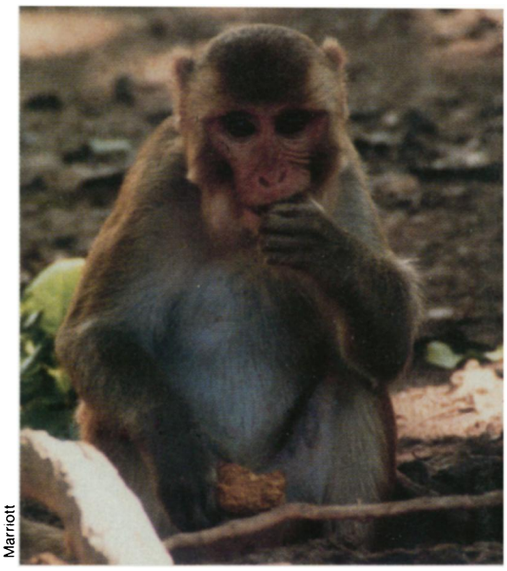
Medicine on the Wild Side

Animals may rely on a natural pharmacy

By RON COWEN



Marriott

A rhesus monkey in a research colony on Cayo Santiago holds a handful of chow provided by scientists while eating a handful of dirt it has dug from beneath the topsoil. In addition to providing essential minerals, the soil particles may act like a charcoal filter during digestion, absorbing poisons from some of the plants the monkeys commonly eat.

Her symptoms read like a classic hospital chart: lethargy, loss of appetite, darkened urine, bowel irregularity. No doubt about it, this was one sick chimp.

The patient, known simply as "CH" to her human observers, lay on the ground or napped in a tree nest from time to time while her primate peers foraged for food. During most of these rest periods, another female chimp or CH's own infant son waited nearby, apparently watching over her.

A few hours after her illness began, CH started chomping on shoots of *Vernonia amygdalina,* a shrub native to her home in Tanzania's Mahale Mountains National Park but rarely eaten by any of the chimpanzees there. She sucked and swallowed the bitter juice from the macerated pith, spitting out the fibrous remains.

By the next afternoon, though still fatigued, CH had begun eating, defecating normally and foraging for longer periods without resting.

Was it mere coincidence that she had munched on *V. amygdalina* the day before recuperating?

Perhaps. But the fact that Mahale chimps rarely ingest this plant — also known as "bitter leaf" — strongly suggests she sought out the shrub for reasons other than sustenance, assert Michael A. Huffman of Kyoto University in Japan and Mohamedi Seifu of the Mahale Mountains Wildlife Research Center. Moreover, they say, studies have documented that African tribes use extracts from the plant's bark, stems, roots, seeds and leaves to treat a variety of human ailments — including intestinal upset and appetite loss — resembling CH's undiagnosed affliction.

The two primatologists suggest that ailing Mahale chimps turn to their local pharmacy — the plants that thrive in their habitat — for treatment.

Though their case study, detailed in the January 1989 PRIMATES, is one of the first to document a sick animal recovering after eating a plant with known medicinal properties, Huffman and Seifu note that other researchers have recounted many incidents in which animals appeared to use nature's medicine chest for health and healing. Indeed, recent reports describe monkeys that eat dirt as a possible detoxifier, birds that feast on bactericidal leaves, and a pregnant elephant that sought an unusual meal just before giving birth. Together, these observations point to a common theme: Some animals appear to doctor themselves, even to the extent of practicing preventive medicine.

Studies of animal self-medication may help confirm the wisdom of traditional cultures in which these same compounds have held therapeutic status for centuries, says Eloy Rodriguez, a plant chemist at the University of California, Irvine. And taking a medicinal cue from animals may be one way to identify potential drugs for humans, he and others suggest.

Rodriguez has already identified powerful pharmacological properties in another group of plants eaten by chimpanzees in Mahale and in Gombe National Park, about 100 miles apart.

He undertook the chemical analysis in collaboration with Harvard anthropologist Richard W. Wrangham, who had noted in 1983 that Gombe chimps occasionally dine on two species of shrubs belonging to the genus *Aspilia* (SN: 1/18/86, p.38). These plants, members of the sunflower family, have a long history as folk medicines in Tanzania. Wrangham observed that chimps consume *A. mossambicensis* and *A. pluriseta* in an uncharacteristic way: They pluck a single leaf at a time, swallowing it whole without chewing.

