

Basic information and recommendations
for care and keeping of *Atelopus balios*,
Rio Pescado stubfoot toad





Contents

1. **Profile**
2. **Why did we include *Atelopus balius* at Citizen Conservation?**
3. **Biology and Conservation**
 - 3.1 Biology
 - 3.2 Threat
 - 3.3 Conservation Efforts
4. **Keeping and Care**
 - 4.1 Conditions and Documentation Requirements
 - 4.2 Transport
 - 4.3 The Terrarium
 - 4.4 Water Chemistry, Technology and Temperatures
 - 4.5 Diet and Feeding
 - 4.6 Offspring
 - 4.7 Rearing of Larvae
 - 4.8 Rearing of Young Animals
 - 4.9 Problems
5. **Further reading**



1. Profile

Scientific Name: *Atelopus balios* (PETERS, 1973)

Common Name: Rio Pescado Stubfoot Toad

Snout-vent length: Normal male 32 mm, female 35 - 37 mm

CC#Amphibians Category: I

Endangerment status according to IUCN Red List: Critically Endangered

CITES conservation status: No

EU Species Protection Regulation status: No

Housing: Rain forest terrarium, e.g. 60 x 50 x 60 cm (length x width x height) for 2–5 animals. Daytime temperatures 24 - 27 °C, night 21 - 24 °C.

Equipment required: Climbing branches and large-leaved plants. Gravel, clay, leaves or moist cellulose as substrate.

Lighting by fluorescent tubes, LED light bars or similar device with UV component. Special flow tank with low water level for breeding, spacious plastic boxes or tanks and small terrariums for larval rearing and metamorphosis. Aerator, flow pump and strong filter for tadpole rearing tanks.

Diet: Feed animals of appropriate size (crickets, bean beetles, aphids, stove fish and flies for adults; springtails and mites for metamorphs), powder with vitamin-mineral preparation before feeding and „fill“ feeders with a balanced diet.





2. Why did we include *Atelopus balios* at Citizen Conservation?

Atelopus balios is highly threatened. The World Conservation Union (IUCN) lists the Rio Pescado Stubfoot Toad as as Critically Endangered (CR) at the highest conservation level for species living in the wild. In 2012, the species was placed on the list of the 100 most threatened species in the world by the IUCN and the Zoological Society of London (ZSL).

The entire genus *Atelopus* (harlequin or stubfoot toads) often exemplifies an entire group of neotropical amphibians (i.e. those found in the American tropics) whose populations have collapsed massively since the 1980s due to the invasive chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*), and therefore represents one of the most threatened animal genera in the world (LA MARCA et al. 2005). Since chytrid fungi have led to the complete extinction of many species of stubfoot toads even in pristine rainforests and cloud forests, classical conservation measures such as the designation of protected areas alone are not effective. Instead, the last hope for many *Atelopus* species lies in ex situ conservation breeding projects, i.e. conservation in terrariums in human care.



Atelopus balios in Amplexus | Amadeus Plewnia



3. Biology and Conservation

3.1 Biology

The genus *Atelopus* (Harlequin toads, stubfoot toads) belongs to the toad family (Bufonidae) within the order frogs (Anura). In English, *Atelopus* are often called Harlequin or Stubfoot frogs, despite their relationship to the toads. In the genus *Atelopus*, *Atelopus balios* probably belongs to a still little known species complex with *Atelopus longibrachius*, *A. gracilis* and *A. elegans*, all of which are native to the region west of the Andes. *A. balios* is a medium-sized *Atelopus* species with a head-torso length of

32 mm in males and 35-37 mm in females. The latter are clearly more robustly built than the thin appearing males. Dorsally (on the back side) the animals have a yellow-green ground colouration with black or brown spots, while ventrally (on the belly side) they are whitish in colour. Orange-coloured palms and feet are used for intraspecific communication or as an aposematic signal, i.e. a warning signal with which the toads inform predators that they are not edible.

The habitat is in tropical rainforests at low to medium altitudes (120-650 metres above sea level). The toads live near smaller streams, which also serve them as spawning waters. Males stay at these streams for longer periods of time, while females live mainly deeper in the forest and only migrate to the streams to spawn in the dry season (June to December). Here, strings with white eggs are attached to the underside of stones. Hatching larvae suck on stones in the current with greatly enlarged mouthparts and graze on algal turf.

