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Three new species of Rainbowfishes (Melanotaeniidae) from the Birds Head Peninsula, West Papua Province, Indonesia

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Abstract

Three new species of melanotaeniid rainbowfishes are described from fresh waters of the Birds Head Peninsula, West Papua Province, Indonesia. *Melanotaenia ericrobertsi* is described from 41 specimens, 18.4-52.1 mm SL, from the upper Kladuk River system. It was first collected in 1982 and included among the type series of *M. irianjaya*. However, recent genetic evidence reveals it is a distinct species, closely related to *Melanotaenia* from nearby drainages including *M. ajamaruensis*, *M. boesemani*, *M. fasinensis*, and two additional new species described in this paper, *M. laticlavia* and *M. multiradiata*. *Melanotaenia laticlavia* is described on the basis of 6 specimens, 33.7-69.6 mm SL from Aifuf Creek, and *M. multiradiata* from 23 specimens, 37.4-122.5 mm SL from Sisiah Creek. These Birds Head species are primarily distinguished on the basis of distinctive adult male colour patterns and cytochrome *b* genetic analysis. However, *M. laticlavia* exhibits two separate patches of vomerine teeth, an unusual melanotaeniid feature, and *M. multiradiata* has a relatively high pectoral-fin ray count (> 90 % with 15 rays or more).

Zusammenfassung

Beschrieben werden drei neue Arten der Regenbogenfische, Melanotaeniidae, aus Süßgewässern der Vogelkopf-Halbinsel, Provinz Westpapua, Indonesien. *Melanotaenia ericrobertsi* n. sp. wird auf der Grundlage von 41 Exemplaren mit einer Länge zwischen 18,4 und 52,1 mm SL vom oberen Kladuk-Flusssystem beschrieben. Sie wurden 1982 erstmals gesammelt und der Typenreihe *M. irianjaya* zugeordnet. Doch haben neuere genetische Untersuchungen ergeben, dass es sich um eine eigene Art handelt, die den Melanotaeniidae aus nahe gelegenen Einzugsgebieten nahe verwandt ist, darunter *M. ajamaruensis*, *M. boesemani*, *M. fasinensis* sowie zwei weitere Arten, die hier ebenfalls beschrieben werden: *M. laticlavia* and *M. multiradiata.* *Melanotaenia laticlavia* wird auf der Grundlage von 6 Exemplaren mit 33,7-69,6 mm SL vom Aifuf Creek beschrieben, während *M. multiradiata* anhand von 23 Exemplaren mit 37,4-122,5 mm SL vom Sisiah Creek beschrieben wird. Die drei zentralen Arten auf der Vogelkopf-Halbinsel lassen sich vor allem durch gut erkennbare Farbmerkmale bei den Männchen unterscheiden sowie durch eine genetische Analyse des Cytochrom *b.* Hinzu kommt, dass *M. laticlavia* an zwei getrennten Stellen Gaumenzähne besitzt, was unter Regenbogenfischen ungewöhnlich ist, und dass *M. multiradiatus* eine relativ hohe Zahl an Flossenstrahlen an der Brustflosse aufweist (> 90 % mit 15 Flossenstrahlen oder mehr).

Résumé

Trois nouvelles espèces de Mélanotaeniidés sont décrites en provenance d'eaux douces de la Birds Head Peninsula, province de West Papua, Indonésie. *Melanotaenia ericrobertsi* n. sp. est décrit sur base de 41 spécimens, 18,4 - 52,1 mm de LS, du bassin supérieur de la Kladuk River. Il a été collecté d'abord en 1982 et inclus parmi les variétés types de *M. irianjaya.* Toutefois, une évidence génétique récente révèle que c'est une espèce distincte, très proche de *Melanotaenia* de drainages voisins comprenant *M. ajamaruensis, M. boesemani, M. fasinensis,* et deux autres nouvelles espèces décrites dans cet article, *M. laticlavia* et *M. multiradiata*. *Melanotaenia laticlavia* est décrit sur base de 6 spécimens, 33,7 - 69,6 mm de LS, de l'Aifuf Creek et *M. multiradiata,* sur base de 23 spécimens, 37,4 - 122,5 mm de LS, de Sisiah Creek. Les espèces du centre de la Birds Head se distinguent essentiellement par des patrons de coloration différents pour les mâles adultes et par l'analyse génétique du cytochrome *b.* Toutefois, *M. laticlavia* possède deux groupes séparés de dents vomérines, une caractéristique inhabituelle pour les Mélanotaeniidés, et *M. multiradiata* a un nombre relativement élevé de rayons à la pectorale (> 90% avec 15 rayons ou plus).

Sommario

Tre nuove specie di pesci arcobaleno sono descritte dalle acque dolci dalla Birds Head Peninsula, Provincia di Papua Occidentale, Indonesia. *Melanotaenia ericrobertsi* n. sp. è descritta sulla base di 41 esemplari, 18,4-52,1 mm SL, dal bacino superiore del fiume Kladuk. È stata raccolta la prima volta nel 1982 ed era compresa tra le serie tipo di *M. irianjaya*. Tuttavia, una recente analisi genetica ha rivelato che si tratta di una specie distinta, strettamente legata alle specie di *Melanotaenia* dei bacini idrogeografici limitrofi, tra cui *M. ajamaruensis, M. boesemani, M. fasinensis* e le due nuove specie descritte in questo articolo, *M. laticlavia* e *M. multiradiata*. *Melanotaenia laticlavia* è descritta sulla base di 6 esemplari, 33,7-69,6 mm SL da Aifuf Creek, e *M. multiradiat*a da 23 esemplari, 37,4-122,5 mm SL da Sisiah Creek. Le specie provenienti dalle zone centrali della Birds Head sono distinte soprattutto sulla base della caratteristica colorazione dei maschi adulti e dell'analisi genetica del citocromo *b*. Tuttavia, *M. laticlavia* presenta due aree separate di denti vomerini, una caratteristica insolita nei melanotenidi e *M. multiradiatus* ha un numero relativamente alto di raggi pettorali (> 90% con 15 raggi o più).

INTRODUCTION

Melanotaeniids are one of only four endemic families (with Neoceratodontidae [extant species only], Lepidogalaxidae and Pseudomugilidae) entirely confined to the fresh waters of Australia-New Guinea. Rainbowfishes are small (usually < 10 cm SL), colourful fishes which occur in a wide range of lotic and lentic habitats from clear, rapidly flowing streams to semi-stagnant mud holes. While many species have quite narrow ranges, they are the most widespread family within Australia-New Guinea where they are often the most abundant fish present (Unmack et al. 2013). Rainbowfishes thrive in captivity and thanks to their often brilliant colours, small size, and ease of breeding, are highly prized by aquarists. Allen and Cross (1982) and Allen (1995) published well-illustrated, reviews of the family. The latter work included accounts of 59 species or subspecies of melanotaeniids and 15 species of the closely allied Pseudomugilidae. However, in the intervening years since 1995, a host of new species have been discovered, particularly in New Guinea (Allen & Renyaan 1996 and 1998; Allen 1996, 1997, 1998, and 2001; Allen & Unmack 2008 and 2012; Allen et al. 2008 and 2014; Allen & Hadiaty 2011 and 2013; Kadarusman et al. 2010, 2011 and 2012; and McGuigan 2001). The family currently contains 83 species belonging to seven genera (Eschmeyer 2014), but many new species can be expected with future exploration, particularly in remote sections of New Guinea. The present paper describes three new species from the Birds Head Peninsula of West Papua Province, Indonesia. Two of these species were collected by the first author in 1982 and 1999, but were not recognized as distinct until recent genetic samples were obtained. The third species was provided by H.-G. Evers and J. Christian, who sampled extensively across the southern portion of the peninsula during October 2013.

Recent phylogenetic evidence (Unmack et al. 2013) indicates that *Melanotaenia* contains three main lineages, western, northern and southern, correlated respectively with the following major biogeographic regions: the Birds Head Peninsula of western New Guinea, northern New Guinea, and the combined southern New Guinea/Australian region. The Birds Head region and adjacent Birds Neck of West Papua (Fig. 1) has proved a particularly fertile area for recent discoveries. Allen (1990) provided a summary of the seven species known to inhabit the Birds Head mainland at that time. A total of 21 species are currently known from the region, including the offshore islands of the Raja Ampat Group (Allen et al. 2014). The present paper describes three additional new *Melanotaenia* from the Birds Head Peninsula.

