Zootaxa 3962 (1): 206–225
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3962.1.13
http://zoobank.org/urn:lsid:zoobank.org:pub:FBCF7375-8ADD-4624-9DD8-1A5427B5FB9A

Revision of the hillstream lizard loaches, genus *Balitoropsis* (Cypriniformes: Balitoridae)

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Abstract

The genus *Balitoropsis* Smith 1945 consists of two species, *B. zollingeri* (Bleeker 1853) and *B. ophiolepis* (Bleeker 1853). *Homaloptera maxinae* Fowler 1937, *Balitoropsis bartschi* Smith 1945, and *Homaloptera nigra* Alfred 1969 are junior synonyms of *B. zollingeri*. *Balitoropsis zollingeri* has been reported from Thailand, Laos, Cambodia, Malay Peninsula, Sumatra, Java, and Borneo, and *B. ophiolepis* is known from Sumatra, Java, and Borneo.

Keywords: *Homaloptera zollingeri*, *Homaloptera ophiolepis*, *Balitoropsis bartschi*, *Homaloptera maxinae*, *Homaloptera nigra*, Southeast Asia

Introduction

Randall and Page (2015) distinguished *Balitoropsis* from related genera, *Homaloptera*, *Homalopteroides, Pseudohomaloptera,* and *Homalopterula*, based on the nuclear recombination activating gene 1 (RAG1) and morphological characters, recognizing only two species in *Balitoropsis*: *Homaloptera zollingeri* Bleeker 1853 and *H. ophiolepis* Bleeker 1853. This classification includes fewer species in *Balitoropsis* than previously recognized (Kottelat 2012, 2013), and the objective of the present study was to use morphological and molecular data to assess the status of species synonymized with *H. zollingeri: Homaloptera maxinae* Fowler 1937, *Balitoropsis bartschi* Smith 1945, and *Homaloptera nigra* Alfred 1969.

Materials and Methods

Morphological. Measurements follow Hubbs and Lagler (2004) or Kottelat (1984); see Randall & Page (2012) for measurements from each source. Counts follow Randall and Page (2014). The terms "origin" and "insertion" refer, respectively, to the anterior and posterior ends of fin bases for both paired and unpaired fins. Lengths were measured to the nearest 0.1 mm using digital calipers and taken on the left side when possible. All measurements are given in millimeters (mm). Head length and measurements of the body are given as proportions of standard length (SL). Measurements of the head are presented as proportions of head length (HL), and eye length as a proportion of interorbital width (IO). Institutional abbreviations follow Sabaj Pérez (2012). When coordinates were unavailable, they were estimated using maps and GEOLocate. Maps were constructed using ArcMap10.

Molecular. To test the monophyly of populations identified morphologically as *Balitoropsis zollingeri*, a molecular analysis of the mitochondrial cytochrome c oxidase subunit 1 gene (COI) was performed based on recently collected tissues (Table 1) and sequences available on Genbank (*Balitora brucei* [accession # KJ774109.1], *Gastromyzon* sp. [accession # JN646091.1], *Metahomaloptera omeiensis* [accession # JN177080.1]). Total genomic DNA was extracted from fin clips or muscle tissue preserved in 95% ethanol using a DNeasy Tissue Kit (Qiagen). COI was amplified and sequenced using the primers FISH-BCL: 5'–TCA ACY AAT CAY AAA GAT ATY GGC AC–3' and FISH-BCH_R: 5'–ACT TCY GGG TGR CCR AAR AAT CA–3' (Baldwin *et al*., 2009).

 Accepted by R. L. Mayden: 29 Mar. 2015; published: 22 May 2015

TABLE 1. Samples produced from this study included in phylogenetic analysis.

Genus	Species	Vial #	Voucher	Origin (region, province, river)	Genbank accession #
Balitoropsis	*ophiolepis*	2006-0588	UF 166109	Sumatra, Lampung, Way Besai	KR052868
	zollingeri	2005-0948	UF 161715	Sumatra, Lampung, Way Rarem	KR052865
		2005-0962	UF 161715	Sumatra, Lampung, Way Rarem	KR052864
		2006-0591	UF 166105	Sumatra, Lampung, Way Besai	KR052867
		2012-0167	UF 183727	Thailand, Nakhon Si Thammarat, Tha Di	KR052871
		2012-0583	UF 235547	Malaysia, Kelantan, Kelantan	KR052870
		2012-0587	UF 235547	Malaysia, Kelantan, Kelantan	KR052869
		2012-0598	UF 235547	Malaysia, Kelantan, Kelantan	KR052866
Homaloptera	*ocellata*	2005-0980	UF 161605	Sumatra. Lampung, Way Abung	KR052873
Pseudohomaloptera	*leonardi*	2012-0597	UF 235746	Malaysia, Kelantan, Kelantan	KR052872

Reactions for the polymerase chain reaction (PCR) followed Randall and Page (2015). The PCR cycling parameters followed Parenti *et al*. (2013). PCR cleaning with ExoSAP-IT and sequencing took place at the Interdisciplinary Center for Biotechnology Research, University of Florida, Gainesville, FL, USA. Geneious 7.1.4 (Kearse *et al*. 2012) was used to view chromatograms, assemble consensus sequences, and generate a final alignment using the Geneious global alignment tool. The final alignment was corrected manually.

A Bayesian Inference (BI) analysis using MrBayes 3.2.2 (Ronquist *et al*. 2012) and a Maximum Likelihood (ML) analysis using RAxML 7.2 (Stamatakis 2014) were performed through the Cyberinfrastructure for Phylogenetic Research (CIPRES) (Miller *et al*. 2010). For the BI analysis, model selection was restricted to those available in MrBayes, where the HKY+I+G was the best fit substitution model of nucleotide evolution for COI using the Akaike Information Criterion with JModeltest version 2.1.5 (Darriba *et al*. 2012). Two Markov chain Monte Carlo (MCMC) analyses with four simultaneous chains were run for 5 million generations sampling every 1,000 generations resulting in 10,002 sampled trees. The standard deviation for split frequencies was 0.003512 and the average potential scale reduction factor for all parameters was 1.001, indicating convergence of the two runs; 25% of the first sampled trees were discarded as burn-in, leaving 7,502 trees. The best tree was viewed in Figtree v. 1.3.1 (http://tree.bio.ed.ac.uk/software/figtree/). The ML analysis procedure followed Randall and Page (2015). *Gastromyzon* a member of the gastromyzonins, sister group to balitorins (Randall & Page 2015), was used to root the gene trees for both BI and ML analyses.

