Rainbowfishes (Melanotaeniidae) of the Rocky Creek springs district on the Atherton Tablelands, north Queensland

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Abstract

Rocky Creek is a tributary stream of the upper Barron River, on the Atherton Tablelands, north Queensland. Freshwater spring systems occur in the upper reaches, the largest of which is Barney Springs. A rainbowfish variety collected from the spring systems and other sites in the Rocky Creek catchment appeared to be distinctively and unusually coloured compared to other *Melanotaenia splendida splendida* and *Melanotaenia eachamensis* samples that were collected from nearby streams elsewhere in the upper Barron catchment. The Rocky Creek rainbowfish is most likely allied to *Melanotaenia s. splendida* although the form appears to have some colour and patterning characteristics of *Melanotaenia utcheensis*, a rainbowfish species from the Johnstone River catchment, to the south of the Barron River.

The distinctive colour form of the Rocky Creek springs rainbowfish may be due to its long isolation in an unusual environment combined with genetic introgression with other forms. Rainbowfish from the main channel of Rocky Creek may be mixed to varying degrees with the more continuous and widespread *Melanotaenia s. splendida* populations that occur further downstream.

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Introduction

The Barron River, with a catchment size of 2,190 km^2, is a significant river system of the Wet Tropics region of north Queensland. The river's headwaters are located in the mountains of the Herberton Range, and the main channel winds its way through the drier northern sections of the Atherton Tablelands, flowing east across the Kuranda Range, and thence to the lowlands, debouching into the sea just north of the city of Cairns.

The present day fish communities of the Barron River catchment are the combined result of several natural and anthropomorphic effects. The geological history of the area suggests that volcanic activity up to 10,000 years ago may have caused headwater capture, allowing interchange of fish species between the upper Barron, Johnstone, Herbert and Mitchell Rivers, the latter being a western (Gulf of Carpentaria) flowing system (Hurwood & Hughes 2001). Several fish species typical of the Gulf of Carpentaria drainage division occur in the upper Barron, a distant reflection of this event. A major migratory barrier on the river, the 125-m-high Barron Falls near Kuranda effectively separates lowland and upland fish communities.

Human assisted habitat modification occurs throughout the system. The rich volcanic soils and mild, wet climate of the Atherton Tablelands make it ideal for a range of agriculture, while the coastal reach supports sugar cane production and increasing encroachment of Cairns urbanisation.

A natural obstruction, Tinaroo Falls on the upper Barron River, has been considerably modified by the construction of Tinaroo Falls Dam in 1953. This created not only a greater upstream barrier to fishes, but also a large recreational fishing lake stocked with translocated native fishes and a network of irrigation channels that deliver water (and its aquatic inhabitants) to the farming areas around Mareeba, in the upper Mitchell River (Gulf of Carpentaria) catchment.

The fish fauna of the Barron River has been extensively surveyed over many years (e.g. Shipway 1947a,b,c, 1948; Pusey & Kennard 1994; Russell *et al*. 2000, 2003). About 30 species occur in the upland reaches above Barron Falls. They include endemic native species, native species that may have invaded naturally from other catchments, translocated native species and exotic species. Of these species, it is thought that thirteen are truly original inhabitants of the area (Russell *et al*. 2003; Burrows 2004).

Two rainbowfish species, Eastern Rainbowfish (*Melanotaenia splendida splendida*) and Lake Eacham Rainbowfish (*Melanotaenia eachamensis*) have been reported from the Barron River catchment and appear to be original inhabitants, the latter species being endemic to the small order feeder streams of the Atherton Tablelands (Pusey *et al*. 1997; Hurwood & Hughes 2001; Russell *et al*. 2003). *Melanotaenia s. splendida* is the dominant rainbowfish species in the Barron River catchment and the Wet Tropics generally (Pusey & Kennard 1994; Allen *et al*. 2002). Throughout its range, this species has a remarkable diversity of colour forms, with distinctively coloured populations known in some Barron catchment streams such as Streets Creek and Davies Creek (Tappin 2011). *Melanotaenia splendida splendida* is thought to be a relatively recent arrival in the area, dispersing across the Atherton Tablelands about 100,000 years ago (Hurwood & Hughes 2001). It is thought that the species may have displaced some original "old endemic" rainbowfish species such as *M. eachamenis*, *M. utcheensis* and others (Pusey *et al*. 1997; McGuigan 2001).

