Bull. Natl. Mus. Nat. Sci., Ser. A, Suppl. 1, pp. 123–136, March 22, 2007

Grallenia, a New Goby Genus from the Western Pacific, with Descriptions of Two New Species (Perciformes: Gobiidae: Gobiinae)

Koichi Shibukawa[1] and Akihisa Iwata[2]

[1] Department of Zoology, National Museum of Nature and Science, 3–23–1 Hyakunin-cho, Shinjuku-ku, Tokyo 169–0073, Japan
E-mail: shibu@kahaku.go.jp
[2] Graduate School of Asian and African Area Studies, Kyoto University, 46 Shimoadachi-cho, Yoshida, Sakyo-ku, Kyoto 606–8501, Japan
E-mail: iwata@asafas.kyoto-u.ac.jp

Abstract A new gobiid genus, *Grallenia*, is described based on 2 new species from the western Pacific. *Grallenia* belongs to the gobiid subfamily Gobiinae, and is distinguished from the other gobiine genera in having the following combination of characters: usually VI-I, 7–10 dorsal-fin rays; I, 7–9 anal-fin rays; segmented caudal-fin rays 7−8+7, most frequently 8+7; gill opening narrow, restricted (or nearly so) to pectoral base; first gill slit moderately open for most of its length, but only slightly closed by membrane ventrally; anterior margin of tongue deeply concave; pelvic fins fused medially together by well developed interradial membrane; pelvic frenum low or absent; no distinct fleshy lobes developed around pelvic-fin spine; sensory-papillae rows on cheek relatively reduced, with no distinct transverse rows; cephalic sensory canals present [with pores C′ (unpaired), D (unpaired), E and F′] or absent; 10+17−18=27−28 vertebrae; typical P-V pattern of 3/II II I I 0/9; a pair of diagonal, elongate black spots at dorsal and ventral corners of posterior-most part of caudal peduncle. The new species *Grallenia arenicola* (13 types and 4 non-type specimens, 9.4−22.6 mm SL, Kashiwa-jima Island, Kochi Prefecture, Japan) differs from the congener *G. lipi* (9 types and 2 non-type specimens, 10.8–18.8 mm SL, Ambon Island, Indonesia) in having: second dorsal-fin rays I, 7–8, usually I, 7 (vs. I, 9–10 in *G. lipi*); anal-fin rays I, 7–8, usually I, 7 (vs. I, 9); vertebrae 10+17−18=27−28, usually 10+17=27 (vs. 10+17−18=27−28, usually 10+18=28); dorsal-fin spines not elongated in either sex (vs. first spine of first dorsal-fin greatly elongated, filamentous in males); second dorsal fin not reaching caudal-fin base when adpressed, length of longest ray 14.0–17.6% of SL (vs. usually reaching to, or beyond, caudal-fin base when adpressed in adult, length of longest ray 17.5–21.8% of SL); length of longest ray of anal fin 8.9–13.3% of SL (vs. 12.6–18.1% of SL); scales on body extending anteriorly to just behind pectoral-fin base (vs. scales on body restricted on posterior half of body, except for isolated patch of scales just behind pectoral-fin base); weak, low pelvic frenum (vs. pelvic frenum absent); length of pectoral fin 20.7–25.9% of SL (vs. 23.2–30.6% of SL); caudal-peduncle length 24.6–28.6% of SL (vs. 20.3–23.6% of SL); cephalic sensory canals with pores C′ (unpaired), D (unpaired), E and F′ (vs. no cephalic sensory canals and associated pores); no orange line on dorsal fins (vs. orange line at middle of dorsal fins in life). Fishes of *Grallenia* are small-sized (less than 23 mm SL) sandy-bottom dwellers found on flat, fine and clean sandy bottoms, not commensal with any marine organisms.

Key words: *Grallenia*, Gobiidae, new genus, new species, western Pacific.