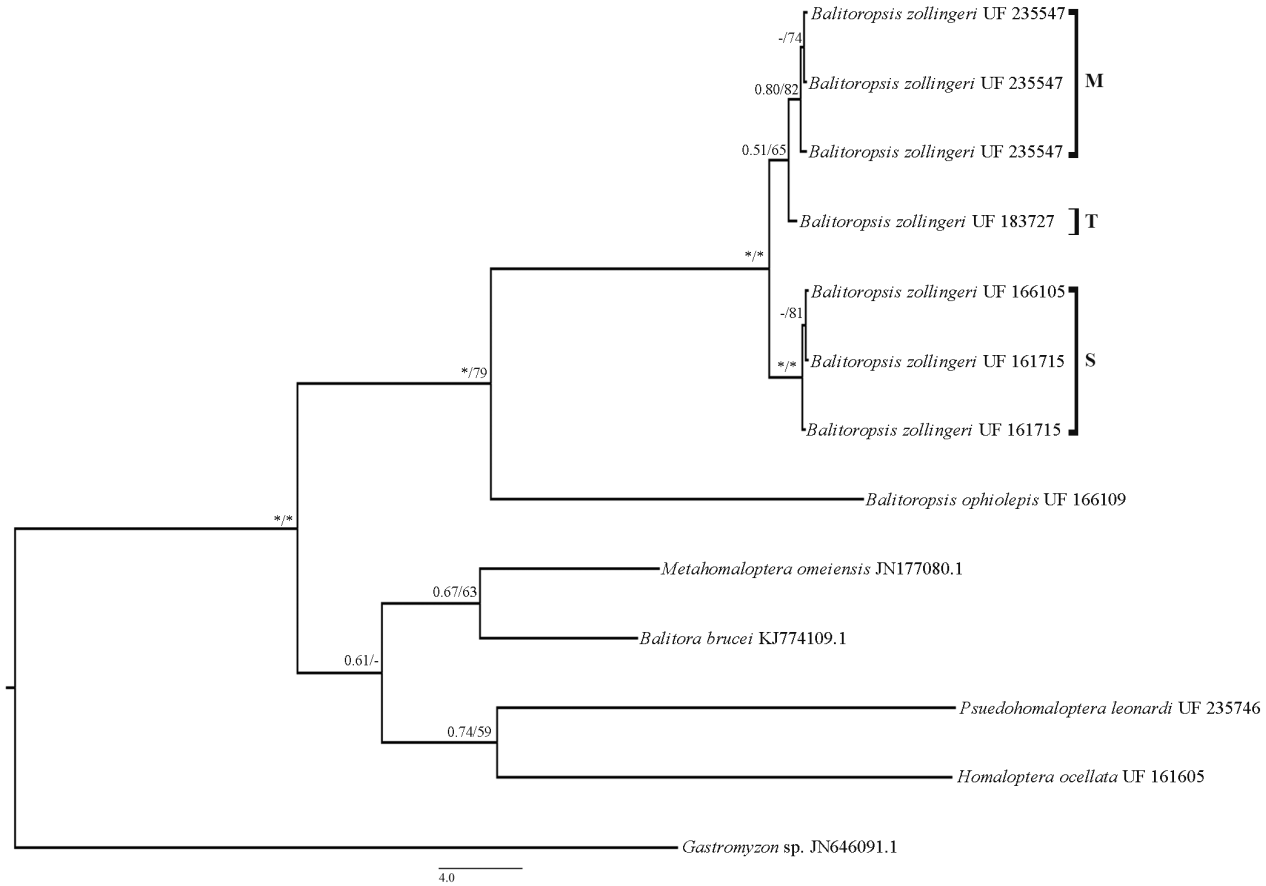

FIGURE 1. Balitorid phylogeny based on Bayesian analysis of CO1. Support values are indicated at the branch lengths (pp/bs). Posterior probability values ≥ 0.95 and bootstrap support ≥ 90 are represented by an asterisk (*). Support values ≤ 50 are represented by a hyphen (-). M) peninsular Malaysia; S) Sumatra; T) Thailand.

Phylogenetic Results

The BI and ML analyses generated an identical topology which is represented in Figure 1 by the BI analysis (greater likelihood score of -2360.32). *Balitoropsis* was monophyletic and the sister group to other genera of balitorini included in the analysis (*Balitora*, *Homaloptera*, *Metahomaloptera*, *Pseudohomaloptera*). *Balitoropsis*

zollingeri was monophyletic with shallow branch divergences among the three populations sampled (peninsular Malaysia, Sumatra, and Thailand). The Thailand population is sister group to the peninsular Malaysian population with weak support. The population from Sumatra is sister group to the other populations with strong support. Only the population from Sumatra is strongly supported as monophyletic in both analyses. The population from peninsular Malaysia is only strongly supported by the ML analysis.

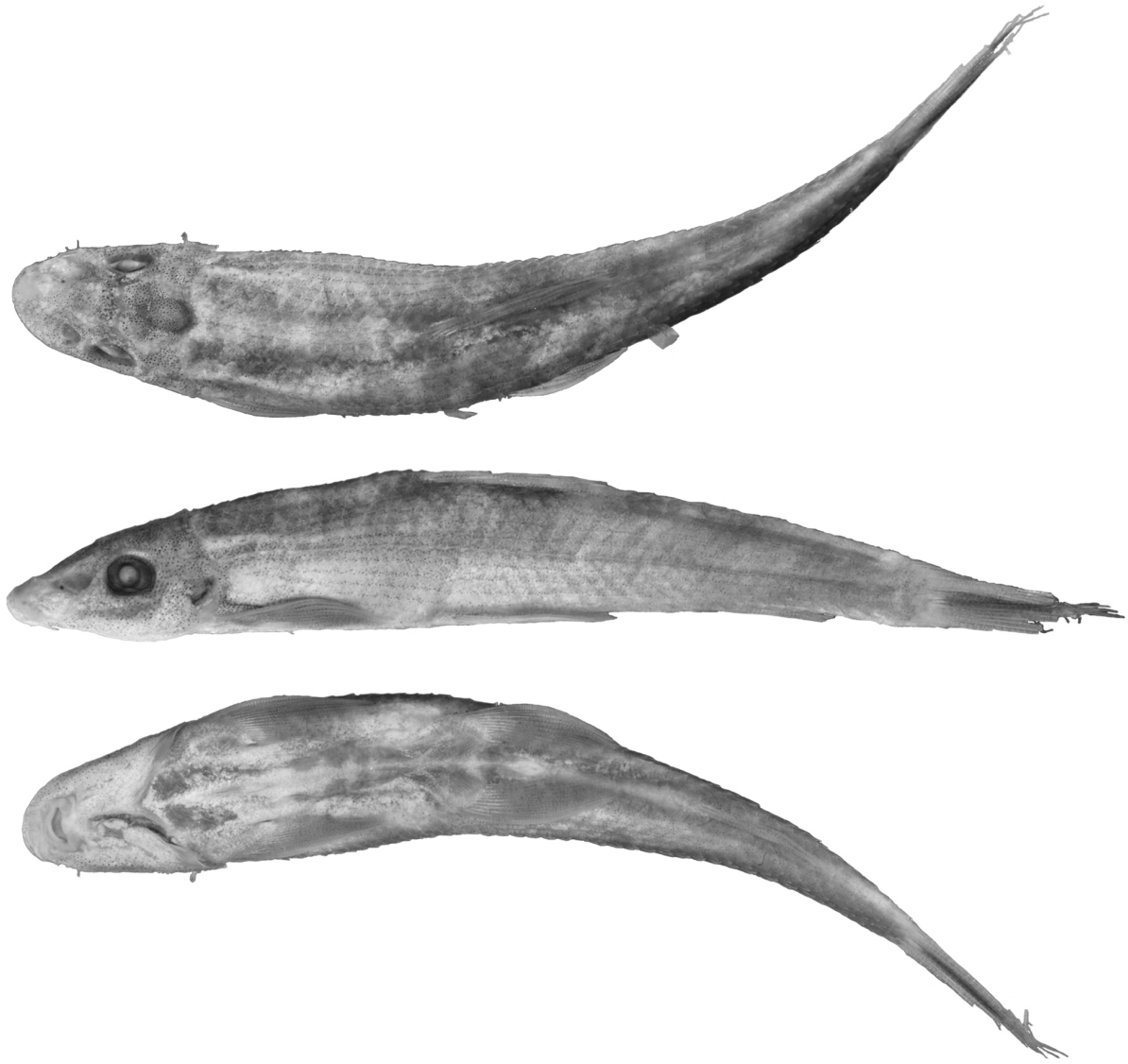

FIGURE 2. Dorsal, lateral, and ventral views of holotype of *Homaloptera maxinae*, ANSP 68004, 34.3 mm SL; Tachin (Samut Sakhon), Thailand.

Balitoropsis **Smith 1945**
Lizard loaches

Balitoropsis Smith, 1945:278. (type species: *Balitoropsis bartschi* Smith 1945:279, by original designation). Gender feminine.

Systematic History. *Balitoropsis* was created for *B. bartschi* Smith (1945) based on having papillated lips and a deep preoral groove extending around the corners of the mouth. However, papillated lips (unculi) and a preoral groove are common characters in balitorid genera, and the genus was recognized as a junior synonym of *Homaloptera* van Hasselt 1823 by Kottelat & Chu (1988).

Balitoropsis was recognized as a subgenus of *Homaloptera* by Tan & Ng (2005) and Randall & Page (2012) and as a genus consisting of 10 species by Kottelat (2012) and of 9 species by Kottelat (2013). Randall & Page (2015) recognized *Balitoropsis* as a genus consisting of 2 species based on molecular and morphological data.

TABLE 2. Morphometrics and meristics for holotype of *Homaloptera maxinae*, ANSP 68004; holotype and paratypes of *Homaloptera nigra*, ZRC 2009, CAS-SU 66424 (2); and *Balitoropsis zollingeri*, BMNH 1866.5.2.53 (Bleeker specimen) (1), other material examined (31). All measurements in mm. Number of individuals with a value shown in parentheses. * denotes meristic counts for holotype.