Atelopus balios is diurnal, at night the animals sleep on the upper side of leaves or branches. On the whole, representatives of the species are extremely quiet, move slowly and without larger leaps. The toads also like to climb near the ground up to a height of several metres.

The species' range is restricted to a few populations in the provinces of Cañar, Azuay and Guayas in Ecuador in north-western South America.



Typical habitat of harlequin toads in the Ecuadorian rainforest | Amadeus Plewnia



3.2 Threat



Deforestation of primary forests, as here in Ecuador, is a major threat for the species after the chytrid fungus. | Amadeus Plewnia

After dramatic population losses due to the chytrid fungus *Bd*, no surviving populations of *A. balios* were known, so that in the 1990s there were fears that the species was already extinct. However, intensive searches fortunately led to the rediscovery of several populations, some of which appear to be stable. In addition to the enormous threat posed by chytridiomycosis, anthropogenic (human-induced) pressure on the natural habitats of the species is currently increasing strongly. The Pacific lowland rainforests of Ecuador are experiencing enormous rates of deforestation, but at least one known occurrence of *A. balios* is in a designated protected area.



3.3 Conservation efforts

Atelopus balios does not currently enjoy international protection status, which is why there is no obligation to provide evidence or documentation.

Like several other Ecuadorian harlequin toads, *Atelopus balios* is bred in a successful conservation breeding project at the Centro Jambatu de Investigación y Conservación de Anfibios in Quito, Ecuador. The Rio Pescado Stubfoot Toads maintained in Citizen Conservation also originate from these animals. A second ex situ group is currently in the Amaru Bioparque in Cuenca, Ecuador. Due to the high threat level, the IUCN Red List recommends the establishment of further ex situ conservation breeds as a conservation measure (IUCN SSC Amphibian Specialist Group 2018).

In order to distribute the risk of conservation breeding as much as possible, it generally makes sense to build up an ex situ population beyond the respective country of origin in order to have greater security against catastrophes, political turmoil, epidemics and possible other problems. Therefore, Citizen Conservation is building up an ex-situ population outside Ecuador in consultation with the scientists from Centro Jambatu. The basic stock of animals for CC comes from Centro Jambatu and was exported through its associated company Wikiri with the permission of the Ecuadorian authorities.



Dr Lukas Reese (left) from Karlsruhe Zoo and Dr Johannes Penner from Citizen Conservation receive the consignment from Ecuador with the first foundation animals of the CC conservation breeding population at Frankfurt Airport.

| Timo Deible, Zoo Karlsruhe



4. Keeping and care

The species of the genus *Atelopus* still pose great challenges in keeping and breeding in the terrarium, and so it is hardly surprising that most species have so far only been bred in highly specialised ex situ facilities. Nevertheless, successful reproduction is also possible in private hands and has been successful several times in the past. The conditions for keeping and breeding are very similar for most species of the genus *Atelopus*, which is why many years of experience with the breeding of related species can be drawn on when keeping *A. balios*, which has hardly been kept up to now. The distribution of *A. balios* at low altitudes seems to be favourable, as the climatic requirements of such species are easier to fulfil in the indoor terrarium.

We base our recommendations on collected knowledge in terraristics on *Atelopus* from the last decades, specifically on the experiences of the Centro Jambatu in Ecuador and those of Amadeus Plewnia of the DGHT-AG Anuren (Anura project group at the German Society for Herpetology and Terraria), who was in charge of compiling these husbandry recommendations for CC.



If you want to study the living conditions of *Atelopus* in their natural habitat, you have to take a long trip - biologist and *Atelopus* breeder Amadeus Plewnia in the South American rainforest. He has been instrumental in compiling husbandry recommendations for *Atelopus balios* for Citizen Conservation. | Amadeus Plewnia



4.1 Conditions and documentation requirements

As already mentioned under point 3.3, there is no documentation obligation resulting of international rules on the part of the authorities for keeping *Atelopus balios* (but check your national laws).

The CC animals are the property of the non-profit Citizen Conservation Foundation gGmbH. This also applies to all offspring resulting from them. Keepers are therefore not allowed to give or sell the offspring themselves. Under no circumstances may the animals be mixed with other *Atelopus balios* that do not belong to the CC programme, or with other *Atelopus* species. It is crucial for the establishment of long-term conservation breeding that the genetic background of the animals can be traced at any time, which is why mixing with animals outside the programme, but absolutely also between generations, must be avoided. So never keep parents and offspring together! Siblings, on the other hand, can be kept together without hesitation and can also be bred with each other until the CC studbook gives different information.