MATERIALS AND METHODS

Counts and measurements that appear in parentheses refer to the range for paratypes if different from the holotype. Type specimens are deposited at Museum Zoologicum Bogoriense, Cibinong, Java, Indonesia (MZB), National Museum of Natural History, Washington, D.C. (USNM), and Western Australian Museum, Perth (WAM). In addition, we have examined relevant type specimens at Naturalis Biodiversity Center, Leiden (RMNH).

Comparative material examined: *Melanotaenia ajamaruensis* – RMNH 28068 (holotype), 78.0 mm SL, Ayamaru Lakes region, Birds Head Peninsula, approximately 1°21'S, 132°16'E; RMNH 28069 (paratypes), 46 specimens, 25.5-63.7 mm SL, collected with holotype; WAM P.26792-001 (paratypes), 6 specimens, 43.8-67.7 mm SL. *M. boesemani* – RMNH 28061 (holotype), 66.3 mm SL, Ayamaru Lakes region, Birds Head Peninsula, approximately 1°21'S, 132°16'E; RMNH 28062 (paratypes), 27 specimens, 35.0-63.0 mm SL, collected with holotype; WAM P. 26791-001 (paratypes), 3 specimens, 49.5-63.4 mm SL. *M. fasinensis* – MZB 17700 (holotype), Ween Village, Birds Head Peninsula, 1°13.856'S, 131°58.186'E; MZB 17701 (paratypes), 4 specimens, 91.0-120.2

mm SL, collected with holotype. *M. irianjaya* - MZB 4952 (holotype), 50.0 mm SL, Fruata, Bomberai Peninsula, approximately 2°59'S, 133° 32'E; MZB 4953, 50 specimens, 20.0-58.0 mm SL, collected with holotype; WAM P.29960-001, 53 specimens, 32.0-79.0 mm SL, near Bintuni, Birds Head Peninsula, approximately 2°05'S, 133° 30'E.

The methods of counting and measuring are as follows: *dorsal and anal rays* – the last ray of the anal and second dorsal fins is divided at the base and counted as a single ray; *lateral scales* – number of scales in horizontal row from upper edge of pectoral-fin base to caudal-fin base, excluding the small scales posterior to the hypural junction; *transverse scales* – number of scales in vertical row (excluding small truncated scales along base of fins) between anal-fin origin and base of first dorsal fin; *predorsal scales* – number of scales along midline of nape in front of first dorsal fin; *cheek scales* – total number of scales covering suborbital and preoperculum; *standard length (SL)* – measured from tip of upper lip to caudal-fin base; *head length (HL)* – measured from tip of upper lip to upper rear edge of gill opening; *caudal peduncle depth* is least depth

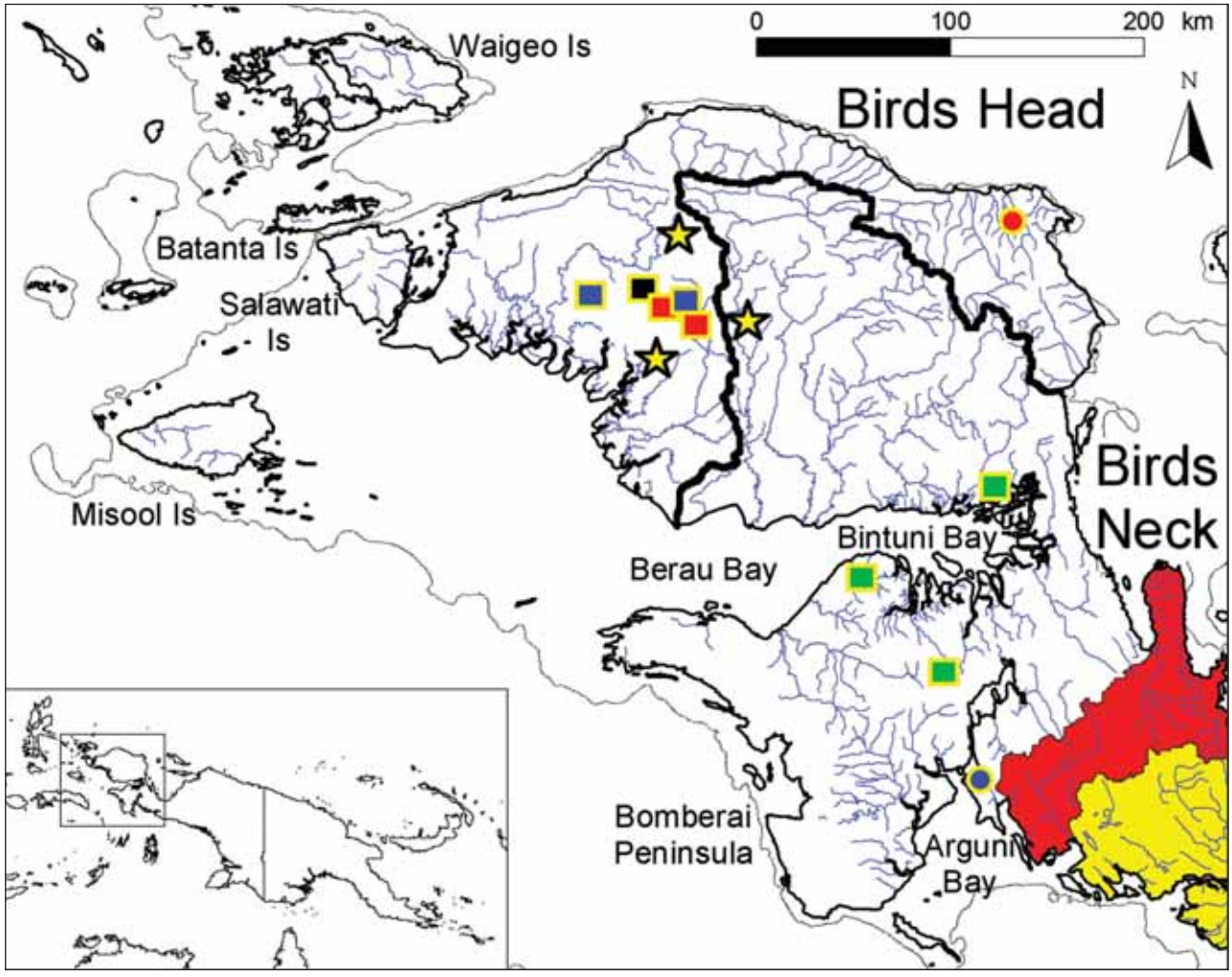

Fig. 1. Map of western New Guinea, West Papua Province Indonesia. Black-edged yellow stars show approximate collection sites of *M. ericrobertsi* (northernmost), *M. laticlavia* (middle), and *M. multiradiata* (southernmost). Sites for other Ayamaru complex *Melanotaenia* include *M. arfakensis* (red circle), *M. ajamaruensis* (black square), *M. boesemani* (red squares), *M. fasinensis* (blue squares) *M. irianjaya* (green squares), *M. veoliae* and *M. wanoma* (the same blue circle). The thick black line through the Birds Head represents the geographic limits of the "northern" and "southern Birds Head" groups. The yellow region in the bottom right corner represents the distributional range of the southern lineage of New Guinea, while the red region represents a poorly explored region between the southern and western lineages which lacks rainbowfish records. The dotted line represents the -135 bathymetric contour which is the approximate position of the coastline during the last glacial phase.

Table I. Rainbowfish species from the Birds Head region of Papua Barat Province used in the phylogenetic analysis including locality data, the number of individuals examined and their GenBank accession number. In the locality field the code AS indicates fish were sourced from rainbowfish aquarium hobbyists.