Six years ago, Rodriguez and others discovered a red, sulfur-containing oil in the leaves of these species. Now known as thiarurbrine-A, the oil kills disease-causing bacteria, fungi and parasitic worms, they found. And last month, at a symposium on natural products research in Oxford, Miss., Rodriguez reported that thiarurbrine-A shows as much anticancer activity in cultured human cervical cells as vincristine and vinblastine, standard chemotherapy agents derived from the periwinkle shrub (genus *Vinca*).

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, Rodriguez and Wrangham say. Whole leaves removed intact from chimpanzee dung show significantly lower levels of this compound than do uneaten leaves, Rodriguez finds. But both researchers caution that the notion of chimpanzees using these plants as medicine will remain speculative until scientists measure thiarurbrine-A concentrations in the blood of chimps that have eaten the leaves, and until studies demonstrate that this compound or some other *Aspilia* ingredient can improve animal health.

In a more recent field study, Wrangham observed that chimps at Uganda's Kibala Forest swallow whole leaves of another plant, *Rubia cordifolia.* Interviews with local residents revealed that Ugandans use this plant to treat upset stomachs, the anthropologist reports in *Understanding Chimpanzees* (Harvard University Press, 1989).

Evidence that plants may offer wild animals a cornucopia of pharmaceutical compounds should come as no surprise, says Kenneth E. Glander, a primatologist at Duke University in Durham, N.C. He points out that most plants defend themselves against insects and other predators with a batch of chemicals, known as secondary compounds, that have potent properties when ingested.

These substances, whose numbers in the plant kingdom may total more than 10,000, can elicit a wide variety of effects, says tropical ecologist Daniel H. Janzen of the University of Pennsylvania in Philadelphia. For example, secondary compounds called tannins bind to plant proteins, preventing predators from effectively digesting those nutrients, Janzen says. Others, such as cyanide and cardiac glycosides, can kill or interfere with heart rhythm.

And if animals choose wisely, says Glander, several secondary compounds may offer them some of the same antibacterial, antiparasitic or antifungal protection these chemicals confer upon plants.

"It's the difference between opening up your medicine chest and taking out cyanide or taking out Anacin," he explains. "It comes down to being able to detect these chemicals and select them, avoiding things that are toxic or inhibit digestion, and selecting things that are beneficial."

Glander says he has circumstantial evidence, based on two decades of field studies, suggesting that some mantled howling monkeys (*Alouatta palliata*) — a tree-dwelling species native to Costa Rica, Panama and Mexico — may use diet to dictate the gender of their offspring. He observed that some female howlers eat a collection of as-yet-unidentified plants before or after copulation but not at other times in the reproductive cycle. 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. He reported these findings in Kyoto last July at a meeting of the International Primatological Society.

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. Glander observed that most female howlers at the top or bottom of the colony's pecking order produced all male offspring. This may give the mothers a reproductive advantage, Glander says, because most offspring at the extremes of the pecking order get killed during infancy by other members of the colony, who view the low-ranking infants as easy targets and the high-ranking ones as future threats. When the few offspring that survive are male, the mother's genes have a greater chance of widespread perpetuation, Glander speculates.

To test the hypothesis, Glander and his colleagues are now measuring vaginal acidity and estrogen levels among Costa Rican howling monkeys. Later, they plan to investigate whether ingestion of particular plants can alter the vaginal pH in these animals.

The bizarre behavior of an elephant led another researcher to consider whether some pregnant animals seek out specific plants for medicinal use. Ecologist Holly T. Dublin spent nearly the entire year of 1975 tracking the daily comings and goings, including dietary habits, of a pregnant elephant at Tsavo Park in Kenya. (Elephant gestation lasts 20 to 22 months.) The 60-year-old expectant mom almost never varied her routine, walking about 5 kilometers a day in search of a standard mix of palate-pleasing bush plants.

But one day, the elephant marched toward a riverbank some 28 kilometers away and stopped in front of a small tree of the family Boraginaceae. This particular species, previously unlisted among the elephant's meal choices, was one Dublin had never seen before. The ecologist watched as her subject devoured the entire tree, leaving nothing but a stump. Four days later, back at the old stomping grounds, the elephant gave birth to a healthy baby.

