

A New, Remarkably Colorful, Small Ricefish of the Genus *Oryzias* (Beloniformes, Adrianichthyidae) from Sulawesi, Indonesia

Lynne R. Parenti¹ and Renny K. Hadiaty²

***Oryzias woworae*, a new species of ricefish, is described from a freshwater habitat on Muna Island off the southeastern coast of the main island of Sulawesi, Indonesia. The new species is distinguished from all other known ricefishes by a remarkable color pattern of both sexes in life: the ventral surface of head and body anterior to the pelvic fins, dorsal portion of pectoral fins, dorsal-fin base, posterior portion of anal-fin base, caudal peduncle, and dorsal and ventral portions of caudal fin are brilliant red; the midlateral scales from just posterior to the eye to the caudal-fin base and the body scales anterior to the anal fin and ventral to midlateral scales are steel blue; the blue coloration is most prominent in adult males. *Oryzias woworae*, the smallest known ricefish from Sulawesi, is hypothesized to be a member of an unnamed clade of ricefishes diagnosed by a truncate, rather than lunate or emarginate, caudal fin. Description of *O. woworae* brings the recognized number of species in the beloniform family Adrianichthyidae to 29, 13 of which are endemic to Sulawesi. Ricefishes, in particular the new species, may serve as icons to generate interest in conservation of the endemic freshwater biota of Sulawesi.**

***Oryzias woworae*, jenis baru ikan padi dideskripsi dari perairan Pulau Muna, perairan pantai Sulawesi Tenggara, Indonesia. Ikan jenis baru ini dapat dengan mudah dibedakan dari jenis yang telah dikenal sebelumnya, dari pola warnanya yang sangat menyolok. Ikan jantan maupun betina berwarna merah cerah dari kepala bagian bawah, tubuh depan bagian bawah sampai sirip perut, sirip dada bagian atas, pangkal sirip punggung, pangkal sirip anal bagian belakang, batang ekor, pangkal sirip ekor bagian atas dan bawah; warna biru terang dijumpai pada sisik tepat dibelakang mata, sisik pada pertengahan bagian tubuh sampai pangkal sirip ekor dan sisik didepan sirip anal dan sirip perut sampai sisik tengah tubuhnya; warna biru ini sangat jelas terlihat pada jantan dewasa. *Oryzias woworae*, jenis ikan padi terkecil dari Sulawesi diperkirakan merupakan anggota dari grup yang belum bernama, bercirikan sirip ekor yang bentuknya lebih cenderung bersegi dari pada bulan sabit ataupun agak cekung. Deskripsi *Oryzias woworae* menyebabkan jumlah species dari ordo Beloniformes, famili Adrianichthyidae menjadi 29, 13 diantaranya jenis endemik Sulawesi. Ikan padi, terutama jenis baru ini memberikan makna pentingnya konservasi dari biota endemik perairan tawar Sulawesi.**

THE geologically and biologically complex islands and main island of Sulawesi, Indonesia, are well known for their high degree of endemism and the extreme morphological specializations, including gigantism or dwarfism, of endemic and non-endemic species. Sulawesi holds the record for the world's largest python (*Python reticulatus* at over 10 m; Whitten et al., 1987) and the world's largest ricefish (the endemic *Adrianichthys poptae* at just under 200 mm SL; Parenti, 2008) and is also home to the endemic dwarf-buffalo (*Bubalus depressicornis*, known locally as Anoa; Whitten et al., 1987). Endemism of freshwater fishes is particularly well documented among the atheriniform orders Atheriniformes and Beloniformes. Sixteen of the 17 recognized species of the atheriniform family Telmatherinidae are endemic to Sulawesi (Saed and Ivantsoff, 1991; Kottelat et al., 1993; Herder et al., 2006). Among beloniforms, nine of the 16 recognized species of the zenarchopterid genus *Nomorhamphus* (Meisner, 2001; Collette, 2004) and 13 of the 29 known Recent adrianichthyids or ricefishes, including the new species described herein (Parenti, 2008), are Sulawesi endemics.

