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Rapid Communication

First report of the hybrid blood parrot cichlid from a rice agroecosystem in Seberang Perai Tengah, Penang, Peninsular Malaysia, with notes on syntopic Midas cichlid, *Amphilophus citrinellus* (Günther, 1864)

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Abstract

The blood parrot cichlid, an artificial fish hybrid, was recorded for the first time in a rice agroecosystem based on specimen collected in Seberang Perai Tengah, Penang, Peninsular Malaysia. A potential parental species of this hybrid fish, the Midas cichlid (*Amphilophus citrinellus*) was also recorded from this agroecosystem. There was no evidence of self-sustaining populations of this hybrid fish in the agroecosystem. Nevertheless, their presence increased the risk of food and space competition with native species (e.g., *Pristolepis fasciata*), as well as the spread of disease such as pneumocystectomy.

Key words: Midas cichlid, alien species, aquarium dumping, ornamental fish, Cichlidae

Introduction

Ornamental fish keeping is a very popular hobby around the world. Due to their various striking patterns, colours and behaviours, ornamental fish have become among the most sought after animals in the world. Some hobbyists also breed fishes through hybridisation in order to obtain desirable traits. However, lack of knowledge of the correct ethical practices has led to the dumping of non-indigenous fish species in the environment (Gertzen et al. 2008). The ornamental fish industry is reported to contribute to more than 30% of invasive species translocations throughout the world (Padilla and Williams 2004). For example, pet abandonment has become the major cause of the introduction of non-indigenous fish species in the water bodies in Singapore (Ng and Tan 2010) and Japan (Ishikawa and Tachihara 2014).

The family Cichlidae is one of the most diverse freshwater fish taxa, and it is very important in the aquaculture and ornamental fish industry (Pullin 1991). For example, *Oreochromis niloticus* (Linnaeus, 1758) and *Oreochromis mossambicus* (Peters, 1852) are the two major non-native species used for

aquaculture in Malaysia (Rahim et al. 2013). These species are highly resistant and adaptable to habitat alterations as they reside diverse trophic levels, which also greatly reduces the cost of rearing them at large scale (Pullin 1991). A study by Aqmal-Naser and Ahmad (2018a) in a rice field in Seberang Perai Tengah, Penang, recorded *Oreochromis niloticus* which was common throughout the paddy planting season. After 50 years of introduction, *Oreochromis* spp. have now established breeding populations in nearly all water bodies in Peninsular Malaysia (Rahim et al. 2013). The latter study recorded another additional species from the family Cichlidae, which was Midas cichlid, *Amphilophus citrinellus* (Günther, 1864) (Aqmal-Naser and Ahmad 2018b). Native to Costa Rica and Nicaragua, this species has been introduced and established in the Asian region, including also Taiwan and Singapore. *Amphilophus citrinellus* has a very bright orange colour morph that has also been reported to be used in the hybridisation programme with another cichlid, *Vieja melanura* (Günther, 1862), which has very colourful pigmentation on the body, to produce the blood parrot hybrid (Li et al. 2018). Some of the hybrid offspring are found to be impaired due to deformities (e.g., narrow mouth and damaged swim bladder which will distort the feeding and swimming of the fishes) related to inbreeding (Noga et al. 1981; Mair 1992; Tave 1999) and genetic inheritance (Russell 2003; Stelkens et al. 2015), and even surgical removal of the caudal fin of the hybrid fish to produce the heart-shaped fish. Apart from that, the external colouration is a vital criterion in selection of ornamental fishes where the retail price is closely linked to attractive and auspicious colouration (Gouveia et al. 2003). The selection process is carried out on those impaired individuals with undesirable traits in terms of colourations and shapes, which are often discarded into natural water bodies.

