Zoopharmacognosy:

The medicinal use of plants by Chimpanzees in the wild

By Justine Dodds 1404/E

Introduction

'Zoopharmacognosy' was coined to describe the process by which wild animals select and use specific plants with medicinal properties for the treatment and prevention of disease." *(C)*

Zoopharmacognosy is a relatively new field of study, so there is as yet no exhaustive body of research on the topic. To date there has been one book published on this phenomenon.

----o----

Background

Potential medicinal plants for wild chimpanzees have been studied in order to discover their physiologically active compounds.

Tests of the physiological activity of the plant species—*Vernonia amygdalina* and *Aspilia mossambicensis*—indicate that they contain a variety of active compounds.

For example, *Vermonia amygdalina* was found to contain an anti-tumour agent and two possible anti-tumour promoters. Furthermore, steroid glucosides were isolated as the bitter substances; which coined the phrase "Bitter pith chewing".

Parasite study identified nematodes, trematodes and protozoa as chimpanzee parasites.
The strongyle nematode species *Oesophagosotmum stephanostomum* is largely responsible for when these medicinal plants are most frequently used by chimpanzees.

Plant biochemistry has been studied for many years but it is only recently that the medicinal effects on chimpanzees has been brought to fore. Plants contain secondary compounds which are toxic if consumed in large dose. However if the appropriate dose is taken they can provide many medicinal effects.

----o----

Plant Species & Method of Ingestion:-

Two plants species and thus methods will be studied:

- Bitter pith chewing of the *Vernonia Amygdalina*)
- Whole leaf-swallowing of the *Aspilia mossambicensis*)

- Method of Ingestion: *Bitter pith chewing*

Vernonia amygdalina is a shrub or small tree of 2 – 5 m with petiolate leaf of about 6mm diameter and has an elliptical shape. The leaves are green with a characteristic odour and a bitter taste. In general it has been found, to have an astringent taste, which affects its intake. The pith has a **chemical** effect due to the anti-nutritional chemical compounds such as alkaloids, saponins, tannins and glycosides. These compounds along with the aforementioned glucosides are responsible for the bitter taste.

It is not a regular part of the chimpanzee diet, and when it is eaten, it is often in small amounts by chimps that appear ill. For this reason it was brought to the attention of researchers that this choice of food could be for a medicinal effect rather than a nutritional one.

It in the Asteraceae family *(i)*, with a similar distribution to that of *Aspilia Mossambicensis.*

Its sesquiterpene lactones have demonstrated anti-tumour activity, and the *Vernonia* chemicals (vernoniosides) of the pith have proven effective against drug-resistant malarial parasites, which are very common within the range of this plant. *(C)*

- Plant Species: *Vernonia amygdalina*

To obtain optimum benefits from the Vernonia plant chimpanzees carefully remove the outer bark and leaves from young shoots, to expose the inner pith, and then proceed to suck out the extremely bitter juice. After feasting on these unappetising piths, the effects seem to increase strength and appetite, recover from constipation or diarrhoea due to the decreased number of parasites.

Much like the labour-inducing effects that African elephants seek out, interestingly, these natural-borne remedies are used across Africa by many of the traditional human cultures. It has a **physical** purging effect. The benefit of bitter pith chewing is pharmacologically based on the activity of steroid glucosides. *(C)*

An entirely new class of compounds was discovered from the pith, one of which, vernonioside B1, was found to possess antiparasitic, antitumour, and antibacterial properties.*(B)*

The leaves contain copius amounts of a certain class of poisonous compounds, found only in the pith. Whilst this method of self-medication seems flawlessly beneficial due to the substances being anti-parasitic, they are likely to be toxic to the chimps.

(Inset: Chimp eating Vernonia amygdalina)

Vernonia amygdalina has more than 25 known medicinal uses among the people of Sub-Saharan Africa, and about half of these are for intestinal and parasitic ailments.

---o---

- Method of Ingestion: *Whole-Leaf Swallowing*

Aspilia mossambicensis is a perennial herb or shrub 10–250cm high, with a single or many stems from short rootstock with numerous fibrous roots and stiff branching; stems often reddish or purple near base. The leaves are sessile and narrowly elliptical.

