Not Every Herbalist is Human

How Animals Use Medicinal Plants in the Wild

Richard Mandelbaum RH

richardmandelbaum.com

What is Zoopharmacognosy?

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**.

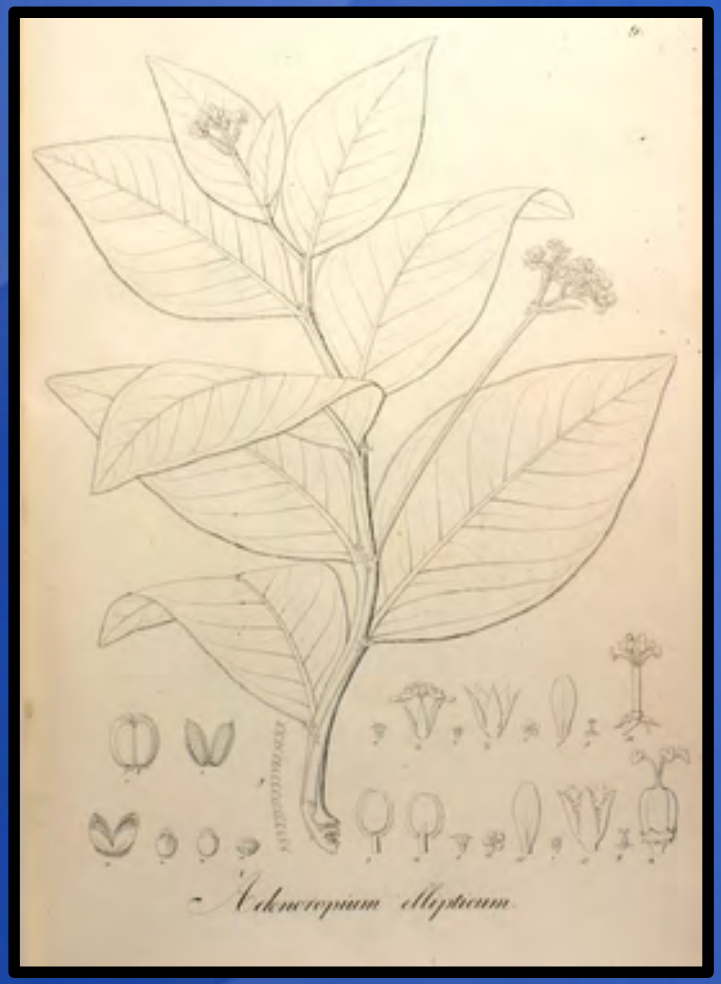
This is distinct from ethnoveterinary or traditional veterinary uses of herbs, although one can and should inform the other.

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

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.