To date, there is no evidence of *Amphilophus citrinellus* and its hybrid being able to breed naturally and establish a viable population in the wild in Peninsular Malaysia. In general, there are no published materials on the record of *Amphilophus citrinellus* in Peninsular Malaysia except in Penang (Aqmal-Naser and Ahmad 2018b). However, based on the information gathered from the Malaysian Facebook angling group (https://www.facebook.com/groups/kelabjoranFB) and Malaysian Freshwater Fish group (https://www.facebook.com/groups/158073811005000/), *Amphilophus citrinellus* is usually caught from man-made lakes (Figure 1) in urban areas (e.g., Selangor and Putrajaya), although no hybrid blood parrot cichlids were recorded. The presence of *Amphilophus citrinellus* could increase the risk of food and space competition with native fish species (Barlow 1983; McKaye and Barlow 1976), as well as spread fish disease such as pneumocystectomy (Lewbart et al. 1995). In this study, we aim to provide more information regarding the introduced *Amphilophus citrinellus* and its artificial hybrid, and highlight the emerging problems from the rising numbers

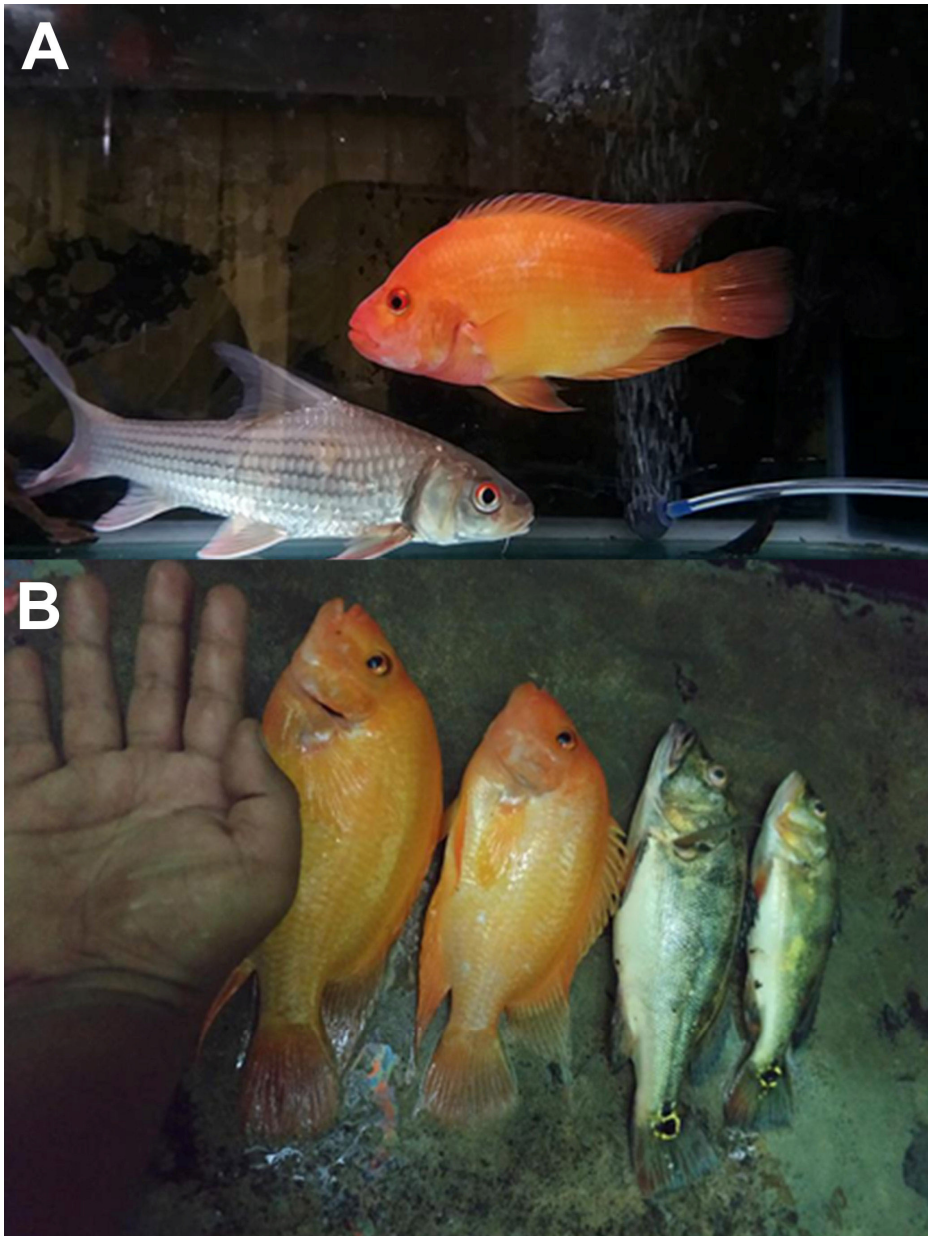

