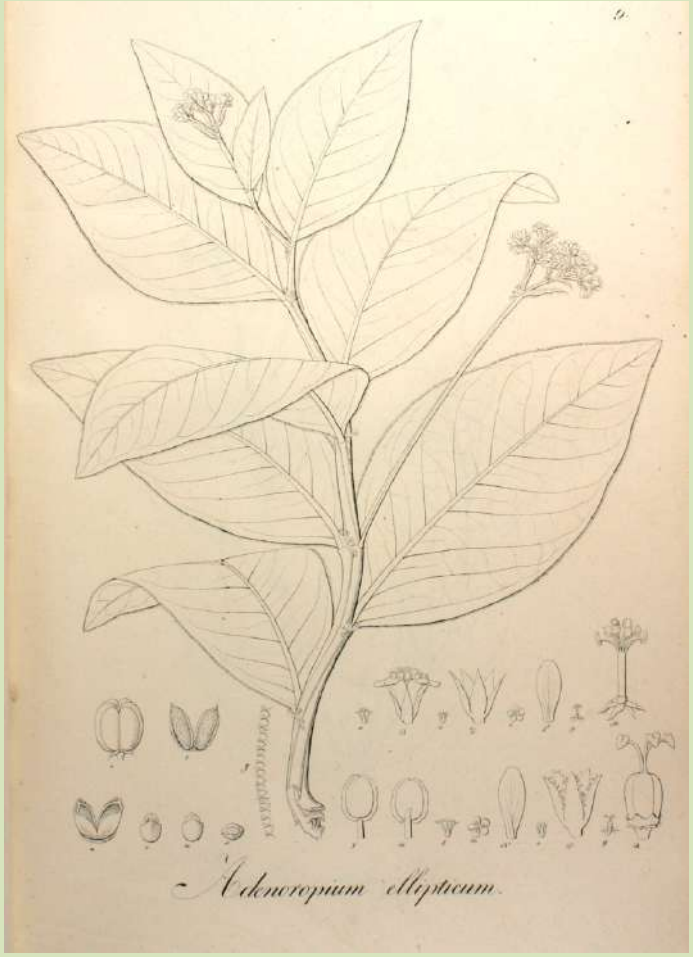
“Rather than eating the root, the bears chewed it and then spit out the mixture of saliva and macerated plant, methodically rubbing it on their paws and fur.”

-"Medicine on the wild side: animals may rely on a natural pharmacy" The Free Library. 1990 Science Service, Inc. 18 Jul. 2016

Snakebite Remedies

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.

Costa-Neto 2012



Do animals use herbs to self-regulate their reproductive health?

Howler Monkeys

“Glander says he has circumstantial evidence, based on two decades of field studies, suggesting that some mantled howling monkeys (Alouatta palliata) ***may use diet to dictate the gender of their offspring****. This, Glander says, may explain another finding that emerged during his studies: A significant number of female howlers in Costa Rica bore exclusively male offspring (or, more rarely, only female offspring) over a period of 20 years* ***--*** *a gender bias unlikely to occur purely by chance.*

Glander says ***he suspects some fertile females seek out either estrogen-like compounds or chemicals that change the pH of the vagina*** ***--*** *two methods known to help shift the gender odds in humans. “*

-"Medicine on the wild side: animals may rely on a natural pharmacy.."
The Free Library. 1990 Science Service, Inc. 18 Jul. 2016

Sheep and red clover: *up for debate*

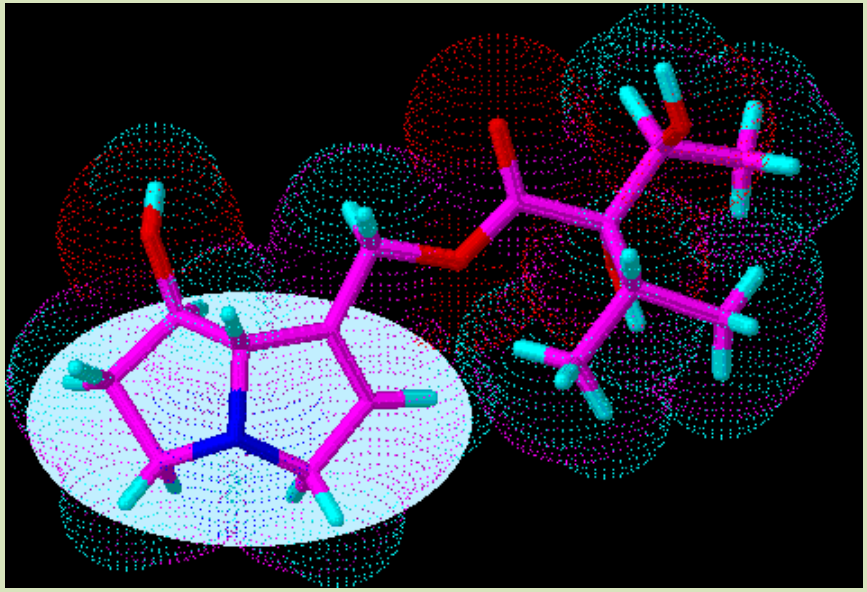
Elephants and Pregnancy

-Biser 1998 reporting on work by Holly Dublin, WWF

Pyrrolizidine Alkaloids

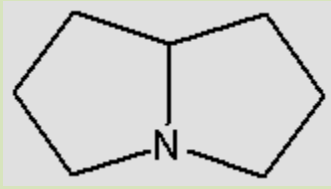
- Boraginaceae: *Symphytum*, *Borago, Pulmonaria*
- Asteraceae: *Senecio*, *Tussilago*, *Petasites, Eupatorium*

