The rare and threatened Western Dwarf Galaxias (mud minnow) near Ellen Brook, southwestern Australia

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The Western Dwarf Galaxias *Galaxiella munda* is a native freshwater fish found only in southwestern Australia between the Vasse and Angove River systems, and in two outlying locations over 300 km farther north near Gingin. An additional two specimens collected from near Ellen Brook in 1973 are held by the Western Australian Museum; however, this record lacks detailed spatial resolution and has rarely been acknowledged in the literature. If from an extant population this would represent an important local range extension of this threatened species. A lack of available data on the freshwater fauna from this area means that further surveys are warranted to assess if the two specimens represent an overlooked extant outlier population. If confirmed, the presence of the species would have considerable implications for its conservation and the protection of local streams and wetlands.

Keywords: *Galaxiella munda*, freshwater fish, threatened fauna, outlier population

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INTRODUCTION

The Western Dwarf Galaxias *Galaxiella munda* (commonly referred to as 'mud minnow'; (Fig. 1) is a diminutive member of the Galaxiidae family and one of six endemic species of freshwater fish from the Gingin–Bullsbrook region, 50 km north of Perth (Morgan *et al*. 1998; Smith *et al*. 2002; McLure & Horwitz 2009; Beatty *et al.* 2010; Hourston *et al*. 2014). Within this region urban development is relatively scant, thus local waterbodies are better suited to maintaining populations of native fishes compared to most other parts of the Swan Coastal Plain. Much of the region is covered by pristine banksia woodland, though there are also sizeable expanses of cleared agricultural lots. The wetlands in this area consist of seasonal damplands, lakes, swamps and brooks (Beatty *et al.* 2010). Most waterways are subject to seasonal desiccation although a few that receive groundwater discharge are perennial (Smith *et al*. 2002; Beatty *et al.* 2010; Hourston *et al.* 2014).

The Gingin–Bullsbrook region hosts outlying populations of two freshwater fish species of conservation significance: *G. munda* is listed as Vulnerable under State legislation (Biodiversity Conservation Act 2016 Western Australia) and the International Union for Conservation of Nature (IUCN; Beatty & Morgan 2019), whereas the Black-stripe minnow *Galaxiella nigrostriata* is listed as Endangered under both State and Federal legislation (Environmental Protection and Biodiversity Conservation Act 1999), and the IUCN (Morgan & Beatty 2019a). In addition, the rare Balston's Pygmy Perch *Nannatherina balstoni*, listed as Vulnerable under both State and Federal legislation, and Endangered by the IUCN (Morgan & Beatty 2019b), was also present in the region until relatively recently, but has not been detected there since 1981 (Morgan *et al.* 1998, 2014). Its disappearance demonstrates the higher risk of extinction faced by these outlying freshwater fish populations compared to their southern counterparts that occupy relatively pristine habitats. Numerous anthropomorphic stressors including secondary salinization, groundwater abstraction, introductions of feral species, climate change, the construction of instream barriers to migration, wetland drainage, and habitat degradation have been implicated in the declines of these threatened species as well as other freshwater fish populations throughout southwestern Australia (Davis & Froend 1999; Hourston *et al*. 2014; Allen *et al*. 2017).

ECOLOGY AND NATURAL HISTORY

Galaxiella munda is typically found in cool, shallow waterbodies, such as brooks, swamps, roadside pools and waterpoints (Morgan *et al.* 1998; Allen *et al.* 2002). These waters typically contain tannins, which tint the water dark brownish red and inhibit visibility. The species also inhabit seasonal waterbodies but perish unless heavy rainfall facilitates access to permanent waterbodies (Pusey & Edward 1990). *Galaxiella munda* prefers acidic water with a pH of 3.0 – 6.5 (Morgan *et al*. 1998), and a low mineral content (Trneny 2001), and struggle to survive in hard, alkaline water with any salt (Morgan *et al*. 2003).

