

The Lungfishes from a Historical Perspective: How Humans See the Other

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Introduction

Three hundred and ninety million years ago during the Lochkovian period, the Earth was devoid of four-legged creatures. The land was colonised with primitive avascular plants and arthropods, and the Lochkovian seas were dominated by marine invertebrates and armoured fish. Within the freshwater basins of Gondwanaland lungfishes evolved, organisms that represent the transition between life in the water and atmospheric oxygen breathing life on land. Human narratives about lungfishes reveal multiple aspects and concerns with this intriguing animal and act as mirrors which present biases (both personal and social) in our attempt to understand ourselves and the Other.

When it comes to unravelling visual experience, especially of non-human animals, it is usually expected that scientific methodology holds the key because objectivity is a fundamental aspect of its approach. However, the perceptions of organisms, including humans, are constructed both through biological apparatuses and subjective experience and interpretation. This has previously been discussed in depth by Thomas Nagel, Jacques Derrida and Donna Haraway, among others, who all interrogate ideas about 'knowing' non-human Others. Thomas Nagel recognized the problems inherent in exploring the subjective perception of other organisms, and wrote that the 'subjective character of experience' (1974, 436) of an individual is exclusive to the organism, one must '*be* that organism' (1974,

436) in order to understand it, and the human mind is the limiting factor preventing full comprehension. Jacques Derrida reminded us that our (human) observation of the Other observing us is almost never from the vantage point that science and philosophy usually takes. For Derrida, ‘knowing’ the animal comes from engaging the animals as objects of their vision, and as beings that look back (2002). Like Derrida, Haraway invites us to see the animal seeing us, saying ‘we polish an animal mirror to look for ourselves’ (1991, 21). She believes the way forward is to address the gap between humans and non-human animals to better understand the world, and that attempting to perceive like the Other involves first tearing down pre-conceived notions about what it is to be human (Haraway 2008).

Jakob von Uexküll is of particular interest because he devised the *Umwelt* theory to investigate the ethological, inner worlds of non-human animals; one that overcame what he believed to be the misguided objectivity of modern science. The *Umwelt* theory argues that each individual constructs its own environment (*Umwelt*) that is dependent on the perceptions, actions and relationships relevant to the individual within the environment. The *Umwelt* is conceptualised by an imagined sphere: a soap bubble surrounding each organism that is continuously reshaped by the interpretation (semiosis) of meaningful signs (all sensory data received) that are relevant to the animal. As Brett Buchanan explains, ‘Uexküll contends that animals must be interpreted by virtue of their environments that they inhabit, and, insofar as it is possible, from the perspective of their behaviour in such environments’ (2008, 7). Uexküll predominantly relied on behavioural experiments to observe the *Umwelten* of non-human animals. For example, Uexküll’s studies on the reflexes of sea urchins showed that darkness is a perception sign relevant to the animal, and as shadow passes over the light sensitive skin of the urchin, the semiotic response is the movement of their quills (2010, 77). This embodied approach of unravelling the phenomenal worlds of the Other sought to combine individual subjectivity with scientific objectivity.

However, the subjectivity of an individual's *Umwelt* means that it is incompatible with science, and lacks scientific merit. Nevertheless, Uexküll's process of investigation still has important lessons to teach in ethology and biosemiotics.

Thus, the construction and outcomes of scientific research are always framed by their human *Umwelt* understandings of the world; as sociologist Bruno Latour reminds us, 'scientific activity is just one social arena in which knowledge is constructed' (1986, 31), and as Donna Haraway has expressed, 'biology is a discourse, not the living world itself' (1992, 299). Just as scientific research is one 'social arena' in which knowledge about lungfishes' visual perception can be attained, other discourses also offer new perspectives on how the *Umwelten* of lungfishes can be investigated and comprehended. It is important to note that the study of human narratives about lungfishes explored in this paper departs from the purely ethological study of the lungfishes' *Umwelten*, and is rather an interdisciplinary investigation about human cultural interpretations and appreciations of the lungfishes and their *Umwelten*. These human narratives add vital knowledge and perspectives for the quest of human understandings of the Other in the context of biases involving cultural sensitivities and history. These narratives reveal both new understandings on the lungfishes' and human *Umwelten* and the places where these *Umwelten* may meet and/or differ.

This paper delves into historical and contemporary stories concerning lungfishes. Indigenous stories are used to reveal alternative frames of knowledge, diverse attempts to understand and make meanings out of this curious animal, which lives in water but possesses lungs. Stories from nineteenth-century Europe illustrate how lungfishes, as 'transitional animals', contributed to the shift from a predominantly religious to a secularly based taxonomy and world view. These stories confirm that science is an important tool and methodology to make sense of the Other animal, but it is always a reflection of the society within which it

operates. Contemporary stories reveal other concerns of Western societies through the lungfishes, such as national pride and human obsession with celebrity. In addition, I will contribute my own personal narrative about a small group of Australian lungfishes that illustrates the intimate connection between ingrained assumptions and understandings about these animals. In general, the paper explores the rich human cultural archives of lungfish stories which reflect the human desire to make sense out of a transitional animal that, in turn, reveal our own (human) anthropocentric limitations in the quest for the non-human *Umwelt*.

