

Basic information and care recommendations  
for *Epipedobates tricolor*,  
Phantasmal Poison Frog





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# 1. Profile

**Scientific Name:** *Epipedobates tricolor* (BOULENGER, 1899)

**Common Names:** Phantasmal Poison Frog, Rana nodriza tricolor ecuatoriana (Spanish)

**Head-torso length:** 19–23 mm

**CC#Amphibians-Category:** III, also suitable for expert beginners

**Endangered status according to the IUCN Red List:** “vulnerable”;

“critically endangered” according to the Ecuadorian Red List

**CITES protection status:** Appendix II

**Protection status EU species protection regulation:** Annex B

**Accommodation:** Rainforest terrarium of at least 40 x 40 x 40 cm for pairs or one male, two females; better kept in larger groups of 5 animals or more in terrariums measuring 80 x 50 x 50 cm or more.

Temperature gradient during the day between 22 and 26 °C; cool down to 19–22 °C at night; lighting with e.g. fluorescent lamps or LED bars; high humidity by sprinkling/spraying several times a day

**Equipment required:** dense planting including bromeliads; structural elements such as roots, stones, pieces of cork; egg-laying sites, e.g. halved coconut shells with flower saucers, spawning houses, film boxes; atomiser or sprinkler/fogging system; small aqua-terrarium, aquarium or plastic boxes (approx. 30 x 30 cm) for rearing tadpoles

**Feeding:** Well-fed food animals dusted with vitamin-mineral powder for the frogs (*Drosophila*, crickets, oven fish, etc.), young frogs also eat springtails; tadpoles eat fish flake food, algae, daphnia, red mosquito larvae, etc.





## 2. Why is *Epipedobates tricolor* a Citizen Conservation Species?

The relationships of *Epipedobates tricolor* are complex and confusing, but important for ex situ species conservation. According to current knowledge, the three species *E. anthonyi*, *E. machalilla* and *E. tricolor* form a closely related complex of frogs that look very similar and at the same time are highly variable. For a long time, *E. anthonyi* and *E. tricolor* were confused. Either both species were regarded as synonymous, or the majority of known animals were wrongly labelled as *E. tricolor*, although they belong to *E. anthonyi*. Only GRAHAM et al. (2004) established that the two species not only differ genetically from each other, but that there is also a corridor of at least 200 km between their distribution areas. Both species must therefore be regarded as clearly separated from each other. The “true” *E. tricolor* in central Ecuador inhabits the smaller, northern part of the formerly assumed distribution area, while *E. anthonyi* occurs south of the distribution gap in south-west Ecuador as far as neighbouring Peru.

In terraristics, the “Phantasmal Poison Frog” has been an extremely popular frog since the 1980s and is bred in large numbers. It is certainly the most frequently kept and bred poison dart frog. The animals kept in the terrariums were labelled as *E. tricolor*. However, the 2004 study revealed that the “terrarium tricolours” are in fact *E. anthonyi*.

Genuine *E. tricolor* were imported to Europe much later and in small numbers via the Ecuadorian species conservation organisation Centro Jambatu and its distribution arm WIKIRI.

Unlike *E. anthonyi*, *E. tricolor* is an endangered species. The IUCN Red List currently classifies it as “vulnerable” according to an assessment from 2019 (IUCN SSC AMPHIBIAN SPECIALIST GROUP 2019). On the Ecuadorian Red List, however, the species is already classified as “critically endangered” in a reassessment from 2021 (ORTEGA-ANDRADE 2021).

Virtually all Phantasmal Poison Frogs kept in terrariums to date therefore belong to the non-endangered species *E. anthonyi*, while the highly endangered *E. tricolor* is hardly ever kept.

The population of *E. tricolor* in its natural habitat continues to decline (COLOMA et al. 2022).

The species is endemic to Ecuador and only occurs there in a small distribution area in central Ecuador in the western foothills of the Andes. Both the habitat and the frogs themselves continue to be threatened by various factors (see 3.2), making it necessary to establish an ex situ population.



Was long regarded as *Epipedobates tricolor*, but is now *Epipedobates anthonyi* | Heiko Werning

Since *E. tricolor* can also be kept well in the terrarium (even if it is apparently not quite as easy to breed and is as keen to show as *E. anthonyi*), it makes sense to use at least part of the numerous capacities for *E. anthonyi* for coordinated breeding of *E. tricolor* in the future and to establish a coordinated conservation breeding programme for this species outside Ecuador in the first place. *E. tricolor* was therefore included in Citizen Conservation.



## 3. Biology and conservation



Both *Epipedobates anthonyi* and *E. tricolor* also lay their clutches openly on leaves; they are then guarded by the males | Wildlife, Alamy

### 3.1 Biology

The poison dart frogs of the genus *Epipedobates* are placed in the superfamily of poison dart frog relatives (*Dendrobatoidea*) and in the family of true poison dart frogs (family *Dendrobatidae*) in the subfamily *Colostethinae*. Seven species are currently recognised in the genus *Epipedobates*. They are distributed west of the Andes in the north-west of South America (Peru, Ecuador, Colombia). They differ from the more closely related ostandine *Ameerega* species not only genetically, but also visibly by the remains of webs between the toes of the hind feet and a smoother dorsal skin.

The close relationship of *E. tricolor* with *E. anthonyi* and *E. machalilla* and the confusion between *E. anthonyi* and *E. tricolor* in the past have already been discussed in more detail under point 2.

*Epipedobates tricolor* is endemic to Ecuador. The species occurs in the western foothills of the Andes in the provinces of Bolivar and Cotopaxi in central Ecuador. It inhabits altitudes of 750-1,769 metres above sea level (COLOMA et al. 2022). The entire distribution area is estimated to be 6,864 km<sup>2</sup> in size, in which the frogs occur in around 20 localities (IUCN SSC AMPHIBIAN SPECIALIST GROUP 2019). *Epipedobates tricolor* lives in the vicinity of streams in rainforests to cloud forests or forest remnants.

Males reach a head-torso length of 1.9-2.1 cm, females are larger at 2.0-2.3 cm and are somewhat broader. The species is therefore somewhat smaller than *E. anthonyi*, which grows to 2.5 or 2.7 cm in length. Another striking but unfortunately useless distinguishing feature in practice is the colour of the bones. While *E. tricolor* has green bones, they are white in *E. anthonyi*.

The head is almost as wide as the body, the eyes are relatively small compared to many other poison dart frogs. The dorsal skin is smooth. On the hind feet, the toes are connected by remnants of instep skins, most pronounced between toes II to IV. The first toe of the forefeet is longer than the second. In males, the third toe of the forefeet is clearly enlarged.



Habitat of the cielito form of *Epipedobates tricolor* near San José del Tambo, central Ecuador | Luis A. Coloma, Centro Jambatu



Location of the Cielito form; like all *Epipedobates* from the tricolour complex, the frogs live near small streams. | Luis A. Coloma, Centro Jambatu

Like *E. anthonyi*, *E. tricolor* is also very variable in pattern and colouration. The animals differ in colouration and markings both individually at one locality and between the different localities, sometimes considerably (vgl. COLOMA et al. 2022; CHRISTMANN S.P. 2004).

Citizen Conservation is currently in charge of the so-called Cielito variant from the San Jose de Tambo region. In a species conservation project, site types must not be mixed together. They reflect the natural diversity of the species, which should be preserved wherever possible.