Spawning takes place from July to October, peaking between late August and early September (Pen *et al*. 1991; Morgan *et al*. 1998). The species is a multiple spawner, depositing clutches of eggs within flooded riparian vegetation, similar to other *Galaxiella* species (Pen *et al*. 1991, 1993; Morgan *et al*. 1998). It has a short lifespan, reaching sexual maturity and spawning within the first year of life, before dying a few months later (Pen *et al*. 1991; Morgan *et al.* 1998). The suggestion that

Figure 1. *Galaxiella munda* from the Deep River catchment about 25 km northwest of Walpole; approximately 35 mm long.

larger individuals have a longer lifespan has not been confirmed (Beatty & Morgan 2004). The brief life cycle of both southwestern endemic *Galaxiella* species (Pen *et al*. 1991, 1993; Smith *et al*. 2002) predisposes populations to rapid declines when environmental conditions are unfavourable (Allen *et al*. 2015).

DISTRIBUTION

Galaxiella munda is predominantly found in the southwestern corner of Western Australia from the upper reaches of the Vasse River, near Margaret River, eastwards to the Angove River, near Two Peoples Bay on the south coast (Morgan *et al.* 1998; Morgan & Beatty 2004), with outlier populations near Gingin, over 260 km to the north (Morgan *et al.* 1998; Beatty & Morgan 2004; Hourston *et al.* 2014; Fig. 2). Within the Southwest the species varies in abundance from scarce in catchments such as the Donnelly River (Morgan & Beatty 2006), to seasonally abundant in others, such as the Shannon and Angove rivers (Morgan *et al.* 1998; Trneny 2001; Julian Ackley pers. comm., 2017).

The two outlier populations near Gingin are in Lennard Brook, a tributary of Ellen Brook in the Swan–Avon system, south of Gingin (Beatty *et al.* 2010; Unmack *et al.* 2012; Galvin & Storer 2012a), and in Gingin Brook, a tributary of the Moore River, north of Gingin (Beatty & Morgan 2004; Galvin & Storer 2012b; Fig. 2). Prior to the introduction of feral species, the construction of instream barriers, and clearing of riparian vegetation, both populations are likely to have been more abundant and widespread throughout their respective tributaries. Both tributaries receive groundwater discharge, a common trait of waterways that contain the species and a critical determinant in preserving populations of obligate freshwater fishes, especially within salinized catchments (Morgan *et al.* 2003; Morgan & Beatty 2005; Beatty *et al.* 2011). Although the species was likely historically more widespread, these northern outliers are now the only populations that remain on the Swan Coastal Plain; this drastic reduction in range has been theorised to be the case in *G. nigrostriata*'s outlying populations in Lake Chandala, Melaleuca Park south of Bullsbrook, Kemerton and Gelorup near Bunbury, and *N. balstoni*'s now-extinct Moore River population (Morgan *et al*. 1998; Smith *et al*. 2002; Galeotti 2013; Morgan *et al.* 2014; Hourston *et al*. 2014; Wetland Research and Management 2019a, b).

SPECIMENS OF INTEREST

Two *G. munda* specimens in the collections of the Western Australia Museum, collected in 1973 (Western Australian Museum 2021, unpublished data), represent a potentially significant range extension of the species; however, these records have rarely been mentioned in the scientific literature. These specimens were collected five years prior to the species' formal description and were initially identified as *G. nigrostriata* by McKay (Glenn Moore, Western Australian Museum, pers. comm., January 2021). Subsequent re-examinations by McDowall (1978) and other ichthyologists assigned both specimens (WAM P.22548.001 and P.22549.001) to *G. munda* (Glenn Moore, Western Australian Museum, pers. comm., January 2021).

The specimens were collected during an excavation of a springline near Ellen Brook (How 1978; McDowall 1978; Glenn Moore, Western Australian Museum, pers. comm., January 2021), for which the coordinates supplied are 31°30'S 115°55'E (Fig. 2). No records of this excavation were found by the author although *G. munda* specimens were captured from a nearby artificial wetland adjacent to Lake Chandala in 2001 (Mike Bamford, Bamford Consulting Ecologists, pers. comm., February 2021). Curiously, these specimens were found in sympatry with the introduced Eastern Gambusia *Gambusia holbrooki*, a species whose pugnacious and aggressive disposition typically compromises the survival of small-bodied native fish species, such as *G. munda* (Griffiths 1972; Morgan *et al.* 2004; Beatty & Morgan 2013; Allen *et al*. 2015). It is possible that the WAM specimens and 2001 records are representatives of the same population.