Lungfishes in Indigenous Communities:

The Dala, The Mmamba, and The Amazonian Killer Lungfish

Before lungfishes captured international attention after their modern Western¹ discovery, their presence and unique position was well known to Indigenous communities. To the Gubbi Gubbi people of Queensland, Australia, the Australian lungfish (*Neoceratodus forsteri*), or Dala², are sacred animals. The Dreamtime story of Dala, woven by Gubbi Gubbi elder Dr. Eve Fesl, tells a story of a fish destined to be the ancestor to all vertebrates:

Many years ago, thousands of years ago, there were no animals on the Earth, and the Earth Mother and our ancestral spirits looked down and decided that they wanted to have animals on the Earth, which would be their children. So, they designated that Dala would, first of all, get a lung, then it could get vertebrae and be able to walk, and that would be the forefather and foremother, really, of all the animals in the world. The breeding place would be near the edges of the river, so that the animals could come out and so we have Dala, the lungfish which only has one lung. It's the only place in the world you could find it, and this place where we stand is one of the most viable breeding places (interview in Franklin 2007).

Although Fesl was not aware of the scientific importance of Australian lungfishes when growing up, she understood that the Gubbi Gubbi people were their sacred

¹ By Western, I refer mainly to the Judeo-Christian version of perceiving/explaining life.

² In the Gubbi Gubbi tongue.

custodians. She had been told about the cultural and ecological importance of Dala from a young age, and remembered a family meeting by the Mary River that involved lungfishes ‘swimming around ... in the water below’ (Franklin 2007). This highlighted the value of such an encounter because it was ‘our sacred fish’ (Franklin 2007), ‘we were taught not to hurt it, to protect its habitat, where it feeds and swims’ because Dala ‘are ancestor spirits’ (statelibraryqld 2009).

This intimate tie between the Gubbi Gubbi people and lungfishes is also linked to their relationship to the Mary River. Both Fesl’s mother and uncle were born on the banks of the Mary River in traditional style, where, ‘when giving birth, the mother has to have her sisters by her side to assist her’ (Eve Fesl, interview in Franklin 2007). In another anecdote Fesl speaks of her grandmother, and the stories told about Dala:

My grandmother wove shelter covers from bladey grass and used paperbark as a soft bed to lie on. At night the family would see the reflection of the stars in the water, and hear the ripple of the water and the occasional explosion of air as Dala, our sacred fish, chose to come to the surface to expel the breath from his lung. It was at these times, the children would be told the story of Dala. As they lay under the stars and beside the rainforest, with its night bird calls, the children listened to the story of the beginning of our culture (documented by JerryinBrisbane 2008).

The cultural importance of Dala, created by the close cultural relationships to the river landscape encompassing the Mary River, family and community, influenced Fesl’s understanding of Australian lungfishes. To Australian Aboriginal groups, oral narratives and the meanings they convey are ‘owned by the individual storytellers in accordance with their position within their social and spiritual universe’ (Klapproth 2004, 34) and are ‘items of exchange in a cultural arena’ (Muecke 1983, 88). In Fesl’s case, these narratives are intertwined with anthropomorphic attitudes towards Dala. Fesl often mentions that ‘Dala will come up beside the canoe and you can stroke Dala. That’s what a friendly creature it is’ (statelibraryqld 2009) and when greeting them in her native tongue, does not

forget to let them know that she is ‘part of the family’ (Franklin 2007). This does not necessarily suggest that Fesl is making Dala more human-like, but rather that non-human animals like lungfishes are important members in the human world. Gubbi Gubbi stories present an alternative position for the human living within the world. The human animal is integrated as part of the natural world and therefore must employ responsibility and respect to other animals.

The liminal ‘Otherness’ in the nature of Dala as a fish with a lung³ is not a ‘problem’ to cultural beliefs. Rather, this view of the world embraces the concept of fluidity in animals’ forms and shapes. The Gubbi Gubbi people were aware of Dala’s ability to breathe atmospheric oxygen air long before the Western scientific community, and unlike this community did not seek to disprove or condemn it as an ‘impossibility’ or ‘abnormality’. Rather, there was a place to accept and appreciate (even if not to fully understand) the Other.

Similarly, *Protopterus aethiopicus*, one of the African lungfish species, is of special value to one of the biggest clans of Buganda, the largest sub-national kingdom within Uganda. One of the first established clans is the Mmamba Gabunga, which translates to the native name for *P. aethiopicus*, also known as the marbled lungfish. Like *N. forsteri* to the Gubbi Gubbi, *P. aethiopicus* is a totem to the Mmamba people, a spiritual emblem to remind them of their ancestry and mythic past. In the Mmamba origin story, the clan’s founder Mabiru, had close ties with the rivers, and gained the king, Kabaka⁴ Kintu’s favour by offering his talents as an expert navigator and canoe maker (Buganda 2016). The Mmamba remain one of the largest and most influential clans of Buganda, and do not eat their namesake due to its symbolism of their clan. Like the story of Dala, the Mmamba understand the human as an integral part of the living environment.

³ The Australian lungfish, *N. forsteri*, is the only species that possesses just one lung, all other lungfish species possess a pair of lungs.

⁴ ‘King’ in the Mmamba language.

While both employ some taxonomical systems in regard to the world around them, the Indigenous populations of Australia and Africa allow for the fluidity of nature in the living world; liminality and difference in ‘Others’ are accepted (and sometimes celebrated). The Western view appears to be more rigid in terms of order within a fixed hierarchy. The Indigenous populations may also have appropriated the ‘Otherness’ of lungfishes to their own position within the newly colonized Western world – the Indigenous knowledge and taxonomy did not fit within the Western system and therefore became either monstrous or completely invalid. Thus, it may explain why the Western discovery of lungfishes during colonization resulted in many mythologies featuring them as ‘monsters’ due to their novel and ‘bizarre’ nature.

