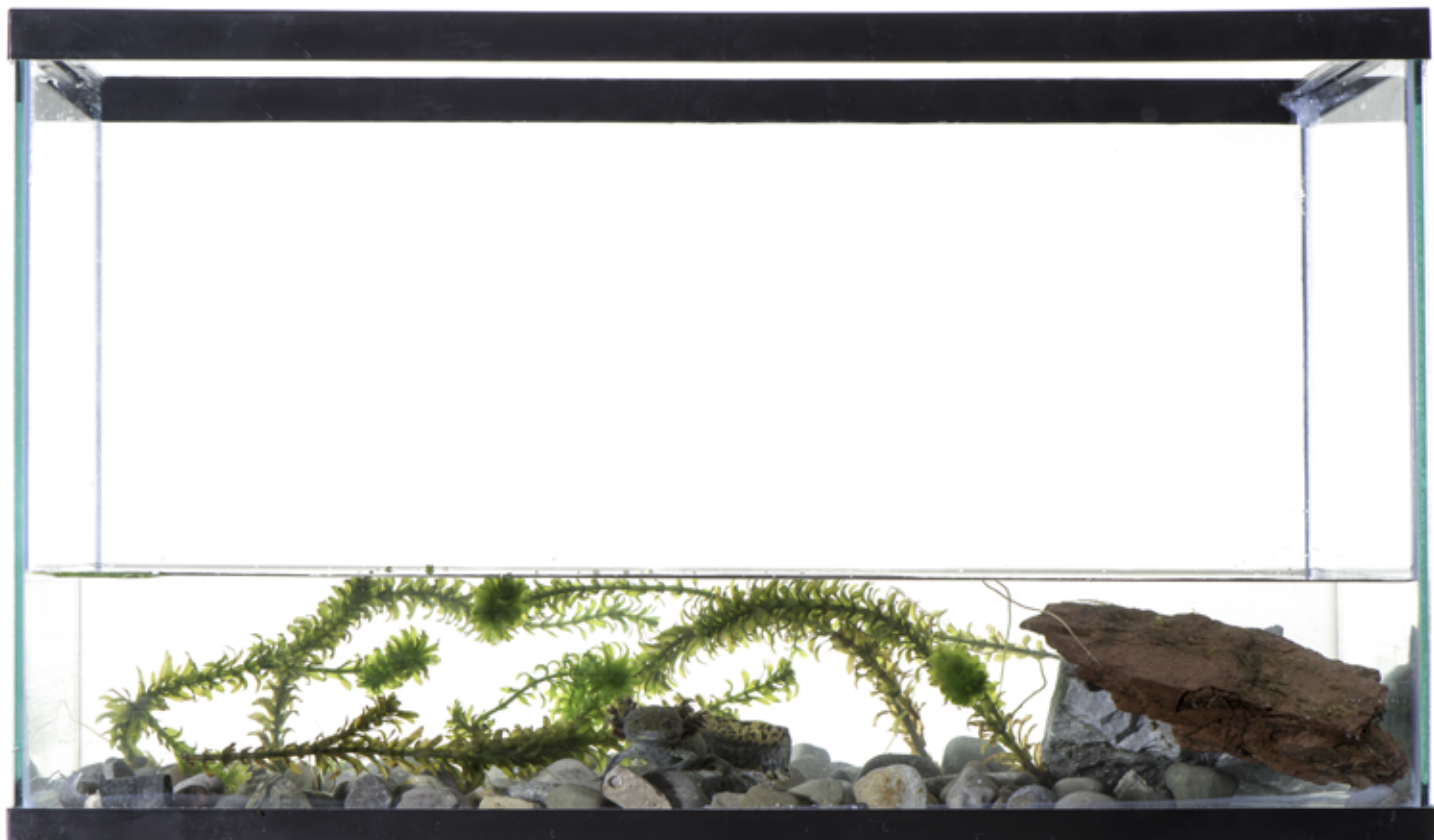


# *Vivaria*



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# Photographic Process

The images that are displayed in this article were made over the course of a month, and are presented to accurately represent each vivarium. They were photographed in a photographic studio, where lighting could be controlled so that the beauty of each habitat, organism, and relationship between the two could be displayed in stunning simplicity. Throughout the entire process, extreme care was taken to ensure the safety and happiness of the organisms involved.

