

FROGCALL

No 164, December 2019



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MEETING FORMAT

Friday 6th December 2019

6.30 pm: Lost frogs: Priority to new pet frog owners. Please bring your membership card and cash \$50 donation. Sorry, we don't have EFTPOS. Your current NSW NPWS amphibian licence must be sighted on the night. Rescued and adopted frogs can never be released.

7.00 pm: Welcome and announcements.

7.45 pm: The main speaker is Marion Anstis, talking about her recent trip to Costa Rica.

8.30 pm: Frog-O-Graphic Competition Prizes Awarded.

8.45 pm: Show us your frog images, tell us about your frogging trips or experiences. Guessing competition, continue with frog adoptions, Christmas supper and a chance to relax and chat with frog experts.

Thanks to all speakers for an enjoyable year of meetings, and all entrants in the Frog-O-Graphic Competition.

Email monicawangmann@gmail.com to send an article for FrogCall.

CONTENTS

President's Page	Arthur White	3
Chytrid, the frog-killing fungus	Arthur White	4
Encounters with Wildlife in Costa Rica ..	Marion Anstis	10
FATS Frog-O-Graphic Competition winners		16-17, 20-21
Centrefold Spread: Peron's Tree Frog	Cassie Thompson	18-19
Gundabooka National Park trip	Karen Russell	22
Early Development of the Axolotl	Daniel Murphy	28
Recent events in the news	Kathy Potter, Chad Beranek	32
Field Trips	Robert Wall	34
Meeting directions		36
Committee members contact details		36

Cover photo: Gladiator Tree Frog, *Hypsioboa rosenbergi* (Costa Rica)

Marion Anstis

President's Page

Arthur White

Another year has passed and FATS continues to do many good things on behalf of frogs. FATS has been as active as ever and has been present in many public events spreading the word about frogs and frog conservation. We have also held several field trips, participated on governmental panels and maintained the Frog Rescue Service.

This year we have spent a lot of time with the Office of Environmental Heritage (OEH) advising about incoming changes to the licensing laws for keeping pet frogs, and advising on matters relating to frog captive care and husbandry. These revisions are likely to be accepted (either in part or in full) sometime this year. I particularly thank Marie Callens for giving up her time and assisting with this project.

FATS remains financially strong, thanks to our long-standing Treasurer Karen White. Because we are so sound, we again offered and awarded four student research grants this year.

FATS again held a number of community and education activities including various garden clubs and frog activities at regular venues such as the Royal Easter Show, Willoughby Fauna Fair, Centennial Park, Mt Tomah and Mt Annan Botanical Gardens, Ku-ring-gai Wildflower Gardens and Narrabeen Wetlands. We also participated in Science in the City at the Australian Museum during Science Week and Science in the Swamp. Great thanks are given to Kathy and David Potter for organising most of these events and extra thanks to Sarah, Ryan and Harriet for helping out at these events.

FATS also undertook the annual Bell Frog auditory surveys at Sydney Olympic Park in November and December. Thanks to SOPA for supporting FATS.

Monica, our editor, has been busy as always, putting out FrogCall, our flagship publication. It is a great credit to her and a wonderful means of getting frog news around. Our special December colour editions produced by Monica Wangmann and Marion Anstis, are keenly sought by non-members and will continue to be published in colour for as long as we can afford it. We have digitised all FrogCall editions 1-164 so that there is a lasting record of these publications.

Robert Wall organised a great series of field trips that are always well attended. They are a great way to become familiar with frogs. Make sure that you get your name down on the attendance sheet as quick as you can after the trips are announced or else you could miss out.

Punia Jeffery has been our meeting spokesperson and also helps out with various other activities. Phillip Grimm has two roles, membership officer and webmaster and does both with great efficiency.

Many thanks to our other executive members: Marion Anstis, Andre Rank, Natalia Sabatino, Vicki Deluca and Jillie Streit. Each has contributed whole-heartedly and helped keep FATS alive and well.

Those of you who know our past Secretary, Wendy Grimm will be pleased to know that she has submitted her Masters thesis on native orchids. She and Phillip are off to recover with a trip to Western Australia.

Of course, I would like to thank all of our members for making FATS such a great group to be in. People who are friendly and helpful really make it a pleasure to run an organisation like FATS.

CHYTRID: the frog-killing fungus

Arthur White

Introduction

Frog Chytrid Disease is well known because of its dire impacts on frog populations (Figure 1) around the world. However, recent research has focussed on the spread of this pathogen and the species most vulnerable to it and similar microbes. These studies have discovered that the Chytrid outbreak is one of a series of pandemic diseases that will erupt in a world where humans continually criss-cross the planet carrying microbes with them, resulting in the formation of new hybrid (and sometimes lethal) strains of pathogens. The Frog Chytrid story is a salient example of a micro-organism taking full advantage of an opportunity in a crowded world.



Fig. 1: Dead frog - victim of Chytrid
Wikipedia

What are Chytrids?

Chytrids are a group of single-celled fungi. They belong to the Chytridiomycota and have been a problematic group within the Fungi. For the early fungal biologists, chytrids were not considered as fungi, but as a kind of primitive animal cell. They thought that chytrids could have been an animal cell because they reproduce by releasing motile zoospores (Figure 2) that can swim. But chytrids also have a cell wall, like plants. Troublesome little beasts!

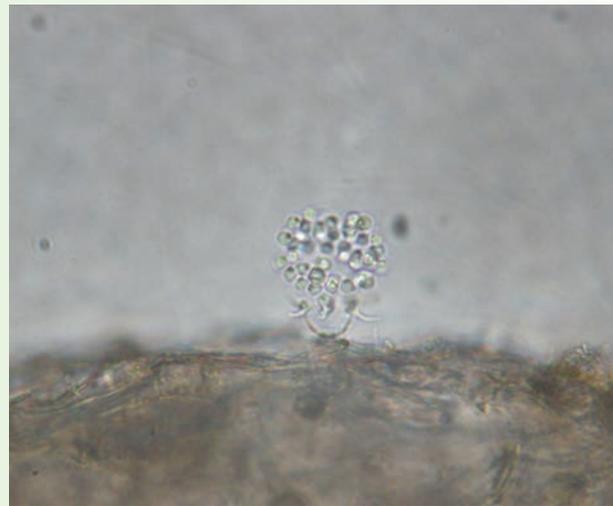


Fig. 2: Zoospores being released. Scientific American

With the development of electron microscopes, the correct placement of Chytrids within the Fungi has been resolved. Chytrids are one of the early diverging fungal lineages; they are true fungi because their cell walls are made of chitin (not cellulose like plant cell walls), they have a posterior whiplash flagellum that propels the zoospore through liquids, they rely on absorptive nutrition, they use glycogen as an energy storage compound, and they synthesize lysine by the α -amino adipic acid (AAA) pathway.

The various species of Chytridiomycota have traditionally been delineated and classified based on development, morphology, substrate and method of zoospore discharge.

Chytrids are unusual among the Fungi in that they reproduce with zoospores. For most of them, sexual reproduction does not occur. Asexual reproduction occurs through the release of zoospores, presumably derived through mitosis (Figure 3).

