

Food for Urodela

Henk Wallays
Ter Goedingen 40
9881 Bellem (Aalter)
Belgium
 henk.wallays@skynet.be

Worms

Most salamanders are crazy about worms. There are several species of worms around, however, and not all of them are equally appreciated by our salamanders.

Worms that live on animal-waste products are best avoided since—through their feeding—they can contain toxic products. Some salamanders such as *Pachytriton* and *Paramesotriton* species will refuse to eat them. They will first smell them, eventually take a first bite, and then spit them out again. When buying worms in pet stores, you will probably get tropical compost worms. These are accepted by some species, but not by all. The trouble with them is that when attacked they will excrete a milky secretion, which is not appreciated by all of our tailed friends.

There also exist a lot of insect-eating salamanders, such as the Plethodontidae, and

worms normally don't fit into their diet. Examples are the mid-American tree salamanders of the genera *Bolitoglossina* or *Oedipus*. Other little salamanders have such a narrow mouth that worms simply don't fit in them (for example, *Plethodon cinereus*). One of the major points (for any food resource) is to choose the size of the prey in relation to that of the predator. The general idea is that the salamander eats the worm and not that the worm strangles the salamander.

Worms are rich in calcium and thus important for growth. Feeding juvenile axolotls solely on earthworms resulted in 15-cm long axolotls in one year, a length they failed to reach when I fed them solely with bloodworms. On the same feeding schedule, young *Hynobius dunni* doubled their size in only two months. Urodeles that readily accept worms include species belonging to *Salamandra*, *Ambystoma*, *Pseudotriton*, *Gyrinnophylus*, *Cynops*, *Paramesotriton*, *Neurergus*, *Necturus*, and *Taricha*.

Slugs

When gardening among my hosta, fern, and bamboo, I'm always happy to discover that I have a garden that's very rich in slugs. My wife—who is an enthusiastic plant lover—doesn't share this sentiment with the same



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Northwestern salamander (*Ambystoma gracile*) enjoying an earthworm meal.



Axolotl (*Ambystoma mexicanum*) and bloodworms.

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enthusiasm, however. The slugs congregate in the shadowy damp places of the garden, underneath stones and, especially, wood or plastic. I offer them to most of my American mole salamanders, who chase them with much appetite. Remarkably enough, they are left unharmed by most of the *Hynobius* species. *Ambystoma maculatum* and *A. macrodactylum*, especially, are true slug chasers. In older literature (Lacerta, Holland) we also read a story that tries to link fertility with feeding with slugs.

Tip. An easy way to catch slugs is to put a sheet of newspaper for a few minutes into a dish with beer, and then put the beer-soaked paper outside in a shady place underneath some stones. It's common knowledge that slugs are attracted by beer. You can harvest them each morning.

Aphids

In the middle of the summer, when the usual food resources were getting scarce, I once took an aphid-infested leaf from a rosebush and placed it in the raising tank of my juvenile *Cynops pyrogaster*. After two days, the quite starved *Cynops* showed off a nicely filled belly again. However, if you plan on feeding aphids, take care to cut only branches of trees or shrubs that you are sure have not been treated with insecticide.

Enchytraeids

These little white worms are quite easy to breed and keep at room temperature (20 °C). Whereas *Daphnia* are the main source of food for aquatic young, enchytraeids have an important place in the feeding of terrestrial juveniles. I culture my enchytraeids in plastic pots filled with composted soil, on top of which I lay a piece of newspaper (to create a layer of darkness and humidity). The ground is quite moist, but not swampy. When I need worms, I mix a large spoonful of rolled oats into the soil. At a temperature of about 17°C, it takes about a week to have large masses of little white worms ready to offer to your precious young. The worms can also be offered to aquatic-stage larvae, since they tend to move around quite a while (hours) and thus attract the attention of the larvae. Rearing enchytraeids with the usual milk and cheese method yields worms that contain much fat, which, when offered frequently, are said to cause liver trouble. I offer enchytraeids especially to young *Ambystoma*, *Cynops*, *Neurergus*, and *Hynobius*.

Tip. If you want to start a fresh culture, here's a tip for catching them. Find a convenient compost heap and put in a slice of bread in a damp place by the heap. Leave it there for two days, then dig it up: normally, you will find lots of enchytraeids underneath the bread.

Bloodworms

Whereas earthworms are the main dish for the terrestrial adults, bloodworms play an important role in the diet of larvae and aquatic animals. In Belgium, we have three sorts of mosquito larvae: translucent white, black, and red. The red form is most suitable: they move more and have a striking coloration, making them easy for larvae or adults to discover them. Especially at night, you will be able to see them dancing around through the pursuing salamanders. They can be purchased at a local fish store

Problems

Egg penetration. I've already observed bloodworms that penetrated the outer layers of eggs. Whether they are actually damaging the egg or not, I've not yet been able to verify.

