

Keeping Caecilians in Captivity

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INTRODUCTION

Caecilians are among the strangest and least known groups of vertebrates. These limbless, worm-like amphibians are found throughout much of the humid tropics where most species live a subterranean life. Herpetoculturists generally have very little experience keeping these fascinating creatures in captivity, relative to other major groups of reptiles and amphibians. With the exception of one species that is commonly seen in aquarium stores, *Typhlonectes natans*, they rarely appear in the pet trade. This is because caecilians are much more difficult to collect than most other amphibians. Perhaps due to the fact that they burrow in tropical soils (which are very stable environments), many caecilians seem to be extremely sensitive to even slight fluctuations in temperature and are therefore difficult to keep alive during transport.

Over the last several years, I have been fortunate enough to have kept many different types of caecilians in captivity. Because they lack common names, I will refer to all of the species discussed in this paper by their scientific names. If healthy individuals can be acquired, most species seem to readily adapt to life in an aquarium half-filled with potting soil. Provided with stable temperatures and an ample food supply, they live for many years. In this paper, I will describe what I have learned through trial and error about keeping caecilians in captivity. This is meant to be a starting point for anyone interested in keeping caecilians, and it is certainly no more than that. Any serious attempts at maintaining and eventually breeding these animals will necessarily involve a great deal of careful experimentation on the part of the reader.

HUSBANDRY

Housing

All caecilians are escape artists and their cages must be covered with tight-fitting and heavily-weighted (or otherwise secure) lids. Although some are aquatic, most species are terrestrial and live in organically rich soils (Taylor, 1968; Wake, 1980; Hebrard et al., 1992). An aquarium, half-filled with a pH-balanced commercial potting soil, and covered with a glass lid, provides a good home. In general, bigger is better for four reasons: 1) many caecilians are aggressive toward one another, and larger containers give each individual space to avoid more aggressive cage mates; 2) as mentioned before, most caecilians are very sensitive to changes in temperature, and the larger the volume of soil the more resistant it is to outside temperature fluctuations; 3) the soil in which caecilians are kept eventually becomes fouled and must be changed. The point of intolerance is reached much more rapidly in smaller volumes of dirt (and with higher densities of animals); and 4) the moisture requirements of most species are not known. However, a large container allows you to add water at one end and create a moisture gradient in the soil. The caecilians can then choose areas in the container with suitable moisture levels.

Most of the terrestrial caecilian species I have kept seem to do best in soil that is moist enough to form tunnels but with no standing water. An exception to this rule is the west African *Geotrypetes* cf. *seraphini* which seems to prefer very wet soil, even to the point of having a small amount of standing water in the deepest layers. Another exception is *Siphonops annulatus* (Fig. 1), a South American species which does very poorly when kept in uniformly damp soil. However, if provided with a moisture gradient that includes a very dry area, they seem to thrive. Lastly, members of the east African genus *Scolecophorus* seem

to not spend much time burrowing, and need to be provided with surface cover such as flat rocks or damp paper towels under which they can hide.

Many caecilians have an aquatic larval stage in their life history. Larvae are externally different from adults in having a much blunter head shape, larger eyes, an external gill slit called a spiracle, and a small tail fin. Larvae have been kept in captivity only rarely (e.g., Breckenridge et al., 1987; Himstedt, 1991). They can be housed in an aqua-terrarium with access to both shallow water (with vegetation or other debris in which to move about) and muddy soil. They do not seem to use open water areas, so these are not important to provide. I have also kept larvae in small plastic containers with shallow water and unbleached paper towels to hide under. This type of arrangement allows for more careful monitoring of the health of individuals but requires frequent water changes to prevent death from unsanitary conditions. If tap water is used, it should be treated to remove chlorine and chloramine. Alternatively, larvae can be kept in distilled water that has been fortified with salts (1.8 g NaCl, 0.05 g KCl, and 0.1 g CaCl₂, added to 1 L distilled water).