Figure 1. Amphilophus citrinellus which was caught from a man-made recreational lake in Putrajaya, Kuala Lumpur and kept in an aquarium (A); the fish was also caught from an unspecified locality in Peninsular Malaysia (B). Source: A – Mohd Iskandar Recondzilla and B – Jenglot Mata Biru Rich.

of the introduced alien species. We investigated the presence of these cichlids in the rice field environment throughout the paddy planting season from June 2018 until March 2019 in Seberang Perai Tengah, Penang, Malaysia.

Materials and methods

Fishes were collected from a rice field ecosystem (i.e. rice agroecosystem) in Seberang Perai Tengah, Penang (Figure 2), by cast net and scoop net from various habitats (Figure 3) in the rice field where the water persists thoroughout the year. The collected specimens were photographed, preserved

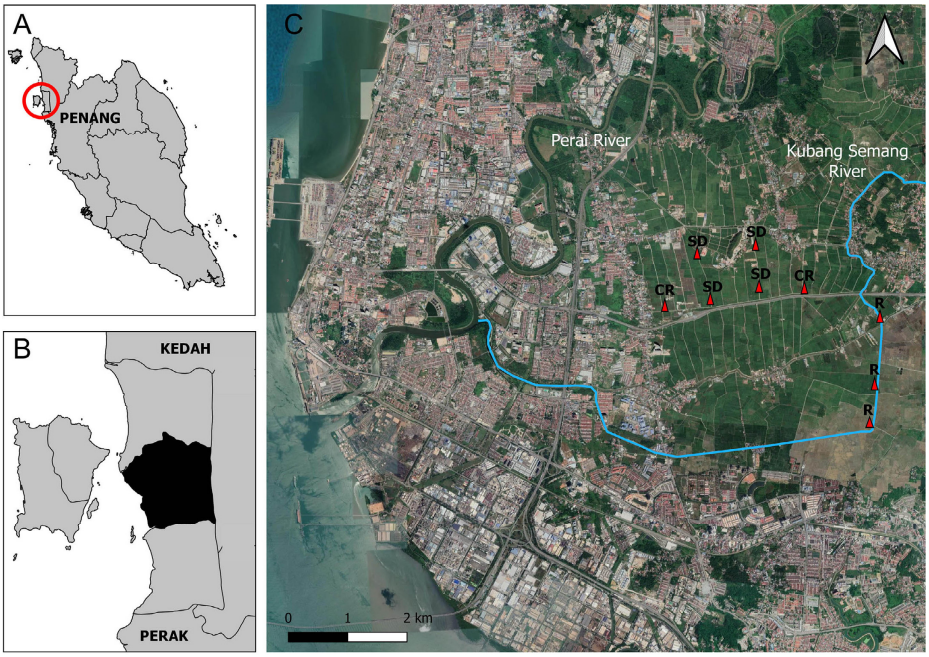

Figure 2. Map of the state of Penang (A) located in the Peninsular Malaysia. The black shaded area (B) shows Seberang Perai Tengah where the study area is located. Red triangles show the distribution of *Amphilophus citrinellus* collected in the study area (C). CR: concretised river, SD: storm drain, R: river.