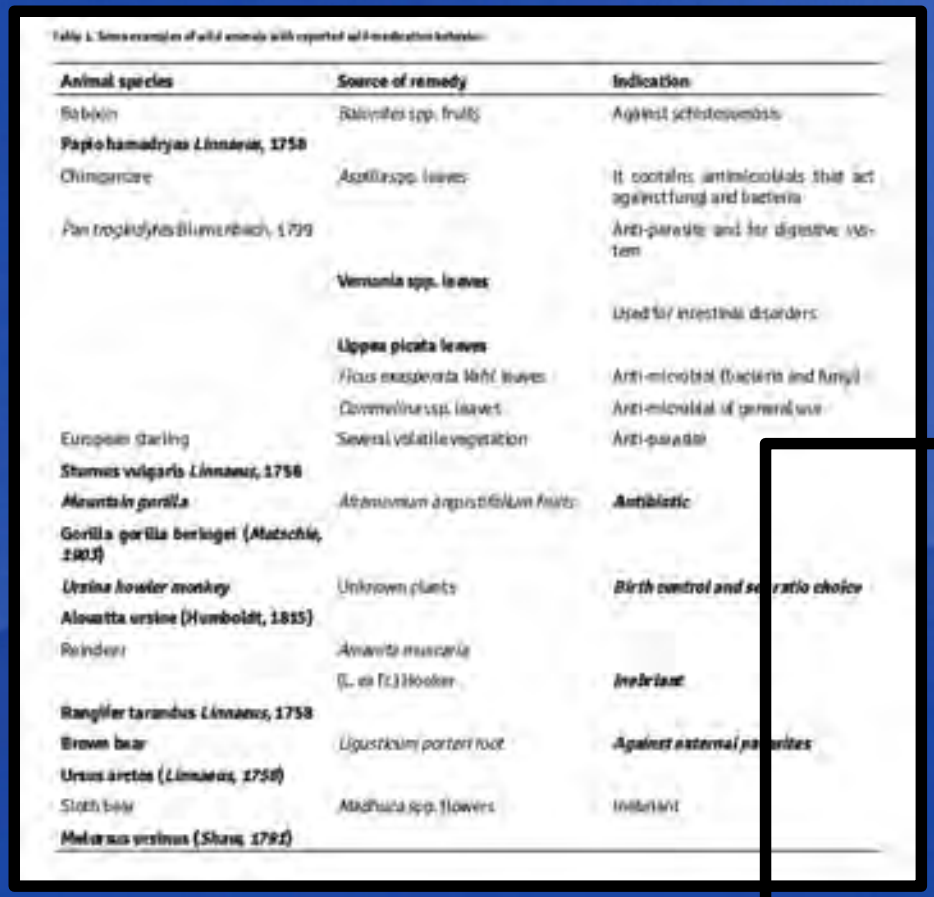
Costa-Neto 2012



“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

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



Animal species	Source of remedy	Indication
Baboon	*Balanites* spp. fruits	Against schistosomiasis
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 spp. leaves	Anti-microbial of general use
European starling	Several volatile vegetation	Anti-parasite
Sturnus vulgaris *Linnaeus*, 1758		
Mountain gorilla	*Atractocarpus angustifolium* fruits	***Antibiotic***
Gorilla gorilla beringei (*Matschie*, 1903)		
Ursine howler monkey	Unknown plants	***Birth control and sexual 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, Huffman 2003

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

-Biser 1998

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

Cousins, Huffman 2002

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

And periodically migrate to higher altitude and there consume *Lobelia* and *Senecio spp.*, genera which include established respiratory remedies.

Cousins, Huffman 2002

Photos CCSA Virunga National Park

“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.

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

Intelligence

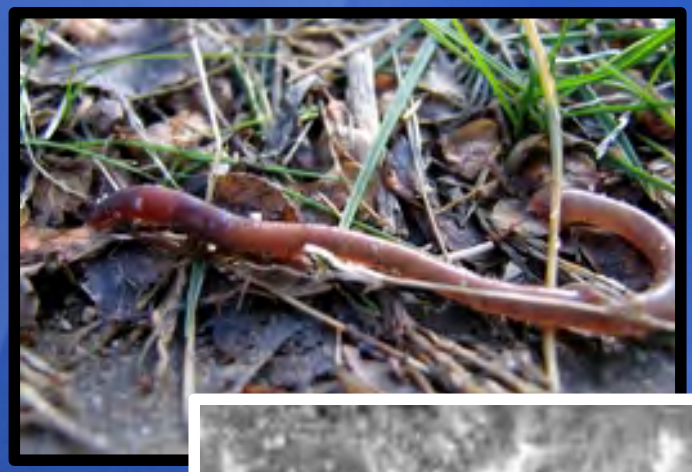
(1) : the ability to learn or understand or to deal with new or trying situations: reason; also: the skilled use of reason