A few South American caecilians (members of the genera *Potomotyphlus* and *Typhlonectes*) are completely aquatic as adults (Moodie, 1978; Nussbaum, 1986; Wilkinson, 1989). I have kept *Typhlonectes* under the same basic conditions as tropical fish for many years. However, they seem to be very sensitive to local water conditions and, like larvae, can be kept in distilled water with added salts (see above recipe) as an alternative to treated tap water (O'Reilly et al., 1995). The water in the aquarium should be well-filtered and shallow enough so the caecilians can reach the surface to breath without swimming. A dark, pea-sized gravel substrate with flat stones for cover seems to lower stress levels and improve the overall health of these nocturnal amphibians.

Diet

Larval caecilians locate and capture prey in a manner similar to aquatic salamanders. Using lateral line organs in the skin which can detect both water movement and weak electric fields, larval caecilians can find living prey in com-

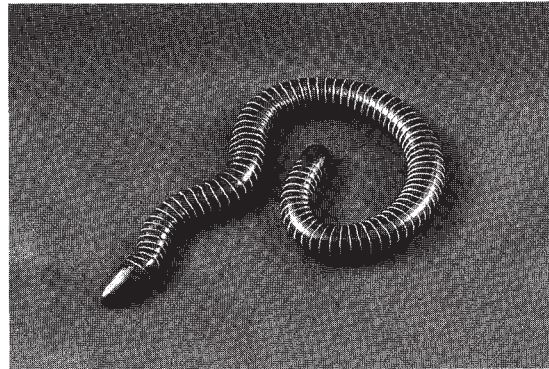


Figure 1. The South American *S. annulatus* needs access to both moist and dry soil to remain healthy. This apparent millipede mimic also moves much more slowly than other caecilians. (Photo by Dan Boone).

plete darkness (Himstedt and Fritzsich, 1990). The eyes of larval caecilians can certainly detect changes in light intensity, but probably play no role in locating food. Adult caecilians find and capture prey in a manner that is fundamentally different from that seen in other terrestrial amphibians. Salamanders and frogs rely primarily on visual cues to locate prey (Roth, 1987), whereas caecilians rely on their sense of smell and on chemosensory cues gathered by their tentacles (Himstedt and Simon, 1995). The tentacle is derived from the tear duct, certain extrinsic eye muscles and other parts of the eye (Wiedersheim, 1879; Billo and Wake, 1987). In many species it can be protruded well beyond the skull to gather large molecules from the substrate. After locating food, most salamanders and frogs use their tongues to capture prey, while caecilians use only their jaws to subdue prey items (Tanner, 1971; Bemis et al., 1983).

As with most aspects of caecilian biology, there is limited information available on their diet in nature (Barbour and Loveridge, 1928; Moll and Smith, 1967; Wake, 1983; Hebrard et al., 1992). However, there is a growing data base on the foods taken and refused by captive specimens (Table 1). The larval *Epicrionops* that I have kept ate only living amphipods when they arrived. However, I conditioned them to eat small pieces of earthworm by waving suitably sized chunks directly in front of their

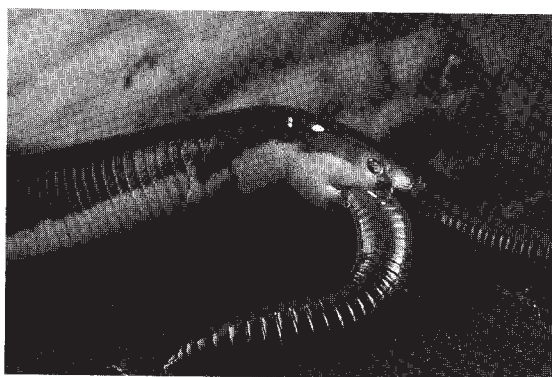


Figure 2. *Ichthyophis kohtaoensis* subduing an earthworm. With few exceptions, caecilians seem to relish earthworms. Many species can easily eat worms up to half their own body size. (Photo by Dan Boone).