A rainbowfish variety originally collected by the authors from Barney Springs, in the Rocky Creek catchment (a tributary of the upper Barron River) appeared to be distinctively and unusually coloured compared to other *M. s. splendida* and *M. eachamenis* samples that the authors had collected elsewhere in the upper Barron catchment.

In this article we describe the appearance of this form, the extent of its occurrence in the Rocky Creek area, and the habitats and sites it occurs in. We also provide a comparison with rainbowfish forms from nearby drainages and discuss factors that may have influenced the development of this unusual form.

The Rocky Creek and Springs Environment

The Rocky Creek area was first settled by Europeans in the 1880's, when Bernard "Barney" Hayes established a hotel and butcher shop at the Rocky Creek crossing, giving his name to the nearby "Barney Springs". The area played a significant part in the World War II history of the region, when a large military hospital was established at Rocky Creek. At its peak, the hospital extracted 4.5 million litres of water per day from Barney Springs. In the years following the war, the area became increasingly popular as a tourist and picnicking area and it is thought that prior to the construction of Tinaroo Dam in the 1950s, Barney Springs and the nearby Devil's Pool were amongst the Tablelands' most popular visitor destinations. Today, the area is little known or visited, even by locals (Mackinnon 2003; Trantor & Trantor 2003).

Rocky Creek is a perennially spring-fed tributary of the Barron River headwaters in the Herberton Range near Mount Emerald, in the Tolga-Walkamin area. The stream flows north-east across mostly agricultural lands to enter the western side of the Barron River about 15 km downstream of Tinaroo Falls Dam. The Rocky Creek catchment is characterised by a number of springs associated with the Atherton Basalt Aquifer. These springs contribute significantly to the dry season base flows of the Barron River.

Rocky Creek is indeed quite rocky throughout its length. The underlying basalt geology of the area means that substrates throughout the stream consist of dark gravel, rocks and in many areas, large black boulders. This, combined with often dense riparian vegetation (especially around the springs and associated outflows) gives an overall darkened appearance to the stream (Fig. 1).

Barney Springs is the largest of several springs that feed into Rocky Creek (Fig. 2). The catchment of the springs covers less than 35 ha, so only limited stormwater runoff contributes to the flows.

The spring source flows from a cleft in the basalt ridge, down through a series of small pools, riffles and cascades, to a large deep pool. Immediately below this pool is a waterfall about 20 m high, below which the watercourse joins the main section of Rocky Creek. The length of the spring stream, from source to waterfall is less than 500 m. It is reported that the springs have never stopped flowing in recorded history. Minimum flow rates from the springs are fairly constant, estimated to be about 55 l/sec, or 1,700 ML per annum. Currently, there are three water extraction licences for the springs, totalling 502 ML per year. This water is used for local rural, stock and domestic purposes (Dept. Nat. Res. Mines 2013).

Figure 1. Rocky Creek lower site.
Photo: K. Martin.

Figure 2. Barney Springs.
Photo: K. Martin.

Another significant spring system occurs about 1 km to the north of Barney Springs. In this review we refer to this unnamed system as "North Springs" (Fig. 3). A significant barrier on Rocky Creek occurs as a 20 m high waterfall above Devil's Pool, a large permanent refuge pool just downstream of the Kennedy Highway crossing (Fig. 4). This waterfall would likely prevent upstream migration of rainbowfishes. The waterfall below Barney Springs would likely represent another obstruction to upstream migrations.

Figure 3. North Springs outflow.
Photo: S. Barclay.

Figure 4. Devil's Pool.
Photo: K. Martin.

A complicating factor in the environmental conditions of Rocky Creek is the presence of the West Barron Main Channel (Fig. 5). This is the main irrigation channel that supplies water from Tinaroo Dam to the agricultural areas west of Mareeba. It is an elevated, open water channel that bisects the Rocky Creek catchment, and is tunnelled underground where it crosses Rocky Creek. The channel contains aquatic life (including rainbowfishes) which presumably originated in Tinaroo Dam. There are various overflow points along the channel, including one near Rocky Creek which when opened, would flood the catchment with water and fishes from Tinaroo Dam.

Figure 5. West Barron Main Channel.
Photo: K. Martin.

Methods and Sample Sites

Topographic maps and aerial photography of the Tolga district were examined to determine the likely extent of rainbowfish habitat, habitat types and potential sampling locations. Available literature on the area was reviewed for background environmental, geological and water resources data.