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

Merriam Webster

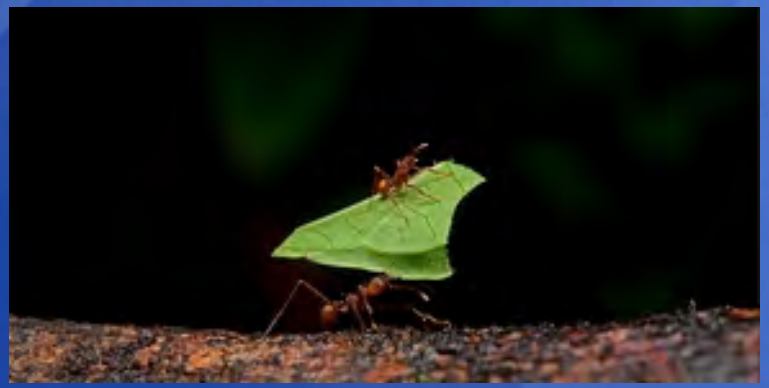
But some degree of intelligence appears…a result which has surprised me more than anything else in regard to worms.

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



Mushroom Cultivation: 50 million years old

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



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

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

2 July 2018, updated 6 July 2018

By Colin Barras

The capuchins have been seen using rocks as tools

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

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

If we run out of time you can check out Snowball dancing here:
https://www.youtube.com/watch?v=cJOZp2ZftCw&t=151s

Rats dance too!

(at least to Mozart piano sonatas)

Spontaneous beat synchronization in rats: Neural dynamics and motor entrainment, Ito et al., Sci. Adv. 8, eabo7019 (2022)

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

Bees 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

And they play…

Dona et al., Do bumble bees play? Animal Behaviour
Volume 194, December 2022, Pages 239-251

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

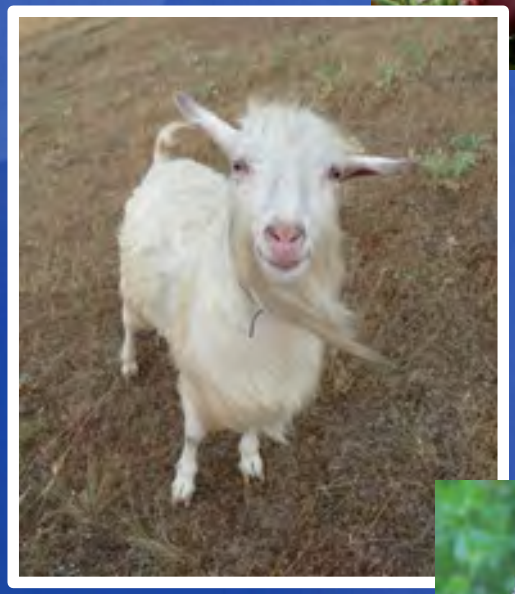
In a rarely seen phenomenon in the simian world, a nine-year-old female known as Yakei has become the boss of a 677-strong troop of Japanese macaque monkeys at a nature reserve on the island of Kyushu in Japan.

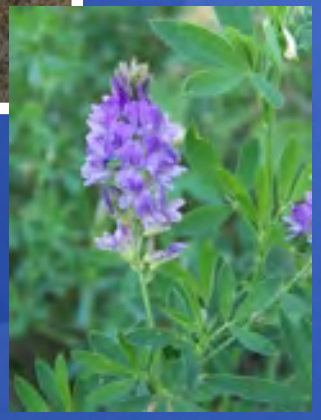
https://www.theguardian.com/world/2021/aug/03/macaques-at-japan-reserve-get-first-alpha-female-in-70-year-history

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)





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)

*"...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.*

-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)

*"Recent research suggests that the **mother may greatly influence her offsprings' dietary habits.**"* Provenza & Balph

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

Cousins, Huffman 2002

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

Organoleptic Skills

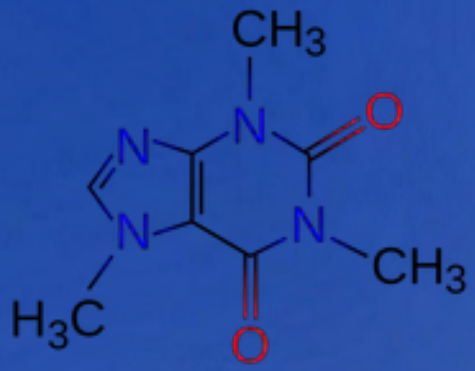
Animals (including humans) can in some cases infer the nutritional, toxic, and potentially medicinal activity of a plant.