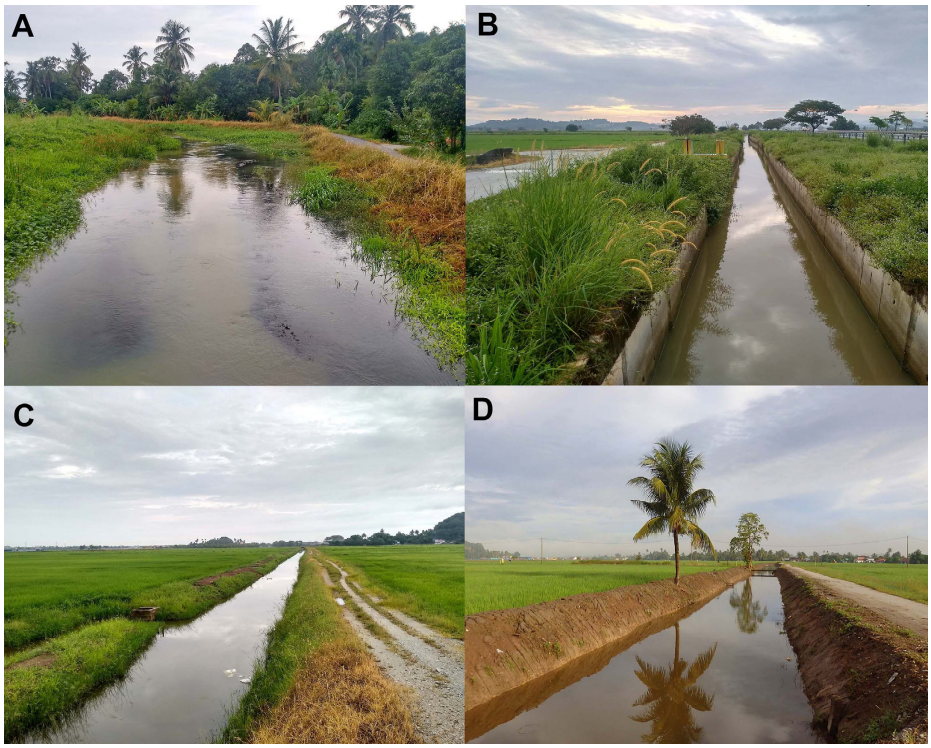

Figure 3. Habitats of *Amphilophus citrinellus* in the rice agroecosystem. A: river, B: concretised river, C and D: storm drain. Blood parrot cichlid was collected from the storm drain. Photograph by M. Aqmal-Naser.

in 10% formalin solution and later transferred to 75% ethanol and deposited in Universiti Malaysia Terengganu Zoological Collection (UMTZC). Standard length (SL) was measured from the tip of the upper jaw to the base of caudal fin using dial calipers. A set of eight selected meristic

Table 1. Comparison of selected meristic counts between *Amphilophus citrinellus*, *Vieja melanura*, and blood parrot fish from literature and specimens collected in this study. Numbers in parentheses indicate the average values. NHM: Natural History Museum, London, UK.

Species	*Amphilophus citrinellus*					*Vieja melanura*	Blood Parrot	*Amphilophus citrinellus*	
Author	Günther et al. (1905)	Astorqui (1972)	Barlow & Munsey (1976)	Villa (1976)	Stauffer & McKaye (2002)	McMahan et al. (2011)	This study		
Origin	Lake Nicaragua	Lake Nicaragua	Lake Nicaragua	Type specimen (NHM)	Syntypes (NHM)	Type locality (Laguna de Petén)	Penang		
n	3	17	30	2	3	85	1	25	mode
Dorsal spine	16–17	16–17	16–17	16–17	16–17	16–18	16	15–17	(16)
Dorsal fin rays	11–12	10–12	10–13	12	11–12	11–12	13	11–12	(12)
Anal spine	7	6–8	7	7	3	5–7	7	5–7	(7)
Anal fin rays	8–9	8–9	7–9	8–9	8–9	7–9	11	8–9	(9)
Pectoral fin rays	–	14–15	–	15	15	13–16	14	14–15	(14)
Pelvic fin rays	–	5	–	5	5	–	5	5	(5)
Caudal fin rays	–	–	–	16	–	–	16	16–18	(16)
Lateral line scales	31–33	30–34	28–31	31–34	30–31	–	30	30–32	(30)