DISCUSSION

Although the author has recorded considerable numbers of *G. munda* within the upper reaches of Gingin Brook (pers. obs. 2020), recent survey efforts by other authors have failed to locate the species in either Lennard or

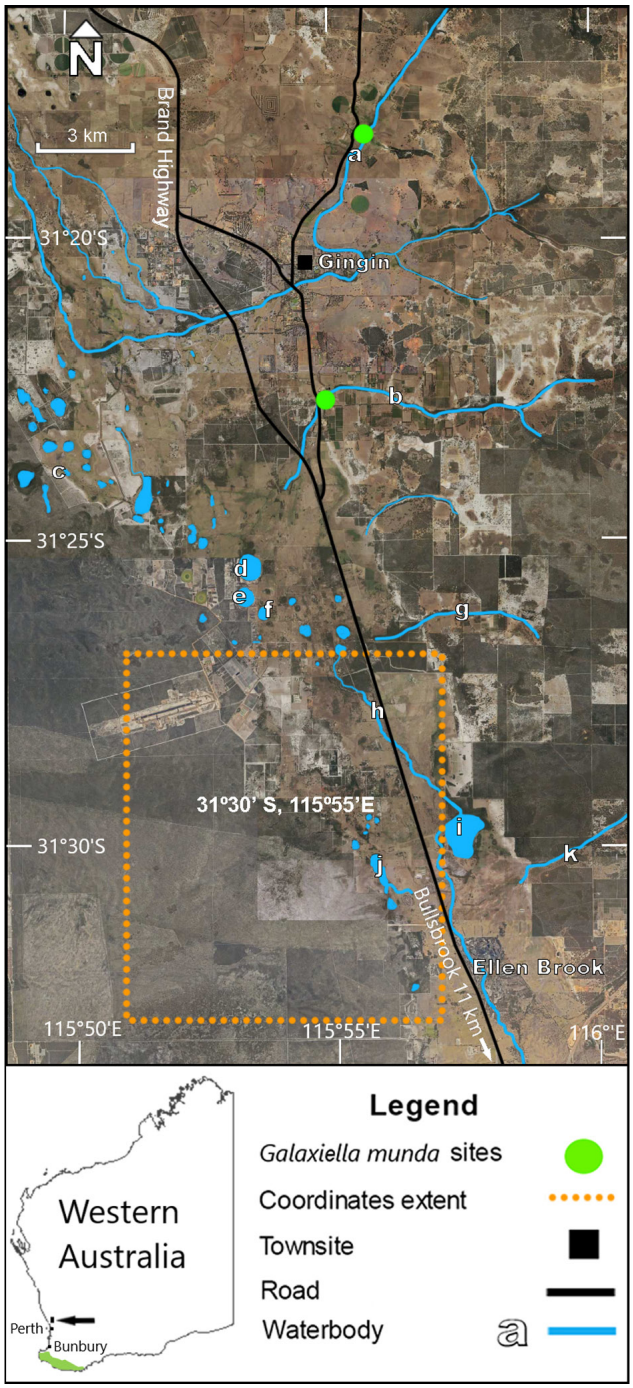

Figure 2. Gingin–Bullsbrook region showing sites with *Galaxiella munda* and various small waterbodies: a) Gingin Brook; b) Lennard Brook; c) Deepwater Lagoon; d) Lake Bambun; e) Lake Nambung; f) Lake Mungala; g) Breera Brook; h) Chandala Brook; i) Lake Chandala; j) Lake Catambro; and k) Yalyal Brook. The study area is arrowed on the inset map, which also shows the main distribution of the species in green.

