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Fishes of the Brantian drainage, Sabah, Malaysia, with description of a new *Rasbora* species (Teleostei: Cyprinidae)

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Abstract. Fish surveys were conducted between 2011 and 2017 in the Brantian drainage, Sabah, Malaysia. The fish fauna of the Brantian drainage includes a total of 34 species in 14 families, of which 23 species are reported from this drainage for the first time. All recorded species except one (*Oreochromis mossambicus*) are native, and 25 species are endemic to Borneo. *Rasbora pycnopeza*, new species, is described herein, based on specimens from the Brantian drainage. Specimens of the new species were earlier identified as *R. sumatrana,* from which it is distinguished by a combination of characters, including: geographic distribution, slender body and distinctive caudal-fin colour pattern consisting of a thick distal black margin (covering ⅓ to ½ of upper and lower caudal fin lobes); a thin black lateral stripe and a black supraanal stripe.

Key words. biodiversity, checklist, freshwater fishes, Borneo, Cyprinidae, *Rasbora*

INTRODUCTION

The freshwater ichthyofauna of the island of Borneo is relatively well studied compared to other islands in Southeast Asia beginning with the pioneering work of Inger & Chin (1962). More recent studies are those on the Kapuas River, West Kalimantan (Roberts, 1989), Sabah (Ng et al., 2017), Sentarum lakes (Kottelat & Widjanarti, 2005), Rejang River (Parenti & Lim, 2005), Belait River (Parenti & Meissner, 2003), Temburong River (Choy & Chin, 1994), Segama River (Martin-Smith & Tan, 1998), Kinabatangan River (Lim & Wong, 1994), Tawau Hills (Nyanti et al., 1995), Bintulu region, Sarawak (Tan & Lim, 2007), Crocker Range (Rahim et al., 2002), and Rayu basin (Doi et al., 2001). Despite these studies, the ichthyofauna of the Brantian drainage near Kalabakan, has not previously been documented.

The Brantian drainage is a medium sized drainage in Sabah, East Malaysia, unlike the larger drainages of the Segama and the Kinabatangan which were the focus of earlier studies of the faunal diversity of freshwater ecosystems (Martin-Smith & Tan, 1998). Seasonal changes in the lowland dipterocarp forests of Borneo are very limited, resulting in no contrasting seasons (Kumagai et al., 2005; Walsh & Newbery, 1999) other than occasional droughts. The Brantian drainage is at low elevation, with sites ranging up to around 400 m above sea level.

Headwater streams dominate the sampling locations in this study and may harbour endemic species (e.g., loaches in the Family Gastromyzontidae) which are specialised for fast flowing, highly oxygenated waters (Roberts, 1989). In addition, horizontal variation in fish communities occurs over short geographic distances in this region (Martin-Smith & Tan, 1998), and is important in determining the overall biodiversity, especially if species composition differs between drainages (Kottelat & Whitten, 1996). Some difference is thus expected between these communities and the Brantian drainage.

The Brantian river and tributaries, predominantly in the Kalabakan Forest Reserve drains a landscape that is a mosaic of twice-logged lowland dipterocarp rainforest, oil palm plantations (planted between 1998 and 2011; with and without riparian buffers), and primary rainforest (Brantian Tantulit Virgin Jungle Reserve). We sampled sites across this land use gradient, as fish communities were thought to be influenced by different land uses.

New species are regularly discovered from Sabah, and more widely across Borneo, demonstrating that our knowledge of freshwater fish in the region is incomplete. A series of field collections from across the drainage were conducted from 2011 to 2017 by both authors. We present here a list of the species known from the Brantian drainage, and describe a new species of *Rasbora* herein (see Appendix 1).

MATERIAL AND METHODS

Qualitative and quantitative samples were taken of fish from 39 streams across the Upper Brantian catchment as part of the Stability of Altered Forest Ecosystems (SAFE) project (Ewers et al., 2011) (Fig. 1) during the period October 2011–June 2017 (Fig. 2a–d).

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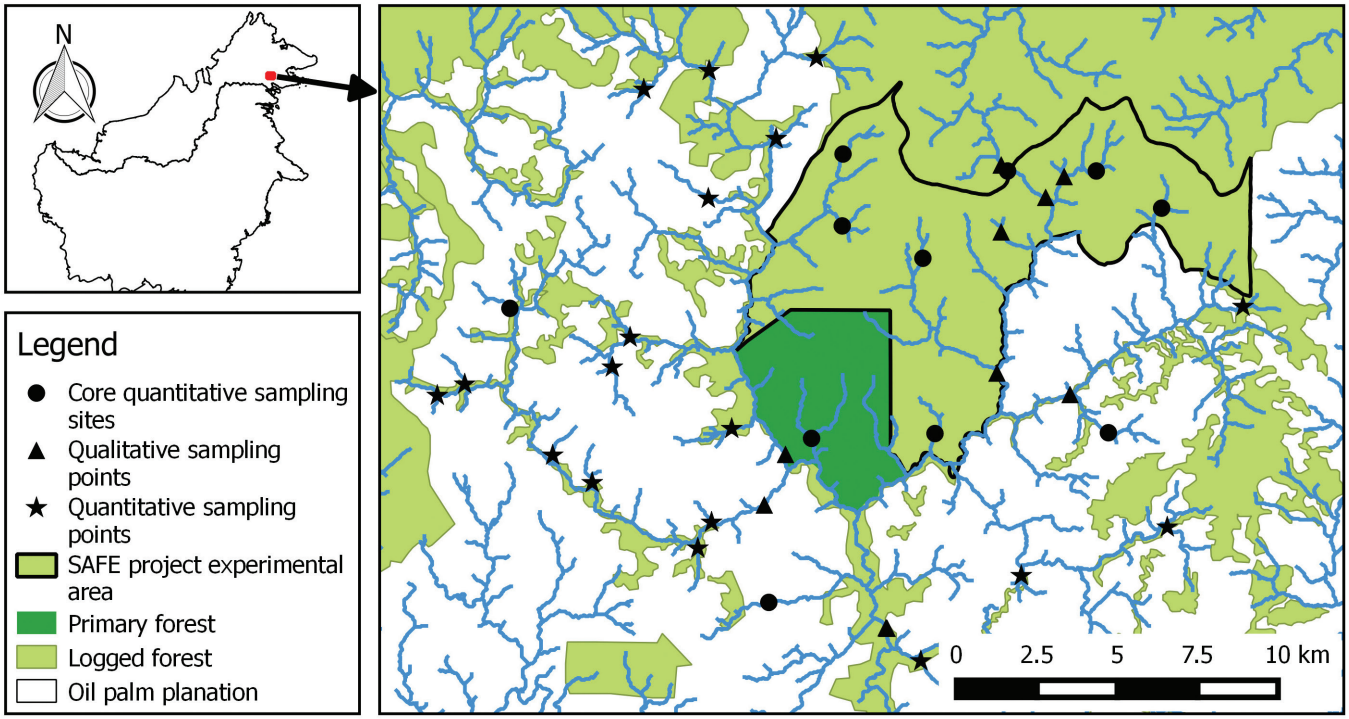

