Leaf Litter

The Magazine of Tree Walkers International and Amphibian Conservation

SPRING 2007

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The Magazine of Tree Walkers International

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MISSION STATEMENT

Tree Walkers International supports the protection, conservation, and restoration of wild amphibian populations through hands-on action both locally and internationally.

We foster personal relationships between people and nature by providing opportunities for citizens of all ages to become directly involved in global amphibian conservation.

Through this involvement, our volunteers become part of a growing and passionate advocacy for the protection and restoration of wild amphibian populations and the environment on which they depend.

Tree Walkers Internationa
www.treewalkers.org

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Director's Welcome

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A 500–Year Plan

What if we were to plan not for just the next year, but were looking at amphibian conservation for the next 500 years? If we look at the natural state of the world of 500 years ago and compare it with today, we have reason to be both optimistic and pessimistic.

It is a fascinating, exciting time for discovery in the global amphibian community. The Internet makes it possible to see the striking image of a red-headed fantasticus while next-day air delivery makes delivery of wonderful animals to our doorstep from across the world a reality. However, this interconnectedness must not cloud the real and significant challenges we face today nor give us a false sense of accomplishment or obscure the fact that, in our own backyards, amphibian habitat is often lost to development and that many of our native species are under a variety of threats.

It is our responsibility as conservationists from throughout the commercial, private, and scientific sectors to come together and, one year at a time, work toward a long term goal that meshes the interests of our diverse membership and brings us together to protect amphibians and conserve their habitats not just for now, but for millennia.

I am confident that Tree Walkers International stands at the vanguard of a holistic conservation approach that does not care if you are a zoo keeper or basement frog keeper, but instead leverages a common love for amphibians and their natural environment. While I cannot guarantee that we will be around as an organization in 2507, I look forward to working with all of you for as long as we are needed.

Sincerely,

Marcos Osorno
Executive Director

Operation Atelopus

photo: Michael Ready

From southern Mexico to the tip of South America, a massive extinction is taking place due to disease, habitat loss, and global climate change. The world has not seen an event like this since the die-out of the dinosaurs.

The aim of Operation Atelopus is to tell the tale of one such group of animals through film, a species teetering on the brink of extinction, the Neotropical toad genus, Atelopus.

an official project of Tree Walkers International

www.atelopus.org

VOLUME 1 NUMBER 1

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ABOVE Epipedobates silverstonei
Photograph by Jason L. Brown

FRONT COVER one of the most frequently encountered toads on the forest floor, Bufo margaritifer.
Photograph by Tim Paine.

Field Notes

Silverstone's Poison Frog, *Epipedobates silverstonei*

by Justin Yeager

Epipedobates silverstonei is one of a small group of Dendrobatids that is fairly common in the terrarium hobby but relatively unknown in the field. The region of the Cordillera Azul where it is found is traditionally known for having an active drug (cocaine) trade and, therefore, has the well-earned reputation for being unstable and often dangerous. There are frequent muggings on even the major roads into and out of the region. Fortunately, we avoided any unpleasant encounters but did hear of two drug patrol officers being shot and their car torched, as well as a taxi driver being tied up, beaten, and his car stolen. Upon hearing all this I must say I was a bit uncomfortable, but yet I was very eager to begin looking. Our agenda not only included *E. silverstonei* but also a form of *Dendrobates lamasi*, which we referred to as the X-backed form (PB-050 in Rainer Schulte's book, Pfeilgiftfrosche "Artenteil-Peru").

E. silverstonei was first described by Myers and Daly in 1979. They speak of how it was originally discovered in the 1940s during the construction of a road crossing the Cordillera Azul. A color photograph of *E. silverstonei* was even used in Cochran's *Living Amphibians of the World*, which helped propel their popularity. This same road is still the route of choice to enter their habitat. While *E. silverstonei* is known mainly from one region in the Cordillera Azul, some biologists working in other parts of the Cordillera have also encountered specimens. All reports that we have heard for *E. silverstonei*

still fit within the originally described elevation of 1,300 meters or more, thus making it a highland species. Our experiences, and those shared by people from the region, put it most common around 1,600 meters elevation, with a maximum elevation of approximately 1,640 meters (holotype was found at 1,330 meters).

Evan Twomey, Enrique (Kike) Rodriguez, and I set out from Tarapoto by private car towards the nearest city to the type habitat. We stayed in the city, venturing into the mountains each morning as early as it was safe to leave. Our driver insisted the region was safe enough for travel provided we adhere to a strict day-only travel routine. Evidently, the zone where *E. silverstonei* is found is too high in elevation for optimum cocaine crops, so the upper regions of the mountains are significantly safer than the zone around 800 meters elevation. The only immediate danger in the upper elevation zones is when the drugs are being transported from one region to another. These transports travel only by the safety of darkness at night, so it permits some "cease fire" time during daylight for safe passage and searching.

The forest in the area is, for the most part, intact. A friend we made in a small village at the crest told us that the people were generally unaccustomed to doing large amounts of physical labor, so they have not cleared much of the land for pastures. The regions that were cleared for pasture house sheep and some cattle. The forest is generally comprised of small trees and bamboos, all of which are covered in mosses. The vegetation is thick, not very tall growing, and is difficult to maneuver through. Orchids and many epiphytic plants (bromeliads included) are abundant.

Small streams and waterfalls also grace the landscape at regular intervals and provide added moisture to the area. Locals said that the region is perhaps the second wettest in all of Peru — a combination of cloud cover, fog, and regular rains contributing to the title. Due to the elevation at which we were working, we were able to see much of the mountain range. From clearings on trails that we hiked, it was possible to see the massive mountains of the Cordillera Azul. In fact, the reason for the name Cordillera Azul also became clear to me one day overlooking the hills: as the clouds descend down from the tops of the mountains, it turns the lush tree-covered hills a beautiful hue of blue.

During our time there we were cursed with unusually dry weather. On our first day in the field, local people told us it had been some five days since the last rain. The lack of rain was immediately noticeable as soon as we stepped into the field. Although the ground was dry, bromeliads and other plants with phytotelmata were still filled with water.

We first started our search at approximately 1,200 meters, but we soon decided to continue moving upwards in elevation. Literally every person we encountered knew exactly what we were talking about when we asked about the red frog. It is known locally as the "Rana Peruana", or Peruvian frog. One would infer the reason is because of the orange/red coloration that is similar to that of the red and white flag of Peru. While it was very reassuring that everyone knew of the frogs, it was also incredibly disheartening because we were having such poor success locating them because of the dry state of the forests. Everyone said the frogs were present in the region, but the only time to see them was when it rained, because this was the time when they came out and "cried" (their word for when the frogs called). We also asked people if they have ever seen our other target, the highland D. lamasi (with the 'X' on the back). These, they said, were also present, but very infrequently, and also only when it rained. They also had a slang name for this frog, but because of the intensive smuggling going on in the region, I feel it prudent to withhold the name. Before arriving, we previously thought the *D. lamasi* from the region would probably associate strictly with bamboo plants, but this was not the case. People mentioned seeing them in other plants as well, such as Xanthosoma.

It was not until our last day in the field that we finally found a frog, and as they say, "When it rains, it pours."

We opted to stay in the house of a man who we had been speaking to a lot over the previous days (so we could have an earlier start in the morning), and we went up to the highest part of the region to search. We entered the forest, with each of us assuming a search spot near a stream. We walked up the streams looking in the nearby areas for the frogs. Continuing with our lack of luck, there was neither any calling nor signs of rain. We looked for several hours…with no luck.