"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



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.

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

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

"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

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

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

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.

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.

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

Birds

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

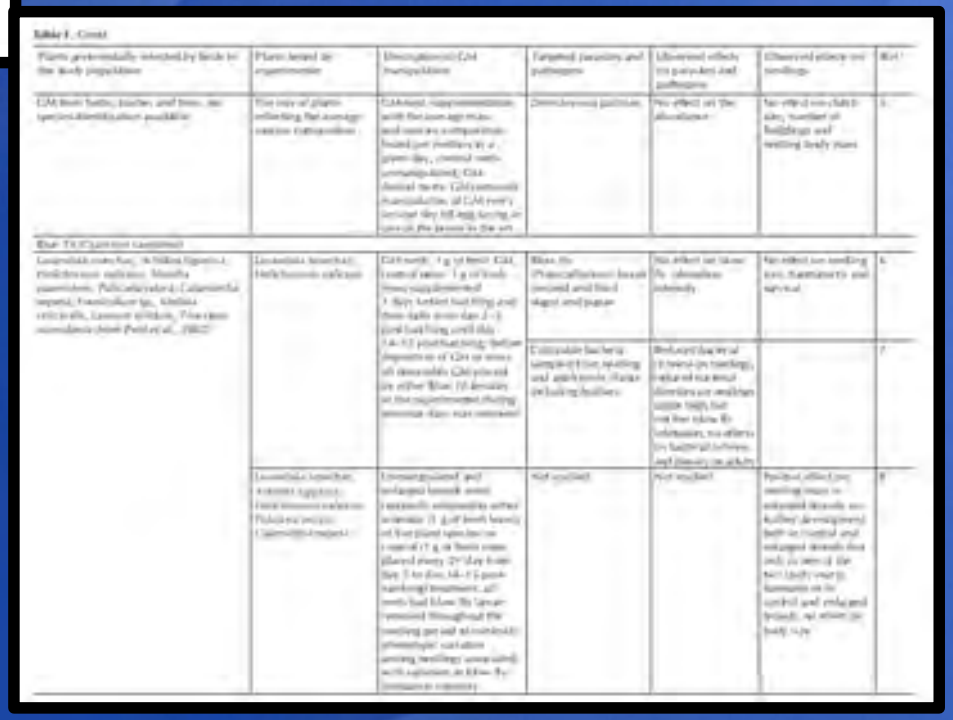
Gwinner 2012

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



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

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

Topical Uses of Herbs: Fur Rubbing

- Apes, monkeys, birds, and other spp. will rub their fur or plumage with plant material, or in some cases, insects that are high in antimicrobial constituents. (Clayton, Wolfe 1993)
- Plants observed include: *Citrus, Clematis, Piper spp.*
- Capuchin monkeys rub millipedes into their fur.