Fig. 1. Map of all core quantitative (circles), other quantitative (stars), and qualitative (triangles) sampling locations in the Brantian catchment.

Fig. 2. Examples of streams across the land use gradient in the Brantian catchment. A, primary forest stream within the Tantulit Virgin Jungle Reserve (2015); B, logged forest river (Brantian River, 2017); C, Oil palm estate river with a riparian reserve (Menggaris River, 2017); D, Oil palm estate stream with no riparian reserve (RR16, 2017).

For quantitative sampling, two methodologies were applied to collect fishes. (1) Fish were sampled every year from 2011 to 2017 (excluding 2012 and 2014) from 200-m transects at 11 different head streams across the land use gradient using cast netting (2.75 m diameter of net and 1 cm mesh size; as done by Wilkinson et al., 2018a, 2018b) and baited funnel traps (1.5 L plastic water bottles with an entrance diameter of 2.6 cm). Streams were sampled for four to six consecutive days, with up to 20 throws of the cast net and 20 traps (10 baited with bread and 10 with fresh fish, placed every 10 m along the stream). This long term experiment was set up to monitor the impact of salvage logging and conversion of land to oil palm plantation in six stream catchments in a before-after-control-impact design, as part of the SAFE project. (2) Exhaustive sampling on clear-weather days using three capture methods, performed in the following order at each site: (a) multiple pass electrofishing (EFGI 650), (b) cast net (2.75 m diameter of net and 1 cm mesh size), and (c) push net (60 cm by 40 cm, mesh size 2mm, double net layer) was used in 100 m transects in the 11 catchments described, and 16 additional oil palm streams with varying widths of riparian reserves and two additional logged forest streams, February–June 2017 (Wilkinson et al., 2018a, 2018b).

Qualitative samples in the Lower Brantian River and tributaries were taken opportunistically based on access to streams and rivers. Ten sites were sampled between February–June 2017 using cast net, push net and electrofishing. Details of these locations and the methods used are given in Appendix 2. The species observed or recorded in the Brantian drainage are listed in Table 1.

All measurements for the new species description are taken with dial callipers from point-to-point on the left side (whenever possible) of specimens. The method for taking counts and measurement follow Kottelat (2001) and Kottelat & Freyhoff (2007). Trunk length is measured from tip of posterior-most margin of opercle to base of caudal fin. The last two branched dorsal and anal rays articulating on a single pterygiophore are counted as "1½". Unless otherwise noted, nomenclature follows Kottelat (2013). Abbreviations: SL = standard length; TL = total length.

Unless otherwise stated, our material will be eventually deposited in the Borneensis Collection, Sabah, Malaysia and the Zoological Reference Collection (ZRC) of the Lee Kong Chian Natural History Museum, National University of Singapore.

RESULTS

A total of 34 species of fishes in 14 families are recorded from present surveys. Twenty-five species (73.5%) are endemic to Borneo, of which *Gastromyzon ingeri* appears to be restricted to Sabah (see Table 1). One family and one species (Cichlidae, *Oreochromis mossambicus*) is non-native to Sabah and the region.

Table 1. List of fishes collected within the Brantian drainage as a result of this study (* endemic to Borneo).

Family Anguillidae
Anguilla marmorata
*Anguilla borneensis**

Family Megalopidae
Megalops cyprinoides

Family Cyprinidae
*Barbodes sealei**
*Barbonymus balleroides**
Cyclocheilichthys apogon
Cyclocheilichthys repasson
*Hampala sabana**
*Leptobarbus melanotaenia**
*Nematabramis everetti**
*Osteochilus chini**
*Osteochilus ingeri**
*Parachela ingerkongi**
Rasbora elegans
*Rasbora pycnopeza**
*Rasbora hubbsi**
*Rasbora rutteni**
Tor tambra

Family Cobitidae
*Pangio mariarum**

Family Nemacheilidae
*Nemachilus olivaceus**

Family Sisoridae
*Glyptothorax major**

Family Bagridae
*Hemibagrus baramensis**
*Hemibagrus fortis**

Family Clariidae
*Clarias anfractus**

Family Gastromyzontidae
*Gastromyzon ingeri**
*Gastromyzon lepidogaster**
*Parhomaloptera microstoma**
*Protomyzon aphelocheilus**
*Protomyzon borneensis**
*Protomyzon griswoldi**

Family Osphronemidae
*Betta ocellata**

Family Channidae
Channa striata

Family Mastacembelidae
Mastacembelus unicolor

NON-NATIVE

Family Cichlidae
Oreochromis mossambicus

Family Anguillidae

Anguilla borneensis Popta

Remarks. Commonly found in small hill streams and larger rivers in all land use types.

Anguilla marmorata Quoy & Gaimard

Remarks. Commonly found in the majority of sites and all land use types.

Family Megalopidae

Megalops cyprinoides (Broussonet)

Remarks. One single sub-adult specimen was collected in the Brantian River mainstream with a cast net. The presence of both Megalopidae and Anguillidae indicate that the Brantian drainage still has direct passage to the sea, as these two taxa require a marine phase in their life cycles.