Afterward, Dublin uncovered a provocative connection: Pregnant women in Kenya commonly brew a tea from the bark and leaves of the same tree to induce labor or abortion.

Though the elephant's tale remains a single, unpublished and inconclusive case report, Dublin told SCIENCE NEWS she suspects that some compound in the tree helped the mother to induce labor. Working with the World Wildlife Fund in Nairobi, she and her colleagues have recently begun analyzing chemicals from the tree.

At least one bird seems to view plants as a natural medicine cabinet, says Rodriguez, who recently began studying an avian oddity known as the hoatzin (SN: 10/21/89, p.269). This tropical species — the only bird known to digest its food in the manner of ruminant mammals, using specialized bacteria to break down plant fiber in a chamber above its stomach — eats a diet of 95 percent leaves.

While performing autopsy studies on the red-eyed, foul-smelling jungle birds in their native Venezuela, Rodriguez discovered that the adult hoatzin harbors remarkably few parasites or disease-causing bacteria. He speculates that the hoatzin's menu selections may somehow contribute to its apparent good health. The leafy diet includes many highly toxic plants, including members of the poison oak family, he notes.

In collaboration with researchers from the Venezuela Institute of Scientific Investigation in Caracas, Rodriguez plans to examine how the specialized bacteria in the hoatzin's foregut may serve to detoxify and exploit plant poisons, possibly by sequestering them for use as antiparasitic and antibacterial agents. A sequestering mechanism would differ from the standard detoxification schemes of other animals, such as the addition of a glucose molecule to a plant poison in the liver or kidneys to hasten its excretion in urine. Rodriguez emphasizes that the hoatzin's diet of leaves chiefly serves as a vital source of nutrition, but that it could also "play a dual role" involving pharmacological activity.

Among the 141 plant species eaten by a colony of rhesus monkeys on the Caribbean island of Cayo Santiago, about half have known medicinal uses in humans, says Bernadette M.

Black bear at Rocky Mountain Wildlife Park holds root of Ligusticum porteri. *The bear chewed the root and then rubbed the saliva-plant mixture on its fur. This behavior suggests that wild bears may use* L. porteri *as a topical insecticide or anti-parasitic agent — two of the many medicinal properties for which native peoples have long gathered the herb.*

Sigstedt

Marriott, a behavioral ecologist with Johns Hopkins University in Baltimore and the Institute of Medicine in Washington, D.C. But another taste displayed by rhesus monkeys leaves Marriott with a dirty story to tell.

Beginning in 1979, she and her coworkers spotted an unusual behavior among wild rhesus monkeys in Nepal as well as in research colonies at Cayo Santiago, near Puerto Rico, and Morgan Island, off the coast of South Carolina. These monkeys ate dirt.

"It was really odd at first. I couldn't believe it," Marriott recalls. "I thought, 'Well, they're getting insects, or they're eating roots in the soil.' But in fact, it's the soil itself they're eating."

Along riverbeds, near excavation sites and in fields, she saw monkeys digging and eating. Some dug little caves used by successive generations of monkeys; a few of the caves were big enough for a monkey to sit inside while dining on dirt. "They dig with their tiny little fingers, just scraping away," says Marriott, who reported her observations in June at a meeting of the American Society of Primatologists in Davis, Calif.

Virtually all of the digging takes place in areas where the soil has a high mineral content, Marriott notes. But she says evidence from an X-ray crystallography study and documentation of human soil eating – a practice known as geophagy – indicates that, in addition to its nutritional benefits, the primate penchant for soil may have a more medicinal function.

Certain clay soils contain a high concentration of kaolin, the active ingredient in the antidiarrheal medication Kaopectate, according to a report in the Feb. 8, 1985 SCIENCE by Donald E. Vermeer of George Washington University in Washington, D.C. In addition, Marriott and Vermeer point out, anecdotal and research reports from around the world indicate that some people who, like the monkeys, eat certain forms of Type B soil (the layer beneath topsoil, containing few organic compounds) regard it as a stomach settler.

In western Bolivia, for instance, people traditionally slather a slurry of soil on the skin of certain bitter-tasting potatoes before eating them, according to a report in the March 1986 JOURNAL OF CHEMICAL ECOLOGY by chemical ecologist Timothy Johns, now at McGill University's MacDonald College in Saint Anne de Bellevue, Quebec. Johns says the slurry apparently offers protection from glycoalkaloids, secondary compounds in the potato skin that could otherwise cause illness.