In the present paper, we describe a new marine goby genus, based on 2 new species from the western Pacific. The species of this genus, belonging to the gobiid subfamily Gobiinae *sensu* Pezold (1993), are diminutive (less than 23 mm in standard length), slender subtranslucent bottom dwellers, found on flat, fine and clean sandy bottoms around rocky/coral reefs (to 50 m depth). They were already reported as unidentified gobies in some recently-published pictorial books of

marine fishes (Kuiter and Tonozuka, 2001; Allen *et al.*, 2003; Senou *et al.*, 2004).

Materials and Methods

Institutional abbreviations follow Leviton *et al.* (1985), except for KPM (Kanagawa Prefectual Museum of Natural History, Japan). Species accounts are presented in alphabetical order.

All fish lengths given are standard lengths (SL). Measurements were made point-to-point with calipers under the dissecting microscope to the nearest 0.01 mm. The methods for measurements followed those of Hubbs and Lagler (1958), with exceptions given below (the snout tip refers to the mid-anteriormost point of the upper lip): interorbital width was the least width between innermost rims of right and left eyeballs; jaw length was measured between the snout tip and the posteriormost point of lip; head width and depth were measured at preopercular margin; body depth was measured at the anal-fin origin; head depth and width were measured at preopercular margin; nape width was measured between dorsalmost margins of gill openings; preanal and prepelvic lengths were measured from the snout tip to the origin of each fin; pectoral-fin length was measured from the base to the tip of the longest ray; pelvic-fin length was measured between the base of pelvic-fin spine and the distal tip of the longest segmented ray; caudal-fin length was measured from the base to the tip of the middle caudal-fin ray. The methods of counting followed Akihito (1984), except for the following: longitudinal scale count was the number of oblique (anterodorsal to posteroventral) rows starting from and including the anteriormost scale and proceeding posteriorly to the mid-base of caudal fin (scaled area of *Grallenia lipi* is divided into two parts, and, thus, the longitudinal scales in anterior and posterior scaled areas were counted separately); three methods of transverse scale counts were taken (see descriptive accounts); circumpeduncular scale count was the number of zigzag rows along a vertical line around the caudal peduncle (counted from the second middorsal scale prior to the anteriormost upper procurrent caudal-fin ray); gill rakers including all rudiments were counted on the outer side of first arch; count of pseudobranchial filaments included all rudiments. Scales (except for predorsal and circumpeduncular scales) and paired-fin rays were counted on both sides, but gill rakers and pseudobranchial filaments are counted on the right side only. Osteological features were observed from radiographs (for all specimens) and some cleared and stained specimens were prepared following the methods of Potthoff (1984). The methods of Akihito (1984) were used in describing the pattern of the interdigitation of the dorsal-fin pterygiophores between the neural spines ("P–V"). Cephalic sensory canals and papillae were observed on specimens stained with cyanine blue, and notations on them followed Akihito (1984) and Miller (1986), respectively.

Descriptions of species were based only on the type specimens; in describing meristic counts of each species, the count of the holotype is asterisked, and the number in parentheses after the count indicates the number of specimens with that count.

Grallenia gen. nov.

(New Japanese name: Sazare-haze zoku)

Type species. *Grallenia arenicola* Shibukawa and Iwata, new species.

Included species. *Grallenia* comprises 2 species, *G. arenicola* and *G. lipi*, both of which are described herein as new. See also "Remarks" of *G. lipi*.

Diagnosis. *Grallenia* belongs to the gobiid subfamily Gobiinae (sensu Pezold, 1993), and is distinguished from the other gobiine genera in having the following combination of characters: usually VI-I, 7–10 dorsal-fin rays; I, 7–9 anal-fin rays; all dorsal- and anal-fin spines slender and flexible; segmented caudal-fin rays 7−8+7 (almost always 8+7); gill opening narrow, restricted