Family Cyprinidae

Barbodes sealei (Herre)

Puntius sealei – Inger & Chin, 1962: 73, Fig. 30C.

Fig. 3. *Rasbora pycnopeza*, new species, live specimen from Tawau, not preserved (photographed by second author in 2008).

Fig. 4. *Rasbora pycnopeza*, new species, freshly dead specimen from Kalabakan Forest Reserve (photographed by second author in 2011).

Remarks. Most common fish in both forested and oil palm estate catchments. Species seems highly plastic, with slight variations in body depth and coloration, dependent upon stream features (e.g., rate of water flow; pers. obs., Martin-Smith & Tan, 1998).

Barbonymus balleroides (Valenciennes, in Cuvier & Valenciennes)

Puntius bramoides – Inger & Chin, 1962: 75, Fig. 33.

Remarks. Present but not abundant in any streams in this study, in comparison to being described as common in Danum Valley (Martin-Smith & Tan, 1998).

Cyclocheilichthys apogon (Valenciennes, in Cuvier & Valenciennes)

Remarks. This appears to be a new record for the Brantian drainage.

Cyclocheilichthys repasson (Bleeker)

Cyclocheilichthys repasson – Inger & Chin, 1962: 67.

Remarks. Common in larger rivers, but rare in fast flowing water, forested stream catchments.

Hampala sabana Inger & Chin

Hampala macrolepidota sabana × *bimaculata* – Inger & Chin, 1962: 82, Fig, 37.

Remarks. Common in forested stream catchments but never abundant (present study; Martin-Smith & Tan, 1998). Rare in oil palm estate catchments. Individuals have been found eating or having just eaten other fishes.

Leptobarbus melanotaenia Boulenger

Remarks. Found predominantly in pools of forested stream catchments. It is common but not abundant.

Nematobramis everetti Boulenger

Nematabramis everetti – Inger & Chin, 1962: 49.

Remarks. Ubiquitous and highly abundant in forested streams. Abundance is lower in highly disturbed or oil palm estate streams.

Fig. 5. *Rasbora pycnopeza*, new species, ZRC56719, holotype, 87.8 mm SL (top with black background, bottom with white background), from SAFE 120m stream in Kalabakan Forest Reserve.

Osteochilus chini Karnasuta

Remarks. Ubiquitous but not very abundant in smaller streams, feeding on detritus and algae.

Osteochilus ingeri Karnasuta

Remarks. Less abundant, but often sympatric with *O. chini*. It differs from *O. chini* in the number of scale rows above lateral line (4–4½ for *O. ingeri* vs. 5–5½ for *O. chini*), and colour of fins (yellowish for *O. Ingeri*, and reddish for *O. chini*).

Parachela ingerkongi (Banarescu)

Remarks. Rare, present in fast flowing, forested streams and large rivers.

Rasbora elegans Voltz

Rasbora elegans – Inger & Chin, 1962: 54.

Remarks. Rare. Found only at one logged forest site (R70B) at the eastern edge to of the Brantian catchment.

Rasbora hubbsi Brittan

Rasbora hubbsi – Inger & Chin, 1962: 60.

Remarks. A small species, TL up to 43.9 mm, considerably smaller than *R. pycnopeza*. Found in fast flowing streams in forested streams and rivers, but rare in oil palm estate streams.

Rasbora pycnopeza, new species
(Figs. 3–5)

Remarks. A new species of *Rasbora* that has been confused previously with *R. sumatrana.* See Appendix 1 for Description and Table 2 for morphometric data.

Rasbora rutteni Weber & de Beaufort

Remarks. Rare. Present only at two sites, including one steep, boulder strewn primary forest stream and one still water pool adjacent to the Brantian River.

Tor tambra (Valenciennes, in Cuvier & Valenciennes)

Remarks. We herein treat *Tor tambra* as one species. *Tor tambra* is the valid name if *Tor tambra* and *Tor tambroides* are assumed to be synonyms (following Kottelat, 2013). Juveniles are common in small fast flowing streams and while larger individuals were found in larger streams and Brantian river. Both morphotypes of *Tor* (*tambra* with a short mental lobe, and *tambroides* with a long mental lobe) are present in this region (see Fig. 6).

Fig. 6. *Tor tambra*, ZRC uncatalogued specimens showing two morphotypes – left specimen 100.0 mm SL with short lower lip mentum, right specimen 107.5 mm SL with long lower lip mentum; both collected from same location on the same day.

Fig. 7. *Gastromyzon ingeri*, ca. 40 mm SL, not preserved; Kalabakan Forest Reserve (photographed by the second author in 2011).

Table 2. Morphometric data of holotype (ZRC 56719) and 20 paratypes (ZRC 56720–56731) of *Rasbora pycnopeza*, new species.

	Holotype	**Paratypes (data below includes holotype)**		
Standard length (mm)	87.8	67.1–104.1		
% standard length		**Range**	**Mean**	±SD
Total length	130.3	127.8–135.8	131.0	2.1
Body length	78.4	74.1–78.8	76.1	1.4
Predorsal length	53.4	49.6–54.6	52.1	1.1
Preanal length	68.7	63.3–69.7	67.1	1.7
Prepelvic length	47.7	42.6–50.1	47.4	1.8
Head length	23.0	22.5–26.7	25.0	1.0
Body depth at dorsal-fin origin	25.6	22.1–25.9	23.9	1.0
Body depth at anus	20.8	18.2–22.3	19.8	0.9
Caudal peduncle depth	13.4	11.9–13.7	12.7	0.5
Caudal peduncle length	21.5	21.2–25.7	23.2	1.3
Dorsal-fin base length	12.0	10.1–13.8	11.9	1.0
Anal-fin base length	10.9	9.5–11.5	10.5	0.4
Pelvic-fin length	20.7	16.7–21.1	18.8	1.1
Pectoral-fin length	22.9	18.1–22.9	20.9	1.1
Upper caudal-fin lobe length	31.8	29.4–35.1	31.8	1.7
Median caudal-fin length	19.0	16.3–20.9	18.1	1.3
Lower caudal-fin lobe length	34.1	31.1–37.2	33.6	1.7
% head length				
Head width	52.0	48.9–57.3	52.7	2.4
Snout length	33.7	28.3–34.2	31.3	1.7
Orbital diameter	25.2	26.5–31.2	28.5	1.3
Interorbital width	44.6	39.4–53.1	46.2	3.6

Family Cobitidae

Pangio mariarum (Inger & Chin)

Remarks. Rare. A single specimen was found inhabiting a submerged root mat in Sungei Menggaris (a low gradient river).