Just as we decided to head back and perhaps try another site, we heard what sounded like *E. trivittatus* and knew it had to be the call of *E. silverstonei*. Myers and Daly confirmed this

in their paper as well — they describe it as a call very similar to that of a *E. trivittatus*. Upon hearing the call, we scrambled up the hill and back into the field with our eyes peeled for what should be an easy spot: a bright orange/red and black frog. A few moments after reaching the top of the hill, Evan finally spotted the frog…inside a clay mud hole. All at once we realized why we were having so much trouble finding them: we had been looking for them like any leaf litter-living *Epipedobates*. We never thought that we should be looking for holes or indentations around roots or buttresses of trees. Once we figured that out, we quickly located four more adults, one sub adult, and a juvenile. Each of them, along with some more that were shown to us earlier by a local man, had different amounts of black on its back and different shades of orange or red. There did not seem to be any correlation between either the amount of black and the elevation at which they were found or the amount of black and the sex of the individual. Both of these were odd rumors that had surfaced over the years to explain the differences in black on the backs, but they did not hold true in what we have seen. We also found one juvenile at a lower elevation (around 1,440 m) on the edge of a forest. The juveniles appeared to be around six months old and had an orange coloration to them. Unfortunately, we were unable to find any eggs or tadpoles. All of the individuals we found were either in clay dirt holes or around roots hidden from view. Based on our observations, there appear to be only two species living sympatrically with *E. silverstonei*.

Overall, this trip only affirmed what anyone who has traveled to the Cordillera Azul already knows: although the region is full of biodiversity, the level of exploration is still low enough as to provide some surprises. From the dramatic landscape to the complexity of a highland forest, this trip was everything I had hoped and more. While we suffered some bad luck with the weather, our enduring patience yielded several of what could be the most beautiful Dendrobatids I have ever seen in the wild. I know a return trip is imminent, but for now I am satiated by the past trip and elated by the photographs that serve as reminders of a fantastic journey.

Thanks: The author would like to thank Mark Pepper and Rainer Schulte for their location suggestions in searching for *E. silverstonei*, as well as Evan Twomey and Enrique "Kike" Rodriguez for joining me in the trek.

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The Smuggling Crisis

by Mark Pepper, Ewan Twomey, and Jason L. Brown

It seems to be an inherently human characteristic to desire that which we do not have.

Acquisition of a new species is one of the most exciting parts of this hobby. Every hobbyist has his or her own wish list, some of which are easily obtainable, others far more elusive. How these wish lists are filled can speak volumes about the integrity of the hobby and the individual hobbyists. The desire for new and rare species has directly fueled the exploitation of these frogs in the wild through a destructive practice known as smuggling.

What is smuggling?

With many amphibian species disappearing worldwide due to disease, global climate change, and deforestation, many conservation efforts have been spawned lately to investigate and combat such threats. However, poison frogs face a threat that has largely been overlooked – illegal smuggling for the pet trade. The last several years have witnessed recent waves of large volumes of smuggled frogs appearing at frog shows or expos, particularly in Europe, however North America is far from innocent. Some species of particular note are Dendrobates mysteriosus, D. granuliferus, D. fantasticus, D. imitator, D. vanzolinii, many forms of D. lamasi (most recently the orange/red form), and D. lehmanni. The list is extensive and continues to grow.

Smugglers exploit the often under-funded governing bodies and enforcement agencies in the countries in which these frogs are native. In Peru, smugglers either carry the frogs out of the country personally, usually several hundred at a time, hidden amongst luggage, or export the frogs illegally, hidden within shipments of tropical fish leaving through Iquitos or Lima. Many times, large quantities of frogs are harvested from often very restricted populations, in most cases severely damaging these populations. Furthermore, impoverished Peruvian farmers are often paid ridiculously low sums of money ($1-2) to collect every poison frog they can find. Not only is this damaging to the frog populations, it instills in these farmers the idea that the forest and its inhabitants are just another resource to be carelessly exploited rather than conserved or managed sustainably.

These frogs, whether concealed in luggage or hidden with fish, are horribly and inhumanely packed, often resulting in the death of 100% of these illegal shipments. Seizure of illegal frogs in Iquitos revealed several film canisters packed with D. lamasi, often literally packed solid with frogs. The frogs face death as a result of the deplorable shipping conditions, or as the result of injuries received during the stress of such conditions, or from bacterial, fungal or viral infections which take over a weakened, stressed immune system. For every smuggled

frog that arrives alive, there are many, many more that die. Customs officials have quoted mortality to be as high as 90%. Similar numbers have been observed within Peruvian seizures; sadly, one must be reminded that many more died before they could even be packed for transport.

Two months ago a new variant of D. imitator arrived in Europe, recently we had the opportunity to return the area the frogs were from and see the impact. The site was dismal. Because the smugglers created a market for these frogs, half a dozen campensinos (farmers) had begun collecting the frogs and placing them in small enclosures. The mortality of the frogs waiting for export had to be considerably high as all the frogs we observed were severely starved and seemed to be barely alive.

Further, a considerable number of frogs which didn't starve to death could have easily died of desiccation, excessive heat, predation, or disease, as many of the cages were so poorly built that frogs could easily escape. However, if they were able to escape, they were now miles away from suitable forests and surely died. Because the smugglers are stealing these frogs, to them, these losses are acceptable and they simply remove more from the wild. They will try again and again when mortality is high. To the campensinos, most of these frogs can be collected while they work in the forests, so the small chance that they live to be exported is still worth the effort. Smuggling has unfortunately become a highly lucrative venture benefiting only the smugglers themselves, as the short-term income to the farmer hardly ameliorates their poverty.

How is it harmful?

Those who knowingly purchase illegal frogs are every bit as guilty as the smugglers themselves and by doing so are directly encouraging this trend to continue. There is no justification for these practices. No one wins, not the frogs, not conservation, not the hobby, and certainly not the local communities. Supporting these smugglers is directly supporting the extirpation of these frogs from the wild and making it much more difficult for the sustainable projects to succeed.

No one can deny the clandestine origins of many of the now common frogs in the hobby, whose origins were smuggled animals. However, our hobby does not have to continue this way. Never in the history of the poison frog hobby have greater opportunities been available to the hobbyist to purchase a wide variety of sustainably produced frogs, which come with the additional benefit that portions of proceeds go to protect the very habitat these frogs come from. In many cases, supporting these projects aids the economies of impoverished local communities by providing them a sustainable source of income and employment opportunities derived from the forest, rather than from unsustainable exploitation.

Smuggling directly undercuts these programs. Projects such as INIBICO and Zoocriadero Exotics Frogs (UE) will not thrive if the market for these frogs is constantly filled by smuggled animals. These projects have signifi-




cant overheads, operating costs, and support several employees. They will simply cease to function if they cannot make the sales they need, and disappearing with these projects would be the onservation potential these frogs have to offer.

What can be done?

Unfortunately, many hobbyists choose to ignore the possibility that frogs they are purchasing may be smuggled or simply take on an apathetic "don't ask, don't tell" mentality, naively assuming that the frogs they are purchasing are of legal origin. We urge hobbyists to ask questions when buying any frog newly arriving on the market. It is a simple matter of asking the seller questions: Where are these frogs from? How were these frogs obtained? If they are captive bred, how were the parents obtained? Could you provide CITES documentation? Any legal seller should have quick answers to these questions and will be able to provide documentation for the frogs they are selling.