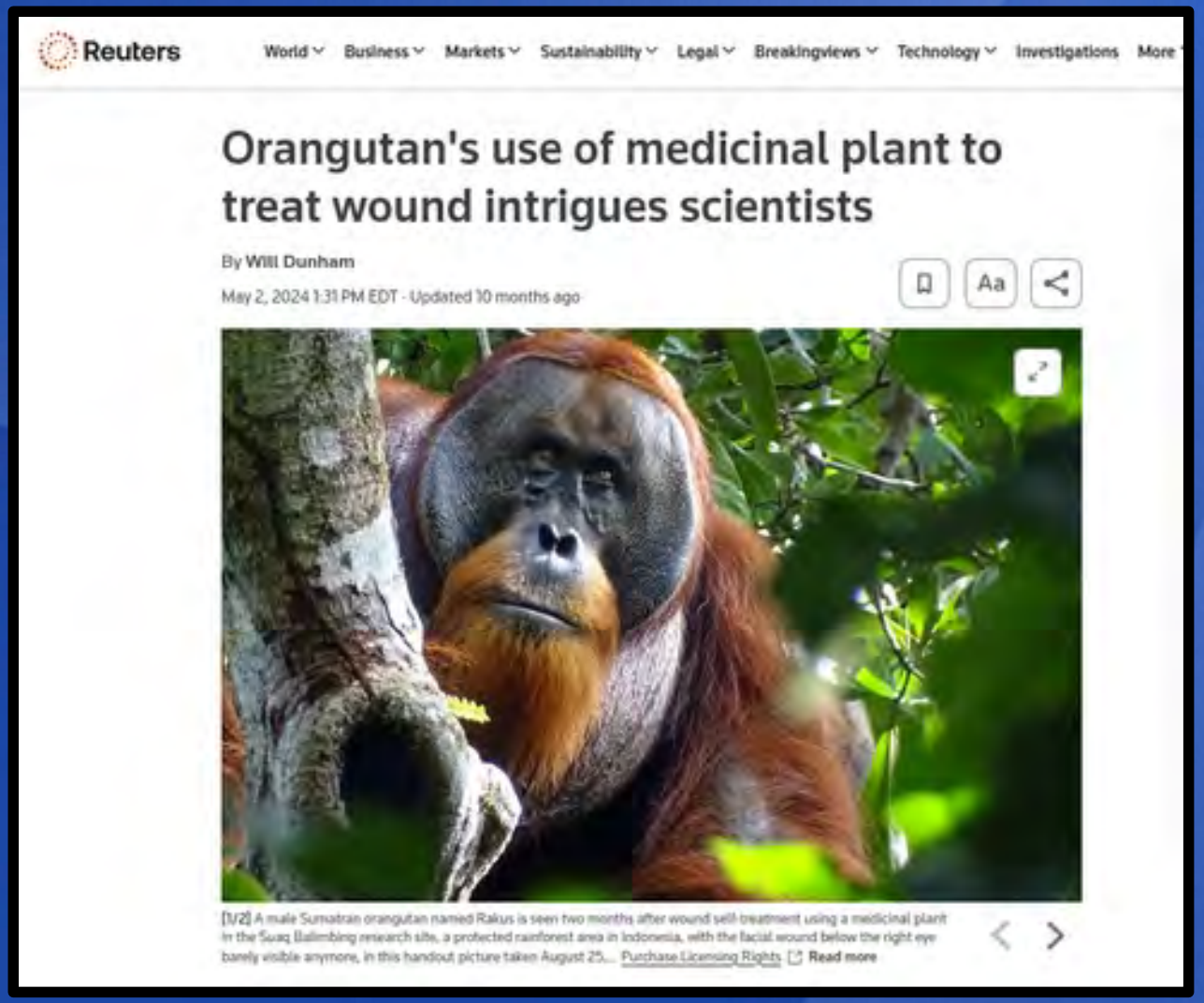
[Biser 1998 (and many others)]

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.

...May 2024...



Reuters

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Orangutan's use of medicinal plant to treat wound intrigues scientists

By Will Dunham

May 2, 2024 1:31 PM EDT · Updated 10 months ago

Aa

[1/2] A male Sumatran orangutan named Rakus is seen two months after wound self-treatment using a medicinal plant in the Suaq Balimbing research site, a protected rainforest area in Indonesia, with the facial wound below the right eye barely visible anymore, in this handout picture taken August 25... Purchase Licensing Rights Read more

Laumer, I.B., Rahman, A., Rahmaeti, T. et al. Active self-treatment of a facial wound with a biologically active plant by a male Sumatran orangutan. Sci Rep 14, 8932 (2024). https://doi.org/10.1038/s41598-024-58988-7

Left: Pictures of *Fibraurea tinctoria* leaves. The length of the leaves is between 15 to 17 cm. Right: Rakus feeding on *Fibraurea tinctoria* leaves (photo taken on June 26, the day after applying the plant mesh to the wound).