Family Gastromyzontidae

Gastromyzon ingeri Tan

Remarks. A common species of *Gastromyzon* found in riffles of forested streams and rivers. The live colouration of this species has not been documented previously (see Tan, 2006). Living fish having a brownish-yellow body colouration, turquoise sheen over body dorsum, with gold highlights on every dorsal and lateral body scale; eye with a thin gold iris; dorsal fin hyaline with 2–3 rows of black spots; pectoral and pelvic fins brownish-yellow; anal fin hyaline; base of caudal peduncle and fin is grey, caudal fin is light-blue with up to 5 rows of black spots (Fig. 7).

Gastromyzon lepidogaster Roberts

Remarks. The most common and abundant *Gastromyzon* in the headwaters of the Brantian stream, found in all land uses. As with other studies, it is the largest *Gastromyzon* (up to 94 mm SL, vide Tan, 2006), can be variable in colour and is often found in small groups.

Parhomaloptera microstoma (Boulenger)

Remarks. This is an uncommon species, but abundant when found in fast flowing riffles of forested streams.

Protomyzon aphelocheilus Inger & Chin

Remarks. This species has been collected thus far in a single fast flowing hill stream only, but can be expected to occur in other similar habitats in the Brantian drainage.

Protomyzon borneensis Hora & Jayaram

Remarks. Uncommon species, but always sympatric with *P. griswoldi*.

Protomyzon griswoldi (Hora & Jayaram)

Remarks. A highly ubiquitous species found in small groups. It can easily be observed feeding whilst snorkelling in streams. Abundant in both forested and oil palm estate streams.

Family Nemacheilidae

Nemacheilus olivaceus Boulenger

Remarks. Ubiquitous species, also commonly found in groups in both forested and oil palm estate streams.

Family Bagridae

Hemibagrus baramensis (Regan)

Remarks. Ubiquitous species, but most common in oil palm estate streams. Predominantly caught in baited traps or electrofishing.

Hemibagrus fortis (Popta)

Remarks. Less common than *H. baramensis*, but also predominantly found in oil palm estate streams.

Family Clariidae

Clarius anfractus Ng

Remarks. Uncommon species, only found in low gradient oil palm estate streams with riparian reserves.

Family Sisoridae

Glyptothorax major (Boulenger)

Remarks. This species inhabits riffles and other fast flowing sections of streams. Specimens from Sabah have all been identified as *G. major* (vide Ng & Kottelat, 2016).

Family Cichlidae

Oreochromis mossambicus (Peters)

Remarks. This is an introduced species thus far obtained from one oil palm estate stream, but its presence is expected to be wider in distribution.

Family Gobiidae

Stenogobius gymnopomus (Bleeker)

Stenogobius gymnopomus – Inger & Chin, 1962: 179.

Remarks. This species was not obtained from the present surveys, as the lower reaches of the Brantian River were not thoroughly sampled. It is included here as it had been previously recorded by Inger & Chin (1962) for completeness.

Family Osphronemidae

Betta ocellata de Beaufort

Betta unimaculata – Inger & Chin 1962: 158.

Remarks. Present in some forested streams, but rare in comparison to its abundance in other catchments (e.g. Segama, Danum Valley; H. H. Tan, pers. obs.).

Family Channidae

Channa striata (Bloch)

Remarks. Uncommon species in this catchment. Several specimens collected from oil palm estate streams.

Family Mastacembelidae

Mastacembelus unicolor Valenciennes, in Cuvier & Valenciennes

Remarks. This species of spiny eel is uncommon, but present in all land use habitats. Only several individuals were encountered.

DISCUSSION

The total number of fish species collected from the Brantian catchment in the Kalabakan Forest Reserve and surrounding area now stands at 34. This is lower than nearby catchments of the Upper Segama (47 species) and Kuamat (36 species; Martin-Smith & Tan, 1998). The Brantian drainage is smaller than the Segama and Kuamat drainages, and has been subjected to more severe logging regimes and conversion of land to palm oil plantations, so this lower number was expected. However, the surveys of this catchment are restricted to foothills and the upper reaches. It is expected that this list could be extended, as in the adjacent Kalabakan basin an additional 20 species were recorded by Inger & Chin (1962; with taxonomic updates herein), predominantly from the lower reaches or tidal areas. These include: *Anguilla bicolor* (Anguillidae), *Nemacheilus elegantissimus* (Nemacheilidae), *Ompok sabanus* (Siluridae), *Leiocassis collina* (Bagridae), *Arius microcephalus* (Ariidae), *Dermogenys bispina* (Zenarchopteridae), *Osphronemus goramy* (Osphronemidae), *Johnius semiluctuosus* (Sciaenidae), *Prionobutis dasyrhycnhus*, *Eleotris fusca*, *E. melanosoma* (Eleotridae), *Periophthalmodon septemradiatus*, *Awaous stamoneus*, *Glossogobius giuris*, *Pseudogobiopsis javanicus*, *P. oligactis*, *Redigobius isognathus* (Gobiidae), *Taenioides cirratus* (Taenioinidae), and *Pao leiurus* (Tetraodontidae).