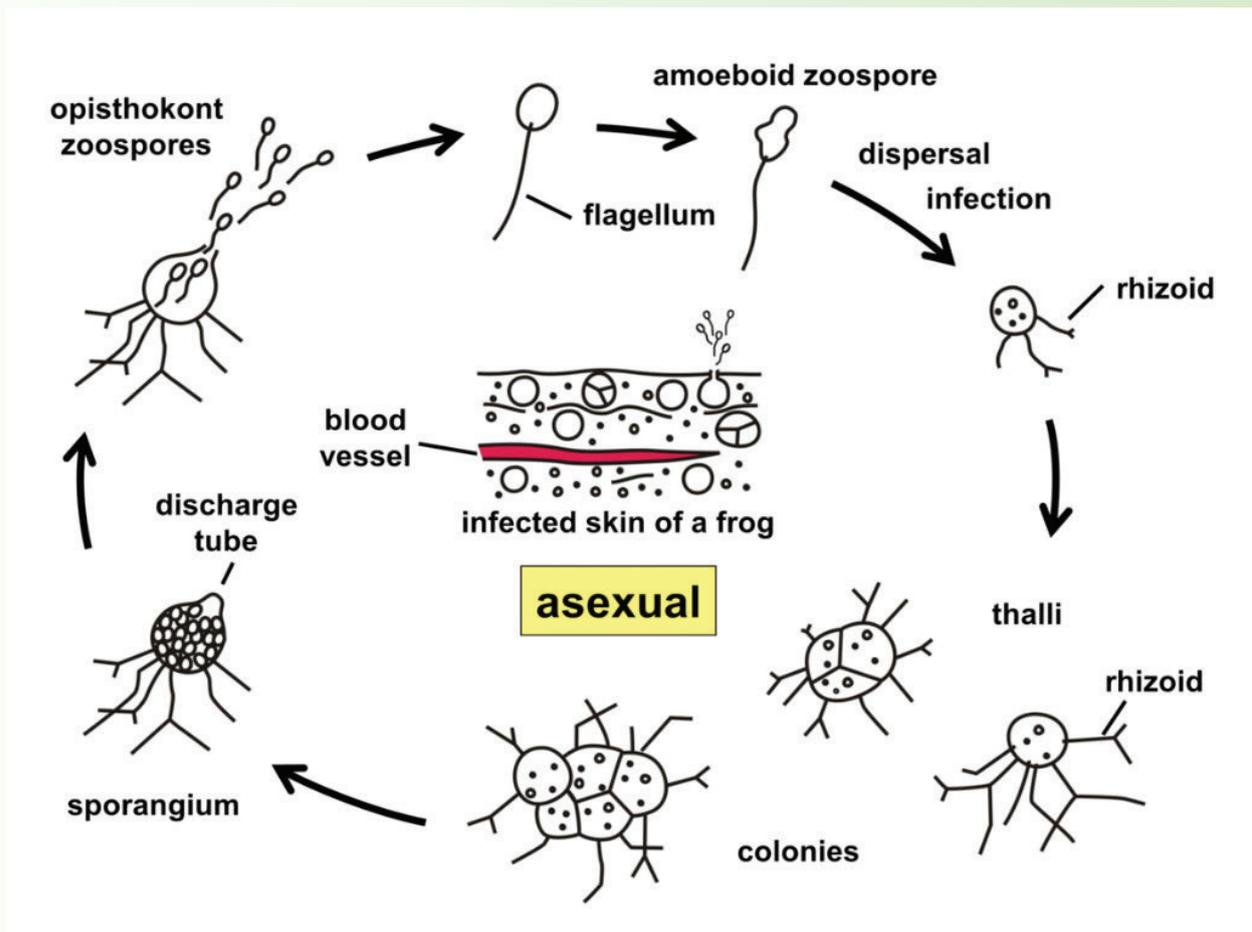


Fig. 3: Life Cycle of Chytrids

Wikipedia

Most Chytrids are aquatic fungi, although many can exist in the capillary networks around soil particles and these chytrids are considered terrestrial. The flagellated zoospore is primarily a means of allowing the fungus to move through a small volume of water in search of a suitable substrate to feed on rather than as a means of long-range dispersal.

Chytrids have been isolated from a variety of aquatic habitats, including peats, bogs, rivers, ponds, springs, and ditches, and terrestrial habitats, such as acidic soils, alkaline soils, temperate forest soils, rainforest soils, Arctic and Antarctic soils. This has led to the belief that many chytrid species are ubiquitous and cosmopolitan. However, recent taxonomic work has demonstrated that the cosmopolitan nature of chytrids conceals the true diversity of these single-celled fungi, where many cryptic species occur.

Frog Chytrid Disease

Frog Chytrid Disease or Chytridiomycosis

is caused by *Batrachochytrium dendrobatidis* (Bd). It is an infectious disease that has resulted in massive frog declines and extinctions around the globe. Frog Chytrid Disease has caused extensive frog mortalities in Australia in the 1970s and 1980s with five frog species eventually becoming extinct. The pathogen was first isolated and identified by Lee Berger in Australia in 1997. But Chytrid had been present in Australia and other parts of the world well before this; for example, the earliest documented occurrence of *Batrachochytrium* is from a Japanese Giant Salamander collected in 1902. For some reason, the chytrid pandemic killing frogs worldwide did not start until the 1970s. A second species of *Batrachochytrium*, *B. salamandrivorans*, was discovered in 2013 and is known to cause chytridiomycosis in salamanders.

Bd consumes keratin (a stiffening protein used in soft tissues) and kills frogs by destroying skin integrity and causing massive secondary infection. Any organism that has keratin

can theoretically be a carrier of Bd. This fact was not discovered until relatively recently and has dramatic implications for the control of the spread of chytrid. Humans can carry chytrid, but are generally not affected by it, possibly because most of the keratinous parts of our bodies are dead cells on the outside of our bodies, but also because our skin is dry, and amphibian chytrid fungus requires a moist environment.

Frogs develop a deep keratinised skin layer during metamorphosis and this makes them an easy target for chytrid zoospores to penetrate and infect (Figure 4). Once the spores have penetrated the soft, outer skin, they begin to consume the deeper keratinised layer, disrupting the frog's respiration and immune systems. Tadpoles have very little keratin in their body, the only notable amount is in the tooth rows and jaws. An infected tadpole can still feed using the bare tooth row and jaw ridges, but is often in poor condition and metamorphoses smaller. The infection then quickly takes hold and affected metamorphs soon die. In 2005, there was a major outbreak of chytrid in Sydney and the Green and Golden Bell frogs



Fig. 4: Chytrid cells within frog skin
J. Lawrence

at Sydney Olympic Park were not spared (Figure 5). Most frog deaths occurred during winter when the frogs were least active (because of the colder conditions). The frog's immune system was depressed by the cold temperatures and Bd is most active at temperatures between 10° and 21°C. However, the trigger for the outbreak is thought to be human-related.



Fig. 5: Chytrid victim, Sydney Olympic Park, 2005 A. White

The geographic range of *B. dendrobatidis* has been mapped (Channing et al. 2013), and spans much of the world. *B. dendrobatidis* has been detected in 56 of 82 countries (Figure 6), and in 516 of 1240 (42%) frog species using a data set of more than 36,000 individuals. It is widely distributed in the Americas, but is detected sporadically in Africa, Asia, and Europe. Asia, for example, has only 2.35% prevalence. The low incidence in Asia may indicate that this is where the disease may have originated, the presumption being that Asian frog species here have had longer to develop an immunity to Chytrid than from elsewhere in the world. See world distribution, Figure 6.

Are all frogs equally prone to Chytrid?

The answer is No. Scheele et al. 2019 have looked at most of the frogs around the world and have been able to determine the species and families most prone to Chytrid (Figure 7, opposite). The pattern is erratic, some frog families are prone while others are not; some genera within the family are prone to it, while others are not. The frog families most at risk to Chytrid are Telmatobidae (toad-like frogs from South America), Eleutherodactylidae (arboreal frogs from Central and South America), Myobatrachidae (ground frogs from Australia), Hylidae (tree frogs from Australia and South America), Bufonidae (toads from Europe, Americas) and Craugastoridae (flesh-bellied frogs from North and South America). Note that toads (family Bufonidae) have been badly affected by Chytrid, yet the Cane Toad (*Rhinella marina*) that was introduced into Australia is not affected and acts as a carrier for the disease.

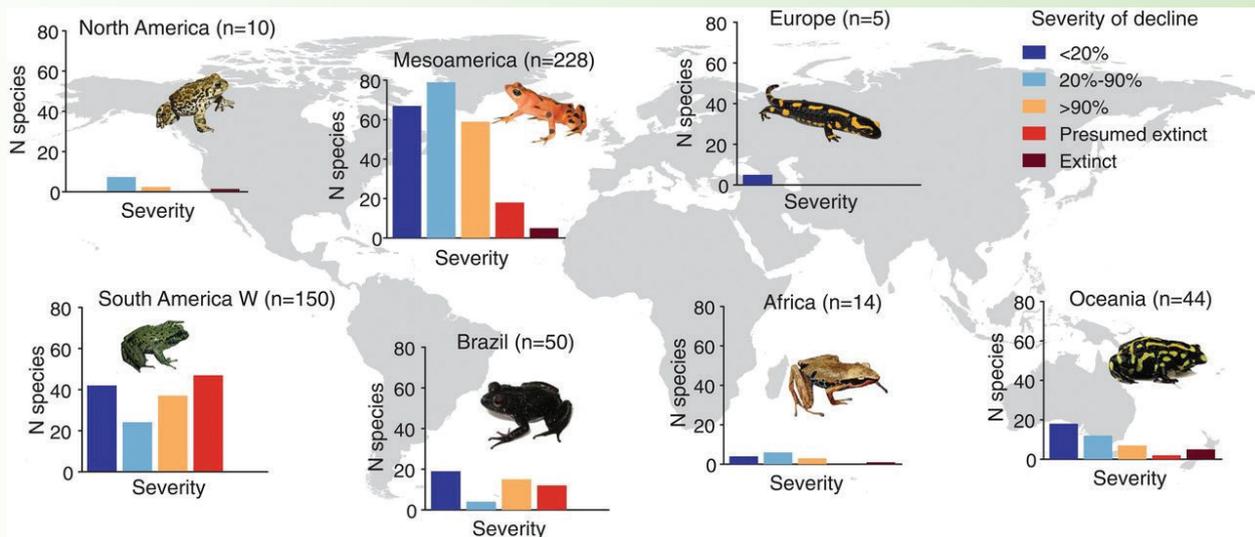


Fig. 6: Distribution of Chytrid worldwide

Scheele et al. 2019

Does the frog's Life Style make it more susceptible to Infection from Chytrid?