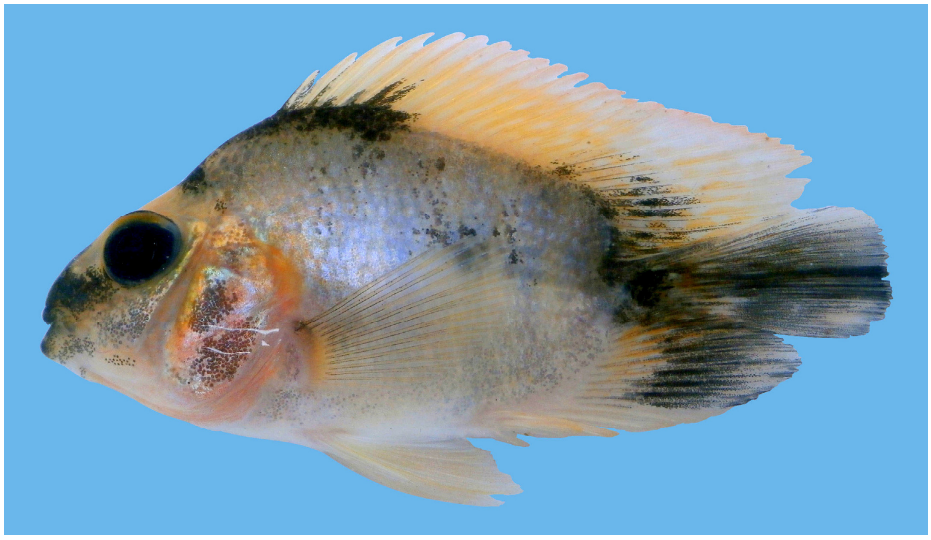

Figure 4. Blood parrot fish with undesirable (for ornamental fish trade) colour and form, 46.0 mm SL specimen. Coll: M. Aqmal-Naser, 22 June 2018. Photograph by M. Aqmal-Naser.

characters were identified and counted; dorsal spine, dorsal spine rays, anal spine, anal spine rays, pectoral fin rays, pelvic fin rays, caudal fin rays and lateral line scales, following Stauffer and McKaye (2002). Data were taken on the left side of specimens (n = 26) by the first author to reduce bias. A simple comparison of selected meristic counts between blood parrot fish, *Vieja melanura* and *Amphilophus citrinellus* from literature and from specimens collected in this study were made to further validate the identitiy of *Amphilophus citrinellus* collected in this study (Table 1).

Results

From this survey, we collected a hybrid cichlid fish, commonly known as blood parrot (Figure 4). Liew et al. (2012) stated that the hybrid is most likely produced through hybridization between two cichlid species, *Amphilophus citrinellus* and *Vieja melanura.* We also collected an introduced

