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### Amphibian Ark

c/o Conservation Planning Specialist Group  
12101 Johnny Cake Ridge Road  
Apple Valley MN 55124-8151  
USA

[www.amphibianark.org](http://www.amphibianark.org)

Phone: +1 952 997 9800

Fax: +1 952 997 9803

[www.amphibianark.org](http://www.amphibianark.org)





## Centro K'ayra for the Research and Conservation of Threatened amphibians of Bolivia at the Alcide d'Orbigny Natural History Museum

**Teresa Camacho-Badani, Sophia Barrón Lavayen, Adriana Águila and Ricardo Zurita Ugarte, Centro K'ayra, Alcide d'Orbigny Natural History Museum, Bolivia**

It has been ten years since the Director General of Bolivian Biodiversity approved the experimental captive breeding component for frogs from the genus *Telmatobius* at the Alcide d'Orbigny Natural History Museum (Museo de Historia Natural Alcide d'Orbigny), in Cochabamba, Bolivia. In September 2008, this institution committed to saving wildlife, and since then, we have learned a lot about the aquatic frogs that inhabit our country. We started off with only three species: the Titicaca Water Frog (*Telmatobius culeus*), the Giant Aquatic Frog (*Telmatobius gigas*) and the Marbled Water Frog (*Telmatobius marmoratus*). Currently, our captive breeding facility has expanded to include the care of five additional species including *Telmatobius hintoni*, the Sucre Water Frog (*Telmatobius simonsi*) and the Sehuencas Water Frog (*Telmatobius yuracare*).

The museum has developed several conservation projects with significant contributions to the current knowledge of Bolivian frog species, for example "Conservación de Anfibios de Bolivia" and the "Bolivian Amphibian Initiative". Additionally, several researchers have joined our cause in the preservation of our country's extremely threatened high Andean amphibians.

As a conservation group, it is important for us to share some of our experiences. In 2008, we began with just thirty tadpoles and twenty juveniles. Now the captive breeding component of the museum has more than 200 individuals. This growth, both in individuals and species, has made it possible for us to develop into a center for research and conservation for the threatened amphibians of Bolivia. Now, after ten years, we would like to introduce our new identity as "Centro K'ayra".

Centro K'ayra for the Research and Conservation of Threatened Amphibians of Bolivia (still at the Museo de Historia Natural Alcide d'Orbigny) consists of an *ex situ* management program for threatened amphibian species, together with the implementation of action plans for amphibian species conservation. These action plans include research and monitoring of amphibian populations and diverse activities focusing on training, awareness and education related to the work being done.

### What is K'ayra?

"K'ayra", in the Andean cultures of Quechua and Aymara, is used to describe frogs that live in rivers and/or lakes in the high Andean mountains. Additionally, in some cases, this word is used specifically in reference to frogs of the genus *Telmatobius*.

Today, Centro K'ayra is the only program in Bolivia dedicated to the *ex situ* management of threatened amphibian species. The program includes more than 200 individuals of five different *Telmatobius* species and we are planning to add more species in the future. To accomplish this, the center intends to expand its facilities as well as to include accommodation for terrestrial species of frogs.



Teresa Camacho-Badani, manager of the Centro K'ayra, at Lake Titicaca.  
Photo: Patricia Mendoza.



The only known Sehuencas Water Frog (*Telmatobius yuracare*), a single male named "Romeo", in his aquarium at Centro K'ayra.  
Photo: Sophia Barrón Lavayen.



A juvenile Titicaca Water Frog (*Telmatobius culeus*) which was bred in captivity at the breeding center in Cochabamba, Bolivia. Photo: Teresa Camacho-Badani.



*Telmatobius hintoni* in the urban area of Cochabamba's city. Photo: Sophia Barrón Lavayen.



A Giant Aquatic Frog (*Telmatobius gigas*) tadpole during a field monitoring trip at Huayllamarca province. This photo shows how large the tadpoles of this species are. Photo: Teresa Camacho-Badani.

To improve functionality of the center, six standard operating procedures for amphibian management have been standardized: Sanitary; Nutritional; Environmental Enrichment; Handling and Transport; Environmental Safety Management and Hygiene; and Identification and Marking. In total these procedures contain thirty-four protocols, several of which have specific applications for the husbandry of aquatic frogs of the genus *Telmatobius*.

Our team is made up of three biologists, a veterinarian, three permanent volunteers and a trainee. The center also receives temporary volunteers on a regular basis, both from within Bolivia and from other countries, for training in amphibian husbandry and research.

### Species at the Centro K'ayra

#### Titicaca Water Frog

The Titicaca Water Frog (*Telmatobius culeus*), is one of the species that has been held the longest and in the highest numbers at the center. Currently, we are the second organization to successfully captive-breed F1 generation animals. These frogs hatched in April 2017 and are now juveniles. The conservation action plan for the Titicaca Water Frog includes working with local communities, research, monitoring, education and awareness programs. We would like to extend this by strengthening national and international inter-institutional relationships, to coordinate the program. This is key in supporting the conservation and management of this species.

#### Valley Water Frog

*Telmatobius hintoni* or "rana acuática de los valles" meaning the aquatic frog of the valleys, is an endemic species from Bolivia which, like the name suggests, lives in creeks, rivers and channels in the high valleys of Cochabamba and in the north part of Potosí and Chuquisaca. Centro K'ayra has had the most success with this species, already successfully producing the third generation in captivity. Furthermore, one of the principal technical personnel in the center, Sophia B. Lavayen, who has been working in the center for the last five years, is currently conducting research on the population of this frog species in urban and rural areas of the city of Cochabamba. The center is contemplating incorporating *Telmatobius hintoni* into a pilot reintroduction program – this would be the first reintroductions attempted by the center.

#### Sucre Water Frog

The Sucre Water Frog (*Telmatobius simonsi*) is endemic to Bolivia and lives in rivers, creeks and water channels next to the roads. Recently wild populations of this frog species have been found in Cajamarca's valleys in the department of Sucre and Totora province in the Cochabamba department. For this reason, we think it necessary to conduct population studies in these areas so we can improve our *ex situ* management for this species.

#### Giant Aquatic Frog

The Giant Aquatic Frog (*Telmatobius gigas*) is endemic to Bolivia and is currently listed as Critically Endangered in the IUCN Red List of Threatened Species. This frog has a distribution which is restricted to the surroundings of the Huayllamarca highland of Oruro and is known for having the largest tadpoles of all the *Telmatobius* species. In cooperation with other collaborators, Adriana Águila, a technician at the center, studied the *in situ* population of these frogs. Results of this research will provide the baselines for conservation efforts for this species.



*Telmatobius hintoni* in the Centro K'ayra.  
Photo: D. Alarcón/D. Grunbaum.



Teresa Camacho-Badani (left) in charge of the Centro K'ayra, helping Patricia Mendoza (right) during the installation of aquariums for Titicaca Water Frogs.  
Photo: Adriana Águila.

#### Sehuencas Water Frog

The Sehuencas Water Frog (*Telmatobius yuracare*), endemic to Bolivia, lives in creeks of the yungas in Cochabamba and Santa Cruz. For the past ten years, the last wild specimen of this species ever found (named "Romeo"), has been living under the careful care of the center. Unfortunately, since his capture, no other individuals of his species have been found. The life span of these frogs is unknown, and possibly Romeo is the last individual of his species. For these reasons, Centro K'ayra and Global Wildlife Conservation are planning to start an intensive search to hopefully find more Sehuencas Water Frogs and try to avoid their extinction.



The Giant Aquatic Frog is known for having the largest tadpoles of all the *Telmatobius* species.  
Photo: Teresa Camacho-Badani.

## Ex situ breeding success and trial reintroduction of the Yellow-spotted Bell Frog

Lauren Hush, Taronga Conservation Society Australia

In November 2017, the first *ex situ* breeding success of the Critically Endangered Yellow-spotted Bell Frog (*Litoria castanea*) occurred at Taronga Zoo in Sydney, Australia. Following this success, Taronga Zoo, in partnership with the New South Wales Office of Environment and Heritage, undertook an initial trial reintroduction of 200 metamorph frogs in the Southern Tablelands of New South Wales.

Following the introduction of amphibian chytridiomycosis into Australia in the mid-1970s, Yellow-spotted Bell Frogs were among the first species to be affected on a large scale, and were thought to have disappeared in 1979. Thirty years later in 2009, a small isolated population of around 100 frogs was rediscovered on a rural property near the town of Yass, in New South Wales. An insurance population of sixteen tadpoles and metamorph frogs was collected shortly thereafter, and housed at Taronga Zoo for rearing and future breeding purposes.

The wild population was monitored and surveyed in the years following the rediscovery, which unfortunately coincided with La Niña weather patterns. The cold weather provided ideal conditions for chytrid fungus to thrive, and as a result, the adult wild population rapidly declined. Flooding throughout the habitat resulted in failed recruitment over two breeding seasons, and the population crashed within three or four years after the rediscovery.

With the insurance population reaching maturity at Taronga Zoo, the goal to establish a strong *ex situ* colony with varied genetics was a priority. As this species had never been bred in a captive environment before, the breeding conditions and tank set-ups were trialled in an experimental fashion. The frogs were established for their first breeding season in tanks that had been successfully used for breeding closely-related Green and Golden Bell Frogs (*Litoria aurea*). While pairs were seen in amplexus, no successful breeding occurred.

A purpose-built facility was created in a converted shipping container, housing twenty-four glass tanks and six breeding tanks with ponds and a larger surface area, allowing more opportunities to bask and hide. All water in the container was carbon and sediment filtered, and the facility was treated under strict quarantine



The first metamorph collected from the Southern Tablelands for the insurance colony to be housed at Taronga Zoo in Sydney. Photo: Michael McFadden.



An adult Yellow-spotted Bell Frog (*Litoria castanea*) showing the distinctive yellow spots on the inner thigh. Photo: Michael McFadden.

conditions. Unfortunately, no breeding success occurred in this facility either.

The next trial was an outdoor suspended aviary with two water bodies and exposure to natural light cycles and weather patterns. In line with previous attempts, this was also unfruitful. A second aviary was constructed with several adjustments. The size was dramatically increased, and a large filtered pond was included with varying thermal zones in shallow and deep ends. Instead of the artificial vegetation used in all previous attempts, live plants were incorporated throughout the aviary, both in the water and around the land areas. Wooden beams were placed around the aviary to provide hiding areas for the frogs in addition to the cover provided by the plants. This aviary was also treated as a quarantine facility.

During the frogs' second season in the aviary, once they were settled and the aquatic vegetation had established, the frogs were heard calling frequently. The work finally paid off one morning in November 2017, when spawn was discovered around the roots of one of the plants in the pond. In order to hedge our bets, half of the eggs were left to develop in the pond, and half were brought up to the glass tanks in the converted shipping container facility. Genetic testing with the aid of the Australian Museum determined that there were two clutches of eggs, and they were set up separately to maintain division of genetics.