Twelve ricefish species have been described during the past two decades from China (Chen et al., 1989), southeast Asia (Roberts, 1998), and Sulawesi (Kottelat, 1990a, 1990b; Parenti and Soeroto, 2004; Parenti, 2008). It was no surprise that collections made in September 2007 from Sulawesi included an undescribed, endemic ricefish species. Astonishing was the discovery of an endemic species with what we consider to be the most striking live coloration of any

known ricefish: adult males and females have a brilliant red and blue color pattern (Figs. 1, 2), as described below. Some information on color in life was reported for 20 of the 28 then known ricefish species by Parenti (2008). Ricefishes are largely translucent in life with a silvery peritoneum and operculum with patterns of melanophores on the body and fins, and, in several species, yellow to orangish-red pigmentation on the caudal, pelvic, and anal fins (Seegers, 1997; Parenti, 2008). This discovery supports the exciting possibility of additional species of endemic ricefishes yet to be collected in Sulawesi and elsewhere throughout the Indo-Australian Archipelago. Ricefishes as a group, and in particular the new species, are ideal icons to generate national and international interest in and encourage conservation of the endemic freshwater biota of Sulawesi.

MATERIALS AND METHODS

Character descriptions, counts, and measurements follow Parenti (2008). Comparisons are made to characters described in that publication and to the material noted below. Measurements are reported as a range of percentage of standard length, with the value for the holotype after the range in brackets. Counts and measurements were taken on a relatively small sample as most specimens were distorted and some dehydrated. Some specimens from the single collection of *O. woworae* are treated as non-types (below) because of their poor condition. We follow a phylogenetic species concept (Rosen, 1978, 1979). Specimens were cleared

¹National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, NHB MRC 159, Washington, D.C. 20013-7012; E-mail: parentil@si.edu. Send reprint requests to this address.

²Museum Zoologicum Bogoriense, Division of Zoology, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Jalan Raya Bogor Km 46, Cibinong 16911 Indonesia; E-mail: renny_hadiaty@yahoo.com.

Submitted: 12 June 2009. Accepted: 11 November 2009. Associate Editor: D. Buth.

© 2010 by the American Society of Ichthyologists and Herpetologists DOI: 10.1643/CI-09-108



Fig. 1. Live adult male *Oryzias woworae* photographed in the field just after collection. Original photograph has been reversed.

and counterstained according to the protocol of Dingerkus and Uhler (1977). Institutional abbreviations follow Leviton et al. (1985).

***Oryzias woworae*, new species**

Daisy's Ricefish

Figures 1–5; Table 1

Holotype.—MZB 15398 (Fig. 3), male, 25.0 mm SL, Indonesia, Sulawesi Tenggara, Muna Island (Fig. 4), Regency of Muna, District Parigi, Village Wakumoro, Mata air Fotuno (Fotuno oe; Fig. 5), 5°04'39.7"S, 122°30'25.7"E, 13 September 2007, D. Wowor.

Paratypes.—MZB 15397, 15.0–27.0 mm SL (35 alcoholic, 1 male cleared and counterstained); USNM 391839, 22.3–28.0 mm SL (10 alcoholic, 1 male, 2 females cleared and counterstained); ANSP 189359, 18.5–21.0 mm SL (3 alcoholic); UF 174265, 20.2–23.2 mm SL (3 alcoholic); BMNH 2009.5.27.1–3, 20.0–27.2 mm SL (3 alcoholic), collected with holotype.

Non-type specimens.—MZB 15399, 14.6–23.6 mm SL (26 alcoholic), collected with holotype.