The best way to prevent smuggling is to avoid purchasing illegal frogs.

dendrobates.org unofficial blacklist

The following frogs have shown up in the hobby lately and are of ILLEGAL ORIGIN. These species and morphs should NOT be purchased!

This list has been composed by people working closely with these frogs, both in the field and in the hobby. However, in some cases, certain species may have been exported under the guise of "*Dendrobates sp.*". Therefore, the following list does have some exceptions (see for example, D. uakarii). The illegality of some of the listed species can be verified by reviewing the CITES database at *www.unep-wcmc.org/citestrade/trade.cfm*. Excel databases generated from the above website can be downloaded below for the following genera:

Dendrobates + ***Minyobates*** CITES Database

Epipedobates CITES Database

Dendrobates auratus – Many legal exports have occurred, although a recently discovered solid orange morph has been targeted by smugglers lately.

Dendrobates duellmani

Dendrobates fantasticus – New, recently discovered morphs began showing up in late 2006, in Marktheidenfeld.

Dendrobates flavovittatus

Dendrobates histrionicus – Some specimens have been legally exported in the past, but the vast majority of new arrivals in the hobby are smuggled.

Dendrobates imitator – Many morphs are illegal, including the orange/blue morph most recently.

Dendrobates lamasi – Red, orange, and green morphs

Dendrobates lehmanni – This species is now considered the most endangered poison frog in Colombia, and smuggling continues to jeopardize many populations. In some places this species has gone completely extinct due to heavy smuggling. These frogs are often purchased by people who think that the species can be established in the hobby, but it is almost impossible to breed in large numbers in terrariums, as they are a highly territorial species that does not do well in captivity. Most recently, European hobbyists have expressed renewed interest in the yellow form of *D. lehmanni*, which was thought to be extinct as of 2005. Smugglers located another population and collected approximately 110 individuals.

Dendrobates minutus – Lately, a red morph has shown up in the hobby, though this species has been exported legally in the past.

Dendrobates mysteriosus – There have been many CITES papers issued for transfer of this species within Europe; however, to our knowledge, no CITES papers have ever been issued for specimens leaving Peru, making all individuals currently in captivity highly suspect. This frog is severely endangered in the wild, purchasing illegal D. mysteriosus compromises projects dedicated to its conservation.

Dendrobates steyermarki

Dendrobates tinctorius – Pic Matecho and Mont la Fumee morphs.

Dendrobates uakarii - Legal individuals may have been imported ca. 1990 under the name D. quinquevittatus, but recently available animals are almost certainly available due to smuggling.

Dendrobates vanzolinii - A large smuggled shipment was confiscated and given to H. Divossen, which have now been made legal in certain countries in Europe if they can be traced back to that line. However, due to the fact that these frogs were originally smuggled, we cannot condone the purchase of any *D. vanzolinii*. Furthermore, the majority of these frogs in the hobby are not of the Divossen line, and hence, completely illegal.

Dendrobates vincentei

Dendrobates cf. 'arboreus'

Epipedobates bassleri - Chrome green morph

Epipedobates pongoensis

Epipedobates rubriventris

An Attempt to Breed *Atelopus flavescens* by Artificial Means

by Peter Mudde

In the summer of 1988 I received a small group of *Atelopus flavescens* through a hobbyist friend. There were four males and a single female in the group; the entire group was from the region of Montagne Matouri in French Guyana. The group was housed in a vivarium with a floor area of 60 by 60 cm (@ 24 x 24 inches) with a sloping glass cover. The vivarium was planted with several epiphytes, which were grown in Xaxim™ (tree fern root) pots standing on stones. The available terrestrial area was restricted to the pots, the parts of stones extending out of the water and the plants that grew throughout the vivarium.

I used rainwater to fill the vivarium. This was sprayed through the vivarium by means of a small pump which fed two tubes one on each side of the vivarium. This way it was always very humid inside the vivarium, somewhere between 80 and 99% relative humidity. The tank was illuminated by two 15 watt fluorescent tubes, and the heat from the transformers of these fixtures was used to heat the tank. This way inside temperatures varied from 20 deg C in the night to 28 deg C in the late afternoon on normal days. Occasionally in the summer the temperature would exceed 28 C and during the winter on at least two occasions the temperature dropped to below 14 C. Neither of these extremes appeared to affect the frogs.

The frogs were fed ad libitum with fruit flies, which were dusted with minerals and vitamins of all kinds. I used a different brand every time, to get as much variation as possible (or, because I could not get the brand I had before. To be honest, the variation story is wisdom in hindsight.) During the summer the frogs were occasionally fed with a variety of other insects from meadow-sweepings. I also collected rotting leaves from beneath trees in our neighbourhood, which were placed in the vivarium in the hope that there would be small arthropods in the leaves, which the frogs could then consume.

After a year, the males became interested in the female and one crawled on her back in amplexus. (Editor's note: in captive populations of *Atelopus varius*, *A. spumarius ssp.* and A. zeteki, males will enter into amplexus with any female encountered regardless if the females is ready to breed or not. In the wild, males tend to only encounter females when the females descend to the streams to oviposit.) I had heard several horror stories about this, as the males tend to stay in amplexus until the eggs are deposited and females are very reluctant to deposit eggs. In other words, the male could stay on the back of the female forever or to be precise, until either the male or the female dies. (Editor's note: In captive populations of *Atelopus zeteki*, lesions have developed on the feet of females in amplexus that result in potentially lethal bacterial infections. The lesions are apparently due to the female either trying to get the male loose and/or carrying the weight of the male). I tried to pull the male off the back of the female but to no avail—within an hour another male had mounted the female. Another hobbyist told me he once broke an arm of a male while trying to get him off, so I

left them alone and hoped for the best. For three months the male remained on the back of the female.

When I observed the pair, I could occasionally see the belly of the female where eggs were developing. This made me hopeful, but even after a month's worth of waiting there was no progress. The male became thinner and thinner and I started to fear for the health of the male, as well as the possibility that the female might reabsorb the eggs. I decided to try to induce spawning by injecting the female with hormones. I managed to get some human gonadotropine (Pregnyl™) and a very small injection needle. (Editor's note: gonadatropine used for salmon are more effective for inducing oviposition in amphibians than mammalian gonadotropins.) I am lucky enough to be married to someone whose profession is to inject substances into people, so I had no fear regarding that.

In an article on artificial breeding of *Litoria caerulea* (Meyer & Schneider 1988. Das Timing von Amfibien mit gonadotropen Hormonen am Beispiel von Litoria caerulea (White 1970) Herpetofauna (in German) 10(55) 13-16) I found a dosage used for *Litoria cearulea*, 5000 IE/animal. I calculated that my frogs were about one-hundredth of the weight (female 4 g, male 2 g,) of the *L. caerulea* and, because in *L. caerulea* a dose of 400IE did make the frogs spawn, I decide to be on the safe side and inject 50IE in the female and half that dose in the male. The injections were given under the skin of the back with as fine a needle as possible. For the frogs this is quite invasive as the needles cause relatively large holes that do not heal immediately. I refrained from injecting into a leg as I thought any movement might press the injected fluid out. (Editor's note: depending on the quantity, it is possible to give injections into the legs without issue. Also, the injection of hormones can be injected into the coelemic cavity.) The first injections produced no results. A week later, a second attempt was made with a tenfold dose. Both the male and female were injected (again under the skin of the back) with 500 IE of gonadotropin. This produced the desired results: the next morning there were white eggs all over (and under) the submerged parts of the tank (stones, twigs…everywhere). I estimated a total of 250-300 eggs. (Editor's note: In *A. zeteki* and *A. varius*, oviposition occurs under stones and other debris. In captivity this can be supplied through the use of deep water and upside down clay pots with access holes provided for the frogs.)