We were extremely fortunate to maintain a very high survival rate of tadpoles and metamorphosed frogs. On March 22nd 2018, two hundred frogs and seven Taronga staff embarked on the road trip to the same rural property in the Southern Tablelands of New South Wales to undertake a reintroduction near where the species was originally rediscovered. The release was attended by various stakeholders in the program, including the Office of Environment and Heritage, the Department of Primary Industries, Local Land Services, and the property owners. Frogs were released according to size in staggered locations along the creek line. All locations were GPS marked to allow for future surveying and monitoring.



One of 200 metamorph Yellow-spotted Bell Frogs released in the Southern Tablelands in March 2018, close to where they were rediscovered. Photo: Taronga Conservation Society.

Reintroduction efforts for this species are being undertaken in an experimental fashion, and a variety of conditions are being trialled. The next stage of the program will be to release another 200 frogs at the same site in October, to determine the effect of season at release on survival. Frogs will also be reintroduced to a second site with suitable habitat.

This conservation program has been made possible with intensive husbandry efforts from the herpetofauna team at Taronga Zoo and



Following a number of enclosure trials, breeding success occurred in this large outdoor aviary in November 2017. Photo: Lauren Hush.

the expertise of Michael McFadden, as well as the valuable work from Taronga's veterinary and pathology teams. Dr Dave Hunter from the Office of Environment and Heritage has been instrumental from the conception of the program, as has Luke Pearce from the Department of Primary Industries. With the last tadpoles reaching metamorphosis from this last season, we are hoping to have another successful breeding season this year.

## Vale Lauren Hush

Sadly, soon after writing the article above on Taronga Zoo's Yellow-spotted Bell Frog breeding and reintroduction success, Lauren (Loz) Hush passed away.

Loz has been an integral and much-loved member of Taronga's Herpetofauna team for the last two years. She was a passionate and enthusiastic conservationist, driven to make a positive difference and contribute to successful threatened species breeding and reintroduction programs. During her short zoo career, Loz made some great achievements. This included writing articles and presenting at conferences on the Yellow-spotted Bell Frog and Booroolong Frog conservation programs, the latter for which she received a best poster award.

Her greatest conservation achievement was her role in the recent breeding, rearing and reintroduction of Yellow-spotted Bell Frogs at Taronga Zoo. The details of this program are discussed in length in Loz's article, demonstrating how significant this conservation breeding program was for the survival of the species. Loz had the leading role in rearing the tadpoles successfully through to metamorphosis, then caring for the many hundreds of valuable young frogs prior to their reintroduction. In March 2018, she was there to conduct the first trial translocation of this species to ensure their persistence in the wild.

Loz was a caring and inspirational person who dedicated her life to conservation. She will be very sadly missed, but never forgotten, living on through Taronga's amphibian conservation programs.



Lauren Hush undertaking a release of the first Critically Endangered Yellow-spotted Bell Frogs (*Litoria castanea*) to the wild. Photo: Taronga Zoo.

## New Amphibian Ark grants program

Since 2009, Amphibian Ark has provided over US\$127,000 to twenty-six new *ex situ* conservation programs for threatened amphibian species, in sixteen different countries. A complete list of the programs that have received these grants is available on our web site ([www.amphibianark.org/seed-grant-winners/](http://www.amphibianark.org/seed-grant-winners/)). Most of these programs have subsequently raised additional funding so the programs can develop and expand, with some of them now maintaining very successful captive breeding programs and working with their colleagues in the field to mitigate threats, and to reintroduce captive-bred animals into repatriated and protected habitats.

Earlier this year we expanded our Conservation Grants program to include a range of other granting opportunities, including grants for start-up programs, scholarships for workshop attendance, multi-year program grants, and *ex situ* research projects to benefit threatened amphibians. Information about the new Conservation Grants program, and guidelines for applications are available on our web site at [www.amphibianark.org/conservation-grants/](http://www.amphibianark.org/conservation-grants/). We will be calling for new applications again in 2019 – keep an eye on our web site and Facebook page for more information.

We received fifteen applications for start-up and start-up extension grants this year, and we are pleased to announce that four of these programs will receive funding to support their conservation projects.

### Rescuing the southernmost Marsupial Frog species (*Gastrotheca gracilis*) in Argentina Mauricio Sebastián Akmentins, Instituto de Ecorregiones Andinas, Unidad Ejecutora del Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina

The Banderita Marsupial Frog (*Gastrotheca gracilis*) is the southernmost species of marsupial frogs. This species was missing for twenty years, but the rediscovered populations are facing new threats. We will start the first conservation actions for this threatened species with a reinforcement of the populations of the Banderita Marsupial Frog by means of a head-starting program, with the establishment of a breeding facility combined with monitoring of the ongoing threats to assess its current conservation status. These actions will be combined with a proactive educational campaign and with the delivery of a technical report to environmental authorities for the implementation of measures prone to mitigate or eradicate the most severe threats on wild populations.

We will establish a breeding facility and husbandry research center to maintain and breed the species. This laboratory will be within the Horco Molle Nature Reserve facility, which is located on the Sierra de San Javier, Tucumán province, Argentina. The facility is managed by the Universidad Nacional de Tucumán, which has been working with the rescue and recovery of native and endemic species for the last three decades and has been designated as a field laboratory for students and scientists for the implementation of several research works. The breeding facility will be finished at the end of December 2018.

The full application can be seen here: [www.amphibianark.org/grants/Gastrotheca-gracilis-2018.pdf](http://www.amphibianark.org/grants/Gastrotheca-gracilis-2018.pdf)

### The return of the Patagonia Frog to Laguna Blanca Federico Kacolis, Museo de La Plata, Argentina

The Patagonia Frog (*Atelognathus patagonicus*) is in danger of extinction. Over the last decade, the wild populations of this species have dramatically declined by more than 90%. The major subpopulation of this species used to be common in Laguna Blanca (White Lagoon) and was surrounded by smaller subpopulations inhabiting neighboring and temporary lagoons into and around Laguna Blanca National Park. However, the introduction of invasive predatory fishes has caused this major subpopulation to become extinct, affecting the entire species. Even in the smallest lagoons where frogs should be thriving, a combination of threats including grazing, and trampling by livestock, chytrid fungus and ranavirus and desiccation caused by climate change, are pushing this whole species to the brink of extinction.

Concerned by this problem, the National Park Administration started a project aimed at managing invasive fishes in the Laguna Blanca, reducing its exotic populations and making the habitat suitable again for native wildlife. However, natural recolonization by Patagonia Frogs is unlikely due to current small populations and bad status of corridors between lagoons.



This project is aimed at helping the Patagonia Frog to return to its home. We will build *ex situ* facilities near the Laguna Blanca and establish a survival colony. We will also harvest clutches from neighbouring lagoons, to develop them in the *ex situ* facilities in order to increase its survival. Both newborns from *ex situ* pairings and eggs produced at the facilities will be reintroduced in restored and fenced habitats within the Laguna Blanca. This project will achieve the return of the Patagonia Frog to the White Lagoon, re-establishing the major population of this species, and thus increasing the long-term viability of the whole species.

The full application can be seen here: [www.amphibianark.org/grants/Atelognathus-patagonicus-2018.pdf](http://www.amphibianark.org/grants/Atelognathus-patagonicus-2018.pdf)

**Fighting back extinction risk: a conservation program for the Venezuelan Andean frog**  
*Enrique La Marca, Rescue of Endangered Venezuelan Amphibians program of the BIOGEOS Foundation, Venezuela*

There is a need to establish an *ex situ* conservation program for Durant's Rocket Frog (*Aromobates duranti*), a species with a distribution restricted to cloud forests of Sierra de La Culata, a mountain range in Merida state, Venezuela. This project is addressed to rescue populations of this Endangered species through captive husbandry and breeding, as well as reintroductions into the wild.

The following objectives have been set for the first year of a three-year program for the species:

- Determine threats, distribution, presence within protected areas, and conservation status.
- Establish an *ex situ* conservation program.
- Develop an *in situ* plan to involve regional communities and education centers through raising concern about the species and to establish an environmental program.
- Develop an *in situ* re-introduction and monitoring program.



To measure the effectiveness of the program during the first year, we will have these measurable items:

- Update of the conservation status in the IUCN Red List and Venezuelan Red Data Book.
- Write a Species Action Plan and Husbandry Guidelines.
- Produce printed material (leaflets, posters, press note) to raise awareness and show *ex situ* results.
- Create a video with program results, and an article for the AArk Newsletter.

The full application can be seen here: [www.amphibianark.org/grants/Aromobates-duranti-2018.pdf](http://www.amphibianark.org/grants/Aromobates-duranti-2018.pdf)

**Head-starting Pool Frogs for the UK reintroduction (start-up extension grant)**  
*Yvette Martin, Amphibian and Reptile Conservation Trust, United Kingdom*

In 2005 the Amphibian and Reptile Conservation Trust (ARC) collaborated with Natural England to successfully translocate northern clade Pool Frogs from Sweden back to the UK, following their extinction in 1995. Significant breeding success was achieved at the first reintroduction site, and in 2015 ARC began the process of head-starting pool frog tadpoles to enable the species to be established at a second site, thereby increasing the resilience of the UK population. The site chosen for this second release was Thompson Common (Thetford, Norfolk), the last recorded location for the species prior to extinction in the 1990s.

After small-scale trials of head-starting methods in 2015 and 2016, ARC decided to look for funding to purchase, equip and staff a biosecure head-starting unit, in order to accelerate population establishment at this second reintroduction site. An Amphibian Ark seed grant was awarded to this project in April 2017, as a contribution to the overall resources required.

With the start-up extension grant we propose to secure the establishment of a second UK population of northern Pool Frogs using head-starting. ARC has now been offered the use of a rental unit and as such we are looking to adapt rather than construct a head-starting facility. The adaptation and equipping of this head-starting facility will be the largest element of expenditure in the project.



The full application can be seen here: [www.amphibianark.org/grants/Pelophylax-lessonae-2018.pdf](http://www.amphibianark.org/grants/Pelophylax-lessonae-2018.pdf)

## New guidelines aim to improve success of amphibian captive breeding programs

Kevin Johnson, Amphibian Ark and Berglind Karlsdóttir

Did you ever face a problem not knowing if anyone had solved it before you? Have you embarked on a project, wishing you had a manual, or a mentor?

Setting up an amphibian captive breeding program, or any other type of conservation program, is extremely complex. Sometimes, it can be hard to find the support or advice needed to proceed with program plans. While there are many successful examples out there, other programs come to a standstill, or lose sight of their objectives over time.

Hot of the press is the new *General Guidelines for Managers and Supporters of Amphibian Captive Breeding Programmes* ([www.amphibianark.org/General-guidelines-for-managers-and-supporters-of-amphibian-captive-breeding-programmes.pdf](http://www.amphibianark.org/General-guidelines-for-managers-and-supporters-of-amphibian-captive-breeding-programmes.pdf)), which is designed for this purpose! The extensive guidelines, published by the Amphibian Ark and Durrell Wildlife Conservation Trust, provide general information on all aspects of *ex situ* program management. Each section is complemented with links to other relevant resources and materials.