Species	Locality	N	GenBank #
Melanotaenia ajamaruensis	Soum Ck, Birds Head	4	KM211354-5.1
Melanotaenia ammeri	trib to Arguni Bay, Birds Neck	4	KC133615.1
Melanotaenia angfa	AS, Yakati R, Birds Neck	3	KC133616.1
Melanotaenia arfakensis	AS, Prafi R, Birds Head	2	KC133617.1
Melanotaenia batanta	Warmon Ck, Batanta Is	3	JQ282008.1
Melanotaenia boesemani	AS, Birds Head	3	KC133618.1
Melanotaenia catherinae I	Kali Raja, Waigeo Is	3	KC133629.1
Melanotaenia catherinae II	Wei Sam Ck, Waigeo Is	1	KC133630.1
Melanotaenia ericrobertsi	Suswa village, Karabara R, Birds Head	2	KC133628.1
Melanotaenia fasinensis	Sawiat Ck, Birds Head		KM211357.1
Melanotaenia flavipinnis	Ifaupan Ck, Misool Is	2	KF954094-5.1
Melanotaenia fredericki I	AS, Birds Head	2	KC133621.1
Melanotaenia fredericki II	AS, Sth of Sorong, Birds Head	2	KC133619.1
Melanotaenia kokasensis	Kokas village, Bomberai, Birds Neck	7	KC133623.1
Melanotaenia laticlavia	Aifuf Ck, Birds Head	2	KM211358-9.1
Melanotaenia misoolensis I	Wai Tama, Misool Is	5	KC133624.1
Melanotaenia misoolensis II	Wai Tama, Misool Is	2	KC133625.1
Melanotaenia multiradiata	Sisiah Ck, Birds Head	2	KM211360-1.1
Melanotaenia parva	AS, L Kurumoi, Birds Neck	4	KC133626.1
Melanotaenia salawati	Kali Doktur, Salawati Is	9	KC133620.1
Melanotaenia sp. Rawarra	Sebyar R, Birds Head	2	KC133627.1
Melanotaenia sneideri	small ck in Kumawa Mnts, Birds Neck	3	KM211356
Melanotaenia synergos I	Wai Bin Ck, Batanta Is	2	KC133631.1
Melanotaenia synergos II	AS, Batanta Is	2	KC133632.1

and *caudal peduncle length* is measured between two vertical lines, one passing through base of last anal ray and the other through caudal-fin base; *caudal concavity* – horizontal distance between verticals at tips of shortest and longest rays.

Rainbowfish species used to generate sequence data are shown in Table I. We sequenced the mitochondrial cytochrome *b* (cyt*b)* gene and used GARLI to obtain the best Maximum Likelihood tree and 1000 bootstrap replicates. Methods for obtaining DNA sequence data and their analyses follows Allen & Unmack (2012) and Allen et al. (2014) except where noted as follows: the model of sequence evolution TrN+G was the best one identified by ModelTest 3.7 (Posada & Crandall, 1998), we used attachmentspertaxon = 58 and trees were rooted with the two "Waigeo" group species *(M. catherinae* and *M. synergos)*. GenBank accession numbers are provided in Table I for all sequences included in this study.

Melanotaenia ericrobertsi, n. sp.

Suswa Rainbowfish

(Figs 2-4; Tables II & V)

Holotype. MZB 22114 (formerly WAM P.27868-001, paratype of *M. irianjaya)*, female, 52.1 mm SL, Auk River, near Suswa Village, 0°56.472'S, 132°17.729'E, about 120 km east of Sorong, Birds Head Peninsula, Papua Barat Province, Indonesia, 0-1.5 m, seine net, G. R. Allen & H. Bleher, 18 November 1982.

Paratypes. MZB 22115 (collected with holotype, also formerly part of WAM P.27868-001, paratypes of *M. irianjaya)*, 10 specimens, 22.7-34.3 mm SL; WAM P. 27868-001, 30 specimens, 18.4-40.3 mm SL.

Diagnosis: A species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays IV to VI + I,13-16 (usually

V + I,14 or 15); anal rays I,23-27 (usually 25 or 26); pectoral rays 13-15 (usually 14 or 15); lateral scales 37-39 (usually 38); transverse scales 9 or 10; predorsal scales 17-19; circumpeduncular scales 12 or 13; total gill rakers on first arch 15-19 (usually 17 or 18); total scales covering preoperculum 12-16 (mean 14.1); origins of first dorsal and anal fins about level; greatest body depth of adult male about 2.7-3.1 in SL; colour of adult male in life generally mauve to pale yellowish with orange stripe between each scale row on side of body; blackish zone on lower two-thirds of caudal peduncle and adjacent body above last few anal rays; blackish patch immediately behind pectoral-fin base; pelvic and median fins reddish with narrow white margin on dorsal fins.

Description: Dorsal rays VI + I,15 (IV-VI + I,13-16); anal rays I,26 (I,23-27); pectoral rays 15 (13-15); pelvic rays I,5; branched caudal rays 15; lateral scales 37 (37-39); transverse scales 10 (9 or 10); predorsal scales 17 (17-19); cheek scales 15 (12-16); gill rakers on first branchial arch 3 + 13 (2-4 + 14 or 15), total gill rakers on first arch 15 (16-19).

Body depth 3.6 (3.8-4.3 in paratypes, 2.7-3.1 in adult males from photographs) in SL, head length 4.0 (3.6-4.0) in SL; greatest width of body 2.3 (2.1-2.6) in greatest body depth; snout length 3.4 (3.0-3.4) in HL; eye diameter 2.9 (2.4-2.9) in HL; interorbital width 2.7 (2.7-3.0) in HL; depth of caudal peduncle 2.3 (2.2-2.8) in HL; length of caudal peduncle 1.4 (1.3-1.6) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends below about anterior edge of pupil; maxillary length 2.9 (2.9-3.3) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 6-9 irregular rows anteriorly, reduced to 1-2 rows posteriorly, where they are exposed when mouth is closed; teeth in lower jaw in about 6-8 irregular rows anteriorly, reduced to 1-2 rows posteriorly; vomerine teeth poorly developed, holotype with a few scattered teeth in narrow band; palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; scale margins weakly crenulate; predorsal scales extending forward to rear half of interorbital space; preopercle with 2 scale rows between its posterior angle and eye; scales absent on preorbital.

Predorsal length 2.1 (2.0-2.1) in SL; preanal length 2.0 (2.0-2.2) in SL; prepelvic length 2.9 (2.6-2.9) in SL; length of second-dorsal fin base 4.6 (4.0-4.9) in SL; length of anal-fin base 2.6 (2.6-2.8) in SL.

First dorsal-fin origin about equal with anal-fin origin; longest spines of first dorsal fin 1.5 (2.1-2.9) in HL, its depressed tip reaching slightly beyond origin of second dorsal fin; longest ray (generally anteriormost) of second dorsal fin 1.8 (1.7-2.0) in HL, depressed posterior rays extending less than one-half length of caudal peduncle; longest anal ray (generally middle rays in type specimens, but anterior rays in adult males as determined by photographs) 2.0 (1.8-2.1) in HL; length of pelvic

Fig. 2. *Melanotaenia ericrobertsi*, from top - freshly captured male, approximately 85 mm SL; aquarium acclimated male, approximately 70 mm SL; aquarium acclimated female, approximately 60 mm SL; and aquarium acclimated female, approximately 50 mm SL, Suswa, West Papua. Photos by G. Lange.

Table II. Proportional measurements of selected type specimens of *Melanotaenia ericrobertsi* expressed as percentage of the standard length.

	Holotype MZB 22114	Paratype WAM P.27867	Paratype WAM P.27867	Paratype WAM P.27867	Paratype WAM P.27867	Paratype WAM P.27867	Paratype WAM P.27867	Paratype WAM P.27867
Sex	female	female	juvenile	juvenile	juvenile	juvenile	juvenile	juvenile
Standard length (mm)	52.1	40.3	38.7	36.6	35.6	33.7	31.1	30.6
Body depth	27.6	26.6	25.1	23.2	25.6	24.9	24.4	25.5
Body width	12.1	10.2	12.4	11.2	11.8	10.4	11.6	11.4
Head length	24.8	24.8	26.1	26.0	26.7	25.8	25.7	27.5
Snout length	7.3	7.7	7.8	7.9	8.4	8.0	8.7	8.5
Maxillary length	8.4	8.2	8.3	8.2	8.1	8.3	9.0	9.2
Eye diameter	8.6	8.7	9.6	9.8	10.1	9.2	10.9	9.5
Bony interorbital width	9.2	8.4	8.8	9.0	9.3	9.5	9.3	9.2
Depth of caudal peduncle	10.6	9.9	10.1	9.3	9.8	9.5	9.6	10.5
Length of caudal peduncle	17.3	16.9	19.9	17.8	16.9	19.6	18.6	16.7
Predorsal distance	48.0	48.4	48.8	48.6	48.6	49.6	49.5	48.0
Preanal distance	49.3	46.4	47.3	49.2	46.9	48.7	47.9	48.4
Prepelvic distance	34.9	35.5	34.6	36.6	35.4	35.9	36.3	38.2
2nd dorsal fin base	21.7	21.8	21.7	21.9	20.5	22.0	22.5	25.2
Anal-fin base	37.2	38.5	37.7	37.4	36.0	37.1	36.0	37.3
Pectoral-fin length	19.4	18.6	18.1	17.5	18.3	16.6	15.4	17.6
Pelvic-fin length	16.3	14.6	15.2	15.0	14.6	14.8	13.8	14.4
Longest ray 1st dorsal fin	16.1	11.2	11.9	12.3	12.1	10.1	11.3	9.5
Longest ray 2nd dorsal fin	14.0	13.4	15.5	13.1	13.5	13.4	14.5	13.7
Longest-anal ray	12.7	13.2	13.4	12.3	14.3	14.2	12.9	15.0
Caudal-fin length	25.1	22.8	24.0	24.6	24.4	23.7	24.4	25.5
Caudal concavity	6.5	5.7	6.7	6.3	5.6	5.6	8.0	7.2

fins 1.5 (1.7-1.9), fin tips when depressed reaching from slightly beyond base of anal-fin origin in most paratypes to base of second soft anal ray in holotype; length of pectoral fins 1.3 (1.3-1.7) in HL; length of caudal fin 1.0 (1.0-1.1) in HL; caudal fin moderately forked, caudal concavity 3.8 (3.2-4.8) in head length.