The eggs were removed from the vivarium to previously prepared small aquaria I had ready, each with an air stone powered by an air pump to provide constantly moving water (which was demineralised). After four days a single egg showed signs of development. In other eggs a small change in size indicated development. After nine days the first tadpole left the egg-capsule and a week later the last tadpole hatched, resulting in a total of fifteen larvae.

The water temperature in the tank was maintained between 21 and 23 C° (Editor's note: in *A. zeteki* and *A. varius*, keeping the tadpoles below 21.1 C results in the tadpoles not feeding well and wasting away). The larvae were fed with Liquifry, algae (grown in an aquarium on a stone which was then placed in the tank), Spirulina powder and yeast. The tadpoles seemed to primarily consume the debris that gathered in the corners of the aquaria where the movement of the water was the least. Yeast resulted in no success and the larvae avoided it as much as possible. (Editor's note: Tadpoles of *A. zeteki* and *A. varius* can be reared on an artificial diet of commercial fish foods that have been ground to a fine powder, mixed with water and offered as a paste smeared on rocks.) The water was changed and uneaten food was removed four times a week from one tank, once a week from another. In the end, the intervals in water changes didn't seem to be of much importance.

In three weeks time, a few larvae had grown to about twice the size of the eggs. A few larvae seemed to just disappear from within the tanks. After eight weeks I had nine left, three of which were slightly larger than the others. From that point on, growth ceased in all the larvae. Four weeks later all larvae were gone except one. It survived two more weeks before dying. It was stored on alcohol and studied. It had reached something between Gosner stage 26 and 30. As far as I could observe there were no differences from the larvae-description by Lescure. The last larvae is in the Zoological Museum of Amsterdam (now Leiden, I suppose)

This story is a bit like that of Mebbs (1980) in that his larvae also stopped growing around the same stage. The few successful results in breeding *Atelopus* I have seen were all single larvae reared in a relatively large volume of water. I think growth-inhibiting factors in the larvae's' own excrement are the cause of the problem. These have been found to influence development in toads like *Bufo bufo*, and larvae used to a constant flow of clean water might be much more susceptible to such factors. (Editor's note: Tadpoles of *A. zeteki* and *A. varius* have been raised successfully communally in 208.2 liter aquariums.)

(Since writing this article, the author has made contact with someone who is going to have an opportunity to visit the breeding locale of *A.flavescens* in French Guyana. Therefore, this account is tentatively "to be continued...")

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Open Call for Tadpoles

I am looking for tadpoles for a study on the effects of pH and water pollution on survival and development in tropical amphibians. This work will utilize the same methodology as my past work on the effects of temperature on Dendrobates auratus (Korbeck & McRobert, 2005). Any tropical species that produces large numbers of tadpoles that are easy to raise should work for the proposed study. If you have surplus tadpoles and wish to be involved in research (and possibly serve as an author on publications), please contact me:

Dr. Scott McRobert
Professor of Biology, St. Joseph's University
smcrober@sju.edu

Constructing an Artificial Beaver Pond for Amphibians

by Brent L. Brock

Creating amphibian habitat around your home can be a rewarding experience. Traditionally, when we think of backyard amphibian habitat, we think of water gardens with lily pads and emergent cattails at the edges. While water gardens can be fun to build and enjoy, there may be opportunities to help amphibians around your home that don't require the effort and expense that goes into constructing a traditional water garden. In this article, I describe how I created an amphibian breeding pool on our rural property in less than an hour using only salvaged materials found around the house.

We are fortunate to have a small spring on our 23-acre (9.3 hectare) rural property. The spring gurgles up from a hillside and forms a straight, narrow channel only a few centimeters deep. It flows straight downhill for about 25 yds. (23 m) before spreading into a wet sedge fen and seeping into a nearby creek. The total distance the spring flows above ground is only about 75 yds. (68 m) and it appears that its channel was altered and straightened around the turn of the 20th century when a now abandoned coal mine adjacent to the spring was active. The spring is a popular watering hole for resident moose, deer, and perhaps an occasional bear or mountain lion but provides no useable habitat for local amphibians, except for moist foraging areas for a few juvenile Columbia spotted frogs (*Rana luteiventris*). But by using a couple scraps of lumber and a small amount of bentonite clay leftover from another project, I created a small artificial beaver dam that should provide a suitable breeding pool for local frogs.

Creating an artificial beaver pond is simple and inexpensive. Beavers create dams using nothing but sticks and mud that can create substantial ponds across surprisingly large creeks and streams. Beavers aren't picky about where they build dams and will often construct them across small drainages and irrigation ditches similar to the channel flowing from our spring. These small impoundments provide excellent breeding habitat for our local amphibians such as boreal chorus frogs (*Pseudacris maculate*), northern leopard frogs (*Rana pipiens*), Columbia spotted frogs, and western toads (*Bufo boreas*). It would be fairly easy to dam our spring using sticks and mud similar to a real beaver dam, but I chose a simpler method by using a couple 2x12 (5 cm x 30 cm) boards.

The dam is constructed so as not to alter the flow of water downstream by allowing the full flow of water to spill over the top of the dam and continue its course. I located the dam about 30 ft. (9m) from the head of the spring at the end of a relatively level stretch of the run. After determining the best site for the dam, the first step was to dig a narrow trench perpendicular to the watercourse (which only needed to be