The intention of each photograph shown in the rest of this article is to display an isolated view of a portion of the habitat. To best achieve this, a solid white or black background was used. The white backgrounds were achieved by being backlit, while the black backgrounds were achieved by placing a sheet of black velvet behind the subject. In every image, photographic exposure was measured before the image was taken so as to disturb the animals as little as possible. Studio flash was used at the lowest setting possible so that the motion of the animals would be crisp. In instances when flash was not needed, it was not used and replaced by tungsten light sources.



An image of the setup used. The lighting setup and use of studio continuous tungsten lights, and flash is shown here.

All images were photographed with a Nikon D800 and either a 105mm Macro lens or an 85mm lens. As each image was taken, changes to the setup were documented to allow them to be reproduced well. The finer details of the way that the images in this article were made will not be told so as to leave some of the magic of the images intact. The images on this page do, however, show a portion of the photographic setup that was used.

If you, or someone you know, is interested in learning more about how, and what I photograph, don't hesitate to ask! Please feel free to email me at:

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An image of the setup used. The photographic workflow between acquisition and review is shown here.

Images were directly imported into Adobe Lightroom and reviewed immediately after imaging. This allowed for quick adjustments to be made to fine details to achieve desirable images. Image post-processing was only used to remove dust spots and scratches on the glass of each enclosure.

**In this article**, the set up and maintenance of vivariums will be shown. Three specific vivariums are shown in detail. However, there are many other kinds of micro-habitats to create! The possibilities seem to be infinite. Information specific to the organisms used in each enclosure will also be given.

There is so much variety in the world that we live in. It is an incredible experience to be able to share and view its wonders. Being able to observe a portion of the world that may be millions of miles away is a practical and beautiful way to study those places. Playing a role in such lively and exotic ecosystems is an immense joy. Owning and maintaining vivariums can be an incredibly rewarding experience!

**Vivariums** are small areas that are usually enclosed. They are used for keeping and raising animals and/or plants for observation. They are occasionally created for research when a large ecosystem can be constructed that adequately simulates every component of an organism's natural habitat.

**Terrariums** are a type of vivarium that contain organisms that live terrestrially. They can range in climate and composition from dry and desert to humid and tropical.

**Aquariums** are a type of vivarium that incorporate organisms that live in aquatic environments.

**Paludariums** are a combination of terrarium and aquarium that are typically either swampy or have a transition from one to the other.



**The contained life** of the flora and fauna of a terrarium can provide an immense amount of detail into the behavioral traits of the inhabitants, while also being very entertaining. Though requiring a modest amount of effort to set up and maintain with care, a micro-habitat is one of the most rewarding ways to own pets. The thrill of being able to choose every component of an ecosystem, then watch them grow symbiotically, gives enjoyment, unparalleled. While providing enjoyment, keeping an environment that is representative of a piece of the world that could not be easily visited, vivaria also provide an observer with an incredible amount of insight into the rest of the world.

In total, the monetary cost of setting up a terrarium can range between \$5 and \$300, depending up on what the creator chooses to incorporate into the enclosure. As the size of the tank and variety of species increases, so does the cost. However, smaller enclosures consisting of natural ingredients found in the immediate outdoors can also be created, and be just as rewarding. The level of input and involvement in the creation and maintenance of the vivarium are up to the owner. Whatever the scale of the project, it is quite affordable and well worth the effort.

The world is yours to grow and cultivate!



# Materials

There are a variety of tools and resources required for each vivarium, dictated by the needs of the organisms that inhabit it. These tools can be split up into three basic categories: lighting, food & water, and space. Along with each of these, monitoring devices (thermostats, humidity detector, etc.) may also be needed. Once each of these necessities is taken care of, along with other smaller ones, one can be creative with creation!



As the needs of the vivarium changes, one must know what is needed to continue monitoring the environment. For example, if a new species of animal is incorporated into an enclosure that requires a specific humidity range, and there wasn't one present already, one must be able to accommodate for that creature. One must be able to accommodate to the needs of the inhabitants so that the space can thrive.

**Lighting** is of utmost importance to plants, as well as maintaining the night/day cycles of the animals that may inhabit the space. The sun provides the basic energy for the inhabitants of this great earth to live off of. In a sense, the lighting of a vivarium does the same. Because of this crucial component, one must take care in choosing which lighting is used.