Planaria. While feeding with bloodworms, one also imports eggs of other, more harmful things into the tank. One of them might be planaria. This little grey flatworm, recognizable by its triangle-shaped head, has an insatiable appetite for salamander eggs. They avoid direct light and start crawling around only during twilight, when they leave their hideouts (underneath a stone or leaf) and climb on the sides of the tank. While breeding *Neurergus strauchii* in 1996 and 1997, I lost well over 80% of the total egg package because of planaria. They intrude through the different

jelly layers in order to reach the egg, on which they feed. One ends up having eggs that look like they have imploded; the eggs shrink day by day. If this sounds familiar, start checking the underside of the stones. So far I have not found a method for eliminating only the planaria from the tank, without harming the other inhabitants. Raising the salt level in the tank seems to work well, but the mortal limit of planaria will also harm the urodela, which are not too keen on brackish water, either. A simple solution is to clean the entire tank by hand. Another practical solution is to move the salamanders to another tank and put little fish in the planaria-filled tank. Some cold-water fish will eventually eat them (sticklebacks do).

When temperatures start to rise suddenly during the springtime, most bloodworms in nature will metamorphose and become mosquitos. In this short period, which most unfortunately always seems to coincide with the reproductive period of the salamanders, bloodworms will not be available in the shops (unless they carry imported material).

Tips for raising juveniles

Terrestrial juveniles can easily be fed with bloodworms, too. Take a piece of wet paper towel and put some bloodworms on it. The wet substrate will keep them alive a long time, and the wriggling red worms on the white substrate are sure to attract the attention of



Planaria

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the young hunting salamanders. After feeding, you simply take away the paper towel, so you don't get the urodatum dirty. I have successfully used this technique in raising *Cynops*, *Paramesotriton*, and *Triturus* species.

Cyclops

It's best to avoid feeding larvae these little crustaceans, since they will attack the larvae. High densities of *Cyclops* can result in the death of the larvae and negate most of your efforts in raising the species.

Artemia

Most people who have formerly kept tropical fishes know about this food resource. The eggs are for sale in the tropical fish stores and can, through an easy process, be hatched and raised in salt-enriched water. The orange brine shrimp can then be offered, and, despite being released in freshwater, they tend to stay alive for awhile. Just as with *Daphnia*, these shrimp seem to contribute a lot to the red coloration of the belly of firebellied newts.

Problems

Separating the shrimp from the remaining eggshells is quite important. After feeding some *Pleurodeles waltl* larvae with *Artemia*, the larvae suddenly started developing gas bellies and floating around the water's surface, and finally dying off. After a search with a microscope, remains of eggshells were found in the intestines, blocking them off.

Daphnia

Feeding larvae of Asian firebellied newts (*Cynops*, *Paramesotriton*) frequently with *Daphnia* will enhance the red belly coloration. We frequently notice captive-bred species with orange bellies; feeding them with *Daphnia* just might make a difference. Adult newts are willing predators on *Daphnia*, too. Currently, it looks as if feeding *Daphnia* to *Neurergus strauchii* might—surprisingly—be troublesome. Further observations and investigations are, however, necessary to confirm this.

Tips. For the raising of salamander larvae, *Daphnia* and their young play an important role in the early phase: they are the main source of food for most captive-bred species. One should choose their size in relation to the

size of the larvae to be fed. This can be done by sifting them through some fine *Daphnia* nets, which are available in various

To assure maximum uptake, it's best to offer of the larvae's eyes. In this way, larvae don't waste unnecessary effort or energy trying to catch and swallow to low *Daphnia* that are too large for them. When there's enough light, they will stay alive in the tank, offering the advantage that they clean up the water while feeding. On the other hand, food stays available, and when the *Daphnia* reproduce, you end up having young *Daphnia* in your tank year round.

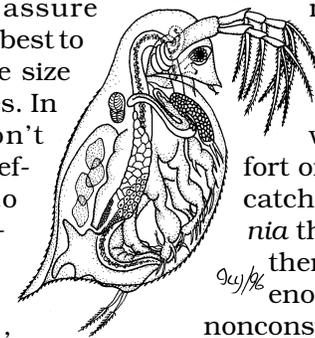
Where. *Daphnia* can be purchased in some tropical pet shops. During the summer months, they can be massively available in stagnant water containing much plant debris or animal waste, sometimes in such densities that the water appears reddish. A small duck pond (in a park) is a handy source. You'll also be surprised how many *Daphnia* you will find if, during the winter, you net through waterweeds in a well-filled garden pond (even under ice).