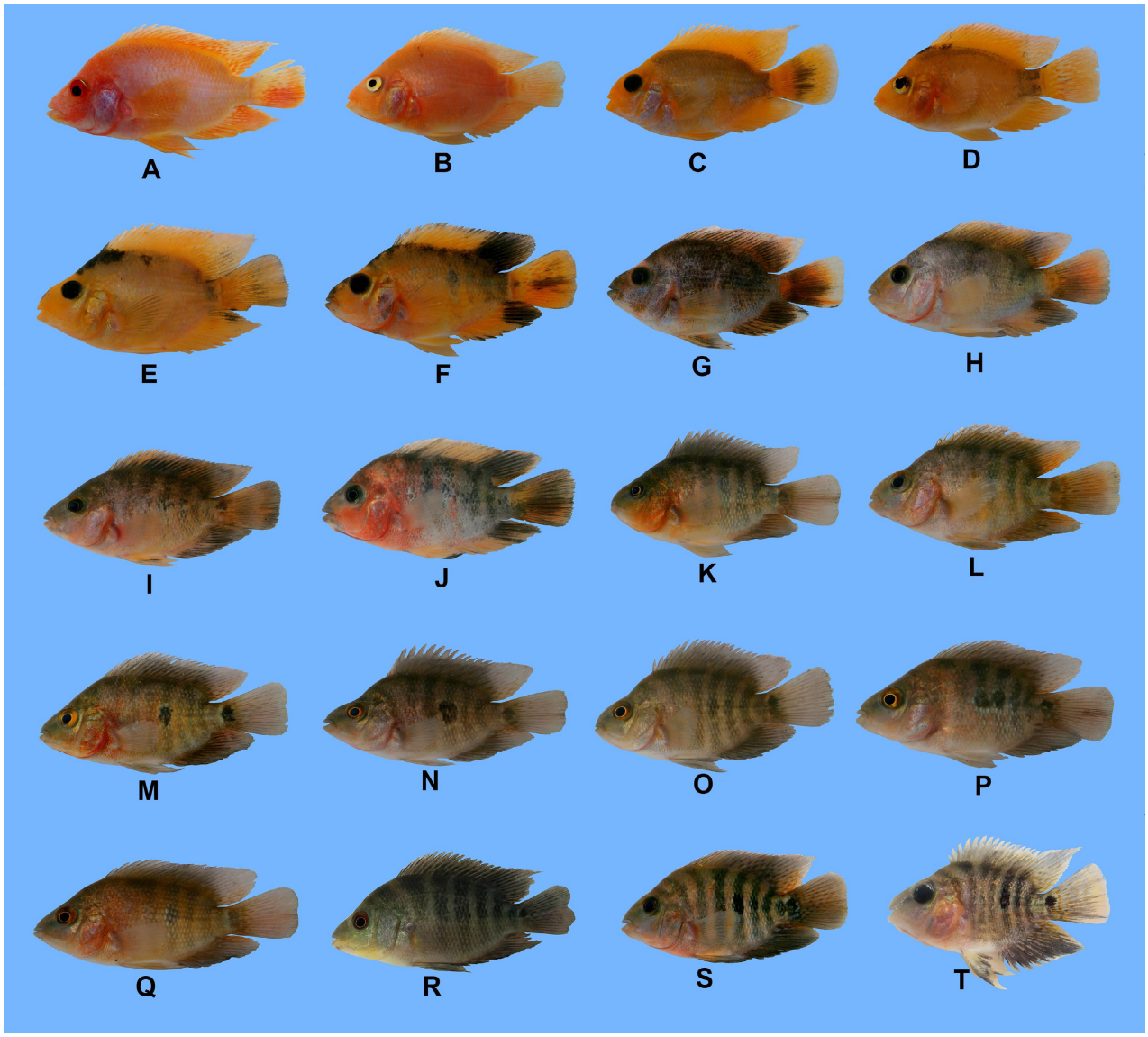

Figure 5. *Amphilophus citrinellus*, SL – 72.0 mm (A), 63.0 mm (B), 52.0 mm (C), 55.0 mm (D), 64.0 mm (E), 54.0 mm (F), 56.0 mm (G), 65.0 mm (H), 70.0 mm (I), 64.0 mm (J), 64.0 mm (K), 42.0 mm (L), 52.0 mm (M), 44.0 mm (N), 44.0 mm (O), 64.0 mm (P), 54.0 mm (Q), 72.0 mm (R), 68.0 mm (S), 62.0 mm (T). coll: M. Aqmal-Naser, June 2018 until March 2019. Photograph by M. Aqmal-Naser.

species, *Amphilophus citrinellus* (Figure 5), commonly known in the aquarium fish trade as Midas cichlid with various phenotypes. However, no specimen of *Vieja melanura* was obtained during the survey.