It is in the Asteraceae family *(i)*, and its distribution includes tropical America, Africa, and Madagascar. Although leaf swallowing basically results in the physical removal of intestinal worms, additional research into the chemical composition of *Aspirin's* parts other than the leaves has indicated the production of a red oil called *thiarubrine-A.* This chemical has been found to inhibit the growth of many disease-causing agents, specifically parasitic worms, micro-organisms, and other intestinal parasites.

- Plant Species: *Aspilia mossambicensis*

When chimpanzees seek out the Aspilia plant to ease their discomfort they carefully use their lips to carefully discard the leaves one by one and draw it into their mouths with their tongue. The course hairs lining the leaf curl up and it is swallowed whole with no mastication. After passing through the intestinal tract they are relinquished undigested in the faeces. By ingesting them this way it enables the removal of adult worms that are adhered to the lining of the gut. *(B)*

This method of self-medication is seen mostly at the beginning of the rainy season when nodular worm infestation starts to increase and apes can swallow from one to a hundred leaves in one bout. Symptoms of nodule worm infestation include diarrhoea, malaise, and abdominal pain.

Various other species of worms including whip worms amongst others burrow into the lining of the intestinal tract, providing themselves with enough protection to escape the scraping motions of the course, hairy Aspilia leaves. The rough leaves also stimulate the bowel which stimulates peristalsis and movement of matter through the gut; namely the unwelcome worms. It also can cause diarrhoea which is an effective way of shedding larvae, worms and potentially their toxins from the body. Furthermore, when adult worms are removed from the gut, larvae emerge from the tissues thereby rapidly relieving more general feelings of ill-health. This instant ease in discomfort is the most likely cause of the chimps following this leaf swallowing self-medication behaviour. *(D)*

Mechanism:

One analysis showed *Aspilia* leaves to contain a bright red oil known as thiarubrine-A, a compound clinically proven to kill parasites, viruses, fungi, and bacteria. However, all other attempts to find thiarubrine-A in the leaves of *Aspilia,* or any other plant species swallowed, have failed. It is of more general consensus that leaf swallowing gets rid of worms by the physical hairs on the leaves sticking like Velcro the worms scraping them through the gastrointestinal tract, eventually to be excreted by the body. Chemicals in the plant may also decrease the ability of the parasites to adhere to the intestine, making it easier for them to be swept out by the leaves. *(Biser, A Jennifer, (3))*

- *Dirt Eating*

Chimps eat dirt. This has been known for years. Geophagy is the practice of eating soil-like substances such as clay and chalk, in order to obtain essential nutrients, occurs widely among many primates. *(A) Chimps eat dirt to boost the anti-malarial properties of certain plants.*

Clay soils consumed by chimps in various regions of Uganda contain the clay mineral kaolinite. This mineral is also used in diarrhoea medicines.

Trichilia rubescens is another plant species also undergoing research for its role in self-medication of chimps. It is known to have anti-plasmodium activity. After being studied it was noted that when eaten alone, the leaves had no apparent pharmacological effect, but when mixed with clay soil the mixture displayed some evident anti-malarial properties.

The chemicals that work to defend against malaria are only activated when fine soil particles bind with chemicals in the leaves. Due to chemical structure and physical properties clay works as an effective binding agent. This allows other chemicals to bond with it and thus lose

their reactivity. Clay is an effective deactivator of toxins from diet or pathogens and is the primary ingredient of the kaolin. *(7)*

Other self-medicating primates include:

- *Charcoal eating in Red colobus monkey*

Red colobus monkeys *(Procolobus pennantii kirkii)* on Zanzibar Island, Tanzania, prefer leaves of the exotic Indian almond and mango trees. Abundant in the monkeys' habitat, these trees yield leaves high in protein. However, they're also high in secondary compounds called phenols, which interfere with digestion. They counteract this toxicity by eating charcoal because charcoal has a high adsorptive capacity for phenols. The toxic phenols stick to the charcoal, whilst allowing proteins to remain free from absorption by the digestive tract. *(3)*

- *Fur-Rubbing in capuchin monkeys*

White-faced capuchin monkeys *(Cebus capucinus)* are known to crack open the fruits of certain citrus plants, and rub the pulp and juice into their fur. This remedies skin irritations while concurrently acting as an insect repellent. Their self-medicative behaviour increases when temperature and humidity rise.