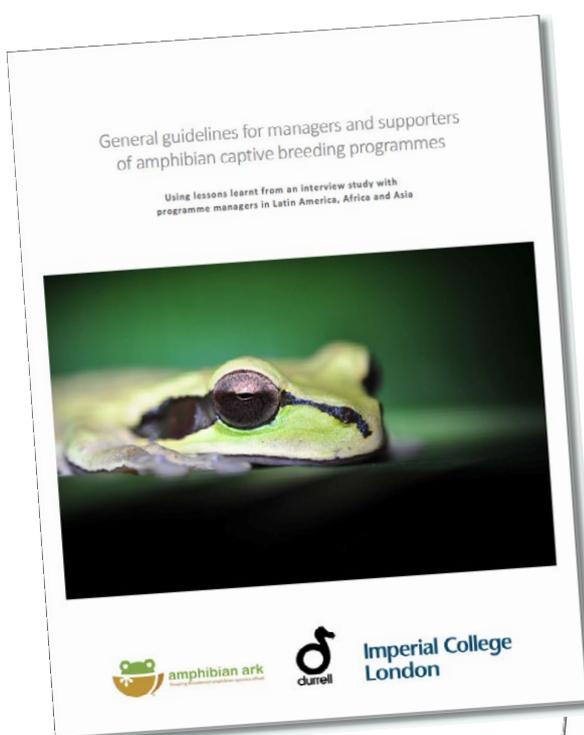
The information presented in the guidelines is based on the knowledge and advice of program managers worldwide. This information was collected through manager interviews by the author, Berglind Karlsdóttir, during her Master's thesis. Left with a desire to pass on the wealth of information provided to her by participating managers, she followed up her thesis with these guidelines. All relevant information from each manager is captured under categories of barriers and enablers to programs, making specific information easy to find.

The guidelines contain three sections: an introduction, the current picture (laying out the findings from her study), and a summary of barriers and enablers to programs. Parts of the guidelines focus on the human aspects of program management, which are not commonly discussed in the literature. Many programs struggle to gather the resources and expertise needed for a well-rounded project. Therefore, the guidelines also make recommendations on the types of support needed from external partners and supporters at different stages during the life of the program. It is important that support for a range of activities is provided to each program, as opposed to blanket solutions.

Knowledge sharing is one of the most important tools to increasing the success of programs. It reduces the need for trial-and-error as problem solving and decision making is improved. Now, current and future managers have the valuable insights and lessons learnt by two dozen programs at their availability at any time.



The author of the guidelines, Berglind Karlsdóttir, swabbing a specimen on a field trip. Photo: Berglind Karlsdóttir.



The guidelines make recommendations on the types of support needed from external partners and supporters at different stages during the life of the program.

The new *General Guidelines for Managers and Supporters of Amphibian Captive Breeding Programmes* help to find the support or advice needed to develop and proceed with *ex situ* conservation program plans.

## Establishing a conservation breeding program for Northern Leopard Frogs

*Lea Randall, Conservation Research Population Ecologist, Calgary Zoo, Canada*

Once widespread throughout the continent, Northern Leopard Frogs (*Lithobates pipiens*) began to disappear from wetlands in western North America in the 1970s and 80s. Although the precise cause is unclear, habitat loss due to wetland conversion, disease, and habitat degradation from agriculture and human use likely contributed to their decline. These factors may have had a greater impact on Northern Leopard Frogs relative to other amphibians because they require distinct sites for breeding, overwintering and foraging as well as good connectivity between these habitats.

The Calgary Zoo's Centre for Conservation Research has been involved in Northern Leopard Frog conservation in Canada since 2003. Currently, our efforts are focused in the province of British Columbia (BC), where Northern Leopard Frogs are listed under the Species at Risk Act as endangered due to their declining abundance and distribution. The Calgary Zoo is part of the BC

The Calgary Zoo's Centre for Conservation Research has been involved in Northern Leopard Frog (*Lithobates pipiens*) conservation in Canada since 2003. Photo: Calgary Zoo.

Northern Leopard Frog Recovery team, which uses conservation translocations to recover the species and prevent local extinction within the province. The long-term goal of the team is to establish self-sustaining populations of Northern Leopard Frogs throughout their historic range in BC.

Historically, Northern Leopard Frogs were found in numerous wetlands in south-eastern BC and the Okanagan, but today only a single native population remains in the Creston Valley. Two reintroduced populations have been established in the East Kootenay region and Columbia Marshes. However, all three of these sites are vulnerable to habitat loss, introduced species, and disease. Reintroductions at the site in East Kootenay have been successful to date and we have observed metamorphosis, overwintering, breeding and colonization of adjacent habitat. However, conservation efforts at the Columbia Marshes have been hindered because there are few eggs and tadpoles available for translocation due to poor reproduction in the wild and low fertilization rates in captivity.





An outdoor enclosure was built with large 950-litre (238 US gallon) tanks at Calgary Zoo in Canada, to rear Northern Leopard Frog tadpoles. Photo: Calgary Zoo.



In 2018, Northern Leopard Frog eggs were collected from the wild and tadpoles were reared to metamorphosis to further expand the breeding program. Photo: Calgary Zoo.

To address this issue, the Calgary Zoo launched a conservation breeding program for Northern Leopard Frogs last year. A new facility for the program was designed with the goal of providing a high standard of care for the frogs. As much as possible, we have tried to replicate conditions in the wild to encourage natural behaviors such as breeding and foraging. The design and construction of the indoor facility and outdoor enclosures was a joint effort by our Conservation Research, Facilities, Animal Care, and Horticulture departments. The indoor facility has a quarantine and water treatment area, a warm area to keep frogs active throughout the year, and an insulated room that can be lowered to about 3°C (37°F) to simulate the natural overwintering conditions and photoperiod of Northern Leopard Frogs, which is believed to encourage breeding. An outdoor enclosure was built with large 950-litre (238 US gallon) tanks to rear tadpoles and adult enclosures with large tanks flush with the ground to allow access to a grassy outdoor space. Tadpoles supplement their diet with natural algae and adult frogs can bask in the sun and hunt natural and supplemented insects.

Vancouver Aquarium, an Ocean Wise initiative, has had an established Northern Leopard Frog breeding program since 2013 and provided fifteen adult frogs to help us found our breeding program in 2017. These frogs were successfully overwintered and demonstrated natural breeding behaviors although no fertilized eggs were produced. In 2018, eggs were collected from the wild and tadpoles were reared to metamorphosis to further expand our breeding program. Small numbers of head-started tadpoles were also released this Spring at the Columbia Marshes reintroduction site.

Our goal is to develop an age-structured breeding population of 200 frogs over the next ten years to produce offspring for reintroduction. We anticipate the first successful reproduction of our frogs in Spring of 2019 or 2020. At full production, we hope to be able to release up to 30,000 tadpoles annually with the aim of establishing a thriving metapopulation. As the program continues, we will conduct research to improve conservation breeding efforts and increase the number of eggs produced at our facility and frogs released in the wild.

## Ex situ breeding results for the Great Crested Newt in Belgium

Johan Auwerx, Instituut voor Natuur- en Bosonderzoek, Belgium



The Research Institute Nature and Forest of the Flemish Government in Belgium has a long tradition of developing species recovery programs for endangered and protected aquatic species. This knowledge and the strengths of the fish farm in Linkebeek (located south of Brussels, in Belgium) were used to set up an intensive breeding program for the highly threatened Great Crested Newt (*Triturus cristatus*). The populations of these newts have declined rapidly in Belgium over the past decades. Changed land use and a far-reaching fragmentation of the landscape are the main causes.

Also due to the construction of a reduced tidal area, a population of Great Crested Newts is likely to disappear due to the effects of tidal action. This is the reason why we chose to use these wild salamanders for a breeding program. With the farmed offspring, nearby areas can be populated again, while maintaining the genetic diversity of the original population.

More than 1,300 young salamanders hatched this spring in an adapted breeding infrastructure. The juveniles were grown in a protected environment to guarantee maximum survival, and this summer they were transferred to their new habitat where they hopefully will start a new population.

A four-week old Great Crested Newt (*Triturus cristatus*) larva from the breeding program at the Instituut voor Natuur- en Bosonderzoek, Belgium. Photo: Johan Auwerx.

## Save the dates for ATAG's 2019 Amphibian Management School!

Monday February 18 – Friday February 22, 2019

Hosted by the Detroit Zoo's National Amphibian Conservation Center in Royal Oak, Michigan, USA

The next Amphibian Management School (AMS) will be February 18 - 22, 2019 hosted by the Detroit Zoo in the USA. This hands-on learning experience focuses on the latest in basic husbandry techniques, exhibit design, support for regional conservation programs, and effective conservation messaging in a zoo or aquarium collection. Participants will learn not only about amphibian husbandry, but also how to connect with conservation projects, breeding program management, enrichment basics, amphibian health fundamentals, and more to improve amphibian management at their institutions and impact amphibians globally.

Under guidance of the Amphibian Taxon Advisory Group (ATAG), AMS provides knowledge about amphibians and skills for managing these sensitive species in captivity that are essential for anyone working directly with amphibians in a zoo, aquarium, conservation, or research settings. AMS is ideal for novice to moderate amphibian zoo keepers, animal health, research or education staff who need more training on handling and husbandry of amphibians, and representatives of nature centers and natural history museums or science centers with limited amphibian experience. The course includes field trip to look for wild mudpuppies!



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For budgeting purposes, course fees are US\$600 (AZA individual members) or US\$700 (non-AZA members) if registered by the Early bird date of November 15, 2018. Lodging will be approximately US\$150/night, although room-sharing with other students is an option to reduce expenses.

Scholarship funding is available through the following competitive process:

### US and Canada: Marcy Sieggreen Professional Development Scholarship

Covers Registration Fee only, not travel expenses. Deadline is November 15, 2018. Please contact Dr. Ruth Marcec via email directly at [rmarcec@dzo.org](mailto:rmarcec@dzo.org), including "Marcy Sieggreen Professional Development Scholarship" in the email subject line. Separate course registration is required in addition to the scholarship application; the winner will be notified of the final award by December 5, 2018 and any registration fees paid will be refunded to the winner.

Course registration and payment information will be shared once finalized, but please budget now to send staff in 2019!

## Panamanian species transferred from the USA to Panama

**Chelsea Thomas, Amphibian Program Coordinator, Atlanta Botanical Garden, USA**

When *Batrachochytrium dendrobatidis* (*Bd*) first threatened Panama, infrastructure and resources for *in situ* captive breeding and research were lacking. In 2004, the first field team for Amphibian Rescue and Conservation Coalition (ARCC, Ron Gagliardo, Ben Eiben, Dr Kevin Zippel, Mason Ryan, Dr Brad Wilson, Heidi Ross, and Edgardo Griffith) formed, and the group began collecting representatives of twenty threatened Panamanian amphibian species with the intention of establishing captive assurance colonies in El Valle de Anton, Panama. However, in 2005 the group agreed that it would take time to build the necessary facilities and caretaker expertise. They therefore obtained permits and exported the initial collection of animals to the USA, where the majority were housed at the Atlanta Botanical Garden (ABG), with some duplication at Zoo Atlanta. Other ARCC members continued to monitor wild populations in Panama.