As expected, species composition varies by land use and stream order. Some species are absent or abundance is drastically reduced in oil palm estate streams (e.g., Gastromyzontidae), but many were also only found within oil palm estate streams (e.g., *Clarias anfractus*, *Oreochromis mossambicus*, and *Pangio mariarum*, present study). Many species are specific to particular stream orders. Members of the Gastromyzontidae are restricted to fast, flowing low order streams, whereas many families (Megalopidae, Siluridae) were only found in higher order rivers, and we expect that species in the families of Ariidae, Zenarchopteridae, Sciaenidae, Eleotridae, Gobiidae, Taeniodidae, Tetraodontidae, would be restricted to the lower reaches with some restricted in brackish waters (Inger & Chin, 1962).

A current total of 166 species has been recorded in Sabah (Ng et al., 2017), however more species are being described, including one in this study, so it is estimated that more species will continue to be discovered. Despite extensive logging or land conversion in the Brantian drainage, relatively high levels of species richness are observed. We urge others to continue to survey widely across Sabah, to document species diversity and to determine how land use change is affecting freshwater ecosystems and thus diversity.

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Appendix 1. Description of *Rasbora pycnopeza,* new species

Rasbora pycnopeza, new species
(Figs. 3–5)

Rasbora sumatrana (non-Bleeker) – Brittan, 1954: 56 (part), fig. 7; Inger & Chin, 1962: 56, fig. 23; Kottelat et al., 1993: 65 (part); Martin-Smith & Tan, 1998: 584; Chin, 2002: S-12, fig. S7.
Rasbora cf. *sumatrana* – Tan, 2013: no. 9.

Material examined. *Holotype*. ZRC56719, 87.8 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, 120 m stream (SAFE project experimental area); Wilkinson CL, July 2015.

Paratypes. ZRC56720, 1 ex., 74.2 mm SL; same locality data as holotype. – ZRC56722, 2 ex., 90.0–104.1 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, 30 m buffer stream (SAFE project experimental area); Wilkinson CL, 21 June 2016. – ZRC56721, 3 ex., 70.3–80.4 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, 30 m stream (SAFE project experimental area); Wilkinson CL, 23 April 2016. – ZRC56730, 3 ex., 74.2–88.1 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, 30 m buffer stream (SAFE project experimental area); Wilkinson CL et al., 23 April 2017. – ZRC56723, 1 ex., 78.3 mm SL, Malaysia: Sabah: Brantian drainage near Kalabakan, Virgin Jungle Reserve stream (SAFE project experimental area); Wilkinson CL et al., 23 June 2016. – ZRC56724, 3 ex., 80.7–100.4 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, 0 m buffer stream (SAFE project experimental area); Wilkinson CL, July 2015. – ZRC56725, 2 ex., 88.3–102.7 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, 0 m buffer stream (SAFE project experimental area); Wilkinson CL, July 2015. – ZRC56728, 6 ex., 63.0–75.5 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, Logged Forest Edge stream (SAFE project experimental area); Wilkinson CL, 4 May 2015. – ZRC56731, 1 ex., 77.8 mm SL; ZRC56730, 3 ex., 74.2–88.1 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, Logged Forest Edge stream (SAFE project experimental area); Wilkinson CL et al., 24 April 2017. – ZRC56729, 2 ex., 64.8–71.0 mm SL; Malaysia: Sabah: Brantian drainage near Kalabakan, Virgin Forest Reserve stream (SAFE project experimental area); Wilkinson CL, 7 May 2015. – ZRC56726, 1 ex., 73.3 mm SL; Malaysia: Sabah: Segama drainage near Danum Valley field centre, West Stream; Wilkinson CL, 1 March 2016. – ZRC56727, 2 ex., 65.5–65.8 mm SL; Malaysia: Sabah: Segama drainage near Danum Valley field centre, Tembaling Stream; Wilkinson CL, 10 March 2016.

Diagnosis. *Rasbora pycnopeza* is distinguished from its congeners in Southeast Asia by the following combination of characters: size up to at least 104mm (SL) and its distinctive caudal-fin colour pattern consisting of a thick distal black margin, covering ⅓ to ½ of upper and lower fin lobes; a distinct thin black lateral stripe starting 5–6 scales posterior to opercle edge to base of caudal-fin; and a black stripe at supraanal region covering entire anal-fin base. When live or freshly preserved, dorsal fin is orange, pectoral, pelvic and anal fins are yellow, and the caudal fin is faintly yellow with a distinct black margin, the upper and lower caudal-fin lobes with up to a third or half black.

Description. General appearance in Figs. 3, 4 and 5; morphometric data of holotype and 20 paratypes in Table s3. Streamlined, slender body, deepest at dorsal-fin origin, tapering towards the caudal peduncle. Snout pointed, symphysal knob present. Dorsal fin with 1 simple and 7½ branched rays; origin above lateral line scale 10–13. Pectoral fin slightly falcate, with 15 rays, not reaching pelvic-fin origin. Pelvic fin slightly pointed, with 9 rays, reaching about anus; axillary scale present. Anal fin with 1 simple and 5½ branched rays. Caudal peduncle 1.6–2.0 times longer than deep, and caudal fin length appears large (TL – SL) is 210.1–279.5 % caudal peduncle depth, with 8–9 + 10 principle rays, 7–8 + 9 branched; deeply forked. Lateral line complete, perforating 28–33 + 1 scales (29 + 1 modally) along lateral line, 10–12 predorsal scales (12 modally), ½4/1/1½ scales in transverse, ½3/1/1½ scales in transverse on caudal peduncle, 1 scale between lateral line and pelvic-fin origin. Vertebral count consist of 15–16 abdominal + 16–17 caudal, total of 31–33 (mode 33, n = 21).

Colouration. See figure of preserved specimen (Fig. 5). Body dark brown on the dorsum, fading to yellowish brown on the lateral and cream on the ventrum. Dorsum has a fine reticulated pattern due to diffused melanophores along posterior edge of body scales, darker and more defined dorsally and paler ventrally only extending below midlateral stripe anteriorly. A black midlateral stripe originating 5–6 lateral scales posterior to opercle edge to caudal-fin base. Black lateral stripe most defined in central to posterior half (up to half a scale deep), and ends in a widened but faint elongated triangular blotch at caudal-fin base, not continuing on median caudal rays. A conspicuous black, elongated supra-anal streak, extending the length of the anal-fin base wider anterior of anal fin. Rest of fins hyaline, without black margins; except the caudal fin, which has a distinct black posterior margin covering ⅓ to ½ of the fin.