Diagnosis.—*Oryzias woworae* is distinguished from all other ricefishes by an autapomorphic color pattern of both sexes in life (Figs. 1, 2): the ventral surface of head and body anterior to pelvic fins, dorsal portion of pectoral fins, dorsal-fin base, posterior portion of anal-fin base, caudal peduncle, and dorsal and ventral portions of caudal fin are brilliant red; the midlateral scales from just posterior to the eye to the caudal-fin base and the body scales anterior to the anal fin and below midlateral scales are steel blue. The operculum and base of the pectoral fin are silvery. *Oryzias woworae* has a truncate, rather than lunate or emarginate, caudal fin that distinguishes it from the large, pelagic Sulawesi ricefish in the genus *Adrianichthys* and five species of *Oryzias*: *O. bonneorum*, *O. nebulosus*, *O. nigrimas*, *O. orthognathus*, and *O. sarasinorum*. *Oryzias woworae* is readily distinguished from other *Oryzias* with a truncate caudal fin by an hour-glass shaped, rather than rounded, ossified portion of the mesethmoid with no cartilage on its midlateral margins, like the ethmoid of some of the larger, pelagic Sulawesi ricefishes.

Description.—Small, maximum size of specimens examined 28.0 mm. Body compressed laterally, slender to somewhat deep-bodied, body depth 22–30 [27]. No pronounced abdominal concavity between pelvic fins and anal fin.



Fig. 2. Live adult female *Oryzias woworae*, center, with two adult males, photographed in the field just after collection. Original photograph has been reversed.



Fig. 3. *Oryzias woworae*, new species, MZB 15398, preserved holotype, male, 25.0 mm SL.

Mouth subterminal, lower jaw extends slightly beyond upper jaw. Dorsal and ventral body profile gently arching from head to dorsal- and anal-fin origins. Dorsal surface of head slightly convex just anterior to orbit. Head small to moderate, head length 24–29 [28]; snout short, length 6–8 [8]; eye moderate to large 8–10 [8], orbit projects somewhat beyond dorsal surface of head. Basal portion of dorsal and anal fin do not project significantly beyond primary body profile. Scales of moderate size, cycloid, and somewhat deciduous; 30–33 [32] in a lateral series. Elongate, filamentous dorsal- and anal-fin rays in males; anal-fin rays without bony contact organs. Innermost pelvic-fin ray connected to body via a membrane along its proximal half. Caudal fin truncate. Male with a short, slightly conical, tubular urogenital papilla; female with bilobed urogenital papilla.

Premaxilla short and broad with distinct ascending process; premaxilla and dentary with two irregular rows of caniniform teeth; males with one to two rows of external conical teeth on the upper and lower oral jaws. No pre-ethmoid cartilage; ossified portions of mesethmoid somewhat hour-glass shaped with no cartilage on midlateral margins; anterior border of ethmoid cartilage irregular. No flanges on the ventral surface of the palatine and the quadrate. Dorsal ramus of hyomandibula not distinctly bifid, single cartilage articulates with sphenotic and pterotic. Lacrimal sensory canal carried in open bony groove. First pleural rib on parapophysis of third vertebra; first epineural bone attaches to parapophysis of first vertebra dorsal to, and not in horizontal line with, posterior epineural bones; lateral process of pelvic bone attaches to third pleural rib (attached to fifth vertebra). Dorsal-fin origin over vertebra 21 or 22. Caudal skeleton with two epural bones; one ventral accessory bone. Anterior procurent caudal-fin rays slightly hooked at their base. Fifth ceratobranchial toothplates subtriangular, with pavement dentition anteriorly, followed by four to five discrete rows of unicuspid teeth; no small, incomplete posterior row of teeth. Basihyal bone triangular, basihyal cartilage elongate and rectangular. Epibranchial elements incompletely to fully ossified; epibranchial two notably smaller than the other epibranchial elements.

Dorsal-fin rays 8. Anal-fin rays 18–19 [18]. Pelvic-fin rays 6. Pectoral-fin rays 9–10 [10]. Principal caudal-fin rays i,5/6,i. Procurent fin rays, dorsal 3–4 [4], ventral 4–5 [4]. Vertebrae 29–30 [29] (11+18–19 [18]). Branchiostegal rays 5–6 (minute 6th, anteriormost ray on left side in one of eight specimens).