(or nearly so) to pectoral base; first gill slit moderately open for most of its length, but only slightly closed by membrane ventrally; anterior margin of tongue deeply concave; pelvic fins fused medially by well developed interradial connecting membrane; pelvic frenum low (*G. arenicola*) or absent (*G. lipi*); no distinct fleshy lobes developed around pelvic-fin spine; sensory-papillae rows on cheek relatively reduced, with no distinct transverse rows and row *e* not or just extending around posterior corner of jaws; cephalic sensory canals present [*G. arenicola*, with pores C′ (unpaired), D (unpaired), E and F′] or absent (*G. lipi*); 10+17−18=27−28 vertebrae; typical P–V pattern of 3/II II I I 0/9; 2 anal-fin pterygiophores anterior to first haemal spine; a pair of diagonal, elongate black markings at dorsal and ventral corner of posteriormost of caudal peduncle. Fishes of *Grallenia* are small-sized (less than 23 mm SL) sandy-bottom dwellers, not commensal with any marine organisms.

Description. Dorsal-fin rays VI–VII-I, 7–10; anal-fin rays I, 7–9; pectoral-fin rays 14–17 (usually 15 or 16); pelvic-fin rays I, 5; segmented caudal-fin rays 7−8+7 (most frequently 8+7), including 5−7+5 branched rays; dorsal unsegmented caudal-fin rays 5–9; ventral unsegmented caudal-fin rays 5–8; longitudinal scale rows 10–29; transverse scale rows from anal-fin origin dorsoanteriorly to base of first dorsal fin 4–7 (in *G. arenicola*) or 0 (in *G. lipi*); transverse scale rows from anal-fin origin dorsoposteriorly to base of second dorsal fin 6–9 (in *G. arenicola*) or 0 (in *G. lipi*); transverse scale rows from second dorsal-fin origin ventroposteriorly to base of anal fin 6–8 (in *G. arenicola*) or 0 (in *G. lipi*); predorsal scales 0; circumpeduncular scales 12; gill rakers on outer surface of first arch 0−3+3−9=4−12; pseudobranchial filaments 3–6.

Body moderately elongate, subcylindrical, compressed posteriorly. Head subcylindrical or slightly depressed, its depth 84.8–97.1% of width. Snout pointed, subequal or shorter than eye diameter, snout length 47.8–101.3% of eye diameter. Eye dorsolateral, large, its diameter 26.9–36.6% in head length; eyes close together dorsomedially, interorbital width narrower than pupil diameter. No raised cutaneous ridges, flaps or barbels on head. Mouth subterminal, slightly oblique, forming an angle of about 35–40 degrees with body axis; lower jaw slightly to well projecting beyond upper jaw; posterior end of jaws extending between vertical lines through anterior margin of eye and middle of pupil. Anterior naris opening at tip of short tube without skin flaps; distal tip of anterior narial tube not reaching to upper jaw when adpressed; posterior narial opening with low rim, located about midway between anterior naris and eye. Anterior margin of tongue deeply concave; tip of tongue free from floor of mouth. Ventral free edge of lower lip interrupted at symphysis; small bulbous mental protrusion present or absent just behind chin. Gill opening narrow, restricted (or nearly so) to pectoral-fin base. No fleshy papillae on lateral margin of lateral wing of cleithrum. No bony projections along posterior margin of preopercle. Dorsal fins well separated from one another; first dorsal fin subequal or slightly higher than second dorsal fin, excepting males of *G. lipi* that have a greatly elongated, filamentous first spine; in adults, all segmented dorsal-fin rays branched except anterior 1–2 rays. Anal fin slightly lower than second dorsal fin in height; anal fin originates at vertical through base of spine or first segmented ray of second dorsal fin; in adults, all segmented anal-fin rays branched except anterior 1–2 rays. Caudal fin almost symmetrical dorsoventrally, nearly rounded, without elongate rays; caudal fin subequal or slightly shorter than head (caudal-fin length 79.8–103.9% of head length). Pectoral fin almost symmetrical dorsoventrally, moderately long, typically extending to or beyond a vertical line through anal-fin origin in *G. lipi*, while not extending to a vertical line through anal-fin origin in *G. arenicola*. Pelvic fins fused medially by well-developed interradial membrane; weak pelvic frenum with smooth posterior margin present (*G. arenicola*) or absent (*G. lipi*); pelvic fin moderately long, extending posteriorly beyond anus.