In life (Figs. 3, 4; Martin-Smith & Tan, 1998: 584): Body silvery, lateral line dark blue; supra-anal streak black, conspicuous; orange dorsal fin; yellow pectoral, pelvic and anal fins; yellow caudal fin with a distinct black posterior margin covering ⅓ to ½ of the fin.

Distribution. *Rasbora pycnopeza* is currently recorded from Kinabatangan (plus the Kuamut sub-basin draining from Danum Valley), Segama, Tawau Hills, and Kalabakan basins in western Sabah. Inger & Chin (1962: 57) also lists the following locations (but material from these locations have not been examined except marked with *): Jesselton District – Menggatal; Kinbatangan District – Sungei Gaja, Sungei Kretam Kechil, Deramakot; Sandakan District – Sungei Gum Gum, Sungei Kabili*, Sandakan, Sungei Sapagaya, Sepilok Forest Reserve*; Semporna District – Sungei Mapat; Tawau District – Selimpopon River, Sungei

Tawau*, Sungei Balung, Sungei Kinabutan, Sungei Tawan, Sungei Magam, Sungei Brantian; Tuaran District – Kiulu. Chin (2002: SC-12) includes Ranau District – Ranau, Sungei Liwagu*. It is expected to occur in the majority of these drainages in Sabah, as well as in the northernmost part of Kalimantan Timur (for example in Sembakung drainage, which originates in Sabah).

Etymology. From the conjugation of the Greek *pyknos*, meaning thick, dense; and Greek *peza*, meaning border, edge; in allusion to the thick black border of the caudal fin. Used as a noun in apposition.

Remarks. *Rasbora pycnopeza* belongs to the *Rasbora sumatrana-elegans* complex described by Brittan (1954: 53), which then included the following valid species on Borneo: *R. sumatrana*, *R. volzii*, and *R. elegans*. Brittan diagnosed this complex by a combination of the following: 12 rows of scales around the caudal peduncle, a complete lateral line, the dorsal-fin origin above or behind the posterior extremity of the pelvic-fin base, the presence of a poorly contrasted mid-lateral stripe (sometimes missing), the axial streak ending in a precaudal spot in some species, or with a conspicuous dark blotch in the middle of the side in some species. These complexes were constructed by Brittan based on the similarity of general appearance, but are now outdated by the description of numerous additional species since 1954 and species being re-described. These complexes are nevertheless a convenient tool to ease comparison of species.

Among the species originally included in the *R. sumatrana-elegans* complex, the status of *R. sumatrana* has been discussed by Tan & Kottelat (2009) and Kottelat (2005). As recognised by Brittan (1954), *R. sumatrana* was distinguished by having a black midlateral stripe ending in a diamond shaped blotch at the base of the caudal fin. *Rasbora sumatrana* sensu stricto is restricted to the highlands of western Sumatra (Tan & Kottelat, 2009). Its whole geographic range is not yet known precisely; there is also a likelihood that several species are presently confused under that name. The fishes earlier identified as *R. sumatrana* from Borneo by Brittan (1954) are now re-identified as *R. hosii* and *R. calliura* (fide Tan & Kottelat, 2009). In Borneo, there are several described taxa which we feel maybe confused with *R. pycnopeza*. These are *R. atranus*, *R. cryptica*, *R. hubbsi*, *R. tornieri*, and *R. rheophila.*

Rasbora pycnopeza is distinguished from *R. rheophila* by snout shape (pointed vs. rounded); snout length (28.3–34.2 % HL, vs. 26.3 %); shortened and conspicuous lateral stripe starting midway between pectoral and pelvic fins (vs. continuous stripe); fewer circumpeduncular scales (12 vs. 14); fewer lateral scales (28–33 +1 vs. 31 + 2); more anterior placement of dorsal-fin origin (position in relation to lateral scales 10–13 vs. 15); wider extent of pigments along the posterior margin of the caudal-fin lobes (⅓ to ½ of the fin covered, vs. extreme outer margin of upper caudal-fin lobe); and longer head length (22.5–26.7 % SL, vs. 22.9).

Tan & Kottelat (2009) concluded that *R. hosii* is the valid name of the Sarawak *R.* '*sumatrana*' from the type locality in the Baram River. *Rasbora pycnopeza* differs from *R. hosii* by a larger size (total length up to 104 mm, vs. 61–73); shorter predorsal length (49.6–54.6 % SL, vs. 55.4–57.3); less body depth at dorsal-fin origin (22.1–25.9 % SL, vs. 26.4–27.9) giving *R. pycnopeza* a slimmer appearance; more distinct black streak along whole anal-fin base (vs. a diffused appearance); midlateral black stripe is distinct and sharply contrasted (vs. indistinct and gradually narrowing on the caudal peduncle); extent of pigments along the posterior margin of the caudal-fin lobes (⅓ to ½ of the fin covered, vs. extreme outer margin).

Rasbora pycnopeza is distinguished from *R. atranus* by a longer body (trunk length 74.1–78.8 % SL, vs. 68.5–74.9); shorter head length (22.5–26.7 % SL, vs. 27.1–30.3); shape of the supraanal stripe (a longitudinal streak along whole anal-fin base, vs. an elliptical to triangular blotch); presence of a conspicuous blackish posterior margin on the caudal-fin lobes (vs. absence); midlateral black stripe clearly marked and gradually narrowing (vs. less sharply contrasted or indistinct and markedly narrowing on the caudal peduncle).

Several other species of *Rasbora* are present in hill stream habitats in Borneo and these include *R. cryptica*, *R. hubbsi*, *R. tornieri, R. vaillanti*, and *R. volzii*. These taxa are also compared with *R. pycnopeza*.

