Observations of a neotenous population of Smooth Newts *Lissotriton vulgaris* from Norfolk

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The Smooth Newt *Lissotriton vulgaris* is a small newt species, growing to 11 cm, and found across most of Great Britain (Speybroeck *et al*., 2016). Smooth Newts can be found in a range of habitats from garden ponds, lakes and open spaces. They can sometimes be mistaken for the largest newt found in the British Isles, the Great Crested Newt *Triturus cristatus*, as the males of *L. vulgaris* also possess a crest. This crest tends to undulate more, with the crest of *T. cristatus* being more jagged in comparison. The tail of *L. vulgaris* is horizontally striped, with blue and orange stripes in males, which is one of the features that can be used to distinguish them from *T. cristatus*. Another good identifying feature is size, with *T. cristatus* growing to be almost twice as big, and being more robust than *L. vulgaris*.

In May 2019, a neotenous population of Smooth Newts was identified inhabiting a disused residential swimming pool in the village of Northwold, Norfolk (TL7549796974). Neoteny is the retention of juvenile characteristics into adulthood as a result of slowed development and is sometimes referred to as paedomorphosis. The pool (Fig. 1) had run into a state of disrepair due to the homeowner at the time suffering from health issues, at which point the pool became the ideal habitat for newts (and other pond life). Despite the fact that the macrophyte cover was limited, a number of invertebrate species also inhabited the pool such as pond skaters *Gerris* sp., backswimmers *Notonecta* sp., and Whirligig Beetles *Gyrinus substriatus*. As well as these aquatic macroinvertebrates, there were vast quantities of zooplankton such as *Daphnia* sp. and *Cyclops* sp. There was also a thick covering of algae at one end of the pond. This provided plentiful and varied food for all life stages of *L. vulgaris*, the only amphibian found in the pool, despite attempts to detect others.

The anatomy and colouration of the neotonous newts was a mix of juvenile and adult features, with some variation between individuals. Of the two caught to be observed, one was darker coloured, more like that of an adult female with a brown back and yellow-cream underside, and had shorter gills than the paler individual. The pale individual was the colour of a typical juvenile. The tails of both newts were taller and had larger fins than the aquatic breeding female, close to that of a juvenile in height and shape, and they both had spotting across the body. They were however smaller than the typical adult Smooth Newt, while being much larger

Figure 1. The disused swimming pool in the residential garden in Northwold, Norfolk where the population of neotenous Smooth Newts were discovered. *Steven Allain.*

Table 1. Count data of Smooth Newts from the summer of 2019, broken into the appropriate age classes.

Date	Adults	Neotenous adults	Metamorphs	Pre-metamorphic juveniles
24/07/2019	0	8	3	32
25/07/2019	0	4	2	19
01/08/2019	1	27	1	15
02/08/2019	1	24	5	17

than a juvenile or sub-adult. The head shape of the neotonous individuals was also shorter than a typical adult, more closely resembling that of juvenile in shape, with the upper jaw overlapping the lower jaw either slide of the snout as in juveniles.

Sadly, no observations coild be made in the breeding season (typically March to April), so it is unknown if the male neotenous newts developed breeding crests or other secondary sexual characteristics.

Surveys were later conducted in July and August between 21:50 and 22:30 hrs, to establish how many neotenous *L. vulgaris* were present in the pond (Table 1). Two techniques were used, torch-light surveys where a strong torch is used to illuminate the water column during the evening on the dates shown, and netting during the daytime.

In August 2019, two individuals were caught from the pond and taken into captivity for observation purposes (Fig. 2). These were placed in a temporary aquarium in water from the pond, approximately 15 cm deep with a number of water lice *Asellus aquaticus*, and bloodworm Chironomidae to feed on. They were later moved to a larger aquarium, with a depth of 25 cm. The newts were initially removed from the pool with the intention of returning them a few weeks later, once their neoteny had been fully documented. However, after a period of 10 days, it was noticed that the gills were shrinking and the body colouration was starting to darken to that of a post-metamorphic individual (Fig. 3). Within the space of three weeks, the newts had taken a near-adult form, and gills had all but disappeared. It was at this time that the *L. vulgaris* were transferred to a terrestrial set

Figure 2. One of the two individual neotenous Smooth Newts that were taken into captivity prior to their metamorphosis. Note the relatively large size, dark colouration and laterally flattened paddle-like tail. *Neil Phillips.*

Figure 3: The smaller of the two individual neotenous Smooth Newts that were taken into captivity prior to their release, after metamorphosis. *Neil Phillips.*

up, before being re-released into the local environment.