From 2005-2008, the collection was housed in the ABG's Frog Lab, then from 2008-2018 this collection was moved into a "pod" style isolation facility at ABG, the first of its kind in the US. With limited husbandry information available (UV lighting, for example, was not initially provided), much was learned, but most species did not thrive. However, two species bred well and populations of Coronated Treefrogs (*Anotheca spinosa*, alt. *Tripurion spinosus*) and Lemur Leaf Frogs (*Agalychnis (Hylomantis) lemur*) were maintained in near quarantine level isolation with regular *Bd* PCR testing, fecal microscopy, and veterinary assessment. Other members of the ARCC reported that the populations of both species had been extirpated from the El Valle Rio Maria region, making those at ABG the last representatives of their genetics.

Meanwhile, the situation in Panama changed drastically. The Panama Amphibian Rescue and Conservation (PARC) project

The "pod" at the Atlanta Botanical Garden, that protected valuable Panamanian amphibian genetics for over a decade.  
 Photo: Chelsea Thomas.

developed as a partnership between the Cheyenne Mountain Zoo, the Houston Zoo, the Smithsonian Tropical Research Institute (STRI), the Smithsonian Conservation Biology Institute, and Zoo New England, all in the US. This year, they are consolidating resources from two sites (the Gamboa Amphibian Research and Conservation Center at STRI and the El Valle Amphibian Conservation Center at the Nispero Zoo) into seven pods at the Gamboa site. There, world-class researchers will continue to maintain the genetics of endangered Panamanian species and prioritize research that could allow successful reintroductions of amphibians into *Bd* positive habitats. In fact, PARC has already begun release trials with Harlequin Frogs (*Atelopus varius*), as reported in the previous issue of this publication.

The pod at ABG was initially built to preserve the genetics of Panamanian amphibian populations because facilities for that purpose were not available within Panama. Given the now greater capacity for amphibian care and research at PARC, as well as the genetic value of the ABG collection for the PARC assurance colonies, it was time to re-evaluate ABG's role. After extensive communications, ABG decided to transition their commitment from maintaining a pod to safely transferring these animals to PARC and other research facilities.

Brian Gratwicke and Roberto Ibáñez of PARC, Brad Wilson and Chelsea Thomas of ABG, and others worked for approximately a year to obtain all necessary paperwork and planning. On May 15 this year Brian Gratwicke and Chelsea Thomas drove the frogs from Atlanta, GA to Washington, DC, where they transferred some representatives of the ABG bloodlines to Matt Evans at the National Zoological Park.

The next day, on May 16, the United States Fish and Wildlife Service inspected and approved the package for export and COPA airlines took the frogs in cargo, with Brian and Chelsea on board the same flight. Despite extensive planning, it took approximately





Coronated Treefrogs (*Anoteca spinosa*, above) and Lemur Leaf Frogs (*Agalychnis lemur*, below) have bred well in the past at the Atlanta Botanical Garden, with some being shipped to Panama earlier this year. Photos: Brian Gratwicke.



four hours to navigate a series of unexpected challenges at the Panamanian airport; however, thanks to the tireless diplomacy of Roberto Ibáñez, the frogs were retrieved and all were found to be in good health. By 9 pm, Roberto, Brian, and Chelsea arrived at the PARC facilities in Gamboa where staff (Jorge Guerrel, Elliot Lassiter, and Nancy Fairchild) had an empty quarantine pod with live-planted tanks prepared for the ABG frogs. Over the next four days, the teams worked together to monitor the frogs, enter information into the Zoological Information Management System (ZIMS), and investigate potential release sites for future generations of Coronated Treefrogs.

The next step for PARC will be to collect and preserve sperm using methods developed there this year and breed the frogs from ABG with those arriving soon from El Valle. ABG's efforts will turn from breeding to investigating the behaviors of these species when released into larger areas (9,040 and 3,550 square-foot greenhouse spaces) and given a variety of artificial breeding opportunities.

Hopefully these efforts can inform PARC decisions when the time comes for the descendants of the ABG collection to be released.



Frogs were packed for international travel with their identification photos and lineage on each container. Photo: Chelsea Thomas.

Chelsea Thomas unpacks some of the frogs which were shipped from the Atlanta Botanical Garden in the US to the Panama Amphibian Rescue and Conservation (PARC) project. Photo: Chelsea Thomas.



## Amphibian Advocates

Our amphibian advocate for this newsletter is Fausto Siavichay Pesántez, Coordinator at the Amphibian Conservation Center at Zoo Amaru in Ecuador. Fausto and his team have been working to help save threatened amphibians in southern Ecuador for more than ten years. In this article, he shares more about their fantastic work.

The profiles of all of our Amphibian Advocates can be found on the AArk web site at [www.amphibianark.org/amphibian-advocates/](http://www.amphibianark.org/amphibian-advocates/). If you would like to nominate an Amphibian Advocate to be featured in a future edition of the AArk Newsletter, please send us an email at [newsletter@amphibianark.org](mailto:newsletter@amphibianark.org) and we'll add your suggestion to our list!

### Fausto Siavichay Pesántez, Coordinator, Centro de Conservación de Anfibios, Zoológico de Cuenca y Bioparque AMARU, Ecuador

I am from the city of Cuenca in the Andes of southern Ecuador, and my city is surrounded by mountains and ecosystems of the Páramo and Andean Forests that still maintain endemic and threatened species of amphibians. This coexistence has motivated my passion for amphibians and their conservation. In 2002 I began my work in the care of amphibians and reptiles at the Amaru Zoo in the city of Cuenca and in 2007 we formed, together with my colleagues, the Amphibian Conservation Center of AMARU (CCA AMARU), an institution that I currently coordinate. Our primary actions are the education for Ecuadorian people, research and *ex situ* management of different species of amphibians from the south of Ecuador.

The work that is carried out in the CCA AMARU has been recognized by the environmental authorities of the city of Cuenca. On one occasion in 2012, the Municipality of Cuenca granted recognition to CCA AMARU for research and conservation of urban amphibians. This has motivated the implementation of several projects to safeguard different amphibian species, such as the creation of natural habitats. This work served as a model for municipalities and people to motivate and replicate this type of initiative.

In the same way, the Philadelphia Zoo has recognized my work done during the last eight years, which was recognized with the Global Conservation Award, together with the Haitian biologist Maxon Fildor in the United States. This recognition really validated my work and served as an engine that allows me to keep moving forward.

The achievements of CCA Amaru, are focused on the following points:

- The safety of Critically Endangered amphibian populations was increased, including the toads of Cajas National Park (e.g. *Atelopus nanay* and *Atelopus exiguus*) and amphibians of the Amazon such as *Atelopus wampukrum sp nov.*;
- Successful breeding and management of several species of glass frogs (Centrolenidae), marsupial frogs (genus *Gastrotheca*), rocket frogs (*Hyloxalus* species) and the Ecuadorian frog (*Ctenophryne aequatorialis*);
- Successful relocation and pilot program of endangered urban frogs (*Gastrotheca* and *Hyloxalus* species) in Cuenca.
- Rediscovery and monitoring of Jambato del Azuay (*Atelopus bomolochos*), which was feared to have become extinct.

I work closely with local schools and share data and recommendations for habitat management at different institutions in the city that manage natural resources.

Currently in my institution I am designing and implementing new laboratories and enclosures to maintain new colonies of amphibians in danger of extinction. In the future I will undertake an information and awareness program for people in the communities where amphibians are monitored, and I will continue to support local governments with our different reintroduction plans.



## Machine learning to improve management of threatened captive and wild frogs

**Deon Gilbert, Threatened Species Project Officer – Herpetofauna, Melbourne Zoo, Australia**

Frogs are the most threatened taxon, with over 30% of species on the IUCN Red List of Threatened Species, including around 200 species that are probably extinct (Alroy 2015). Much of this decline is caused by the global pandemic disease chytridiomycosis (Berger et al. 1998), although habitat loss is also a major driver of frog declines (Cushman 2006). Faced with this catastrophic loss of amphibian biodiversity, improved ways of managing *in situ* and *ex situ* populations are needed for the most endangered species. However, frogs are small and cryptic, making them difficult to study in the field and in captivity without frequent intrusive and time-consuming intervention. This project proposes to develop new automated methods for identifying species and individuals, then apply those methods to answer questions that are difficult to solve in other ways. We aim to understand movement and survival of critically endangered species in captivity, to more effectively manage and understand group breeding systems (polyandry/polygamy) as well as allow targeted genetic management for conservation breeding programs.

We will also take the bold step of testing this approach in the field, where these frogs are rare, where minimizing intrusion is important but where traditional methods of study are laborious, intrusive, and often ineffective. Our non-invasive video traps, with machine-learning facilitating species and individual identification, will enable insights into population size, survival and movement of frogs throughout the breeding cycle. By constantly monitoring sites in a way that is impossible using standard trapping methods, we will be able to measure which parts of the landscape are used, when and by which life stage, including insights into when juveniles move away from breeding sites. Such insights are critical for understanding what threats these frogs face throughout their an-

A rare find, adult female Baw Baw Frog (*Philoria frosti*) during pit line trapping surveys in an effort to secure adult females for the captive recovery program at Melbourne Zoo. Photo: Deon Gilbert.



nual migrations and thus, for effectively managing the landscape to maximize chances of persistence.

### Methods Overview

- Use day/night video capture to obtain training data for individually recognized animals, which is used to train the deep-learning algorithms. Then release these animals into a larger communal enclosure to gather test data for automated identification, measurement of activity and survival.
- Develop machine-learning methods for managing unlabelled individuals and species, which will appear through breeding within the tank, but also will be important for wild populations.
- Record video from free-ranging populations. Identify different species and use unsupervised methods to identify individuals. Concurrent mark-recapture methods will enable comparison of population size estimates and provide training data for a subset of the population. Evaluate survival, movement, and timing of activity using a grid of cameras.
- Key positions: Post doc: three years doing the machine learning; a PhD project for each zoo/species with a field component; in-kind husbandry expertise, equipment, and field assistance from each zoo.

### Outcomes

- New automated techniques for evaluating survival and movement, and species recognition, that can be applied in captivity and in wild populations.
- Improved management of captive populations with reduced husbandry input.
- Improved risk assessments for wild populations, including use of non-breeding habitat, population size, reservoir host activity, and over time, population trajectories.

### Collaboration

These new approaches have applications for many threatened frog species with a captive-breeding program. The Melbourne Zoo and Deakin University, Australia, would like to partner with other zoos on a collaborative research application to develop and apply these new technologies. Indicative investment for each species/zoo in an ARC linkage grant: AU\$40,000, AU\$20,000, AU\$20,000, in years 1, 2 and 3 respectively. The project will also need a PhD scholarship for each zoo/species, funded directly (AU\$28,000/year), or through a local university.