Color in life.—See Diagnosis, above.

Color in alcohol.—Ground color yellowish-gray, belly pale yellow. Pigmentation quite variable in preserved specimens

from pale gray overall in smaller specimens to more darkly pigmented in large males. Dorsal surface of head and dorsal and lateral surface of body with dense dark brown to black chromatophores. A diffuse row of melanophores from the dorsal surface of the head to the dorsal-fin origin, a faint midlateral black line from the head to base of the caudal fin. Females and lighter-colored males with diffuse line of dark chromatophores dorsal from just posterior to anal-fin origin, along body just dorsal to anal-fin base to middle of caudal peduncle. Urogenital papilla heavily pigmented in gravid females, paler brown to cream in other specimens. Pectoral fins of females hyaline to dusky. Fins of males dusky to darkly pigmented; dorsal and ventral margin of caudal fin with dark melanophores in some specimens (Fig. 3).

Distribution and habitat.—The single known collection of *O. woworae* was from the type locality, a freshwater stream with a canopy cover of about 80 percent and substrate of mud and sand with leaf litter (Fig. 5). *Oryzias woworae* was schooling with a species of halfbeak, *Nomorhamphus* sp., in a blue hole about 3–4 m deep, opposite the outlet of a freshwater spring. Specimens were captured from a blue hole with a scoop net from a depth of 1 to 1.5 m. The pH was 6–7 and current nil. Specimens of another ricefish species, *O. javanicus*, were collected on the same day from a different

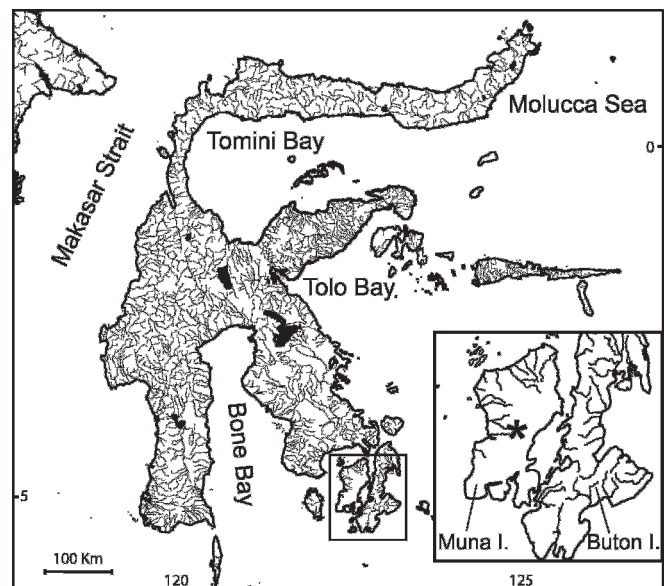


Fig. 4. Outline map of Sulawesi with southeastern region (in small box) expanded in larger box. Star indicates type locality of *Oryzias woworae*, new species.