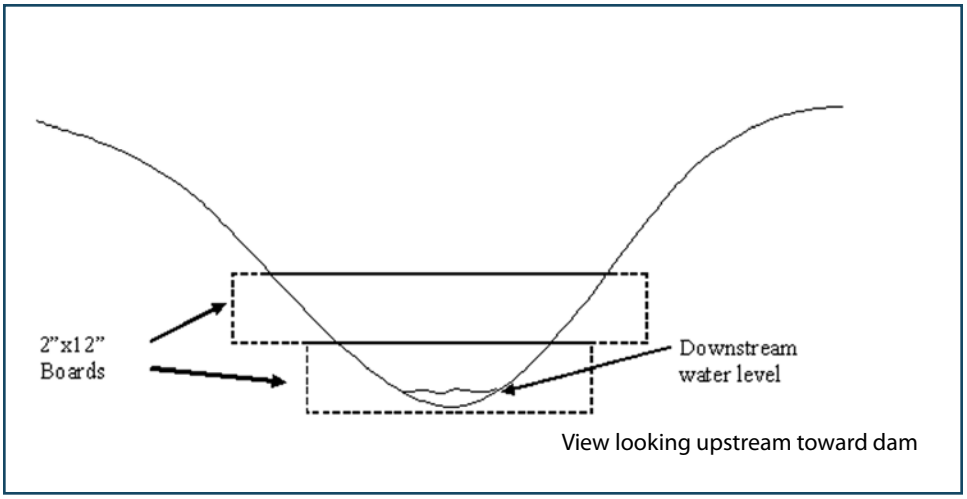

Figure 1

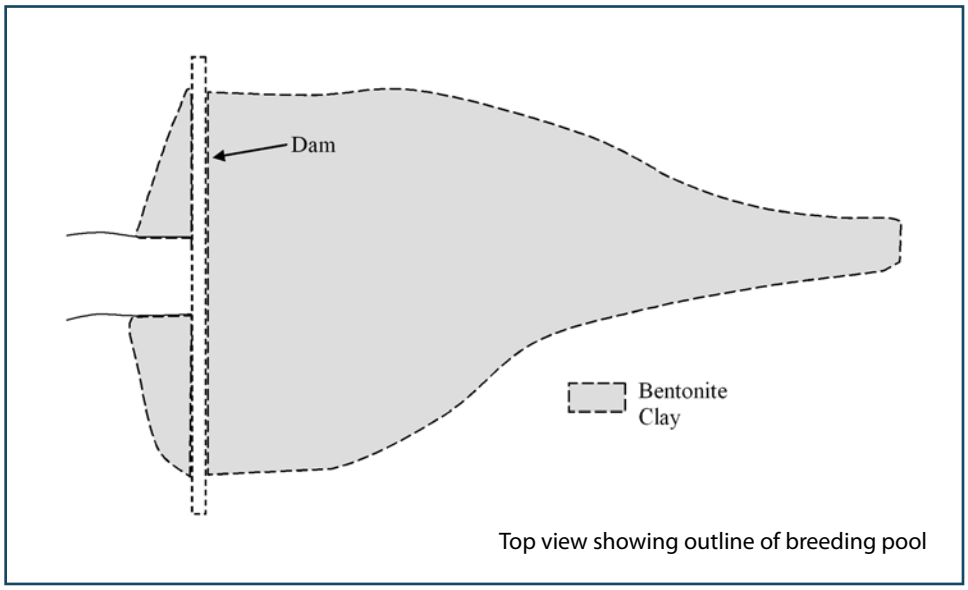

Figure 2

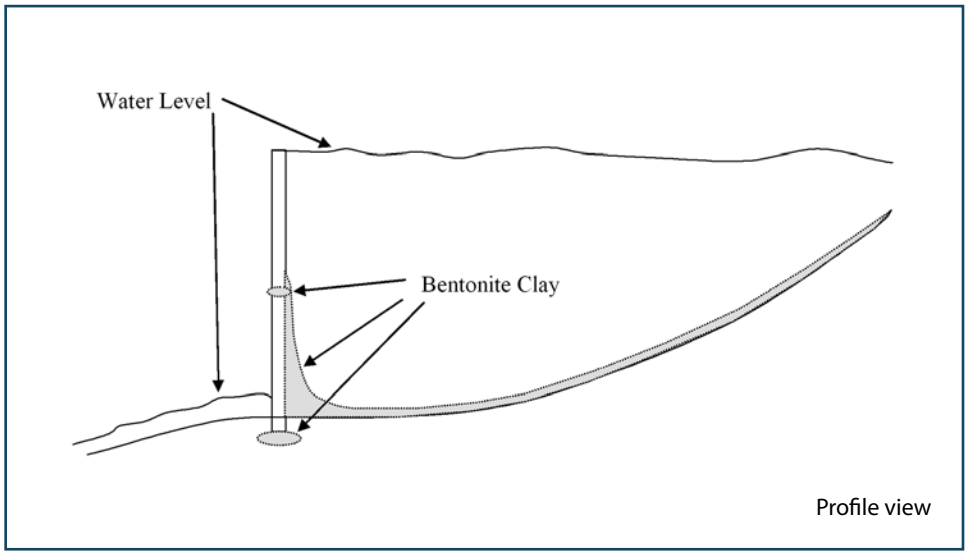

Figure 3

a couple inches wide to form a slot in which to insert the boards). The less the soil was disturbed, the more solidly the boards would be held in place. The bottom of the trench was 4-6 inches (10-15 cm) bellow the bottom of the existing watercourse and its length only long enough to except the first 2 x 12 board, the top edge of which would extend 6-12 inches (15-30 cm) into the existing stream bank. Once the trench was dug, I added a one-inch (2.5 cm) layer of bentonite clay to help seal the bottom. Bentonite clay is a natural material that swells when wet to form a watertight seal. It is frequently used to seal ponds and livestock watering tanks. It can usually be purchased as bags of dry granules at farm and ranch supply stores, concrete suppliers, or landscaping companies.

After the trench was lined with clay, I inserted the first board and backfilled the trench at the ends of the board to restore the original contour of the bank. I then tamped the board firmly into the bottom of the trench, making sure it was level. Next I dug a trench to receive the second board, the bottom of the trench being level with the top of the first board and extending outward into the bank similar to the first. Before inserting the second board, I smeared a quarter-inch layer of moistened bentonite onto the top of the first to form a seal at the seam where the two boards would meet. I then inserted the second board on top of the first, using the same method previously described, to complete the dam. The total structure was approximately 22 inches (56cm) tall and 4 ft. (1.2m) across at its widest point.

To help the resulting pool seal and avoid water loss to ground seepage, I sprinkled a layer of bentonite over the areas submerged by the pool, using my hands to agitate the water to allow the bentonite to settle to the bottom. I also smeared a thick coating of bentonite

Looking upstream toward the dam

over the upstream side of the dam to minimize leakage. Additionally, I added bentonite below the dam to help direct water spilling over it back into the original channel, minimizing water loss. Finally, as the pool filled with water, I made final adjustments to make sure it was level by pounding down the high end until water flowed evenly over the top of the dam (it's okay if water leaks under and/or through the dam so long as the leakage does not prevent the pool from filling and spilling over the top).

The spring now sports a small pool that is about 18 inches (46 cm) deep, 4 ft. (1.2 m) wide at its mouth and about 10 feet (3 m) long. Because I did not disturb the vegetation during construction of the pond, it already has emergent grasses around its banks that should provide instant habitat for breeding chorus frogs and other local species. Eventually the boards used in the dam will rot, but by that time, mineral deposits from the spring will likely coat the structure and form a more permanent pool. It is also possible that this small pool might actually entice real beavers to construct their own dam and increase its size. Regardless, I didn't have to wait long for the first actual signs of activity. As I waited for the pool to fill, only minutes after completing the dam, I spied something black swimming slowly in the gathering water: a juvenile spotted frog. No doubt it will be pleased with this new addition.

Not everyone is lucky enough to have a spring on their property, but there may be other opportunities to make very slight habitat modifications to benefit local amphibians. For example, many of us have low spots and ditches that fill with water each spring that would provide ideal breeding puddles for chorus frogs and spring peepers if they held water long enough for tadpoles to survive to metamorphosis. A five-dollar bag of bentonite may be all that is required to improve the water retaining properties of those puddles to help our amphibious friends. So take a few minutes to walk around your home to see if you have similar opportunities to invite a chorus of amphibians to your home.

A Visit to Two Unique Mantella Populations

in East-central Madagascar

by Devin Edmonds

View from on top of a deforested hill on the way to find Mantella.

The dirt road turned into an ankle deep river of mud in a matter of minutes once it started to rain, and the brown, sandy earth that coated my pants from walking through rice paddies the past few hours was quickly replaced by the red of the logging road we now sloshed through. Under my borrowed rain coat was the prize for this uncomfortably wet and physically exhausting journey – a 1GB digital camera card with photographs of a frog I could never have imagined, had I not seen it myself.

I was in Madagascar and on a mission, searching for seven species of the endemic amphibian genus Mantella. They are perhaps the most well-known frogs on the island, many of which display attractive aposematic coloration, similar to that of the familiar Central and South American Dendrobatids. Having passionately kept Mantella species in captivity for over a decade, I had dreamed of seeing those in the wild for many years, and now, with knowledge from journal articles and direction from Malagasy guides, it was becoming a reality.

