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Rapid Communication

First records of the introduced sailfin catfish *Pterygoplichthys* in the United Kingdom

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Abstract

Sailfin catfish, *Pterygoplichthys*, is a genus of fish common in the ornamental aquarium trade. Originally from South America, they are now invasive in numerous locations around the globe. We report the first records of *Pterygoplichthys* in the United Kingdom. We captured one *Pterygoplichthys joselimaianus* and one *Pterygoplichthys pardalis* in an artificial side channel of the River Kelvin in Glasgow, Scotland on 30 August 2021 and 6 September 2021, respectively. Further monitoring and public education will be important as river temperatures increase to prevent establishment of these species, which have become invasive in other parts of the world.

Key words: Armored catfish, aquarium trade, ornamental, invasive, Loricariidae

Introduction

Sailfin catfish or "plecos" are the common names given to *Pterygoplichthys*, a genus of armoured catfishes in the Loricariidae family native to South America. Members of *Pterygoplichthys* are some of the most successful freshwater invaders, in part because of their popularity in the aquarium industry (Orfinger and Goodding 2018). As of 2018, different species of *Pterygoplichthys* have been found in 21 countries on five continents and have extended their range in South America (Orfinger and Goodding 2018). To date, however, there have been no published reports of wild-caught *Pterygoplichthys* in the United Kingdom.

Pterygoplichthys disjunctivus (Weber, 1991) and *Pterygoplichthys pardalis* (Castelnau, 1855) have been particularly successful in invading new habitats. This may be because of their popularity in the aquarium industry and not anything specific about their biology *per se* (Orfinger and Goodding 2018). Other less common species within the same family have also been found outside of their native range. For example, *Pterygoplichthys joselimaianus* (Weber, 1991) is originally endemic to the Tocantins River basin in Brazil but has been found in the reservoirs of Singapore (Ng and Tan 2010). Although

not formally established in Singapore, as only large adults have been caught, the successful breeding of closely related species in the same reservoirs has led researchers to speculate that it is likely established or at least capable of establishing there (Ng and Tan 2010). Importantly, removing *Pterygoplichthys* once it has established in an area is challenging and eradication is likely only feasible soon after initial introduction (Hill and Sowards 2015). Here, we report the first known occurrence of two species of *Pterygoplichthys* in the River Kelvin in Scotland.

Materials and methods

Two individuals of *Pterygoplichthys* were collected in an artificial freshwater side channel of the River Kelvin in Glasgow, Scotland (55.878946; –4.284794). The River Kelvin is a tributary of the River Clyde. Fish were collected in a portion of the river that runs through a city park (Kelvingrove Park) that is widely used by the public (Figure 1). The side-channel that the fish were found in has a gravel bottom with minimal instream vegetation. Directly in front of the inflow, it has concrete walls and a sloped floor, with additional sediment that has accumulated to form a silt substrate bottom. The maximum depth of this initial section is around 1 meter. The length of this section is approximately 3 meters, at which point there is an abrupt transition, formed by a wall approximately 50 cm height, into a natural substrate with a depth of around 10 cm for the remainder of the length of the side-channel.

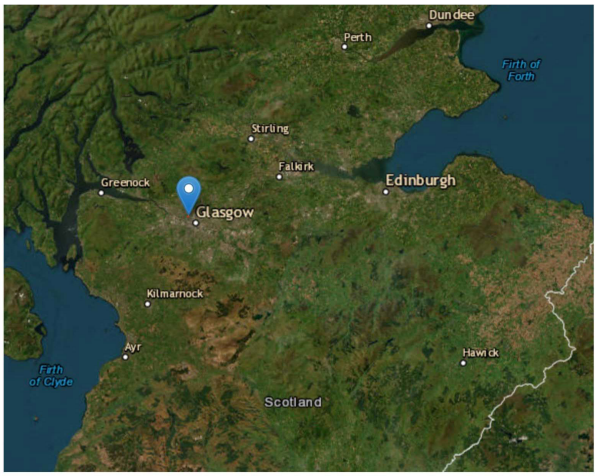
One *Pterygoplichthys* was collected incidentally via dip net from the initial, deeper section of the side channel on 30 August 2021. It was photographed, measured and transported to a laboratory aquarium at the University of Glasgow. Temperature of the water where the fish was captured was recorded at this time. The other individual was collected via electrofishing on 6 September 2021 in the shallower section of the side channel, after researchers were contacted by a member of the public regarding a possible sighting of an additional individual. This fish died following transport to the lab and was photographed and dissected to determine sex. Both individuals were identified from photographs by AGB.