MORPHOMETRICS	***H. maxinae***	***H. nigra***			***B. zollingeri***	
		Range	**Mean±%SD**	**BMNH 1866.5.2.53**	**Range**	**Mean±%SD**
Standard Length	34.3	45.3-57.0		57.9	27.3-67.7	
Total Length	40.7	54.5-61.9			35.0-86.4	
% of Standard Length						
Lateral head length	23.1	22.5-25.9	24.0±1.8	25.4	20.8-26.7	23.4±1.3
Body depth	15.0	14.8-16.0	15.3±0.6	13.6	13.7-17.6	15.1±0.8
Body width	14.5	13.2-16.0	14.6±1.9	15.5	12.3-18.5	14.9±1.5
Distance from pelvic fin to anal fin	30.9	30.7-31.6	31.1±0.4	33.5	27.0-32.2	30.5±1.3
Dorsal-fin base length	14.5	13.2-15.2	14.3±1.0	13.0	12.7-15.8	14.4±0.8
Dorsa-fin length	24.6	24.0-24.3	24.1±0.2	21.6	22.4-26.9	24.7±0.9
Pectoral-fin length	22.0	21.9-23.0	22.3±0.6	27.6	21.5-24.9	23.3±0.9
Pelvic-fin length	21.1	18.8-20.2	19.5±0.7	21.8	19.2-23.1	20.5±1.0
Anal-fin length	16.5	15.3-16.6	15.9±0.7	15.5	14.6-18.0	16.2±0.9
Head-dorsal length	25.4	24.5-27.3	26.3±1.6	31.8	22.8-29.8	26.4±1.8
Predorsal length	48.6	46.1-49.7	48.2±1.8	52.3	45.1-50.2	47.9±1.3
Caudal-peduncle length	17.1	15.6-17.8	17.0±1.2	14.0	12.8-17.9	15.5±1.4
Caudal-peducle depth	8.4	8.4-8.8	8.6±0.2	8.1	8.0-9.3	8.5±0.3
% of Head Length						
Head width	68.8	71.5-77.6	73.9±3.3	67.3	69.4-87.4	78.3±5.6
Head depth	51.3	43.1-50.0	46.7±3.5	35.4	44.3-56.4	49.6±2.9
Snout length	50.0	52.3-53.0	52.7±0.4	43.5	44.3-56.6	50.8±3.4
Length of orbit	21.3	20.8-25.5	22.9±2.4	19.0	20.4-27.1	23.1±1.9
Interorbital width	33.8	33.1-37.3	34.9±2.1	30.6	30.5-40.1	34.4±2.5
Pectoral-fin length	95.0	88.5-97.1	93.2±4.4	108.8	85.5-113.6	97.7±14.4
% of Interorbital Width						
Length of oribit	63.0	62.8-68.4	65.5±2.8	62.2	54.1-80.1	67.3±7.9

...Continue on next page

TABLE 2. (Continued)

MERISTICS	*H. maxinae*	*H. nigra*	*B. zollingeri*	
Individuals examined	1	3	BMNH 1866.5.2.53	31
Dorsal-fin rays	iii, 8½	iii, 8½	iii, 8½	iii, 8½
Pectoral-fin rays	iv, 10, i	iv, 10, i (2*); v, 9, i & iv, 9, i (1)	iv, 10, i	iii, 10, i (1); iv, 10, i (30)
Pelvic-fin rays	ii,8	ii, 8	ii, 8	ii, 7 (1); ii, 8 (28); ii, 9 (2)
Anal-fin rays	ii, 5½	ii, 5½	ii, 5½	ii, 5½ (30); ii, 6½ (1)
Caudal-fin rays	17	17 (2*), n/a (1)	17	17
Total lateral-line scales	44	42-43	44	42-46
Circumpeduncular scales	18	17, (1), 18 (2*)	18	17 (5); 18 (22); 20 (4)
Number of scale rows above / below lateral line	6 / 6	5-6 / 5	7 / 6	6-7 / 5-6
Number of scale rows below lateral line to pelvic-fin origin	6	5	6	5-6
Predorsal scales	13	13-15	15	13-15

Diagnosis. Anus closer to pelvic-fin base than to anal-fin origin; dorsal-fin origin anterior to or above pelvic-fin origin; 8½ branched dorsal-fin rays; 7–9, usually 8, branched pelvic-fin rays; forked caudal fin; keeled scales; 42–55 lateral-line scales; 13–15 predorsal scales; large rostral cap; 2 thick rostral barbels in close proximity to one another; thick crescentic upper lip; fleshy pad between lateral portions of lower lip (Randall and Page 2015).

***Balitoropsis zollingeri* (Bleeker 1853)**
Black Lizard Loach (Figures 2, 3, 4, 5, 6A, 7)

Homaloptera javanica van Hasselt 1823: 133 (nomen nudum, Kottelat, 1987)
Homaloptera Zollingeri Bleeker 1853: 159 (type locality: Indonesia: Java: Batavia [Jakarta] and Bandong [Bandung]); syntypes: lost, Bleeker, 1860: 89
Homaloptera javanica Bleeker 1860: 89 (unnecessary replacement name for *Homaloptera zollingeri* Bleeker, 1853)
Homaloptera maxinae Fowler 1937: 152, figs. 52, 53 (type locality: Tachin [Tha Chin, Samut Sakhon], Siam [Thailand]); holotype: ANSP 68004
Balitoropsis bartschi Smith 1945: 279, fig. 56 (type locality: Thailand: Trang Province: waterfall stream on Kao Chong); holotype: USNM 107963
Homaloptera nigra Alfred 1969: 217, pl. 1 figs. 1–2 (type locality: Malaysia: Pahang: King George V National Park [now Taman Negara], Chegar Sireh, Tahan River); holotype: ZRC 2009
Balitoropsis zollingeri.—Kottelat 2012: 47

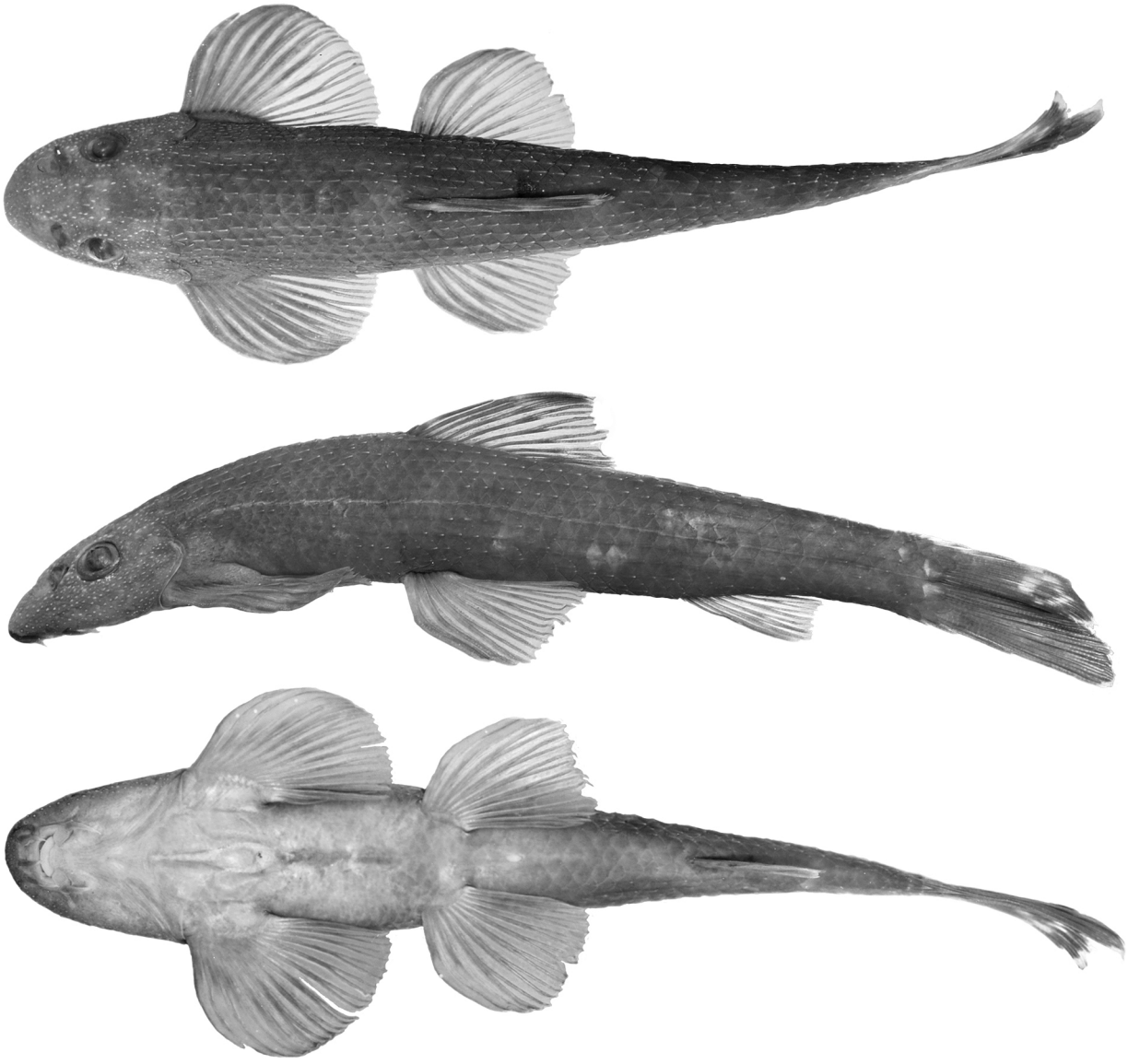

FIGURE 3. Dorsal, lateral, and ventral views of holotype of *Homaloptera nigra*, ZRC 2009, 50.1 mm SL; Pahang, Malaysia.

Remarks. The three specimens examined in the original description of *Homaloptera zollingeri* Bleeker 1853 were lost after several moves of Bleeker's collection or from theft (Bleeker 1860). Gunther (1868) assumed that one of the three specimens sent to him by Bleeker was a type (Norman and Whitehead 1984:305), and recognized it as the holotype (catalog number not listed, but it would correspond to BMNH 1866.5.2.53 [1]). This specimen is from Lahat, Sumatra, and not from the type localities of *B. zollingeri* (Jakarta and Bundung, Java). Specimens of *B. zollingeri* from the type localities are unknown to us.