Mantella milotympanum, one of the smallest mantellas, was on my list of species to see. It's only known from its type locality in east-central Madagascar, in forests around the town of Fierenana. During my research prior to the trip, I came across several articles which referred to populations of M. milotympanum-like frogs to both the south and north of their type locality. Some of these were described

Top Left: Wood chippings from recent logging activity at variable *M. cf. milotympanum* locality. Many frogs were found around this pile of wood chips.

Bottom Left: *M. cf. milotympanum* from the variable population, appearing much like typical M. milotympanum

Bottom Right: *M. cf. milotympanum* from the variable population, red in color like M. milotympanum but with a pattern like M. crocea

as looking identical to the typical red M. milotympanum, but instead being green in color. Additionally, at least one population was said to be variable, being intermediate in pattern between M. crocea and M. milotympanum. These were the populations I planned to visit, though with only GPS coordinates of where they occurred and no direction of how to get there, I was not confident I would find them.

Traveling by taxi-brousse (bus-like vans or pickup trucks, outfitted with extra seats to accommodate twice as many people as they can safely fit), I headed north of the city Moramanga, joined by a guide named Dupsie I had met previously while searching for Mantella elsewhere. We were unsure exactly where we were going, but had a map marked with known Mantella localities. We passed it around to other taxi-brousse passengers, asking them if they knew any of the locations on it. As it turned out, we were in luck, with a woman having grown up in a village near one of the variable Mantella cf. milotympanum populations. We got off the taxi-brousse with her in a small, dusty town on the side of the road, found a local farmer who agreed to lead us to red frogs that sounded like mantellas, and then slept that night at his friend's house.

We started hiking early the next morning. As we walked, the surrounding landscape changed from treeless hills (victims of slash and burn agriculture), to patches of forest, interrupted only by frequent rice paddies and a red-dirt logging road. We followed this road for a couple hours until it ended at a pile of lumber and a footpath, which we then followed into the forest.

Descending down the side of a hill, a familiar sound could faintly be heard in the distance. The untrained would not have noticed it as they walked past, and if they had, they likely would have disregarded the sound as field crickets, not realizing it to be a unique population of critically endangered frogs. It was what Dupsie and I had been waiting to hear. We walked further down the hill and then into the forest towards the sound. The farmer found the first one, a bright orange frog looking like M. milotympanum but with a black mask around the face, similar to M. crocea – exactly what we were looking for! Others in the population were patterned like typical M. milotympanum, red with solid black dots on the tympanums, while most frogs were somewhere between the two extremes and had varying amounts of black on their flanks and face.

When we visited, the forest was under pressure from selective logging, with many frogs being found close to a pile of wood chips from recent logging activity. Running through the forest was a small stream, near which

Top: *M. cf. milotympanum* from the variable population, very similar to *M. crocea* but more orange in color and with a slightly thicker frenal stripe.

Bottom: *M. crocea* (captive) for comparison.

male frogs called from the cover of underbrush and the tops of fallen logs. Exploring the area further revealed that the forest on one side of the stream had been cleared, and what remained was a bed of ferns and small shrubs. Within these ferns, occasional frogs could be heard calling, but not like the high densities found on the other side of the stream where there was forest.

We returned to the roadside town in the late afternoon, and started to make plans for the next day. I was hopeful that we would be able to locate the green Mantella cf. milotympanum I had read about and seen in the pet trade, and asked the farmer about the possibility of finding those. He wasn't aware of any green frogs in the area that were small enough to be a Mantella species, but said he would ask around town and try to find someone who knew of them. The farmer returned that evening with an old, bald man; his father. According to him, 30 km to the east was a village where he had seen frogs that sounded like what we were looking for. Interestingly enough, he said that the stream near the population of variable M. cf. milotympanum we had visited earlier continued on to the east, and it was around this same stream where the green mantellas could be found.

The next morning Dupsie, the farmer, and I again left at dawn. We ignorantly thought we could hike the 60 km to the village and back in one day. Continuing along the same path we had followed previously, we again walked up and down treeless hills until reaching the forest and red-dirt logging road. Along the way we met a group of teenagers walking back to the roadside town. Dupsie translated to me that one of them said he was from the village we were hiking to and, even better, knew exactly where green mantellas were. We continued on at a fast pace, with the teenager leading the way.

As the sun rose, it became very hot, and the occasional mud puddles in the road dried. We cut back and forth between the road, forest footpaths, and rice paddies, the entire time half-running/half-walking, in hopes we would get back before dark. Around 1:00 P.M. we descended the side a forested hill, toward a grassy valley below. As we walked through a transitional zone of ferns and bushes between the hillside and valley, both Dupsie and I stopped, listened, turned to each other, and with a big smile on our faces said "Mantella!"

Completely unexpected, we had stumbled upon a population of mantella frogs, only halfway to our destination. The chorus was unmistakable, and certainly a Mantella species, but the thick fern bed from which they were calling was so dense it prevented us from seeing any. All four of us got on our hands and knees and started carefully looking for the source of the cricket-like chirps that surrounded us. I spotted the first one: a beautiful lemon yellow M. milotympanum-patterned frog, calling from the top of a concealed fallen log within the ferns. Other frogs located turned out to be yellowish-green in color. While excitedly photographing this unique population, the farmer came to me holding something between his fingers. Dupsie followed saying "It's different, very different!" I was blown away as the farmer revealed what he was holding. Between his fingers was a mantella like no other I had seen before. Its appearance was similar to the other

Top: *M. cf. milotympanum*, greenish in color.

Bottom: *M. cf. milotympanum*, yellow in color.

yellowish M. cf. milotympanum, but with light blue marbling on the posterior half of its dorsum and hind limbs. I'm unsure if this particular blue individual represents others within the population, or was just a uniquely colored frog. Either way, it was an incredible find, and more than I could have expected.

After the initial excitement of finding and photographing frogs, I spent some time walking around the area. I ventured along the path through the ferns and into the grassy valley, and as I did so the frog calls became distant. Walking along the border of the ferns and knee-high grass, I found

Top and Bottom: *M. cf. milotympanum* with blue marbling posteriorly.

the calls to again become distant as the transitional zone disintegrated into the underbrush of a forest. It seemed that these newly found M. cf. milotympanum were confined to a tiny patch of ferns surrounding the footpath, elsewhere being absent (or at least silent) on the day I visited. We left the area in the late afternoon, and as we hiked up the forested hill back to the roadside town, the teenager who had been guiding us noted that the valley would be turned into a rice paddy next year. His prediction was enforced as I looked around and noticed that the other valleys I could see were green with rice, with the valley we had just explored being the only one in eyesight without agricultural development.

Hiking back, it started to rain. At first I was thankful for the water because it cooled my sunburned skin and helped quench my thirst (we drank all of our water on the way there). But as the rain continued to pour down from above, our path turned into mud and I trudged along at a slow pace, trying hard not to fall and embarrass myself in front of my Malagasy companions. We returned to the roadside town nearing sunset, soaking wet and covered in mud, with little hope of drying our clothes as the rain continued on through the night. I was content though, and slept well that night, comforted by a camera full of photographs of an unforgettable mantella frog.

A transitional zone between a forested hill and grassy field. From within the ferns, male Mantella cf. milotympanum call loudly.