snouts with a small pair of forceps. With the exception of members of the east African genus *Boulengerula*, which seem to prefer termites and other small arthropods (Barbour and Loveridge, 1928; Hebrard et al., 1992; O'Reilly et al., 1995; M. Wilkinson, pers. comm.), all adult caecilians that have been kept in captivity readily eat earthworms (Fig. 2). Some species, such as members of the genus *Caecilia* seem to eat nothing but earthworms. Others, such as *Hypogeophis rostratus*, will eat many types of foods including some that are unlikely to be available in nature (Tanner, 1971). The best tactic is to offer new specimens a variety of food items and keep careful notes on what they will and will not eat.

Health Problems

Caecilians suffer a variety of health problems in captivity. Signs of distress include inflammation or hemorrhaging of the skin, spending large amounts of the time on the surface of the soil, or sluggish behavior. Wake (1994) reports treating skin problems by placing terrestrial species on damp paper towels in a plastic box and adding a penicillin-streptomycin-gentamycin solution. I have found that moving the animal to fresh soil or (if the soil is already fresh) trying a new brand of potting soil often leads to a quick recovery from skin problems.

A more serious skin ailment is the presence of sores that penetrate the dermis and leave a gaping wound that exposes the underlying muscle. I have only seen these on recently imported specimens, never on long-term captives. They may originate with some sort of physical trauma, but the exact cause of these usually fatal sores is not known. The sores do not seem to respond to antibiotics and may be caused by a virus.

Many wild-caught caecilians seem to have low level nematode infestations (Hebrard et al., 1992). These usually are not a problem but can get out of control and become lethal when animals are stressed. *Typhlonectes natans* often has small hard lumps in the skin that are caused by nematode eggs (M. Wake, pers. comm.). When the nematode larvae hatch and emerge from the skin, open wounds form that often become host to fungal infections. These infections have been successfully treated with gentamycin (M. Wake, pers. comm.)

REPRODUCTION

As far as is known, all caecilians have internal fertilization. Males possess an erectable intromittent organ called a phallosome that is used to transfer sperm into the cloaca of the female. The common ancestor of all living caecilians probably laid two strings of eggs in a terrestrial nest and guarded them until they hatched. After hatching, larvae lived an aquatic life for many months before metamorphosing into terrestrial adults. Many species of caecilians still have this life history, but new life history patterns have appeared independently several times during caecilian evolution. In some lineages, the eggs hatch directly into terrestrial juveniles, while others are viviparous, with the female retaining young in the oviducts and providing nutrition to them for many months before birth.

No oviparous caecilians have been bred or even induced to lay fertile eggs in captivity. There is a single report of a *Siphonops* laying a clutch of eggs but these were apparently infertile (Gans, 1961). Clutches of eggs have been gathered from the wild and successfully hatched in captivity (Breckenridge et al., 1987; R. Nussbaum, pers. comm.). I have successfully reared a clutch of *Grandisonia* eggs (col-

Table 1. Prey taken and refused by various caecilians based on observations of captive specimens and gut contents of wild specimens. *Only dead individuals offered. **Had to be conditioned to recognize worms as food (see text).