“Three days after the injury he selectively ripped off leaves of a liana with the common name Akar Kuning (Fibraurea tinctoria), chewed on them, and then repeatedly applied the resulting juice onto the facial wound. As a last step, he fully covered the wound with the chewed leaves.”

Before and After (approximately one month)

As forms of active wound treatment are not just a human universal but can also be found in both African and Asian great apes, it is possible that there exists a common underlying mechanism for the recognition and application of substances with medical or functional properties to wounds and ***that our last common ancestor already showed similar forms of ointment behavior***.

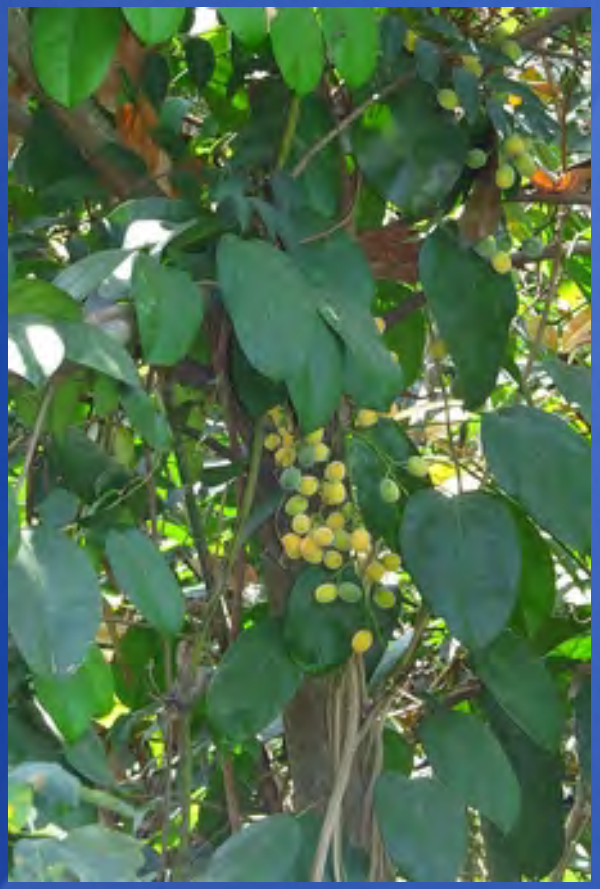
Laumer, I.B., Rahman, A., Rahmaeti, T. et al. Active self-treatment of a facial wound with a biologically active plant by a male Sumatran orangutan. Sci Rep 14, 8932 (2024). https://doi.org/10.1038/s41598-024-58988-7

Fibraurea tinctoria, Akar Kuning

traditional medicine throughout South and Southeast Asia

Assam, Borneo, Cambodia, India, Jawa, Laos, Malaya, Myanmar, Nicobar Is., Philippines, Sulawesi, Sumatera, Thailand, Vietnam