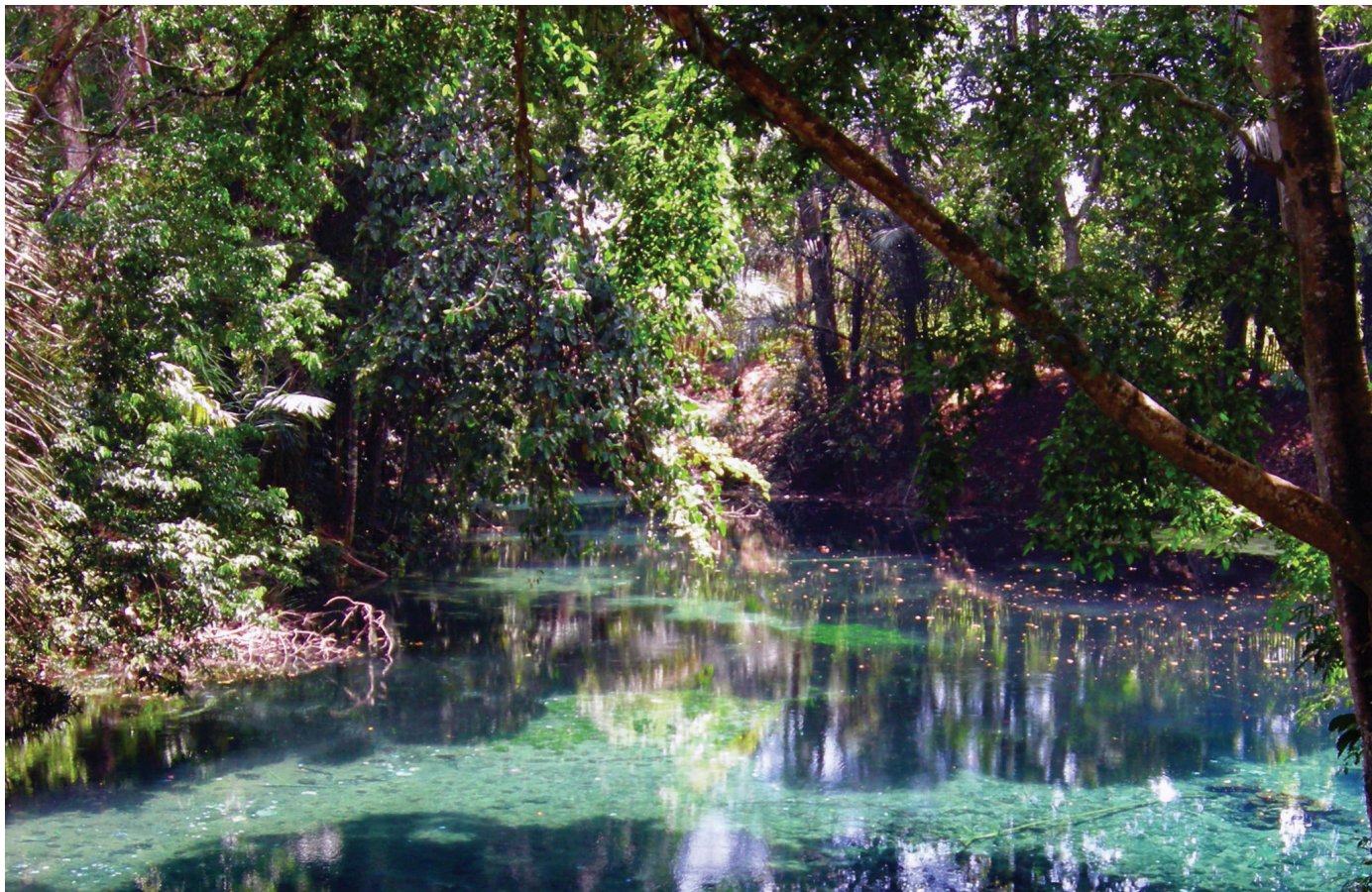


Fig. 5. Type locality of *Oryzias woworae*, new species, Mata air Fotuno (Fotuno oe), a freshwater stream running through the Wakumoro Village, Parigi District, Muna Island.

Table 1. Morphometric and Meristic Data for Select Specimens of *Oryzias woworae*. Measurements are reported as a percentage of standard length. Number of examined paratypes (USNM 391839 and MZB 15397, cleared-and-counterstained specimen) indicated in parentheses. Mean includes holotype.