Species	Prey Taken	Prey Refused	Sources
Caeciliidae			
<i>Boulengerula boulengeri</i>	termites	earthworms	Barbour and Loveridge (1928); O'Reilly et al. (1995)
<i>Boulengerula taitanus</i>	termites, <i>Acheta</i> , raw fish		Hebrard et al. (1992); M. Wilkinson (pers. comm.)
<i>Caecilia orientalis</i>	earthworms	<i>Acheta</i> , <i>Mus</i>	O'Reilly et al. (1995)
<i>Caecilia</i> sp.	<i>Galleria</i> larvae		O'Reilly et al. (1995)
<i>Chthonerpeton indistinctum</i>	earthworms, <i>Acheta</i> , <i>Mus</i> , <i>Anolis</i> , <i>Arceiva</i> , <i>Galleria</i> larvae, orthopterans, hemipteran larvae, coleopteran larvae, dermapterans, termites		Tanner (1971)
<i>Dermophis mexicanus</i>	earthworms		Moll and Smith (1967); Bemis et al. (1983)
	earthworms		Wake (1983); O'Reilly et al. (1995)
<i>Geotrypetes seraphini</i>	earthworms, termites, orthopterans		Bennett and Wake (1974)
<i>Grandisonia alternans</i>	earthworms		O'Reilly et al. (1995)
<i>Grandisonia brevis</i>	earthworms		O'Reilly et al. (1995)
<i>Gymnophis multiplicata</i>	earthworms, termites, orthopterans		Tanner (1971); Bemis et al. (1983)
<i>Hypogeophis rostratus</i>	earthworms, <i>Eisenia</i> , <i>Formica</i> pupae, <i>Mus</i> , <i>Calliphora</i> larvae, <i>Rana</i> , termites, <i>Tenebrio</i> pupae, cerambycid beetle larvae, raw fish, <i>Galleria</i> larvae and pupae	<i>Tenebrio</i> larvae and adults, <i>Galleria</i> adults, various moth caecrpillars, <i>Calliphora</i> pupae, <i>Anguis</i> , <i>Natrix</i> , <i>Bufo</i> , frog eggs, salmon roe, various anuran larvae, slugs, veal	Tanner (1971); O'Reilly et al. (1995)
<i>Schistometopum thomense</i>	earthworms		O'Reilly et al. (1995)
<i>Siphonops annulatus</i>	earthworms, <i>Acheta</i> , <i>Mus</i>		O'Reilly et al. (1995)
<i>Typhlonectes compressicaudus</i>	insect pupae (Coleoptera?), raw fish		Wake (1978); Exbrayat and Delsol (1985)
<i>Typhlonectes natans</i>	earthworms, <i>Carassius</i> *, <i>Pseudacris</i> *	crayfish, <i>Tubifex</i>	O'Reilly et al. (1995)
Ichthyophiliidae			
<i>Ichthyophis banananicus</i>	earthworms		O'Reilly et al. (1995)
larval <i>Ichthyophis glutinosus</i>	<i>Chironomus</i> larvae		Breckenridge et al. (1987)
<i>Ichthyophis glutinosus</i>	earthworms		Tanner (1971); Breckenridge et al. (1987)
<i>Ichthyophis kohtaoensis</i>	earthworms, <i>Acheta</i> , <i>Galleria</i> larvae		O'Reilly et al. (1995)
Rhinatreumatidae			
<i>Epicrionops</i> sp.	earthworms		O'Reilly et al. (1995)
larval <i>Epicrionops</i>	amphipods, earthworms**	<i>Tubifex</i> , <i>Artemia</i> *	O'Reilly et al. (1995)
Scolecocomorphidae			
<i>Scolecocomorphus kirikii</i>	earthworms		J. O'Reilly (pers. obs.)