Scales on body ctenoid with peripheral cteni;

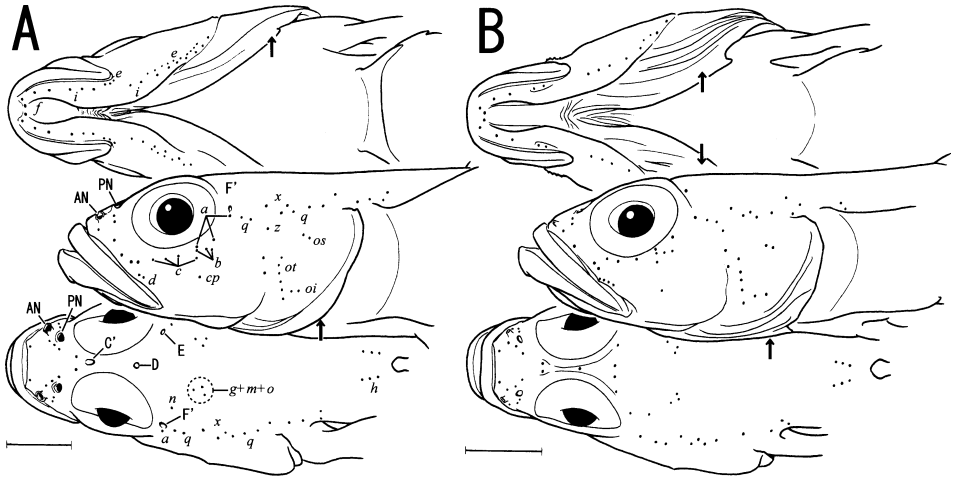

Fig. 1. Ventral (top), lateral (middle) and dorsal (bottom) views of heads of 2 species of *Grallenia*, showing cephalic sensory-canal pores (indicated by uppercase letters, except for AN and PN) and papillae (indicated by roman lowercase letters). A: *Grallenia arenicola*, NSMT-P 73195, holotype, male, 19.4 mm SL; B: *Grallenia lipi*, NSMT-P 56840, holotype, male. AN and PN, anterior and posterior nares, respectively. Arrows show positions where gill membrane attaches to isthmus. Left-side pore E of holotype of *G. arenicola* is abnormally undeveloped. Bars indicate 1 mm. Drawn by K. Shibukawa.

head, nape, breast, belly, anterodorsal part of body around base of first dorsal fin and pectoral-fin base (and also, in *G. lipi*, trunk and anterior half of caudal part of body, except for isolated patch of scales just behind pectoral-fin base) naked; no modified scales with enlarged cteni.

Teeth on jaws unicuspid, slender, more or less inwardly curved; on each jaw, 3 rows of teeth anteriorly, narrowing to a single row posteriorly; largest teeth on anterolateral part of middle row in lower jaws; no enlarged stout canine-like teeth on jaws; no teeth on vomer or palatine.

Cephalic sensory systems are illustrated in Fig. 1. Anterior oculoscapular canal present [*G. arenicola*, with pore C′ (unpaired), D (unpaired), E and F′ (*note.* —pore E of left side of the holotype abnormally absent)] or absent (*G. lipi*); posterior oculoscapular canal and preopercular canal absent. Sensory papillae rows on cheek relatively reduced, with no distinct transverse rows; all sensory-papillae rows on head uniserial or comprising a single papillae; sensory-papillae row *a* comprising 3 well-spaced papillae; row *b* short, comprising 3 papillae, its anterior end just below anterior end of row *a*; row *c* comprising 4 papillae, its posterior end reaching to a vertical line through anterior ends of rows *a* and *b*; row *cp* comprising a single papilla; row *d* very short, comprising 2–4 papillae along jaws; row *e* greatly reduced (i.e., anterior end of row *e* located around posterior corner of jaws in *G. arenicola*, and row *e* comprises only 2 papillae around posteroventral part of preopercle in *G. lipi*); a pair of sensory papillae (=row *f*) just behind chin.