It's been proposed that *M. crocea* and *M. milotympanum* may in fact be one species, and the intermediately patterned population I first visited visually suggests this. Individuals within it vary in color from red to orange, some only with two black spots on their tympanums (typical of *M. milotympanum*) and others with a black face mask (typical of *M. crocea*). I'm hopeful that future genetic work will be carried out on both species, as well as intermediate populations, to help sort this out.

Unfortunately, time is running out for work to be done on these frogs, with slash and burn agriculture and timber extraction eating away at their small, remaining habitat. The effect humans are having on the frogs was most noticeable at the first population I visited. While there were many frogs in the selectively logged area, the deforested field of ferns across the other side of the stream seemed to have few frogs, with only occasional calls heard. Data should be collected to obtain population estimates and confirm this observation. Also somewhat alarming was the statement the teenager made about the future of the valley where we found the yellow M. cf. milotympanum, and how it will likely be a rice paddy next year. Systems should be put in place now to protect these unique amphibians, which may be an important piece of the taxonomic puzzle called Mantella.

I plan to return to the area northeast of Moramanga sometime in the next year to again search for mantella frogs. It's incredible to realize that in only a couple days of exploring the area, we were able to locate a previously unknown Mantella population. With this potential, there is no telling what we could do with more time there and what exceptional frogs could be found.

The Broken Cycle

originally published in
the Swedish Dendrobatid Society magazine *Pilgiftaren*

by Brent L. Brock
Illustrations by Johan Malmstrom; Swedish Dendrobatid Society

Can soil make red frogs redder, tadpoles healthier, and froggers happier? The answers may surprise you. The potential roles of substrates used in vivaria are often overlooked. Given enough light, water, and humidity, plants will grow in just about anything, and for most vivarists, this is all they ask. Hydroponic substrates like expanded clay pellets are appealing because they are clean, lightweight, and work extremely well for supporting healthy growth for a wide variety of plant species. In contrast, soil is heavy, messy, potentially harbors insects and disease, and tends to get soggy when wet. An alternative to mineral soils are potting mixes that are sterile but suffer from the other disadvantages of soil plus the organic matter contained within them breaking down over time, changing their texture and reducing the substrate's ability to drain. But there may be hidden advantages to soils that may surprise you.

Studying nature provides lessons about what might be missing in our vivaria. Let's compare the way nutrients cycle in a vivarium versus the way they cycle in a tropical rainforest. In nature, rocks and minerals in the earth weather and break down over time to form soil. The texture of soil allows it to retain moisture and create an environment where microbes like bacteria, fungi, and algae can grow, forming the basis for the soil ecosystem. These microbes extract minerals from the soil and fix nitrogen from the air, which forms the beginning of the nutrient cycle. Tiny invertebrates feed on the microbes and, in turn, become food for larger invertebrates. Plants send roots into the soil to extract the nutrients made available by the activities of the microbes. These nutrients get stored in stems, bark, and leaves. Eventually the leaves drop or the plants die and fall back to the surface of the soil. Invertebrates chew up the wood and leaves into small pieces and convert them into frass or invertebrate tissues. Microbes then digest the frass and dead invertebrates, once again releasing the nutrients back into the soil and completing the cycle (Fig 1). Throughout this process arthropods are everywhere, consuming nutrients at every

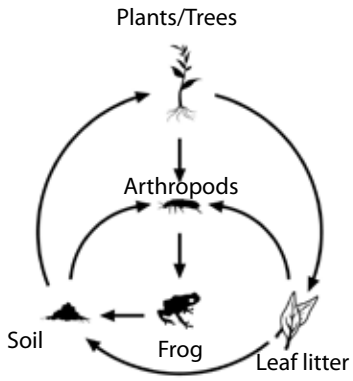

Figure 1: Natural Nutrient Cycle

stage. Some feed on microbes or other invertebrates in the soil, others feed on living plants, and still others feed on the dead and decaying leaves and wood on the forest floor or suspended in the forest canopy. Of course the frogs are there consuming arthropods of many

ABOVE: Both frogs shown were from the same breeding pair, but the frog in the top photo was raised in a vivarium without a naturally-occurring nutrient cycle and the other frog was raised in a vivarium where arthropods were supported by the soil and leaf litter.

different kinds and using compounds from throughout the nutrient cycle for their own use. In a vivarium a similar cycle occurs but with some important differences.

The substrate in a vivarium supports microbes, just as in a natural forest, and those microbes free up nutrients for plants to consume. Plant tissues die and fall back to the sub-

strate where they are decomposed by microbes to renew the cycle (Fig 2).

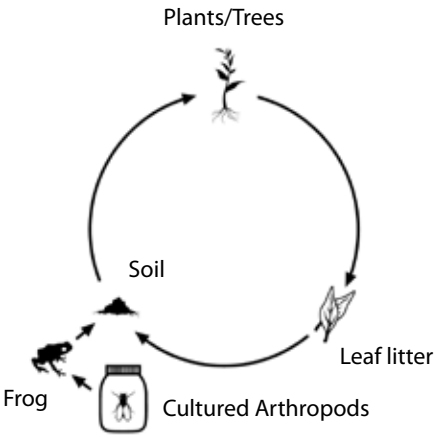

Figure 2: Vivarium Nutrient Cycle

However, in a vivarium the arthropods are often all but missing. Instead, insects are cultured on a prepared medium outside the vivarium and introduced as food for the frogs. The medium used to culture the insects contains the basic nutritional requirements of the feeder insect and may contain supplements to enhance the nutritional value of the insects to the frogs. In addition, vitamin and mineral supplements are routinely added to the feeder insects to ensure the frogs obtain all of their nutritional requirements. If the frogs are receiving a nutritious diet, why does it matter that the nutrient cycles are different in a vivarium from those in natural forests?

Nature is a chemical factory that reaches its peak in the moist, tropical forests where dendrobatids live. As mentioned earlier, the arthropods in natural forests are consuming almost every kind of living tissue. Microbes, plants, and arthropods don't particularly like to get eaten, so many of them produce toxic chemicals to help protect themselves against predators. These defenses are almost never 100% effective because there is almost always some species that has evolved a way to get around those defenses. But the defenses are good enough to ensure species survival, so the chemicals continue to get manufactured and passed along through the food web. In addition, disease is ever present in the warm, humid environment of the tropical rainforest and the organisms that live there produce many other chemicals to defend themselves against infection and disease. The end result is that the plants and microbes of the forest collectively produce a chemical soup that gets passed along through arthropods and ends up in frogs. Even if the chemicals have no nutritional value, the frogs use many of these chemicals to defend themselves against predators and disease and to produce brilliant colors. Cultured insects do not supply the frogs with a chemical soup to exploit. At best they only supply a weak broth. It's likely that many of the chemicals our frogs would utilize in the wild are already present in the vivarium within the rich variety of plants we grow in order to provide a comfortable home for the frogs and a pleasing display for ourselves. But in the case of most vivaria, the frogs can't access those chemicals because the cycle has been broken.

In a typical vivarium few arthropod species survive, either because they do not have suitable habitat or because they are eaten by frogs faster than they can reproduce. In the confined space of a vivarium, the arthropods most likely to succeed will be those that are small enough to hide in tiny cracks, crevices, and pores, allowing a high enough proportion of them to escape predation by the frogs and sustain the population. Providing at least a thin layer of soil or potting mix with an ample layer of decaying leaves will increase the chances that the vivarium will be able to sustain a thriving population of small arthropods that can supplement the frogs' diets and complete the natural cycle, thus reconnecting the frogs to the chemical soup stored within the plants. Increasing the diversity of arthropods will also increase the number and amount of stored chemicals that become available to the frogs because different arthropod species will have different potentials for consuming, storing, and transporting chemicals to a frog. A white springtail is much less likely to transfer red pigments to a frog than is a red soil mite.