*Epipedobates tricolor* is generally characterised by a dark brown dorsal colouration and a vertebral (on the middle of the back) and two lateral (on the flanks) yellowish longitudinal stripes, all three of which can also be discontinuous. The front part of the head is marked with a yellow line running from the upper jaw to the base of the foreleg. The front area of the top of the head is often coloured yellow over a wide

area, the longitudinal stripes originate here and extend to the loins. The three longitudinal stripes gave rise to the name "Phantasmal Poison Frog". In the "other Phantasmal Poison Frog", *E. anthonyi*, these longitudinal stripes are usually turquoise to cream-coloured, while the basic colouration is more reddish to bright red.

In *E. tricolor*, the stripes are usually yellow to yellow-green in colour, while the ground colouration is darker and more brownish. The upper side of the extremities is marked with light-coloured stripes and spots. There are often reddish spots in the armpits, on the groin and on the "popliteal fossae" of the hind legs. The ventral side is marked with yellow spots that merge into a net pattern or can even completely replace the dark base colouring.

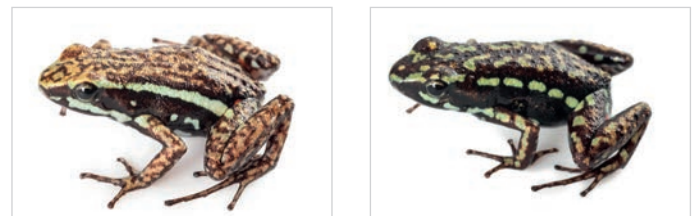


In the Cielito variant, which is maintained in Citizen Conservation, the central stripe on the back is broken up into rows of dots; the two dorsolateral stripes are also reduced and sometimes interrupted. The color of these markings (stripes, dots, spots) varies between yellow, whitish and blue-green. The cielito variant is occasionally also called "cielito azul". "Cielo" is the Spanish word for 'sky', 'cielito' is the diminutive form, meaning 'small sky'. The name probably alludes to the fact that these frogs actually show a pattern reminiscent of a starry night sky. The suffix "azul" refers to the frequent blue tinge of the stripes and "stars".

Frogs of the genus *Epipedobates* belong to the group known colloquially as poison dart frogs, and in nature they actually have effective skin toxins, as has been demonstrated at least by *E. anthonyi* (for details see LÖTTERS et al. 2007). These include two particularly striking compounds, namely the highly toxic batrachotoxin and the anaesthetic alkaloid epibatidine. The latter was, as the name suggests, first discovered in *Epipedobates*, namely in *E. anthonyi*, which were still categorised as *E. tricolor* at the time. It was discovered in 1977 by US scientists, who also discovered that it has an effect comparable to that of strong opiates. Subsequently, 750 of the animals were collected in order to extract this substance from them and investigate it further. At the end of the 1980s, the structure of epibatidine was elucidated, which proved to be extremely analgesic and significantly more effective than morphine, thus promising considerable economic potential for the production of painkillers. Since then, technical processes have been successfully used to modify and synthesise the substance, even though no drug has yet been developed from it to market maturity.



High variability even at one locality: *Epipedobates tricolor* of the "Rio" variant from Moraspungo | WIKIRI



The Cielito variant of *Epipedobates tricolor* is also very variably marked. | WIKIRI

As early as 1998, the economic potential of a marketable painkiller that might result from this was estimated at 40 billion US dollars (WERNING 1999). The case caused some political uproar in Ecuador. It was no longer possible to prove that the animals had been legally exported in the 1970s, and Ecuador refers to the UN Convention on Biological Diversity (Nagoya Protocol), according to which every country has the right to its natural resources.





When it was still regarded as *Epipedobates tricolor*, the highly effective epibatidine was discovered in the skin venom of *E. anthonyi*, which has a stronger effect than morphine. | Arco

Accordingly, it would like to share in the expected profits from the potential drug. However, the USA has never ratified this convention, and the US pharmaceutical company Abbot, which is working on the epibatidine drug, is keeping a very low profile with regard to the demands from South America. The case not only exemplifies the lines of conflict surrounding the utilisation of genetic resources and the debate about neo-colonialism, but also highlights the huge potential that biodiversity, and amphibians in particular, still harbours for humans. Species conservation can therefore also be directly justified by the potential economic benefits for humans, as we cannot yet know what opportunities various genetic resources of animals and plants will offer us in the future.

The skin venom of *Epipedobates tricolor* serves the frogs themselves as a defence against microorganisms such as fungi, which could otherwise easily grow on the unprotected skin in the warm and humid environment, as well as against predators. The conspicuous colouring

of many poison dart frogs is interpreted as a warning colour. Despite the name, however, most poison dart frogs were not used by the indigenous peoples of South America to poison arrows; only the *Phyllobates* species were used for this purpose. Nevertheless, the skin venom of *E. tricolor* is classified as dangerous for humans. Care should be taken when handling wild-caught frogs and direct contact should only be made when wearing nitrile gloves - also in the interests of the frogs themselves.

However, poison dart frogs cannot produce their skin toxins on their own, they have to ingest it (or important precursors) with their natural food. This is why frogs in terrariums gradually lose their toxicity. Offspring - and only these are distributed via Citizen Conservation - are completely non-toxic.



Male *Epipedobates tricolor* transporting tadpoles | Avalon red, alamy

Their diet in nature is made up of a variety of small and tiny invertebrates: Mites, ants, small insects, springtails, spiders, etc.

*Epipedobates tricolor* has a trilling, relatively quiet call that is perceived by humans as pleasant or at least usually not disturbing. The diurnal frogs call mainly in the morning hours. As with other tropical frogs, the intensity of reproductive activity throughout the year is linked to the course of the rainy and dry seasons. As there are no major temperature fluctuations over the course of the year in the equatorial distribution area (but a daytime climate with night-time cooling) and there is rainfall all year round, year-round reproduction with reduced activity in the drier seasons is also to be expected.

It is known from observations in terraria that the clutches are deposited in the leaf litter or on plants. The males take care of the brood, i.e. water the clutch and guard it, and after hatching they transport the tadpoles on their backs to a suitable watering hole (see point 4.7). They are very flexible in their choice of water source. They use streams as well as puddles and even footprints of cattle, even with a water volume of less than 300 ml (LÖTTERS et al. 2007 for *E. anthonyi*). The tadpoles then undergo their further larval development there.

An average life expectancy of 4-5 years is given for *E. anthonyi* in the wild; in the terrarium the small frogs can live for over ten years. It can be assumed that this information also applies to *E. tricolor*.



### 3.2 Threat situation



*Epipedobates tricolor* is listed as “critically endangered” on the Ecuadorian Red List. The greatest threat comes from the destruction of its habitat and environmental pollution from agrochemicals. | Luis A. Coloma, Centro Jambatu

*Epipedobates tricolor* only inhabits a small distribution area in the western foothills of the Andes in Ecuador and is only known from around 20 localities. It is still common locally in some places. However, the populations appear to be declining and some have already become completely extinct (IUCN SSC AMPHIBIAN SPECIALIST GROUP 2019; COLOMA et al 2022). The reasons cited for this are water pollution caused by chemicals from agriculture and the destruction of habitats due to on-going deforestation for agriculture, livestock farming and transport. In addition, the species, which is only found in small areas and is tied to streams, is at risk from events such as earthquakes, volcanic eruptions and weather-related natural disasters, and therefore also from climate change. *E. tricolor* no longer occurs in habitats that have been heavily modified by humans. However, it can also survive in forest fragments near pastures (IUCN SSC AMPHIBIAN SPECIALIST GROUP 2017).

*Epipedobates tricolor* is listed as “vulnerable” on the Red List of the International Union for Conservation of Nature (IUCN). In a reassessment of the Ecuadorian Red List, the species was classified as “endangered” (ORTEGA-ANDRADE et al. 2021).