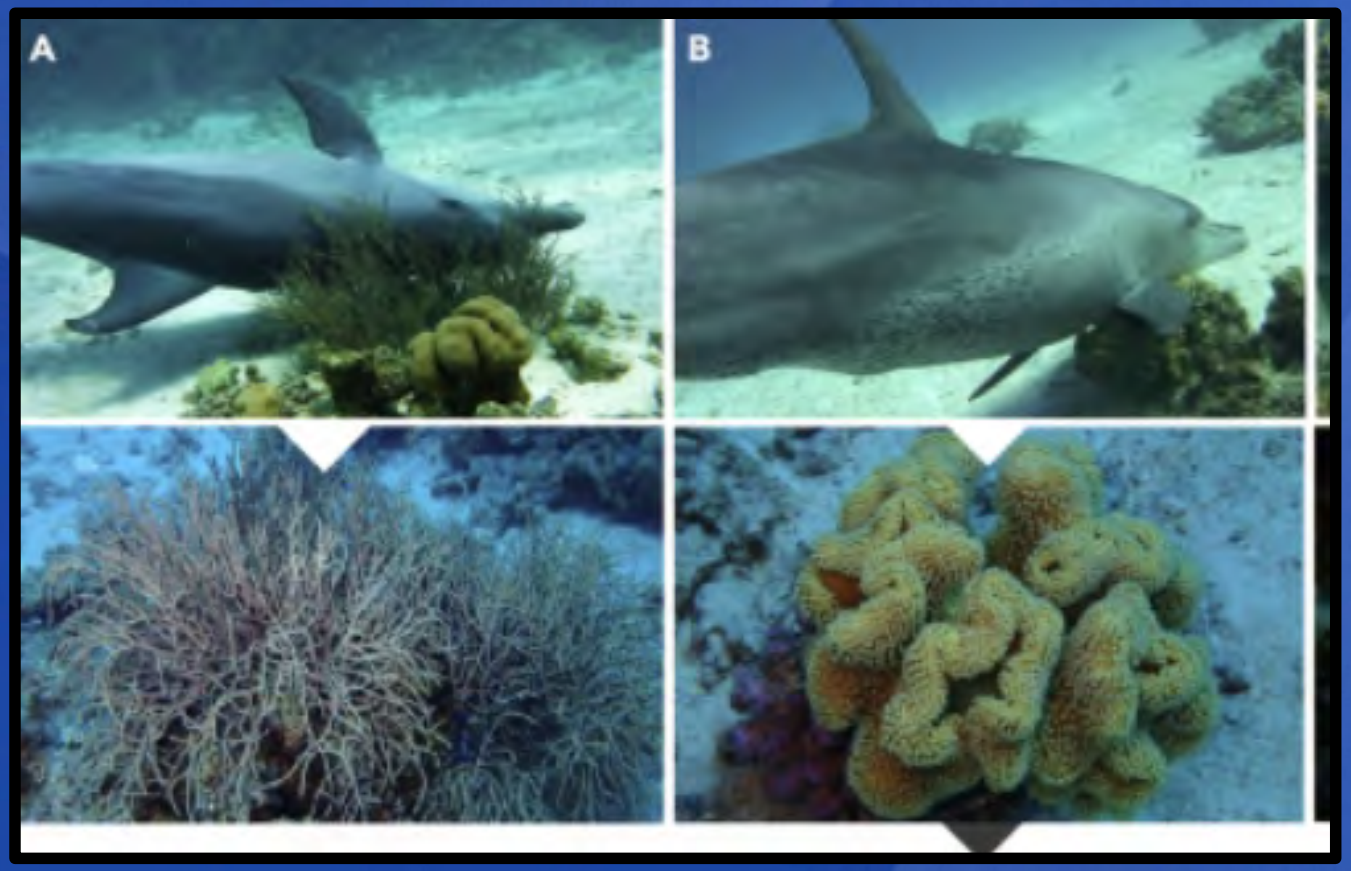
Rich in protoberberine alkaloids, furanoditerpenoids, and other compounds exhibiting a strong antibacterial, analgesic, and anti-inflammatory activity. Also strong antimalarial activity.



Dolphins use topical medicine too

(in this case, coral to prevent pathogenic dermal disease)

Morlock et al., Evidence that Indo-Pacific bottlenose dolphins self-medicate with invertebrates in coral reefs, iScience, Volume 25, ISSUE 6, 104271, June 17, 2022



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****.*

“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