Selected osteology. Vertebrae 10+17−18= 27−28; P-V typically 3/II II I I 0/9; anal-fin pterygiophores anterior to first haemal spine 2; single epural; posterior 3 preural vertebrae with antero-posteriorly broadened, flat neural/haemal spines; first and second pterygiophores of second dorsal fin lacking autogenous middle radials; ossified scapula relatively reduced, partially encircling scapular foramen; 4 pectoral radials; dorsalmost pectoral radial abuts dorsal part of cleithrum; dorsal/ventral postcleithra absent; lower hypural plate (hypurals 1+2) articulates with urostyle+dorsal hypural plate (hypurals 3+4); 5 branchiostegal rays; no ossified gill rakers; basihyal triangular, its anterior margin not concave; infrapharyngobranchial 1 absent; interarcual car-

tilage small, ovoid, well separated from infrapharyngobranchials; basibranchial 1 cartilaginous; basibranchial 3 reduced and very short, well separated from basibranchial 4; rostral cartilaginous; ascending process of premaxilla long, well differentiated from articular process; mesopterygoid absent; bony canal support of preopercle undeveloped; posteromedial part of preopercle with a well-developed, dorsally directed bony projection, articulating with condyle of hyomandibular for opercle.

Comparison. *Grallenia* clearly belongs to the gobiid subfamily Gobiinae sensu Pezold (1993) in having: interorbital portion of oculoscapular canal fused, single unpaired anterior interorbital pore (=pore C) present (although cephalic sensory canals absent in *Grallenia lipi*); single epural; typically 3-22110 first dorsal-fin pterygiophore insertion pattern (=3/II II I I 0/9 P-V pattern); 2 anal-fin pterygiophores anterior to first haemal spine. The vertebral count (i.e., 10+17−18=27−28) of *Grallenia* places it in the gobiine subgroup "Bathygobius Group," which is a phenetically-united assemblage not supported by any synapomorphies (Birdsong *et al.*, 1988). As well as *Grallenia*, the following 10 genera are assigned to this subgroup (Birdsong *et al.*, 1988; Hoese and Larson, 2005): *Bathygobius* Bleeker, 1878, *Caffrogobius* Smitt, 1900, *Coryogalops* Smith, 1958, *Glossogobius* Gill, 1859, *Gorogobius* Miller, 1978, *Hetereleotris* Bleeker, 1874, *Lesueurigobius* Whitley, 1950, *Nematogobius* Boulenger, 1910, *Psammogobius* Smith, 1935, and *Palutrus* Smith, 1959. [*Note.*—Birdsong *et al.* (1988) listed the species of *Coryogalops*, i.e., *C. sordida*, in *Monishia* Smith, 1959 (a junior synonym of *Coryogalops*). The recently described genus *Pascua* Randall, 2005, also assigned to the Bathygobius Group, was subsequently regarded as a junior synonym of *Hetereleotris* by Hoese and Larson (2005)]. *Grallenia* is readily distinguished from the other members of the "Bathygobius Group" in having 8+7 segmented caudal-fin rays and small-sized (less than 23 mm SL) slender body with a pair of characteristic black spots at dorsal and ventral corners of end of caudal peduncle; the other members of the Bathygobius Group have 9+8 segmented caudal-fin rays and more or less larger and stouter body, and no such black markings on caudal-fin base. Furthermore, *Bathygobius* has free filamentous rays on upper part of pectoral fin (vs. no free rays in *Grallenia*), small fleshy bump below anterior naris (vs. absent), and well-developed longitudinal pattern of sensory-papillae rows on cheek, with long parallel-running horizontal rows *b* and *c* (vs. sensory-papillae rows on cheek relatively reduced, with short rows *b* and *c* not running parallel one another); *Caffrogobius*, *Coryogalops*, *Gorogobius*, *Hetereleotris* (exclusive of the *Pascua*-type species) and *Nematogobius* have well-developed, distinct transverse pattern of sensory-papillae rows on cheek (Miller, 1978, 1986; Akihito and Meguro, 1981; Hoese, 1986a, b; Harrison, 1990; Goren, 1991); the *Pascua*-type species of *Hetereleotris* [i.e., *H. caudolinea* (Randall, 2005), *H. readerae* Hoese and Larson, 2005, and *H. sticta* Hoese and Larson, 2005] have reduced sensory-papillae rows on cheek, but have characteristic modified scales with enlarged cteni on caudal-fin base (vs. absent), sensory-papilla row *b* closer to posterior margin of preopercle than anterior end of row *a* (vs. closer to anterior end of row a than posterior margin of preopercle), and, like all other congeners, the first gill slit closed by membrane (vs. well open) (Randall, 2005; Hoese and Larson, 2005); *Glossogobius* and *Psammogobius* have more or less broader gill opening [extending anteriorly to, or beyond, a vertical line through posterior margin of preopercle vs. restricted (or nearly so) to pectoral-fin base], well-developed longitudinal pattern of sensory-papillae rows on cheek, with long parallel-running horizontal rows *b* and *c* (exclusive of *Glossogobius circumspectus* with numerous transverse rows of sensory papillae below eye) (vs. rather reduced, with short rows *b* and *c* not running parallel one another) (Akihito and Meguro, 1975; Akihito *et al.*, 2002); *Lesueurigobius* has well-developed longitudinal pattern of sensory-papillae rows on cheek, with long parallel-running horizontal rows