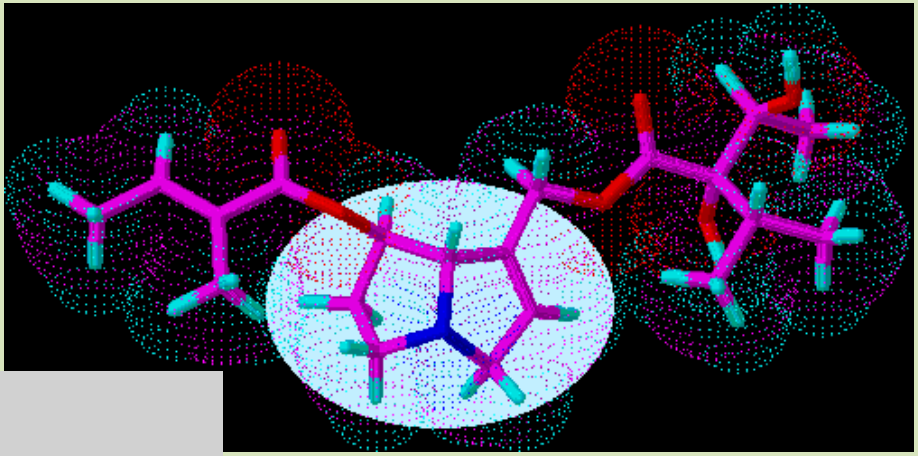
Pyrrolizidine Alkaloids (PAs)



Lycopsamine

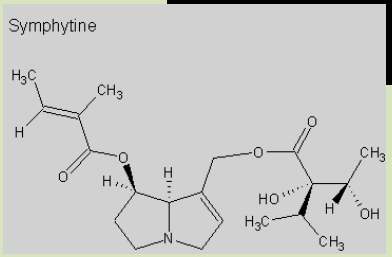
Necine rings





Symphytine

Necine rings are metabolized into toxic pyrroles in the liver cells

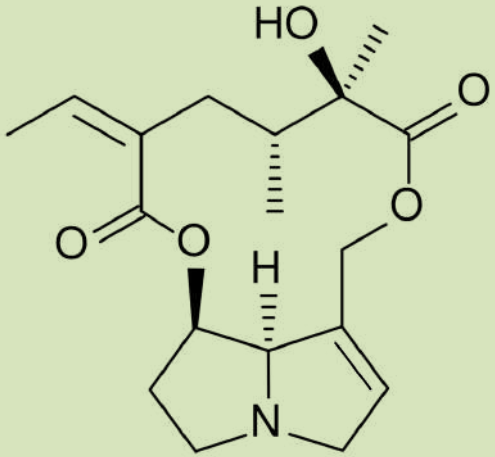


Pyrrolizidine Alkaloids

- Some types are considerably more toxic than others
  - Saturated PAs are non-toxic
  - Unsaturated macrocyclic esters are especially toxic
- Most cases of human PA intoxication are due to crops contaminated w/high-PA weed species, e.g. *Senecio vulgaris* in wheat
- Some people receiving acute exposure develop VOD; many, but not all, recover

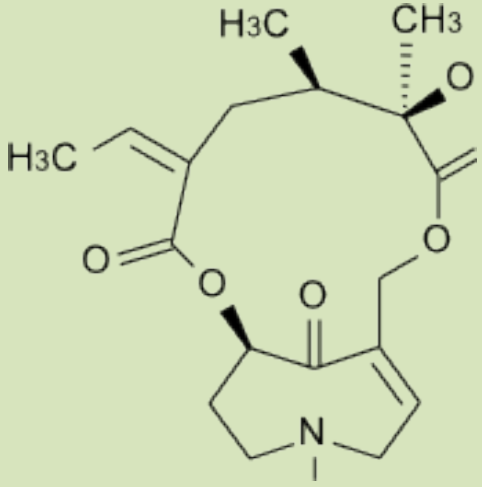
PAs: Macrocyclic Esters

Macrocyclic esters (e.g., in *Senecio* species – over 1500 spp. worldwide) are the most toxic type of PAs



Senecionine

Senecio jacobaea



Senkirkine

Caterpillars and Pyrrolizidine Alkaloids

Woolly bear caterpillars (*Grammia incorrupta*) intentionally consume 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.


Copyright © 2013 Bob Beatson

Caterpillars and Pyrrolizidine Alkaloids

“Consistent with theoretical prediction, excessive ingestion of these toxins reduces the survival of unparasitized caterpillars. Parasitized caterpillars are more likely than unparasitized caterpillars to specifically ingest large amounts of pyrrolizidine alkaloids.

“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.“

Singer et al., Self-medication as adaptive plasticity: increased ingestion of plant toxins by parasitized caterpillars, PLoS One. 2009;4(3):e4796. doi: 10.1371/journal.pone.0004796 2009 Mar 10.

Chen Hungsho (1599-1652)

Ling Zhi [reishi] is “bitter and balanced. It mainly treats binding in the chest, boosts the heart qi, supplements the center, sharpens the wits, and [causes people] not to forget”

The Divine Farmer's Materia Medica, circa 250 A.D.