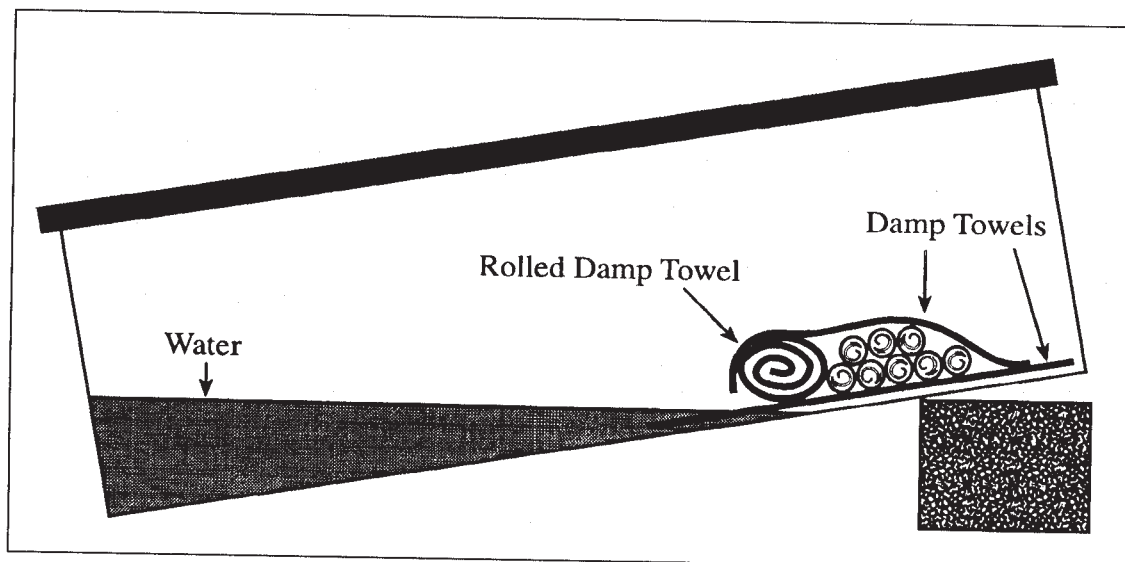


Figure 3. Eggs of *Grandisonia* have been successfully reared to hatching in the above arrangement. The eggs need to be rolled daily (a task normally performed by the mother). Eggs with dead embryos were removed as needed. Paper towels were changed at least once a week. (Illustration by Robyn O'Reilly).

lected by R. Nussbaum) in a small plastic shoebox (Fig. 3). The eggs were rolled and any dead eggs removed on a daily basis. The towels were changed weekly.

Viviparous species that have given birth in captivity include *Chthonerpeton indistinctum* (Barrio, 1969), *Dermophis mexicanus* (Wake, 1980), *Gymnophis multiplicata* (M. Wake, pers. comm.), *Schistometopum thomense* (R. Nussbaum, pers. comm.), *Typhlonectes compressicaudus* (Murphy et al., 1977; Billo et al., 1985; Exbrayat and Delsol, 1985), and *Typhlonectes natans* (Cummings, 1985; Lyman-Henley, 1993; O'Reilly and Ritter, 1995). There are several reports of *Typhlonectes* becoming gravid and giving birth in captivity (e.g., Billo et al., 1985; Exbrayat and Delsol, 1985). Based on these reports and observations of wild populations it appears that the gestation of *Typhlonectes* is approximately six months in duration (Exbrayat and Delsol, 1985). After this period, up to eight young are born (Exbrayat and Delsol, 1985; O'Reilly and Ritter, 1995). Moodie (1978) reports up to 14 fetuses from a single *Typhlonectes compressicaudus*, but there is no evidence that this many young ever complete development. Exbrayat and Delsol

(1985) report that young in the wild and in captivity reach sexual maturity in about 18 months (at approximately 30 cm total length [TLL]).

The central American *Dermophis mexicanus* is the only other species for which gestation period is known. Based on a series of specimens taken at different times of year from a single locality (Departamento de San Marcos, Guatemala), Wake (1980) estimates that gestation takes about one year in this species. After this period, up to 16 young are born (Wake, 1983). Maturity is reached in two to three years in the wild, males reaching maturity at a smaller size (23 cm TLL) than females (32 cm TLL) (Wake, 1980).

Sustainable captive reproduction of any species would necessarily involve the breeding of individuals that were themselves born in captivity. As far as I know, this has only been achieved in *Schistometopum thomense*, an African species which has been bred in captivity for multiple generations (R. Nussbaum, pers. comm.). In all reports, the young of viviparous species are fully independent after birth. In the aquatic species, it is important that gravid females be kept in very shallow water.