On 8 September 2021, a third individual was reported in the shallow section of the side channel by the same member of the public that initially reported the sighting of the second individual. While the third individual was never conclusively identified, on 20 September 2021 skeletal remains where located that could have come from a *Pterygoplocthys*. Although there was no additional sampling specifically for *Pterygoplichthys*, the River Kelvin is periodically sampled and there have been no further sightings.

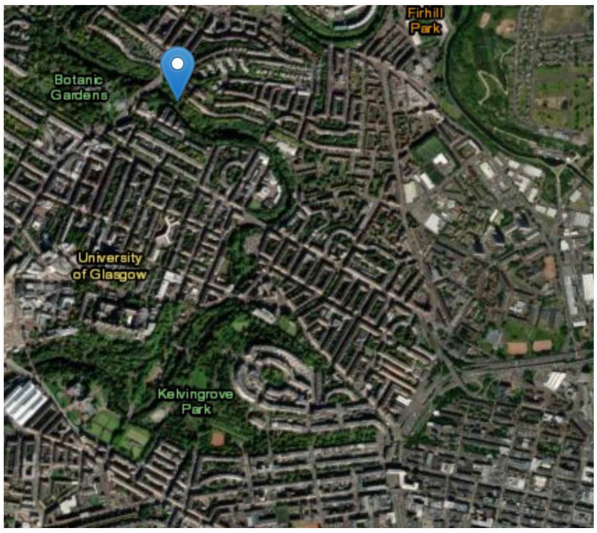
Results

We caught two *Pterygoplichthys* catfish in the River Kelvin, Glasgow, Scotland, one week apart, on 30 August 2021 and 6 September 2021. The first individual was identified as *Pterygoplichthys joselimaianus* (Figure 2)

A.



B.



C.

Figure 1. Location of collection. A. Wide and B. detailed maps of where *Pterygoplichthys* were collected (Blue marker) along the River Kelvin in the northwest of Glasgow, Scotland (Maps from USGS). C. Photograph of side channel where specimens were found. The side channel gets deeper and connects to the mainstem of the River Kelvin through the cement wall on the right side of the picture (blue arrow).