b and *c* (vs. rather reduced, with short rows *b* and *c* not running parallel one another), and 12–17 dorsal/anal-fin segmented rays (vs. 7–10) (Miller, 1986); and *Palutrus* has rounded or truncate tongue (vs. distinctly concave) (Smith, 1959; Larson and Murdy, 2001). Other than *Grallenia*, 5 genera of the Bathygobius Group, i.e., *Bathygobius*, *Glossogobius*, *Hetereleotris*, *Palutrus* and *Psammogobius*, are distributed in the western Pacific (e.g., Larson and Murdy, 2001), but the gobies of these 5 genera are estuarine and/or reef-dwelling species, not inhabiting the flat, fine and clean sandy bottoms around coral reefs as does *Grallenia*.

General physiognomy of *Grallenia* is similar to the Indo-Pacific commensal gobies of the genera, e.g., *Bryaninops* Smith, 1959, *Pleurosicya* Weber, 1913, *Luposicya* Smith, 1959, *Phyllogobius* Larson, 1986, or *Minysicya* Larson, 2002. Species of these genera are small (usually less than 40 mm SL), subtranslucent (when alive) and more or less slender, with a pointed head, moderate to large eyes, 6 spines on first dorsal fin, typical P-V pattern of 3/II II I I 0/9, single epural, 2 anal-fin pterygiophores anterior to first haemal spine, and relatively reduced sensory-papillae rows on cheek (Larson, 1985, 1986, 1990, 2002; Birdsong *et al.*, 1988). *Grallenia* is, however, not commensal with any marine organisms, and readily distinguished from these 5 genera in having: no distinct fleshy lobes developed around pelvic-fin spine (vs. well-developed fleshy lobes around pelvic-fin spines in the latter); 8+7 segmented caudal-fin rays (vs. typically 9+8); 10+17−18=27−28 vertebrae (vs. 10+16=26); a pair of diagonal, elongate black markings at dorsal and ventral corners of caudal-fin base (vs. no such markings, except for *Minysicya*). The last feature, i.e., a pair of diagonal black markings at base of caudal fin, would be useful in distinguishing *Grallenia* from other similar sandy-bottom dwelling gobies (particularly young or juvenile).

Etymology. The new generic name, *Grallenia*, is named for Gerald R. Allen (G+R+Allen+suffix "-*ia*"), a former curator of fishes in the WAM, in honor of his great contribution to our knowledge of the diversity of coral-reef fishes. The gender is feminine.