If the young are born in deep water they quickly drown before having a chance to shed their large gills (O'Reilly and Ritter, 1995).

The primary requirement for raising all young caecilians successfully is an abundant supply of suitable food. This requires frequent and generous feeding and close attention to the unsanitary conditions that can result (both from increased metabolism and uneaten food). In the case of terrestrial species with terrestrial young, the need for high maintenance can be avoided by placing the young in a large terrarium with an actively reproducing colony of small earthworms. Under these conditions, it takes *Dermophis* and *Schistometopum* from one to two years to reach adult size. *Typhlonectes* takes a similar amount of time to reach sexual maturity in the laboratory (Exbrayat and Delsol, 1985).

DISCUSSION

Caecilians are perhaps the least known major group of tetrapods. Their secretive habits in the wild have resulted in a lack of basic information on the life history and behavior of most species. Keeping caecilians in captivity is probably our best opportunity to gain insight into their secretive lives, and thus offers many more opportunities for herpetoculturists than simply keeping a strange pet. Observations on activity patterns, food choice, and social interactions of captive specimens are likely to be valuable scientific contributions.

It is clear that we lack a great deal of information needed to successfully keep and breed most types of caecilians in captivity. With this in mind, it is absolutely essential that serious attempts to keep these animals involve an experimental approach. This should include trying different housing conditions, food, and medicines. Most importantly, it should involve keeping careful notes and sharing them with colleagues. Only through a cooperative effort can we expect to make reasonable progress towards a fuller understanding of the requirements and behavior of these unusual animals.

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LITERATURE CITED

- Barbour, T. and A. Loveridge. 1928. A comparative study of the herpetological fauna of the Uluguru and Usambara Mountains, Tanganyika Territory, with descriptions of new species. *Mem. Mus. Comp. Zool.* 50:87-265.
- Barrio, A. 1969. Observaciones sobre *Chthonerpeton indistinctum* (Gymnophiona, Caecilidae) y su reproducción. *Physis* 28:499-503.
- Bemis, W.E., K. Schwenk, and M.H. Wake. 1983. Morphology and function of the feeding apparatus in *Dermophis mexicanus* (Amphibia: Gymnophiona). *Zool. J. Linn. Soc.* 77:75-96.
- Bennett, A.F. and M.H. Wake. 1974. Metabolic correlates of activity in the caecilian *Geotrypetes seraphini*. *Copeia* 1974:764-69.
- Billo, R. and M.H. Wake. 1987. Tentacle development in *Dermophis mexicanus* (Amphibia, Gymnophiona) with an hypothesis of tentacle origin. *J. Morphol.* 192:101-11.
- _____, J.O. Straub, and D.G. Senn. 1985. Vivipare apoda (Amphibia: Gymnophiona). *Typhlonectes compressicaudus* (Duméril and Bibron, 1841): Kopulation, tragzeit und geburt. *Amphib.- Reptilia* 6:1-9.
- Breckenridge, W.R., S. Nathanael, and L. Pereira. 1987. Some aspects of the biology and development of *Ichthyophis glutinosus* (Amphibia: Gymnophiona). *J. Zool. Lond.* 211:437-49.