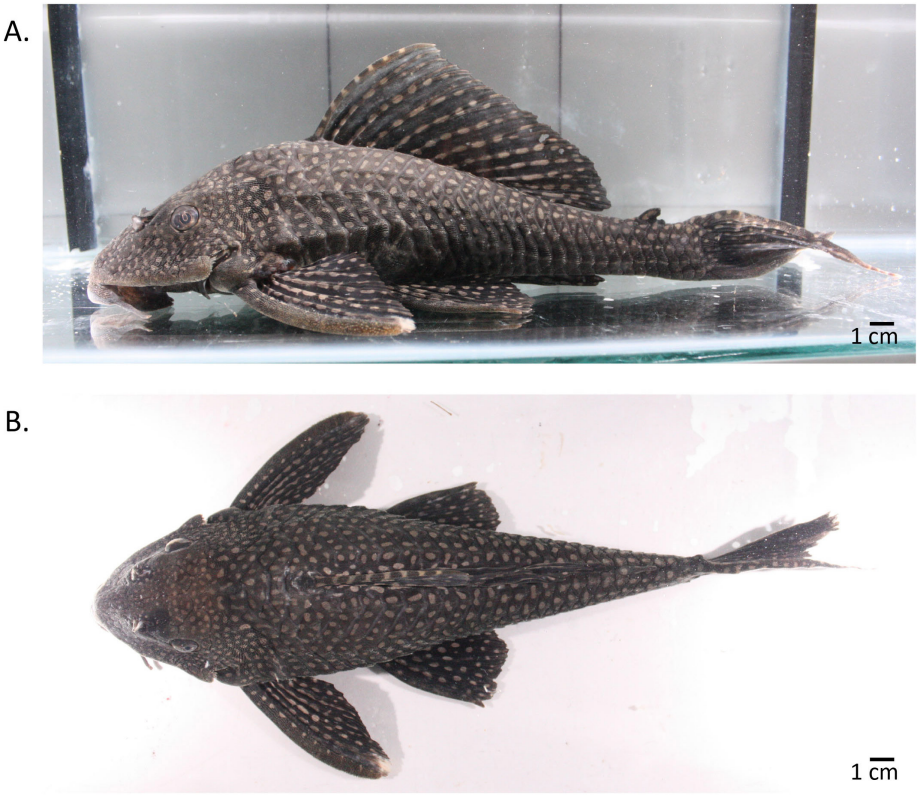


Figure 2. A. Lateral and B. dorsal photographs of *Pterygoplichthys joselimaianus* collected in the River Kelvin on 30 August 2021. Photographs by Shaun Killen.

It was 22.3 cm (standard length), 30 cm (total length) and 263 grams. The second individual was identified as *Pterygoplichthys pardalis* (Figure 3). It was 21.5 cm (standard length), 28.5 cm (total length), and 242 grams. Following dissection, the second individual was identified as female by the presence of eggs (Figure 4).

Pterygoplichthys is often confused with *Hypostomus* but was distinguished by the number of dorsal fin rays with two unbranched rays followed by 10 to 14 branched rays in *Pterygoplichthys* (Weber 1992) and two unbranched rays followed by seven branched rays in in *Hypostomus*. Both individuals collected here had numbers of branched dorsal fin rays consistent with *Pterygoplichthys* (*P. joselimaianus*: 12, *P. pardalis*: 13). The *P. pardalis* was identified by having black spots on the body, generally coalesced spots on the trunk and uncoalesced spots on the abdomen, and a supraoccipital on the same plane as the plates of the nuchal region, not forming an elevated crest. *Pterygoplichthys joselimaianus* was identified by having uncoalesced white spots on the trunk and abdomen, and a supraoccipital on the same plane as plates of the nuchal region, not forming elevated crest (Armbruster and Page 1996).

Discussion

Here we report the collection of two *Pterygoplichthys* catfishes in the River Kelvin, Glasgow, Scotland, the first known records in the United Kingdom. Although they have never been recorded in the United Kingdom, *Pterygoplichthys*