Currently, the best way to maximize the diversity of arthropods in a vivarium is to seed it with living compost or natural forest humus. However, seeding with wild materials presents the risk of introducing undesirable insects or disease, so it is not for the timid. In particular, the seed material should never be collected where pesticides have been used or chytrid fungus is potentially present. But it is worth considering carefully what is deemed as undesirable. Snails, slugs, and millipedes are typically considered undesirable in a vivarium. But many plants produce defensive chemicals only in response to damage by a predator, so low levels of herbivory by invertebrates may actually benefit the vivarium by increasing the production of chemicals that our frogs are able to exploit.

Reconnecting our frogs to the natural nutrient cycle may solve some of the lingering problems associated with dendrobatid husbandry. The probability of successfully creating a small but sustainable population of soil arthropods in a vivarium depends on several factors. Foremost is the ratio of frog biomass to soil volume. The fewer grams of frog per unit of soil in a vivarium, the lower the predation pressure on the arthropod population will be and the higher the chances that the population will persist. Secondary is the availability of refugia. Refugia are places where organisms can escape (i.e., take refuge) and predators cannot

reach them. For soil arthropods, refugia can be found under leaves, in crevices of wood, and within the soil itself. The greater the variety of pore space sizes between substrate particles, the greater the variety of arthropods the soil will support. And the more pores of suitable sizes that are available, the greater the population of arthropods the vivarium as a whole can support. Finally, the potential population of soil arthropods will depend on the productivity of the soil ecosystem. Productivity is measured by the amount of biomass that can grow in a given time. There are two things that primarily determine soil productivity. One is the amount of nutrient availability. In a vivarium this is supplied by frog waste, dead insects, and decomposing plant material, so maintaining a generous layer of leaf litter will ensure that there are plenty of nutrients available to support a thriving arthropod population. The second factor is soil capacity. This is the amount of nutrients that can be stored in the soil. The soil acts like a rechargeable battery: it stores nutrients and then releases them slowly to the organisms within the soil. A soil's nutrient capacity is largely determined by its clay content. Clay particles, being negatively charged, bind to positively charged nutrient molecules. So soils that contain some clay have a greater capacity to store nutrients than soils lacking clay. However, too much clay will drain poorly and eliminate larger pore spaces where arthropods can live, so there is a trade-off.

There is evidence that completing the cycle works. For the past nine years I have maintained a large (1m x 1m x 0.5m) vivarium containing *Dendrobates pumilio* "Blue Jeans." The substrate is pure clay kitty litter 7 – 14 cm thick and topped with a 0.5mm layer of humus that has built up over the years, along with a thick layer of

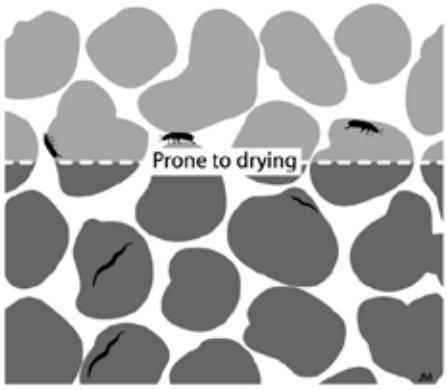

Figure 3:

decomposing leaves on the surface. The substrate supports a diversity of invertebrates including springtails, mites, centipedes, millipedes, slugs, isopods and an unidentified beetle (Fig. 3). For the first several years new froglets were removed from this vivarium when they attained a size of about 1 cm in length and placed in a traditional planted vivarium for rearing. Survival rate was about 50% and all froglets matured with faded color compared to the vividly colored adults, despite receiving carotenoid-rich supplements. Over the past two years I have left froglets in the larger vivarium until they reached maturity. During this period, survival rate has been slightly higher for froglets left in the larger vivarium, possibly due to the availability of small arthropods, which they continuously forage. The results have shown a dramatic improvement in adult coloration. Unlike their siblings that have been raised in a conventional vivarium, the froglets reared in the vivarium containing abundant soil arthropods are as brightly colored as the adults and indistinguishable from their wild-caught parents (Fig 4). It's impossible to know why the froglets reared in this larger vivarium develop better coloration than those reared elsewhere, but I believe it is because the abundance of soil arthropods unleashes the full nutrient potential of the vivarium by reconnecting the frogs to the natural nutrient cycle. Providing substrates that support a diverse population of soil arthropods may be an overlooked ingredient in dart frog husbandry.

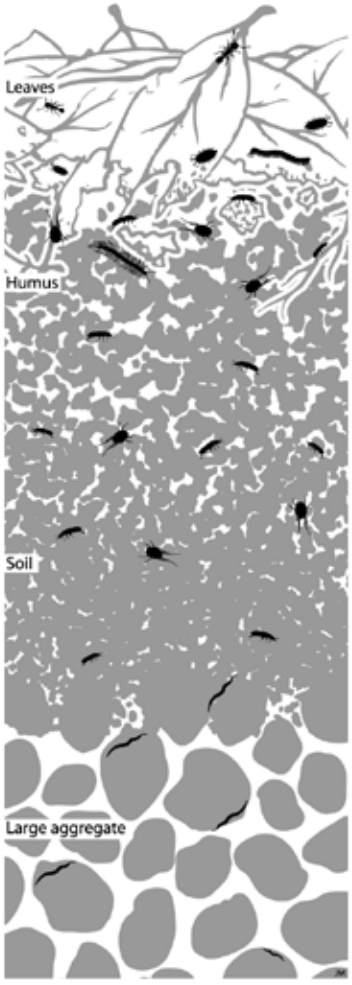

Figure 4:

Definitions

Invertebrate – animals lacking a backbone

Frass – digestive waste products produced by arthropods

Arthropod – animals lacking a backbone and containing an exoskeleton made of chiton (e.g. insects, spiders, crustaceans, centipedes, millipedes)

Insect – a class of arthropod possessing three pairs of legs and a body divided into three segments (head, thorax, and abdomen).

Amphibians are disappearing faster than traditional conservation methods can save them.

The Amphibian Stewardship Network (ASN) is a network of volunteer stewards dedicated to the preservation of both captive and wild populations of amphibians.

The ASN exists to address two important goals:

1. Eliminate unsustainable harvest of amphibians from the wild.

2. Support the protection and restoration of critically threatened amphibian populations in the wild through captive management and propagation.

The ASN is available to amphibian enthusiasts of all experience and skill levels. For more information or to get involved, visit www.treewalkers.org.

Amphibian Steward Network

an official program of Tree Walkers International

photo: Michael Ready

Leaf Litter exists to draw attention to, form discussion around, and encourage action toward amphibian conservation. To accomplish this, the articles contained within each issue will focus on three different (but related) areas:

- captive husbandry.
- trips to native amphibian habitat.
- projects and issues related to amphibian conservation.

It is our hope that Leaf Litter becomes a catalyst of forward movement and progression in the area of amphibian conservation, keeping members aware of the various ways in which ordinary people are doing extraordinary things for the cause of one of the most collectively endangered groups of animals on the planet.

www.treewalkers.org