----o----

Conclusion

It is clear there has been an adaptive significance of self-medication in the wild. Chimpanzees live in tropical environment where the threat of re-infection is undeniable. The monsoon season brings with it a vast range of parasitic species and chimpanzees have found ways to control these outbreaks without creating resistance to the chemicals in plants. Plants eaten on a regular basis most likely do not contain highly active secondary compounds. It is only when the chimpanzees displayed irregular feeding habits that these plants came under scrutiny.

Whether it be chimpanzees selectively ingesting plants in ways that lead to the seasonal expulsion of certain parasites, the use of clay as a treatment for gastrointestinal distress, or the seeking out of labour inducing plant species *(from the Boraginaceous family)* in African elephants, the complexity of animal, parasite, and plant interactions cannot be denied. Study of these interactions in the context of self-medication may provide a new level of complexity to our understanding of animal behavioural ecology.

BIBLIOGRAPHY

JOURNALS:

(A) L.A Ketch, D. Malloch, W.C Mahaney, M.A Huffman.
Comparitive microbial analysis and clay mineralogy of soils eaten by chimpanzees *(Pan troglodytes schweinfurthii)* in Tanzania.
Soil Biology & Biochemistry 33 (2001) 199-203.

(B) Sabrina Krief, Claude Marcel Hladik, Claudie Haxaire (2005).
Ethnomedicinal and bioactive properties of plants ingested by wild chimpanzees in Uganda.
Journal of Ethnopharmacology 101 (2005) 1-15.

(C) Sabrina Krief, Marie-Therese Martin, Philippe Grellier, John Kasenene and Thierry Sevenet.
Novel antimalarial compounds isolated in a survey of self-medicative behaviour of wild chimpanzees in Uganda.
Antomicrobial agents & Chemotherapy, Aug. 2004.

(D) Scott Buchanan
Zoopharmacognosy: Animal self-medication. Apr. 2002.
http://www.colostate.edu/Depts/Entomology/courses/en570/papers_2002/buchanan.htm

WEBSITES:

(1) Do humans and chimpanzees share a natural medicine? From scientific to local knowledge in Kanyawara, Uganda
http://www.behav.org/IEC/default.php?proc=search&search=a_num&id=499

(2) Chemo-ethology of Hominoid Interactions with Medicinal Plants and Parasites
http://jinrui.zool.kyoto-u.ac.jp/CHIMPP/CHIMPP.html

(3) Really Wild Remedies—Medicinal Plant Use by Animals
http://nationalzoo.si.edu/Publications/ZooGoer/1998/1/reallywildremedies.cfm

(4) African apes and ethnomedicine

http://www.berggorilla.org/English/gjournal/texte/25cousins.html

(5) Vernonia amygdalina

http://www.fao.org/ag/aga/AGAP/FRG/Visit/Ida/Vernonia%20amygdalina.htm

(6) Aspilia mossambicensis

http://www.aluka.org/action/showMetadata?doi=10.5555/AL.AP.FLORA.FTEA006598&pgs=&cookieSet=1

(7) DNApes: Chimps eat dirt, Leave to fend off malaria

http://dnapes.blogspot.com/

Abstract-only Online Journals:

D. COUSINS (2006). Review of the use of herb gardens and medicinal plants in primate exhibits in zoos.
International Zoo Yearbook 40 (1) . 341-350 doi:10.1111/j.1748-1090.2006.00341.x
http://www.blackwellsynergy.com/doi/abs/10.1111/j.17481090.2006.00341.x?cookieSet=1&journalCode=izy

Koichi Koshimizu[1] , Hajime Ohigashi[1], Michael A. Huffman[2], Toshisada Nishida[2] and Hiroyuki Takasaki.
Physiological activities and the active constituents of potentially medicinal plants used by wild chimpanzees of the Mahale mountains, Tanzani
http://www.springerlink.com/content/p350533247311068/

WEBSITE PORTALS:

http://pin.primate.wisc.edu/news/journals/journals.php

BOOKS:

(i) Applied Botany: for Veterinary Students

Zsuzsanna Horvath, Janos Vetter