The lighting setup shown at left cost \$8 for the lamp housing and the bulb, and provides full visible spectrum white light. It also provides a slight amount of heat for the enclosure when the filament in the bulb burns and emits light. This type of light is best used for generic purposes. Plants, depending upon their chlorophyll contents and concentrations, will have a particular affinity for a certain range of wavelengths of light. In most cases, a bulb that emits the full visible spectrum evenly is best, as no plant will be left behind.

There are also other types of bulbs that are used for more specific purposes. Desert terrariums will require heat lamps. They are made to only emit a large amount of heat, while giving off little or no light. Bulbs made specially for taking care of lizards that are found in hot and dry climates emit into the infrared portion of the electromagnetic spectrum. As the specificity of the bulb increases, the cost also goes up.

There are special terrariums that do not require light at all, as the organisms living within them live naturally within caves, or other areas with little to no light. Certain types of fungi or bacteria that are chemoheterotrophic do not need light. These environments are rare as a created space because they require specific chemical nutrients that are, typically, only found in the area where the organism was originally found.

When incorporating any light source into an environment, care must be given to its interaction with the organisms it is lighting. A plant in shade that requires a lot of light will not do well. This means that multiple light sources may be needed. Alternatively, too much light may make certain animals unhappy, as they do not encounter a lot of light in their natural habitats. One must tailor the light source(s) to the needs of each component of the enclosure.

**Temperature** control of a vivarium is of the utmost importance. A fluctuation of a few degrees could spell catastrophe for certain organisms. A bearded dragon that inhabits a desert terrarium will not be able to live in a cold climate, as it is cold-blooded and needs to sunbathe. There are many ways that an enclosure can be kept at a certain temperature, or range of temperatures.

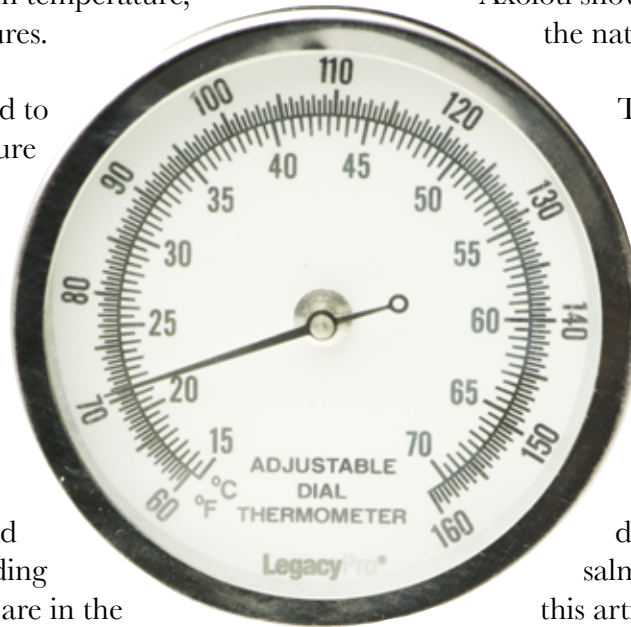
To accompany this, a thermometer is needed to monitor the temperature of the habitat.

There are several ways that one is able to heat an enclosure. Heating pads, heating lamps, and heating coils are most commonly employed. Each should be considered, depending upon what organisms are in the tank. Using a heat lamp to keep an aquarium at a certain temperature will not work as well as other methods because it will not give off as much heat, and will not be as consistent.

A **heating pad** is typically placed underneath an enclosure that has a soil or other kind of sediment layer. Providing a very constant amount of heat, pads are used to keep the lower regions of the enclosure warm. Ranging in cost, they are a great addition to a terrarium that has a lot of plants and/or wildlife that burrow.

**Heating coils** typically come with a fan to provide a synthetic warming breeze. They are used to heat the atmosphere of the habitat. Coils are typically used in larger units that accompany very large terrariums, and can be costly.

**Heat lamps** have the same effect as heating coils, but are used on a much smaller scale. Within the bulb of a heat lamp, there is a small filament. When a voltage is applied to the filament, it burns and gives off heat.