Yes. In their analysis of the epidemiology of Chytrid, Scheele et al. 2019 found that one of the biggest risk factors for Chytrid is how large the distributional area is. For frogs with a small geographic range, the onset of Chytrid could result in the complete extermination of the species. For frogs that are widely distributed, the outbreak of Chytrid could result in the local extermination of a population or two of the frogs, but the species is more likely to

survive (see Fig. 8, page 8).

The five frog species that have become extinct in Australia to Chytrid, (*Rheobatrachus silus*, *Rheobatrachus vitellinus*, *Taudactylus acutirostris*, *Taudactylus diurnis* and *Litoria nyakalensis*). We had thought that *Litoria castanea* had become extinct as well but a tiny population presumed to be this species was found in the ACT and so maybe some of that species will survive Chytrid.

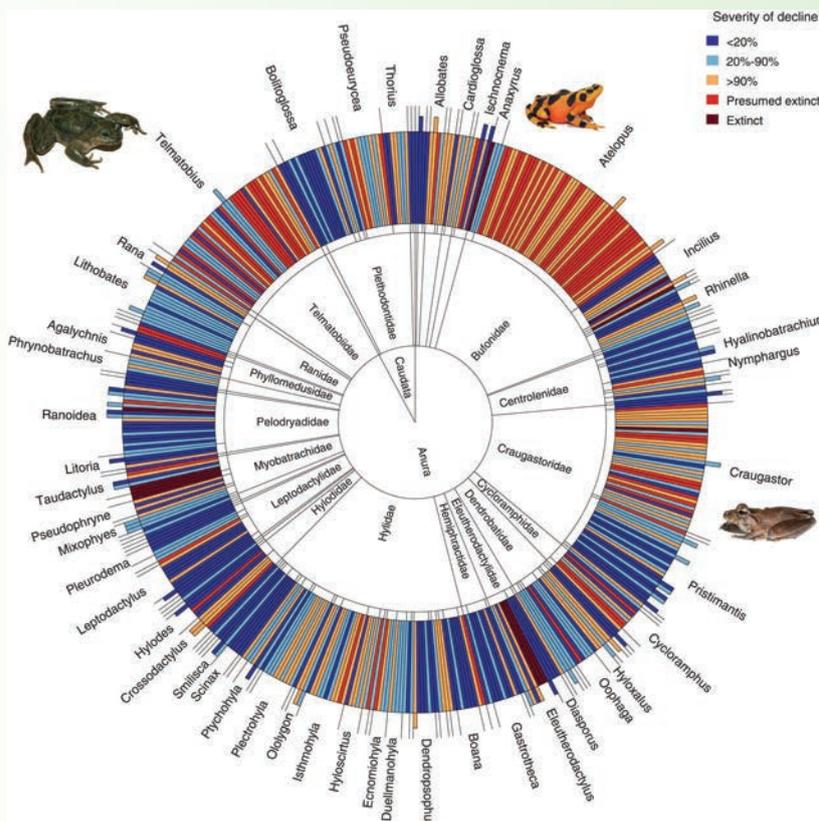


Fig. 7: Frog families around the world affected by Chytrid.

Scheele et al. 2019

Did the Chytrid Epidemic occur at the same time all around the World?

No. Bd was present in all of the continents (except Antarctica) by the early 1970s but the trigger for the epidemic was different in each location. Scheele et al 2019 have also plotted the times of the eruption of Chytrid around the world (Figure 9, page 8). From this it is clear that the worst eruptions occurred in 1980, 1983, 1985, 1989, 1990, 1993, 1995 and 2003. Since then the eruptions have been less severe and there have been far fewer extinction events.

Epidemiology of Chytrid

The capacity for *B. dendrobatidis* to cause major declines is

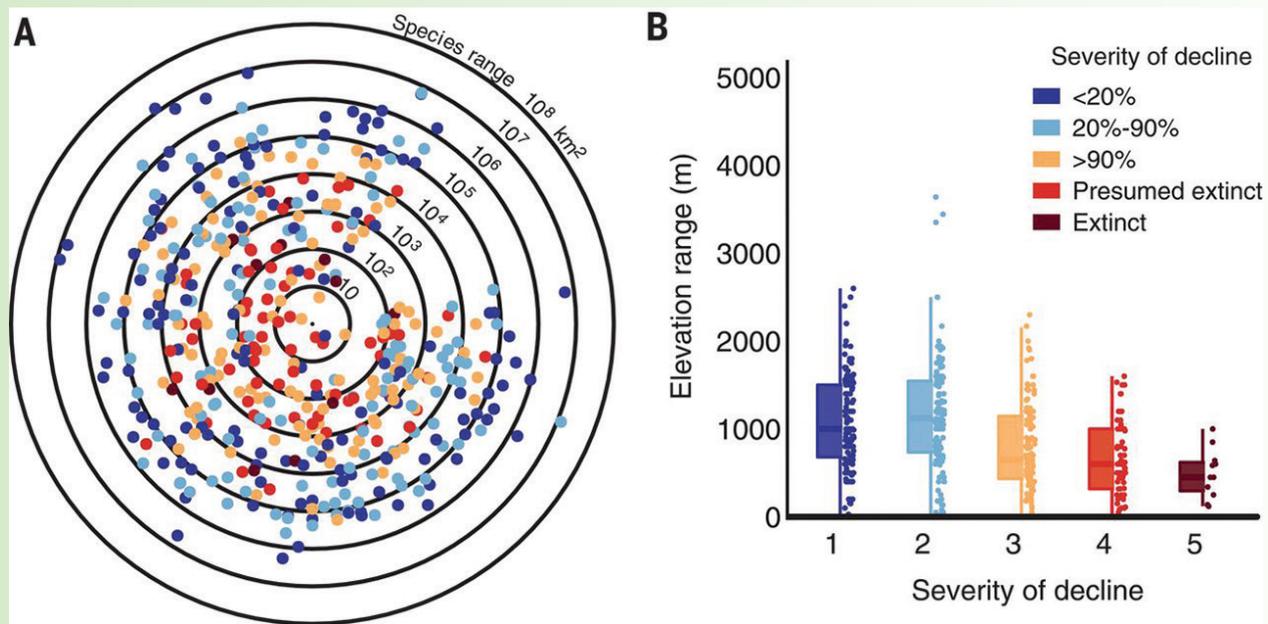


Fig. 8: Graph of the distributional area of the frogs, and the likelihood of severe chytrid impacts.

Scheele *et al.* 2019

attributable to its maintenance of high pathogenicity, broad host range, high transmission rate within and among host species, and persistence in reservoir host species and the environment. For many frog species, chytridiomycosis is the principal driver of frog decline, exemplified by sudden mass mortalities in undisturbed environments. In other frog species, chytridiomycosis acts together with habitat loss, altered climatic conditions, and invasive species to exacerbate species declines. It appears that frog populations that are under stress (eg. from habitat degradation or pollution) are much more at risk of infection by Chytrid and other

pathogens. The pathogenicity of Bd is greatly increased when frogs are exposed to insecticides (which interfere with the frog's normal immune response). Many outbreaks of Chytrid began in agricultural areas and spread from there to more natural areas.

How does frog Chytrid Differ from other Chytrids?