The “Cielito tricolours” managed by Citizen Conservation originate from legally collected specimens from the Centro Jambatu de Investigación y Conservación de Anfibios in Quito. The frogs are bred in this research and conservation breeding centre and then legally exported via the distribution partner WIKIRI. The proceeds from sales finance the species conservation and environmental education work of the Centro Jambatu.



### 3.3 Protection efforts



No protected area ensures the conservation of *Epipedobates tricolor* in its natural habitat. Here a male of the Rio form guarding his clutch. | Steven Guevara S., Centro Jambatu

The most important measure to protect *Epipedobates tricolor* would be to preserve the frogs' habitat. Unfortunately, there is currently no protected area in their distribution range, meaning that the future of the species itself, and even more so of the individual local forms, is uncertain. The establishment of ex-situ populations is therefore of particular importance. There is such a population in the Centro Jambatu in Quito (see 3.2). To spread the risk, it makes sense to establish a reserve population outside Ecuador as well. This is the aim of Citizen Conservation.

Due to the importance of poison dart frogs in the international pet trade, all *Epipedobates* species (like all "classic" poison dart frog genera) are protected under Appendix II of the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and accordingly under Appendix B of the EU Endangered Species Regulation.



## 4. Husbandry

*Epipedobates tricolor* is a species that is easy to keep and can also be recommended to newcomers to keeping poison dart frogs. However, it is shyer and lives more hidden than *E. anthonyi*, which is particularly popular in terrariums and zoos.

*Epipedobates tricolor* is kept in lushly planted rainforest terrariums. The tanks can be designed very attractively, which is what makes keeping poison dart frogs so appealing to many terrarium keepers.

Almost all terraristic publications (at least before 2004) on *E. tricolor* actually refer to *E. anthonyi*. However, the two species appear to be very similar in their terrarium requirements. However, they are not identical, as the different shyness of the animals shows. At least Cielito Phantasmal Poison Frogs are much shyer and less productive than *E. anthonyi*. It is therefore important - and this is also a task of Citizen Conservation - to expand and consolidate knowledge about the keeping and breeding of this species through further experience with the cielito animals of *E. tricolor* and, if necessary, to work out differences to *E. anthonyi*. These husbandry recommendations will therefore be dynamically adapted from time to time in the future as our knowledge grows.

These husbandry recommendations are still mainly based on extensive experience with *E. anthonyi* (see e.g. FRIEDLI 2023; LÖTTERS et al. 2007). They are supplemented by specific information on *E. tricolor* (COLOMA et al. 2022) and experiences with keeping "true" *E. tricolor*, provided by Kaj Maciejek, Bernd Pieper and Nicolas Chalwatzis.

Despite the confusing taxonomic history of the species, there is no reason to fear confusion between *E. tricolor* "Cielito" and *E. anthonyi* due to their clearly different appearance.



Doris and Nicolas Chalwatzis keep *Epipedobates tricolor* for Citizen Conservation. | Chalwatzis



Terrarium for *Epipedobates tricolor* | Heiko Werning

Basic knowledge of terraristics (expertise) is a prerequisite for participation in CC and must be demonstrated to the CC office before the animals are accepted. They are therefore not conveyed in our husbandry recommendations, at best only touched on briefly.

Especially in keeping poison dart frogs, there is a wealth of experience on numerous individual aspects, from terrarium construction, design and technology to planting and various options for rearing tadpoles. We therefore strongly recommend that, in addition to general terrarium expertise and these species-specific husbandry recommendations for *E. tricolor*, you also consult the general literature and relevant internet sources.

A good, practice-orientated basic work on keeping poison dart frogs in general is "Faszinierende Pfeilgiftfrösche" by SALTERBERG (2016). If you want to delve deeper into the subject and are also interested in scientific aspects, please refer to "Pfeilgiftfrösche - Biologie, Haltung, Arten" by LÖTTERS et al. (2007).

In German, an excellent practice-oriented treatise specifically on keeping the closely related *Epipedobates anthonyi*, which is also recommended to all keepers of *E. tricolor*, is the volume "Der Dreistreifen-Baumsteiger - *Epipedobates anthonyi*" from the series "Art für Art" (FRIEDLI 2023).

Finally, the DGHT Mönchengladbach/Krefeld city group has launched the "Rüdiger Project", in which the path of an *E. anthonyi* from egg to sexually mature frog was traced step by step in an entertaining and child-friendly way. The result is a highly recommended book that can be recommended not only to children but also to all epipedobate keepers. It can be obtained from the DGHT city group (<https://moenchen-gladbach-krefeld.dght.de/ruediger-das-buch-zum-projekt/>).

In principle, the regulations in the general CC guidelines (<https://citizen-conservation.org/wp-content/uploads/2024/05/CC-Leitlinien.pdf>) and in the recruitment contract apply to all CC animals.



#### 4.1 Requirements and documentation obligation

*Epipedobates tricolor* is protected under Appendix II of the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora, Appendix B of the EU Species Protection Regulation and "specially protected" under the Federal Nature Conservation Act. This means that keepers must be able to prove the legal origin of the animals and register their population and any changes to the population with the responsible local authority. You can easily google the responsible authority by entering the name of your place of residence and the keyword „protected animals“ or similar; it is usually the lower nature conservation authority of the city or district.

With CC, keepers always receive the animals with a certificate of origin, which is recognised for deliveries within the EU in order to prove the legal origin. Accordingly, CC breeders must ensure that the "Certificate of origin and transfer" form provided by CC is completed in full and signed when handing over their animals. Not only the origin of the parent animals of the offspring should be stated, but also that of the parents of the parent animals. This ensures complete back documentation. All paperwork relating to transfers within or out of CC must be sent to the CC office ([amphibians@citizen-conservation.org](mailto:amphibians@citizen-conservation.org)) immediately as a scan or photo.

The obligation to register applies to the owners of the animals, i.e. those who actually keep them, irrespective of the fact that the animals are the property of CC. The official notification should be made immediately after the transfer, preferably by submitting a copy of the CC certificate of origin and transfer or adequate proof

of origin. Any changes to the stock must also be reported regularly to the authorities, i.e. both offspring and deaths or transfers. Please clarify the desired procedure with your authority, especially in the case of offspring. Frequently, only a six-monthly report or similar is requested, often only for young frogs that have undergone metamorphosis, for example, and not for tadpoles, which is often hardly possible in practice. However, the requirements of the respective authorities differ here, so that the mode should be agreed with the first report.

Different rules apply to imports and exports from or to outside the EU (e.g. Switzerland, Great Britain). Here, the relevant export and import documents must be applied for in advance.

All CC animals are the property of the non-profit Citizen Conservation Foundation gGmbH. This also applies to all resulting offspring (see CC guidelines and contract). Keepers are therefore not allowed to give away or sell the offspring themselves. Offspring are distributed within the project as long as this makes sense in terms of population management. If offspring cannot or should not be distributed within the project, they can be sold outside the project by prior arrangement with the CC office or the CC office can arrange for them to be sold to licensed dealers, for example. Proceeds from this go to CC and contribute to the financing of our species conservation programme. The sale to retailers also supports CC's species conservation work.



An essential part of CC is the coordination of our inventory, which is why we must always be informed about its development. CC participants are therefore contractually obliged to submit a stock report twice a year, on 1 March and 1 September. This stock report (number of animals, their sex if possible, animals that have died or bred in the last six months) can be submitted online. You will receive a reminder from the CC office in good time; you will also be informed of the current procedure for submitting the stock report.