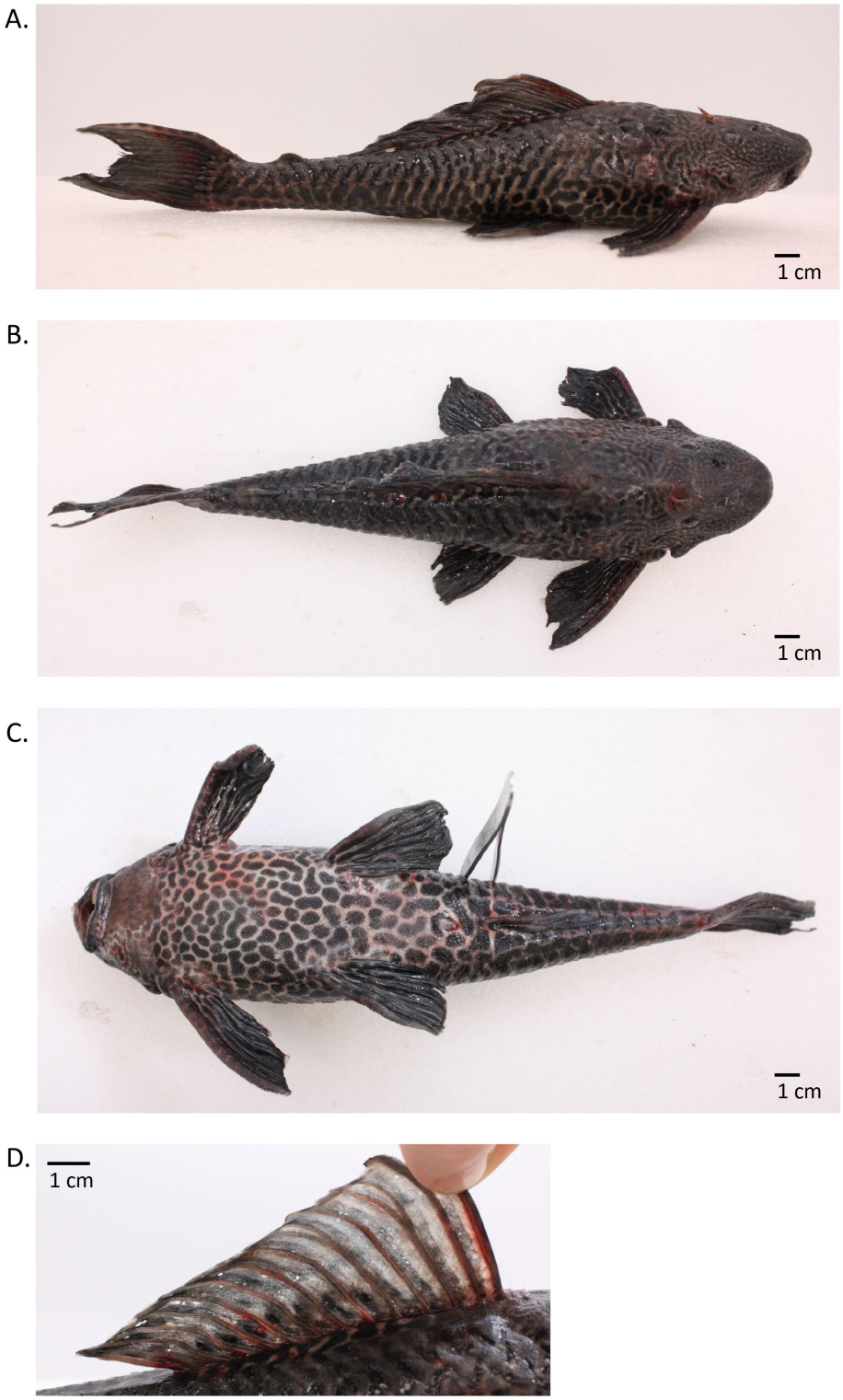


Figure 3. A. Lateral, B. dorsal and C. ventral photographs (taken after death) of *Pterygoplichthys pardalis* collected in the River Kelvin on 6 September 2021. D. Detail photograph of extended dorsal fin. Photographs by Amelia Munson.

are successful invaders in other countries, with official reports in 21 countries on five continents (Orfinger and Goodding 2018). Several traits have repeatedly been found to predict which fish species are likely to become successful invaders (Marchetti et al. 2004; Ruesink 2005; García-Berthou 2007). *Pterygoplichthys* exhibit many of these traits, including rapid