The Bd that causes Frog Chytrid Disease appears to be a recent hybrid between two distant and benign strains of Bd. It is likely that these strains were accidentally introduced to each other via human contact and the resulting

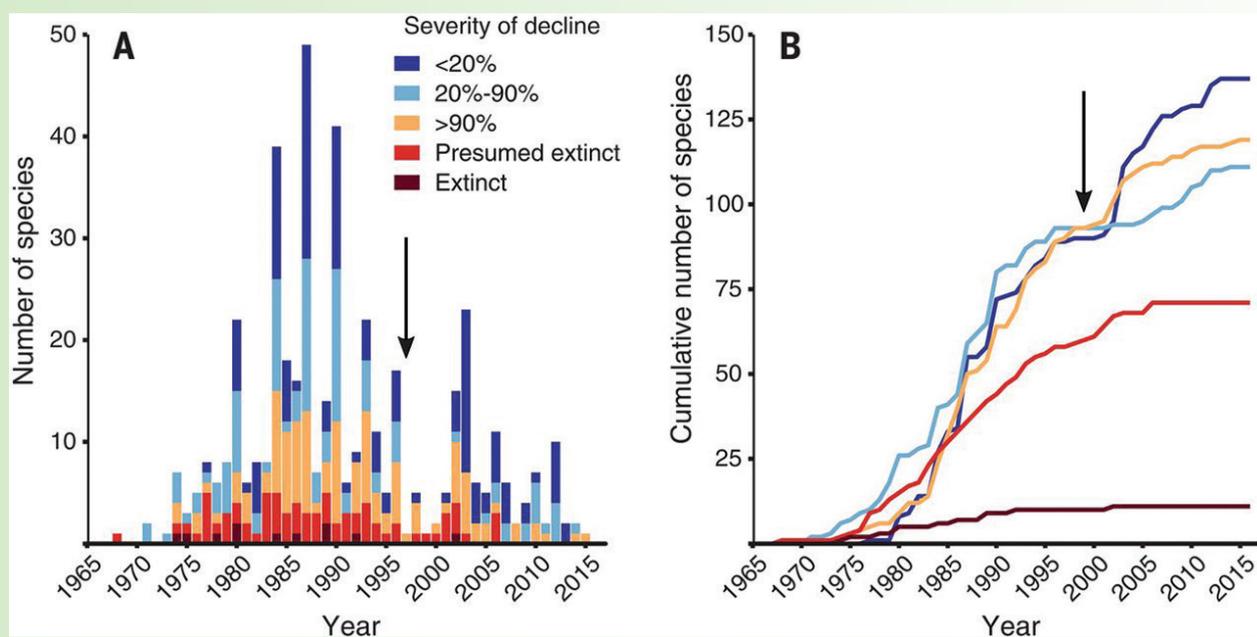


Fig. 9: Timing of the major outbreaks of Chytrid around the World.

Scheele *et al.* 2019

hybrid proved to be lethal to frogs. Humans and other animals (e.g. birds) continue to act as vectors for Chytrid cells and it is likely with so much international travel and lax bio-security that new combinations will emerge, with different target species (possibly even humans) eventually being affected.

Controlling the Spread of Chytrid

Chytrid spores can be transferred in damp soil, hair, clothing as well as contaminated water. We now know how to kill isolated Chytrid cells but controlling them in the wild and over large distances is currently impossible. Instead of trying to kill Chytrid cells (e.g. by using broad spectrum fungicides), it is more practical and safer for the environment to try to prevent the spread of Chytrid. For this reason, in 2006, FATS worked with the DECC (National Parks) to develop a Frog Hygiene Protocol to limit the spread of Chytrid in Australia. This protocol had one important directive: because it is so hard to tell if a frog is infected or not, all frogs must be treated as if they are infected. Thus, any frog habitat area must also be regarded as a potential source of Chytrid spores. The following simple steps are important in controlling the spread of Chytrid:

- Before entering wetlands, disinfecting stations are required to kill potential spores already on the person.
- Water, soil or other potential sources of chytrid must not be moved between wetlands without strict protocol being adhered to, and in the case of frogs and tadpoles, under scientific license.
- Boots, equipment and other items that may have been in contact with water must be sterilised.
- Assume all frogs that you encounter are infected. Treat them as infected animals.

Infected frogs in captivity can be treated for Chytrid. Today, the best treatment to use is carefully monitored heat treatment. Many fungicides also work but they also severely impact sick frogs. By elevating the temperature of a container holding a sick frog to 28° C for a period of at least 8 days, all Chytrid spores in the frog can be killed (and many tree frogs enjoy the warmer temperatures). The only field

technique known to limit Chytrid spread is salt treatment of associated water bodies. This method has only been trialled on frog species that have some salt tolerance (ie. Bell frogs). FATS follows the Frog Hygiene Protocol on all of its field trips and outdoor activities.



Fig. 10: Ken Griffiths sterilises his boots before FATS field trip.
Arthur White

Suggested Reading:

Berger L, Hyatt AD, Speare R, Longcore JE. 2005. "Life cycle stages of the amphibian chytrid *Batrachochytrium dendrobatidis*". *Diseases of Aquatic Organisms*. 68: 51–63. doi:10.3354/dao068051

"Chytridiomycosis (Amphibian Chytrid Fungus Disease)"(PDF). Australian Government Department of Sustainability, Environment, Water, Population and Communities. 2007.

Channing, A., et al. 2013. In Stajich, Jason E (ed.). "Mapping the Global Emergence of *Batrachochytrium dendrobatidis*, the Amphibian Chytrid Fungus". *PLoS ONE*. 8 (2): e56802. doi:10.1371/journal.pone.005680

Scheele, et al. 2019. Amphibian fungal panzootic causes catastrophic and ongoing loss of biodiversity. *Science* 363 (6434):1459-1463.

Encounters with wildlife in COSTA RICA

Marion Anstis

In July this year, I had the pleasure of joining a photography workshop with a small group of keen wildlife photographers in Costa Rica for a week, led by a professional wildlife photographer. The workshop was based in a beautiful forest lodge near the town of Puerto Jimenez on the south-eastern side of the Osa

Perhaps the first inhabitants I was intrigued by on arrival were the long trains of Leaf Cutter ants, as they laboriously carted their precious leaf pieces in line formations criss-crossing much of the grassland areas and paths all around our lodges. They often had trails up and down trees, cutting and transporting their



Map of Costa Rica. Arrow indicates the Osa Peninsula and Puerto Jimenez where I visited.

Peninsula in the Golfo Dulce region. The area around Puerto Jimenez has remnant lowland tropical rainforest, town dwellings, a grey sandy beach with restaurants and a relaxed lifestyle and very rough unsealed roads. We stayed at Crocodile Bay Resort, a 5-star resort in landscaped gardens where many birds such as toucans, humming birds and a variety of other wildlife including frogs, butterflies, sloths, ant-eaters and reptiles all co-exist.

harvest. July is during the wet season in Costa Rica, and the poor ants often suffered setbacks after a heavy downpour of rain, when their soaking leaf pieces were laid flat on the ground. The ants had to come back after the pieces had dried a bit and pick them up and start their procession again!

After a session of photography tips and suggestions from our workshop leader, we had



This Yellow-throated Toucan was a regular visitor to fruiting palm trees.

a walk around the extensive grounds at the resort, photographing birds, lizards butterflies and flowers. Two of the most intriguing birds I photographed were the Yellow-throated Toucan and Boatbill Heron, pictured above.

Over the following five days, we were treated to daily trips in 4WD vehicles and even a boat trip, looking for wildlife in the forest beside the very rough roads, or in mountain forest,



Granulated Poison Dart Frog (*Oophaga granulifera*), Corcovado National Park



A Boatbill Heron gets ready to roost beside a river in forest near the resort.

stopping whenever the amazing guides spotted interesting subjects for us to photograph.

While I was only able to see a very small area of the country during my stay, part of it included visits to the largest national park in Costa Rica – Corcovado National Park covering 424 square kilometres! Here we got close to two species of Poison Dart Frogs (below). Every day of the workshop that week was packed



Golfo Dulce Poison Dart Frog (*Phyllobates vittatus*), Corcovado National Park



Common Basilisk (*Basiliscus basiliscus*), Corcovado National Park



Yellow form of Eyelash Viper (*Bothriechis schlegeli*), Corcovado National Park



Fer de Lance Viper (*Bothrops asper*), a highly toxic species, Corcovado National Park



Golfo Dulce Anole (*Norops polylepis*), Corcovado National Park



Gladiator Tree Frog (*Hypsiboia rosenbergi*), Corcovado National Park



Red-eyed Leaf Frog (*Agalychnis callidryas*), Corcovado NP



Small-headed Tree Frog (*Dendropsophus microcephalus*), calling at night above a pond, Osa Peninsula.



Hourglass Tree Frog (*Dendropsophis ebraccatus*), Osa Peninsula



Masked Tree Frog (*Smilisca phaeota*), Osa Peninsula

with life from the smallest insects to the large troops of Howler monkeys hooting and leaping across treetops in the forest, and everything in between. Wonderfully colourful birds, frogs, mammals, invertebrates and reptiles abound in this region and it was very hard to give them the time needed to get worthwhile shots!

We were also taken to two wildlife conservation reserves, the Golfo Dulce Reserve and La Tarde Conservation park in the Corcovado National Park. Here the park managers gave us a chance to get up close to various frogs and reptiles, all collected the day before in the surrounding forest. After we had photographed them they were immediately released. Three of the snakes were highly venomous, but we used telephoto lenses for them, enabling us to stand further away! At Golfo Dulce Reserve, we saw a large Boa constrictor, and several frogs and lizards. Birds and butterflies also abound in these parks and we were never short of great subjects to point a lens at. There were two colour forms

of the Eyelash Viper at La Tarde Conservation Park, one with red spots on green/beige background and another striking yellow form. Both forms occur here naturally and are venomous.