Please contact the author, Deon Gilbert ([dgilbert@zoo.org.au](mailto:dgilbert@zoo.org.au)), for further information or to collaborate on this project.

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## Amphibian Ark (AArk) Training Program

Luis Carrillo, Training Officer, Amphibian Ark

Meeting Amphibian Ark’s mission of “Ensuring the survival and diversity of amphibian species **focusing on those that cannot currently be safe-guarded in their natural environments**”, requires well-managed *ex situ* programs with strong ties to *in situ* conservation activities.

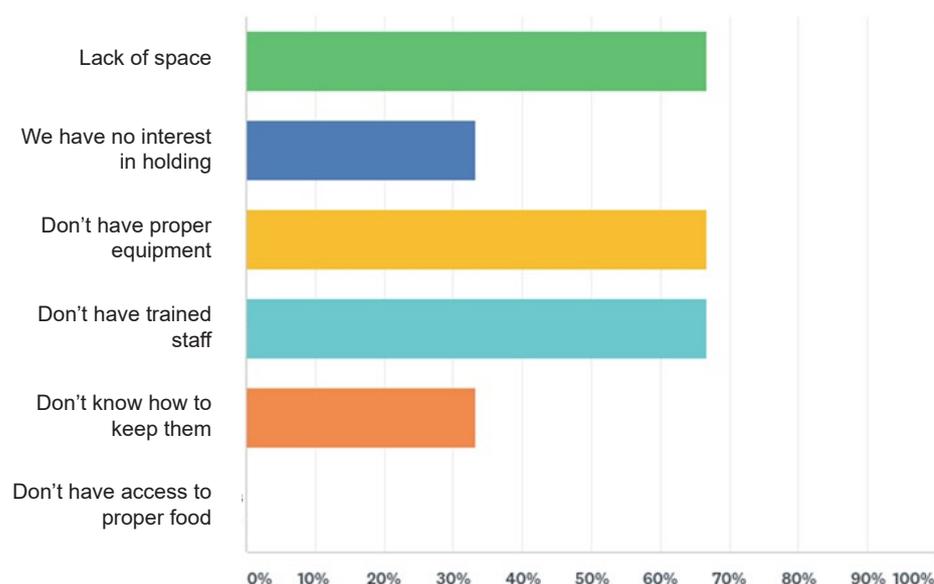
In turn, developing successful *ex situ* programs requires personnel who are well-trained in areas such as amphibian husbandry, amphibian veterinary care, and small population management. One way in which AArk supports the establishment of *ex situ* programs is through its training and capacity-building activities. Our mission for the Amphibian Ark training programs is “To develop institutional and national capacity that results in the implementation of successful *ex situ* amphibian conservation programs in the context of integrated amphibian conservation plans”.

Our training program objectives are:

1. To provide technical skills necessary for long-term management of *ex situ* populations of amphibians, from species selection to reintroductions, with a focus on husbandry, health, biosecurity and population management.
2. To build networking capacity for practitioners in range countries/areas/regions to better work together in taking charge of the conservation of local species.
3. To stimulate interest in amphibian conservation in the regions.
4. To provide guidance on developing regional conservation plans and strategies for collaboration with *in situ* conservation practitioners and municipal partners in the regions.

During the past ten years Amphibian Ark and partners have delivered seventy-four training courses in thirty-three different countries with more than 2,000 students trained worldwide.

AArk training courses encompass anuran (frogs and toads) and salamander husbandry and conservation, *ex situ* population management, and veterinary care. Two courses have focused exclusively on veterinary care, and an AArk team of veterinarians has visited facilities in Ecuador and Colombia to advise on veterinary facilities and care.



Respondents to surveys in 2009 and 2016 indicated that lack of space, lack of trained personnel, and lack of equipment were the main barriers to working with amphibians.

The Amphibian Ark instructor team consists of experienced professionals from the zoo, academic and private communities around the world who donate their time and expertise towards training the new generation of experts.

To understand the impact of our training courses, we measure the knowledge gained through pre- and post-course evaluations, and to date, at least 90% of the students said that information and knowledge acquired were excellent. Nevertheless, AArk is always looking for ways to improve our training courses. Post-training course assessments and training needs surveys provide additional feedback from the *ex situ* amphibian conservation community.



In 2009 and 2016 surveys were sent to the Latin American *ex situ* community asking about their participation in *ex situ* amphibian conservation programs and the status of amphibians within their animal collections. Both surveys indicated that while 80% of animal collections keep or have previously kept amphibians in the

past, they are under-represented in both animal collections and *ex situ* conservation programs. Respondents indicated that lack of space, lack of trained personnel, and lack of equipment were the main barriers to working with amphibians.

When asked about their capacity-building needs, survey respondents enumerated the challenges they face in terms of training:

- Veterinary management
- Captive breeding
- Live-food production
- Nutrition
- General husbandry

In 2017, Berglind Karlsdóttir, at that time a Masters student at the Imperial College of London, UK, conducted semi-structured interviews with fifty program managers to identify the most critical or common barriers to, and

enablers of, programs for her dissertation, “*Barriers and enablers to amphibian captive breeding programs in Latin-America, Africa and Asia*” (Karlisdóttir, 2017). Among other topics, she explored staff training as part of the study. She concluded:

- Program expertise in amphibian husbandry requires a very specific profile of staff, an in-depth knowledge of the species and their physical environment, and an ongoing learning process.
- Lack of expertise and training is one of the leading causes of failures and can lead to the death of animals from unsuitable husbandry conditions. Expertise (information and knowledge) is essential in the successful implementation of each stage of implementing and managing a program.
- An expert workforce is paramount in a timely learning process for developing protocols and problem-solving, and the increased use of an evidence-based approach where possible.
- Programs vary a great deal in their access to veterinary expertise and laboratory facilities, and it seems that the two don't always go hand-in-hand.

To cope with some of the training needs identified, AArk will launch an online training program this year so basic themes can be learned using this platform. Some of the topics covered are grant writing, establishing new programs, enclosure design and management.

For more information on AArk Amphibian husbandry training workshops visit [www.amphibianark.org/husbandry-training/](http://www.amphibianark.org/husbandry-training/).

#### Additional resources

In addition to training courses, the AArk website ([www.amphibianark.org](http://www.amphibianark.org)) offers a series of resources and tools for program managers and amphibian keepers. These include information on amphibian husbandry skills and standards, establishment of new programs, species information, program resources, founder animals and population management.

**Husbandry documents:** A collection of husbandry documents relating to various aspects is available at [www.amphibianark.org/husbandry-documents/](http://www.amphibianark.org/husbandry-documents/). Some of the main topics included here are:

- Facility design
- Feeding and nutrition
- Biosecurity and quarantine
- Diseases
- Population management
- Reproduction and rearing
- Program development

To further support the already established amphibian conservation programs around the world, AArk launched a mentorship program and a mentorship grant in 2018. The mentorship program offers mentoring in different areas of *ex situ* amphibian management, such as breeding, population management, veterinary care, etc. through one of AArk mentors. Our mentors are well-experienced individuals who are willing to share their knowledge and expertise to help improve the success of the target program. This mentorship is delivered via e-mails, WhatsApp, Skype, and other means of communication.

Parallel to the mentorship program, the AArk's Mentorship Grant was created to support organizations which have previously received an AArk seed or start-up grant, to bring in a designated outside expert to assist with any aspect of their amphibian conser-

vation efforts (e.g. veterinary training, environmental control etc.). Grants up to US\$1,500 are available. See [www.amphibianark.org/conservation-grants/](http://www.amphibianark.org/conservation-grants/) for further information.

Rescue and capacity-building must occur together or at least sequentially. Successful amphibian conservation will be achieved when a given species is sustainably managed by its own range country experts, receiving the highest standards of care and eventually reintroduced back to secure and protected habitat the wild.



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## Good new(t)s for salamander conservation – the first reproduction of the Vietnamese Crocodile Newt in captivity

**Anna Rauhaus, Christian Niggemann, Joana Kuchenbecker and Thomas Ziegler, Cologne Zoo, Germany; and Truong Quang Nguyen, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, Vietnam**

The herpetology section at Cologne Zoo in Germany has a strong focus on the husbandry and conservation breeding of threatened or poorly known species, in particular from South-East Asia, which is the focal area of our *in situ* and *ex situ* amphibian and reptile conservation projects. Besides sharing a number of our project activities with South-East Asian species in diverse terraria in the public section of the zoo, we are also breeding amphibians in facilities behind the scenes, where we also conduct research e.g. on larval morphology and development. One of these species is the Bony Headed Toad (*Ingerophrynus galeatus*), which is listed as Vulnerable in the Vietnam Red Data Book (Tran et al. 2007), and which has been regularly bred at Cologne Zoo since 2015 (see Rauhaus et al. 2018). Besides our studies on husbandry and development of the species, a considerable number of offspring have already been provided to other zoos to ensure the maintenance of a reserve population in captivity.

Together with the Institute of Ecology and Biological Resources of the Vietnam Academy of Science and Technology in Hanoi, we also follow this approach at the Me Linh Station for Biodiversity in northern Vietnam. Here we have jointly built indoor and outdoor amphibian and reptile facilities (Ziegler et al. 2013, 2011, 2016) in order to combine husbandry and breeding of threatened and poorly-known species with research and conservation measures, as well as housing and releasing rescued, mostly confiscated animals.

Cologne Zoo is partner of the World Association of Zoos and Aquariums (WAZA) with Conservation Projects 07011 (*Herpetodiversity Research - To study the diversity and ecology of amphibians and reptilians in Vietnam and Laos*), and 07012 (*Amphibian and Reptilian Breeding and Rescue Stations - To establish and maintain breeding and rescue stations for amphibians and reptilians in Vietnam*).

Just recently, in August 2018, in collaboration with the Asian Turtle Program, and the Cuc Phuong Turtle Conservation Centre, we were involved with the release of a large number of rescued turtles, among them several Giant Pond Turtles (*Heosemys grandis*)

which were formerly housed at the Me Linh Station for Biodiversity.

For several years, this Vietnamese-German collaboration group has been working with the Vietnamese Crocodile Newt (*Tylotriton vietnamensis*). This salamander species is endemic to northern Vietnam, and is listed as Endangered in the IUCN Red List (IUCN 2016) and in the Vietnam Red Data Book (Tran et al. 2007). The Vietnamese Crocodile Newt is only known to occur in a few localities in four provinces, where it inhabits evergreen lowland forests with mixed vegetation of hardwoods, bamboo and shrubs. The natural habitats are severely fragmented and vulnerable to degradation by deforestation for agricultural use (Bernardes et al. 2013). In addition, this and other species of *Tylotriton* are known to be collected for use in traditional medicine, and a number of Vietnamese Crocodile Newts have already been identified in the international pet trade, adding unsustainable harvesting as another likely threat factor for the species (IUCN 2016).



Freshly metamorphosed juvenile Vietnamese Crocodile Newts in June 2018. Photo: Thomas Ziegler.