“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**.”

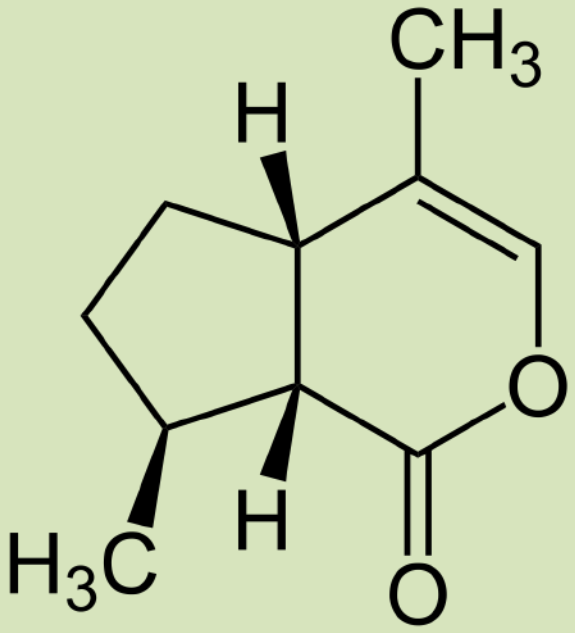
Fossey, D. 1983. Gorillas in the Mist,
Hodder & Stoughton, London.

“Both the scarcity of the fungus and the gorillas’ liking of it cause many intragroup squabbles, a number of which are settled by the silverback, who simply takes the item of contention for himself .”

Homo sapiens with *Ganoderma tsugae*

Part III: The Use of Natural Psychoactive Substances by Animals

Nepeta cataria - catnip



Jaguars and *Banisteriopsis*

“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.”

Dr. Barbara Natterson-Horowitz

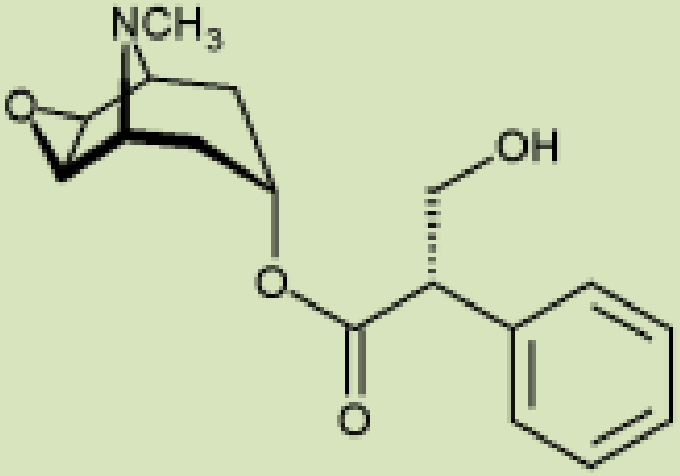
The oldest hallucinogen is thought to be the fly-agaric mushroom, Amanita muscaria, discovered in Siberia by observing the behavior of intoxicated reindeer.

-H Abraham, A Aldridge, P Gogia
The psychopharmacology of hallucinogens,Neuropsychopharmacology, Volume 14, Issue 4, Pages 285-298

Ethiopian Legend of Coffee and the Dancing Goats

Baboons

There are anecdotal reports of baboons eating *Datura inoxia* and *D. stramonium*.



Gorillas and Iboga (*Tabernanthe iboga*)

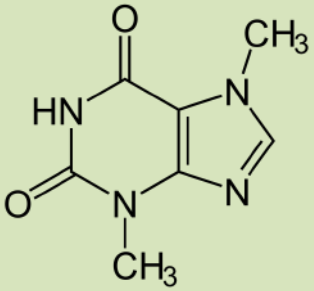
“The plant is employed in traditional African medicine, along with Tabernanthe montana species, for manic depression, leprosy and as an aphrodisiac. In the former Belgian Congo (Democratic Republic of Congo) the sap is used in the treatment of pox, and the leaves for gum and tooth diseases (Dubois, 1955).”

Cousins, Huffman 2002

Iboga

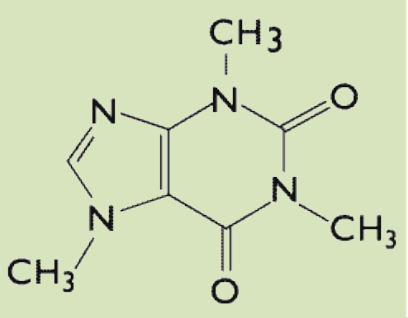
"T. iboga is an essential component in African religious cults and rites...it is possible that the pygmies themselves discovered the properties of the plant ***by watching wild boars digging up and eating the roots****, only to go into a wild frenzy, jumping around and fleeing from perhaps frightening images. Similar behaviour has been reported by indigenous peoples for* ***porcupines and gorillas who are said to be fond of the roots*** *(Pope, 1969; Raponda-Walker & Sillans, 1961). "*

Cousins, Huffman 2002



“Gorillas seem to be attracted to caffeine and theobromine bearing plants. In Equatorial Guinea they eat the leaves of Caffea liberica (Rubiaceae) and the fruits of Theobroma cacao (Sterculiaceae) (Sabater Pi, 1977).”