Character	Holotype	Paratypes	Mean
Dorsal-fin rays	8	8 ($n = 14$)	8
Anal-fin rays	18	18–19 ($n = 14$)	18.3
Pelvic-fin rays	6	6 ($n = 14$)	6
Pectoral-fin rays	10	9–10 ($n = 14$)	9.5
Principal caudal-fin rays	i,5/6,i	i,5/6,i ($n = 14$)	i,5/6,i
Procurrent fin rays	4/4	3–4/4–5 ($n = 14$)	3.2/4.1
Vertebrae	29 (11+18)	29–30 (11+18–19) ($n = 14$)	29.1 (11+18.1)
Branchiostegal rays	5	5–6 ($n = 7$)	5.1
Scales in lateral series	32	30–33 ($n = 10$)	31.6
Head length	28	24–29 ($n = 10$)	26.9
Snout length	8	6–8 ($n = 10$)	7.2
Eye diameter	8	8–10 ($n = 10$)	8.9
Body depth	27	22–30 ($n = 10$)	26
Predorsal length	75	68–82 ($n = 10$)	77.5
Preal length	65	59–65 ($n = 10$)	63.2
Dorsal-fin base	9	7–9 ($n = 10$)	8.1
Anal-fin base	26	23–28 ($n = 10$)	25.5
Caudal peduncle depth	10	8–11 ($n = 10$)	9.2
Standard length (mm)	25.0	22.3–28.0 ($n = 14$)	24.9

stream in the Parigi District, Muna Island. At least two female paratypes (USNM 391839) were gravid, from which we infer that the species was breeding when collected; the largest eggs of a female 22.5 mm SL measured about 1 mm in diameter.

Etymology.—The trivial name *woworae* honors Daisy Wowor, a systematic carcinologist from the Museum Zoologicum Bogoriense, who collected specimens of the new species and had the foresight to take color photographs of the fish alive.

Remarks.—Daisy's Ricefish is chosen as a common name in English for the new species following Parenti (2008), in which common names were provided for all other ricefishes. Ikan padi, Indonesian for fish (ikan) of the rice paddies (padi), is another common name for ricefishes as a group. The large, pelagic adrianchthyids of Sulawesi lakes are known by the local vernacular Buntingi (Kottelat, 1990a).

DISCUSSION

Oryzias woworae is unambiguously a member of the genus *Oryzias* (sensu Parenti, 2008) as it shares with congeners an array of synapomorphies including reaching no more than 60 mm SL, having 34 or fewer vertebrae, and a hyomandibula with a single rather than bifid head articulating with the otic region of the skull. Among *Oryzias*, *O. woworae* is a small species, according to the classification of Parenti (2008): adults reach greater than 26 mm SL and less than 40 mm SL. Further, it is the smallest ricefish known from Sulawesi. Of the 14 other ricefishes that live in Sulawesi (12 endemics plus *O. celebensis* and *O. javanicus*), species of *Adrianchthys* all reach more than 60 mm SL, and species of *Oryzias* all reach more than 30 mm SL. *Oryzias woworae* is not the smallest ricefish; there are eight known miniature ricefish species, following the arbitrary definition of miniature fishes that specimens reach no larger than 26 mm SL (Weitzman and Vari, 1988), all of which live outside of Sulawesi.

Although *O. woworae* is easily diagnosed, relationships of the new species to other *Oryzias* are enigmatic. *Oryzias woworae* is hypothesized to be a member of an unnamed clade of ricefishes, which comprise Node I in Parenti's (2008:figs. 30, 31) phylogenetic analysis. Node I is a polytomy of three clades: 1) *O. timorensis*, from Timor, Indonesia, the easternmost extent of ricefishes; 2) the Malili Lakes, Sulawesi, ricefishes (*O. matanensis*, *O. marmoratus*, and *O. profundicola*); and 3) *O. celebensis* plus all other ricefishes that live outside of Sulawesi. The unambiguous synapomorphy of the clade is a truncate, rather than lunate or emarginate, caudal fin which *O. woworae* shares with included species. A second synapomorphy of that clade is lateral margin of the ethmoid cartilage notched, rather than entire. The new species has a somewhat hour-glass shaped, ossified portion of the mesethmoid with no cartilage on the midlateral margins, like the ethmoid morphology of some of the larger, pelagic Sulawesi ricefishes, such as *O. bonneorum* (Parenti, 2008:fig. 5a), not like other species included in Node I. Also, a third character of that clade, midlateral dark brown blotches on males, characterizes many of the included species, but not *O. woworae*. To resolve with confidence the polytomy at Node I (Parenti, 2008:figs. 30, 31) requires more material, especially that of *O. timorensis*, the Timor, Indonesia, endemic ricefish. The limited preserved material of *Oryzias timorensis* has faded dark brown