In 2013 Vietnamese Crocodile Newt eggs were transferred to the Me Linh Station for Biodiversity to document the larval development (Bernardes et al. 2017) and to build up an assurance colony in captivity. After hatching, four larvae were brought to the Cologne Zoo to share resources and to build up an additional breeding approach. The freshly metamorphosed newts proved to be rather sensitive and only two of the four juveniles survived the first year. Fortunately, these two remaining individuals developed well and turned out to be a male-female pair. In 2016, the two salamanders were transferred to a newly-created show exhibit in the “Vietnam Section” of Cologne Zoo’s public terrarium area, where they serve as ambassadors and flagship species for the Tay Yen Tu Nature Reserve in Bac Giang Province, northern Vietnam - one of the few known localities where the Vietnamese Crocodile Newt can be found.

The newts continued to grow well, and after we had lowered temperatures and the water level of the water in the public enclosure at the end of 2017, then slowly began to increase it again in March 2018, we noticed that the male in-



Display exhibit for Vietnamese Crocodile Newts (*Tylotriton vietnamensis*) at the Vietnam Section of Cologne Zoo’s public terrarium area. Photo: Anna Rauhaus.



Rearing boxes for Vietnamese Crocodile Newt larvae.  
Photo: Anna Rauhaus.



Vietnamese Crocodile Newt larva. Photo: Anna Rauhaus.

creasingly stayed in the water. Then, on 18th March, we observed courtship activities, namely the male following the female through the water. On the next day, we found the female sitting on top of a clutch of around 100 eggs under some moss on a stone at the transition between the water and the land. The female stayed at the egg clutch until dark, when we then removed the eggs and incubated them behind the scenes of Cologne Zoo's Terrarium Section in the amphibian breeding room at temperatures between 23-25°C.

Sixty larvae hatched between 29th March and 4th May 2018 and were subsequently raised in plastic boxes containing about eight liters of water. The maximum group size was five individuals, and water temperatures were maintained between 22-23°C. Larvae were fed with *Artemia*, *Daphnia*, and later with Tubifex and small earth worms (*Dendrobaena*). Especially during the early developmental stages, the larvae appeared to be sensitive, e.g., towards fluctuations in water parameters, but with increasing body sizes, we had no further losses. Between 10th June and 11th July, fifty juvenile salamanders with total lengths ranging between 57-69mm moved to the land section. The juveniles are raised in small groups of four or five individuals and so far all are developing well.

Two months after metamorphosis, the young newts measure around 65-80mm and weigh 2-3g. In the future, they will be provided to other institutions which are interested in joining a conservation breeding program.

To our knowledge, this breeding success marks the first reproduction of Vietnamese Crocodile Newts in captivity (Sparreboom 2014) and hopefully can serve as the basis for a stable captive reserve population. Further information on husbandry and larval development of the Vietnamese Crocodile Newt will be shortly provided in detail elsewhere.

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Juvenile Vietnamese Crocodile Newts two months after metamorphosis.  
Photo: Anna Rauhaus.

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## AArk Husbandry Document library

The Husbandry Document library on the AArk web site ([www.amphibianark.org/husbandry-documents/](http://www.amphibianark.org/husbandry-documents/)) currently has over 150 articles in it, with additional articles being added regularly. A new search engine has recently been installed on the Husbandry Documents page, which can now search for particular words or phrases within all pdf files. This results in more accurate results when searching the document library for particular topics.

Four new documents have been added recently:

### General guidelines for managers and supporters of amphibian captive breeding programmes (English)

Author: Berglind Karlsdóttir

These guidelines are produced based on information provided by managers of amphibian captive breeding programs in Latin America, Africa and Asia, along with input from experts at Durrell Wildlife Conservation Trust, the Amphibian Ark (AArk) and the Amphibian Specialist Group (ASG) Captive Breeding Working Group. This information was gathered as part of an MSc thesis with Imperial College London, looking at barriers which might prevent amphibian captive breeding programs from achieving conservation success.

Publication: Version 1, 2018

[www.amphibianark.org/General-guidelines-for-managers-and-supporters-of-amphibian-captive-breeding-programmes.pdf](http://www.amphibianark.org/General-guidelines-for-managers-and-supporters-of-amphibian-captive-breeding-programmes.pdf)

### Captive husbandry and breeding of File-eared Tree Frogs, *Polypedates otilophus* (English)

Author: Benjamin Tapley and Suzan Meryem Girgin

Six File-eared Tree Frogs (*Polypedates otilophus*) were reared from small juveniles to adult breeding size over a period of 18 months. An account of captive husbandry and breeding is provided. Clutch size ranged from 44–119 eggs. Eggs hatched after ten days and tadpoles attained total lengths of 85mm. Metamorphosis took 74–84 days at 22–26°C.

Publication: The Herpetological Bulletin 132, 2015: 5-8

[www.amphibianark.org/Captive-husbandry-and-breeding-of-Polypedates-otilophus.pdf](http://www.amphibianark.org/Captive-husbandry-and-breeding-of-Polypedates-otilophus.pdf)

### Practitioner and scientist perceptions of successful amphibian conservation (English)

Author: Helen M.R. Meredith, Freya A.V. St. John, Ben Collen, Simon A. Black, and Richard A. Griffiths

Conservation requires successful outcomes. However, success is perceived in many different ways depending on the desired outcome. Through a questionnaire survey, we examined perceptions of success among 355 scientists and practitioners working on amphibian conservation from over 150 organizations in more than 50 countries. We also sought to identify how different types of conservation actions and respondent experience and background influenced perceptions.

Publication: Conservation Biology, Volume 32, No. 2, 366–375  
[www.amphibianark.org/Meredith-H-M-R-et-al-2018-Amphibian-conservation-success.pdf](http://www.amphibianark.org/Meredith-H-M-R-et-al-2018-Amphibian-conservation-success.pdf)

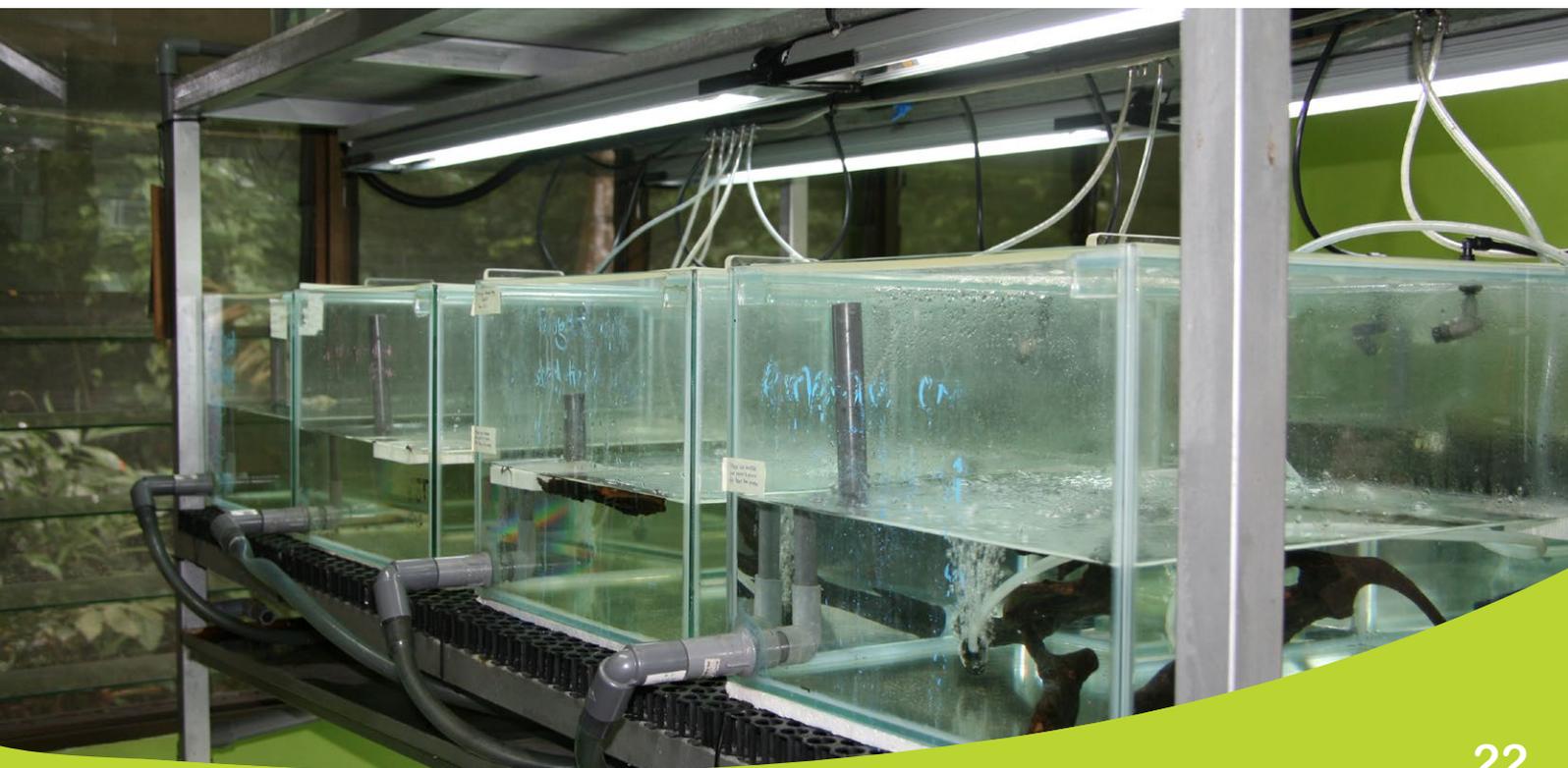
### Husbandry, captive breeding, larval development and stages of the Malayan horned frog *Megophrys nasuta* (English)

Author: Marlen Wildenhues, Anna Rauhaus, Rike Bach, Detlef Karbe, Karin Van Der Straeten, Stefan T. Hertwig, and Thomas Ziegler

We report long-term experience with the successful keeping and breeding of Malaysian Horned Frogs (*Megophrys nasuta*) at the Cologne Zoo's Amphibian Breeding Unit and compare data with other breeding reports. In addition, we document the development and morphology of different larval stages of *M. nasuta*.

Publication: Amphibian and Reptile Conservation 5(3):15-28, 2012

[www.amphibianark.org/Husbandry-captive-breeding-larval-development-and-stages-of-the-Malayan-horned-frog.pdf](http://www.amphibianark.org/Husbandry-captive-breeding-larval-development-and-stages-of-the-Malayan-horned-frog.pdf)



## Bringing conservation workers together: Mitsinjo expands its public terrarium exhibition

**Sebastian Wolf, Association Mitsinjo, Madagascar**

When you work in a survival assurance facility that must meet strict biosecurity measures, you sometimes really miss the joys of running larger, natural-looking setups. Prevention of disease introduction is important though it limits the operation of multi-species terraria that are structured with material that cannot be disinfected properly. Over the years, it has become a wish of our frog technicians to build cages they can enrich in a more natural fashion.