Blood parrot hybrid

Material examined: One specimen (UMTZC 8001) from stagnant water in a storm drain, in rice field, Seberang Perai Tengah, Penang, coll: M. Aqmal-Naser, 22 June 2018.

Diagnostic characters: The specimen was identified as blood parrot based on following characteristics: 13 dorsal fin rays, 11 anal fin rays, truncated body shape with thick foreback, beak-shaped mouth that cannot be fully closed, which is different from a typical *Amphilophus citrinellus* that possess 12 dorsal fin rays, 9 anal fin rays, compressed body with steeper

forehead and fleshy lip. The hybrid also usually has oddly shaped and variations of iris – either oval or round. Some of the juveniles have dark stripes, but these eventually fade away within the first four months as they grow (Fishlore 2018). The tail might be cut off to produce a heart shape body (thus it is also called as heart parrot).

Amphilophus citrinellus

Material examined: 25 ex. (UMTZC 8002; 25) from stagnant water in a storm drain, in rice field, Seberang Perai Tengah, Penang, coll: M. Aqmal-Naser, June 2018 until March 2019.

Diagnostic characters: This species has great variation in colouration and morphology, thus its identification can be more complicated compared to other species (Barlow 1976; Tan 2014). According to Barlow (1976), *Amphilophus citrinellus* has a steeper anterior head profile, deeper body and thinner upper and lower lips compared to the nearest species, *Amphilophus labiatus* (Günther, 1864). In Malaysia, the identification becomes easier as there are not many species that look similar to *Amphilophus citrinellus*, especially those with orange colouration. The barred morph of *Amphilophus citrinellus* could be distinguished from the Mayan cichlid (*Mayaheros urophthalmus*), another introduced cichlid in Peninsular Malaysia, by having a smaller ocellus with no white ring at the caudal peduncle (Tan 2014). None of the individuals collected bear the characteristics of *Mayaheros urophthalmus* or *Amphilophus labiatus.*

Discussion

From the survey, we recorded one species of cichlid, *Amphilophus citrinellus* and its hybrid the blood parrot cichlid (*Amphilophus citrinellus* × *Vieja melanura*). We collected several medium size individuals (42 mm to 72 mm SL) of *Amphilophus citrinellus* in this study. This would indicate that the species could thrive well in a rice field ecosystem. The cichlid were collected from several localities (Figure 2); however, we did not collect any small fish (juveniles) of *Amphilophus citrinellus*; thus we believe the fish has not established a breeding population in this rice field ecosystem. All *Amphilophus citrinellus* collected in this study are of similar size, suggesting that these could have been a single cohort released simultaneously. We also surveyed local aquarium shops, but did not find any *Amphilophus citrinellus* or its hybrid on sale. To compare, *Amphilophus citrinellus* has already established breeding populations in Singapore, with breeding pits and size classes from juveniles to egg brooding adults detected (size ranging from 10 mm to 236 mm total length), with the species being most abundant in man-made urban stormwater ponds (Kwik et al. 2013).

The specimen of blood parrot cichlid collected might be an escapee or abandoned fish related to aquarium dumping. The caudal part was not

removed and it lacked the bright orange colour that is preferable in the trade. The blood parrot fish that have some deformities or undesirable traits (body shape and colors) are more prone to be dumped or discarded into the wild. The male blood parrot is known to be sterile; however, the female blood parrot has been reported to have the ability to breed with other cichlids (Fishlore 2018; Sharpe 2018). Some physical deformities may also prevent these fish from establishing viable populations and surviving in natural water bodies (Liew et al. 2012). The presence of *Amphilophus citrinellus* in this ecosystem could facilitate the hybridization process with other cichlids in this rice field. The degree of existing hybridization between *Amphilophus citrinellus* and other cichlids in this study area could be underestimated, because the hybrid populations are hard to detect without genetic approaches (Smith et al. 2003; Magalhães et al. 2015; Meier et al. 2017) as the family Cichlidae has shown wide intra- and inter-specific morphological and behavioural diversity (Seehausen 2006).