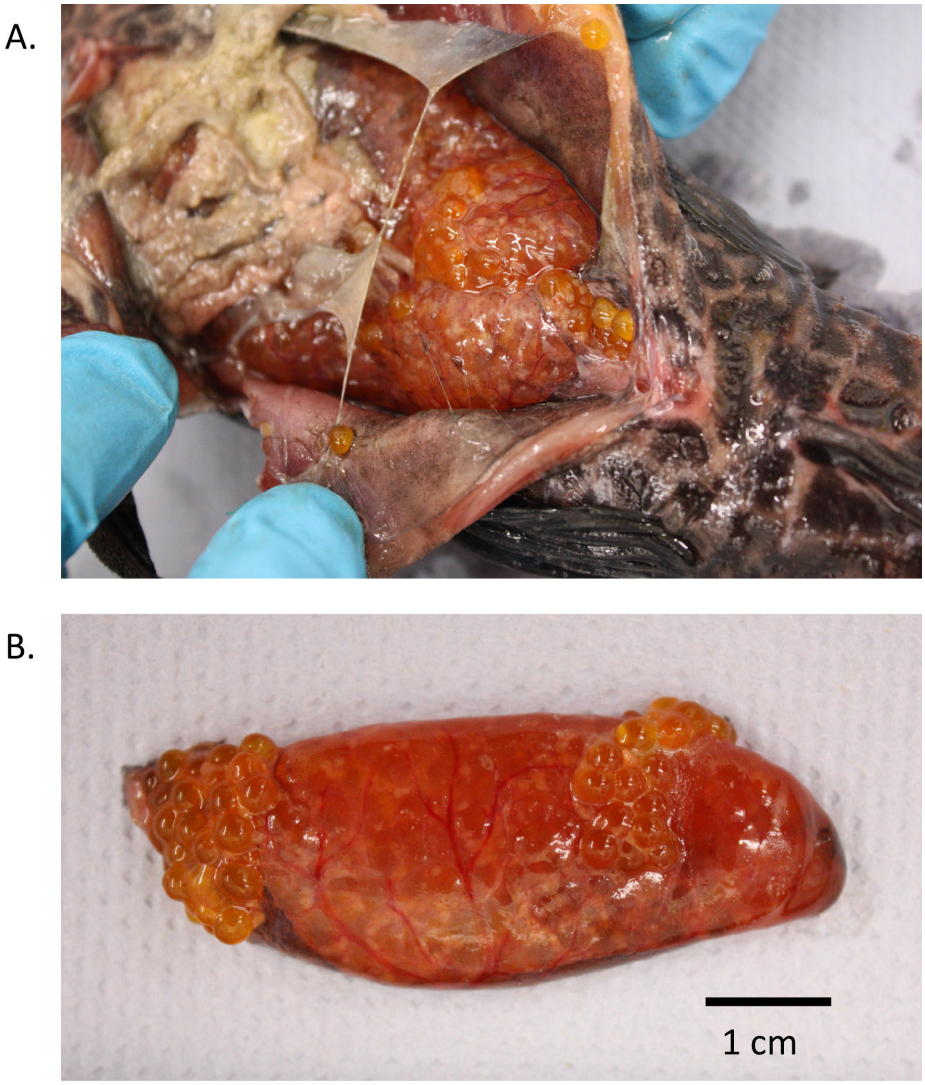


Figure 4. A. Ventral dissection of *Pterygoplichthys pardalis*. B. Dissected out ovary with eggs. Photographs by Shaun Killen.

growth (Gibbs et al. 2013), and protection against a broad range of predators in the form of hard dermal plates and rigid spines (Ebenstein et al. 2015). They are also relatively long-lived (Gibbs et al. 2013). The high potential for invasiveness in *Pterygoplichthys* makes the discovery of these fish in Scotland concerning.

Pterygoplichthys also exhibit parental care, nest and have large eggs (Orfinger and Goodding 2018; Araujo and Langeani 2020), traits associated with increased success of establishment. In part of their introduced range in Florida, *P. disjunctivus* were found to be multiple spawners and over the course of a three-year study, females became capable of spawning at a smaller size and a larger proportion of the population spawned each year (Gibbs et al. 2013). Indeed, one of the individuals that we found, was carrying eggs. *Pterygoplichthys* can hybridize with others in the same genus in waters where they have been introduced (Bijukumar et al. 2015; Orfinger and Goodding 2018), which can facilitate their establishment even with low initial numbers. So, although two different species were found here, this

would not exclude the possibility of reproduction and future establishment (Orfinger and Goodding 2018; Lardizabal et al. 2020), however there is currently no evidence of establishment in Scotland.

Perhaps most importantly, because of their popularity in the aquarium trade, *Pterygoplichthys* can have high propagule pressure where they are frequently released into local waterways when they become too large or otherwise unwanted by home aquarists. The sudden appearance of these individuals in an easily accessible portion of the river, along with the absence of any nearby populations, leads us to believe that these individuals were recently released from a domestic aquarium. Deliberate release is a common issue, particularly in urban rivers. Due to the species' rapid growth, which is beneficial for the fish once they are introduced into a new system (Gibbs et al. 2013), they are challenging for many hobby aquarists. *Pterygoplichthys* are purchased as juveniles and then rapidly outgrow tank set ups, prompting owners to release them into local waterways.