Rainbowfish samples were collected live using dip nets, a frame net, a seine net and baited traps. At most sites narrow, fast flowing rocky channels with dense edge vegetation were the main habitat feature, and frame netting was the most productive capture method. Rainbowfish samples were transported to holding tanks where they were photographed in life. They were then forwarded live to the Northern Territory Museum for further taxonomic and genetic research. Standard water quality measurements were recorded at each site.

Rainbowfishes were sampled at four sites in the Rocky Creek catchment including: an upstream headwaters site near the base of the range and above the Devil's Pool waterfall; a mid-reach site between Devil's Pool and the Barron River; Barney Springs; and the outflow channel from North Springs. Samples of rainbowfishes were also taken from immediately adjacent catchments including: the West Barron Main Channel near Rocky Creek; Spring Creek, a small spring-fed stream in the adjacent catchment to the east of Rocky Creek; and Priors Creek, a tributary of Mazlin Creek, the first major catchment south of Rocky Creek which enters the Barron River above Tinaroo Falls Dam. We also received photographs of a rainbowfish type from Maud Creek, a tributary of Granite Creek, the first major stream to the north of Rocky Creek. For comparison, we collected rainbowfish samples from two locations in the Gwynne/Leslie Creek catchment. This is an upper tributary of the Barron River about 15 km to the south-east of Rocky Creek and is a known area for *Melanotaenia eachamensis* (K. Martin unpubl. data). Locations of all sampling sites are shown in Figure 6.

Results

All sites in the Rocky Creek, Spring Creek, West Barron Channel and Maud Creek areas were at altitudes between 600 and 700 m, with the uppermost site at an altitude of 698 m. The other sites (Prior Creek, Gwynne Creek) were between 700 and 760 m altitude. General water quality parameters at most sites were quite similar. The pH at Barney Springs was lowest, at 6.3, while at all other sampled sites, pH ranged between 7.3 and 7.9. Electrical conductivity (E.C.) was highest at the spring-fed sites, particularly Barney Springs (216 µs) and North Springs (228 µs). The lowest E.C. readings were at Kennie Creek (50 µs), Priors Creek (79 µs) and the West Barron Channel (73 µs). Water temperatures were similar at most sites – between 20.6°C and 23.8°C. The lowest temperature recorded was at Priors Creek (18.4°C), which was the highest altitude site.

Rainbowfishes collected from Barney Springs and North Springs, and from the upper and lower main channel of Rocky Creek, had a distinctive colouration and patterning which was easily recognisable as different to other examples of *M. s. splendida* and *M. eachamenis* from nearby areas in the upper Barron catchment, although based on size, form and finnage arrangements, they appeared to be more closely allied to *M. s. splendida* than *M. eachamenis*. The most intensely coloured specimens were from Barney Springs and North Springs. Although rainbowfish from the two Rocky Creek stream sites were less striking in appearance, it was clear that they were variations of the same form, possibly with some mixing of standard *M. s. splendida* from downstream areas.

Overall colouration of adult males from Barney and North Springs was a highly reflective steely blue. Sub-adults had prominent orange speckled lines which became less evident with maturity. Adults also had darker scale edgings giving a slightly