Mysis (Freshwater Shrimp)

In some brackish water, it's possible to find *Mysis*. This creature looks like a little shrimp and can be eaten by various aquatic salamanders. I have, however, not yet worked with this food resource. It's also not an easy task to bring home captured *Mysis* alive.

Fruitflies and Their Larvae

In most terrarium pet shops, you can buy the well-known pots with fruitfly maggots. They are, perhaps, more commonly used by frog keepers, but they also have a value for the urodel keeper. Some plethodonts are mainly insect eaters. For little species such as *Plethodon cinereus*, they are good-sized prey, which in no time will be discovered and captured by means of a sticky tongue. Land-phase juvenile salamanders will accept both flies and larvae. The maggots, however, are delivered in a smelly paste, which is better not spread around the raising tank. Offering them



in a small pot, on the other hand, carries the risk that your juveniles will fall into this swamp and drown. For this reason, I herewith quote a nice, clean, and practical solution, which was originally worked out by Henri Janssens, Brugge, Belgium.

Take a piece of a plastic electric tubing and seal off one of the ends. Fill the tube halfway to two-thirds full with the jelly and maggots. Cover the other end with a fine mosquito netting. Place the tube in the rearing tank with the end with netting somewhat higher than the sealed end. When the maggots want to spin their cocoon for their metamorphosis, they will search for a dry spot and start climbing out the open end—where after a while the young salamanders will know to find them.

Waxmoths and Larvae

Waxmoths are very nutritious and fairly easy to breed and keep. There are various ways of raising them; one is to make your own mixture, and another consists of keeping them on used wax combs, which you might obtain from someone who keeps bees as a hobby. However, in this last case, it's better not to pronounce the name of this little insect in their hearing. One escaping waxmoth might mean the end of their hobby.

Tadpoles

Tadpoles are frequently predated on by newts in nature, so it must not be a shock to see this food item on the list. I have personally observed predation by adult *Alpestris* on frog eggs. The newts started crawling over the egg mass and picked out just the eggs. After the festival, only an empty transparent jelly remained. Species like *Pachytriton* and *Paramesotriton* just love tadpoles and will chase them around in the tank. However, be aware that most European frog and toad tadpoles are protected by law. So you will need to breed the frogs if you want to offer this type of food.

Fish

Some of the larger neotenic species, such as *Andrias*, neotenic Ambystomids, and *Necturus* (to name a few), will also eat live fish. This feeding behavior has given mudpuppies and other species a very negative name to sports fishermen. The overall damage mudpuppies can do to salamander populations has been

quite exaggerated, however. But anyway, you can readily offer little fish to these species.

Buffaloworms

You can purchase these little mealworm-like animals in some pet shops as food for exotic birds. They are tinier in size than mealworms, and I have offered them to various sorts of terrestrial urodela such as *Ambystoma*, Plethodontidae, and even *Hynobius*. Especially when raising juveniles of *Hynobius*, *Ambystoma opacum*, and *Macrodictylum*, such a food resource comes in handy. As in the case of mealworms, one should not feed solely these little worms, since they are rich in fat and are said to cause liver troubles.

Problems

Don't feed buffaloworms in polystyrene foam (for example, Styrofoam or Tempex) boxes: they will eat their way through, making little 'ventilation holes.' The danger with this is that they get eaten on the way by the salamanders, who at the same time devour the Tempex. This can lead to constipation and eventual death of the juveniles.

Beef heart

Beef heart can be purchased at a butcher shop or at the meat counter of a grocery store. It might not look or smell appealing, but it is a powerful food resource for salamanders. Some salamanders used for lab research are mainly fed on this. For the larger species, it's sufficient to cut the meat into little strips and move it in front of the animals. Most of them will react to the movement and snap at it (e.g., *Ambystoma gracile*). For aquatic urodela, I cut the meat in pieces and stir it thoroughly until it becomes a paste. Then I take an ice-cube tray from the freezer and divide the meat into little portions and freeze it. From one beef heart you can get a lot of food. Fifteen minutes before you want to start feeding you can pick out one of the cubes and let it thaw (or put it in the microwave briefly), then divide it among the different tanks. The scent of blood will spread through the water and most of the newts react to it quite soon. Streamside salamanders, especially, are very successful in locating the prey and can react quite aggressively. I have successfully tried out this food resource with *Pachytriton*, *Paramesotriton*, *Neurergus (strauchi and crocatus)*, *Cynops*,

axolotls, *Triturus*, and *Pleurodeles*, and even aquatic Gymnophiona such as *Typhlonectes compressicauda*. In Oregon (USA), we even barehandedly caught neotenic Dicamptodons this way. After a short adaptation period—to recognize and appreciate the food—most salamanders readily ate this food resource, which might just make the difference during the periods of the year when other supplies are unavailable (early spring and midsummer).