As a general rule, *Atelopus balios* should be kept at CC in so-called species tanks, i.e. not socialised with other amphibian or reptile species. Exceptions to this rule may be possible in consultation with the CC office.

An essential part of CC is the coordination of our stock, about whose development we must therefore always be informed. Twice a year, CC participants are therefore contractually obliged to submit a population report, namely on 1 March and 1 September. From 2024, this report of the population (number of animals, if possible their sex, animals that have died or bred in the last six months) can be made online via the Wild at Home platform. In addition, we are happy to receive observations and experiences in husbandry and breeding, as an important goal of CC is to generate knowledge on ex situ keeping and biology of the species managed in our conservation breeding network. We also gladly accept photos, which we then use e.g. for publications or social media. Permission to use the images within the framework of the CC programme is deemed to have been granted when they are sent, unless explicitly objected to; we always name the authorship of the images in publications, unless explicitly objected to.

In case of deaths, please inform the CC office informally by e-mail to amphibien@citizen-conservation.org, so that further steps can be taken, such as examinations of the other animals, a necropsy or veterinary care. In the case of clutches and young tadpoles, often only estimated values are possible, which are nevertheless helpful. Please also inform the CC office of any offspring outside of the stock reports, so that we can look for new owners to place the offspring in good time. If owners are no longer able or willing to keep the animals or offspring, the CC office should be informed as early as possible so that we can place the animals in subsequent homes.



One of the aims of CC is to generate knowledge about the species kept. Careful documentation of the animals kept by the keepers and regular stock reports to the CC office are important components of this. | Amadeus Plewnia

With every change of location within CC, i.e. the change of animals from one person to the next, veterinary tests are to be carried out beforehand, a skin swab for the chytrid fungus *Bd* and a faecal sample for parasites are to be obligatory, if necessary *Bsal* will also be tested. Instructions and the necessary dry swab and faecal sample tubes are provided by CC, the examination costs are borne by CC. A corresponding examination order for a suitable examination laboratory is available from the CC office.

When transferring animals, it is mandatory to fill in a CC transfer certificate, in case of own offspring a proof of origin.

In principle, all *Atelopus balios* kept in CC are subject to the general guidelines of CC as well as the provisions in the recruitment contract.



4.2 Transport

You will normally receive the animals in the Citizen Conservation #Amphibians programme directly from the breeders or previous owners. You are responsible for organising the transport, any costs incurred (i.e. travel costs to the breeders or shipping costs) must be borne by you. The CC office may be able to help arrange shipping, but in order to keep administrative costs as low as possible, we ask that you organise the transport yourself if possible. When shipping, only carriers approved for live animal transport may be contracted; the respective guidelines for shipping must be strictly adhered to!

Each time the animals are moved, they undergo a veterinary check beforehand (see section 4.1). You will therefore receive animals that are most likely free of pathogens such as *Bd* or many parasites. Parasites may nevertheless be present; not every parasite load is worthy of treatment. In addition, there is always a risk that pathogens will not be detected despite examinations. You can place the animals at home directly into the designated terrarium, which of course has been thoroughly disinfected before being put into operation. It should then already be running in working mode and immediately offer the appropriate climatic conditions for the toads. The usual quarantine rules in terraristics should be observed if possible, especially if you also maintain your own amphibian population.

For transport, the *Atelopus balius* are packed individually in small plastic boxes (e.g. cricket boxes). It is important that the air holes do not have any edges on the inside so that the toads do not injure themselves with their delicate skin on the sometimes sharp-edged plastic. Put some damp kitchen paper in the box beforehand. These transport boxes should then be placed in a polystyrene box or insulated bag, secured against slipping, to protect the toads from external weather influences such as overheating or hypothermia. In winter or summer, it may be necessary to add a cooling battery or hot water bottle to the box. Caution - always separate such elements safely from the transport boxes (e.g. wrap them in a towel) so that the toads in their box cannot overheat or overcool through direct contact with a neighbouring cooling or heating element. Heatpacks in Styrofoam boxes must be taped in front of a small hole in the Styrofoam wall so that oxygen can be drawn from outside for the chemical reaction in the heatpack (and not all the oxygen in the Styrofoam box is consumed). Overheating must be avoided, especially in summer, as *Atelopus* are very sensitive to heat. CC participants can obtain suitably insulated transport boxes directly from the supplier at reduced rates.