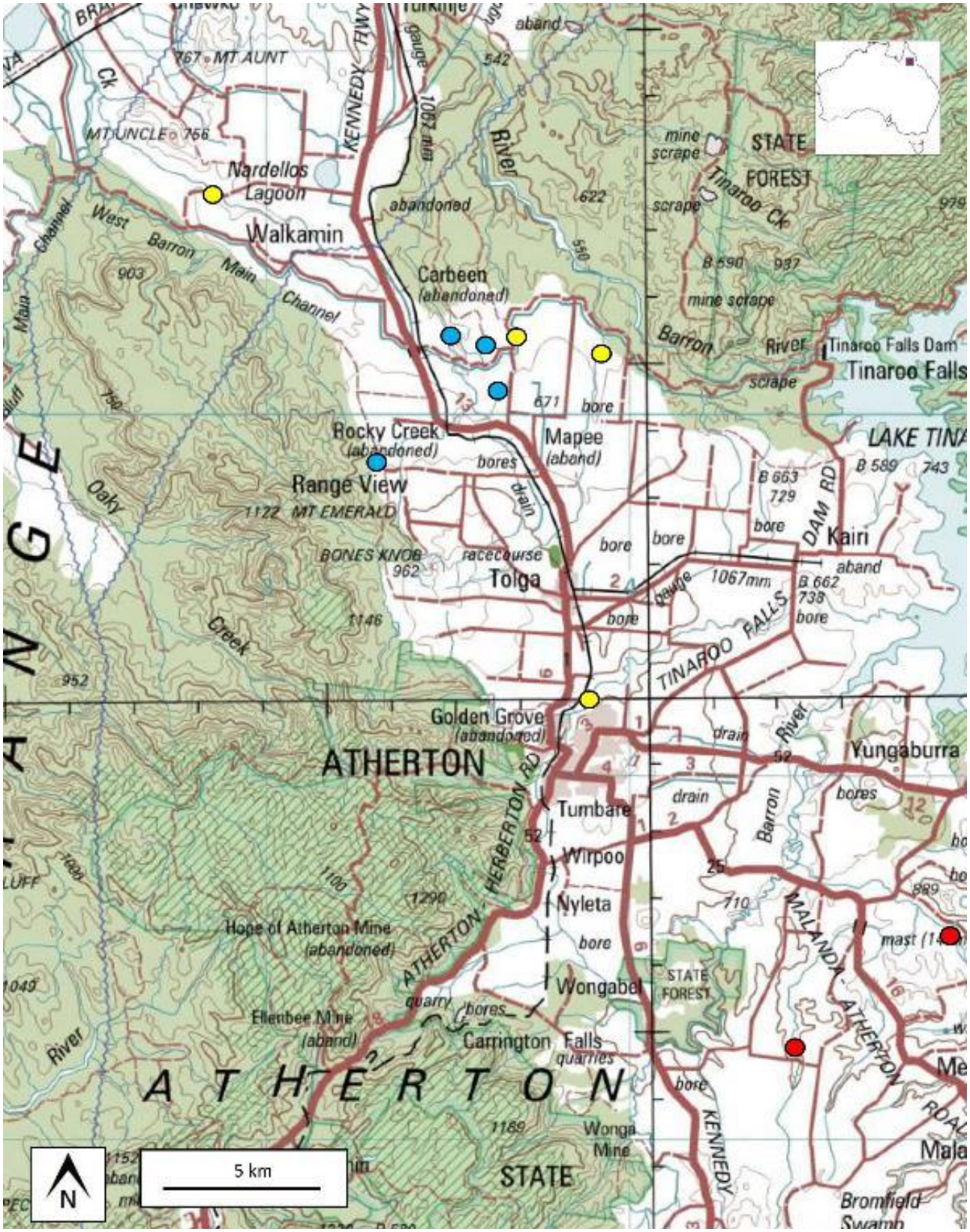

Figure 6. Location of sampling sites.
Blue dots represent Rocky Creek and springs sites, yellow dots represent adjacent catchment sites, red dots represent Gwynne Creek sites. Base map: Geosciences Australia.

"checkerboard" patterning to the body. There was only a slight sign of any solid dark mid-lateral stripe and silver under-stripe flashing typical of *M. s. splendida* from the upper Barron River catchment. All fins were greyish with blue reflections, and were unspeckled or with faint reddish ray edges. The fin edges of the dorsal and anal fins were black, and the pelvic fins were all black. The two caudal fin lobes each had a faint dark spot. Examples of adult male rainbowfish from Barney Springs and North Springs are shown in Figures 7a,b.

The Barney Springs rainbowfish appear to be a moderately sized form, larger than *M. eachamenis*, but smaller than *M. s. splendida*. Body shape was also moderate – neither slender nor stout. The largest specimens had short dorsal and anal fins compared to *M. s. splendida* of the same size. The pointed finnage shape was more similar to the *M. s. splendida* forms than the *M. eachamenis* forms. Fin and scale counts (n=3) are as follows: dorsal rays V to VII, 11-13; anal rays 1, 18-20; horizontal scale rows 10; vertical scale rows 35-38. These counts fall within the range for *M. s. splendida* or *M. utcheensis*, but outside the counts for *M. eachamenis*, although the vertical scale row count is unusually high (Allen *et al*. 2002). Rainbowfishes from North Springs had very similar appearance to the Barney Springs fish, with prominent steely-blue background colouration, fine orange striping and unspeckled finnage (Fig. 7b). Preliminary genetic analysis of samples from the two springs sites does indicate that the form is allied to *M. s. splendida* although it probably has some introgression with "old endemic" rainbowfish forms (P. Unmack, pers. comm.).