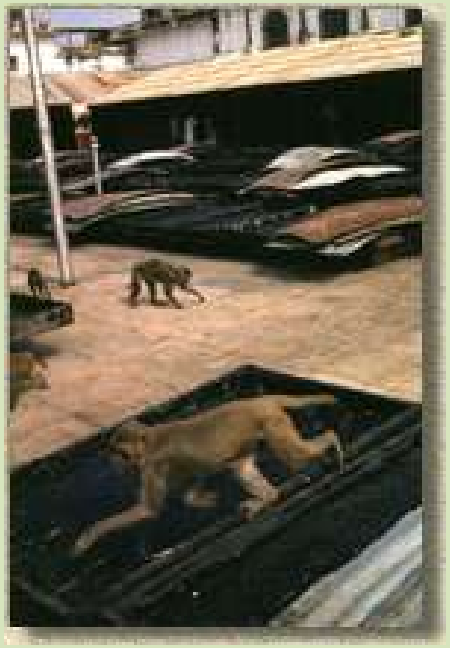
Cousins Huffman 2002



BBC NEWS

Inside the world's largest opium factory

By Amarnath Tewary
Ghazipur



“Monkeys still have the run of the factory, eating opium waste and dozing all day. ‘They have become addicted to opium. Most of the time we have to drag dozing monkeys away from this place,’ a worker says. “

BBC NEWS

'Stoned wallabies make crop circles'

“We have a problem with wallabies entering poppy fields, getting as high as a kite and going around in circles. Then they crash.”

- Lara Giddings, Attorney General, Tasmania, 25 June 2009

UPI.com
OVER 100 YEARS OF JOURNALISTIC EXCELLENCE

Amber fossil suggests dinosaurs may have eaten ancient LSD

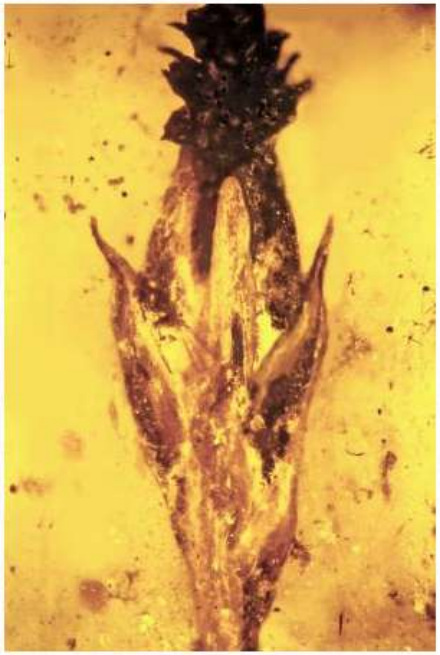
Published: Feb. 11, 2015 at 12:28 PM

Brooks Hays

Amber fossil links earliest grasses, dinosaurs and fungus used to produce LSD

02/09/2015

CORVALLIS, Ore. – A perfectly preserved amber fossil from Myanmar has been found that provides evidence of the earliest grass specimen ever discovered – about 100 million years old – and even then it was topped by a fungus similar to ergot, which for eons has been intertwined with animals and humans.



Ergot has played roles as a medicine, a toxin, and a hallucinogen; been implicated in everything from disease epidemics to the Salem witch trials; and more recently provided the hallucinogenic drug LSD.

Apparently both ergot and the grasses that now form most of the diet for the human race evolved together.

And if they already seemed a little scary, imagine a huge sauropod dinosaur that just ate a large portion of this psychotropic fungus, which in other animal species can cause anything from hallucinations to delirium, gangrene, convulsions or the staggers. The fungus, the grasses it lived on and dinosaurs that ate grass co-existed for millions of years.

GEORGE POINAR JR., STEPHEN ALDERMAN & JOERG WUNDERLICH,
One hundred million year old ergot: psychotropic compounds in the Cretaceous?,
Palaeodiversity 8: 13–19; Stuttgart 30 December 2015.

"An octopus doesn't have a cortex, and doesn't have a reward circuit," Dölen, assistant professor of neuroscience at Johns Hopkins University, told Gizmodo. "And yet it's able to respond to MDMA and produce the same effects, in an animal with a totally different brain organization.

Edsinger, Dolen, A Conserved Role for Serotonergic Neurotransmission in Mediating Social Behavior in Octopus. Current Biology : CB 20 Sep 2018, 28(19):3136-3142.e4

“At first, when they received a little too much MDMA, they breathed erratically and turned white. But on lower doses, one animal “looked like it was doing water ballet,” swimming around with outstretched arms. Another spent part of the time doing flips, and another seemed especially interested in minor sounds and smells.”

Ethanol (Alcohol) Consumption Among Animals

"…rare but consistent accounts of birds and mammals consuming fermented fruits and becoming ‘‘drunk’’ (Siegel and Brodie, 1984; Fitzgerald et al., 1990)…it is safe to conclude that frugivores occasionally consume highly fermented fruits."

Birds and other frugivores avoid rotting fruits, but "fruits most likely to contain ethanol are also the rotting fruits most likely to be consumed by birds."