For shipping, the toads are placed individually in small plastic boxes lined with moist cellulose paper. These boxes are then placed in a well-insulated transport box and secured against slipping. | Wikiri



4.3 The Terrarium

In the following, two different concepts for keeping *Atelopus balios* are presented. These sensitive toads are either kept under well-controlled, semi-stable conditions, as is often successfully practised in Latin American ex situ facilities, or in a large, temperature-stable and planted rainforest terrarium. The latter will probably be more popular with private individuals and will therefore be presented first. Terrariums with a floor space of 60 x 50 x 60 cm (length x width x height) or more are suitable for about 2-5 animals.

As the animals do not show any aggression towards each other, keeping them in groups is possible without any problems (but see below the comments on the problem of too frequent/long amplexus when keeping both sexes together). Of course, larger terrariums are also suitable, but it should be noted that *Atelopus balios* is a rather reluctant eater and therefore needs a high food density in the terrarium to be able to hunt enough prey. This is more difficult to achieve in large terrariums. If larger groups are kept together, it is also important to make sure that the tank has enough structural elements, especially enough suitable leaves for sleeping and exposed places for calling, so that the animals do not stress each other.



Naturally furnished terrariums for keeping *Atelopus balios*
| Amadeus Plewnia



It is possible, but not absolutely necessary, to have a water section that is always kept very clean and has water flowing through it. However, standing water or a water bowl should be avoided! *Atelopus* like to stay in flowing water, but they are poor swimmers, which is why a stream in the terrarium should not be deeper than the body length of the animals or should be well designed with structural elements in the water (e.g. protruding stones, plants climbing into the water) so that the animals can easily leave the water. Long stretches of deeper water on steep walls such as windows or smooth, vertical stones should be avoided.

Ideally, the substrate for the terrestrial part should be stones or coarse gravel, alternatively low-nutrient loam or xaxim covered with leaves. Harlequin toads spend most of the day in the vegetation close to the ground, especially large-leaved plants are suitable here, on whose leaves they also sleep at night. *Philodendrons* or bromeliads have proven to be good.

Climbing branches, roots, lianas and similar furnishings provide further structural elements, movement areas and hiding places. It is best to tie the plants onto these structures and cultivate them purely epiphytically (without soil) - this makes hygienic maintenance work easier. The side walls are best designed in such a way that they offer the toads additional space to move around and, if necessary, hiding places. For this purpose, modelled polystyrene, peat or cork board walls are suitable, for example. In order to prevent bacterial infections, it is very important that the toads have dry places in the terrarium despite the tropical and humid environment. The ventilation should therefore be dimensioned in such a way that the plants are dried off again two hours after spraying.



Foliage can be used well to cover the substrate. | Timo Deible, Zoo Karlsruhe



Atelopus balios can basically be kept singly, in pairs or in both mixed-sex and sex-separated groups. The males are not aggressive among themselves, so groups with several males and females are basically no problem. However, according to current knowledge, the reproductive readiness of *A. balios* is not bound to special triggers; observations in nature also indicate that the animals can basically get into a reproductive mood at any time of the year. Therefore, it increases the probability of reproduction if you do not keep only one pair of animals. The lack of synchronisation of the sexes due to external factors, even in the natural biotope, is probably also the reason why *Atelopus* males like to cling to a female when they are ready to mate and then let themselves be carried

around in the amplexus until the female also becomes ready to reproduce. However, this can sometimes take days or weeks. This prolonged amplexus involves risks for the animals because the male does not eat during this time and can lose weight, or because the long (or too frequent) clinging can cause sores in the female. Therefore, it is safest and most promising to keep several animals separated by sex, e.g. two males and two females in one terrarium each, and then put them together in the spawning tank for mating. If both sexes are kept together permanently, care must be taken that amplexus does not occur too often or for too long; if necessary, the males must then be carefully separated from the females (see 4.9).



Roots and stones are used as structural elements in the terrarium. It is important to always provide dry places even in the tropical humid terrarium! | Timo Deible, Zoo Karlsruhe



Large-leaved plants, on which the toads like to rest, are an important part of the terrarium setup. | Amadeus Plewnia



An alternative form of husbandry for *Atelopus* consists of a much more hygienic housing in which the animals are kept in plastic boxes. Moist, chlorine-free bleached cellulose is used as the substrate, which must be changed every two days. Also, a fresh box is then used for the animals, while the previous one is disinfected in 1% Virkon-S solution. A halved plastic pot is used as the only hiding place.