He adds that the Navajo, Hopi, Zuni and Keres tribes in northern Mexico and the U.S. Southwest also use clays (called "potato clays" by the Hopi) to protect against toxins in the skin of wild potatoes. And in a report to be published in ECOLOGY OF FOOD AND NUTRITION, Johns and Martin Duquette of McGill describe their laboratory simulation of an unusual culinary tradition of the Pomo tribe in California, showing that clay added to acorns during cooking binds and breaks down bitter-tasting tannins from the seeds, thus preventing a possible bellyache.

Marriott says such reports suggest that the dirt eaten by rhesus monkeys, while serving primarily as a way of obtaining adequate nutrition, may also function as a detoxifier. The large surface area of many soil particles, particularly clays, as well as their negative electrical charge, may enable them to bind up poisonous secondary compounds unwittingly ingested as the monkeys munch on plants. Even rhesus monkeys fed a nutritious diet in the research colonies still eat dirt, she points out.

She and her colleagues plan to analyze the feces of dirt-eating rhesus monkeys to determine what materials in the soil might benefit the animals. Marriott stresses that the soil's role in the body appears highly complex. Some researchers argue that the ability to bind toxins may also enable some soils to tie up desired nutrients, preventing their use in the body. J. Cecil Smith, a biochemist at USDA's Human Nutrition Research Center in Beltsville, Md., calls these opposing actions of soil "a Jekyll and Hyde" phenomenon that remains poorly understood.

Rodriguez

Tanzanian chimpanzees occasionally swallow whole leaves of Aspilia mossambicensis, *a member of the sunflower family.* In vitro *tests show that the leaves contain a red oil, called thiarurbrine-A, that kills bacteria, fungi, parasitic worms and certain cancer cells.*

Ethnobotanist Shawn V. Sigstedt injects a bear story into the tales of animal self-medication. For centuries, humans have used preparations of the plant genus *Ligusticum* as medicines, says Sigstedt, a graduate student at Harvard University. In China, India, Mexico and the U.S. Southwest, traditional uses for various species of this plant have included antibacterial agents, dewormers, insecticides and treatments for upset stomach and rheumatism. More recently, researchers have derived from the plants a host of anticoagulant compounds known as coumarins, which have been widely prescribed for patients suffering heart disease and stroke.

In the late 1970s, after seven years spent living with a Navajo family and learning about traditional tribal medicines, Sigstedt began to investigate the American Indian folklore behind *Ligusticum.* A legend holds that The Bear gave Native Americans these plants; their Navajo name means "bear medicine," Sigstedt notes.

Now, he says his own observations of captive bears, together with anecdotal reports of wild bear behavior, suggest a biological basis for the legend.

Sigstedt focused on *Ligusticum porteri,* a vanilla-celery-scented herb growing in the Rocky Mountains and the Southwest, among other regions. He gave samples of the herb's root to groups of caged polar and grizzly bears in Colorado. 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, he says.

Sigstedt maintains that his findings, while inconclusive, are consistent with the plant's recorded use as an insecticide and antiparasitic agent. He adds that reports of bear scat and bear pawprints at patches of *L. porteri* in the Rockies suggest that tribes in the Southwest – where the plant is locally endangered – face some formidable competition for their "bear medicine." Sigstedt reported on his work in Tempe, Ariz., last March at the annual meeting of the Society of Ethnobiology.

For now, the evidence linking animals to medicinal compounds in nature remains tentative. "All of this is hypothesis," says Glander. "We really don't know the outcome of some of these apparent associations."

As researchers in this field begin to test their theories more rigorously, they may strengthen or discard some of the weaker links. Wrangham, for instance, plans a full-scale study assessing the Gombe chimps' health and the effect of *Aspilia* plants, and Huffman has already embarked on a similar project in Mahale. Next year, Wrangham plans to monitor the behavior of free-roaming chimpanzees who will receive the plants at the Detroit Zoo.

Whatever their outcome, such investigations represent far more than Dr. Dolittle curiosity.

As Janzen puts it, "If you can 'talk' to animals – understand their 'language' by observing what they eat and what they don't," you can begin to unlock a storehouse of pharmacological compounds still awaiting discovery by humans. □