In addition, we are happy to receive observations and experiences gained in keeping and breeding, as an important aim of CC is to generate knowledge about ex situ husbandry and the biology of the species in our conservation breeding network. As already emphasised under point 2, this applies in particular to *E. tricolor*, for example to determine possible differences to *E. anthonyi*.

We are also always happy to receive photos of animals and their facilities. We can then use these for publications or social media, for example. Permission to use the images within the framework of the CC programme is deemed to have been granted upon sending them, unless expressly objected to; CC always names the image authorship in publications, unless expressly objected to.

Please also inform the CC office about deaths informally by e-mail to [amphibien@citizen-conservation.org](mailto:amphibien@citizen-conservation.org) between the stock reports, so that further steps can be discussed if necessary, such as examinations of the other animals, a necropsy or veterinary care.

In the case of clutches and young tadpoles, it is often only possible to make estimates, which are nevertheless helpful. The CC office should also be informed of any successful offspring outside of the stock reports so that new keepers can be found for the offspring in good time.



The founder animals of *Epipedobates tricolor* for Citizen Conservation were bred at the Centro Jambatu in Ecuador

| Steven Guevara S., Centro Jambatu

If keepers can no longer or no longer wish to keep the animals or offspring, the CC office must be informed as early as possible so that we can place the animals in subsequent homes.

Veterinary tests must be carried out every time the animals are moved within CC, i.e. from one person to the next. A skin swab for the chytrid fungus *Bd* and a faecal sample for parasites must be taken, and further tests can be arranged if necessary. Instructions and the necessary dry swab and faecal sample tubes can be provided by CC, the examination costs are borne by CC. A corresponding test order for a suitable test laboratory is available from the CC office.

Under no circumstances should the animals be mixed with other *Epipedobates*, not even with other *E. tricolor*, neither the "Cielito" form nor other localities. It is crucial for the development of long-term conservation breeding that the genetic background of the animals can be traced, which is why uncontrolled mixing with animals from outside must be avoided. From a studbook management perspective, it is often desirable to avoid mixing between generations. So please do not keep parents and offspring together without prior consultation with the CC office! Siblings, on the other hand, can be kept together without hesitation and can also be brought together for breeding until the CC studbook gives other information.





## 4.2 Transport

You normally receive the animals in the Citizen Conservation #Amphibians programme directly from the breeders or previous owners. The future owners are responsible for organising the transport themselves; any costs incurred (i.e. travel costs to the breeders, shipping costs if applicable) must be borne by you. The CC office may be able to help arrange shipping – however, in order to minimise the effort and administrative costs, we ask that you organise the transport yourself if possible. Only forwarding agents authorised to transport live animals may be used for shipping; the relevant guidelines for shipping and all legal regulations must be complied with!

The animals undergo a veterinary examination each time they are moved (see section 4.1). Parasites may still be present; not every parasite load is worthy of treatment. In addition, there is always a risk that pathogens will not be recognised despite examinations.

The usual quarantine rules in terraristics should usually also be observed by the new owner when taking over CC animals.

For transport, *Epipedobates tricolor* are best packed individually in small plastic boxes (e.g. cricket boxes). It is important that the air holes do not have any inward edges so that the frogs do not injure themselves on the sometimes sharp-edged plastic with their delicate skin. Put some damp kitchen paper in the box beforehand. These transport boxes are then placed in a polystyrene box or insulated bag, secured against slipping, to protect the frogs from external weather influences such as overheating

or hypothermia. In winter or summer, it may be necessary to add a cooling battery or heat pack to the box.

Caution - always separate such elements safely from the transport boxes (e.g. wrap in a towel) so that the frogs in their box cannot overcool or overheat due to direct contact with a neighbouring cooling or heating element. Heat packs must not be placed in the polystyrene boxes immediately after activation; they become too hot at first and consume too much oxygen. To be on the safe side, you can stick them in front of a small hole in the outer packaging of the box. Overheating must be avoided, especially in summer. CC participants can purchase appropriately insulated transport boxes directly from the supplier at favourable conditions.



For dispatch, the frogs are placed individually in plastic tins with moist paper. The tins are then placed in an insulating polystyrene box and secured against slipping. Here at the dispatch of *Atelopus balios* by WIKIRI to CC. | WIKIRI



Terrarium for keeping *Epipedobates tricolor* with bromeliads and leaf litter | Nicolas Chalwatzis

### 4.3 The terrarium

*Epipedobates tricolor* can be kept in pairs, but is better kept in groups. Cube-shaped terrariums with an edge length of 40 cm are recommended as the minimum size for a terrarium for 1.2 animals (one male, two females). However, larger tanks are better. Suitable sizes are e.g. 60 x 60 x 40 cm, 80 x 50 x 60 cm or 100 x 50 x 60 cm (length x width x height) for groups of 5-10 animals.

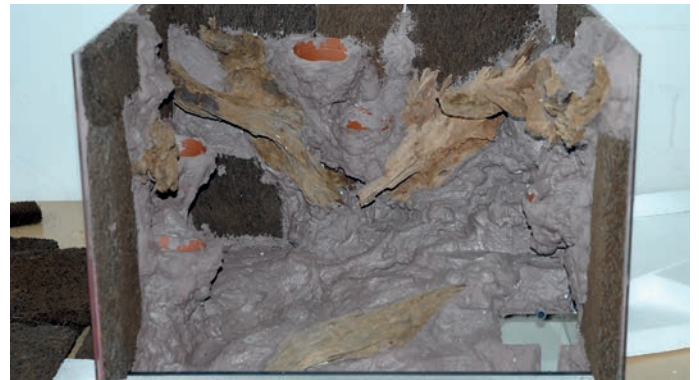
Of course, such size specifications are always somewhat arbitrary. Poison dart frogs also behave differently and the terrarium design also makes a difference; the more richly the terrarium is structured and also includes the back and side walls, the more usable space is available for the animals. The "General keeping guidelines for anurans" of the DGHT-AG Anurans specify a minimum terrarium size of 50 x 25 x 20 cm for a group of four ground-dwelling poison dart frogs.

All-glass terrariums have proven to be the best for poison dart frogs. In order to maintain the humidity in the terrarium at the required high values, the ventilation areas must not be too large. It is best to use the ventilation system commonly used in standard terrariums, where the vents are installed at the front under the sliding panes and at the top in a side pane or at the back at the top of the lid. The resulting chimney effect also prevents the windows from misting up. The ventilation areas must be sealed with Drosophila-proof gauze. It requires a little sensitivity to select the ventilation areas or reduce them by covering them so that the fresh air supply is good on the one hand, but the high humidity in the terrarium is maintained on the other.



In terrariums specially designed for keeping poison dart frogs, the ventilation areas are already optimised for this purpose and can usually be used in this way. Such tanks also have a sloping bottom with a drain and a small "moat" in front of the front pane. If the tank needs to be kept moist, the water then automatically runs forwards through the drainage layers of the substrate, flushing through the floor and can be regularly drained through the drain, which makes maintenance work much easier.

A drainage layer, e.g. a few centimetres of expanded clay, is first added to the tank as a substrate. A well-permeable fleece is placed on top, as is common in plant care and is available everywhere. The actual substrate with soil, moss, shredded coconut, leaves or similar is then placed on top. Alternatively, you can also cut a substrate from cork or polystyrene sheets, into which you can then carve small "ponds". There are plenty of instructions available in the literature and on the internet.