After the 1837 discovery of the South American lungfish by Johann Natterer, reports flooded in about a mythical beast, the *minhocao*⁵ of Brazil, and its possible ties to lungfishes. The tales of *minhocôes* stem from Goyaz, a state in central Brazil, where in the deep lakes of Padre Aranda and Feia, *minhocôes* torment the locals by dragging horses, mules and cattle into the water. Saint Hilaire, a scientific journalist visiting the area in the mid-nineteenth century, investigated these reports by residents near the lake and described the creature thus:

The word *minhocao*, is an augmentative of *minhoca*, which, in Portuguese, signifies *earth-worm*; and, indeed, they state that the monster in question absolutely resembles these worms, with this difference, that it has a visible mouth; they also add, that it is black, short, and of enormous size; that it does not rise to the surface of the water, but that it causes animals to disappear by seizing them by the belly (1847, 279).

Further investigation led Saint Hilaire to fishermen who said the *minhocao* ‘was a true fish, provided with fins’ (1847, 279). This search led him to Richard Owen’s paper on the newly discovered African species *Lepidosiren annectens*, and

⁵ Singular of *minhocôes*.

Natterer and Fitzinger's recent discovery of the South American *L. paradoxa*. To Saint Hilaire, both these animals fit the description given by the fishermen and Owen, and *L. paradoxa* shared the habitat of the *minhocao*, so he concluded: 'These characters agree extremely well with those which we must of necessity admit in the *minhocao*, since it seizes very powerfully upon large animals, and drags them away to devour them'. Finally, he continued with great confidence that 'it is, therefore, probable that the *minhocao* is an enormous species of *Lepidosiren*' (1847, 280). Saint Hilaire's story illustrates how the 'different' can become monstrous and result in exaggerated tales, in this case created by Western cultural biases surrounding the 'exotic' and the unknown of newly colonised land.

More recently, in the mid-twentieth century, the *buru*, an ancient animal of the Ziro valley of India was thought to be a lungfish. At the end of World War II, explorer Charles Stonor and anthropologist J. P. Mills travelled to the valley and heard the legend of the *buru*, a now extinct group of creatures that were a blight to the Apatani people of the Ziro valley (Izzard 2001). According to Apatani elders, the valley's marshes were populated by these creatures and when their people settled in the valley, livestock and residents were attacked by these large, reptilian-like water dwelling monsters. The Apatani people were so afraid of the *buru* that all marshes were drained of water, which eventually caused the extinction of *burus*, who either perished without water or burrowed deep into the underground springs of the valley. In 1948, Stonor accompanied news correspondent Ralph Izzard to the neighbouring Rilo valley, where locals insisted that *burus* still existed. After an extensive search, Izzard and Stonor failed to find evidence that *burus* were still at large (Izzard 2001).

Many cryptozoologists have tried to identify this mythical beast. The general contenders are reptiles, such as modern day dinosaurs, crocodiles or water-dwelling monitor lizards. However, cryptozoologist Karl Shuker believes that the *buru* was a now extinct species of lungfish – an Asian counterpart to the

species inhabiting Africa, Australia and South America. The lungfishes' aquatic lifestyle, behaviour, morphology and association with burrowing into the earth for long periods of time have convinced Shuker that the *buru* may have been a more primitive lungfish. More interestingly, a personal experience with an African species of lungfish may have cemented Shuker's beliefs:

One of the most popular exhibits of the ichthyological practicals during my days as a zoology student at university was a living specimen of an African lungfish *Protopterus*, which was sometimes placed on display in order that we could observe its behaviour. As it happened, for much of the time there was actually very little that we could observe, because it would spend most of the practical resting [*sic*] motionless at the bottom of its tank. Every so often, however, and usually when everyone's attention was diverted elsewhere, it would solemnly perform its *pièce de resistance*. All at once, without any prior warning, it would raise the front part of its large body upwards, until its head just touched the surface of the water. Sometimes it would then simply nudge the tip of its snout above the water, but if we were lucky (by now, everyone would have rushed up to its tank to watch its celebrated performance) it would actually raise its entire head, after which it would remain in this position for several minutes, ventilating (2012).

This experience, articulated in detail, left a lasting impression on Shuker. The locals of the Himalayan valley have recalled that the *buru* would occasionally raise its head out of the water to make a bellowing noise. Lungfishes, when respiring through their lungs do the same and Shuker commented that 'this scenario [of the *buru*'s bellowing] is one that has strong lungfish associations for me' (2012) even though others argue against the *buru* being a lungfish. Shuker's personal and cultural background, which included a personal encounter with the captive animal, left a lasting impression that may have influenced why he chose to believe the lungfish to be related to a mythical beast. Although separated by time and context, this story is not unlike that of Saint Hilaire and the *minhocao*. In both narratives, the 'monstrous' nature of the *buru* and *minhocao* led Saint Hilaire and Shuker, respectively, to associate them with lungfishes, a transitional animal – a fish that can breathe air – with no prior record of attacking locals and dragging

animals into the water. This indicates that the lungfish may have been suspect due to its inability to fit within a clear hierarchical taxonomy.

In addition, these stories also represent the clash between the Indigenous worldview and the Western colonialist one – the loved and respected animal became a dangerous beast: the human within and equal to the rest of the living world assumed dominion and control, and anything that did not fit within the order was deemed to be monstrous.