The advantage of this housing method is the better control of the animals and the amount of food consumed, as well as the lower risk of parasites and pathogens becoming rampant. However, humidity and temperature are less constant and require more intensive monitoring.



Keeping different *Atelopus* species on wet pulp at the Panama Amphibian Rescue and Conservation Center. | Amadeus Plewnia



4.4 Water chemistry, technology and temperatures



Spraying the quarantine terrarium for newly moved-in *Atelopus balios* at Karlsruhe Zoo | Timo Deible, Zoo Karlsruhe

Stale chlorine-free tap water can be used to sprinkle the terrarium. The terrarium should be sprayed regularly (once or twice a day). The relative humidity should normally be in the range of 60-80 %, 70 % has proven to be an average guideline.

For lighting, fluorescent, LED or energy-saving lamps are sufficient for basic illumination during the day. Lamps with a (low) UV content have a positive effect on the health of the toads and are a must for rearing the sensitive young animals.

Due to the high altitude distribution of *Atelopus balios*, temperatures should be 24-27 °C during the day and 21-24 °C at night. Occasional temperatures below this do not pose a problem for the animals, whereas temperatures that are too high can quickly prove fatal.

If these values are not achieved by the location of the terrarium and the lighting, a heating mat or heating cable can be used; these heating elements are installed on one side of the terrarium or under a part (!) of the base plate - never heat the entire base plate! A timer ensures a regulated daily routine. The daily lighting time should be about 12 hours.



Atelopus balius are cautious eaters, so that sufficient food density must always be provided in the terrarium - as here with fruit flies. | Lukas Reese, Zoo Karlsruhe

4.5 Diet and Feeding

Commercially available food insects such as house crickets, bean beetles, springtails, *Drosophila*, aphids, oven fish and for young animals springtails, *Drosophila melanogaster* and mites at the beginning are suitable as food. CC participants have the opportunity to obtain food animals at reduced prices from cooperating suppliers.

The size of the food animals must of course be adapted to the size of the toads, i.e. they must be easily overwhelmed by them. For crickets, only the commercially available „micro“ category should be fed.

Adult toads should be fed two to three times a week, young animals daily. All food animals themselves are fed well and varied („well-loaded“) before being fed, in order to provide the toads with as valuable a meal as possible. This means that crickets and other food animals are cared for in appropriately sized containers (e.g. Faunaboxes) and fed a varied and high quality diet, such as a mixture of dry food (fish food, cereal flakes, food pellets, etc.) and fresh food (salads, wild herbs, fruit, carrots, cucumbers, etc.) before feeding. Before the food animals are put into the terrarium, they are gently shaken in a vitamin-mineral preparation until they are completely dusted with the powder. This procedure is important to prevent deficiency diseases of the animals, as Harlequin toads quickly develop signs of paralysis, especially in the case of calcium deficiency. As *Atelopus* are very reluctant eaters, there must always be a sufficiently high density of food animals in the terrarium. Crickets and crickets often quickly become too large to serve as food and should then be carefully intercepted, as they can otherwise eat plants and sometimes even sleeping amphibians.



4.6 Offspring

A prerequisite for breeding is that only healthy, well-fed animals are used for reproduction. Harlequin toads naturally spawn in the dry season, but males can be available for breeding all year round.

As soon as the females are ready to spawn (recognisable by a massive increase in volume of the abdomen and lower abdomen), the males can be placed with the females in the terrarium. If amplexus occurs here, carefully transfer the clinging pair to a suitable spawning tank. Keep them therein until spawning takes place. If nothing happens, the toads should be transferred back into their normal terrarium after one or two weeks.

The spawning tank should have a water level of approx. 15 cm and be equipped with several bubbling stones and a pump with a moderate current and very good aeration. Larger stones and roots with an extensive crevice system serve as spawning substrate. The animals must always have access to several larger, dry stones in the upper part of the tank.