After Mitsinjo built its education center (located near the biosecure facility), the technicians were keen to construct four smaller terraria within it, to house some excess stock from the frog facility. Biosecurity does play a minor role there, so handling, entry and cleaning protocols are much less complicated; furthermore, all visitors can have a look at those setups. Reactions from people have shown that they welcome the opportunity to see smaller species which they normally miss, due to secretive or seasonal lifestyle, or even remote habitats.

After this first success at raising awareness of amphibians and the successful operation of the terraria, it soon became clear that the public exhibit could increase its extent. Additional space was available, and planning for more exhibits began. In December 2017 we were really lucky when we received the news that Amphibian Ark was able to support this idea with the help of an anonymous donation of US\$ 3,000. This gave us the opportunity to build two of the three planned terraria by acquiring materials, building the cages and paying technicians' salaries.

Selection of construction materials is somewhat restricted by the materials which are available in Madagascar; basically, both terraria will be one square meter and set up as vivaria, i.e. featuring an underwater and a terrestrial section. Two types of "main frog biotopes" present in the Andasibe region will be featured: a swamp/forest edge display and one that shows a brook/rainforest habitat. The terrariums will be constructed in a way that enables variation of rainfall and therefore water levels to underline the seasonal characters of these biotopes.

As the setups are planned to be included in future environmental lessons for locals, the species composition will be one that can be found in their habitats around Andasibe. Selection is also based on giving as many observation opportunities as possible within the confined area of a terrarium. Therefore, three species will be housed in each terrarium, each with a different ecology, reproductive mode and tadpole type. These species also meet another important criteria: none of them has been bred in captivity before so any successful propagation will hopefully shed light on the biology of these species.

It is probably not exaggerated to state that these new terrariums will serve for recreational, educational and scientific purposes, and our ability to move forward with the development of them has only been possible due to the extra funding being made available to us. We are therefore really grateful to the donor and to Amphibian Ark for giving us the chance to build these terraria and hope to be able soon to report here about their ongoing development and management.



The well-camouflaged Anamalozoatra Madagascar Frog (*Spinomantis aglavei*) is an obligate screw pine breeder.  
Photo: Sebastian Wolf.



*Mantidactylus* frogs from the diverse subgenus *Ochthomantis* have never been kept or bred in captivity before. As far as we know, all show some egg attendance by the males.  
Photo: Sebastian Wolf.

## A critically endangered frog trapped in a shrinking 'ecological capsule'

**Enrique La Marca, Michelle Castellanos and Gabriel Sánchez Dávila, Biogeos Foundation, Rescue of Endangered Venezuelan Amphibians Program, Venezuela**

The Mucuchíes' Frog (*Aromobates zippeli*), which has not yet been evaluated by the IUCN Red List of Threatened Species, is in imminent risk of extinction. This frog lives only in the Mucuchíes region of the Venezuelan Andes. Through an AArk seed grant in 2017 we initiated an *ex situ* program to rescue the species.

The species is trapped in an 'ecological capsule' of dry forests separated from other such ecosystems by moist high Andean mountain paramo environments on their tops and seasonal humid forests on their lower parts. These dry forests are an ecological response to the relative dry conditions within this portion of the Chama river basin.

Dry montane forests are among the most threatened ecosystems in the northern Andes. In Venezuela, this type of forest has been subjected to human intervention (to almost full depletion) for more than 3,000 years. The deforestation started with ethnic groups that relied on wood for building housing structures, and conditions later worsened with European settlers bringing their crops, mainly wheat, to establish an agriculture favored by the dry and cold conditions. This succession of harmful events led to the Montane dry forests almost disappearing, along with the species they housed.

One of the last survivors of this ecological disaster is the Mucuchíes Frog, a small amphibian that adapted to these dry montane forests, living in their wettest places. Those places



A female Mucuchíes' Frog (*Aromobates zippeli*).  
Photo: Enzo La Marca.

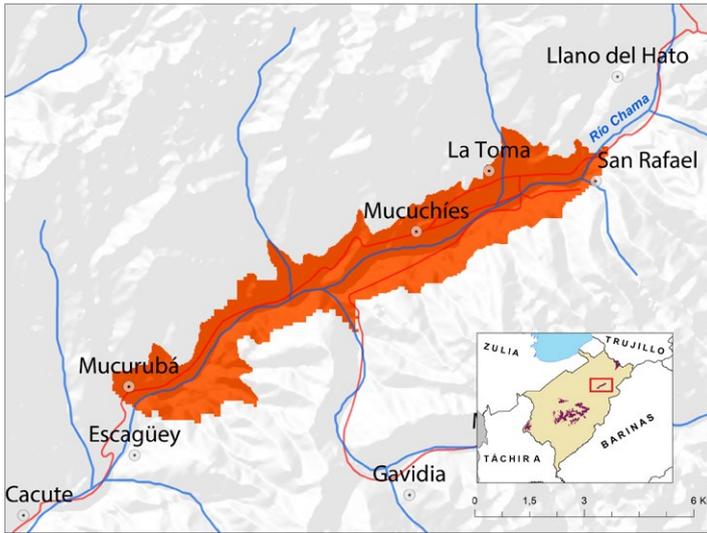
most likely escaped fires and were left untouched for agriculture because of some unfavorable topographical positions – usually deep depressions that serve as surface water runoffs which create humid microhabitat conditions.

We calculated the hypothetical maximum extension of the life zone where the species is most likely to occur, the Montane dry forest, as about twenty-eight square kilometers. Only two percent of this area is actually covered by dry forests. We surveyed many suitable places to discover that the frogs are gone from most places where they were abundant in the past, according to local people. Personal interviews with old locals further reveal a dark panorama for this frog. The easternmost locality we could track the species back was San Rafael de Mucuchíes, at 3,072 meters above sea level, while the westernmost (and also the lowest) was Mucurubá (2,270 meters above sea level). The closest to the type locality was Misintá, at 3,240 meters (the highest altitudinal record), where frogs were last seen two years ago, when the small creek where they lived dried out. Most populations were gone in the whole region between fifteen and twenty-five years ago. Our visits to the type locality near Mucuchíes (2,970 meters) revealed neither frogs nor vocalizations. A visit to the stream Los Alisos in the El Mocoa sector (at 2,906 meters), where some specimens had been collected by the senior author about three decades ago, yielded no specimens either.

After intense searching in the region, we only found a small population of Mucuchíes' Frog at a place at 2,690 meters above sea level, close to Mucuchíes, in a secondary river basin of about four square kilometers in the Moconoque sector, that satellite images show



Moconoque (upper photo) and El Mocoa (lower photo) sectors of the Mucuchíes region. Note how the Montane dry forests have been completely destroyed. Photos: Enrique La Marca.



Portion of the Chama river basin in the Merida Andes, in red-orange, showing the extent of the Montane dry forest' life zone in the Mucuchies region. The lower right insert shows its relative position within Merida state, in western Venezuela. Note isolation from other dry montane forests within Merida state.

to have only 0.15% of the total of the life zone in the region. Since these forests are not within any kind of protected area and given that they are still subjected to destruction for agricultural and rural purposes, the fate of these last forest remnants is obscure and the frogs (as well as any other endemic organisms) they house face a high risk of local or total extinction in the near future.

Our finding is the second documented locality ever for the species and became the source of specimens for the captive breeding program. This population lives in a relatively isolated remnant of vegetation within a matrix of cultivated lands in a rural landscape. The frogs are likely trapped in an 'ecological capsule' naturally affected by drought during the driest months of the year. Other threats to the animals are water extraction from a water spring where this population occurs, which is conducted all year round for agricultural purposes, and parasites. We found a heavy load of nematodes in several specimens, with one of them dying during its quarantine period in the *ex situ* facilities after defecating bloody feces full of parasites.

The *ex situ* program is running with an initial stock of thirty founder specimens. There has been one instance of egg laying, with a mass of eighteen eggs deposited over a decaying leaf covered



Near-hatching tadpoles in a Mucuchies' Frog egg mass. Photo: Enrique La Marca.

by leaf litter. Tadpoles are growing healthy in the *ex situ* facilities, giving hope to the program.

To finish with a conservation appraisal for the species, we state that the Mucuchies' Frog is an endemic frog whose habitat has been declining due to past and ongoing deforestation as well as by other human activities. We consider it rare within its range, with a highly fragmented distribution restricted to seven known locations (only one with a current living population). We suggest that this frog be considered as a Critically Endangered species (category CR A2c; B1b) in the IUCN Red List, based on an estimated population reduction of  $\geq 80\%$  in the past, with continuing decline inferred in the area of occupancy, where the causes of reduction have not ceased, with an area of occurrence of less than ten square kilometers and having ninety-eight percent of habitat loss over more than 100 years.

We strongly recommend that an *ex situ* population be maintained to guarantee survival of the species, that captive husbandry be maintained for reintroduction purposes, and that public awareness be raised to save this unique Neotropical amphibian.

A metamorphing Mucuchies' Frog tadpole growing in the *ex situ* facilities of the Rescue of Endangered Venezuelan Amphibians Program in Venezuela. Photo: Enrique La Marca.



## Creating a SAFE haven from chytrid: How saving the Mountain Chicken could help end the global amphibian crisis

Luke Jones, Durrell Wildlife Conservation Trust, Mountain Chicken Recovery Program, Montserrat

Amphibians all over the world are facing extinction at unprecedented rates. In the last ten years alone, over 200 known species have vanished off the face of the earth and scientists estimate that around 30% of remaining amphibian species are at risk of following the same fate (Stuart et al., 2004; Alroy, 2015)

This dramatic decline has largely been attributed to the impact of a single microscopic fungus, *Batrachochytrium dendrobatidis*, more commonly known as chytrid.

The Mountain Chicken (*Leptodactylus fallax*) serves as one of the best recorded examples of the dramatic impact of chytrid fungus on an amphibian population and remains to date one of the fastest declines of a vertebrate ever recorded (Hudson et al., 2016a). Within just eighteen months of the fungus arriving on the island of Montserrat in the Caribbean back in 2009, the species was on the brink of extinction with only a handful of wild individuals remaining. By 2014 this number had been reduced further still to only two individuals. Yet, in the midst of all of this loss, hope still remains!

Durrell Wildlife Conservation Trust has worked with partners in the Mountain Chicken Recovery Program, which includes the Zoological Society of London (ZSL), Nordens Ark in Sweden, and Chester, Paignton and Bristol Zoos in the UK, as well as the local governments of both Montserrat and Dominica, also in the Caribbean. The team evacuated a representative sub-population of Mountain Chickens into biosecure facilities within their zoological collections at the first signs of the chytrid outbreak.

Since then, these captive populations have served as an invaluable resource in understanding not only the unusual biological characteristics of the Mountain Chicken, but also its relationship with the chytrid fungus. They have produced several generations of offspring that have facilitated a series of trial reintroduction projects, each testing a new method in mitigating the impact of chytrid, from translocations and soft releases through to antifungal treatments, each trial bringing us one step closer to a true solution.