The Great Lungfish Controversy:

How the Discovery of a Fish Shook the West

In 1817, the young zoologist Johann Natterer was chosen to be part of one of the biggest scientific expeditions to leave Austrian soil. During the next twenty-two years, Natterer amassed a collection of over twelve thousand specimens from South America's natural landscape (Barreto and Machado 2001). One of these was an animal he found so peculiar that he brought it to reptile curator Leopold Fitzinger for a closer inspection in 1837. Natterer had found two specimens, one in a swamp on the left bank of the Amazon and another in a pond in the river Madeira (Natterer 1840). The animals were long, slender, and had mottled brown patterns upon their backs. The head and bodies were decidedly eel-like. Their fins were extremely delicate for their size and descended from the creatures' bodies like vestigial appendages when they relaxed, motionless, on the river bed (Bischoff 1840, 116-159). By all accounts this animal was a fish at first glance. However, when Fitzinger examined the creatures he discovered that they possessed what was undeniably a pair of lungs. In Fitzinger's day, amphibians fell under the umbrella of 'reptile', but even classified amphibians such as particular salamander species (or 'sirens') that teetered upon the line between fish and reptile with their feather-like gills, had limbs with digits that resembled the fingers and toes of terrestrial reptiles. This creature had no such appendages. So

bewildered was he by this unique animal, Fitzinger christened it *Lepidosiren paradoxa* – ‘lepido’ for the scales, ‘siren’ for the eel-like salamanders it resembled, ‘paradoxa’ for his confusion – and firmly placed the animal within the classification of reptile (fig. 1).

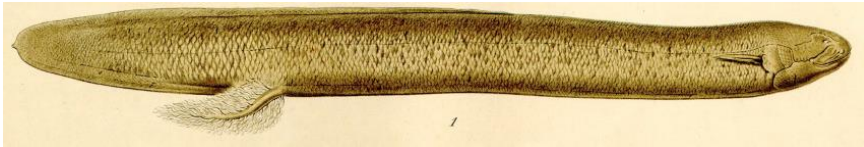


Fig. 1. Adult male *L. paradoxa* during breeding season (Kerr 1900, Plate 12).

Although Charles Darwin’s *On the Origin of Species* had not yet been published, evolution as an explanation for new natural history findings was already being discussed in the scientific community. His personal stance upon the matter is unknown, but Fitzinger’s confusion and uneasiness about *L. paradoxa* is reflected in the naming of the South American lungfish as a ‘paradox’. It is important to note that even in his recognition of an animal that did not fit into pre-existing taxonomy, he still did not venture to change the boundaries and acknowledge this animal as being transitional. Fitzinger and Natterer were prisoners of nineteenth-century Western scientific assumptions and the ideology of fixed species created by God’s will or plan. Nevertheless, the South American lungfish was the first in a number of species that threatened to change the minds of many because of its liminal nature.

Two years before Natterer’s and Fitzinger’s encounters with *L. paradoxa*, another similarly paradoxical animal was taken from the Gambian river, Senegambia, and presented to the Royal College of Surgeons by Thomas Weir. Richard Owen, whose legacy would include being the first director of the Natural History Museum in London, took it upon himself to classify this new organism. His attempt to place this animal within the known taxonomic groups created a rift between what Owen believed and what he observed. What lay before him was

evidently a fish, which he named *Lepidosiren annectens* in 1839⁶ (fig. 2). Fish-like on the outside, this fish, like *L. paradoxa* of the Amazon, had lungs as well, a fact Owen could not ignore. The presence of an organ that could take in air from the atmosphere placed this creature out of the Class of Fishes, the taxonomic group he initially proposed. A fish with lungs was not a fish according to scientific convention of the time.

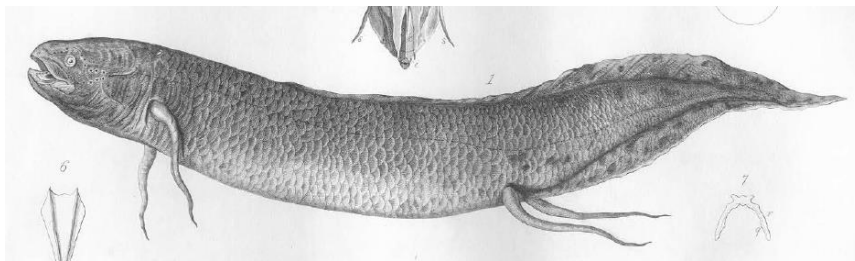


Fig. 2. *L. annectens* specimen examined by Owen (Owen 1840, tab. 23).

Owen famously opposed Charles Darwin. Owen did not believe in evolution by natural selection as Darwin explained it. To Owen, there was no such thing as transitional animals that could belong to a number of phylogenies. The existence of such animals would further prove Darwin's theory of gradual change through time; that groups were not fixed and evolution occurred through natural selection. Because of the lungfish, Owen (consciously or not) disregarded true scientific reporting in favour of his religious and cultural beliefs. As a result, Owen's observations and notes about the lungfish's nose were congruent with these beliefs. He wished to prove that the lungfish was not using its lung to breathe, as only then could this animal truly be a fish. 'The nostrils', Owen wrote, 'appear as two small perforations leading to blind sacs' (1840, 330). This was his proof: the nostrils did not lead to the lungs, rendering the lungs useless. Owen hypothesised that these organs were 'swim- or air-bladder(s)' (1840, 353); hence the lungfish

⁶ This later changed to *Protopterus annectens*.

was a fish after all. Owen's final statement after describing the various systems of animal in excruciating detail was as follows:

In the organ of smell we have, at least, a character which is absolute in reference to the distinction of Fishes from Reptiles. In every Fish it is a shut sac communicating only with the external surface; in every Reptile it is a canal with both an external and an internal opening.

According to this test, the *Lepidosiren* is a Fish: by its nose it is known not to be a Reptile: in other words, it may be said that the *Lepidosiren* is proved to be a Fish, not by its gills, not by its air-bladders, not by its spiral intestine, not by its unossified skeleton, not by its generative apparatus, nor its extremities, nor its skin, nor its eyes, not its ears, but simply by its nose (1840, 352).