The **food and water** that each organism requires is the most specific and necessary component of keeping a vivarium alive and thriving. The care of an animals that live in very remote and distant locations can be very hard to feed because of the lack of availability of their food. In many cases, including that of the Axolotl shown in this article, food similar to that of the natural habitat can be provided.

The diet of an individual organism must be researched well in order to understand its requirements. As an example, an Axolotl is primarily a carnivorous creature, eating everything from small worms to fish. It will eat nearly anything that it can fit into its mouth. Because of this, an Axolotl can be fed supplementarily. The Indiana University Axolotl Colony caretakers fed their Axolotls a diet of high protein and vitamin enriched salmon pellets<sup>2</sup>. The Axolotl shown in this article is fed Brine Shrimp, and the same salmon pellets that IU used.

The water provided to the inhabitants of a vivarium must be treated to remove pathogens, as well as harmful chemicals. The easiest way to do this is to treat, carefully, tap water and/or bottled water with chlorine tablets and other chemical-removing agents.

To **control** the environmental controls used in the vivariums displayed in this article, an automated timer was used. These types of timers turn on/off the current supplied to appliances like lamps, filters,



and others used in vivariums. These handy devices can be used to regulate night and day cycles of micro-habitats. Costing between \$10 and \$30, they can save a caretaker an immense amount of time and worry, as they remove the need to be at the enclosure to turn on/off the equipment.

# Choosing A Habitat

A time lapse of vivarium creation, shown photographically.

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The creation of one's vivarium should be lively and inventive, while still maintaining respect to the its inhabitants. Every part of the whole must be considered, so that they may live symbiotically. It is easiest to model a micro-habitat after an environment that already exists. When one does this, detail must be considered. Every trophic level must be incorporated so as to keep the others in check.

The enclosure on this page displays a terrarium and an aquarium, kept separately, but within the same tank. This allows the entire enclosure to stay mildly humid. It is also easier to view!

A drainage layer of rocks was laid down first, then a combination of potting soil and outdoor soil was added. Special attention was taken to include decomposers like worms in the soil. Next, a layer of dead leaves was added. Several plants were strategically placed, and wall of bark with moss was put on the side of the tank. These flora and environmental controls create the setting of a forest floor in the temperate Northern Americas. Beta Fish friendly water was put in the aquarium, along with some personal touches. A Leopard Frog lives in the terrarium, and a Beta Fish lives in the aquarium.





# Choosing Inhabitants

An ecosystem encompasses an entire matrix of energy and nutrient flow that stays relatively contained within a certain area or within a certain group of organisms. The draw of being able to have a small ecosystem is that each component can be viewed and/or studied in relation to the others or individually. While it is possible to study a very large area that an ecosystem may cover, it may be best left to major biologists who are trained in that sort of thing. The most amount of time taken in setting up a terrarium should be in research and making sure that all components meant to co-habitate will also cooperate. A few methods of choosing inhabitants include:

**Study** ecosystems that already exist and choose a combination of inhabitants from that.

**Assemble** a list of inhabitants that exist within the same climate or region, but may not necessarily live within close proximity to each other.

**Experiment** with desired inhabitants. It is advised that this method should only be employed by trained caretakers and those with experience.

As one goes about choosing which animals one may want to inhabit their Vivarium, one may employ a variety of methods. The most important part of choosing animals is to make sure that they can, at the very least, co-habitate. It is much better if the components of the micro-ecosystem can benefit from one another being within a close proximity and live symbiotically. Forcing two beta fish to both live in a small tank together is a terrible idea, as one will probably kill the other.

When one becomes well accustomed to building and maintaining terrariums, one may choose to try new techniques. As an example, it may be possible to keep poison tree frogs in the same enclosure as an axolotl, as each species inhabits different terrestrial levels of the ecosystem. The space that each species requires should always be considered and given a good amount of leeway to ensure that co-habiting animals do not feel the need to compete for territory.



# Plants

Coming in many more varieties, as well as requiring a different set of nutrients aside from animals, plants are the essential basis in which a terrarium exists. Of crucial importance to the livelihood of flora are light, water and humidity, as well as the myriad of minerals that each requires to thrive. Because plants may not be as animated as animals, they do not, typically, readily exhibit signs of unhappiness to the untrained eye. When a plant begins to wilt or display odd colorations, one must take care of it immediately.