Successful invasion of *Pterygoplichthys* into an area can have important economic and ecological costs. *Pterygoplichthys* construct burrows in the banks of the rivers and streams which the males use to guard developing eggs (Hoover et al. 2004). While these burrows help *Pterygoplichthys* to persist during drought and cold weather, the excavation of the tunnels can lead to siltation and erosion problems (Nico et al. 2009; Nico 2016). Dense aggregations of *Pterygoplichthys* have also been shown to create biogeochemical hotspots of nitrogen and phosphorus which have the potential to alter overall nutrient dynamics (Capps and Flecker 2013). In addition to these abiotic alterations, non-native *Pterygoplichthys* can also alter biotic interactions. They can outcompete native herbivorous species for food and, as bottom feeders, may incidentally ingest or disturb the eggs of other fish species (Hoover et al. 2004). This is of particular concern in rivers like the Kelvin, where habitat restoration is actively underway to create salmon nurseries. Additionally, these large sedentary fish can pose threats to fish-eating birds, as erection of their spines can lead them to become lodged in the throats of birds that attempt to swallow them (Bunkley-Williams et al. 1994). They also may be potential vectors for the introduction of novel parasites (Nitta and Nagasawa 2013; Rodríguez-Santiago et al. 2016). In an overall assessment of their impacts, they have been scored as having low to moderate effects on socioeconomic and environmental factors, although the assessors acknowledged that these threats are poorly studied (Orfinger and Goodding 2018).

Media coverage about the potential introduction of these *Pterygoplichthys* in the UK focused on the welfare of the released fish in water that was presumed to be colder than their native range, as opposed to the ecological damage that they could cause. Notably, however, *Pterygoplichthys* have broad physiological tolerances, so may be able to establish in the River Kelvin. In the Grijalva-Usumacinta River delta in Mexico, this genus is expanding from upstream freshwater sites to downstream estuarine habitats; with

individuals being able to survive exposures to 10 ppt salinity with little mortality over a 10-day period (Capps et al. 2011). *Pterygoplichthys* are also tolerant of polluted waters (Chavez et al. 2006) and have modified digestive tracts which allow them to breathe air (Armbruster 1998). This can help them to survive in hypoxic conditions (Gibbs and Groff 2014) and they are able to spend several hours outside of the water without serious harm (Bunkley-Williams et al. 1994; Hoover et al. 2004). Temperature tolerance is a particularly important factor determining species' ranges generally (Payne et al. 2016) and of invasive species' specifically (Budy et al. 2013). Originally from South America, *Pterygoplichthys* species are adapted to warmer temperatures than those typical in the waterways of the UK. For example, the water was 14.5 °C where these individuals were collected. While one fish was in poor condition, the other fish was healthy and, after transport to the laboratory, was kept at 14.5 °C for 24 hours before gradually being acclimated to 25 °C. While colder than their native range, these temperatures may not be prohibitive of survival or reproduction. In parts of Texas where this genus has successfully invaded, water temperatures reach 6 °C in the winter (Nico 2016) which is similar to minimum temperatures in the River Kelvin during the winter. While *Pterygoplichthys* may still be temperature-limited during the winter in Glasgow, if water temperatures continue to increase as is predicted by climate models (Trivedi et al. 2007; Undorf et al. 2020), that may not be the case in the future. Not only could rising temperatures allow *Pterygoplichthys* to establish in areas from which they were previously excluded, but it could make their presence particularly damaging to native species already struggling to cope with increasing temperatures.

Once established in an ecosystem, *Pterygoplichthys* species are challenging to remove (Hill and Sowards 2015), however there are several thresholds that species must overcome to successfully colonize an area (Chapple et al. 2012). Preventing introduction is the most effective measure to avoid successful invasions. *Pterygoplichthys* are typically introduced from pet owners and hobbyists, so the most important method for prevention is education of the public about the potential dangers associated with releasing nonnative fish into waterways. Local pet shops are particularly important areas for disseminating information as they are an effective place to reach the intended audience. Continued monitoring and removal of any nonnative species prior to establishment, can also reduce the impacts of introductions.

Author's contribution

AM and SK collected the *Pterygoplichthys joselimaianus*. DM, MW and WY collected the *Pterygoplichthys pardalis*. AGB and DC assisted with species identification. AM wrote the original draft and all authors contributed to manuscript revision, read and approved the final submitted version.

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Ethics and permits

Animals were housed at the University of Glasgow under project license PB948DAA0.

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