However, Owen's conclusions were questioned when anatomists Bischoff and M'Donnel examined members of the same species and concluded that the blind sacs spoken of by Owen did in fact connect to the mouth, and thus this animal was a reptile. M'Donnel concluded that this group of fishes were indeed the transitional creatures Owen fought to deny. He wrote, 'I know of no animal more calculated leading [*sic*] to the adoption of the theory of Darwin than the *Lepidosiren*' (quoted in Zimmer 1998, 27).

These narratives surrounding the Western discovery of the transitional lungfishes illustrate how religious ideologies fed into the classification and naming conventions of nineteenth-century science. The Judeo-Christian teleological influences stemmed from Carl Linnaeus (1707-1778) and his widely accepted system of plant and animal classification by binomial nomenclature introduced in the eighteenth century. Linnaeus was a devout and orthodox Christian who believed early in his career as a botanist, physician and zoologist, that as Man, he had been ordered by God to study nature and its laws. He then created what we know as the Linnaean system of ordered taxa that includes genus and species. Linnaeus believed that every species was decided by God's original creation, writing 'every genus is natural, created as such at the beginning – hence not to be rashly split up or stuck together by whim or according to anyone's

theory' (translated in Ramsbottom 1938, 197). Although later in his career, Linnaeus adopted the theory of transformism⁷ and hybridization in speciation, he still did not alter his belief that the natural world consisted of systematically ordered works of Creation (see Gardiner 2001). Linnaeus's fixism⁸ was widely adopted by the scientific community despite his creationist views because, for the first time, clear and consistent rules for classification were possible. These biases are evident in Fitzinger's classification of *L. paradoxa* as an anomaly that could still firmly fit within a pre-existing taxonomic Class, and more explicitly in Owen's incorrect identification of *L. annectens*.⁹

On the other side of the world, Gerard Krefft, director of the Australian Museum, was trying to enjoy his dinner (Olsen 2010). This particular meal was made for him by Robert Forster, a squatter from Queensland who had acquired a position at the Australian Museum as a cook. Forster had been trying to alert Krefft to a new species of fish unknown to science for a number of years. Known as *baramoonda* or *baramoondi* by the local indigenous populace (fig. 3), the white colonisers of Queensland called it the Burnett, or Dawson salmon (for where it is found), but Krefft did not seem interested. Finally, Forster took it upon himself to place the fish precisely under the director's nose and cooked the delicacy for Krefft himself, hoping that his experience of the meat would reveal what made this fish so special. Krefft was shocked to find that the torso of this fish contained a darker organ that looked suspiciously like a single lung (Krefft 1870a). He immediately implored Forster to collect more specimens to examine. As an apology and thanks, Krefft christened the fish *Ceratodus forsteri*¹⁰ in 1870 after Forster (Krefft 1870b).

⁷ For more information on the concepts of transformism, see Corsi 2005.

⁸ Fixism is a non-religious theory that all species alive today are identical to those in the past, and these organisms emerged already adapted to the environment without undergoing changes (see Ereshefsky 2001).

⁹ It is interesting to note that lungfishes still remain in Owen's Class of choice, the Fishes.

¹⁰ The name eventually changed to *Neoceratodus forsteri*.

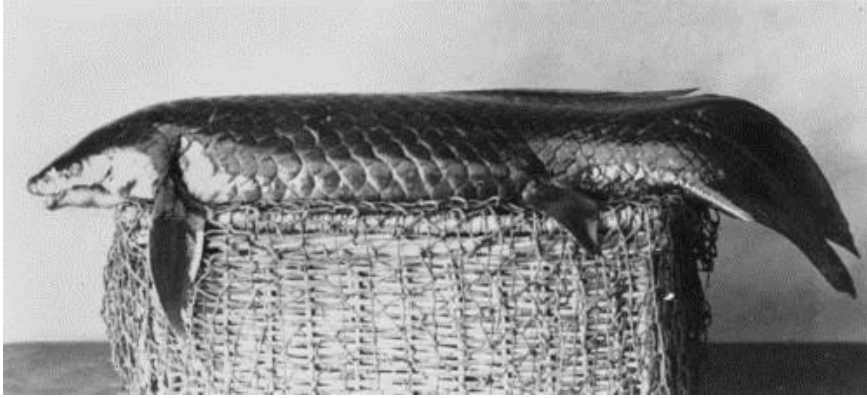


Fig. 3. Australian lungfish lying on a cane fishing basket ('Lungfish laying' 1895).



Fig. 4. Two fishermen with their Australian lungfish catch, Coomera River, Queensland ('Two fishermen' 1917).

The Australian discovery of its very own lungfish species was momentous for the young country, because it was one of the first of a new species to be announced in

an Australian broadsheet (Krefft 1870a). Krefft defied his conservative superiors, who had insisted he transport the specimens to England for a 'proper' assessment, and in doing so, claimed the discovery for himself and Australia. This was one of the first public instances where regional science from British colonies attempted to extract itself from European authority and assert its independence. The Australian lungfish in this case, became a symbol of national pride, positioning Australia as a legitimate and important nation within the world. Krefft described this lungfish as an amphibian, allied to the ones discovered in Gambia and the Amazon. Unlike Owen, Krefft was an advocate of Darwinism and commented that 'we cannot be surprised at fresh links connecting the ancient fauna of the present day. It is in Australia in particular where zoological questions of great importance will yet be solved' (1870a). Scholars like Albert Günther, who examined the Australian lungfish to verify Krefft's claims, were impressed and entertained the possibility that this lungfish was indeed a living representation of the transitional animals of which Darwin spoke; those that first crawled out from the sea to colonize the land (Günther 1871a; 1871b). James Hector, of the newly colonized New Zealand wrote:

The chief interest attaching to this (lung)fish arise [*sic*] from the circumstance that it is the living representative of an intermediate class of amphibious animals from which in early times sprung fishes on the one hand, and true reptiles on the other. Unlike any other fish, it has a lung, but also gills, thus possessing two distinct modes of purifying and oxygenating its blood (1874, 490).