Following this week, I stayed on for a second week after the workshop and had my own more personalised field trips, one of which was an overnight stay at La Tarde reserve in the beautiful mountain rainforest of Corcovado National Park. This magnificent Park is the largest in Costa Rica and covers a staggering 424 square kilometres!

My own personal guide gave me a wonderful afternoon, night and morning, finding me many small birds not seen on the workshop trips, and frogs in their natural habitat by day and night, plus spiders, vipers (one Fer de lance viper curled up outside my tented lodge!), a wasp with a paralysed spider, a Tentmaker Bat, a Three-toed Sloth and even a Cane Toad! He was amazing at finding things, so I had a great



Reticulated Glass Frog (*Hyalinobatrachium valerioi*), tending 3 egg clutches on the underside of a leaf, each at different stages of development. The empty jelly remains of a fourth clutch was also at one end of this leaf, Corcovado National Park.

two days. Perhaps two highlights for me was the discovery of a Reticulated Glass Frog male, protecting his three live egg clutches and the jelly remains of a fourth on the underside of a leaf above our heads...he'd had his way with four different females! Sadly though, there was no water beneath the eggs for the hatchlings to fall into, so unless there was heavy rain soon, the embryos would all die. Soon after this, my guide discovered a male Granulated Poison Dart Frog poised in the calling position on a palm stem just above the ground. At the time he wasn't calling, and very well hidden, so I



Granulated Poison Dart Frog (*Oophaga granulifera*), calling in afternoon light, Corcovado National Park.

was impressed with the guide's skill at finding him. And before long, while I was photographing him, he began to call in the afternoon light, so that was very special!

The third day of the three-day tour with my guide was a trip to Matapalo Beach at the southern tip of the Golfo Dulce. Again we traversed the long, slow, very bumpy gravel road stopping whenever he heard a bird of interest, spotted a hidden Screech Owl in the trees above, or various Monkeys, birds of prey, vultures etc. And during lunch at the beach, we were entertained by some beautiful Scarlet Macaws feeding in the palms above. These magnificent parrots are quite commonly seen in treetops feeding on seeds, and when they fly the wing colours are stunning.

I can highly recommend a visit to this magical place, but be prepared for a long trip and the best part of two days in travel. I only wish I had been able to see more of it, but wherever you go in this country you will see wildlife, so definitely be prepared for some wonderful experiences and great photographic memories!

FATS Frog-O-Graphic



BEST IMAGE: Above: Red-eyed Leaf Frog, *Agalychnis callidryas* Costa Rica

Marion Anstis

BEST IMAGE and PEOPLE'S CHOICE (see centrefold): Peron's Tree Frog, *Litoria peronii*

Cassie Thompson



Competition WINNERS



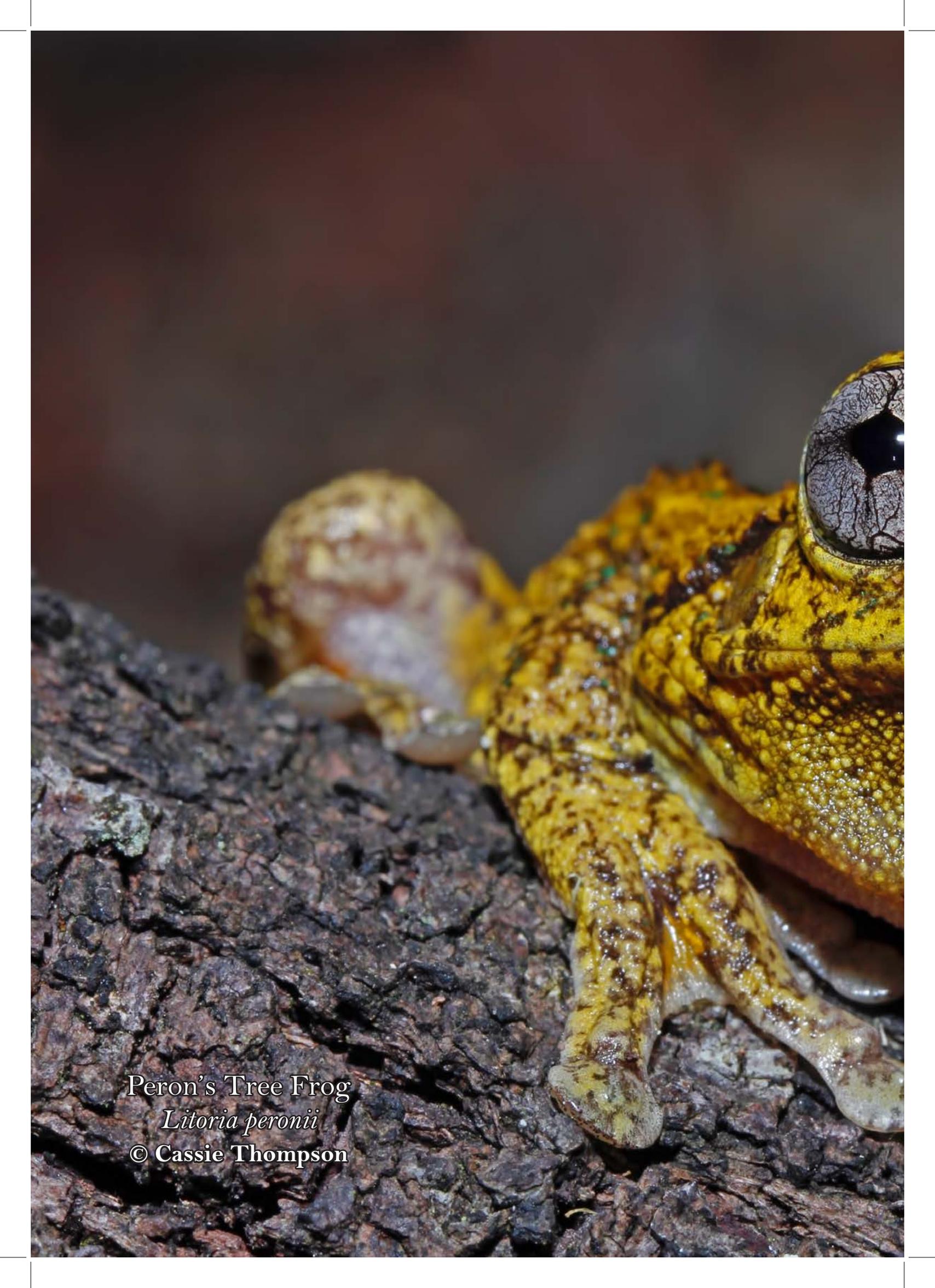
MOST INTERESTING IMAGE: Above: Crucifix Frog, *Notaden bennetti*

Karen Russell

MOST INTERESTING IMAGE: Below: Australian Lacelid, *Litoria dayi*, showing reticulated inner eyelid.

Michelle Toms





Peron's Tree Frog
Litoria peronii
© Cassie Thompson



Frog-O-Graphic Winners



BEST PET IMAGE: Green Tree Frog, *Litoria caerulea*, known as 'Hat' because he sits on the heads of larger frogs! **Kathy Potter**

OTHER ENTRIES: Tasmanian Tree Frog, *Litoria burrowsae*

Josie Styles



...and some other entries



OTHER ENTRIES (above): Giant Burrowing Frog, *Heleioporus australiacus*

Jordan Crawford

OTHER ENTRIES (below): Green-eyed Tree Frog, *Litoria serrata*

Michelle Toms



A herpetologist's wonderland: Gundabooka National Park

Karen Russell



The Darling River, dwindling to a creek with the effects of the drought, Gundabooka National Park.

Karen Russell

Along with my love of frogs, I also have a passion for reptiles and photography. So when the opportunity to visit Gundabooka National Park came along in 2017, I had the good fortune to include all three interests while spending time with good friends. Most of the group were members of the Australian and Victorian Herpetological Societies. Gundabooka National Park is located in north-west NSW, approx 50 kms from Bourke.

This adventure was every herper's dream, and we compiled a list of the species we encountered for the Park's staff. The trip was in late October, 2017 and was so successful that

another official Australian Herpetological Society field trip to the area was organised by Kelly Nowak in the later part of 2018, which I was also lucky enough to attend.

So as not to rush our trip from Sydney we took two days to get there in our vehicles. We stayed at the Nyngan Caravan Park the first night. This allowed plenty of time the next day for many, many stops to photograph and admire the numerous Shinglebacks (*Tiliqua rugosa*) and Central Bearded Dragons (*Pogona vitticeps*) that were spotted basking on the side of the road or sunning themselves in nearby trees.

In 2018 we stayed at the historic Redbank Homestead. The homestead has all the comforts of home including a well-equipped kitchen and an outside barbecue. This ensured that we all ate well, and at the back of the Homestead a pergola overlooking the Darling River was a lovely backdrop for us to enjoy our meals or relax with a few drinks. This was also a great vantage point to observe a magnificent Lace Monitor who had made its home in the hollow of a nearby tree.