Colour in life (Figs 2 & 4-upper): upper part of head and predorsal region greenish brown; body generally mauve to yellowish, usually with narrow orange stripe between each horizontal scale row; body scales with narrow brown margins, imparting overall network appearance; blackish patch, mainly covering first 3-4 mid-lateral scales

Fig. 3. *Melanotaenia ericrobertsi*, preserved female holotype, 53 mm SL, Suswa, West Papua. Photo by G. R. Allen.

behind pectoral-fin base; prominent blackish zone occupying lower two-thirds of caudal peduncle and adjacent body above last few anal rays; head with broad black stripe behind eye, extending to upper rear margin of operculum, usually with silvery yellow or reddish spot immediately below; remainder of operculum and adjacent cheek dusky greyish; pelvic and median fins reddish with narrow white margin on dorsal fins; submarginal blackish stripe present on second dorsal fin of adults, but often poorly developed; pectoral fins translucent. Young specimens, approximately 5 cm total length, are similar, but generally pinkish overall rather than yellowish.

Colour of holotype in alcohol (Fig. 3): generally light brown dorsally, grading to pale yellowish tan on lower sides; scale margins with fine, brown margins, imparting network appearance; faint, grey mid-lateral stripe on middle of side, more distinct on posterior third of body, including caudal peduncle; pelvic and median fins grey; pectoral fins translucent. Paratypes are similar in colour with the dark mid-lateral stripe showing variable intensity.

Sexual dimorphism: Not apparent among type specimens, which are invariably females or juveniles. However, photographs of captive adults (Figs 2 & 4-upper) indicate typical *Melanotaenia* sexual differences consisting of a deeper body (32.4-37.6 % of SL, calculated from photographs), taller first dorsal fin, and longer soft dorsal and anal rays. Males generally have the longest anal rays at the beginning of the fin compared to the middle of the fin in females.

Remarks: Within western New Guinea there is a complex of *Melanotaenia* species with similar morphology and colouration (herein called the Ayamaru complex). A number of these species occur in the region near Lake Ayamaru, e.g., *M. ajamaruen-*

Fig. 4. Comparison of *Melanotaenia ericrobertsi*, male, approximately 70 mm SL, Suswa, West Papua (upper) and *M. irianjaya*, male, approximately 70 mm SL (middle), and male, approximately 60 mm SL (lower), Fruata, West Papua. Photos by G. Lange (upper) and N. Khardina (middle and lower).

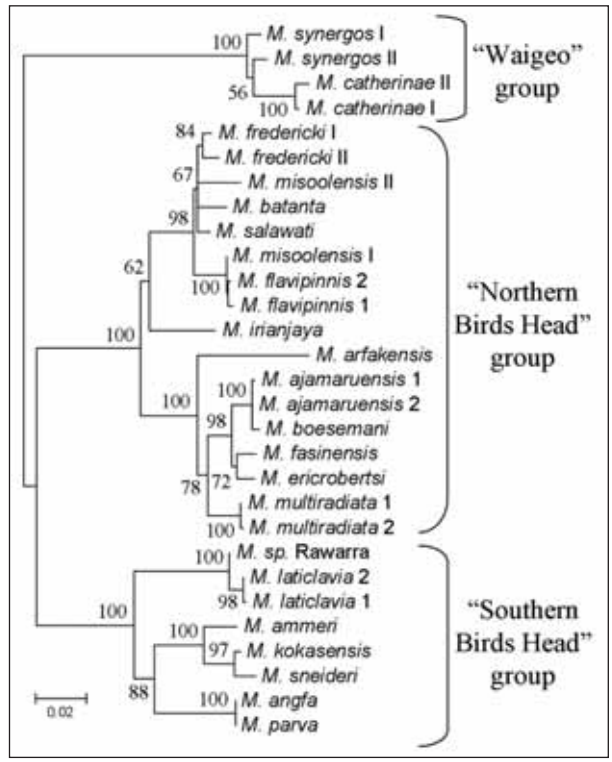

Fig. 5. Maximum likelihood tree for Birds Head region *Melanotaenia* species based on analysis of cytochrome *b* sequences (1,141 bp). Bootstrap values were obtained from 1,000 replicates. Roman numerals after a species name indicate different lineages within a species (as per Unmack et al. 2013), numbers indicate different individuals within a population.

sis, *M. boesemani*, and *M. fasinensis*, but others such as *M. arfakensis*, *M. irianjaya*, *M. veoliae* and *M. wanoma* occur more broadly across the Birds Head region (Fig. 1). This group also contains the three new species described herein: *M. ericrobertsi*, *M. laticlavia*, and *M. multiradiata*. Most of these species are part of the same genetic clade within the western lineage, although some such as *M. laticlavia* are more distantly related genetically (Fig. 5). These fishes are generally similar in appearance and characterised by relatively high dorsal and anal fin ray counts, and a live colour pattern that features a dark submarginal stripe and outer white margin on the second dorsal fin.

Two of the new taxa, *M. ericrobertsi* and *M. multiradiata*, were previously confused with *M. irianjaya*, which was described on the basis of 170 specimens collected by G. R. Allen (Allen 1985) at widely scattered locations on the Bomberai and Birds Head peninsulas of West Papua, but now believed to occur mainly on the Bomberai Peninsula (Fig. 1). Based on general similarity in colour pattern, morphometric proportions, and meristic features the specimens were believed to represent a single, slightly variable species. Moreover, without recourse to current genetic methods, it did not seem unusual for a rainbowfish to have such a broad distribution, encompassing numerous river systems. However, an emerging pattern based on recent genetic results (Unmack et al. 2013) reveals that many of the former widespread species are likely divisible into two or more taxa with individual taxa frequently being restricted to one or a few river basins.

Melanotaenia irianjaya was originally described on the basis of relatively small individuals (largest 58 mm SL), which did not show typical adult colouration, including that of the adult male, which is particularly diagnostic. Thanks to their eventual introduction to the aquarium hobby, photographs and tissue samples were obtained of live adults from the type locality (Fruata, West Papua) and from Suswa, where 41 paratypes were collected by G. R. Allen in 1982. Photographs of live adults (Fig. 4) and DNA results (Fig. 5) from the two locations revealed important species-level differences between these two populations and prompted our description of the Suswa fish.

Colour differences include the presence of pronounced blackish zones on the anterior and posterior, mid-lateral parts of the body in *M. ericrobertsi*, and much narrower white margin on the second dorsal fin in comparison to *M. irianjaya*. Photographs (Fig. 4) also reveal a difference in the shape of the anal fin of mature males, a feature that

Fig. 6. Aerial view of the type locality of *Melanotaenia ericrobertsi* near Suswa, Birds Head Peninsula, West Papua Province. Photo by G. R. Allen.

is not evident in the relatively small type specimens of both species. The anal fin of *M. irianjaya* is more rounded, with the tallest rays in the middle of the fin in contrast to that of *M. ericrobertsi*, which has the longest rays anteriorly, a condition that is unusual among male members of the genus, which usually have the longest anal rays either centrally or posteriorly.

Genetic results (Fig. 5) indicate that the new species is actually more closely related to *M. fasinensis* (Fig. 10C), which occurs further downstream in the same catchment. These species appear to be nearly morphological twins with no reliable morphometric or meristic features to distinguish them. However, colour pattern and genetic differences are diagnostic. The two prominent blackish zones on the body of *M. ericrobertsi* and lack of this feature in *M. fasinensis* is particularly useful for separating them, at least in adult fish. Additional differences between this species and the other two new taxa are provided in the remarks sections for *M. laticlavia* and *M. multiradiata*.