Bleeker (1860) synonymized *H. zollingeri* Bleeker 1853 with *H. javanica* van Hasselt 1823 after examining specimens of *H. zollingeri* from Lahat, Sumatra, and noting its resemblance to the original unpublished drawings of *H. javanica*. However, the name *H. javanica* lacked a description or figure and is unavailable (Kottelat 1987). The first available name for this species is *H. zollingeri* (Art. 12.1, ICZN 1999).

Homaloptera maxinae Fowler 1937 was described from Tachin (Samut Sakhon), Thailand. After examining its holotype (ANSP 68004), Smith (1945) synonymized *H. maxinae* with *H. zollingeri* commenting that putative differences might be due only to age. The only character differentiating the holotype of *H. maxinae* (ANSP 68004) (Fig. 2 and Table 2) from other *B. zollingeri* is head width (68.8% vs. 69.4–87.4% HL), which may be unreliable due to the poor condition of the holotype. See Smith (1945) for comments on miscounts in Fowler's (1937) original description of *H. maxinae*. Silas (1953) tentatively followed Smith's synonymization of *H. maxinae*, Rainboth (1996) treated *H. maxinae* as valid, and Kottelat (2012, 2013) recognized it as a questionable junior synonym of *Homalopteroides smithi* (Hora 1932).

Balitoropsis bartschi Smith 1945 was described from Kao Chong River, Trang Province, Thailand, as the type of the genus. Following Kottelat and Chu (1988) and Randall and Page (2015), *Balitoropsis bartschi* is a junior synonym of *B. zollingeri*.

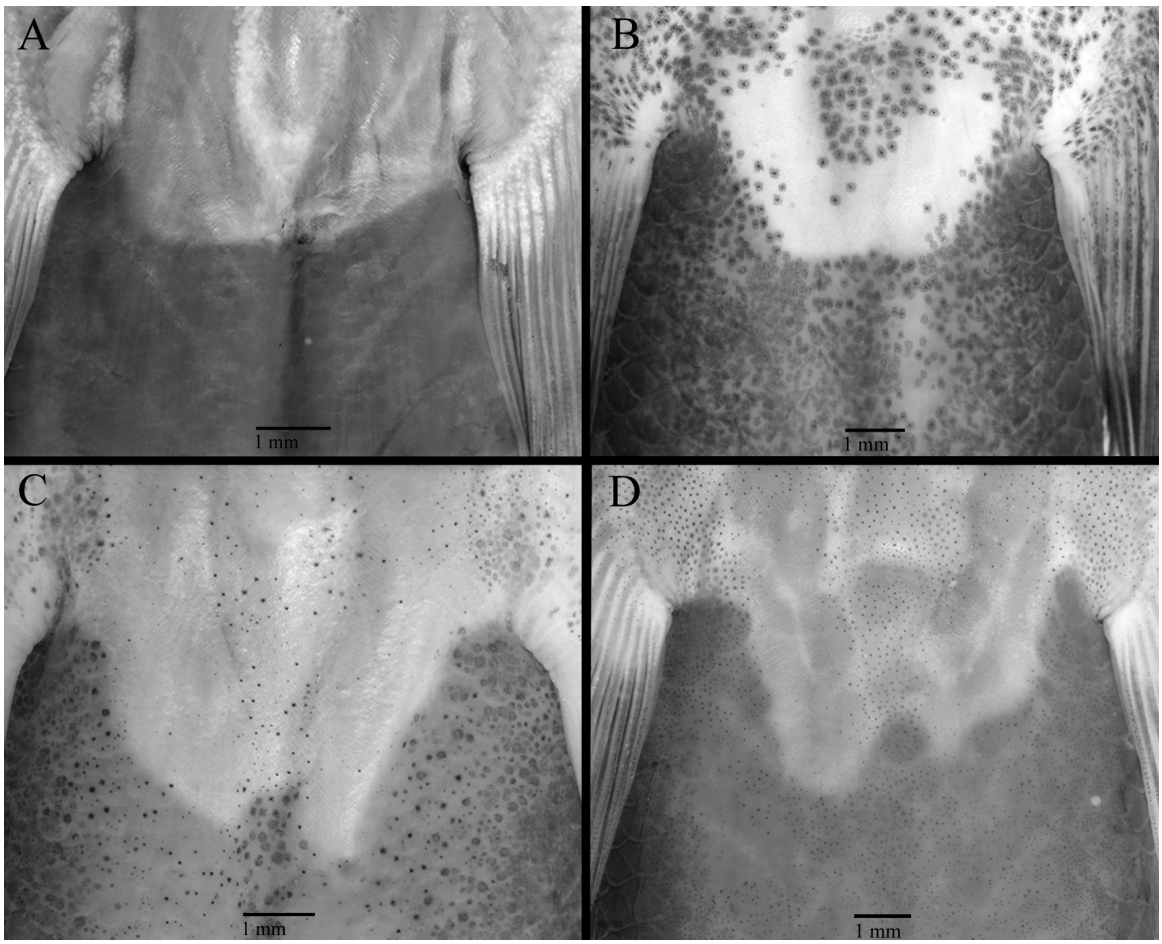

FIGURE 4. Ventral squamation pattern of preserved *Balitoropsis zollingeri.* (A) CAS-SU 66424 (paratype of *Homaloptera nigra*), 57.0 mm SL; Pahang, Malaysia. (B) UF 235547, 61.7 mm SL; Kelantan, Malaysia. (C) UF 183727, 64.4 mm SL; Nakhon Si Thammarat, Thailand. (D) CAS-SU 49331, 67.7 mm SL; Kalimantan Barat, Borneo. Squamation pattern shaded. Anterior at top of figure.

Homaloptera nigra Alfred 1969 was established based on populations in the Malay Peninsula and distinguished from *H. zollingeri* by color and squamation on the ventral surface of the body. Roberts (1989) synonymized *H. nigra* with *H. zollingeri* after finding only slight differences between specimens of *H. zollingeri* from the Kapuas drainage of Borneo and type material of *H. nigra*. Kottelat (2001, 2012, 2013) followed the classification of Roberts (1989).

Comparison of the type series of *H. nigra* (Fig. 3 and Table 2) with specimens of *B. zollingeri* shows no distinction in morphometrics or meristic counts. Pigmentation varies among individuals throughout the range of *B. zollingeri,* with some individuals being much darker than others, likely due to variation in habitat substrate. Squamation on the ventral surface varies intraspecifically (Fig. 4) but shows no geographic pattern. Two of the four individuals in Figure 4 (B & C) differ in squamation but clearly are indicated as conspecific in the phylogenetic analysis (Fig. 1).

Diagnosis. Member of *Balitoropsis* as defined by Randall and Page (2015). *Balitoropsis zollingeri* is distinguished from *B. ophiolepis* (Table 3) by mostly black caudal-fin with 1–3 black bands on distal extremity of white upper lobe vs. hyaline with multiple black bands; caudal-peduncle depth 8.0–9.3% vs. 4.0–5.1% SL; body depth 13.6–17.6% vs. 9.2–11.9% SL; 42–46 vs. 48–55 total lateral-line scales; and 17–20 vs. 13–14 circumpeduncular scales.

TABLE 3. Characters distinguishing species of *Balitoropsis*. Number of specimens examined in parentheses.

Character	***B. zollingeri*** (36)	***B. ophiolepis*** (9)
Caudal-fin patterning	mostly black with 1–3 small black bands on clear portion of upper lobe	hyaline with dark brown bands
Caudal-peduncle depth	8.0–9.3% SL	4.0–5.1% SL
Body depth	13.6–17.6% SL	9.2–11.9% SL
Total lateral-line scales	42–46	48–55
Circumpeduncular scales	17–20	13–14

Description. Dorsal, lateral, and ventral views of *B. zollingeri* are shown in Figure 5. Measurements and meristic counts are given in Table 2. Body arched predorsally and flattened ventrally. Head with two rows of prominent tubercles longitudinally between nares. Eyes dorsolateral, shorter than interorbital width. Rostral cap large. Dorsal-fin origin anterior to or at pelvic-fin origin. Pectoral fin reaching about midway between pectoral-fin insertion and pelvic-fin origin. Pelvic fin reaching far past anus. Anus closer to pelvic-fin base than to anal-fin origin. Anal fin not reaching caudal-fin base. Axillary pelvic lobe absent. Caudal fin forked with rounded lobes; lower lobe longer.

Dorsum with large keeled scales; scales on ventral surface without keels, deeply embedded between pectoral and pelvic fins. Total lateral-line scales 42–46, predorsal scales 13–15, circumpeduncular scales 17–20. Scales above and below lateral line 5–7/5–6, respectively. Scales below lateral line to pelvic-fin origin 5–6. Modal fin-ray counts (variation given in Table 2): dorsal iii, 8½; anal ii, 5½; pectoral iv, 10, i; pelvic ii, 8; total caudal 17.