Gingin Brooks, suggesting there may have been local declines in both tributaries (Galvin & Storer 2012a, b; Department of Water, unpublished data). The introduced *G. holbrooki* has recently been recorded in both tributaries; however, it is not present in the upper reaches of Gingin Brook that *G. munda* inhabits, suggesting an instream barrier prevents the upstream passage of *G. holbrooki* (Beatty & Morgan 2004; Galvin & Storer 2012b; pers. obs., 2020). By comparison, *G. holbrooki* has been recorded at both upstream and downstream sites along Lennard Brook (Galvin & Storer 2012a), likely having an adverse impact on *G. munda* in this tributary.

Further surveys are required to evaluate and record the assemblages of native fishes in the Gingin–Bullsbrook region, as many of the waterbodies in the area remain poorly studied. Specific attention should be given to the poorly studied wetlands in the southern part of the study area, to establish whether or not it has an extant population, as suggested by the 1973 WAM specimens and 2001 records. The only waterbody in the area that has been surveyed for fishes is Lake Chandala; however, these studies have yielded differing findings: Beatty *et al.* (2010) recorded only *G. holbrooki*, whereas McLure & Horwitz (2010) recorded the Nightfish *Bostockia porosa* and *G. nigrostriata*, and Bamford (unpublished data) recorded the Western Galaxias *Galaxias occidentalis*, *G. munda*, Bluespot Goby *Pseudogobius olorum*, the introduced Goldfish *C. auratus* and *G. holbrooki*. Although the waterways in the region show little resemblance to those with *G. munda* elsewhere, comprehensive surveys are required to fully evaluate this possibility. Parallels may be drawn with the recent discovery of *G. nigrostriata* populations at Gelorup, south of Bunbury (Wetland Research and Management 2019a, b), in wetland habitats within cleared agricultural lands that were previously believed to be unsuitable for the species (Morgan *et al.* 1998; Galeotti *et al.* 2010).

Due to the geographical separation between the outlier and main populations of *G. munda*, a great degree of genetic divergence exists (Unmack *et al.* 2012); even populations within neighbouring tributaries of the same catchment can display such divergence (Phillips *et al.* 2007; Beatty *et al.* 2010). In order to preserve these genetically unique populations, captive breeding should be considered, similar to what has been accomplished by aquarium hobbyists for the species' eastern Australian relative, the Eastern Dwarf Galaxias *Galaxiella pusilla* (Leggett & Merrick 1987). It may also be advisable to evaluate if *G. munda* individuals can be translocated from Gingin or Lennard Brooks into an adjacent tributary or wetland deemed suitable for the species. Nearby Yalyal Brook, southeast of Lake Chandala, may be a viable option (Beatty *et al.* 2010), as may be Breera Brook (Fig. 2).

Various threats such as secondary salinization, introduced species, wetland drainage and degradation, groundwater abstraction, and climate change currently jeopardise the survival of native freshwater fishes throughout southwestern Australia (Allen *et al.* 2017). These anthropogenic threats are most evident within the heavily urbanised wetlands of the Swan Coastal Plain, where native species are extremely scarce in comparison to introduced species (Davis & Froend 1999; Hourston *et al.* 2014). As most of these threats (e.g. feral species invasions, a drying climate) are extremely difficult to manage or mitigate, it is critical that conservation efforts are directed towards remnant populations of native freshwater species, with priority given to the most threatened and restricted species. *Galaxiella munda* is arguably one of the most susceptible

to anthropogenic stressors due to its short life-cycle and requirement for near pristine habitat conditions (Beatty *et al.* 2010), as shown by the loss of the species at Big Brook Dam in the Warren River catchment, where it was previously abundant prior to the introduction of the Redfin Perch *Perca fluviatilis* (Pen *et al.* 1991; Morgan *et al.* 2002). The survival of this species within the Gingin–Bullsbrook region is a crucial priority and is contingent on habitat protection and restoration. Captive breeding and translocations should also be investigated as such interventions may be required to conserve these populations in the face of many threats, while further surveys are needed in the understudied waterbodies of the region.

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