Using Styrodur, construction foam, tile adhesive and a covering substrate, the foundation stone of a small rainforest section for a poison dart frog terrarium including plant trays in the back and side walls is created step by step. With a little skill, you can make such an interior yourself; there are plenty of instructions in literature and on the internet. Alternatively, you can have ready-made terrariums made by specialised suppliers. | Heiko Werning



Phantasmal Poison Frogs are not exclusively ground-dwelling, but also like to climb. Calling males in particular often expose themselves on low leaves or stones. The side and rear walls should be designed to be usable for the frogs, i.e. climbable, with small plateaus and platforms as well as recesses for inserting plants. Planted Xaxim back walls have also proved successful. Climbing plants are simply attached to the Xaxim. They grow quickly and well on it. This creates green, densely overgrown walls. There are no limits to the wall design in particular, from imitation rain-forest tree roots to artificial rock back walls, everything is possible here - there are numerous DIY instructions in specialist literature and on the internet. Various ready-made artificial backgrounds are available on the market.

Once the back and side walls as well as the floor have been designed and installed, further furnishings such as roots, stones, pieces of cork, lianas and branches are added to create a terrarium rich in structure. In addition, mini-ponds with a low water level (approx. 2 cm) should be created, for example with flower coasters, stone-look drinking bowls or halved Brazil nut shells. It is also important to ensure that there are drier areas in the terrarium, e.g. slate slabs that dry out quickly. If a spotlight is used, such a drying and basking area should be located in its light cone. Several spawning burrows are important; see point 4.7. Several feeding places should also be available in the terrarium.

The terrarium should be lushly planted. *Epipedobates tricolor* in particular tends to live in hiding and needs dense planting to feel comfortable. All species that can cope with a warm, humid climate are suitable. In addition to plants standing on the ground, epiphyte branches can also be used very well and the walls should be enhanced with climbing plants. Bromeliads, whose leaf axils are particularly favoured by *E. tricolor* for laying eggs, have proved particularly successful in keeping poison dart frogs. Good planting not only creates visually appealing habitats for the frogs, but also good conditions for an ideal microclimate and plenty of structural elements and hiding places.



Cielito Phantasmal Poison Frog like to stay in the leaf litter; you can cover part of the terrarium floor with beech or oak leaves. | Nature Picture Library, alamy



For examples of plant arrangements and a list of particularly suitable plants, see FRIEDLI (2023).



The back and side walls should be designed in such a way that the frogs can use them for climbing. They can be equipped with plants, spawning caves and small plateaus.

| Nicolas Chalwatzis



Phantasmal Poison Frogs like to climb onto leaves. The leaf axils of bromeliads are particularly popular for hiding, as egg-laying sites and as a viewing platform.

| Nicolas Chalwatzis



The small Cielito frogs often climb in the vegetation.

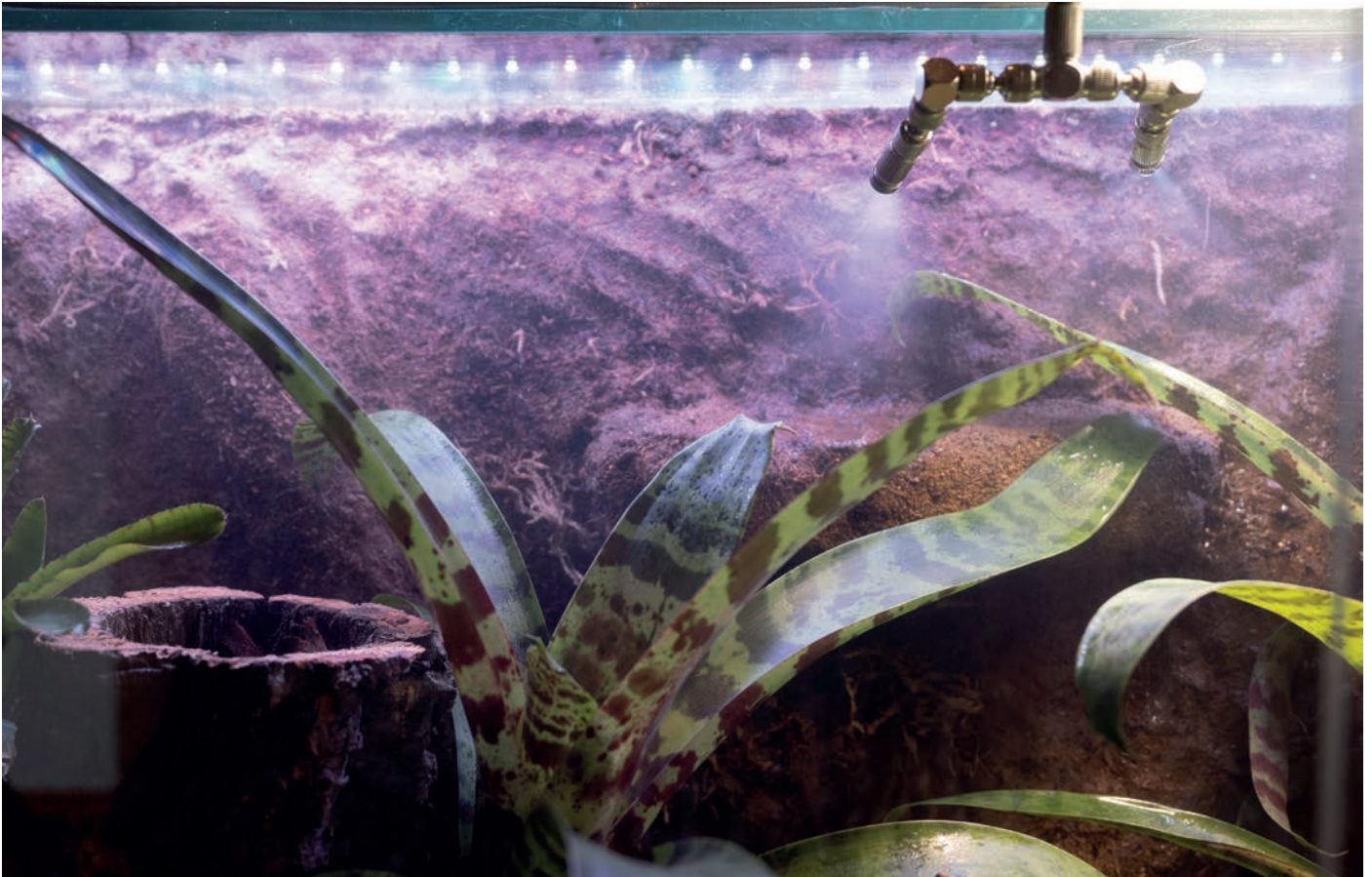
| Nature Picture Library, alamy



Poison dart frog terrarium also suitable for *Epipedobates tricolor* with lush planting, designed back and side walls, drainage made of gravel as the bottom layer of the substrate with a mixture of stones and moss as a cover, a small "pond" with a few centimetres of water at the front and plenty of plants and climbing opportunities | Heiko Werning



#### 4.4 Technology and temperatures



A sprinkler system is highly recommended. | Nicolas Chalwatzis

Phantasmal Poison Frogs have no special lighting requirements. „To be on the safe side, a UV component in the light is usually recommended nowadays, both when keeping frogs and tadpoles. Specialised lamps are available from pet shops. However, the frogs can be kept without any problems and without any recognisable differences in their well-being, even without UV light. The lighting can therefore be orientated primarily to the needs of the plants. Fluorescent lamps or LED bars have proven to be effective for basic illumination, possibly also a small spotlight to create a “heat island” and the desired temperatures in the terrarium. The lighting duration is around 12 hours per day and can vary slightly over the course of the year.

The temperature range of 22-26 °C should be covered in the terrarium during the day, i.e. cooler and warmer areas should be available in the terrarium at the same time. This allows the frogs to always visit the temperature zones that suit them best. *Epipedobates tricolor* come from medium altitudes and do not like excessively high temperatures.