Zoogeography and habitat: The new species is known only from the vicinity of Suswa Village (Fig. 1), which is situated in the foothills of the Tamrau Mountains at an elevation of about 176 m, approximately 120 km east of the city of Sorong. The type locality (Fig. 6) is part of the extensive Kladuk River system and is approximately 215 km upstream from the Karabra Estuary on the south coast of the Birds Head Peninsula. The stream, which ranged from about 15 to 30 m in width at the type locality, was flowing through primary and secondary rainforest habitat over gravel and sand substrate with minimal aquatic vegetation. Rainbowfish were mainly concentrated around log debris. Temperature and pH values of 27-28° C and 7.5 were recorded at the time of collection.

Etymology: The new species is named *ericrobertsi* in honour of Eric Roberts, a pilot with Associated Mission Aviation (AMA), Papua Province, Indonesia. Eric is an aquarium fish enthusiast who collected live specimens and is responsible for the introduction of this species to the aquarium hobby.

Melanotaenia laticlavia, n. sp.

Aifuf Rainbowfish

(Figs 7-8 & 10D; Tables III & V)

Holotype. MZB 22116, male, 69.6 mm SL, Aifuf Creek, 1°19.613'S, 132°35.415'E, about 43 km

Fig. 7. Aquarium photograph of *Melanotaenia laticlavia*, male (lower) and female, approximately 65 and 55 mm SL, Aifuf Creek, West Papua. Photo by H.-G. Evers.

east of Lake Ayamaru, Birds Head Peninsula, Papua Barat Province, Indonesia, 0-1.0 m, seine net, H. G. Evers and J. Christian, 6 October 2013. Paratypes. MZB 22117 (collected with holotype), 3 specimens, females, 33.7-36.1 mm SL; WAM P.34025-001, 2 specimens, 57.0-61.6 mm SL.

Diagnosis: A species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays IV-VI + I,14-17; anal rays I,24-26 (usually 24); pectoral rays 14 or 15 (usually 14); lateral scales 36-37 (usually 37), transverse scales 9 or 10; predorsal scales 16-18 (usually 17); circumpeduncular scales 13; total gill rakers on first arch 16 or 17 (usually 16); total scales covering preoperculum 13-19 (adults with 16-19); adult with two separate patches of vomerine teeth; origin of first dorsal fin about level with anal-fin origin; greatest body depth of adult male 2.8-3.0 in SL; colour in life generally olive green to yellowish with faint orange stripe between each horizontal scale row; mid-lateral dark stripe often present, broader and more prominent on posterior half of body; dorsal and anal fins with dark submarginal stripe and pale outer margin; dorsal and ventral margins of caudal fin narrowly blackish.

Description: Dorsal rays V + I,14 (IV-VI + I,15-17); anal rays I,24 (I,24-26); pectoral rays 14 (14 or 15); pelvic rays I,5; branched caudal rays 15; lateral scales 36 (37); transverse scales 9 (10); predorsal scales 18 (16-17); cheek scales 16 (13-19); gill rakers on first branchial arch 2 + 14 (2 + 14 or 15), total gill rakers on first arch 16 (16 or 17).

Body depth 2.9 (2.8- 3.0, 3.4-3.5 in juveniles) in SL, head length 3.8 (3.5-3.7) in SL; greatest width of body 2.7 (2.5-2.6, 2.1-2.2 in juveniles) in greatest body depth; snout length 2.9 (3.2-4.1) in HL; eye diameter 3.2 (2.6-3.0) in HL; interorbital width 2.8 (2.7-2.9) in HL; depth of caudal peduncle 2.4 (2.4-2.7) in HL; length of caudal peduncle 1.6 (1.5-2.0) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends below about anterior edge of pupil or slightly anterior to this point; maxillary length 2.6 (2.7-3.4) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 6-7 irregular rows anteriorly, reduced to 1-2 rows posteriorly, where they are exposed when mouth is closed; teeth in lower jaw in about 12 irregular rows anteriorly, reduced to 1-2 rows posteriorly; vomerine teeth in 2 well-separated patches, with about 10-12 teeth in each patch of holotype; palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; scale margins weakly crenulate; predorsal scales extending forward to rear half of interorbital space; preopercle with 2-3 scale rows between its posterior angle and eye; scales absent on preorbital.

Predorsal length 2.1 (2.0-2.2) in SL; preanal length 2.0 (1.9-2.1) in SL; prepelvic length 2.6 (2.6-2.7) in SL; length of second-dorsal fin base 3.8 (3.8-4.3) in SL; length of anal-fin base 2.5 (2.4-2.5, 2.7-3.0 in juveniles) in SL.

First dorsal-fin origin about half eye diameter behind level of anal-fin origin; longest spines of first dorsal fin 1.9 (1.5-1.6, 2.4-2.6 in juveniles) in HL, its depressed tip reaching origin of second dorsal fin in juveniles and reaching to about base of second soft ray in mature males; longest ray (generally anteriormost in juveniles and penultimate in

Fig. 8. *Melanotaenia laticlavia*, preserved male holotype, 69.6 mm SL. Photo by G. R. Allen.

Table III. Table II. Proportional measurements of selected type specimens of *Melanotaenia ericrobertsi* expressed as percentage of the standard length.

	Holotype MZB 22116	Paratype WAM P.34025	Paratype WAM P.34025	Paratype MZB 22117	Paratype MZB 22117	Paratype MZB 22117
Sex	male	male	male	juvenile	juvenile	juvenile
Standard length (mm)	69.6	61.6	57.0	36.0	36.1	33.7
Body depth	34.3	35.2	33.7	28.9	29.1	29.4
Body width	12.6	14.1	12.8	13.6	13.9	13.4
Head length	26.1	26.8	27.7	27.2	28.8	27.9
Snout length	9.1	8.4	8.8	7.8	8.3	6.8
Maxillary length	9.9	10.1	9.8	9.4	10.2	8.3
Eye diameter	8.2	9.4	9.1	10.6	11.1	10.1
Bony interorbital width	9.5	9.6	10.2	9.4	10.0	9.5
Depth of caudal peduncle	10.9	11.0	10.9	10.8	10.8	10.7
Length of caudal peduncle	16.8	15.7	14.2	18.6	16.6	16.3
Predorsal distance	48.7	49.2	51.1	46.4	48.5	47.2
Preanal distance	50.3	48.1	49.8	50.3	51.5	51.9
Prepelvic distance	38.1	36.7	38.2	38.3	38.2	39.2
2nd dorsal-fin base	26.6	26.0	26.3	26.1	26.3	23.1
Anal-fin base	40.5	39.9	42.1	33.6	34.6	36.5
Pectoral-fin length	19.0	19.2	19.3	19.4	19.7	19.0
Pelvic fin length	18.1	19.2	18.4	15.3	14.7	15.1
Longest ray 1st dorsal fin	14.1	18.0	17.7	10.3	11.9	11.0
Longest ray 2nd dorsal fin	14.9	13.3	12.6	13.1	11.4	11.3
Longest anal ray	14.1	12.5	13.5	11.1	10.5	10.1
Caudal-fin length	21.7	21.4	22.5	23.9	23.5	23.1
caudal concavity	8.0	6.0	5.3	8.9	7.8	5.6

males) of second dorsal fin 1.8 (2.0-2.5) in HL, depressed posterior rays extending less than one-half length of caudal peduncle in juveniles and nearly full length of caudal peduncle in mature males; longest (sixth to ninth rays in males and females) anal rays 1.9 (2.1, 2.5-2.8 in juveniles) in HL; pelvic fin tips when depressed reaching to base of second or third soft anal fin ray in mature adults; length of pelvic fins 1.4 (1.4-1.5, 1.8-2.0 in juveniles); length of pectoral fins 1.4 (1.4-1.5) in HL; length of caudal fin 1.2 (1.1-1.3) in HL; caudal fin moderately forked, caudal concavity 3.3 (3.1-5.3) in head length.