The overall impression of the Rocky Creek samples, especially in the vicinity of the springs, is of a rainbowfish with highly reflective steely blue background colouration, generally plain greyish fins with dark margins, and characteristic fine orange lines on the posterior of the body, somewhat reminiscent of patterning seen in *Melanotaenia utcheensis*, a species known from the Johnstone River catchment south of the Barron River.

Figure 7. Rainbowfish varieties (presumed *M. splendida* forms) from the Rocky Creek catchment: a) Barney Springs; b) North Springs; c) Rocky Creek lower site; d) Rocky Creek upper site.
Photos: K. Martin.

Rainbowfish from adjacent catchments including: West Barron Main Channel; Spring Creek; Priors Creek; and Maud Creek were markedly different in appearance to fish from the Rocky Creek catchment, resembling more closely the appearance and colouration of typical *M. s. splendida* found elsewhere in the Upper Barron catchment. These fish had a more uniform yellowish background appearance, sometimes with a faint darker lateral stripe and silver sublateral margin, and dark speckled yellowish fins with no darker margin. The main variation was the Priors Creek fish, which had a pinkish tinge to the dorsal, anal and caudal fins. Examples of rainbowfish forms from catchments adjacent to Rocky Creek are shown in Figure 8a-d.

Rainbowfish collected in the higher altitude sites of the Gwynne Creek subcatchment (Gwynne and Kennie Creeks) were small reddish-finned fish, with a dumpy build, short finnage and a more rounded head. Based on size and morphology, rainbowfishes from these sites were identified as *Melanotaenia eachamensis*. (Fig. 8e).

Discussion

The distinctive form and colour of the Rocky Creek rainbowfish suggests that it may have been living in Rocky Creek and the associated springs for a very long time. Populations isolated in upland habitats such as springs may be subjected to different environmental conditions (e.g. water chemistry, flow rates and food availability) or reduced genetic flow compared to populations in less isolated sites, and these variables may influence specific colouration patterns or body forms. For example, at the time of the surveys the two springs sites had lower pH and higher electrical conductivity values than any of the other sites sampled. Studies of other *Melanotaenia* species have shown that habitat diversity, especially hydrological flows, can also impact on variations in body shape and finnage placement (McGuigan *et al*. 2003). Similarly, variations in colour pattern in another rainbowfish (*Melanotaenia australis*) were attributed to a response to predator pressure in more exposed downstream habitats (Young *et al*. 2011). It is not known to what extent these variables contribute to the observed colour form of the Rocky Creek rainbowfish.

The striking steely blue background colour form found in rainbowfish from the two springs populations appears to be unique to these isolated locations and has not been documented from these or other locations previously. Other distinctively coloured *M. s. splendida* forms in the Barron catchment tend to show an emphasis on deeper and brighter red colouration on the finnage and posterior of the body such as seen in the "Kuranda Reds" (Tappin 2005).

The general colouration and appearance of the rainbowfish from areas downstream of the springs seemed to infer that some mixing between the springs fish variety and the more commonly observed *M. s. splendida* forms from further downstream may have occurred. Rainbowfish from the uppermost site (ie. above the Devil's Pool waterfall) showed similar patterning to the lower site fish, but were less intensely coloured.

Throughout the Atherton Tablelands, *M. s. splendida* populations are often admixed with "old endemic" taxa genes (Zhu *et al*. 1998; McGuigan 2001). The Rocky Creek fish, while appearing to resemble *M. s. splendida* superficially, also exhibits some characteristics of colour patterning seen in *M. utcheensis* (an "old endemic" form) such as the presence of thin orange body lines. This observation is supported by preliminary genetics testing (P. Unmack, pers. comm.) although further detailed analysis of the genetics would be required to understand the origins of this form.

The Rocky Creek and springs area is currently subject to various environmental pressures including water extraction, clearing of adjacent lands for agriculture, cattle grazing and runoff from industries including an abattoir. The area has had a history of human disturbance which has carried over to present day influences such as weed and feral fish (guppy) invasions. Given the attractiveness of the springs, waterfalls and plunge pools in the area, these sites have surprisingly little visitor usage, although they are not signed or promoted. During our surveys, we found that even local people were unaware of the presence of these sites. A Management Plan has been developed for the area (Mackinnon 2003) but this plan contains no information on the fish resources of the area.