Rasbora pycnopeza is distinguished from *R. cryptica* by a longer body (trunk length 74.1–78.8 % SL, vs. 72.0–75.1); shorter predorsal length (49.6–54.6 % SL, vs. 54.0–56.2); different caudal fin pattern (thick black margin, covering ⅓ to ½ of caudal-fin lobes, vs. none); a distinct thin black lateral stripe 3-5 scales posterior to opercle edge till base of caudal-fin, vs. a thin diffused stripe with a mid-body black blotch and an elongate triangular black blotch at caudal peduncle.

Rasbora pycnopeza lives sympatrically with *R. hubbsi* in the Kalabakan and Segama drainages. *R. pycnopeza* is distinguished from *R. hubbsi* by reaching a greater size (maximum standard length up to 104 mm vs. 41.4–43.9); less body depth at dorsal-fin origin (22.1–25.9 % SL, vs. 26.8–9.2), longer median caudal length (16.3–20.9 % SL, vs. 13.3–16.4), having 12 vs. 14 circumpeduncular scales rows, 1 vs. 2 scale rows between the lateral line and the origin of the pelvic fin, and an distinct midlateral black stripe with an equal intensity along whole length (vs. thick stripe, more intense posteriorly, with an abrupt transition to the much diffused anterior portion).

Rasbora pycnopeza differs from *R. tornieri* by having fewer circumpeduncular scales rows (12 vs. 14); a different lateral head profile (slightly concave vs. straight); caudal-fin pattern consisting of a thick black margin, covering ⅓ to ½ of caudal-fin lobes (vs. a black margin ¼ to 1/5 of caudal fin); distinct thin black lateral stripe starting 5–6 scales posterior to opercle edge to base of caudal-fin (vs. presence of a broad, dark, sharply defined midlateral stripe, extending from opercle to caudal-fin base and separated from the dark dorsum by a

highly contrasting cream longitudinal area); and a distinct black stripe at supraanal region covering entire anal-fin base (vs. none or a faint black streak at supraanl region).

Rasbora pycnopeza differs from *R. vaillanti* in having a shorter predorsal length (49.6–54.6 % SL, vs. 55.2–58.8); less body depth at dorsal-fin origin (22.1–25.9 % SL, vs. 27.4–32.7), body depth at anus (18.2–22.3 % SL, vs. 21.8–24.2), and caudal peduncular depth (11.9–13.7 % SL, vs. 13.0–13.8); a conspicuous black streak along anal-fin base, thicker at the anterior end (vs. a less distinct and thinner streak, not extending along the whole length of the anal fin base); and caudal fin with thicker black margin (⅓ to ½ of caudal-fin lobes vs. extreme outer margin).

Rasbora pycnopeza is distinguished from *R. volzii* by the shape of the black mark above the anal-fin origin (a conspicuous thickened black streak, vs. thin black streak along whole anal-fin base); pointed snout (vs. rounded); the colour of the fins in life (orange/yellow, vs. hyaline); presence of a black distal margin on caudal-fin lobes (vs. absence).

Rasbora pycnopeza can be distinguished from *R. calliura* by shape of the black mark above the anal-fin origin (a conspicuous thickened black streak, vs. thin and diffused black streak along whole anal-fin base); longer snout (vs. shorter); distinct mid-lateral stripe (vs. indistinct, present on posterior half of body); the colour of the fins in life (orange/yellow, vs. reddish-orange); caudal fin with black margin (black margin thickened on ⅓ to ½ of caudal-fin lobes, vs. ¼ of caudal fin lobes).

Comparative material. *Rasbora atranus*: ZRC-51186, 5 ex., 65.3–80.8 mm SL; Borneo: Kalimantan, Mahakam drainage: Barito Utara. – *Rasbora calliura*: ZRC 56406, 5 ex., 46.7–76.3 mm SL; Borneo: Sarawak: Upper Sarawak basin, Kiri River, Kan River. – *Rasbora cryptica:* ZRC-52463, 1 ex., ZRC-52462, 4 ex., 44.3–70.8 mm SL; Borneo: Sarawark: Penrissen foothills near Serian. – *Rasbora hosii*: ZRC 42725, 5, 61.1–77.3 mm SL; Borneo: Brunei. – *Rasbora hubbsi*: ZRC, 2 ex., 41.4–43.9 mm SL; Borneo: Sabah: Brantian drainage. – *Rasbora rheophila*: ZRC47505, 1 ex., paratype, 68.1 mm SL; Borneo: Sabah: Kota Marudu. – *Rasbora sumatrana*: ZRC 42289, 5 ex., 42.1–59.5 mm SL; Indonesia: Sumatra: Danau Lingkat. – *Rasbora tornieri*: ZRC 46077, 2 ex., ZRC 42726, 3 ex., 84.8–111.7 mm SL; Borneo: Sarawak: Miri, & Brunei. – *Rasbora vaillanti*: ZRC, 5 ex., 54.6–62.4 mm SL; Borneo: Kalimantan: Mahakam drainage: Kota Bungan. – *Rasbora volzii*: ZRC 47024, 5 ex., ZRC 45627, 1 ex., 59.9–109.8 mm SL; Borneo: Kalimantan: Kayan drainage.

Appendix 2. Sampling locations in the Brantian drainage.

Core quantitative sampling using electrofishing, cast netting, tray netting and funnel traps:

S1 – 0m: small, logged forest stream, within the SAFE project experimental area (N 04° 41.991′ E 117° 34.379′), steep rapids and deep pools, substrate sandy and rocky.

S2 – 5m: small, logged forest stream, within the SAFE project experimental area (N 04° 42.452′ E 117° 33.059′), steep rapids and deep pools, substrate sandy and rocky.

S3 – 15m: small, logged forest stream, within the SAFE project experimental area (N 04° 39.051′ E 117° 34.568′), relatively shallow with some deep pools, substrate gravel and rocky.

S4 – 30m: small, logged forest stream, within the SAFE project experimental area (N 04° 43.520′ E 117° 37.338′), a large flood in 2011 stripped the bank side vegetation and the stream is recovering.

S5 – 60m: small, logged forest stream, within the SAFE project experimental area (N 04° 43.699′ E 117° 33.031′), steep rapids and deep pools, substrate large boulders and stones/pebbles.