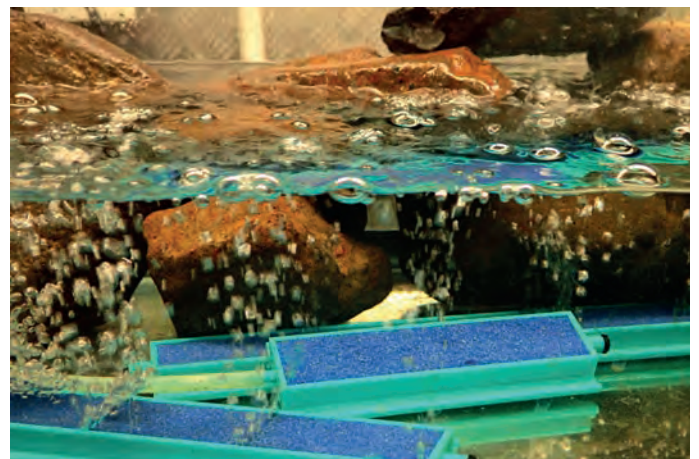
The water is not heated and half of it is changed every three to four days.

The water should have a neutral pH value (7) and a low total hardness.

The spawn is laid in the form of strings with white eggs and attached to the underside of stones. Fresh spawn is sensitive to light and should not be manipulated under any circumstances. Whether spawning has occurred can be easily determined by the body volume of the female.



Atelopus balios in Amplexus | Amadeus Plewnia



A well ventilated tank with stones protruding from the water and dry in the upper area serves for spawning.

| Amadeus Plewnia



The spawning lines are attached to the underside of stones.

| Raf Stassen



4.7 Rearing of Larvae

As soon as the larvae hatch, they have the ability to attach themselves to stones in the current. First of all, you should wait until the burbot have completely absorbed their yolk and have turned dark. Then you can distribute some of the burbot into larger tanks.

These should be kept quite simple (without plants) and only contain a few stones that the burbot can suck on. A constantly high oxygen content is also important here, which can be achieved by using several air pumps per tank. A filter provides further flow, but care must be taken that no burbot can be sucked into the filter or pumps.

Regular water changes are important, as in their natural habitat the animals only live in very clear, nutrient-poor streams. The use of humic substances in the water („burbot tea“) is not recommended for *Atelopus*.

Table 1 shows the most significant water parameters under which *Atelopus* tadpoles were successfully reared at the Panama Amphibian Rescue and Conservation Center.

Temperature	pH	Conductivity	Salinity	Oxygen	NH ₃ + NH ₄ ⁺
21–23 °C	7,0–7,8	570–800 µS	0,2–0,4 ppm	70–95 %	< 0,02 mg/l

Water values for tadpole rearing of different *Atelopus* species according to experiences of the Panama Amphibian Rescue and Conservation Center



Well ventilated tank for burbot rearing | Amadeus Plewnia



Stream pool for rearing *Atelopus* tadpoles | Nick Stacey

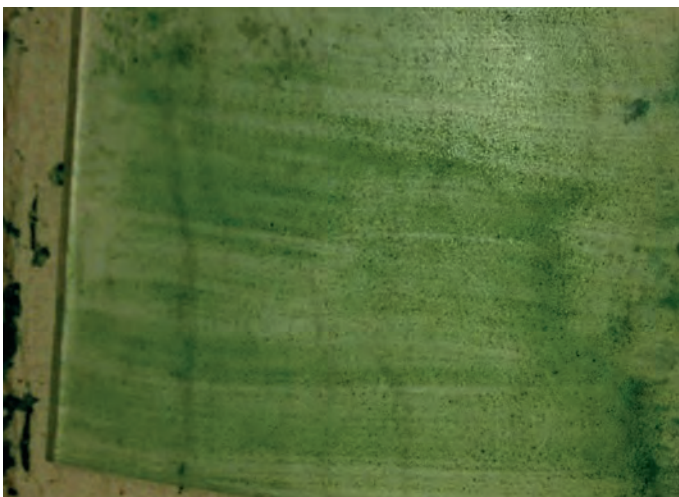


Algae serve as food for the tadpoles of *Atelopus balios*.
| Nick Stacey



View into a rearing tank - the larvae of *Atelopus balios* attach themselves to the stones, from which they also graze the algae growth | Amadeus Plewnia

In their natural habitat, tadpoles of this species mainly rasp algae off stones, which is why the diet in the tank must be adapted to this behaviour. For this purpose, spirulina mixed with other algae (chlorella), boiled dandelion leaves and a smaller portion of „Sera Micron“ is mixed with water to form a paste that can be applied to stones and glass plates. After drying, these can be placed in the tank so that the burbot can then scrape off the food. Alternatively, you can also offer algae-covered stones that have previously been placed in separate tanks for growing. Diatoms, which are weak in competition, seem to be particularly suitable for this purpose. A description of diatom breeding and further information on tadpole rearing in *Atelopus* can be found in POOLE (2006).