Neoteny (or paedomorphism) in newts has been extensively researched, as has the similar phenomenon of overwintering larvae (Denoël, 2017). It is important to distinguish between the two, with neoteny involving maturity, which is likely in this scenario given that a number of the newts observed in the pool were adult-sized. This made it easy to distinguish them from the younger individuals that had been born that spring. Overwintering involves individuals that fail to metamorphose before winter, and are therefore stuck in their natal pond, in their pre-metamorphic state. This can happen for a number of reasons, such as slow development due to low water temperatures. Overwintering can have some advantages, such as becoming a bigger metamorph come the spring, which helps decrease the risk of desiccation (if the pond does not dry out before then). Either strategy is risky in a temporary waterbody but they can be advantageous in permanent ones, such as the pool described within. In many species of newts or salamander, paedomorphosis is facultative, allowing for intraspecific niche partitioning, or as a response to the environment (Whiteman, 1994; Denoël *et al*., 2005). In some populations, there may also be a genetic component to paedomorphosis (Denoël *et al*., 2005), although this is unlikely in the case of the population described here.

While we cannot be certain that breeding of the neotenous individuals was taking place due to the timing of the observations; some neotenous males were seen with crests, which would indicate that these individuals may have bred that spring. Given the time of year, it would be unusual to find neotenous individuals in the pond throughout the entire summer period, if they were overwintering. Overwintering usually only occurs in a handful of individuals within a cohort at a time, not an entire population, which again indicates that the newts observed were in fact neotenous. Across a survey period of four months, the peak number of metamorphosed adult *L. vulgaris* in the pool was a single individual, whereas the peak count of neotenous adults was 37 across the same time period. This disparity is not observed in populations of newts that are not considered paedomorphic/neotenous. Juveniles and larvae were also seen on surveys, when the pool was searched by torchlight in the evening, while also surveying for the adults.

Neotenous populations of *L. vulgaris* occur elsewhere in Europe, with them being particularly abundant in the east of the species range (Cicek & Ayaz, 2011; Gvoždík *et al*., 2013). However, no populations of truly neotenous newts have been found within Great Britain, although the occasional neotenous individual does occur (Allain & Smith, 2017).

The reason for the sudden metamorphosis of the two captured *L. vulgaris* is unknown, but we have a few hypotheses. The water used to fill the aquarium the newts were later housed in, was from a water butt in South Essex, and this may have led to a significant change in water chemistry, compared to that of the pool where the newts were collected from. It may have been this change that triggered the metamorphosis. There is the possibility that there were elements (such as iodine) that were absent in the pool but present in the later aquarium water. Iodine is an essential element in amphibian

metamorphosis (Venturi, 2011), a lack of it has been linked to delayed metamorphosis in some species (Swingle, 1923). The later transfer of the newts to an aquarium will have also led to a change in water depth. The aquarium was only 25 cm deep whereas the pool ranged in 50 cm to 150 cm in depth. This is a significant reduction in depth which in nature would signal to the newts (and other inhabitants) that the aquatic habitat is evaporating or draining, and would be in danger drying out. In normal circumstances, many amphibians use this as one of the cues for metamorphosis (Denver, 1997). The same may have been the case here.

We cannot be certain why this neotenous population persisted although we have provided some potential explanations as to why when removed, two of the newts metamorphosed. The neoteny observed may be explained by one of the factors above, or a combination of them all. Unfortunately, we cannot go back and test any of these, as the helpful and cooperating homeowner has since sold the property.

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