Levey 2004

The Washington Post

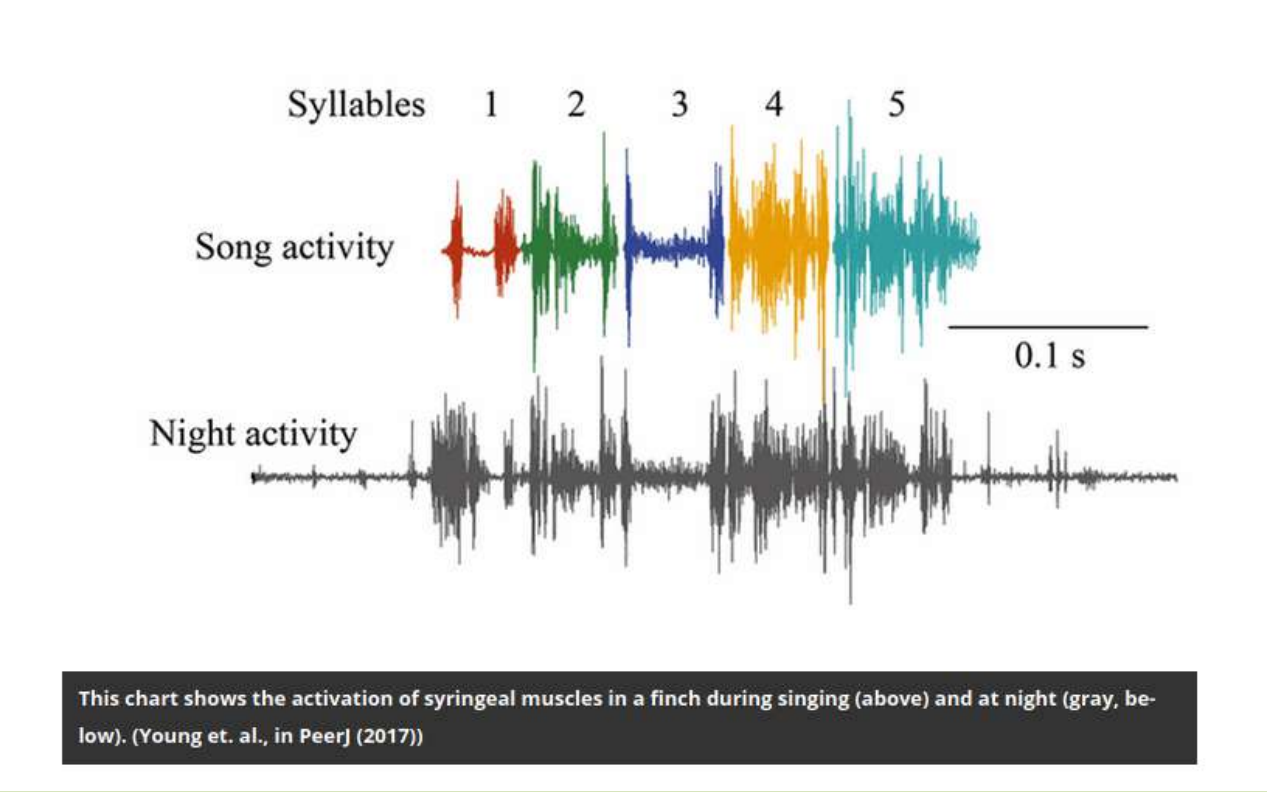
Speaking of Science

Scientists show that drunk birds ‘slur’ their songs

Olson CR, Owen DC, Ryabinin AE, Mello CV (2014) *Drinking Songs: Alcohol Effects on Learned Song of Zebra Finches.* PLoS ONE 9(12): e115427. doi: 10.1371/journal.pone.0115427

Zebra Finches Practice their Songs in their Sleep

https://www.smithsonianmag.com/science-nature/zebra-finches-dream-little-dream-melody-180969925/



This chart shows the activation of syringeal muscles in a finch during singing (above) and at night (gray, below). (Young et. al., in PeerJ (2017))

What do octopuses dream of?

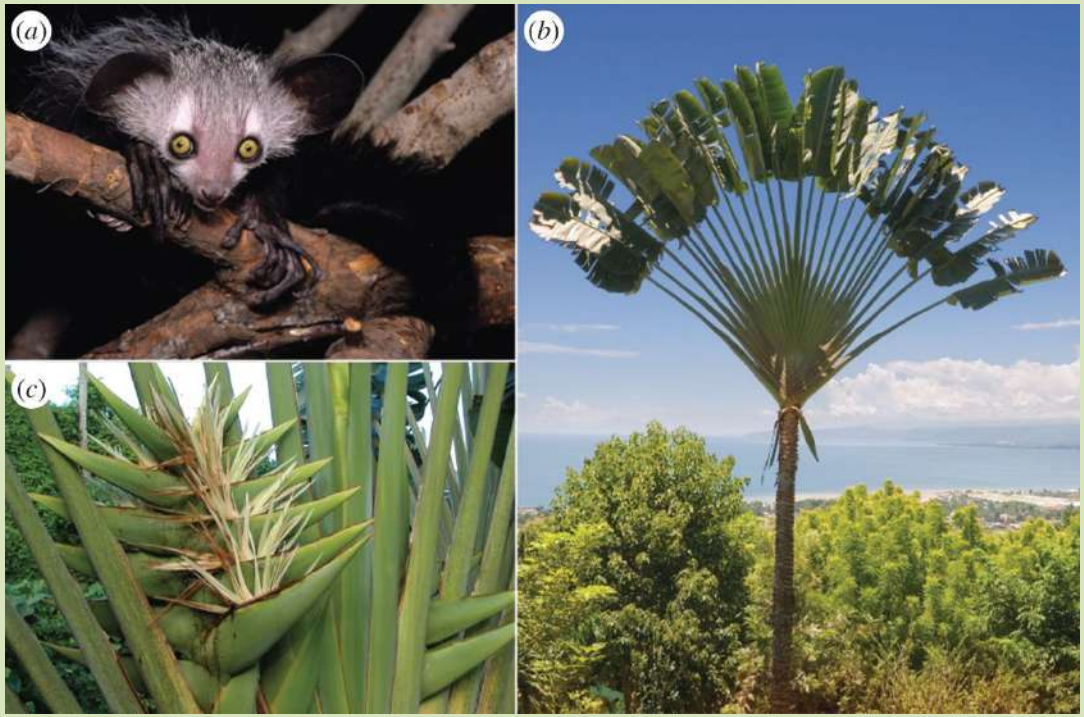
https://www.pbs.org/wnet/nature/octopus-dreaming-trept6/19376/