Mouth (Fig. 6A) inferior; lips with tiny unculi, continuous around corners of mouth. Distal-lateral extension of lower lip uncommon. Fleshy pad present between lateral halves of lower lip. Rostral and post-labial grooves present. Two pairs of rostral barbels, one pair of maxillary barbels. Barbels with tiny unculi, rostral barbels in close proximity to each other. Medial-rostral barbels separated at base. Lateral-rostral barbel longer than medial-rostral barbel, reaching to maxillary barbel. Maxillary barbel reaches horizontally to vertical at anterior orbital rim. Under surface of head covered in small tubercles; branchiostegal membrane united to isthmus with small central furrow.

Color in 70% ethanol (Fig. 5): Dorsally light-dark brown with dark brown mottling. Some specimens dark overall with dorsal saddles hard to differentiate. Six brown-black dorsal saddles usually present. 1st saddle between supraoccipital and 2nd saddle; 2nd saddle from anterior to dorsal-fin to just behind origin of fin; 3rd saddle spans most of dorsal-fin length; 4th saddle between distal extremity of dorsal-fin to just past anal-fin origin; 5th saddle spans most of anal-fin length; 6th saddle at caudal-fin base. In some individuals, 5 (5th and 6th saddle fused) or 7

(extra saddle between 2nd and 3rd saddles) saddles present. Brown-black triangular blotch between posterior orbital margins and supraoccipital.

Venter cream; heavily stippled posterior to anal-fin origin, less so between anal and pectoral fins, stippling becoming patchy near head. Undersurface of head heavily stippled dark brown. Barbels stippled brown with hyaline tips. Lips and fleshy pad lightly stippled brown.

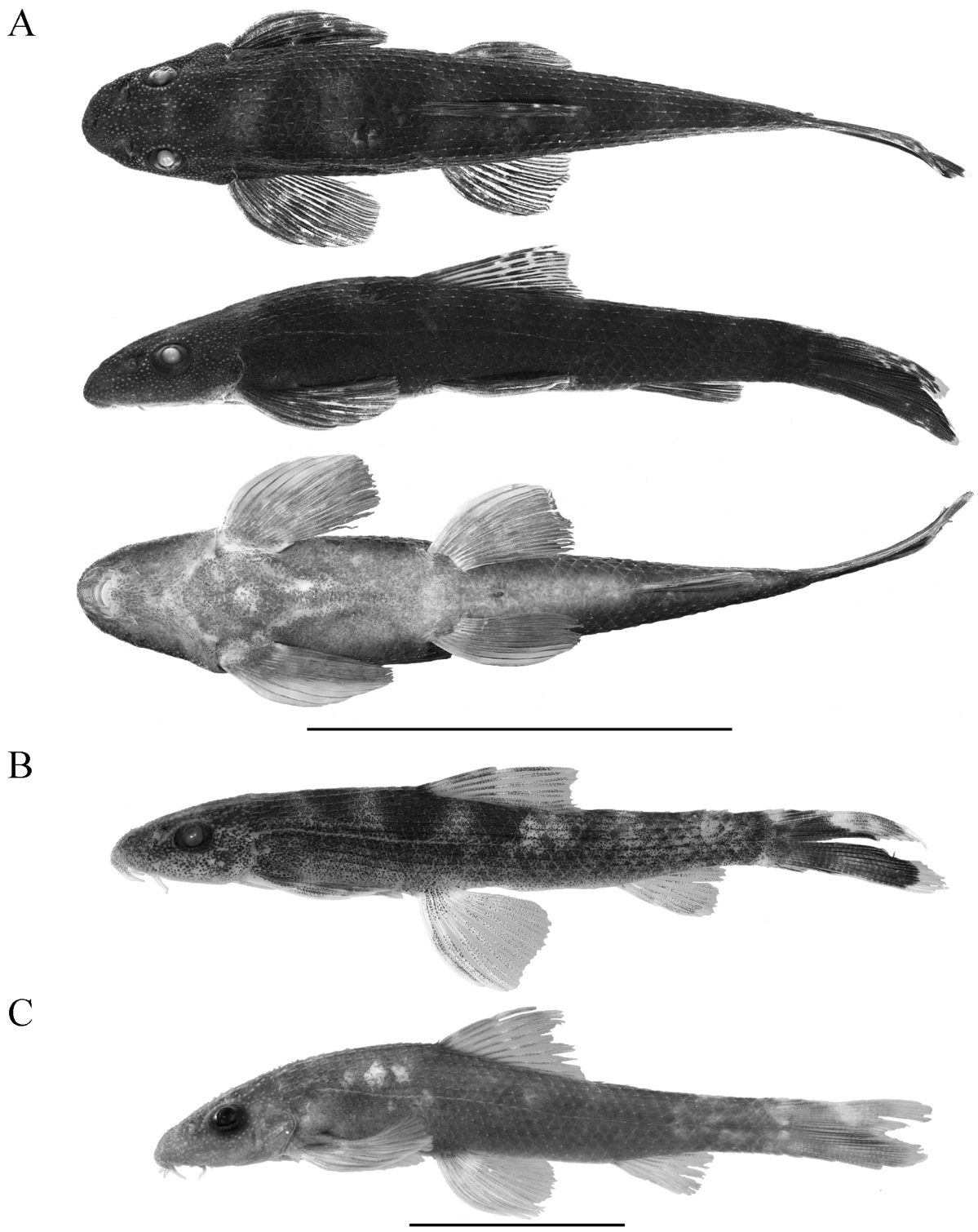

FIGURE 5. *Balitoropsis zollingeri*. (A) Dorsal, lateral, and ventral views of UF 166094, 52.1 mm SL; Sumatera Selatan, Sumatra; scale bar 30 mm. (B) UF 235545, 32.1 mm SL; Nakhon Si Thammarat, Thailand. (C) USNM 288456, 27.9 mm SL; Pahang, Malaysia. Scale bar for B and C 10 mm.

All fins dark brown-black; sometimes 2–3 black bands on dorsal fin. Caudal fin mostly black; 1–3 small black bands on clear portion of upper lobe, white tips on upper and lower lobes.

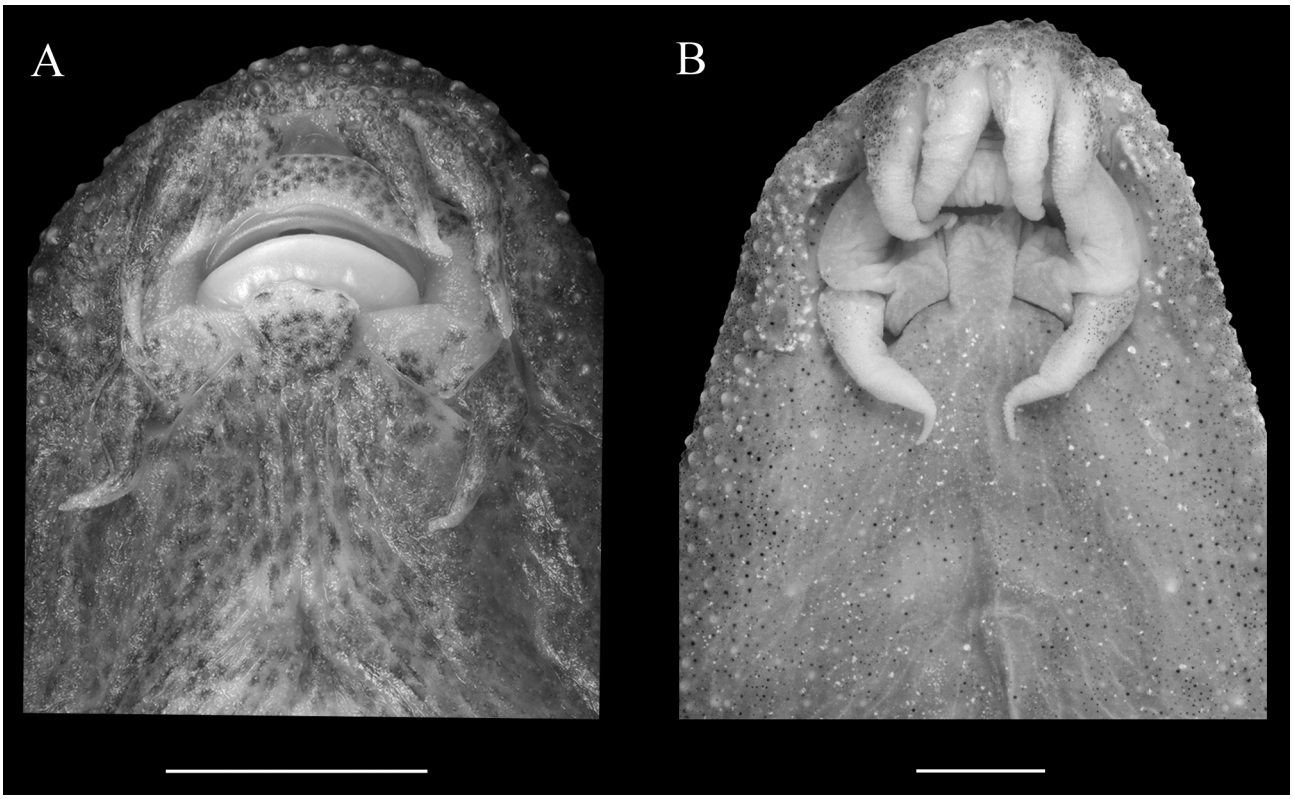

FIGURE 6. Oral morphology of (A) *Balitoropsis zollingeri*, UF 166094, 52.1 mm SL; Sumatera Selatan, Sumatra, (B) *B. ophiolepis*, UF 166109, 101.2 mm SL; Lampung, Sumatra. Scale bar 3 mm.