In Krefft's case, the cultural influences on his understandings of *N. forsteri* predominantly lay in his acceptance of Darwinian ideologies and a political desire for Australia to be legitimised and independent from governing English authorities in matters of animal biology.

The origin of terrestrial vertebrates was a major and important focus in the history of scientific ideas. The discovery of lungfishes prompted excitement and

heated debate on the existence of evolution by natural selection. Academics like William Caldwell flocked to Australia to study transitional animals like the lungfish and platypus (Caldwell 1884). Another researcher, Richard Semon, spent two years in Australia attempting to collect and study the Australian lungfish's eggs (Semon 1901). Papers announcing this new species requested any new specimens to be sent to London and beseeched those in the lungfish's native land to resist temptation to hunt and eat this valuable species. P. L. Sclater placed such a note in *Nature*, writing:

In conclusion, I may express a hope that this short notice may have the effect of calling the attention of some of the colonists of Queensland to the wonderful nature of this relic of the Denovian epoch that is now swimming about beneath their noses, and that they will cease, for the present at least, to kill it and eat it as "salmon". Any specimens that may "rise to their fly" should be carefully kept out of the way of the cook, preserved in alcohol and transmitted to the British Museum or some other scientific institution. When the existence of *Ceratodus forsteri* becomes more widely known, there will be no lack of applicants for examples of it (1870, 170).

This time, the new Australian immigrants 'colonised' the unique animals of the continent to establish their hold on the land. Despite the lungfishes' 'discovery', long before, by the Indigenous population, it had to be 'rediscovered' to the Western world by Western colonists. While the Indigenous people respected lungfishes within its environment, the colonialists captured and shipped them to be displayed in other countries (dead or alive), removing the fish from its environment and transforming it into a human 'commodity'.

The Secret of Immortality:

Contemporary Cultural Influences of The Australian Lungfish

The Chicago World's Fair of 1933 was named 'A Century of Progress International Exposition' to celebrate the city's centennial. The fair's motto 'Science Finds, Industry Applies, Man Conforms' celebrated technological

innovation, but one particular exhibit had little to do with technology. Two Australian lungfishes, a male and a female, had arrived from Taronga Zoo, Sydney to be witnessed by Chicagoans for the first time at the Shedd Aquarium. Walter Chute, the aquarium's director, wanted rare, precious fish to attract visitors to the fair – a testament to the human fascination with the exotic. This act illustrated that despite all technological innovation and control, there were still things beyond our understanding, such as a fish with lungs. When Chute discovered the steamship collecting exotic fish from Hawaii was also heading to Australia, he promptly asked permission from Taronga Zoo for one of the continent's own 'mud-fish' to become a permanent resident of Shedd.



Fig. 5. Granddad arrives at the Shedd Aquarium, May 1933 (© Shedd Aquarium 2013).

Not long after, Shedd's railroad car, *The Mariposa*, collected thirty containers of exotic fishes from Los Angeles to Chicago, including the fish Chute had requested, one of which was christened Granddad (fig. 5) (Furnweger 2013). Although the age of this lungfish is unknown, since he came to Shedd as an adult

(fig. 6), the 80th anniversary of his captivity was celebrated on September 17th 2013, making him the oldest living animal in captivity since the death of George, the Galapagos tortoise.

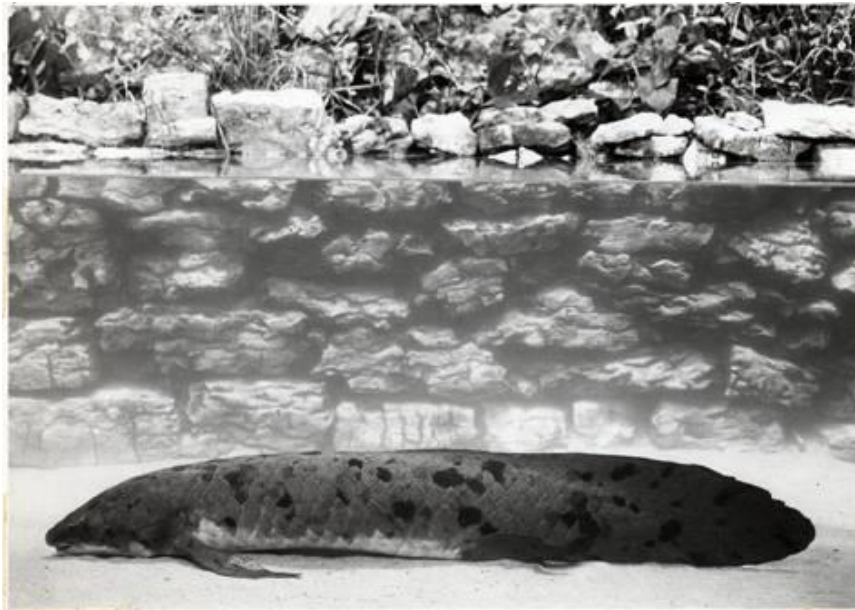


Fig. 6. Granddad in his aquarium (© Shedd Aquarium 2013).

Granddad has become a celebrity and national treasure in those eighty years. He has been praised as ‘an ambassador for the conservation of his 100 million year old species’ by the Consul-General of Australia, Hon. Roger Price (Australian Government 2013). His name also implies a familial fondness from the humans that care for him. The Shedd Facebook page was inundated with comments about Granddad, such as ‘Happy Birthday!!!’ by Kristy Wilsey; 20 September 2013, ‘He’s a true national treasure’ by Mark Konzerowsky, 8 November 2013; ‘I’m so glad to see Granddad’s still around’ by David M. Prus, 18 September 2013; and ‘He’s so cute! Many years to come’ by Emily Cassady-Oliviera, 18 September.