Preference for fermented nectar among the aye aye and the slow loris in Madagascar

“Here, we report the results of a multiple-choice food preference experiment with two aye-ayes and a slow loris. We conducted observer-blind trials with randomized, serial dilutions of ethanol (0–5%) in a standard array of nectar-simulating sucrose solutions. **We found that both species can discriminate varying concentrations of alcohol; and further, that both species prefer the highest available concentrations.** These results bolster the hypothesized adaptive function of the A294V mutation in ADH4, and **a connection with fermented foods, both in aye-ayes and the last common ancestor of African apes and humans.**”

Samuel R. Gochman, Michael B. Brown, Nathaniel J. Dominy , Alcohol discrimination and preferences in two species of nectar-feeding primate, R. Soc. open sci. 2016 3 160217; DOI: 10.1098/rsos.160217. Published 20 July 2016

Natural history underlying the hypothesized adaptive function of the A294V mutation in the gene that encodes ADH4 [11]: (a) the aye-aye (Daubentonia madagascariensis; photograph by David Haring, reproduced with permission); (b) the traveller's tree (Ravenala madagascariensis; Strelitziaceae) is an enduring symbol of Madagascar [15] in part because of its distinctive, distichous leaf arrangement; (c) the axillary inflorescence of R. madagascariensis is distinguished by congested overlapping bracts, some of which are shown with protruding flowers (photograph by Gerald McCormack, reproduced with permission).



Samuel R. Gochman et al. R. Soc. open sci. 2016;3:160217

ROYAL SOCIETY OPEN SCIENCE

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At least one primate species is a verified consumer of fermented nectar [34]: (a) the slow loris (Nycticebus coucang; photograph by David Haring, reproduced with permission); (b) the bertam palm (Eugeissona tristis; Arecaceae) is a fiercely spiny acaulescent palm endemic to Peninsular Malaysia and Thailand [35] (photograph by Annette Zitzmann, reproduced with permission); (c) the woody pencil-shaped flowers of E. tristis are well suited for supporting the weight of scansorial mammals attracted to the frothing, fermented nectar [36].

Samuel R. Gochman et al. R. Soc. open sci. 2016;3:160217

ROYAL SOCIETY OPEN SCIENCE

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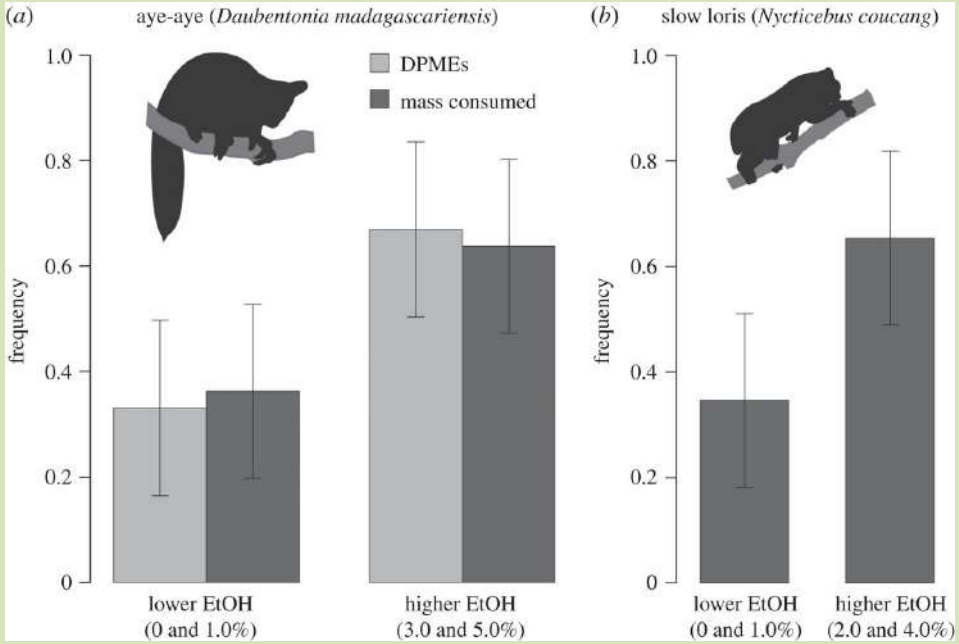
Bar graphs of mean proportional alcohol consumption (whiskers: ± 1 s.d.) across all trials in a multiple-choice feeding experiment: (a) for aye-ayes (n = 2 animals, 15 trials each), the mean proportion of digital-probe-to-mouth-events (DPMEs) and the consumed mass of alcohol in an array of Ravenala nectar-simulating solutions differed between lower- (0.0 and 1.0%) and higher-alcohol (3.0 and 5.0%) concentrations, indicating a preference for higher concentrations; (b) for a slow loris (n = 1 animal, 5 trials), the consumed mass of alcohol in an array of Eugeissona nectar-simulating solutions differed significantly between lower- (0.0 and 1.0%) and higher-alcohol (2.0 and 4.0%) concentrations, indicating a preference for higher concentrations.