FIGURE 7. Lateral views of living *Balitoropsis zollingeri.* (A) UF 235547, 61.7 mm SL; Kelantan, Malaysia. (B) UF 235545, 27.3 mm SL; Nakhon Si Thammarat, Thailand. Scale bar 5 mm.

Color in Life. Live large and small individuals shown in Figure 7. Both have similar color pattern with exception of orange infraorbital blotch in smaller individual. Head, body, and fins stippled black. Orange mottling on head, highlighting dorsal saddles, and on hyaline portions of fins. Large orange-red patch between pectoral fins on larger individual.

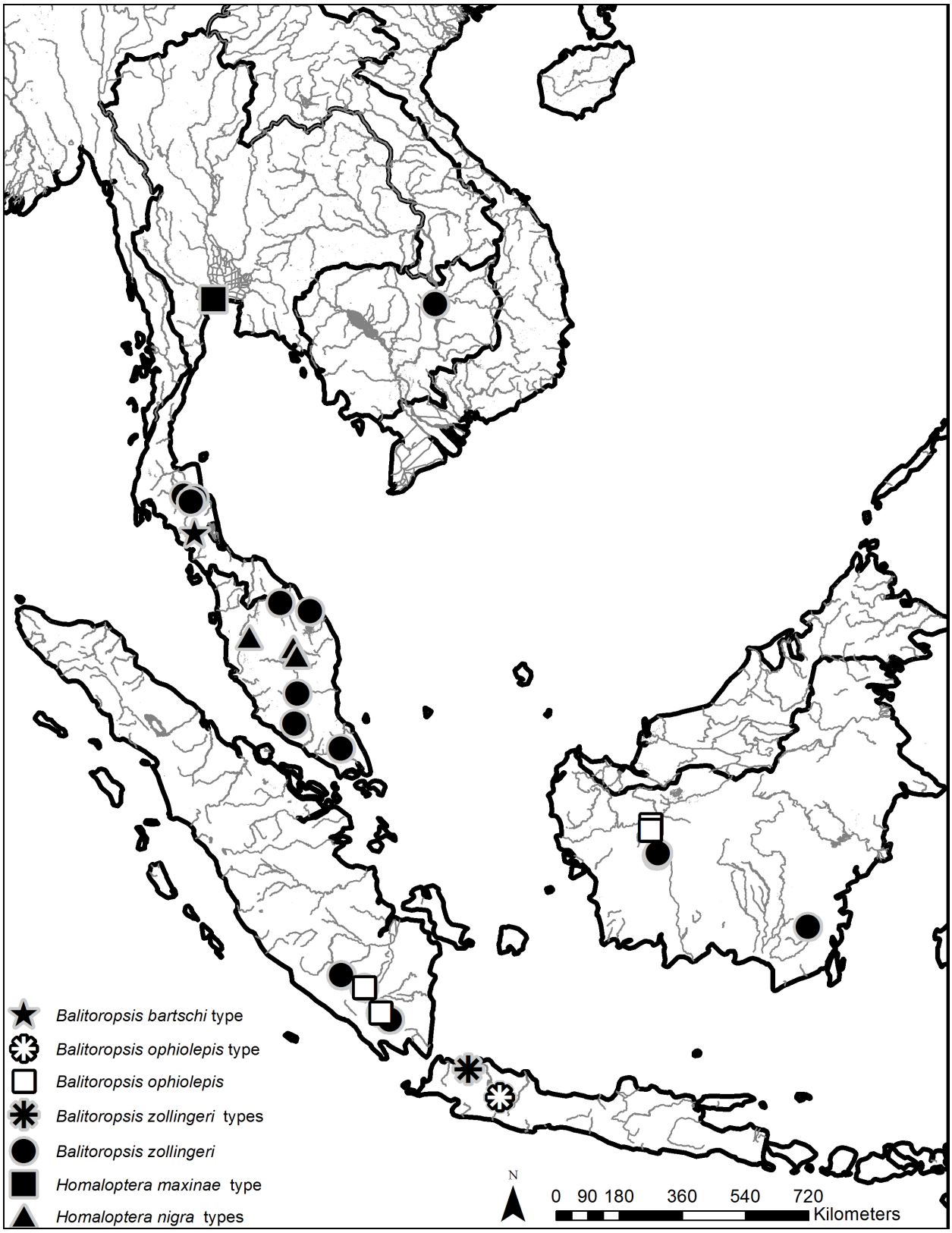

FIGURE 8. Distribution of *Balitoropsis*. Locality in Cambodia from Rainboth, *et al*. (2012).

Distribution and Ecological Notes. No recent collections are known from the type localities of Jakarta and Bandung, Java, and the species has likely been extirpated from these highly developed areas. The species is known to occur in Sumatra: Lampung (Tulangbawang basin) and Sumatera Selatan (Musi basin); Borneo: Kalimantan Barat (Kapuas basin) and Kalimantan Selatan (Barito basin); peninsular Malaysia: Pahang (type locality of *Homaloptera nigra*) (Pahang basin), Negri Sembilan (Muar basin), Kelantan (Kelantan basin), Terengganu (Setiu basin), and Johore (Endau basin); Thailand: Samut Sakhon (type locality of *Homaloptera maxinae*) (Chao Phraya basin), Nakhon Si Thammarat (Ta Pi and Mai Siap basins), and Trang (type locality of *Balitoropsis bartschi*) (Trang basin); Cambodia: Stung Treng (Mekong basin) (Fig. 8). The species was reported from the Mekong River, downriver of Khone Falls in Laos (Kottelat 2001).

FIGURE 9. (A) Dorsal, lateral, and ventral views of lectotype of *Homaloptera ophiolepis*, RMNH 4986, 79.4 mm SL; Bandong (Bandung), Java. (B) Label from RMNH 4986.

Balitoropsis zollingeri has been collected from fast-flowing waters with rocky substrates and is reported to feed on insect larvae (Rainboth 1996). In the Kapuas basin, *B. zollingeri* was collected syntopically with *B. ophiolepis* (field number Kapuas 1976-27, Roberts 1989).

Material examined.—*Balitoropsis zollingeri*: Sumatra: BMNH 1866.5.2.53 (Bleeker specimen) (1); UF 161715 (3), 166094 (2), 166095 (1), 166102 (1), 166105 (1). Borneo: CAS 49331 (1); USNM 230253 (2); USNM 393008 (1). Thailand: ANSP 68004 (Holotype of *Homaloptera* maxinae); UF 183727 (1), 183812 (1), 235545 (2); USNM 107963 (Holotype of *Balitoropsis bartschi*) (Photo only). Malaysia: CAS-SU 66420 (2), 66424 (Paratypes of *Homaloptera nigra*) (2); USNM 288456 (1); UF 235547 (9), 235421 (2), 235420 (1); ZRC 2009 (Holotype of *Homaloptera nigra*).

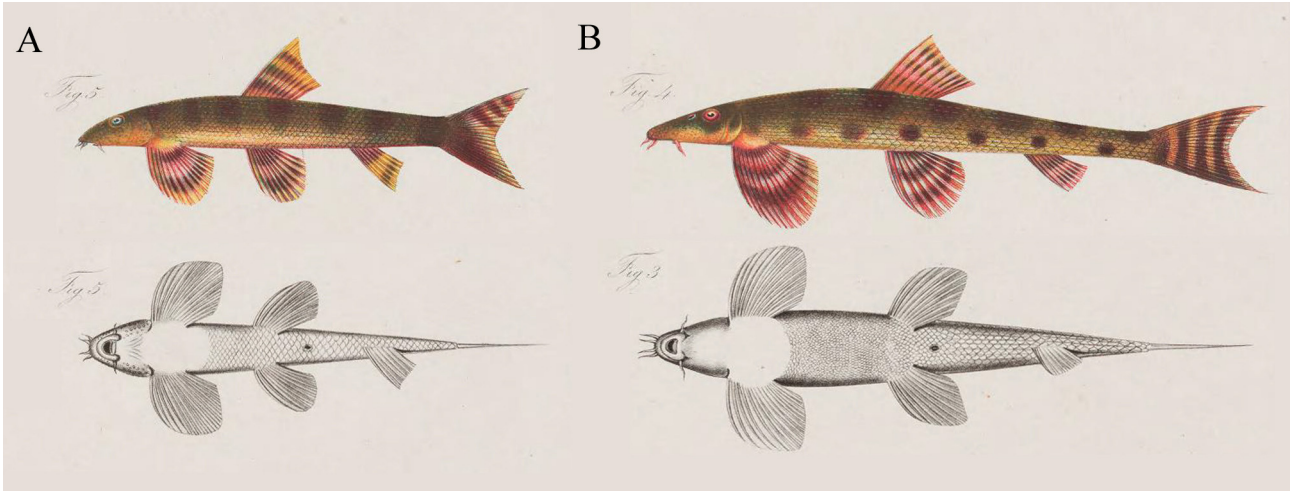

FIGURE 10. Original drawings from Bleeker (1863–1864). (A) *Balitoropsis zollingeri*, (B) *B. ophiolepis*. Positions modified from original publication. Designation of lateral view of *B. ophiolepis* as "Fig. 4" is an error.