Frogs in the mist: A nebuliser not only ensures high humidity, but also creates great visual effects in the terrarium.  
| Heiko Werning



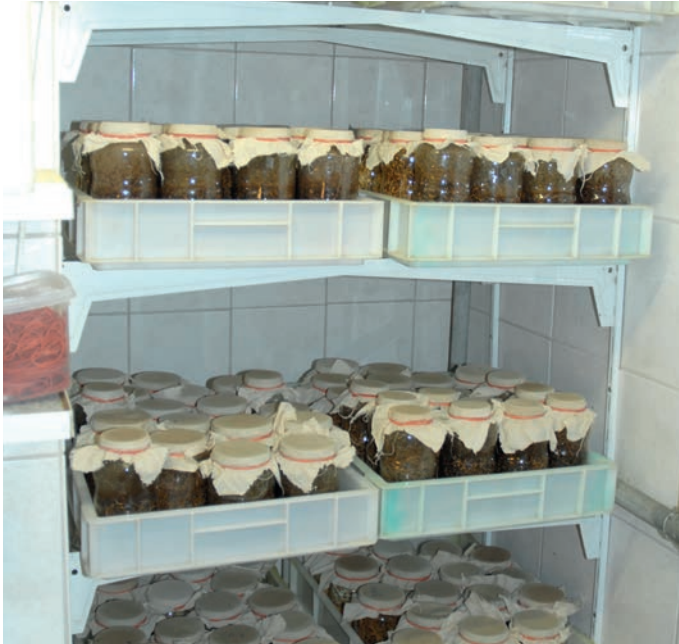
The sprinkler system and nebuliser are best filled with rain-water or osmosis water. | Doris Chalwatzis

The desired temperature values are normally achieved through a combination of normal room temperature and lighting. If necessary, the desired temperature range can be set by switching on a spotlight of suitable intensity, e.g. 35 W. Heating mats or cables are not normally used for keeping poison dart frogs.

At night, the values drop to room temperature by switching off the lighting, which may be somewhat cooler for *E. tricolor* (18-20 °C). In winter, temperatures can be a little lower overall. Although there is no summer or winter in the natural tropical habitat as there is here, the alternating rainy and dry seasons mean that temperatures are not completely constant all year round. Keeping the frogs somewhat cooler and drier in winter for around three months also seems to be conducive to a high life expectancy of the animals, because no or reduced reproductive activity takes place during this time, which gives the frogs a "breather".

A high level of humidity in the terrarium is important, although waterlogging of the floor must be avoided. To achieve this, spray or sprinkle the terrarium regularly. This can be done by hand with water atomisers or pressurised sprayers used in flower care, but given the frogs' humidity requirements, sprinkler systems are recommended, with which the terrarium is sprayed several times a day (e.g. three times a day) for 20-60 seconds, depending on the strength of the nozzles or the size of the droplets. Care should be taken to ensure that the tank does not become waterlogged. As a general rule, the furnishings in the terrarium (e.g. plant leaves) should be dried again about an hour after spraying. In winter, you can spray less frequently and/or for a shorter time.

Fogging systems are also used successfully, often in combination with sprinkler systems. A humidity level of around 100 % is achieved through misting. The activity of the frogs then increases noticeably and audibly. Such systems are available in various sizes and types from specialised retailers. The water used in the terrarium can be decalcified using an osmosis system in order to avoid or limit ugly limescale stains on the panes and leaves of the plants.



Homemade still tastes best: large-scale fruit fly breeding at a poison dart frog breeder with a correspondingly large population | Heiko Werning



Pea aphids are readily eaten by *Epipedobates tricolor* and can be bred with little effort. | Nicolas Chalwatzis

#### 4.5 Feeding

Poison dart frogs generally eat small food. Although *Epipedobates tricolor* is a rather small species of poison dart frog, these greedy eaters also prey on comparatively large prey. This simplifies the care of the animals considerably and extends the range of easily obtainable food animals. Only live, moving invertebrates are eaten.

The number one staple food of poison dart frogs is fruit flies (*Drosophila*). In addition, Phantasmal Poison Frogs also like to eat small crickets, oven fish, aphids, terflies, bean beetles, white woodlice and springtails. Both isopods and springtails are also well suited as "ground police" for free-range keeping in the terrarium, breaking down organic waste in the tank. However, they are always eagerly decimated by the frogs.

You can easily breed all the food animals mentioned yourself, then you always have the right food available in sufficient quantities and can control the quality yourself by feeding the invertebrates. There are plenty of breeding instructions available in the literature. However, the species mentioned can also be obtained from pet shops. CC participants can purchase food from co-operating suppliers at a reduced price.





The adult animals are fed around two to three times a week in the “dry season”, increasing to four to four feedings in the “rainy season”.

All feed animals must be fed high-quality feed themselves. Before they are fed, they are enhanced by dusting them with commercially available vitamin and mineral supplements. This nutritional enhancement is of great importance for successful keeping and breeding. The standard preparations known in terraristics such as “Korvimin ZVT”, “Herpetal +Amphib” etc. are suitable. Many poison dart frog keepers particularly like to use the preparation “Amivit” (“Birkhahn-Pulver”), which can be obtained from specialised suppliers.

It is advisable not to feed the frogs too often and too much so that they do not become fatty, but also so that they hungrily eat the food insects offered and thus also absorb the vitamin-mineral powder. Otherwise the feeder insects will get rid of it again if they crawl around in the terrarium for longer. It is best to feed only as much as the frogs can eat in a few minutes.

Feeding is best done at fixed feeding stations. For hygienic reasons, feeding bowls, flower stands, stone slabs or similar have proven to be suitable.

An enriched environment for animals in human care is also playing an increasingly important role in terraristics. It is therefore advisable to vary feeding times, types and locations from time to time.



Always ready: Tin with vitamin-mineral mixture, with which the food animals for the frogs are dusted directly before feeding | Nicolas Chalwatzis



Dinner is ready! Today we have fruit flies.  
| Doris Chalwatzis



#### 4.6 Socialisation

Provided the terrarium is large enough, *E. tricolor* can be socialised well. Pairs, groups with one male and several females, several males and females together and even groups with a surplus of males can be kept together.

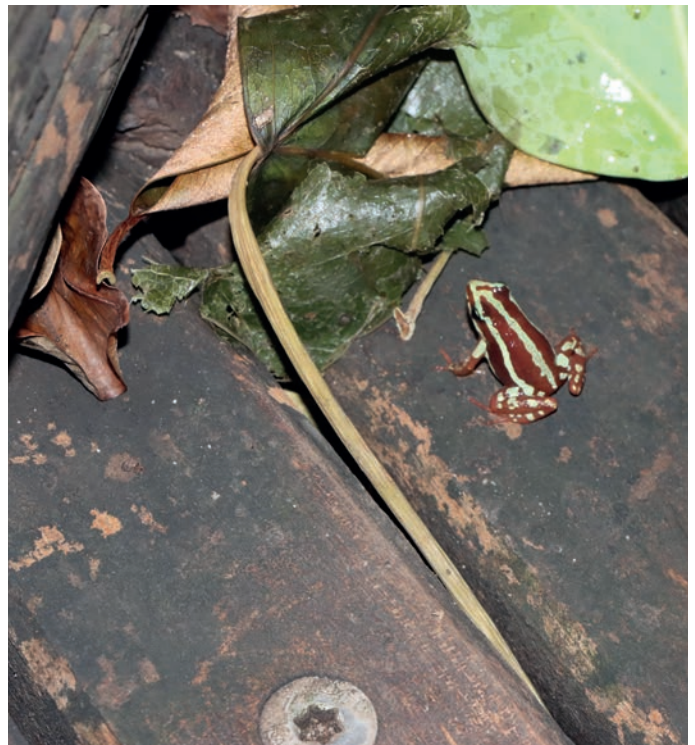
The frogs are nevertheless territorial and form hierarchies among themselves, both among the males and the females. This initially leads to conflicts in which the frogs jump at each other or cling to each other in small “wrestling matches”. This usually results in dominant and subordinate pairs. It therefore makes sense to offer several feeding places in the terrarium when keeping groups so that all animals get enough to eat.