Samuel R. Gochman et al. R. Soc. open sci. 2016;3:160217

ROYAL SOCIETY OPEN SCIENCE

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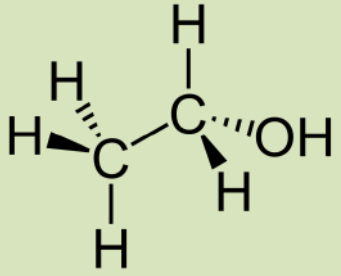
SPIEGEL ONLINE
01/18/2011 05:05 PM

Black Out

German Police Pick up Drunken Owl

“The bird will be released once it has sobered up, police said.”

Honey bees and alcohol



"…it has been demonstrated that **ethanol induces aggression and the disruption of locomotive, learning, and decision-making abilities in both humans and honey bees** (Abramson, Stone, Ortez, Luccardi, Vann, Hanig, et al., 2000; Abramson, Place, Aquino, & Fernandez, 2004; Abramson, et al., 2005; Božič, Abramson, & Bendencic, 2006). Like humans, honey bees also demonstrate self-administration of ethanol and exhibit preferences for commercially available alcoholic beverages (Abramson, Kandolf, Sheridan, Donohue, Božič, Meyers, et al., 2004).

Mixson, Abramson, Bozic 2010

“Drunken elk rescued from Swede's apple tree”

The Local: http://www.thelocal.se/20110907/36002
Published: 07 Sep 2011 12:38 GMT+02:00

“Drunken elk are common in Sweden during the autumn season when there are plenty of apples lying around on the ground and hanging from branches in Swedish gardens.”

The Washington Post

Animals

Raccoons drunk on crab apples cause false rabies scare in West Virginia

abc NEWS VIDEO LIVE SHOWS

Birds in Minnesota 'literally get drunk' and dive-bomb cars and homes

By BRAD MIELKE and KELLY TEREZ

WATCH | 'Drunk' birds are dive-bombing cars

Why?

“Bighorn sheep in the Canadian Rockies scrape psychoactive lichen off rocks, even if it leaves their teeth ground down to the gums. Water buffalo in Asia eat bitter poppies—in other words, opium.”

Dr. Barbara Natterson-Horowitz

theguardian

Elephants on drunken rampage kill three people

Village left reeling after around 70 elephants destroyed 60 homes after feasting on hooch produced locally for a festival

Jason Burke

Friday 3 December 2010 12.38 EST

Binge-drinking elephants, drunk on local hooch, have killed three people and destroyed 60 homes in a four-day rampage in east India.

Yesterday they were reported by local officials to be sleeping off hangovers as shocked communities tried to clear the wreckage left by the 70-strong herd in remote villages on the borders of the states of Orissa and West Bengal.

With a local festival approaching, villagers had stockpiled the fermented-rice based drink which is stored in earthenware vessels and, according to Bijay Kumar Panda, a local administrator, the elephants found and drank it.

"Yesterday they were reported by local officials to be sleeping off hangovers as shocked communities tried to clear the wreckage left by the 70-strong herd in remote villages on the borders of the states of Orissa and West Bengal."