At night time there would be many *Dtella* geckos running around the outside homestead walls. A friendly echidna also made itself known at night to one guest who chose to camp outside the homestead.

Water levels were much lower compared to the previous year's trip in 2017, and in parts it could be seen that the river was getting to critically low levels.

The Darling River also attracts many different species of water birds and parrots as well as large groups of goats. Unfortunately feral goats and pigs cause a great deal of damage to the Park. When goat numbers get out of hand, the Park's staff organise contractors to herd them up for market.

An inexperienced eye would generally not even be aware of the many reptile species inhabiting the area, but this group of seasoned herpers had no trouble locating or spotting them!



Central Netted Dragon (*Ctenophorus nuchalis*) on his lookout. **Karen Russell**

Central Bearded and Netted Dragons were common throughout the Park and a few of the group had an uncanny ability to spot these species from a considerable distance, even while in a moving car. The Central Netted Dragons



The iconic Central Bearded Dragon (*Pogona vitticeps*) poses for a photo.

Karen Russell



Crucifix frog (*Notaden bennetti*) emerges. **Karen Russell**



Water-holding Frog (*Cyclorana platycephala*) **Karen Russell**

in particular could be observed perched on the ridges of the roadsides trying to look inconspicuous.

A big bonus of the trip was when one of the group found a beautiful big Inland Carpet Python (*Morelia spilota metcalfei*) foraging at night in the Darling River in close proximity to the Homestead. I can still remember one of the group saying that you need to think like a snake to find one. He must have been onto something as he always did manage to find them.

Foraging under old bits of tin and exploring other hot spots around the property and other neighbouring areas kept everyone happy and busy. This resulted in locating a large variety of species. Some of the reptiles found included a de Vis' Banded Snake or Mud Adder (*Deniso-*

nia devisi), Red-naped Snakes (*Furina diadema*), Strap-snouted Brown Snake (*Pseudonaja aspidorhyncha*), Curl Snake (*Suta suta*), Yellow-faced Whip Snake (*Demansia psammophis*), Central Bearded Dragons (*Pogona vitticeps*), Central Netted Dragons (*Ctenophorus nuchalis*), Shinglebacks (*Tiliqua rugosa*), Sand Goannas (*Varanus gouldii*), Broad-banded Sand Swimmers (*Eremiascincus richardsonii*), Blue-tongued Lizard (*Tiliqua scincoides*), Tree Dtella Geckos (*Gehyra variegata*), Bynoe's Gecko (*Heteronotia binoei*), Marbled Velvet Geckos (*Oedura marmorata*), Burton's Legless Lizards (*Lialis burtonis*), Eastern Spiny-tailed Gecko (*Strophurus williamsii*) and Eastern Beaked Geckos (*Rhynchoedura ormsbyi*).

The property also attracted many bird species. An afternoon chilling out at the front of the homestead with our cameras always close



Inland Carpet Python (*M. spilota metcalfei*) **Karen Russell**



Desert Tree Frog gravid female (*Litoria rubella*) **Karen Russell**



Desert Tree Frogs (*Litoria rubella*) waste no time pairing to breed after rain. Even the crickets are out for a drink! **Karen Russell**

by was rewarding as we got to observe beautiful Variegated Wrens, White-plumed Honeyeaters, Little Friar birds and Striped Honeyeaters. Red-winged Parrots, Mulga Parrots and Australian Ring-necks were often sighted at the property and while cruising the dirt roads, we came across Emus, a Wedge-tailed Eagle, Cockatiels, White-browed Woodswallows, Black-faced Cuckoo Shrikes and Apostlebirds, just to name a few.

During the week we travelled the 50 kms to Bourke to top up with groceries. Storm clouds built up while in town, and as we raced back to the property we drove straight through a dust storm. But just as we approached the homestead, the heavens opened and the rain poured down.

The welcome onset of rain signalled the possibility of finding some of the desert frogs that



Sudell's Frog (*Neobatrachus sudellae*) sits alongside an Eastern Beaked Gecko (*Rhynchodeura ormsbyi*).

Karen Russell



Birds abound in Gundabooka NP. Some examples are these parrots, the Australian Ringneck (left) and the Red-winged Parrot. Both inhabit inland areas.

Karen Russell

night. Well, we weren't disappointed! Along with a large number of Sudell's frogs (*Neobatrachus sudellae*), we also witnessed the emergence of the Crucifix Frogs (*Notaden bennetti*).

One of the group (Kelly) managed to photograph one of these as it was emerging from the mud. Other frogs spotted around the homestead included Peron's Tree Frogs (*Litoria peronii*) and Desert Tree frogs (*Litoria rubella*).

It is hard to imagine how the abundant wildlife out here copes with the hardships of drought but despite even these current dry conditions, nature has managed to put on a spectacular display of flannel flowers this spring in Gundabooka National Park. The call of the out-back will always bring our group back to this amazing area and we can only hope that our next trip will see some relief from this current, ongoing, insidious drought.



Two beautiful geckos we found were the Marbled Velvet Gecko (*Oedura marmorata*) at left, and the Eastern Beaked Gecko (right) (*Rhynchoedura ormsbyi*).

Karen Russell



One of our many photo stops on the way. **Karen Russell**

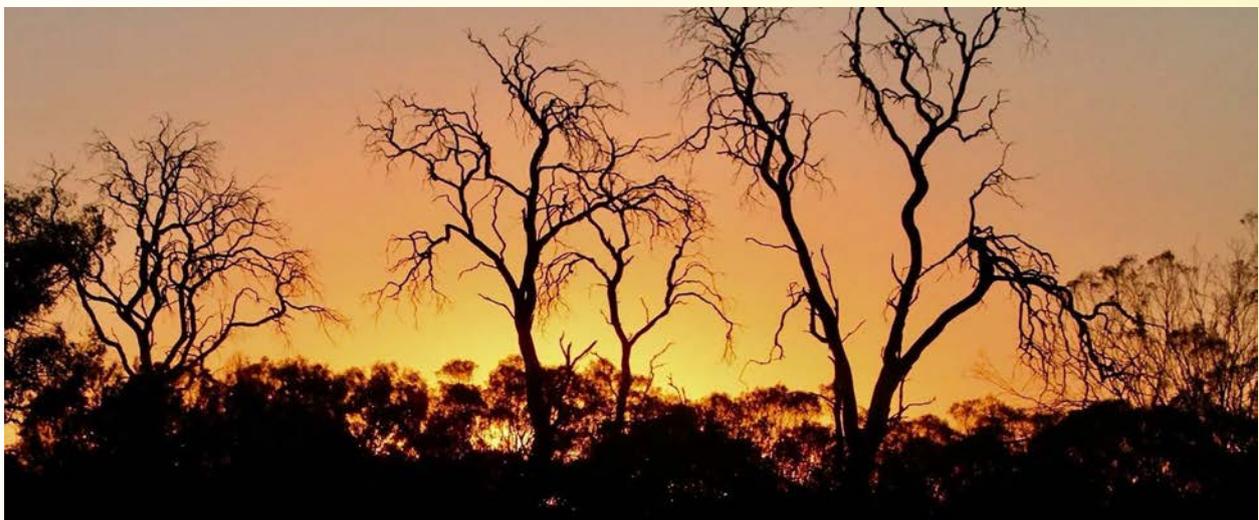


A huge Lace Monitor regards us from this tree. **Karen Russell**



A magical display of Flannel flowers carpets the ground. Taken in Spring, 2019.

Richard Bjork



The sun sets on our wonderful trip to Gundabooka.

Karen Russell

A classroom study of the development of Axolotls

Daniel Murphy



Fig. 1: Juvenile Axolotl in tank, showing abnormal backward-facing 4th digit on hand.

After a long hiatus since owning an axolotl, I was intrigued to own another one. It was at that time I was teaching year 1, and we were studying life cycles in the middle of June. After describing different animals and studying the life cycle of frogs, butterflies and silkworms, it came to my attention that most of these inner city students had never seen a tadpole or a frog in real life. I was determined to give these students some hands on experience to observe, take notes, draw and make predictions while watching frogs grow. However, the time of year was against me to locate young tadpoles. Through some careful research, I found out that winter was the breeding season for axolotls, another amphibian and an unusual animal for my students to observe.

Watching axolotls grow from egg to adult was a huge highlight for many of my students, as we carefully plunged into the adventure raising some 200 eggs. What I learnt during this year I will share with you now.

The Axolotl or Mexican Walking Fish is not a fish, but a neotenic salamander, originally found in high altitude closed lakes in Mexico. Due to the introduction of invasive fish, pollution, farming and development they are all but extinct in the wild. However, they have been bred successfully in captivity and sold in pet stores or by private breeders worldwide. The axolotl is unusual amongst amphibians as they reach adulthood without going through metamorphosis (neotenic), and can reproduce in their larval state. Unlike other amphibians, axolotls retain their gills to breathe, they can also absorb oxygen through their skin and have lungs which they use to gulp air if oxygen levels are too low in the water.