lateral blotches and reaches 30 mm SL (Parenti, 2008). This extremely poorly known species is critical for understanding the evolution of Sulawesi ricefishes and how they are related to non-Sulawesi taxa. Implications for biogeography and conservation of the Indonesian freshwater fish fauna are profound.

An endemic freshwater fish species with a unique and striking live color pattern is an exciting discovery in the natural history of Sulawesi. We note with some irony that the new species, when first collected, was thought by non-ichthyologists to be a Guppy, *Poecilia reticulata*, a widely introduced South American cyprinodontiform. Although exotic species have taken hold in Sulawesi and threaten the endemic fish fauna (Soeroto and Tungka, 1991, 1996), we are not ready to replace documentation of endemism with documentation of introductions. We do not know what other "jewels" remain to be discovered among the freshwater biota of Sulawesi, but are encouraged by collection of a small, red and blue ricefish to continue searching.

MATERIAL EXAMINED

Adrianchthys oophorus: USNM 348386, 4, cleared and counterstained, Indonesia, Sulawesi Tengah, Lake Poso.

Adrianchthys poptae: USNM 322423, 1, cleared and counterstained, Indonesia, Sulawesi Tengah, Lake Poso.

Oryzias celebensis: USNM 340424, 2, cleared and counterstained, Indonesia, Sulawesi Selatan, Gowa District.

Oryzias javanicus: MZB 15400, 3, Indonesia, Sulawesi Tenggara, Muna Island, Parigi District; USNM 348513, 4, cleared and counterstained, Singapore, Sungai Buloh.

Oryzias nebulosus: MZB 11650, 5, cleared and counterstained, Indonesia, Sulawesi Tengah, Lake Poso.

ACKNOWLEDGMENTS

We are principally indebted to D. Wowor (MZB) for collecting material of the new species, photographing living specimens, and making her material and photographs available to us. The specimens were collected under the authority of LIPI (Lembaga Ilmu Pengetahuan Indonesia), the Indonesian Institute of Sciences, on a fieldtrip coordinated by L. Deharveng (MNHN). Figures 1, 2, and 5 were prepared from photographs taken by D. Wowor. Figure 3 was prepared by S. Raredon (USNM) who also skillfully prepared numerous radiographs. D. Cole (USNM) supplied a base map used in Fig. 4. J. Clayton (USNM) provided additional technical assistance. R. Vari (USNM) advised on manuscript preparation.

LITERATURE CITED

- Chen, Y. R., H. Uwa, and X. L. Chu. 1989. Taxonomy and distribution of the genus *Oryzias* in Yunnan, China (Cyprinodontiformes: Oryziidae). *Acta Zootaxonomica Sinica* 14:239–246. [In Chinese with English summary]
- Collette, B. B. 2004. Family Hemiramphidae Gill 1859—halfbeaks. California Academy of Sciences Annotated Checklists of Fishes No. 22:1–35.
- Dingerkus, G., and L. D. Uhler. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. *Stain Technology* 52:229–232.
- Herder, F., A. Nolte, J. Pfaender, J. Schwarzer, R. K. Hadiaty, and U. K. Schlieven. 2006. Preliminary checklist of sailfin silversides (Teleostei: Telmatherinidae) in the