To make sure that plants are especially happy, they must have the correct compositions and adequate amounts of soil, decomposers, water, and light. Depending upon the species of plant, they may require different nutrients and environmental factors. It is important to research the requirements of each plant before one begins to create a habitat for it.

The soil a plant is provided is incredibly important. There are several nutrients that plants need, with the most important ones being Potassium, Nitrogen, and Phosphorous. Microbes and decomposers are very necessary, as well. Fertilizers and outdoor soil must be mixed to provide these nutrients, microbes, and other plant necessities.

As most plants respire, they uptake basic nutrients,  $\text{CO}_2$ , and  $\text{H}_2\text{O}$ . Energy is then spent to convert these components into sugars, and Oxygen is released. The amounts at which each plant does this is dependent upon the species and well-being of the plant in relation to the concentration of components of its diet present in the environment.

When one maintains an aquarium, it is necessary to both water quality and the aesthetics of the tank to keep water plants in it. Elodea, a type of water weed, is shown at right. Being particularly fast-growing, Elodea is especially good at removing harmful chemicals that may still be present in water, even after treatment. Other water plants uptake specific nutrients, and only live in specific habitats.



*Dracaena Sanderiana*



Elodea, a water-borne weed

# Northern Leopard Frog

The Leopard Frog is a very commonly found frog that inhabits temperate climates in the North America, as well as in small populations around the world. The frog shown on this page is, specifically, a Northern Leopard Frog. It is the official amphibian of the US states of Vermont and Minnesota<sup>4</sup>. It also holds particular importance in cancer, physiology, and neuroscience research settings<sup>5,6</sup>.

The terrarium that this frog lives in was created to model a temperate forest floor ecosystem. The frog was found in the outdoors and brought into the terrarium. This method of finding inhabitants for a vivarium is a cost free, but very risky. Any time that an organism is moved into a new place, care must be taken to ensure that it is happy.

Incorporated in the ecosystem are a modest amount of dead leaves that the frog can burrow beneath, bark and twigs that can be used as additional coverage, and plants that are sturdy enough for the frog to climb on. These components are a representative sampling of the type of environment that the animal was taken from for observation. To mimic the diet that it would have in the wild, small insects, worms, and other such prey are collected periodically and placed in the enclosure. When food cannot be found from the outdoors, a supply of *Drosophila* are kept alive and ready to be put in the habitat.

The Leopard Frog is a very versatile species. It lives anywhere between sea level and 10,000ft, is very well adapted to cold climates, and can swim, climb, and leap very rapidly. Being brown and green in coloration, with patches of dark brown or black, it resembled the patterning of a Leopard, which is how it got its name. Because of its well-adapted traits, it is also a skilled hunter, and has been found to eat most anything in size between flies to small snakes. The image at right shows how the frog will use its large tongue to lash out and catch prey.



An image of a Northern Leopard Frog taking shelter under leaves in the forest floor.



An image of a Northern Leopard Frog lunging forward and using its tongue to catch prey.

# Axolotl

## Facts and Care

Axolotls are only found in the wild in Lake Xochimilco, Mexico. The lake, with its many streams, rivers, and man-made canals, has become a threatened space. Mexico City uses Lake Xochimilco as a water source, and has contaminated a large amount of it. The reduction and pollution of Lake Xochimilco, along with the introduction of large predatory fish, and the hunting of Axolotls for Mexican food markets (they are considered a delicacy) has significantly decreased the total population of axolotls in the wild. They are critically endangered.

If an axolotl lives to its fullest, it can be 15 years in age and nearly 12 inches in length. They are neotenal, meaning that they retain juvenile characteristics throughout their entire life, in most cases. Because of their neoteny, they are subject to many scientific studies. Neotenal creatures exhibit the ability to re-grow limbs and, in the case of some Axolotls, portions of their brains. The large dorsal tail and protruding gills are juvenile characteristics as well.

Their neoteny is caused by a thyroid disorder, which can be artificially altered. Through injections of thyroid stimulating hormones or chemicals such as thyroxine or iodine, they can be induced to grow to full maturity. This is very rare and does not occur naturally. When mature, their gills retract, teeth grow, the dorsal tail shortens, and the fingers lengthen. These changes allow adult Axolotls to live on land. A mature Axolotl resembles a tiger salamander.