The decline of axolotls began when the Aztecs started to drain the lakes to create chinampas. Chinampas appear as floating land masses built up of reeds and soil. The chinampas and fertilizers used for farming started the destruction and pollution of the axolotl habitat. Later Asian Carp

and African *Talapia* were introduced to the lakes as a food source for people, both invasive species threatened axolotl food supplies and disrupted their breeding cycle by eating their eggs causing population destruction.

One feature of axolotls that interests scientists and hobbyists is their ability to regenerate. The axolotl does not heal by scarring, but by regeneration. Axolotls can regenerate their body from minor cuts, abrasions to the more extreme by regrowing limbs, tails, gills and even parts of the brain and heart. Axolotls can also accept transplants from other axolotls without rejection. An example of this is the firefly morph, in an embryonic state tails are grafted from one axolotl to another creating a firefly appearance, this is often more impressive with Green Fluorescent Protein (GFP) axolotls (see colour morphs later). Although they have regenerative abilities, the more times they lose a limb, the more likely it is not going to grow back correctly, often leaving axolotls with extra toes, fingers or even feet. Fig. 1 shows a juvenile axolotl with a backward-facing digit on hand, looking like a claw. Some people find these abnormalities desirable.

Axolotls are relatively easy to keep for someone who is dedicated to looking after them. Axolotls generally reach sexual maturity at about 12 months old. However, due to the strenuous nature of breeding for females, this is not encouraged until they are fully grown at 18–24 months old. Once genders are determined, males and females should be kept separate unless breeding is required. Breeding usually occurs in the cooler months of the year, however they can breed all year round given the right conditions. Female axolotls can lay up to 1500 eggs at a time. The female body puts so much energy into egg production that they can become malnourished.

If breeding is your intention, wait for the temperature to drop in the tank before adding the male, this will insure both male and female are ready. Have lots of plants in the tank for the female to lay her eggs on, plastic plants are better as they do not rot. The male will begin courting the female by nudging her and leading her around the tank. The male drops between 5 to 25 spermatophores around the tank and attempts to lead the female over them. The female will pick one up with her vent and internal fertilisation takes place instantly.

After a few hours to two days, the female will begin spawning, laying each egg individually. This takes place over a couple of days. She will lay eggs on



Fig. 2: Newly laid eggs rescued from the tank, each in its own jelly capsule. **Daniel Murphy**

plants and if these are not available, rocks, walls or on substrate. Once she has finished laying, it is best to remove the male and separate the eggs from the female. Personally, I take the eggs out of the female tank and set up a nursery tank. Pictured are newly laid eggs, each egg is in its own jelly like casing. If the eggs are fertile, they will start to elongate as the embryo develops and will hatch in about 12–17 days, depending on the temperature of your tank. Warmer water causes axolotls to hatch faster, but this can be at the detriment of their overall development. Axolotls that hatch too quickly often die within a day or two. Those that develop slowly are pretty hardy, but with the large amount of eggs



Fig. 3: Embryos close to hatching. **Daniel Murphy**



Fig. 4: Embryo just hatched.

Daniel Murphy



Fig. 6: Colour increases and arms emerge.

Daniel Murphy



Fig. 5: Embryos grow and develop eyes.

Daniel Murphy



Fig. 7: Adult albino Lucy and blue-gilled Lucy **Daniel Murphy**

laid, there are often genetic complications.

Within 24 hours following hatching, they will start to eat. Many people use different foods, I prefer to start with microworms. They are small enough for the axolotl larvae to eat and easy to keep. Microworms can be kept in a container with moistened oats and dry yeast. Long term feeding of microworms however is not recommended as axolotls can develop air bubbles in their stomach which causes them to float, in turn not being able to catch food and can lead to death.

The next step in their diet is baby brine shrimp or daphnia, both can be sourced from pet stores or online, but both have their trials in maintaining an ongoing culture. After brine shrimp I move my axolotls from black worms, an aquatic worm that lives in fresh water and is ideal for having a constant supply of food. All newly hatched axolotls only eat live food, it is not until they have developed all four legs that they can eat pellets. Some people choose to feed axolotls frozen bloodworms, however these are not nutritional and

should be considered junk food for the axolotls.

At this young stage all larvae can be kept together, and should be kept in cooler water with an almost 24-hour supply of food on offer. Daphnia and microworms are the best food for keeping in the tank with young axolotls as they can co-exist without harming the axolotls until they are eaten. Baby brine shrimp need to be hatched in salt water and usually die after a few hours in fresh water, which requires more frequent water changes.

Axolotl larvae will grow at the rate that they eat, so as they get bigger, you will need to separate different-sized juveniles to prevent them injuring each other when eating, or eating each other. As axolotls grow they develop their front legs first and then back legs (opposite to frogs). As the legs start growing the size of their food increases, and you will need to separate them into larger tubs with less occupants in each tub. It is by this stage that the colours should start to develop. In my experience they still develop their colour for another 8–12 months.



Fig. 8: Melanoid axolotl with white tail regenerated following a graft, and leucistic form with black tail grafted. **Daniel Murphy**

Once the hind legs are fully developed, the larvae are now miniature versions of the adults, so they should now be called juveniles, or sub-adults. Growth is steady at about 1cm per week, and juveniles are quite capable of eating small pieces of earthworms which is my main food source for adult axolotls.

One of the most interesting aspects of axolotls is their variety of colours or morphs. The axolotl comes in many types of morphs the most common type is the Wild Type, a combination of greens, browns, and blacks. They often have shiny gold

iridophore pigments. The next most common type is the Leucistic (Lucy) that have the white body, dark eyes and bright red gills. The Dirty Lucy has the same characteristics as a Lucy however has dark spots on its head and sometimes down its back as well. The White Albino is similar to the Lucy however has clear or red albino eyes. Both the Gold and Golden Albino axolotls have a yellow/gold appearance with red gills – the only difference is the colour of the eyes. Melanoid axolotls are similar to Wild Types but have an increased amount of dark pigment (melanophores), appearing solid black, and lack shiny pigments.



Fig. 10: Melanoid and Golden colour forms **Daniel Murphy**

Some more unusual morphs include GFP (Green Fluorescent Protein). GFP axolotls can be any morph, but they have genetically modified protein in their DNA that was introduced in a lab setting. The original purpose of this was for cancer regeneration research. The gene is a recessive gene and is passed on from generation to generation. GFP axolotls are illegal in Australia. Coppers are a less common morph, however they are most prevalent in Australian aquaria. The Copper is a variety of albino axolotl, and has a red-tinted eye. Even though their eye appears dark, they can be many different shades of copper, from light tan to almost dark brown.

Recent Events

Inspiring Women and Forgotten Frogs

Kathy Potter



Conference speakers

The inaugural Women Researching and Talking Herpetology conference: “Inspiring women and Forgotten Frogs”, was held on 28th September 2019 and was a great success. The venue was full, with standing room only, and the audience was enthusiastic and engaged, contributing some interesting questions and discussion points to the panel discussion on the future of herpetology. The speakers were truly inspiring women. Kathy Potter was MC and panel convener.

The organisers, Kathy Potter and Kimberly McReynolds, would like to thank both FATS and Hawkesbury Herpetological Society for their generous sponsorship. A big thanks also to the speakers for sharing their research, Stephen Mahony for use of his photographs, and everyone who helped make the day run so smoothly. Below is the list of talks:

1. Deborah Bower from University of New England: **Impacts of disturbances on reptiles and amphibians**
2. Jordann Crawford-Ash from UNSW and Australian Museum: **The prevalence and intensity of bd in three frog species**
3. Chantelle Derez from University of Queensland: **Human-wildlife conflict and translocation of snakes**
4. Kaya Klop-Toker from University of Newcastle: **Treatment of injured frogs**
5. Kimberly McReynolds from University of New England: **The pioneers of women in herpetology**
6. Claudia Santori from University of Sydney: **Ecology and conservation of the murray river turtles**
7. Lin Schwarzkopf from James Cook University: **Old and new problems to solve: amphibians as model systems**
8. Sarah Stock from University of Newcastle: **Population genetics and reproductive biology of *Litoria littlejohni***

9. Lou Streeting from University of New England: **Bell's turtle conservation strategies**
10. Birgit Szabo from Macquarie University: **Clever gidgee: gidgee skink behaviour**
11. Kate Umbers from Western Sydney University: **How vulnerable are reintroduced corroboree frogs to australia's alpine predators?**
12. Samantha Wallace from University of Newcastle: **The effects of agricultural intensification and swamp cropping on amphibians**