- Malili Lakes of Sulawesi (Indonesia), with a synopsis and threats. *Proceedings of the Royal Society B* 273:2209–2217.
- Kottelat, M.** 1990a. Synopsis of the endangered Buntingi (Osteichthyes: Adrianichthyidae and Oryziidae) of Lake Poso, Central Sulawesi, Indonesia, with a new reproductive guild and descriptions of three new species. *Ichthyological Exploration of Freshwaters* 1:49–67.
- Kottelat, M.** 1990b. The ricefishes (Oryziidae) of the Malili lakes, Sulawesi, Indonesia, with description of a new species. *Ichthyological Exploration of Freshwaters* 1: 151–166.
- Kottelat, M., A. J. Whitten, S. N. Kartikasari, and S. Wirjoatmodjo.** 1993. Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions (HK) Ltd., Hong Kong in collaboration with the Environmental Management Development in Indonesia (EMDI) Project, Ministry of State for Population and Environment, Republic of Indonesia, Jakarta.
- Leviton, A. E., R. H. Gibbs, Jr., E. Heal, and C. E. Dawson.** 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resources collections in herpetology and ichthyology. *Copeia* 1985: 802–832.
- Meisner, A. D.** 2001. Phylogenetic systematics of the viviparous halfbeak genera *Dermogenys* and *Nomorhamphus* (Teleostei: Hemiramphidae: Zenarchopterinae). *Zoological Journal of the Linnean Society* 133:199–283.
- Parenti, L. R.** 2008. A phylogenetic analysis and taxonomic revision of ricefishes, *Oryzias* and relatives (Beloniformes, Adrianichthyidae). *Zoological Journal of the Linnean Society* 154:494–610.
- Parenti, L. R., and B. Soeroto.** 2004. *Adrianichthys roseni* and *Oryzias nebulosus*, two new ricefishes (Atherinomorpha: Beloniformes: Adrianichthyidae) from Lake Poso, Sulawesi, Indonesia. *Ichthyological Research* 51:10–19.
- Roberts, T. R.** 1998. Systematic observations on tropical medakas or ricefishes of the genus *Oryzias*, with descriptions of four new species. *Ichthyological Research* 45: 213–224.
- Rosen, D. E.** 1978. Vicariant patterns and historical explanation in biogeography. *Systematic Zoology* 27:159–188.
- Rosen, D. E.** 1979. Fishes from the uplands and intermontane basins of Guatemala: revisionary studies and comparative geography. *Bulletin of the American Museum of Natural History* 162:267–376.
- Saeed, B., and W. Ivantsoff.** 1991. *Kalyptatherina*, the first telmatherinid genus known outside of Sulawesi. *Ichthyological Exploration of Freshwaters* 2:227–238.
- Seegers, L.** 1997. Killifishes of the World. Old World Killis I. Aphyosemion, Lampeyes, Ricefishes. A.C.S. Glasser (Aqualog), Mörfelden-Walldorf, Germany.
- Soeroto, B., and F. Tungka.** 1991. Fish fauna, fisheries and Adrianichthyoidei in Lake Poso, p. 12–14. *In: Phylogeny and Species Differentiation of Adrianichthyoidei in Indonesia*. Study Report. Monbusho International Scientific Research Program, Monbusho, Japan.
- Soeroto, B., and F. Tungka.** 1996. The inland fishes and the distribution of Adrianichthyoidea of Sulawesi Island, with special comments on the endangered species in Lake Poso, p. 1–5. *In: Proceedings of the First International Conference on Eastern Indonesian-Australian Vertebrate Fauna*, Manado, Indonesia, November 22–26, 1994. D. J. Kichener and A. Suyanto (eds.). Western Australian Museum for Lembaga Ilmu Pengetahuan Indonesia, Perth, W.A.
- Weitzman, S. H., and R. P. Vari.** 1988. Miniaturization in South American freshwater fishes; an overview and discussion. *Proceedings of the Biological Society of Washington* 101:444–465.
- Whitten, A. J., M. Mustafa, and G. S. Henderson.** 1987. *The Ecology of Sulawesi*. Gadjah Mada University Press, Yogyakarta, Indonesia.