Because they do not have fully grown teeth, Axolotls rely on sucking in their food with the surrounding water. As such, they will eat nearly anything that can fit into their mouths. One must take care to not include anything in the tank that small. They are happiest being fed worms, small waterborne creatures such as Daphnia or Brine Shrimp, and will also eat fish pellets to gain essential nutrients.

Costing around \$40, Axolotls are interesting pets that require a modest amount of care. They must be fed nearly every day, and must be kept in an aqueous environment of around 70° F. One must take care to keep an Axolotl aquarium devoid of serious bacteria, as well as many chemical treatments. This can be done by using tap water, removing the chlorine using chlorine tablets, letting the water sit for a few days before exposing the axolotl to it, in addition to keeping water plants in the tank to remove pollutants.



# Beta Fish

## Facts and Care

Siamese Fighting Fish, commonly known as Beta Fish, are popular freshwater fish. They are native to the rivers and rice paddies of southern Asia. They are listed as a vulnerable species in the wild, and have been extensively and selectively bred in captivity for their brilliant colors. This type of breeding began in the mid-1800's. Male Betas are more commonly bred, as they show more vibrant colors than the opposite sex. They can live anywhere between two and ten years.

The incredible coloration variations that are associated with Siamese Fighting Fish are a result of breeding, as well as a variety of changes the fish can make in response to environmental cues. There are wide gamut of these fish that exhibit coloration variations. In nature, they exhibit intense colorant variation when agitated, depending upon environmental pollutants, and when in the presence of the other sex. Their color variation does not come from pigmentation, but from the refraction of light through a thin layer of guanine crystals.

Adult Betas can often be seen taking oxygen from the air, rather than only through their gills. They possess this ability due to the presence of the labyrinth organ. This organ is a small sac used for holding air.



The Siamese Fighting Fish shown on this page is a male Crowntail with red and blue color variation. He is fed a diet of Beta pellets, Daphnia, and, on occasion, Drosophila. This diet was created to mimic the carnivorous diet that a Beta would encounter in the wild. In their natural habitat, they eat small plant matter, zooplankton, small crustaceans, and some small insect larvae.

Male Siamese Fighting Fish release bubbles that accumulate on the surface of the water. This behavior is known to be the preparation of the male for mating and the development of the eggs. When a male and female mate, the female releases her eggs into the water, and the male releases milt. As the eggs are fertilized, the male retrieves the sinking eggs and deposits them into the bubbles at the surface, known as the bubble nest.

Beta fish are incredibly resilient fish and will live in many conditions, as it shown by their range in the world. They are also quite aggressive and will become extremely hostile towards other fish if put in close a proximity. They will sometimes become aggressive towards their own reflection, if kept in a tank with the wrong glass. The same behavioral complex that allows them to respond to environmental cues allows them to be trained. Siamese Fighting Fish can be taught when food is coming through controlled and repeated stimuli and reward.



# Basic Terrarium

One can make a wide variety of terrariums, differing in size and cost. The terrarium displayed on this page is one of the smallest, cheapest, and easiest to take care of. The inhabitants include moss gathered from a dead log, leaves from the forest floor, soil and decomposers, and a small fern was removed from an area near to the moss.

The contents of this terrarium were all gathered from the great outdoors. As they were extracted from the wilderness, care was taken to ensure that they were not too terribly disturbed. Although plants can be very sensitive, they can usually withstand the pressures of being transplanted, as long as one makes sure that the plant remains whole. Each of the inhabitants was chosen because of their ability to exist stably by themselves. They do not require much other than some water, nutrients from the soil or decaying matter, and sunlight. If one is feeling particularly adventurous, small herbivorous insects may be added.

Kept on a windowsill, this enclosed terrarium can live for weeks or months without needing care. Moss is typically used in terrariums as an indicator of the health of the whole system, as it is fairly sensitive to poor conditions. If moss ever begins to lose its color or wilt, the causation should be investigated. Routine maintenance of this kind of terrarium may include opening the jar every few weeks to let in  $\text{CO}_2$  and release oxygen, and adding some water.



# Sources and Additional Reading

- 1 <http://www.axolotl.org/>
- 2 <http://www.axolotl.org/feeding.htm>
- 3 <http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm>
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- 6 <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1392564/>
- 7 <http://www.bettatalk.com/food.htm>



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