S6 – 120m: small, logged forest stream, within the SAFE project experimental area (N 04° 42.902′ E 117° 38.413′), steep rapids and deep pools, substrate gravel to medium-large rocks.

S7 – VJR: small, primary forest stream, within the Brantian Tantulit Virgin Jungle Reserve (N 04° 39.008′ E 117° 32.498′), moderate gradient, substrate sand/gravel with some rocky boulders.

S8 – LFE: small, logged forest stream, adjacent to the SAFE project experimental area (N 04° 43.484′ E 117° 35.900′), moderate gradient, but deeper than previous streams, substrate coarse sand, bedrock and rocky.

S9 – Binuang estate: small, oil palm stream with no riparian reserve, close to the SAFE project experimental area (N 04° 41.156′ E 117° 27.379′), high turbidity and sedimentation levels, substrate sand, gravel and silt.

S10 – Merbau: small, oil palm stream with ~30 m riparian reserve, close to the SAFE project experimental area (N 04° 39.073′ E 117° 37.481′), substrate sand, small-medium rocks.

S11 – Gaharu: small, oil palm stream with ~60 m riparian reserve, close to the SAFE project experimental area (N 04° 36.147′ E 117° 31.844′), substrate sand, small-medium rocks.

Other quantitative sampling locations:

S12 – RR1A: small, logged forest stream, adjacent to the SAFE project experimental area (N 04° 45.382′ E 117° 32.623′), moderate gradient, but deeper than previous streams, substrate sand, small-medium rocks.

S13 – RR2: small, oil palm stream with narrow riparian reserve, close to the SAFE project experimental area (N 04° 42.989′ E 117° 30.749′), substrate sand, small-medium rocks.

S14 – RR3A: small, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 40.632′ E 117° 29.380′), substrate sand, small-large rocks.

S15 – RR3B: small, steep, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 40.188′ E 117° 29.122′), substrate sand, small-large rocks.

S16 – RR4: medium sized, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 39.731′ E 117° 26.190′), substrate sand, small-medium rocks.

S17 – RR4A: small, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 49.855′ E 117° 26.644′), substrate sand, small-medium rocks.

S18 – RR8A: small, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 35.226′ E 117° 34.339′), substrate sand, small-medium rocks.

S19 - RR11: small, oil palm stream with narrow riparian reserve, close to the SAFE project experimental area (N 04° 44.058′ E 117° 31.928′), substrate sand, small-large rocks.

S20 – RR13: small, oil palm stream with narrow riparian reserve, close to the SAFE project experimental area (N 04° 36.642′ E 117° 36.052′), substrate sand and gravel.

S21 – RR14: small, oil palm stream with no riparian reserve, close to the SAFE project experimental area (N 04° 37.471′ E 117° 38.459′), substrate sand, small-medium rocks.

S22 – RR16: small, oil palm stream with no riparian reserve, close to the SAFE project experimental area (N 04° 38.672′ E 117° 28.148′), substrate sand, small-medium rocks.

S23 – R16A: small, oil palm stream with narrow riparian reserve, close to the SAFE project experimental area (N 04° 38.245′ E 117° 28.798′), substrate sand, small-large rocks.

S24 – R19A: small, steep, oil palm stream with narrow riparian reserve, close to the SAFE project experimental area (N 04° 39.150′ E 117° 31.153′), substrate sand, small-large rocks.

S25 – RR20: small, steep, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 38.000′ E 117° 26.647′), substrate sand, small-large rocks.

S26 – R21A: small, steep, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 37.563′ E 117° 30.804′), substrate sand, small-large rocks.

S27 – R21B: small, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 37.166′ E 117° 30.566′), substrate sand, small-large rocks.

S28 – RR30: small, oil palm stream with riparian reserve, close to the SAFE project experimental area (N 04° 44.486′ E 117° 29.675′), substrate sand, small-large rocks.

S29 – R70B: small, logged forest stream, close to the SAFE project experimental area (N 04° 41.194′ E 117° 39.733′), substrate sand, bedrock and small rocks.

Qualitative sampling locations:

S30 – Sungei Brantian: Medium sized river in logged forest, within the SAFE project experimental area (N 04° 40.132′ E 117° 35.649′), substrate silt, sand and bedrock.

S31 – Sungei VJR/Brantian: Medium sized river in logged forest, adjacent to the Brantian Tantulit Virgin Jungle Reserve (N 04° 38.729′ E 117° 32.030′), substrate sand and rocks, turbid from rain.

S32 – Sungei Rob: Small, steep stream in logged forest, within the SAFE project experimental area (N 04° 41.842′ E 117° 35.340′), substrate sand, rocks and bedrock.

S32 – Sungei Gaharu (RR10): Medium sized, fast flowing river in oil palm plantation, close to the SAFE project experimental area (N 04° 37.827′ E 117° 31.677′), substrate sand and rocks.

S33 – Sungei Brantian (Seraya estate): Large river in oil palm plantation, close to the SAFE project experimental area (N 04° 36.651′ E 117° 33.542′), substrate sand and rocks.

S34 – Pool next to Sungei Brantian: Stagnant pool next to Brantian river (N 04° 36.651′ E 117° 33.542′), water almost clear.

S35 – 30m (downstream): Small, fast flowing stream in logged forest, within the SAFE project experimental area (N 04° 43.368′ E 117° 36.748′), substrate sand, rocks and bedrock.

S36 – LFE (~1km downstream of quantitative transect): Medium sized, fast flowing stream in logged forest, within the SAFE project experimental area (N 04° 43.046′ E 117° 36.448′), substrate sand, rocks and bedrock.

S37 – Sungei Menggaris:): Medium sized, fast flowing river in oil palm plantation, close to the SAFE project experimental area (N 04° 39.727′ E 117° 36.879′), substrate sand and rocks

S38 – LFE (~300m upstream of quantitative transect): Small, fast flowing stream in logged forest, within the SAFE project experimental area (N 04° 43.475′ E 117° 35.791′), substrate sand, rocks and bedrock.