Based on information gathered from social media (Facebook angling group, https://www.facebook.com/groups/kelabjoranFB), cichlids have become extremely widespread and established across Peninsular Malaysia. Ng and Tan (2010) reported that cichlids are ubiquitous in Singapore, especially in estuarine and artificial freshwater systems, with *Amphilophus citrinellus* having established in almost all types of man-made habitats including reservoirs, mud ponds and concretized waterways (Ng and Tan 2010; Kwik et al. 2013; Tan 2014). Detailed knowledge on the exact distribution of *Amphilophus citrinellus* throughout Peninsular Malaysia is, however, still undetermined. The cichlid is usually recorded in abandoned mining pools and recreational lakes within the urban area where they are caught alongside other introduced cichlids including *Parachromis managuensis* (jaguar cichlid) and flower horn (another artificial hybrid cichlid) (Figure 6). In the Seberang Perai Tengah agroecosytem, *Amphilophus citrinellus* was found only in the major waterways which are the river, concretised river and storm drain. The slow-flowing to stagnant water and substratum in those habitats is similar with the native habitat of *Amphilophus citrinellus* in Lake Nicaragua, which has stagnant water and a muddy bottom (Barlow 1976).

In general, the ability of the introduced species to exploit different niches could be one of the reasons it may outnumber native species; however, the ecological effects are often hard to estimate and quantify (Trexler et al. 2000). Hassall (2014) suggested *Amphilophus citrinellus* could have a major impact on the fish assemblage of artificial habitats in Singapore. Unfortunately, the true ecological impact of the cichlid introduction on native species in natural habitats remains understudied. Possible impacts due to the existence of cichlids in rice field ecosystems on indigenous species populations include competition for natural resources (food and space) and the spread of parasites and diseases (Corfield et al. 2007). Both *Amphilophus citrinellus* and the hybrid are reported to be highly

Figure 6. *Amphilophus citrinellus* (A) caught alongside with other cichlids, *Parachromis managuensis* (jaguar cichlid) (B) and flower horn (C). Source: Fitri Mohd Noor.

aggressive (McKaye and Barlow 1976; Magalhães et al. 2017). In addition, captive cichlids have shown increased levels of aggressiveness due to competition (Oldfield 2011). Native species which share the same habitat with *Amphilophus citrinellus* in this agroecosystem are *Clarias macrocephalus*, *Pristolepis fasciata,* and several smaller species, such as *Rasbora trilineata*, *Oryzias javanicus* and *Lepidocephalichthys hasselti* (Aqmal-Naser and Ahmad 2018a, b). In this rice agoroecosystem, *Amphilophus citrinellus* also co-exist with other introduced species such as *Trichopodus pectoralis*, *Oreochromis niloticus* and *Barbonymus gonionotus* (Aqmal-Naser and Ahmad 2018a, b). Since *Amphilophus citrinellus* is omnivorous and consumes a variety of food, including algae, insects and small fishes (Barlow 1976), fish larvae and small-sized species in this ecosystem are prone to the predation threats posed by *Amphilophus citrinellus*.

Conclusion

The existence of the *Amphilophus citrinellus* and the associated hybrid in the Seberang Perai Tengah rice agroecosystem provide a clear signal that artificial environments with high degrees of disturbance are not a major obstacle for introduced species to thrive. Dumping of introduced aquarium fish species, one of the major vectors of biological invasion of the aquatic environment, must be monitored. Public awareness may be the only efficient approach to reduce the spread of introduced species in Malaysian

waters as ornamental fish keeping hobby starting to grow and flourish among Malaysian. At the moment, little has been done to increase awareness among local hobbyists, but continuous awareness programmes through social and mass media could spark awareness of the threats caused by alien introduced species toward native ecosystems.

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