

Aquatic fauna and flora

The incredible platanna and its deadly legacy

Long since indispensable to science, the humble platanna is a remarkable creature, with an incredible instinct for survival.

Article by Dr Jo van As.

The South African clawed toad *Xenopus laevis* commonly referred to as the platanna occurs naturally in water bodies throughout much of southern and central Africa. It has also been introduced all over the world and is now established in natural habitats in large parts of the USA, the UK, most of western Europe, and is invading Chile at an alarming rate. Apart from these feral populations you are also likely to find colonies of these toads in laboratories in many university cities around the world.

The clawed toad is today, together with half a dozen other creatures, the standard laboratory research animal all over the world. From the turn of the twentieth century these toads were cultured in laboratories and after the Second World War became the dominant experimental animal in Developmental Biology and Biochemical studies. During the early thirties discoveries were made that would result in the South African clawed toad *X. laevis* becoming world famous.

Dr Lancelot Hogben a Cambridge-trained physiologist was, unlike many of his contemporaries, not a man of independent means. He actually had to have paying jobs to support him and his family. As a result, he often moved to better paying positions in different institutions in the UK, later to Canada and in 1927 to Cape Town, South Africa. This is where he came into contact with *X. laevis* and was so enthralled with the animal that he named his house in Cape Town after it.

In 1930, Hogben published a paper in which he, in principle, demonstrates that

X. laevis could be used as an indicator of the presence of gonadotrophins in the urine of pregnant women. He did not mention the possibility of using *X. laevis* in pregnancy testing.

Before he could pursue the matter further, it was again time for Hogben to move on, this time to London, and as a new chair of Social Biology at the London School of Economics. One of the colleagues at the University of Cape Town described Hogben as "arrogant, supercilious with a caustic personality". In addition to finding Hogben difficult and unpleasant, staff and students were incensed by his lack of concern for the animals on which he experimented. His unpopularity and abrasive personality may also have contributed to his frequent relocations.

In October 1933, two former Cape Town colleague, Shapiro and Zwarenstein presented a paper to the Royal Society of South Africa which announced that in the previous month they had successfully used *X. laevis* in 35 pregnancy tests. Their findings were published in *Nature* the next year. This sparked a long public feud between Hogben and his former co-workers as to the claim of the breakthrough.

It was never really satisfactorily resolved, but by 1939 the Hogben test, as it became generally known, was established as a rapid diagnosis for pregnancy. Despite the name attached to the test there is no doubt that HA Shapiro should have the credit for developing the test, so writes another colleague JWC Gunn in an article to the *British Medical Journal* in 1939.

The test required just one injection of urine from a woman suspecting that she was pregnant, into the dorsal lymph sac of a female *X. laevis*. If indeed she were pregnant, the urine will contain low levels of gonadotrophic hormone which will induce egg-laying by the *X. laevis* 8-12 h later. This meant that a woman suspecting she may be pregnant could provide a urine sample to pathologist and have the result the next day.

The Hogben tests remained the standard procedure for early pregnancy testing all over the world until the 1970s when it was replaced by immunological methods. It is interesting that this test never ever produced a false positive result. It did sometimes produce a false negative if the level of gonadotrophic hormone were too low at a very early stage of pregnancy. By the 1960s *X. laevis* was firmly established as an experimental animal in biological research and remains so today. Most if not every student of Biology had at some stage in his/her studies dissected a specimen of *Xenopus laevis*.

The platanna is a truly remarkable creature. It is an opportunistic omnivore feeding on almost anything available, taking live prey as well as scavenging on dead animals. Adult *X. laevis* do not feed directly on plankton but utilise plankton blooms in a bizarre way.

X. laevis tadpoles are filter feeders of plankton, which they convert to biomass. The adults then cannibalise their own tadpoles and in so doing also utilising seasonal plankton blooms.

These toads are also very resilient creatures, and are known to survive for extended periods without food. *Xenopus laevis* can live up to 20 years, but has a generation time of only eight months under ideal conditions, and has a very long breeding season, which extends from early spring to late summer making them very prolific breeders.