Colour in life (Figs 7 & 10D): generally olive green to bronzy yellow, often darker dorsally, with darker scale margins imparting network appearance; narrow orange stripe between each horizontal scale row on side of body; frequently with dark blue to blackish mid-lateral stripe on side of body, often interrupted and usually narrower on anterior half and much broader (up to 3 scales wide) posteriorly; breast yellow orange in adult male, whitish in female; both sexes usually with broad blue-grey zone, tapering nearly to a point posteriorly, on lower side from below pectoral-fin base to above middle of anal fin; dorsal and anal fins pale orange to vivid orange in adult males, pale yellow to bluish in females; second dorsal and anal fins with dark brown to blackish submarginal stripe and pale blue outer margin; caudal fin translucent with dusky greyish rays and narrow blackish dorsal and ventral margins; pelvic fins orange in adult males and whitish in females; pectoral fins translucent; iris mainly golden yellow; broad blackish stripe across uppermost part of operculum and vivid red spot (about half pupil size) immediately below.

Colour of holotype in alcohol (Fig. 8): head brownish dorsally, grading to whitish ventrally; operculum with blackish stripe crossing uppermost portion with silvery patch immediately below; light brown on back, grading to whitish ven-

trally; each scale of side with thin brown margins imparting overall network appearance; blackish mid-lateral stripe on side from pectoral-fin base to caudal-fin base, poorly developed and interrupted on anterior half, but distinctly wider (covering up to 3 scales) on posterior half; second dorsal, anal, pelvic and caudal fins generally dusky grey with blackish sub-marginal stripe (more prominent on dorsal fin) and narrow whitish margin on dorsal and anal; caudal fin with narrow, blackish upper and lower margins; pectoral fins translucent. The two adult male paratypes (WAM) exhibit similar markings, but are overall much darker with thicker dark scale margins and numerous microscopic melanophores on the lower portion of the sides. Juvenile paratypes (33.7-36.1 mm SL) are yellowish tan, grading to white ventrally. The largest juvenile has a well-developed, dark mid-lateral stripe, which is only visible on the posterior portion of the body in the smaller juveniles. A remnant of the blue-grey zone on the lower side, mentioned in the live colour description, is also evident in the largest juvenile.

Sexual dimorphism (based on photographs because no adult female specimens were available for comparison): males appear to have a deeper body compared to females which is typical for the genus. The greatest depth of the three adult male types is 33.7-35.2% of SL compared with about 30% of SL for the female shown in Fig. 7. In addition, the greater height of the first dorsal fin (significantly overlapping the dorsal fin origin) and last soft dorsal rays (extending for most of caudal peduncle length) are typical male features of the genus. Finally, the dark upper and lower margins of the caudal fin are more vivid in males compared to females.

Remarks: Live colour pattern of adult males (Figs 7 and 10D) and DNA analysis (Fig. 5) provide the

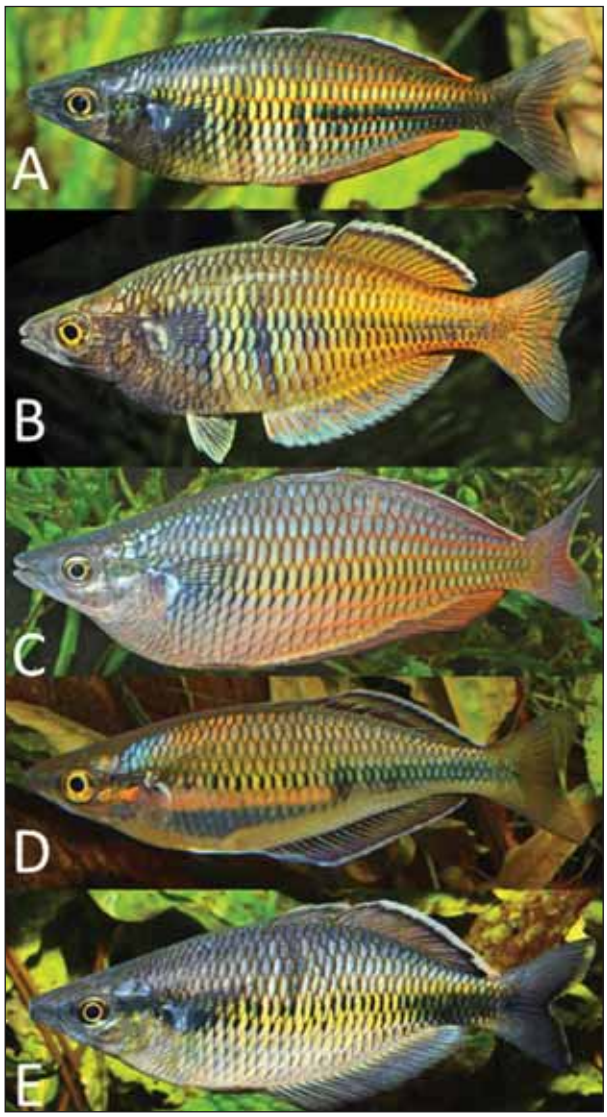

Fig. 9. Comparison of colour patterns of Ayamaru complex *Melanotaenia*: A) *M. ajamaruensis*, B) *M. boesemani*, C) *M. fasinensis*, D) *M. laticlavia*, and E) *M. multiradiata*. Photos by H.-G. Evers except B by G. R. Allen.

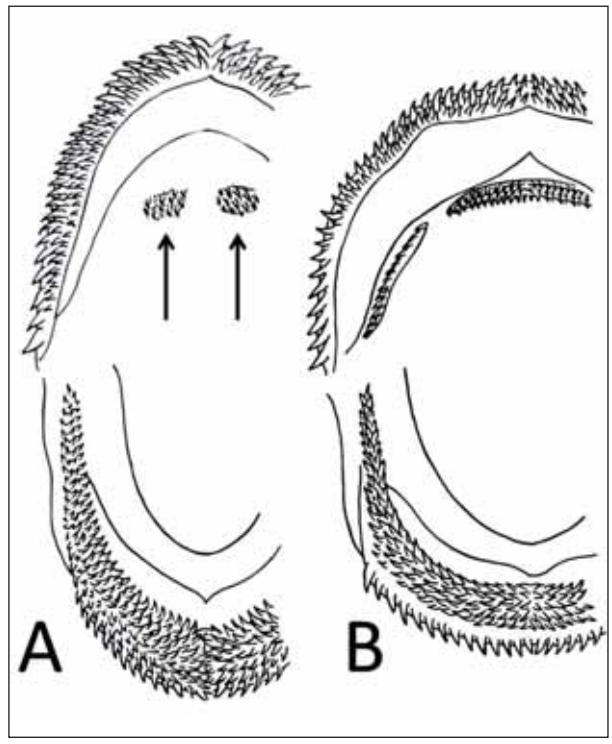

Fig. 10. Diagram showing dentition of upper and lower jaw, vomer, and palate of *Melanotaenia laticlavia* (A) and *M. rubrostriata* (B).

best means of separating *Melanotaenia* from western New Guinea. However, *M. laticlavia* is distinguished from other members of the Ayamaru complex, and all other *Melanotaenia* examined to date, in having two separate patches of vomerine teeth (Fig. 11A) in adults. Most members of the genus possess a single medial patch (Fig. 11B) or in the case of a few species from outside this region, may lack these teeth entirely. However, this feature is most obvious in large adults and is often lacking or poorly developed in juveniles and subadults.

This species (as well as *M. ericrobertsi* and *M. multiradiata)* is further separable from *M. ajamaruensis* and *M. boesemani* on the basis of 9 or 10 transverse scale rows versus only 7 or 8 for the latter species. It also lacks the pair of diffuse, dusky grey bars on the ventral, anterior body, as well as the dusky blue-grey colour on the lower head and breast region, characteristic of adult males of these two species (Fig. 10A & B). *Melanotaenia laticlavia* is also distinguished by the dark upper and lower caudal-fin margins (also shared by *M. irianjaya)*, the possession of a dark submarginal stripe and prominent white outer margin on both dorsal and anal fins (only on the dorsal fin of other Ayamaru complex species), broad blue grey zone on lower side (tapering porteriorly), and a red spot on the operculum, which although common in the genus, is either rudimentary or absent on other Ayamaru complex species.

Fig. 11. Habitat of *Melanotaenia laticlavia* at the type locality, Aifuf Creek, Birds Head Peninsula, West Papua Province. Photo by H.-G. Evers.

Zoogeography and habitat: The new species is known only from Aifuf Creek in the Birds Head region of West Papua (Fig. 1). The type locality (Fig. 11) consists of a narrow (about 1-2 m wide), relatively shallow (to about 0.5-1.0 m depth) stream with very gradual gradients flowing through second growth forest. The type specimens were mainly collected over sand and gravel bottoms. The stream is located in the upper reaches of the Kamundan River system, one of several large rivers that flow into the mouth of Berau Bay at the southernmost portion of the Birds Head Peninsula. The type locality, at 154 m elevation, is situated about 108 km north of the river mouth or following the meandering path of the river it is approximately 220 km upstream from the sea.