Balitoropsis ophiolepis (Bleeker 1853)

Slender Lizard Loach (Figures 6B, 9 & 11)

Homaloptera ophiolepis Bleeker 1853: 160 (type locality: Indonesia: Java: Bandong [Bandung]; lectotype: RMNH 4986; designated by Alfred 1961:35.
Balitoropsis ophiolepis.—Kottelat 2012: 46.

Remarks. In the description of *H. ophiolepis* Bleeker 1853, two individuals 100 and 83 mm in total length from the type locality (Bandung, Java) were examined. Gunther (1868) assumed that one of the specimens sent to him by Bleeker was the type (Norman and Whitehead 1984:305), and recognized it as the holotype (catalog number not listed, but it would correspond to BMNH 1866.5.2.48 [1]). However, according to Alfred (1961), Bleeker, faced with a shortage of collecting jars, would at times place specimens from several localities (including type localities) into the same jar. The specimen assumed by Gunther to be the type (BMNH 1866.5.2.48 [1], 109 mm TL) is likely one of five specimens collected by Bleeker from Lahat, Sumatra (Bleeker 1860). Alfred (1961) examined Bleeker's specimens at BMNH and RMNH and assigned type status to specimens that closely matched the description of *H. ophiolepis* Bleeker 1853. RMNH 4986 (98 mm TL) was designated lectotype (Fig. 9A), and RMNH 1929 (82 mm TL) paralectotype. Both the lectotype and paralectotype are presumed to have been stored together with RMNH 4623, based on the label in Figure 9B, which was found in RMNH 4986. RMNH 4623 consists of three individuals examined by Bleeker from Lahat, Sumatra, and are not types.

The lateral view of *B. ophiolepis* in Bleeker (1863–1864, Tab 3) is labeled 4 instead of 3 (Fig. 10), identifying it as *Homaloptera ocellata* van der Hoeven (1830) (see also Gunther 1868). Oijen and Loots (2012, figs. 13, 14) repeated the error made by Bleeker (1863–1864) in reversing the figures of *B. ophiolepis* and *H. ocellata*.

Diagnosis. See *B. zollingeri* diagnosis and Table 3.

Description. Dorsal, lateral, and ventral views of *B. ophiolepis* are shown in Figure 11. Measurements and meristic counts are given in Table 4. Body long and compressed (body depth 9.2–11.9% SL). Head with two rows

of prominent tubercles longitudinally between nares. Eyes dorsolateral, shorter than interorbital width. Rostral cap large. Dorsal-fin origin anterior to pelvic-fin origin. Pectoral fin small reaching about midway to pelvic fin. Pelvic fin small reaching far past anus. Anus closer to pelvic-fin base than to anal-fin origin. Axillary pelvic lobe absent. Caudal fin forked with rounded lobes; lower lobe longer.

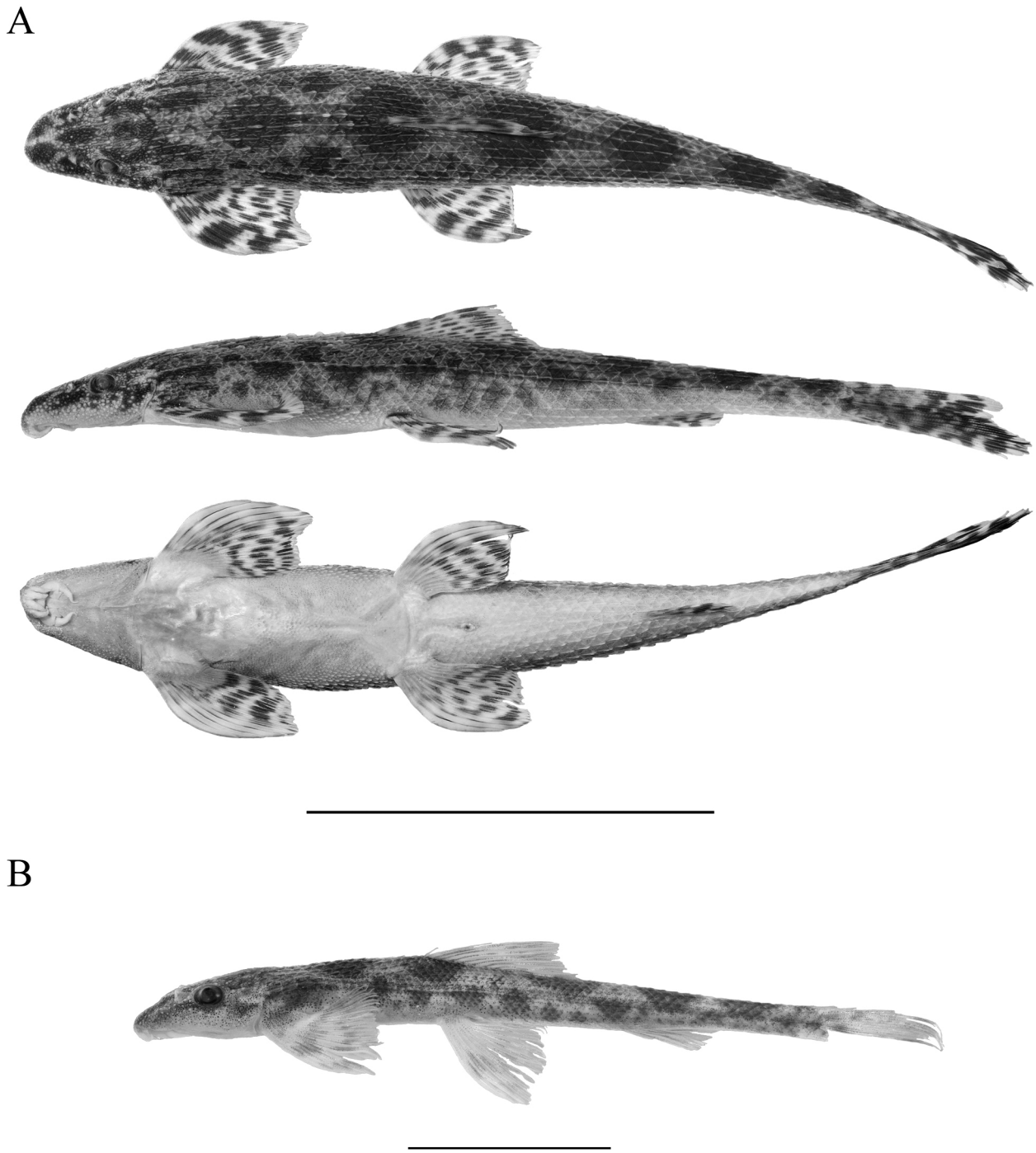

FIGURE 11. Dorsal, lateral, and ventral views of preserved *Homaloptera ophiolepis.* (A) UF 166109, 101.2 mm SL; Lampung, Sumatra. (B) USNM 230251, 34.7 mm SL; Kalimantan Barat, Borneo.

Dorsum with large keeled scales; up to 8 keels per scale. Larger individuals with hypertrophied keels (Fig. 11). Scales on ventral surface posterior to anus with keels, deeply embedded between pectoral and pelvic fins. Total lateral-line scales 48–55, predorsal scales 12–15, circumpeduncular scales 13–14. Scales above and below lateral line 6–7/4–6, respectively. Scales below lateral line to pelvic-fin origin 5–6. Modal fin-ray counts (variation given in Table 4): dorsal iii, 8½; anal ii, 5½; pectoral iv, 10, i; pelvic ii, 8; total caudal 17.

TABLE 4. Morphometric measurements and meristic counts for *Balitoropsis ophiolepis*. All measurements in mm. Number of individuals with a value in parentheses. * denotes meristic counts for smallest individual sampled (USNM 230251).