Although it spends its whole lifecycle in water, this toad can survive without water for long periods and move overland when its habitat dries up. This usually happens at night or in the early morning hours when the vegetation is moist. It can also survive in mud for months on end, in a process known as aestivation, where its metabolism slows down to a state of suspended animation. It is an air breather and needs to surface to gasp for air, but it also acquires oxygen through its skin directly from the water.

Females deposit thousands of sticky small eggs underwater which attach to plants. The tadpoles, when they hatch, are gregarious and remain in a large group. This behaviour confuses bird predators which do not identify the large moving mass as potential prey. When a tadpole strays away from the tadpole mass it becomes vulnerable for predators.

Xenopus laevis is the epitome of perfect adaptation, and it is no wonder that it was as successful in non-native environment as it is pre-adapted to survive in almost any freshwater habitat. This may be wonderful for the toads but bad news for the environment and ecology in its new non-native habitat. It often becomes invasive out competing local species resulting in a decline in the biodiversity.

An animal as successful as *X. laevis* and being repeatedly introduced into so many different countries is an environmental hazard. With even the best security measures you cannot contain *Xenopus laevis* in captivity. It can and will escape though the drainage system and in many other ways but, is most often distributed by people with misguided but never the less good intentions.

Its hardiness and ease to culture that made *X. laevis* the super successful laboratory animal also made it an ideal candidate for the pet trade. It is of no surprise that it could establish viable feral populations in so many parts of the world. Many of these populations the result of misguided ethical considerations, often also ignorance by releasing pet toads into the nearest pond or stream, after the owner lost interest, or flushed them down a toilet. They will disappear out of sight, but will most likely survive the ordeal.

From an evolutionary view, *X. laevis* presents a perfect example to illustrate adaptation and the concept of pre-adaptation. It celebrates its success as an international laboratory animal and to top it all *X. laevis* is a supreme host for a wide range of incredible unique parasites and symbionts.

Platannas have a rich assembly of symbionts, more so than most other frogs and toads. The reason for this phenomenon is that the platannas are different from most frogs and toads. All stages of their lifecycle are aquatic, whereas in most toads and frogs the adults are land dwellers.

X. laevis are therefore not only exposed to symbionts that evolving together with their own lineage over a period of almost 150 million years, but also to symbionts evolving together with the fish lineage dating even further back. In many respects the platannas way of life overlaps with that of fishes and it is inevitable that they will be exposed to the same symbionts. *X. laevis* symbionts from fish origin such as *Trichodina xenopodos* have evolved to become unique symbionts and specific to their *X. laevis* host.

The spectrum of *X. laevis* symbionts is truly remarkable. They include representatives of at least 30 genera from seven invertebrate groups inhabiting different parts of the body. This includes on the skin, under the skin, lateral line (sense organ on body), nostril, Eustachian Passage (the bony passage connecting the middle ear to the nasopharynx), eyelid, mouth, oesophagus, intestine, stomach, rectum, urinary bladder, in the blood and even

in the pericardium (sack enclosing the heart). These parasites and symbionts have been well studied due to the high profile of this popular laboratory animal. With all its extraordinary characteristics the platanna has a horrifying legacy. Although none of its parasites, which are all specific to their only host *X. laevis* have so far not been reported to be transferred to any other aquatic host throughout its worldwide distribution. That is except the deadly Chytridiomycota fungus generally known as chytrid-fungus. This fungus has little or no effect on its vector the platanna but is deadly to any other amphibian it comes into contact with. It has now been confirmed that the drastic decline and in some cases extinction of amphibians is the result, amongst others, of the chytrid-fungus. And the origin of the vector and the chytrid is from South Africa.



Louis Du Preez

An adult platanna, *Xenopus laevis*.



Louis Du Preez

The tadpole of the platanna.



Linda Basson

A micrograph of silver impregnated specimen of the adhesive disc, about 0.08 mm in diameter, of a ciliophoran urinary bladder parasite, *Trichodina xenopodos*.