Food is placed on glass plates or stones to be eaten by the tadpoles. | Amadeus Plewnia



Stones covered with Spirulina | Amadeus Plewnia



The tadpoles need approx. 80-120 days until metamorphosis. A detailed description of larval development in the closely related *Atelopus elegans* is given by MARCILLO-LARA et al. (2020); it is similar in *A. balios*.

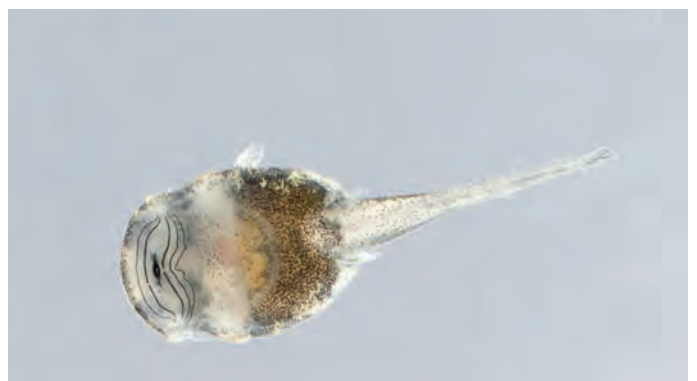
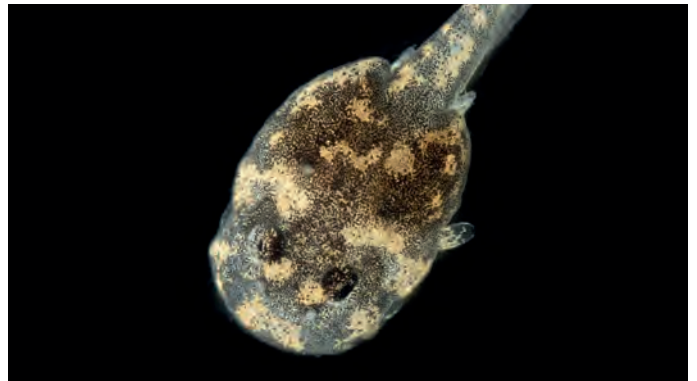
As soon as the front legs break through, the tadpoles' suction disc, with which they attach themselves to the substrate, regresses. The tadpoles can then no longer hold on in the current and soon go ashore, although they still have comparatively long tails. A special shore basin is not necessary. The freshly metamorphosed animals climb onto stones sticking out of the water or simply up the glass where they can be collected. The danger of drowning does not seem to exist with the metamorphosing juveniles - of course they have to be collected during regular checks and put into a rearing terrarium. In the first days they still live on the resorption of the long tail and sit in a very humid environment during this time. Only then do they migrate further away from the water.

Attention! As the freshly transformed juveniles like to climb up the walls of the larval container, it is absolutely necessary that it is secured by a tightly closing lid, otherwise the juveniles will escape from the container and dry out.



Larvae of the harlequin toads suck themselves to the substrate to avoid being carried away by the current.

| Amadeus Plewnia



Dorsal and abdominal view of a tadpole of *Atelopus balios* | Christopher Heine & Amadeus Plewnia

Metamorph of *Atelopus balios* - the land walk occurs at a stage when the young still have relatively long tails.

| Amadeus Plewnia





4.8 Rearing of Young Animals

After leaving the water, the young toads usually stay in the immediate vicinity of the water for the first two to three days and first resorb the remains of their tails before they start feeding on day two or three. Freshly metamorphosed *Atelopus* measure only a few millimetres and are even too small to overpower *Drosophila* or adult springtails. Thus, mainly young springtails are suitable as „starter food“, but also non-predatory mites. After some time, adult springtails, aphids and fruit flies can be fed.

When rearing, it is particularly important that the feeders are well nourished themselves, as mentioned above, and also powdered with a vitamin-mineral preparation before feeding.