Etymology: The new species is named *laticlavia* (Latin: having a broad stripe) with reference to the broad bluish-grey stripe along the lower side of the body.

Melanotaenia multiradiata, n. sp.

Moswaren Rainbowfish

(Figs 10E & 12-14; Tables IV & V)

Holotype. MZB 22118, male, 122.5 mm SL, Sisiah Creek, 1°27.784'S, 132°14.546'E, about 25 km east of Teminabuan, Birds Head Peninsula, Papua Barat Province, Indonesia, 0-1.5 m, seine net, G. R. Allen, M. Allen & S. Renyaan, 5 September 1999.

Paratypes. MZB 22119 (collected with holotype), 7 specimens, 37.4-83.7 mm SL; USNM 427109, 5 specimens, 40.7-97.3 mm SL; WAM P.31569-001, 10 specimens, 37.4-97.5 mm SL.

Diagnosis: A species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays IV-VI + I,14-17 (usually V + I,15); anal rays I,23-26 (rarely 23); pectoral rays 14-17 (usually 15 or 16); lateral scales 37-38; transverse scales 9; predorsal scales 17-19; circumpeduncular scales 12 or 13; total gill rakers on first arch

16-19 (usually 17 or 18); total scales covering preoperculum 13-17 (mean 15.8); origin of first dorsal fin usually about eye diameter behind level of anal-fin origin, but occasionally level of dorsal and anal-fin origins about even; greatest body depth of adult male 2.7-3.2 in SL; colour in life generally bluish green to yellowish, grading to white ventrally; mid-lateral dark stripe usually present, broader and more prominent on posterior half of body; dorsal fins with dark submarginal stripe and pale outer margin.

Description: Dorsal rays V + I,13 (IV-VI + I,14-16); anal rays I,24 (I,23-26); pectoral rays 14/15 (14-17); pelvic rays I,5; branched caudal rays 15; lateral scales 38 (37 or 38); transverse scales 9; predorsal scales 18 (17-19); cheek scales 16 (13-17); gill rakers on first branchial arch 3 + 14 (2-4 + 14 or 15), total gill rakers on first arch 17 (16-19).

Body depth 2.7 (2.7- 3.6, 3.6-40 in juveniles < 43 mm SL) in SL, head length 3.9 (3.5-4.0) in SL; greatest width of body 2.7 (2.2-2.8) in greatest body depth; snout length 2.7 (2.7-3.0) in HL; eye

Fig. 12. Aquarium photograph of freshly collected holotype of *Melanotaenia multiradiata*, male, 122.5 mm SL, Sisiah Creek, West Papua. Photo by G. R. Allen.

Fig. 13. Aquarium photograph of freshly collected paratype (WAM P.31569-001) of *Melanotaenia multiradiata*, female, 97.5 mm SL, Sisiah Creek, West Papua. Photo by G. R. Allen.

Table IV. Proportional measurements of selected type specimens of *Melanotaenia multiradiata* expressed as percentage of the standard length.

	Holotype MZB 22118	Paratype WAM P.31569	Paratype WAM P.31569	Paratype MZB 22119	Paratype MZB 22119	Paratype WAM P.31569	Paratype MZB 22119	Paratype WAM P.31569
Sex	male	female	male	male	female	male	female	female
Standard length (mm)	122.5	97.5	96.1	83.7	80.5	71.3	58.2	50.6
Body depth	37.6	30.6	37.4	35.2	31.8	32.5	29.0	27.9
Body width	14.0	13.2	14.3	14.0	13.3	13.3	11.7	11.7
Head length	25.6	25.2	26.4	28.3	26.3	26.1	25.8	27.5
Snout length	9.6	8.7	8.8	9.6	9.2	9.0	8.9	9.1
Maxillary length	9.7	9.0	9.3	9.2	9.6	9.1	9.1	9.1
Eye diameter	6.7	6.6	7.3	8.1	7.2	8.0	7.4	8.7
Bony interorbital width	8.9	9.5	10.2	9.7	9.1	9.5	8.8	9.7
Depth of caudal peduncle	11.1	10.2	11.4	10.9	10.1	10.7	10.3	9.9
Length of caudal peduncle	16.0	17.1	15.7	15.4	16.5	17.7	19.1	17.8
Predorsal distance	50.9	50.5	52.4	49.8	49.9	51.5	48.3	50.4
Preanal distance	46.7	49.3	48.0	48.3	52.3	49.2	49.3	52.2
Prepelvic distance	35.6	36.5	38.1	37.5	39.1	36.5	36.1	37.7
2nd dorsal-fin base	26.9	25.6	26.8	25.0	25.3	24.4	22.2	21.9
Anal-fin base	45.8	39.1	44.1	44.3	38.5	40.7	37.5	36.0
Pectoral-fin length	17.3	17.9	16.6	19.1	18.6	19.1	18.4	16.8
Pelvic-fin length	19.5	18.5	18.7	19.4	18.9	19.6	17.0	15.4
Longest ray 1st dorsal fin	14.6	13.1	14.6	17.1	14.5	12.8	12.7	13.0
Longest ray 2nd dorsal fin	14.1	10.9	15.6	17.3	12.0	14.6	12.5	13.0
Longest anal ray	14.7	14.4	15.0	15.4	12.9	14.2	11.3	10.3
Caudal-fin length	19.6	19.3	21.4	21.0	21.2	19.8	19.4	21.7
Caudal concavity	6.9	9.0	6.8	7.6	7.6	4.8	4.3	7.5

diameter 3.8 (3.2-3.8) in HL; interorbital width 2.9 (2.6-3.0) in HL; depth of caudal peduncle 2.3 (2.3-3.0) in HL; length of caudal peduncle 1.6 (1.4-1.8) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends below about anterior edge of pupil; maxillary length 2.6 (2.7-3.1) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 6-7 irregular rows anteriorly, reduced to 1-2 rows posteriorly, where they are exposed when mouth is closed; teeth in lower jaw in about 10 irregular rows anteriorly, reduced to 1-2 rows posteriorly; vomerine teeth in 2 separate patches (variable in paratypes, ranging from absent in smaller specimens to either a single narrow band or two separate patches); palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; scale margins weakly crenulate; predorsal scales extending forward to rear half of interorbital space; preopercle with 2-3 scale rows between its posterior angle and eye; scales absent on preorbital.

Predorsal length 2.0 (1.9-2.1) in SL; preanal length 2.1 (1.9-2.1) in SL; prepelvic length 2.8 (2.6-2.8) in SL; length of second-dorsal fin base 3.7 (3.7-4.6) in SL; length of anal-fin base 2.2 (2.3-2.8) in SL.

First dorsal-fin origin about half eye diameter behind level of anal-fin origin (paratypes variable, ranging from level with anal-fin origin to about eye diameter behind level of anal origin); longest spines of first dorsal fin 1.8 (1.5-1.6, 2.4-2.6 in juveniles) in HL, its depressed tip reaching slightly beyond origin of second dorsal fin in females and to about base of second or third soft ray in mature males; longest ray (generally anteriormost in females and juveniles, and penultimate in males) of second dorsal fin 1.8 (1.6-1.8 in adult males, 2.1-2.3 in males less than about 60 mm SL and females) in HL, depressed posterior rays extending

Table V. Frequency distribution of pectoral-ray counts for Ayamaru complex *Melanotaenia*. Counts were taken on both sides of each individual for *M. ericrobertsi*, *M. fasinensis*, *M. laticlavia*, and *M. multiradiata*. Counts for *M. arfakensis*, *M. veoliae* and *M. wanoma* are from Allen (1989) and Kadarusman et al. (2012) respectively, but were only presented as ranges in these publications, thus values of X only represent the range of values recorded.

	Number of Pectoral Rays					
Species	12	13	14	15	16	17
M. arfakensis		X	X	X		
M. ajamaruensis		3	32	12		
M. boesemani		1	37	18	5	
M. ericrobertsi		5	18	19		
M. fasinensis			6	3	1	
M. irianjaya		4	10	2		
M. laticlavia			10	2		
M. multiradiata			4	31	9	2
M. veoliae	X	X				
M. wanoma		X	X			

about one-half length of caudal peduncle or less in females and juveniles, and nearly full length of caudal peduncle in mature males; anal rays of adult males more or less subequal except last few rays shorter than others, tallest rays 1.8 (1.7-1.8) in HL; rays of anterior half of female and juvenile anal fin taller than those of posterior half, tallest rays 1.8-2.7 in HL; length of pelvic fins 1.3 (1.3-1.8, fin tips when depressed reaching to base third or fourth soft anal fin ray in mature males and to first or second soft anal ray in females; length of pectoral fins 1.5 (1.4-1.6) in HL; length of caudal fin 1.3 (1.1-1.3) in HL; caudal fin moderately forked, caudal concavity 3.7 (2.8-6.0) in head length.