If they do not have enough space available, males can engage in ongoing aggressive “wrestling matches” with each other. This can also result in one animal being drowned or pushed away completely so that it begins to suffer.

Socialisation with one’s own offspring is usually not recommended in conservation breeding for population genetic reasons. This is why CC animals should normally not be socialised. Young animals should be kept separate from their parents to avoid intergenerational mixing. Different husbandry methods may be possible by arrangement.

Due to the risk of hybridisation, *E. tricolor* should not be kept together with other local forms of the same species, but also not with other *Epipedobates* species. Despite its small size, at least *E. anthonyi* is considered problematic when socialising with other species because the frogs are very dominant and often

quickly eat the food of other species. Even geckos are often suppressed. In sufficiently large and well-structured terrariums, however, socialisation with various poison dart frogs and other species has already been successful. *Epipedobates tricolor*, on the other hand, is much more shy in the terrarium and lives in hiding. Socialisation could therefore also be problematic. CC generally recommends keeping them in species tanks.



At least *Epipedobates anthonyi* is not easy to socialise with, as it quickly suppresses its fellow inhabitants with its voracious appetite. At Nuremberg Zoo, they socialise successfully with various frog species - albeit in a large rainforest hall where the frogs hop around freely. | Axel Kwet



#### 4.7 Offspring

The first reproductive activities in *Epipedobates tricolor* begin at the age of 6-10 months after going ashore. Males presumably become sexually mature somewhat earlier than females. The first clutches of females are smaller than usual and usually do not develop yet; clutches are often laid before they actually reach sexual maturity, which then of course do not develop. The life expectancy of frogs is normally around 8-10 years, in some cases up to 14 years. The animals reproduce until they are about 7-9 years old, but productivity starts to decline after the age of five. Older parent frogs are more prone to malformations, especially of the front legs.

Phantasmal Poison Frogs can breed all year round. However, it is better to simulate a dry season for them in winter in order to give them a break from laying through cooler temperatures, slightly drier housing and reduced feeding frequency.

During the peak of the annual laying period in the "rainy season", the females of *E. anthonyi* can produce a clutch of eggs every 1-2 weeks. *Epipedobates tricolor* of the Cielito variety, however, do not appear to be nearly as productive according to initial experience.

It is important to provide several suitable egg-laying sites in the terrarium so that the animals can reproduce and the eggs can be easily removed. Phantasmal Poison Frogs particularly like to lay their eggs in the leaf axils of bromeliads. Clutches are also laid on large leaves of other terrarium plants. Alternatively, artificial burrows are often used, such as halved coconut shells into which a small entrance has been cut and which are placed on a flower saucer or a petri dish, on which a smooth, dead leaf, e.g. an oak or beech leaf, is placed. The now largely historical film canisters are also particu-

larly popular. Specialised retailers now offer special spawning houses for poison dart frogs as a practical substitute. In general, smooth surfaces are favoured for laying eggs.



The perfect place to lay eggs: leaf axil of a bromeliad  
| Nicolas Chalwatzis



Classic film boxes are also very popular as spawning dens.  
| Nicolas Chalwatzis



View of a poison dart frog terrarium with numerous alternative egg-laying sites at different heights: Film canisters and halved coconut shells | Heiko Werning



Calling male of *Epipedobates tricolor* of the Rio variant  
| Luis A. Coloma, Centro Jambatu

Even when they are kept in groups, they form permanent pairs that repeatedly breed together. During courtship, the males try to attract females with their trilling. The calls are mainly made in the morning, especially after sprinkling or fogging. The males stimulate each other with their trilling. If a female ready to spawn approaches a calling male, the male changes his calling frequency and emits a different call, which is described as a short croak. With this repeatedly emitted "croak", it now runs to an egg-laying site and lures the female after it. Sometimes the process takes several hours, during which time several egg-laying sites may be visited before the pair decides on one. Once at the final egg-laying site, the male moves onto the female's back, or she moves under the male. The male then clings to her head with his front legs. This is known as the head amplexus. During the amplexus, the male releases his semen and the female then lays her eggs in the same place while the male moves away.

A clutch usually consists of 10-30 eggs, depending on the constitution and age of the female. Young females lay fewer eggs.

The males of *Epipedobates tricolor* practise brood care. They return to the clutch and keep watering the eggs with water throughout the entire development period, which they take up from a watering hole, store in the urinary bladder and then release at the clutch. In this way, they prevent the clutch from drying out. The male also guards the clutch and chases away other frogs that approach by jumping on them and clutching them. Occasionally carers are also "attacked". The tadpoles hatch after 9-14 days.

The eggs can develop in the terrarium. When the first tadpoles hatch, the male sits on the clutch and actively helps the larvae to free themselves from the egg shell with his movements. The tadpoles move with wriggling movements over the front and hind legs drawn to the body onto the back of the father and cling to it. If tadpoles miss the opportunity to get onto the male's back, they stay behind and are not picked up again later.

With the burbot on its back, the male begins to search for suitable small bodies of water where it releases the larvae into the water. It can take several days of travelling with the burbot before it is ready.



When rearing in a terrarium, it is always possible for clutches to become mouldy or tadpoles to be eaten. This can be a population management measure to limit the number of offspring. However, if breeding is to be as targeted and quantitatively productive as possible, we recommend removing the clutches from the terrarium. This is best done a few days after the eggs have been laid, when the developing embryo on the yolk can already be clearly recognised in the transparent eggs. Clutches removed earlier are more likely to become mouldy.

The clutch is then transferred to a small, closed plastic container at a controlled temperature of approx. 22-24 °C with a slight night-time drop and constantly high humidity (no ventilation of the incubation container). A little osmosis or rainwater is then added to the substrate so that the eggs are wetted but not completely submerged. After about a week, increase the water level slightly by a few millimetres. The tadpoles hatch after about two weeks.

During incubation, check regularly whether the eggs are developing well. If not, dead or mouldy eggs should be carefully removed to prevent fungi from spreading to the developing eggs.



Head amplexus in *Epipedobates tricolor* of the Rio variant  
| Steven Guevara S., Centro Jambatu



Clutch of *Epipedobates tricolor*  
| Steven Guevara S., Centro Jambatu



The male waters the clutch regularly.  
| Nicolas Chalwatzis



Heavy load: Cielito male with tadpoles on his back  
| Luis A. Coloma, Centro Jambatu



#### 4.8 Rearing

Further larval development after the hatched tadpoles have moved to a suitable waterhole can also take place in the terrarium. In well-established terrariums, the tadpoles can even grow without additional feeding if there is sufficient wood and plants as well as algae growth and microorganisms in the water section. However, it is more reliable to feed them daily when rearing them in the terrarium.

The larvae of *E. tricolor* are not cannibalistic and are well tolerated by each other. However, better rearing results may be achieved if the tadpoles are reared individually.

Either way, the tadpoles are kept in small plastic containers with a water level of 1-2 cm during the first week of separate rearing. Only osmosis or rainwater should be used as water and it should be slightly acidic (pH 6-7).