Fig. 7. Granddad's 80th birthday cake (© Shedd Aquarium/Brenna Hernandez 2013).

His birthday celebration earned him even more well-wishers and reached an estimated audience of over four million on the day. He made the news, blog posts were published and comedian Jimmy Fallon mentioned him in his opening monologue on September 21 2013. A press release outlined the event and esteemed guests attended the celebration, including the Consul-General of Australia. Granddad and the four female lungfishes in his tank were treated to an exclusive 'ice cake' of shrimp, smelt, herbivore gel squares, yellow squash, green peas, grated carrot and sweet potato moulded into a two-tiered castle (fig. 7). The cake was covered in seaweed frosting, garnished with shredded greens, carrots and raspberries and placed into the tank – an anthropomorphic gesture to symbolise the significance of the animal to humans, probably more than benefit the animal himself (fig. 8).

Bonnie McGrath illustrated the bond felt between human and lungfish when she wrote of Granddad in an article released about the lungfish's anniversary:

When I met Granddad in 1978, he was just about to celebrate his 45th anniversary as a South Loop resident. And I thought he was old then! He's been living in the South Loop a lot longer than I have. I've only been here 19 years. But we both came to live here during the month of September, although I arrived 61 years later (McGrath 2013).

Michelle Sattler of Shedd said, 'A lot of people have a great relationship with [Granddad], and a lot invested in him. So, we hope to see him for years to come here at the aquarium' (quoted in Hayes and Jordan 2013) and Ken Ramirez, Shedd's executive vice president of animal care, added 'Granddad makes people happy. Everybody knows him' (quoted in Coffey 2013).



Fig. 8. Granddad at his 80th anniversary celebration (© Shedd Aquarium/Brenna Hernandez 2013).

After his milestone as the oldest fish in captivity, Granddad enthusiasts are pondering if he holds the secret to immortality. As WGNtv.com reported, 'Scientists are hoping that by studying [Granddad] and other lungfishes, they may unlock the secrets to longevity, which can then be applied to us' (Hayes and Jordan 2013). Such stories reveal the nature of human desires in contemporary Western society, illustrating our obsession with celebrity: we care more for one

‘famous’ lungfish than for the environment that sustains the species. In addition, due to this celebrity, we create anthropocentric items of ritual celebration that have no meaning for the fish, like a birthday cake and Facebook comments, rather than, for example, choosing to release him back into the wild. This emphasises again the Western world view of dominion and control, which in its extreme places non-human animals in an otherness that allows them to be viewed as tools that can be utilised for human needs and desires.

Nine Blind Lungfishes: A Personal Narrative

The last four years of my life have concentrated on studying the visual perception of lungfishes. Although my research touches on several species, my encounters with lungfishes in the flesh have been with the Australian species, *N. forsteri* (fig. 9). Australian lungfishes possess a well-developed colour vision system despite living a predominantly nocturnal lifestyle in freshwater rivers among the macrophytes of Queensland. Australian lungfishes possess one rod photoreceptor type used in dim light, and four cone photoreceptor types that are optimally sensitive to the red, yellow, blue and ultra-violet ranges of the visual spectrum (Hart et al. 2008, 1-14). Part of my research into their visual perception involved testing the colour vision capabilities of *N. forsteri* to confirm if they utilize their potential for colour vision. Eyes such as these are more commonly found in diurnal birds or reptiles, not fish. Hence, this visual system does not seem to complement the behavioural patterns of lungfishes. In many respects, their visual system makes them as ‘paradoxical’ as their lungs, since their visual machinery, one that enables them to see many colours, seems to be at odds with the environment they have evolved in, which is dimmed and muddy.



Fig. 9. A juvenile Australian lungfish, *N. forsteri* (2010, reproduced with kind permission from S.E. Temple, S.P. Collin, N.S. Hart and R.G. Northcutt).

After an arduous wait at the beginning of this project, nine juvenile Australian lungfishes travelled from Queensland to my laboratory in Western Australia. I personally checked on their welfare every day, feeding them and making sure the water quality in their tanks was optimal. I noticed subtle differences between the personalities of each fish. It is difficult to remain indifferent when caring for an organism, human or otherwise, and I was no exception. I anthropomorphised my charges, grew fond of them, and looked forward to observing their responses to different coloured lights. After four months, a photographer visited our research group to document the various animals we were studying. I took advantage of this rare opportunity to photograph my own fish, preparing a freshly clean glass tank in a room bathed in light. I picked one fish and carefully brought it down to model for the camera. As the photographer was setting up the equipment, I noticed something peculiar. Amidst the bright lights and through a freshly cleaned glass, the head of this particular individual looked strange: the fish appeared to have no eyes. I was numb with shock. The shape and colour of the lungfishes' head were normal, but its eyes were not where they should have been (fig. 10). There was no scarring, no indication that eyes had been removed or deformed in some way; they seemed simply to have not developed at all.