Problems

Water pollution. Leftover pieces of beef heart should be removed from the tank, since they pollute the water. This problem can be avoided by the introduction of meat-eating red water snails. In contrast with the other snails—who mainly devour plants—this red form prefers flesh. But, on the other hand, they might also eat some of the salamander eggs (e.g., *Cynops* and *Neurergus*). If you offer beef heart frequently, water changes should be performed on a regular basis, too.

Housefly maggots. This food resource still meets with much discussion; some people talk about the danger of perforated stomachs or intestines, other people just praise it. I will not take in a position in the debate, but can only confirm that, over the years, I have raised quite a lot of salamanders (*Hynobius*, *Neurergus*, *Ambystoma*, *Triturus*, *Pachytriton*, *Cynops*) on this easy and cheaply available resource without encountering troubles. Only the *Paramesotriton* are not too crazy about it.

Tip. From a urodela meeting in the Netherlands, I have the following practical tip from Edo Van Uchelen for actually raising your own maggots "a la carte." The advantage of the procedure is that you can raise them to any size you need, even very handy little ones (which are generally not available in pet shops).

Take some cat or dog food out of a can and put it outside in a sunny place. Be sure to keep the food wet when placed in the sun, and when you have dogs or cats in the environment, pay attention that they don't run off with all your efforts for dinner. On account of the odor, it's recommended that you place this somewhere outside. If all goes well, the flies will soon show interest and lay their eggs. After some days, you will get a not-very-good-smelling, moving jelly of crawling larvae and half-eaten meat. You can dip out the neces-

sary portion of larvae daily by putting them in a little *Daphnia* net. By washing off the remains of the jelly under water (to prevent fungi from flourishing) you will get pure food for juveniles that you can safely release in the raising tank.

Water Sow Bugs

In standing water with much plant waste, especially, you'll find a lot of these crustaceans. In my garden, I keep a large plastic container (100 liter) filled with waterweeds and swamp plants. In the fall and winter these plants die off and pollute the water. An explosive culture of sow bugs follows as a reaction during the late winter and early spring. I offer these especially to my *Neurergus* species to enrich their diet. If they are small enough, they will also be consumed by the larvae.

Pill bugs, Rolypolys, Sow Bugs

These crustaceans can be found under pieces of rotten wood in humid and shady places. During the winter, I have even found a large aggregation pressed together between the roots of still-living trees. During other seasons, you'll probably find them in your own garden under stones and in moist wood, from which they are easy to remove. I feed them mainly to my land-dwelling species and even to land-phase *Triturus*. Since most of my tanks are configured in a natural way (with pieces of wood and ferns) and have at least five hours of lighting, the nonconsumed animals stay around and even reproduce in the urodariums, thus offering a large variety in size. This is very practical if you have young to raise. Refreshing with newly captured animals from time to time may be necessary.

Hyalella Azteca

Another good friend suggested to me a second unusual food resource: the American species *Hyalella azteca*. Some streamside salamanders young such as *Neurergus* and *Salamandra* larvae consume large amounts of these crustaceans under natural conditions.

These little crustaceans are much smaller than their European counterpart, *Gammarus*, which is not suited for keeping at room temperatures. Furthermore, transportation of *Gammarus* is not that easy either because they need much oxygen. In the USA and Canada, *Hyalella* is a much-used lab animal



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Typhlonectes compressicauda and shrimp.

for testing water quality. They are found in standing or gently flowing waters, where they live as sediment burrowers feeding on plant debris. Under favorable conditions, they can be present quite massively and are a good healthy nutrient for fish and salamanders. Adults measure from 6 to 8 mm.

Concerning Captive Maintenance

The optimal temperature is around 23°C, which, together with a 16-hour light cycle, will result in a large reproduction. Temperatures higher than 33°C are lethal. As food, you can offer them fish flakes, trout pellets, and even maple leaves.

I recommend that you give the animals a

substrate in which they can hide. A piece of cotton or nylon nets are suggested in the literature, but some more natural substrate such as pebbles might work as well.

Finally, in water, salamanders act like little predators who will hunt down anything that is moving and soft enough to ingest, including their own larvae. Some (*Ambystoma*) salamanders are even the top predators in fishless waters. Aside from the above mentioned food resources, there are certainly many other prey that might be useful. This list is only meant to be a first practical step, mainly based on my personal experiences. As we encounter and use other sources, I hope to extend this list. If anyone else has other useful ideas and tips, feel free to inform me.