Breeding can be done in small groups. Terrarium conditions and equipment correspond to those for adult animals. Suitable dimensions for rearing terrariums are boxes with the size 40 x 40 x 40 cm to 50 x 40 x 50 cm (length x width x height) for 20-40 young animals. In terrariums that are too large, there is a risk that the density of food animals is not high enough.

As hygienic husbandry is particularly important for young animals, they can alternatively be reared in smaller containers with moist cellulose as a substrate, which should be changed every two days. It should also be noted that the containers for the tiny young toads must be escape-proof.



After the landing, the metamorphosed juvenile toads first resorb their tail remnant. | Amadeus Plewnia



Rearing tank for *A. elegans*, closely related to *Atelopus balios*, at Centro Jambatu, Quito | Amadeus Plewnia



4.9 Problems

Matchstick legs: The dreaded underdevelopment of the skeleton and muscles of the extremities, especially of the front legs, in growing young toads occurs due to a complex mixture of causes. Ultimately, the process has not been fully elucidated to date; it has also been observed in nature. A safe prophylaxis and treatment are not possible. One reduces the risk of this syndrome by feeding the breeding animals as well as the tadpoles and juveniles as optimally as possible, possibly a UV component in the light also has a positive effect on preventing matchstick legs. *Atelopus* in particular are very susceptible to this syndrome, but studies on Panamanian species could show that its occurrence could be reduced by increased calcium levels (LASSITER et al. 2020).

Chytridiomycosis: As one of the main threats to the entire genus, the chytrid fungus can also destroy entire terrarium populations within a short time. Primarily, an introduction can be prevented by basic hygiene, such as the use of disposable gloves when working in the terrarium. All equipment should be disinfected before

use (see the brochure „Handlungsempfehlungen zum Umgang mit seuchenartig verlaufenden Amphibienkrankheiten“ by the DGHT in cooperation with CC, which all participants receive in the starter kit and which can also be downloaded free of charge from the internet). However, if an infection does occur and is detected early, heat treatment, which is often used, is not possible for these temperature-sensitive animals. The only option then is treatment with itraconazole after veterinary advice. In order to limit the spread of *chytridiomycosis* in terrarium populations, all CC animals should be tested for the pathogen whenever they are moved (see 4.1).

Bacterial infections: If the terrarium is kept too humid or not sufficiently hygienic, bacterial skin infections, e.g. with *Citrobacter* or *Pseudomonas*, can quickly occur, which in some cases can cause paralysis or the so-called red leg syndrome. Sufficient ventilation of the terrariums and dry areas are a simple prophylaxis, but should the disease still occur, antibiotics under veterinary care are often successful.



Camille Dufourt from Karlsruhe Zoo with *Atelopus balios*. Due to the sensitive skin, the toads should only be handled with nitrile gloves. | Timo Deible, Zoo Karlsruhe



Health risk permanent amplexus | Amadeus Plewnia

Drowning: As already mentioned, *Atelopus balios* is a poor swimmer despite its close attachment to streams. In deeper water, the animals panic easily if they cannot „get out“ easily. They then swim around frantically, quickly lose strength and possibly eventually drown - a common keeping problem with *Atelopus* species.

Therefore, the water part of the terrarium should only be high enough so that the animals can easily reach the substrate with their hind legs, or there must be easy exits at several places, e.g. stones that protrude from the water, which are not too steep and smooth, or plants hanging or climbing from the land part into the water. Deep water points without an exit directly next to glass panes, especially in the terrarium corners, should be avoided.

Amplexus: As already explained in chapter 4.3, the reproductive readiness of *Atelopus balios* is not directly synchronised between the sexes by environmental influences. Each animal can therefore be ready to reproduce at different times of the year. Therefore, when males are in a reproductive mood, they tend to cling to females even if they are not yet ready to mate. The pairs then often stay in the amplexus for a very long time, possibly for several days or even weeks. During this time, the males do not eat, which is why they are in danger of becoming emaciated. Females, on the other hand, can get sores from clinging too long or too often. The readiness of females to mate can be easily recognised by their clearly increasing girth. If you observe that females that are not ready to mate are in the amplexus for several days, you should carefully detach the male to protect both animals. This is easily done by gently pushing the male's feet upwards from below. If this problem occurs frequently, the sexes should be separated. It is even safer to keep the animals separated by sex anyway and only put them together for mating in the spawning tank described in 4.6 if the female is clearly ready to reproduce.



5. Further Reading:

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