The tadpoles are then best placed in small aquaterrariums for joint rearing, which have a water level of up to 10 cm in the front section and a land section at the back; the transition from "deep water" to the bank should be as smooth as possible. These tanks can then also be used as terrariums for terrestrials. A simple possible technique is to set up small plastic terrariums (e.g. "fauna boxes") at an angle. Of course, you can also design attractively furnished glass terrariums so that they offer such conditions.

Alternatively, tadpoles can also be reared in aquariums or plastic boxes with a water level of up to 10 cm. Gravel is added to the water section as a substrate and, for example, some oak leaves, almond tree leaves and alder cones as cover, structural elements and to positively influence the water quality; they have a bactericidal effect and make the water more acidic. Herbaceous aquatic plants can also be introduced. Temperatures should be around 22-24 °C. The water is changed as required, e.g. weekly.

The best control is achieved by rearing the tadpoles individually as soon as they have reached the free-swimming stage. Each tadpole is placed in a small plastic container with a leaf and possibly some aquatic plants. The water must also be changed regularly as required, e.g. once or twice a week. The easiest way to do this is to carefully pour water out of the tin, then remove the tadpole with a spoon when the water level is low and place it in the new tin that is already waiting. Important: The fresh water must be at the same temperature and have the same water values. It should therefore be prepared some time in advance, e.g. by placing a leaf in it.

The tadpoles start feeding a few days after hatching. They are fed daily with fish flake food, shrimp food, spirulina algae, water fleas and chopped red midge larvae. A varied diet makes for healthier terrestrials. In a well-established water section with gravel as a substrate, shiny worms and other micro-organisms will ideally also settle, which the tadpoles can also prey on as they please.



The larvae take 6-10 weeks to develop, depending on the temperature and diet. As with all frogs, the hind legs develop first, followed by the front legs. When all four legs are developed, metamorphosis is imminent, even if the animals still have a long tail at this stage. The later light-coloured markings on the otherwise black tadpoles can now be seen.

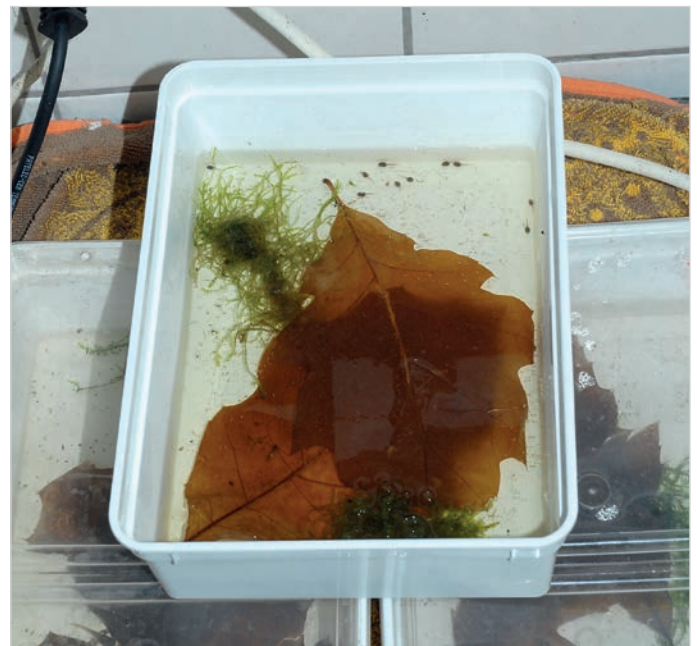
Now it is important that the terrestrials can easily leave the water. With the “bank aquaterrariums” described above, this is a given; alternatively, you can also use stones, cork or aquatic plants that protrude from the water to create a “land section” that can be easily climbed. It is important that the transition from water to land is gentle and can be easily managed by the tiny metamorphs.

The total duration of larval development from hatching through the tadpole stage to the landfall is strongly dependent on the temperature, but also on feeding. The range for *E. anthonyi* is 43-89 days, under the rearing conditions described above it is normally around 60 days (FRIEDLI 2023).



To time the clutches separately, they are carefully transferred to petri dishes or small plastic trays and moistened with a little water before being timed outside the terrarium until the tadpoles have reached the free-swimming stage.

| Heiko Werning



Further rearing of the tadpoles can also take place in small plastic containers as mini-aquaria with a water level of up to 10 centimetres. Before metamorphosis, the tadpoles must then be transferred to a terrarium. | Heiko Werning



The reward for the effort: adult Cielito Phantasmal Poison Frog | Danita Delimont, alamy

After coming ashore, the freshly metamorphosed frogs are around 8-10 mm in size. Further rearing takes place in terrariums that are similar to those of the adults in terms of climate and equipment. The rearing terrarium should not be too large in order to provide the necessary density of food animals and to keep an overview of the tiny animals. About three days after coming ashore, the young frogs begin to eat; until then they are still feeding on the reserves of the tadpole tail, which is now finally absorbed. Colouring and markings also become clearer and stronger during this time.

The young frogs are fed once or twice a day for the first few weeks. They eat springtails, small fruit flies (*Drosophila melanogaster*) and freshly hatched crickets (trade name: micro). Fruit flies and crickets are always dusted with vitamin-mineral preparations before feeding. It takes about eight months for the frogs to reach their final size and fully develop their colouring and markings. After about two months, the feeding frequency begins to be gradually reduced. When they reach adult size, the offspring are fed just as frequently as the adults.

The young frogs are much shyer than their parents and show themselves less often. They prefer to hide on the ground, e.g. in a layer of leaf litter (beech or oak leaves), which should be available accordingly. They can easily be reared in larger groups.





Regular microscopic examinations of faecal samples for parasites and PCR analyses of skin swabs for the chytrid fungus *Bd*, as here at Centro Jambatu, ensure that the frog population remains healthy.

| Diego Acosta L, Centro Jambatu

#### 4.9 Problems

One of the greatest dangers in keeping poison dart frogs is the chytrid fungus *Bd*, which has already eliminated entire terrarium populations. Keepers should therefore pay particular attention to preventing the introduction of the fungus. The tricky thing is that some species/individuals live with the fungus without becoming ill, while others are highly sensitive to it, immediately fall ill and eventually die. Although *Bd* can be treated, the treatment is relatively costly. With bad luck, the fungus can be introduced via all possible routes, but can be significantly reduced if a few simple precautions are taken.

- Every new addition to your own stock (i.e. also in other terrariums) should undergo quarantine and be tested for *Bd*. CC animals must be tested once at CC's expense when they are handed over. However, many keepers have a private animal population that does not belong to CC. It is their responsibility and in their own interest to also test for *Bd* in new additions to their private stock.
- You should not bring in any furnishings, either from nature or from the trade, without first disinfecting them safely.

With the support of CC, the DGHT has produced a brochure on this topic ("Recommendations for dealing with epidemic amphibian diseases"), which is sent to CC participants in the welcome pack and can be downloaded at any time from the CC website (<https://citizen-conservation.org/wp-content/uploads/2024/05/Handlungsempfehlungen-zum-Umgang-mit-seuchenartig-verlaufenden-Amphibienkrankheiten.pdf>)

A common problem when keeping frogs and especially poison dart frogs are the so-called matchstick legs: Young animals develop insufficiently developed or, in rare cases, no front legs at all during metamorphosis and then die sooner or later. The exact causes are still unclear. They are probably related to the diet of the tadpoles or even the parents, and the constitution of the parents may also be a reason. Perhaps the water parameters for rearing tadpoles are not ideal, or the tadpoles suffer too much stress (e.g. too dense stocking). If the problem occurs frequently, all husbandry conditions should be checked and improved.



## 5. Further Reading

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