Colour of holotype in life (Fig. 12): generally bluish green on dorsal portion of head and body, grading to whitish ventrally; body scales, including those of breast and ventral portion of side, with narrow blackish margins imparting overall network appearance; usually with prominent

Fig. 14. *Melanotaenia multiradiata*, preserved male holotype, 122.5 mm SL and female paratype, 97.5 mm SL (WAM P.31569-001), Sisiah Creek, West Papua. Photo by G. R. Allen.

dark blue to blackish mid-lateral stripe from pectoral-fin base to caudal-fin base, less distinct and occupying single scale row on anterior half to two thirds of body, but more vivid and wider (covering 2-3 horizontal scale rows) on posterior body including caudal peduncle, although not clearly visible in Fig. 12 it was evident when first collected; head with broad blackish stripe from snout to upper rear margin of operculum, interrupted by eye; silvery spot on upper operculum immediately below aforementioned dark stripe, remainder of operculum and cheek yellowish to bronze; dorsal fins reddish with pronounced dark brown to blackish submarginal stripe and broad, white outer margin; anal fin bluish grey to yellow or reddish; caudal fin dusky grey with narrow, white posterior margin; pelvic fins dusky grey to whitish; pectoral fins translucent. Adult male paratypes generally similar, but sometimes with pronounced yellow area occupying 3-4 horizontal scale rows on middle of side (Fig. 10E). Females (Fig. 13) are similar to the pattern described for the holotype with adults generally displaying a conspicuous dark blue to blackish mid-lateral stripe.

Colour of holotype in alcohol (Fig. 14, upper): head and body brown dorsally, grading to yellowish tan on ventral half; blackish stripe crossing uppermost portion of operculum, continued on body as blackish mid-lateral stripe to caudal-fin base, less distinct anteriorly and consisting of broad vertical streak on each scale, forming continuous stripe on posterior third of body with maximum width of about two scale rows; pelvic and median fins dusky grey, second dorsal with blackish submarginal stripe and broad, white outer margin, also narrow white margin on caudal; pectoral fins translucent. Adult paratypes similar, although most adult specimens with more vivid, blackish mid-lateral stripe on body, particularly prominent on largest (97.5 mm SL) female (Fig. 14, lower). Juvenile paratypes (37.4-43.0 mm SL) are pale brown dorsally, grading to tan ventrally with a

Fig. 15. Habitat of *Melanotaenia multiradiata* at the type locality, Sisiah Creek, Birds Head Peninsula, West Papua Province. Photo by H.-G. Evers.

blackish mid-lateral stripe similar to that described for adults evident in the largest juvenile.

Sexual dimorphism: Although sample size was relatively small for most size classes, males typically have a deeper body compared to females. The average body depth of males greater than 80 mm SL is 35.2% of SL (range 31.5-37.6%, n = 8) and that of specimens from 50-79 mm SL is 31.2% of SL (range 29.6-32.5%, n = 2). In comparison females in these same size classes have average body depths of 31.2 (30.6-31.8%, n = 2) and 28.5 (27.9-29.0 %, n = 2) % of SL. The average body depth of juveniles, 37-43 mm SL was 26.4% SL (range 25.1-28.1 %, n = 6). Other male differences include the greater height of the first dorsal fin (significantly overlapping the dorsal fin origin) and last soft dorsal rays (extending for most of caudal peduncle length).

Remarks: *M. multiradiata* is distinguished by its relatively high pectoral-fin ray count compared to other Ayamaru complex species with 91.3% of specimens having 15 or more pectoral rays (Table V). This value is significantly greater than 25.5% recorded for *M. ajamaruensis*, 37.7% for *M. boesemani*, 40.0% for *M. fasinensis*, 12.5 % for *M. irianjaya* and 16.7% for *M. laticlavia.* Diagnostic colour pattern features of *M. multiradiata* include a distinct white, posterior margin on the caudal fin and the possession of a well-developed and expanded mid-lateral, dark stripe on the posterior body (also shared with *M. ericrobertsi).*

Zoogeography and habitat: The new species is known only from Sisiah Creek near Moswaren Village, which lies about 25 km east of the town of Teminabuan, near the south coast of the Birds Head region of West Papua (Fig. 1). The type locality (Fig. 15) consists of a 15-20 m wide stream with depths to about 2 m and slow to moderate flow through second growth forest. The type specimens were mainly collected over a limestone rock bottom, and were concentrated around log debris in the deeper sections. The stream was exceptionally clear at the time of collection with estimated underwater visibility of 20 m. The type locality is situated at an elevation of about 86 m, approximately 58 km upstream from where it eventually flows into Waromge Bay.

Etymology: The new species is named *multiradiata* (Latin: many rays) with reference to the relatively high number of pectoral-fin rays.

Genetic results and discussion: A total of 70 individuals were sequenced from 19 species from the western lineage in the Birds Head region for the mtDNA cyt*b* gene (Table I). Within species genetic diversity was low, with only six species *(M. ajamaruensis, M. flavipinnis, M. fredericki, M. laticlavia, M. misoolensis, and M. multiradiata)* containing two haplotypes (the remaining 13 species each had only a single haplotype). Sequence analysis of the 29 OTUs (Table I) yielded 849 invariant characters, 39 variable but parsimony uninformative characters, and 253 parsimony informative characters. ML analysis recovered one tree with a likelihood score of -4260.229554 (Fig. 5). The relationships recovered were broadly congruent with the larger sequence dataset in Unmack et al. (2013). Rainbowfishes in the western lineage from the Birds Head region consist of three deeper clades. The most divergent is the "Waigeo" group which consists of the species *M. catherinae* and *M. synergos* from Waigeo and Batanta islands. The remaining species separate in two groups, "Northern Birds Head" and the "Southern Birds Head" on the southern side of the Birds Head Peninsula and the Birds Neck region (Figs 1, 5). New samples included in this study reinforce the boundary between the "northern" and "southern Birds Head" groups. That is, rainbowfishes in drainages that enter up to the western edge of Berau Bay are part of a distinct clade ("southern Birds Head" group) relative to those in drainages west and north of this region ("northern Birds Head" group). This is likely influenced by low sea level drainage patterns which would potentially allow historical connections between drainages within Berau Bay and the adjacent Bintuni Bay (Fig. 1).

Several Birds Head rainbowfishes are separated by relatively small genetic divergences, such as *M. ajamaruensis* and *M. boesemani* with a p-distance of 0.4%, *M. kokasensis* and *M. sneideri* by 0.6%, *M. ericrobertsi* and *M. fasinensis* by 1.3%. These values are similar to or less than variation within some Birds Head rainbowfishes such as *M. synergos* I and II (1.2%), *M. fredericki* I and II (1.0%), and *M. catherinae* I and II (0.7%). However, most of these closely related species pairs in western New Guinea are located at different sites within the same drainage (except *M. kokasensis* and *M. sneideri),* whereas different populations of the same species are found in separate well-isolated drainages, which helps to explain their larger genetic divergences. Clearly though these closely-related species pairs have remained sufficiently isolated from one another despite their close geographic proximity to

maintain these genetic divergences as well as having usually evolved differences in colouration, meristic counts and/or morphometric proportions. These differences beg the question as to whether intervening populations represent a series of intermediate variants, or whether species are separated by distinct boundaries due to differences in habitats or barriers. Only further sampling for each species pair can resolve that question. In the meantime, the combination of evidence supports their status as distinct species.

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APPENDIX

1. *Melanotaenia ajamaruensis*, males, photo by H.-G. Evers. 2. *Melanotaenia ajamaruensis*, female, photo by H.-G. Evers. 3. *Melanotaenia boesemani*, male, Lake Ayamaru, Irian Jaya, Indonesia, photo by H. Bleher. 4. *Melanotaenia boesemanni*, Aytinjo Lake, bred by M. Dielen, photo by N. Khardina. 5. *Melanotaenia fasinensis*, female, photo by H.-G. Evers. 6. *Melanotaenia fasinensis*, male, photo by H.-G. Evers.