MORPHOMETRICS	**Lectotype**	**Bleeker specimen**		**Non-types n=7**	
	RMNH 4986	**BMNH 1866.5.2.48**	**USNM 230251**	**Adult Range**	**Adult Mean±%SD**
Standard Length	79.4	93.6	34.7	60.5-101.2	
Total Length	n/a	109.4	43.2	78.2-127.4	
% of Standard Length					
Lateral head length	18.8	19.7	21.2	17.7-20.4	19.3±1.3
Body depth	9.2	10.2	9.7	10.5-11.9	11.2±0.8
Body width	11.3	14.5	11.1	12.2-14.7	13.0±1.2
Distance from pelvic fin to anal fin	29.6	29.8	29.3	29.5-31.2	30.3±0.7
Dorsal-fin base length	13.9	13.4	14.8	13.2-15.0	14.0±0.7
Dorsa-fin length	17.8	19.8	23.5	19.9-22.0	21.3±1.2
Pectoral-fin length	19.4	19.3	19.6	18.6-20.2	19.4±0.6
Pelvic-fin length	17.0	17.4	18.5	17.0-18.4	17.8±0.6
Anal-fin length	n/a	12.2	13.4	12.0-14.6	12.8±0.9
Predorsal length	42.6	45.1	44.9	43.5-45.4	44.7±0.7
Caudal-peduncle length	15.5	18.5	20.4	18.2-19.9	19.2±0.9
Caudal-peducle depth	4.0	4.8	4.6	4.7-5.1	4.8±0.2
% of Head Length					
Head width	67.8	65.8	67.9	70.7-76.5	72.3±2.9
Head depth	33.6	43.4	40.8	43.8-49.5	45.1±2.8
Snout length	56.4	54.9	59.9	55.7-58.2	57.6±1.4
Length of orbit	20.8	16.5	21.7	15.7-19.5	18.1±2.1
Interorbital width	34.2	33.7	35.3	33.0-38.7	36.0±1.8
Pectoral-fin length	103.4	98.3	92.4	92.9-112.8	101.3±7.4
% of Interorbital Width					
Length of oribit	60.8	48.9	61.5	42.6-59.2	50.4±7.2

...Continue on next page

TABLE 4. (Continued)

MERISTICS	Lectotype (RMNH 4986)	Bleeker specimen (BMNH 1866.5.2.48)	Non-types n=7
Dorsal-fin rays	iii, 8, ½	iii, 8, ½	iii, 8, ½
Pectoral-fin rays	iv, 10, i & iv, 9, i	iv, 10, i	iv, 10, i (4*); iv, 11, i (2); iv, 11, i & v, 10 (1)
Pelvic-fin rays	ii,8	ii, 8	ii, 8 (6*); ii, 8 & ii, 9 (1)
Anal-fin rays	ii, 5, ½	ii, 5, ½	ii, 5, ½
Caudal-fin rays	n/a	17	16 (1); 17 (6*)
Total lateral-line scales	49	48	48-52, 55 (*)
Circumpeduncular scales	13	14	13-14, 14 (*)
Number of scale rows above/below lateral line	6 / 4	6 / 6	6 / 5-6, 7 / 6 (*)
Number of scale rows below lateral line to pelvic-fin origin	5	6	6
Predorsal scales	15	15	12-14, 13 (*)

Mouth (Fig. 6B) inferior, lips with tiny unculi, continuous around corners of mouth. Upper lip crenulated, distal-lateral extension of lower lip common. Fleshy pad present between lateral halves of lower lip. Rostral and post-labial grooves present. Two pairs of rostral barbels, one pair of maxillary barbels. Barbels with tiny unculi, rostral barbels in close proximity to each other.

The smallest individual of *B. ophiolepis* (Fig. 11B) differs in measurements and meristic counts from the larger individuals (Table 4). Major differences are: 55 vs. 48–52 total lateral-line scales, scales on ventral surface anterior to pelvic fin absent vs. present, scales with 1 vs. up to 8 keels.

Color in 70% ethanol (Fig. 11): Dorsally light cream-brown with dark brown stippling. Six dark brown saddles usually present. First saddle between supraoccipital and dorsal fin; 2nd saddle at dorsal-fin origin; 3rd saddle at end of dorsal fin; 4th saddle anterior to anal-fin origin; 5th saddle at end of anal-fin; 6th saddle immediately anterior to caudal-fin base. One individual has an extra saddle between saddles 5 and 6. Light brown mid-dorsal stripe extends from supraocciptal to posterior saddles. Large blotches sometimes surround anterior saddles. Two large blotches extend posteriorly from each side of the supraoccipital and often join the post-orbital bar. Large blotch on head between post-orbital bars and nares, at the nares and opercle. Tip of snout with two lateral blotches divided by cream-colored bar.

Lateral-line covered with large blotches, usually positioned between saddles, decreasing in size posteriorly. Venter cream-colored and lightly stippled. Undersurface of head lightly stippled.

Number of dark brown bands on fins: dorsal 4–5; pectoral 4–5; pelvic 3–5; anal 2–3; caudal 4–6. Dark brown bands at upper lobe of caudal fin of some individuals faint. Dorsal, pectoral, and anal fins with black base. The smallest individual (USNM 230251, 34.7 mm SL) differs slightly in color having a less pronounced 6th dorsal saddle at caudal-fin base; 2 bands on dorsal, pectoral, pelvic, caudal (?) (lower lobe missing) fins; 1 band on anal fin.

Distribution and Ecological Notes. No recent collections are known from the type locality of Bandung, Java, and the species has likely been extirpated from this highly developed area. The species is known to occur in Java: West Java (Tjitaroem basin); Sumatra: Sumatera Selatan (Musi basin) and Lampung (Tulangbawang basin); Borneo: Kalimantan Barat (Kapuas basin) (Fig. 8). The species has been collected from rocky riffles with swift currents.

Material examined. *Balitoropsis ophiolepis*: Java: RMNH 4986 (lectotype of *Homaloptera ophiolepis*); BMNH 1866.5.2.48 (Bleeker specimen) (1). Sumatra: UF 166109 (3), 166103 (1), 166101 (1). Borneo: RMNH 28866 (1); USNM 230251 (1).

Discussion

Randall and Page (2015) examined the relationships within Balitorinae by analyzing the nuclear recombination activation gene-1 (RAG 1) and found *Homaloptera* van Hasselt 1823 and *Pseudohomaloptera* Silas 1953 to be the closest relatives of *Balitoropsis*. *Balitoropsis* is easily distinguished from *Homaloptera* and *Pseudohomaloptera* by having the anus closer to the pelvic-fin base than to the anal-fin origin. *Balitoropsis*, *Homaloptera,* and *Pseudohomaloptera* are found in the aquarium trade and have been given the same common names over the years (e.g., lizard loaches) since members of these genera were thought to belong to the same genus (*Homaloptera* sensu lato). Given that species of *Balitoropsis* have a more superficial appearance to some lizard groups by exhibiting strong keels, we have chosen to refer to them as lizard loaches.

Both species of *Balitoropsis* are found on several landmasses. *Balitoropsis zollingeri* occurs in mainland Southeast Asia (Thailand, peninsular Malaysia, Laos, Cambodia) and the Sundaland islands (Sumatra, Java, Borneo). *Balitoropsis ophiolepis* has a more restricted distribution, being found only in Sumatra, Java, and Borneo. It is likely that the two species of *Balitoropsis* diverged in one of the Sundaland islands with *B. zollingeri* dispersing into mainland Southeast Asia during a glaciation event. To test this hypothesis, molecular samples of *B. zollingeri* from Borneo, Laos, and Cambodia; and samples of *B. ophiolepis* from Borneo are needed in combination with the samples analyzed here from Thailand, peninsular Malaysia, and Sumatra. We are unaware of any recent collections of *Balitoropsis* from Java, and it is likely that this genus has been extirpated from the Indonesian island, due to anthropogenic influence.

Key to *Balitoropsis*

1a. Caudal fin mostly black with 1–3 small black bands on clear portion of upper lobe; caudal-peduncle depth 8.0–9.3% SL; total lateral-line scales 42–46; circumpeduncular scales 17–20 . . . . . *B. zollingeri*

2b. Caudal fin mostly hyaline with dark brown bands; caudal-peduncle depth 4.0–5.1% SL; total lateral-line scales 48–55; circumpeduncular scales 13–14. . . . . *B. ophiolepis*

Acknowledgments

We thank Ronald de Ruiter (RMNH) for photographs of *B. ophiolepis* specimens and Shawn Daniels (UF) and Dirk Bakker (Leiden University Institute for Area Studies) for translating Bleeker (1853). For specimen loans and access to institutional specimens, we thank Mark Sabaj Pérez (ANSP), James Maclaine (BMNH), David Catania (CAS-SU), Ronald de Ruiter (RMNH), Robert Robins (UF), Jeffrey Williams (USNM), and Kelvin Lim (ZRC). We thank Larry Page (UF), Robert Robins and anonymous reviewers for comments on the manuscript. The U.S. National Science Foundation award (DEB 0845392) to David Reed provided the Visionary Digital System used for Figures 4A and 5A. Funding for this study was provided by the All Cypriniformes Species Inventory Project funded by the U.S. National Science Foundation (DEB 1022720).

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