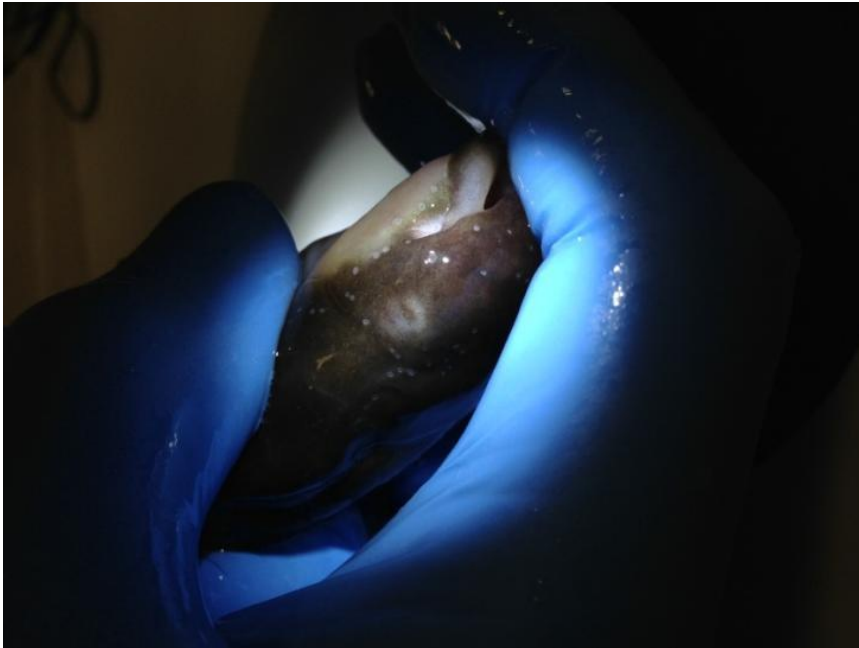


Fig. 10. Confirming the visual deformity in abnormal *Neoceratodus forsteri*: the eye is clearly absent (Appudurai 2013).

Distraught, I could not believe the irony of the situation: how was I to research the visual system of lungfishes if my specimens had no eyes? I tried over and over again to understand how I had failed to notice the deformity when the fish first arrived, or when I had fed them and cleaned their tanks every day of the next four months. The only explanation I have is that I, and the others involved in my project, took it for granted that a fish has eyes. My understanding of lungfishes, garnered from basic gathered knowledge and assumptions of what a fish ‘should be’ clouded my ability to see until I was faced with an undeniable ‘truth’. As for Owen, my expectation of a certain ‘truth’ inhibited an understanding possible only when these expectations were cast aside.

With my previous expectations dissolved, I could now investigate and observe these animals in a new light. The perception signs relevant to the ‘normal’ counterparts of their species were not relevant here, and studying their *Umwelten* needed a systematic approach that combined behavioural, electrophysiological

and anatomical analyses. Histologically, I confirmed the presence of subcutaneous eyes embedded approximately 4.2 mm beneath muscle and connective tissue. These eyes contained most of the structures typical of the eyes of normal Australian lungfishes, but did not contain a clear cornea (Appudurai 2016, 166-167). The electrophysiological study demonstrated that the retina of the fishes was still receptive to light, despite the eyes buried under skin since birth (Appudurai 2016, 158). However, when tested behaviourally, only one individual demonstrated statistically non-random behavioural responses to light and dark (a similar experiment to that of Uexküll and the sea urchin), suggesting that the tissue covering the eye of that fish still allowed enough ambient light through (Appudurai 2016, 148). As a representation of their species, or even their abnormality, each individual's *Umwelt* was different, as demonstrated by these experiments.

The Connection Between Human Cultural History and the Lungfish *Umwelt*

Here, I have outlined different stories about lungfishes and the humans who invented and told these stories. To the Indigenous peoples of parts of Australia and Africa, the liminal nature of lungfishes have made them celebrated creatures of the living world, and illustrated an understanding of the embeddedness of the human within the natural environment. In the mythical stories of the *minhocao* and the *buru* spread by colonialists of the New World, however, the differences of lungfishes as transitional animals made them monstrous. For Richard Owen in Victorian England, the fiercely embedded ideologies of a Linnaean creationist taxonomy combined with Owen's own personal biases resulted in an incorrect description of *L. annectens*, a transitional creature that did not fit the established natural order of nineteenth-century European science. In newly colonised Australia, the 'rediscovered' lungfish was a commodity that shored up the position of 'Australian' science. The narratives about Granddad illustrate a

contemporary self-absorption and obsession with celebrity and immortality that positions lungfishes as commodities and tools for human advancement. Finally, my own story reveals how reality is obfuscated by preconceived assumptions of what a lungfish 'should' be.

These inescapable biases are formed by ingrained beliefs, assumptions and ideologies which, often subconsciously, force a particular understanding of what lungfishes are and/or should be. John Berger discusses this intimate connection between what we 'see' and what we 'know', saying, 'The way we see things is affected by what we know or what we believe ... we never look at just one thing; we are always looking at the relation between things and ourselves' (2008, 9). Human cultural narratives of lungfishes show that these biases are prevalent across cultures and throughout history, and thereby influence how humans choose to understand liminal creatures like lungfishes because, '[narrative] accounts are not simply representations of the world; they are part of the world they describe' (Hammersley 2007, 107). The exploration of narratives about lungfishes does not directly give us insight into the *Umwelten* of lungfishes from an ethological perspective, but understanding *Umwelten* still requires human interpretation, which changes throughout history, among cultures, and individual experience. This ultimately impacts how humans 'know' and understand non-human animals. In addition, these narratives also illustrate that non-human animals are capable of eliciting an unsettling response in humans, especially when they threaten the security of fundamental religious ideologies and definitions of life. Just as scientific research is one 'social arena' in which knowledge about how a lungfish may visually perceive the world may be examined, cultural ideologies and assumptions influence how humans comprehend the visual experience of lungfishes and Other organisms. In many respects, all these narratives can reflect on different *Umwelten*, of human and non-human animals interacting together;

some may merge, some may burst – but all combine into a multifaceted perceptual world.

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