- Cummings, L.W. 1985. Gilled young born to *Typhlonectes natans* (Amphibia:Gymnophiona). *Georgia J. Sci.* 43:11.
- Exbrayat, J.M. and M. Delsol. 1985. Reproduction and growth of *Typhlonectes compressicaudus* – A viviparous gymnophione. *Copeia* 1985:950-55.
- Gans, C. 1961. The first record of egg laying in the caecilian *Siphonops paulensis* Boettger. *Copeia* 1961:490-91.
- Hebrard, J.J., G.M.O. Maloiy, and D.M.I. Alliangana. 1992. Notes on the habitat and diet of *Afrocaecilia taitana* (Amphibia: Gymnophiona). *J. Herpetol.* 26(4):513-15.
- Himstedt, W. 1991. Zur biologie und larvenentwicklung der Thailändischen blindwühle *Ichthyophis kohtaoensis* (Amphibia: Gymnophiona: Ichthyophiidae) *Veröff. Naturhist. Mus. Schleusingen* 6:16-24.
- _____ and B. Fritsch. 1990. Behavioral evidence for electroreception in larvae of the caecilian *Ichthyophis kohtaoensis* (Amphibia, Gymnophiona). *Zool. Jb. Physiol.* 94:486-92.
- _____ and D. Simon. 1995. Sensory basis of foraging behavior in caecilians (Amphibia, Gymnophiona). *Herpetol. J.* 5:266-70.
- Lyman-Henley, L.P. 1993. Observations on a captive-born litter of typhlonectid caecilians (Amphibia: Gymnophiona). *Herpetol. Rev.* 24(4):146-47.
- Moll, E.O. and H.M. Smith. 1967. Lizards in the diet of an American caecilian. *Nat. Hist. Misc. (Chic.)* 187:1-2.
- Moodie, G.E.E. 1978. Observations on the life history of the caecilian *Typhlonectes compressicaudus* (Duméril and Bibron) in the Amazon basin. *Can. J. Zool.* 56:1005-8.
- Murphy, J.B., H. Quinn, and J.A. Campbell. 1977. Observations on the breeding habits of the aquatic caecilian *Typhlonectes compressicaudus*. *Copeia* 1977(1):66-69.
- Nussbaum, R.A. 1986. *Chthonerpeton onorei*, a new caecilian (Amphibia: Gymnophiona: Typhlonectidae) from Ecuador. *Rev. Suisse Zool.* 93:911-18.
- O'Reilly, J.C. and D.A. Ritter. 1995. Observations on the captive birth of a caecilian. (Amphibia: Gymnophiona). *Herpetol. Nat. Hist.* 3(2):199-202.
- _____, D. Fenolio, and M. Ready. 1995. Limbless amphibians: Caecilians. *The Vivarium* 7(1):26-29, 35, 36, 52-54.
- Roth, G. 1987. *Visual Behavior in Salamanders*. Springer-Verlag, Berlin. 301pp.
- Tanner, K. 1971. Notizen zur pflege und zum verhalten einiger blindwühlen (Amphibia: Gymnophiona). *Salamandra* 7:91-100.
- Taylor, E.H. 1968. *The Caecilians of the World: a Taxonomic Review*. University of Kansas Press, Lawrence. viii + 848pp.
- Wake, M.H. 1978. Comments on the ontogeny of *Typhlonectes obesus*, particularly its dentition and feeding. *Pap. Avulsos Zool. (Sao Paulo)* 32:1-13.
- _____. 1980. Reproduction, growth and population structure of the central American caecilian *Dermophis mexicanus*. *Herpetologica* 36:244-56.
- _____. 1983. *Gymnophis multiplicata*, *Dermophis mexicanus*, and *Dermophis parviceps*. Pp. 400-1. In D.H. Janzen (ed.), *Costa Rican Natural History*. University of Chicago Press, Chicago.

- _____. 1994. Caecilians (Amphibia: Gymnophiona) in Captivity. Pp. 223-28. In J.B. Murphy, K. Adler, and J.T. Collins (eds.), *Captive Management and Conservation of Amphibians and Reptiles*. Contributions to Herpetology. Vol. 11. Society for the Study of Amphibians and Reptiles, Ithaca, New York.
- Wiedersheim, R. 1879. *Die Anatomie der Gymnophiona*. Gustav Fischer Verlag, Jena. 101pp.
- Wilkinson, M. 1989. On the status of *Nectocaecilia fasciata* Taylor, with a discussion of the phylogeny of the Typhlonectidae (Amphibia: Gymnophiona). *Herpetologica* 45(1):23-36.