World environment on NBCNEWS.com

Elephants electrocuted in drunken rampage

They had found rice beer in Indian village; incident reflects loss of habitat

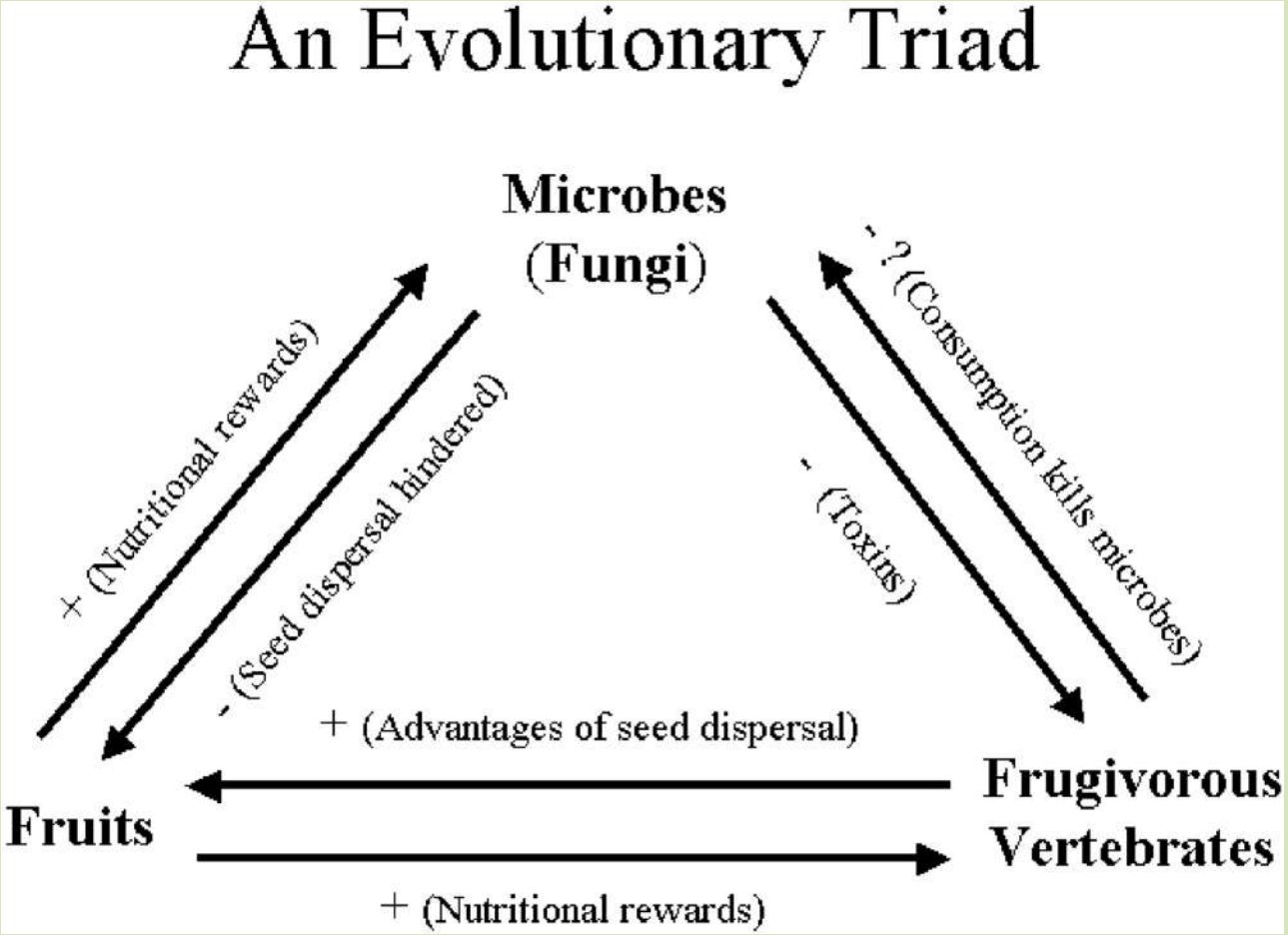
Is Every Single Elephant a Village-Wrecking Booze Hound?

By Eli MacKinnon, Life's Little Mysteries Staff Writer | November 9, 2012 11:41am ET

In this hypothesis, ***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 (Dudley, 2000, 2004). Just as we speak today of diabetes running wild in human populations due to excessive caloric intake (Diamond, 1992), 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.***

Milton 2004

Fig. 1. Production of ethanol by microbes in fruit is best viewed as a component of a three-way interaction between fruiting plants, microbes (yeast and other fungi), and frugivorous vertebrates.



Douglas J. Levey Integr. Comp. Biol. 2004;44:284-289

“…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****.”*

Dr. Barbara Natterson-Horowitz, cardiology professor, David Geffen School of Medicine, UCLA Co-author of Zoobiquity: The Astonishing Connection Between Human and Animal Health.

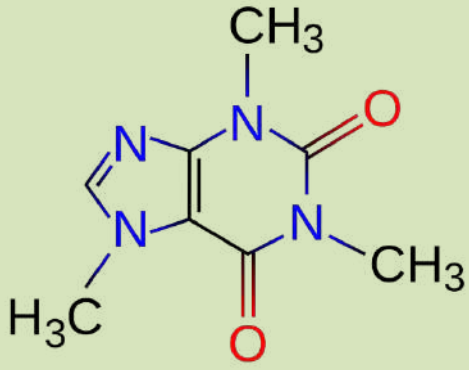
Coffee and Citrus Plants Boost Bee Memory With Caffeine

By Christie Wilcox | March 7, 2013 2:39 pm

Caffeine has been a part of human cultural heritage for more than five thousand years. From ancient teas and coffees to todays energy drink craze, you could say that as a species, we're hooked. But we're not the only ones — a new study published in Science today has found that pollinators get a daily buzz off caffeine, too, and it keeps them coming back for more.

It was originally thought that plants produced caffeine as a pesticide, which is, in part, true.

Honeybee visiting a coffee flower.



Wright G.A. et al. (2013). Caffeine in Floral Nectar Enhances a Pollinator's Memory of Reward, Science, 339 12021204. DOI: 10.1126/science.1228806

Bumble bees show an induced preference for flowers when primed with caffeinated nectar and a target floral odor

Sarah E.J. Arnold, Jan-Hendrik Dudenhöffer, Michelle T. Fountain, Katie L. James, David R. Hall, Dudley I. Farman, Felix L. Wäckers, Philip C. Stevenson Current Biology DOI: 10.1016/j.cub.2021.06.068

"While previous studies have shown that bees like caffeine and will more frequently visit caffeinated flowers to get it, ***this study shows that consuming caffeine in their nest actually helps bees find certain flowers outside of the nest****."*

-Science Daily, July 28, 2021

*“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 coevolution of early herbivores, especially mammals and their utilization of primitive gymnosperms and later angiosperms as medications.“*

-Eloy Rodriguez, personal correspondence

Zoopharmacognosy can serve to remind us of

who we are
what we have lost
what we can regain

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