### The creation of an amphibian SAFE haven from chytrid fungus

Durrell's latest project, the creation of a SAFE (Saving Amphibians From Extinction) haven against chytrid disease, is currently in its first phase and focuses on three major outcomes, which tackle the shortcomings of previous studies:

1. Being able to manage, mitigate or remove chytrid *in situ* in an environment where it is already abundant.
2. The creation of an effective, scalable solution that is easily implementable across a range of ecosystems.
3. The formation of a strategy that facilitates the affected amphibians in developing their own immune response to the chytrid fungus, which will hopefully lead to the development of an effective and long-lasting biological resilience to the fungus.

In order to create this SAFE haven from chytrid, we are utilizing an inherent weakness of the fungus: its intolerance to temperatures exceeding 28°C (Greenspan et al., 2017). With this knowledge in mind, we aim to manipulate the environment out of the temperature range in which chytrid thrives, creating a SAFE haven for amphibians against the disease.

Our SAFE haven will be divided into two sides: one hot and one cold. Not only is this necessary to enable the frogs to control their

own body temperature, it will also act as a control representing the normal temperature fluctuations in the environment. The cold side will remain relatively untouched, apart from the addition of a permanent pond. The hot side on the other hand will be subject to a series of environmental manipulation techniques aimed at frequently raising the temperature to above 28°C. These frequent periods of increased temperature should not only act to purge the chytrid from the environment, but also from infected frogs whenever they move through the hotter environment.



Field staff checking the health of Mountain Chickens.  
Photo: Laura Bambini.

This initiative capitalizes on a behavior observed by Daskin et al. (2011), where individuals with a high chytrid load spend more time basking in heated areas. It has been hypothesised that this acts to induce a 'behavioral fever', purging the fungus from the contaminated host.

Removal of tree canopy in the hot side of the SAFE haven, along with the provision of optimized basking sites, should not only act to reduce environmental chytrid levels, but also provide the frogs with plenty of suitable basking sites to allow them to properly express this behavior. The provision of solar heated basking sites has the added benefit of coming into direct contact with the underside of the frog – the main hot spot for chytrid infection – enabling delivery of a localised 'heat shock' treatment to the main site of infection.

Amphibians infected with chytrid are also known to spend prolonged periods of time bathing (Hudson et al., 2016b). Normally this acts to further the spread of the fungus, as chytrid thrives in water at moderate temperatures (10-25°C). To counteract this, we will be trialling the use of multiple solar heating techniques to raise the pond's temperature to within the range of 30-35° C. This should result in amphibians with a higher infection load utilizing the heated ponds more frequently. These ponds will not only reduce background reservoir levels of chytrid in the water, they will also act to treat the frogs by raising their body temperatures above the threshold suitable for chytrid whilst they are bathing in the water.

This project will be the first ever to trial habitat manipulations and heat treatment of chytrid within a semi-wild *in situ* setting. If successful, this technique could be used to treat the thousands of amphibians at risk of extinction as a result of chytrid and



Mountain Chicken froglet and its mother. Photo: Jeff Dawson.

present a very real possibility of halting the ongoing amphibian extinction crisis.

To make this a reality, we really need your support! Become a part of our solution by supporting us on our Experiment campaign page, which you can find at: [www.experiment.com/mountainchicken](http://www.experiment.com/mountainchicken) Here you will find all the information, videos and updates on our project.

You can also follow us on:

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**Twitter:** Mountain Chicken Recovery Programme @ReWildCaribbean

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Durrell Research Assistant Luke Jones and a volunteer digging trial ponds for habitat manipulations. Photo: Luke Jones.

## Old is the new New

Andrew R. Gray, Curator of Herpetology, The Manchester Museum, UK

Research carried out at the University of Manchester has highlighted that species we think we understand can hold new secrets, and, as it turns out, be much more threatened than we originally thought. Prior to the paper published last month, the Splendid Leaf Frog (*Cruziohyala calcarifer*) was a well-known species with a wide distribution, admired by all with an interest in amphibians due to its large size and striking orange and black markings. I was one of them. Curator of herpetology at the Manchester Museum, I have studied these frogs and their kin for many years. However, when I first saw a strange looking individual in Ecuador in 1996 I knew immediately that something was fundamentally different. I strongly suspected that it belonged to a new species but, unable to bring any examples back, could not prove anything. Proving my theory would set me on a 20 year quest, which would take me on many adventures to the rainforests of South and Central America as well as visiting museum collections all over the world.

The first documented example of the Splendid Leaf Frog, *C. calcarifer*, is held at the Natural History Museum in London, where it was originally described in 1902 by the well-known British naturalist George E. Boulenger. When I first saw the type specimen it was plainly my mystery Ecuadorian frog. It had the same distinctive features, including some unusual dark markings on its underside, markings found on no other member of this tree frog family. The finding turned the whole story on its head, as it was clear that the frog everyone knew as the being the Splendid Leaf Frog was not the same - but a new species.

Further investigation showed that in 1927 a similar looking frog to the original splendid leaf frog had been collected in Panama by American herpetologist Emmet R. Dunn and accessioned in the USA under the same name, but it was not the same animal.

Ever since, the two species have been confused; a distinct new species hiding in plain sight for nearly 100 years. Finally, last year I was able to obtain a number of live specimens from Ecuador for the collection at Manchester Museum and was able to finally conclude my research.

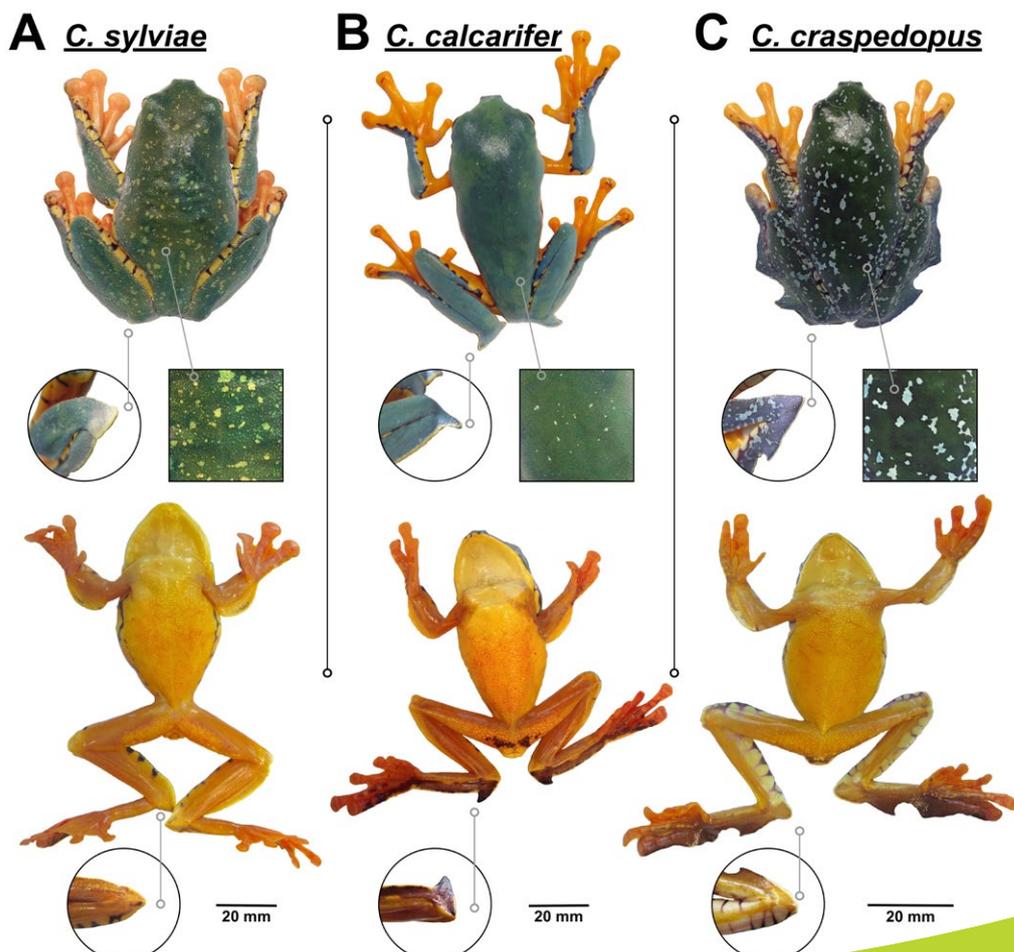
The research, which includes detailed morphological, biochemical, and genetic work in fully reviewing the genus *Cruziohyala*, shows that three species are actually represented in the genus. The new species is more closely related to *Cruziohyala craspedopus* (the Fringed Leaf Frog) than to the frog it had been confused with all these years.

So, the famous and charismatic frog, well known for nearly a hundred years as being The Splendid Leaf Frog, is not one. I have been honoured to name it *Cruziohyala sylviae* after my three-year-old granddaughter, Sylvia. The true splendid leaf frog, *Cruziohyala calcarifer*, is now understood to be a very rare animal indeed, with the need for a review of this species' conservation status being highlighted as a result of the work.

This story illustrates the mysteries that may still lie undiscovered right under our very noses, and shows that historical scientific records are still incredibly valuable and relevant. I hope if nothing else this story inspires future scientists to question our understanding of the natural world and make their own contribution to it.

Gray, A. R (2018). Review of the genus *Cruziohyala*, with description of a new species. *Zootaxa*, 4450.4.1 <https://biotaxa.org/Zootaxa/article/view/zootaxa.4450.4.1>

<http://research.amnh.org/vz/herpetology/amphibia/Amphibia/Anura/Phyllomedusidae/Cruziohyala/Cruziohyala-sylviae>



Species of *Cruziohyala*.

## Amphibian Ark donors, January-August 2018

The work of AArk is possible due to the generous support of the following individuals and institutions:

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Chris Carvalho  
Valrie Fingerman & Stephen Hirsch  
James Hanken  
Vivienne Holm  
Alyce Hopko  
Adam Kosloff, in memory of Matias Sosa-Wheelock  
Max McBarron  
Thomas Miskovsky, in honor of George Rabb  
Ella Rowan  
Adam & Erin Scimone  
Suzanne Sharp Johnson, in memory of George Rabb  
Ceil Slauson  
George Sommer  
Barbara Trautner  
Alethe Vassay  
Stuart Weeks  
Georgianne Wilcox

### Up to \$10

Paul Babicki Babicki  
Jason Define  
Brayden Diehl  
Alicia Loeza  
LW  
Carina Lerch  
Tam Ly  
Rebekah McFarland  
Don Smith  
Lucy Smith  
Miho Takayama

### Up to \$1,000

Abilene Zoological Gardens  
Don Arnold & Sue O'Brien  
Beastly Threads  
El Paso Zoo  
Chandra Jessee  
Lee Richardson Zoo  
Minnesota Zoo  
Rosamond Gifford Zoo  
Sacramento Zoo  
Alistair Ward  
Woodland Park Zoo