Watch out of next year's dates at <http://wrath.org.au/>

Frogs and Fish

Chad Beranek

PhD Candidate | School of Environmental and Life Sciences | University of Newcastle

Chad Beranek from the University of Newcastle and Gumnut Naturalist spoke at the Frog and Tadpole Study Group October 2019 meeting. He told the story of competition and evolution set in the aquatic world of frogs and fish. In this talk we learnt about some of the findings from Chad's PhD research. The study helped understand aspects of habitat use in many different frog species in Australia, enabling us to understand which frogs are compatible with which fish species and why. This then helps people better understand how to build the best frog friendly habitat and which Australian native (emphasis on native) fish make the most frog friendly tadpole companions in their garden pond. Visit Chad Beranek's Facebook page (and also Jayden Walsh, a passionate aspiring ecologist and wildlife photographer from Sydney, who has led field trips for FATS)at:

<https://www.facebook.com/gumnutnaturalist/>

<http://gumnutnaturalist.com/>



Field Trips

Please book your place on field trips. Due to strong demand, numbers are limited. Be sure to leave a contact number. Regardless of prevailing weather conditions, we will continue to schedule and advertise all monthly field-trips as planned. It is YOUR responsibility to re-confirm in the last few days, whether the field trip is proceeding or has been cancelled. Phone Robert Wall on 9681 5308.

7th December: 8-15pm Castlereagh Nature Reserve Leader: Peter Spradbrow

Meet at the Shell Service Station, Richmond Rd, Berkshire Park (opposite Windsor Downs Estate). It is between St Marys Rd and Llandilo Rd.

Tonight we will re-visit Cumberland Plain Woodland and look at the frogs of the shale country. These frogs have learned to endure quite different conditions to their cousins of the coastal sandstone. We will discuss these differences and also look at some of the threats that have led authorities to list the Cumberland Plain Woodland as an endangered ecological community. Because of the highly restricted occurrence of these woodlands, many of the frog species are rarely encountered in the Sydney region.

Peter has lived and studied the wildlife of the Cumberland Plain for most of his life. He is an accomplished herpetologist, and has become an authority on the reptile and frog fauna of this region. Tonight he will also discuss the changes that he has witnessed in the frog and reptile populations here.

1st December: Australian Reptile Park Annual Herpetological Groups BBQ; ph (02) 4340 1022
Email: admin@reptilepark.com.au Please contact the ARP to clarify if you need to bring proof of membership of any herp group (including FATS) Find ARP on Facebook and at www.reptilepark.com.au

18th January: 7.45pm Homebush Bay Leader: Josie Styles

Meet at Wentworth Common carpark. The carpark is in Marjorie Jackson Parkway, about 150m from the intersection with Bennelong Parkway.

Tonight, the star of the show is the Green and Golden Bell Frog. This frog captured the attention of the world during the Sydney Olympics. The Bell Frog is known for its almost constant movement between water bodies. We will look at some of the varied habitats around the Olympic Park precinct and try to make some sense of the very erratic movements this frog. We will also look at some of the other frog species of Homebush Bay, and will look at what influence, if any, they might have on the Bell Frog.

Josie, a biodiversity specialist, has acted as a consultant to numerous organisations. She provides advice on the environmental impacts of major roads and construction projects, and develops mitigation measures to lessen the impact of those projects. She is particularly well-acquainted with the Bell Frogs of Sydney Olympic Park as she spent many years with the Australian Museum monitoring the Bell Frog population here.

22nd February: 7.30pm West Head/Kuring-gai NP Leader: Cassie Thompson

Meet at the Duckholes Picnic Area, corner of McCarrs Creek Rd and West Head Rd, Terrey Hills. From earliest days, Sydney's northern suburbs fell victim to extensive ridge-top development. The high ridges were considered more desirable for housing. The fearful combination of housing, roads and storm-water drains reduced bushland and forever altered water-flows and introduced urban run-off. Species unique to the ridge-tops lost habitat. In addition, the frogs that relied on soaks for moisture, or dwelled in the streams below faced new struggles for survival. Tonight, we will look at some of the frog species that were once widespread across the ridge-tops of Sydney.

Cassie is an Environmental Officer with the Roads and Maritime Service. She specializes in biodiversity issues and has a responsibility to both recognize and manage the "flow-on" effects of proposed developments. Tonight, she will introduce us to some of the small populations that have survived at West Head.

We will consider the reasons other populations have succumbed to the extensive urban development of the North Shore.

NB: In the event of uncertain frogging conditions (e.g. prolonged/severe drought, hazardous and/or torrential rain, bushfires etc.), please phone 9681-5308. Remember: rain is generally ideal for frogging! Children must be accompanied by an adult. Bring enclosed shoes that can get wet (gumboots are preferable), torch, warm clothing and raincoat. Please be judicious with the use of insect repellent – frogs are very sensitive to chemicals. Please observe all directions that the leader may give. Children are welcome, however please remember that young children especially can become very excited and boisterous at their first frogging experience – parents are asked to help ensure that the leader is able to conduct the trip to everyone's satisfaction. All fieldtrips are strictly for members only – newcomers are however, welcome to take out membership before the commencement of the fieldtrip. All participants accept that there is some inherent risk associated with outdoor fieldtrips and by attending agree to; a release of all claims, a waiver of liability, and an assumption of risk.

FATS meets at 7pm, on the first Friday of every EVEN month at the **Education Centre, Bicentennial Park, Sydney Olympic Park**. An easy walk from Concord West railway station and straight down Victoria Ave. By car: enter from Australia Ave at the Bicentennial Park main entrance, turn off to the right and drive through the park. It's a one way road. Just follow it and turn right at the P10f parking sign. Or you can enter from Bennelong Road / Parkway. It is a short stretch of two-way road. Park in P10f car park, the last car park before the Bennelong Rd exit gate. Take a good torch in winter. It is a short walk from the car park to the Education Centre, Bicentennial Park. It is a short walk to the single story education centre and its tall tower. Both can be seen from the car park. Directions from your home: <http://www.sydneyolympicpark.com.au/maps/getting-to-the-park?type=venue&id=384059>



Dingoo in morning light at Smiths Lake

Andre Rank

THANK YOU to the committee members, FrogCall supporters, meeting speakers, Frogographic competition entrants, events participants & organisers, David, Kathy and the Potter family and Ryan Kershaw for a great year. The FrogCall articles, photos, media and webpage links, membership administration and envelope preparation are all greatly appreciated. Special thanks to the many newsletter contributors, Robert Wall, George Madani, Jilli Streit, Karen & Arthur White, Andrew Nelson, Michelle Toms, Josie Styles, Jodi Rowley, Steve Weir, Wendy & Phillip Grimm and Marion Anstis. Special thanks also to Marion Anstis who has produced our glossy colour collector's edition each December.

FATS MEETINGS: Commence at 7 pm, (arrive from 6.30 pm) and end about 10 pm at the Education Centre, Bicentennial Park, Sydney Olympic Park, Homebush Bay. Meetings are usually held on the **first Friday of every EVEN month** February, April (but not Good Friday), June, August, October and December. Call, check our web site or email us for further directions. We hold six informative, informal, topical, practical and free meetings each year. Visitors are welcome. We are actively involved in monitoring frog populations, field studies and trips, have displays at local events, produce the newsletter **FrogCall** and **FrogFacts** information sheets. FATS attend many community fairs and shows. Please contact Kathy Potter if you can assist as a frog explainer. We always need help, even for just an hour. No experience required. Encourage your frog friends to join or donate to FATS. Donations help with the costs of frog rescue, student grants, research, conservation and advocacy. All expressions of opinion and information in FrogCall are published on the basis that they are not to be regarded as an official opinion of the Frog and Tadpole Study Group Committee, unless expressly so stated.

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FATS ON FACEBOOK: FATS has over 2,700 Facebook members from almost every continent. Posts vary from husbandry, disease and frog identification enquiries, to photos and posts about pets, gardens, wild frogs, research, new discoveries, jokes and habitats from all over the world. The page includes dozens of information files. <https://www.facebook.com/groups/FATSNSW/>

RESCUED FROGS are seeking forever homes are at our meetings. Contact us if you wish to adopt a frog. Cash donation (\$30-\$50) required to cover care costs. Sorry we have no EFTPOS. FATS must sight your current amphibian licence. Licences can be obtained online from NSW NPWS, Office of Environment and Heritage: <http://www.environment.nsw.gov.au/wildlifelicences/GettingAnAmphibianKeepersLicence.htm>. You must join FATS before adopting a frog. This can be done on the meeting night. We recommend you get your frog checked annually by a vet.

NB: FATS now has **Student Memberships** available for \$20 annually, including electronic Pdf Frog Call issues, but no hard copy mail-outs. <https://www.fats.org.au/membership-form>

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