Further studies on this unusual fish population are recommended, and if the form turns out to be a distinct evolutionary unit then steps to manage its continued survival should be implemented.

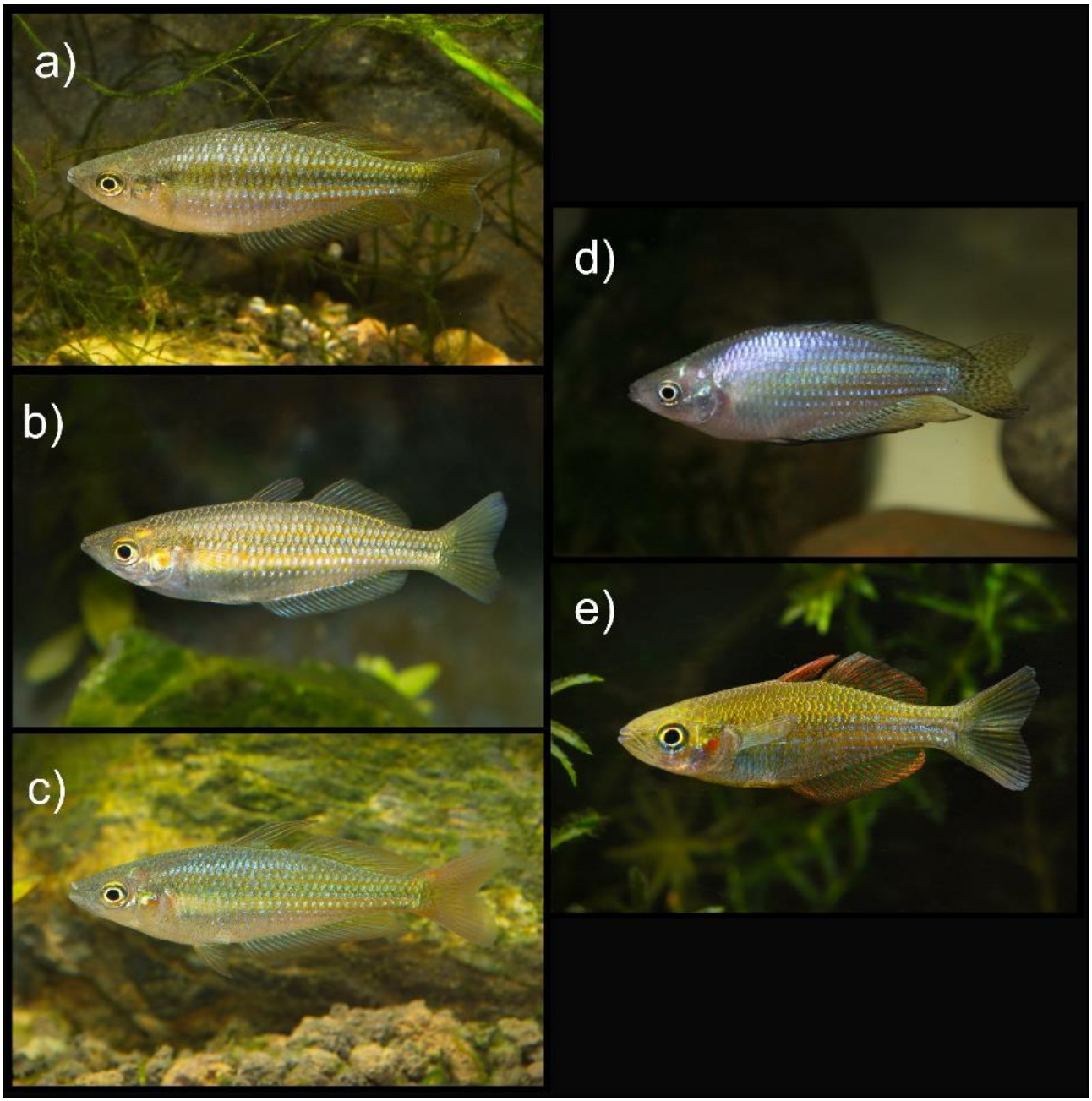

Figure 8. Rainbowfish varieties (presumed *M. splendida* forms) from adjacent catchments: a) West Barron Main Channel; b) Spring Ck; c) Priors Ck; d) Maud Ck; and e) *M. eachamensis* from Gwynne Ck.
Photos: K. Martin, except d) – G. Briggs.

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