Remarks. Most gobioids have 17 segmented caudal-fin rays, exclusive of some examples with 16 or fewer segmented caudal-fin rays. Regarding the Gobiidae, Larson (2001) noted that *Nesogobius* has 13 segmented caudal-fin rays, and 6 gobionelline genera [i.e., *Calamiana*, *Chlamydogobius*, *Mugilogobius*, *Pseudogobius*, *Tamanka* and *Weberogobius* (synonymized with *Mugilogobius* in the latter part of her paper)] have 16 segmented caudal-fin rays. Murdy and Shibukawa (2003) reported that *Caragobius*, belonging to the gobiid subfamily Amblyopinae, has 12–15 (typically 13) segmented caudal-fin rays. So far as we are aware, there are no gobiid genera that typically have 15 segmented caudal-fin rays, exclusive of *Grallenia*. Although fishes of the eleotrid subfamily Eleotrinae and the butine genus *Kribia* share the condition of 15 segmented caudal-fin rays with *Grallenia* (Hoese and Gill, 1993), this is a homoplastic condition, considering that these eleotrids lack several gobiine synapomorphies (e.g., five branchiostegal rays, pelvic fins fused medially, single epural, and interorbital portion of oculoscapular canals unified medially) found in *Grallenia*.

Within the Gobiinae, *Grallenia* is specialized in having putative apomorphies such as 15 segmented caudal-fin rays, greatly reduced sensory-papillae row *e*, and a pair of diagonal black markings at base of caudal fin; these characters support the monophyly of *Grallenia*. However, the phylogenetic position of *Grallenia* is not clear as our study did not hypothesize any outgroups or sister groups. Further studies, including molecular analysis, are necessary in order to elucidate a phylogeny of *Grallenia*.

Grallenia arenicola sp. nov.

(New Japanese name: Sazare-haze)

(Figs 1A, 2A, 3A–B and 4A; Table 1)

Gobiidae, indet. gen. and sp. 11: Senou *et al.*, 2004: 477 (underwater photograph and brief description; Kochi

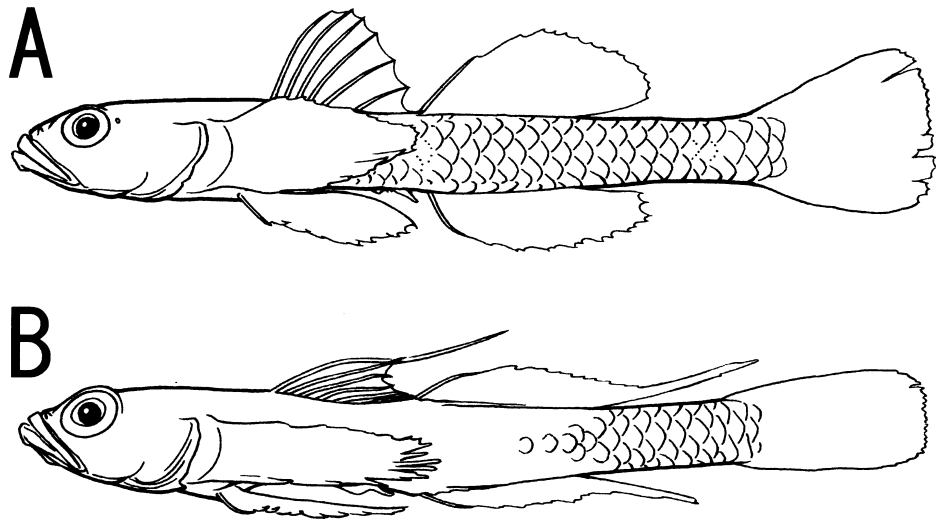

Fig. 2. Schematic illustrations of 2 species of *Grallenia*. A: *Grallenia arenicola*, NSMT-P 73195, holotype, male, 19.4 mm SL; B: *Grallenia lipi*, one of AMS I. 43870-001, paratype, male, 16.7 mm SL.

Prefecture of Shikoku and Okinawa-jima Island of Ryukyu Islands, Japan).

Holotype. NSMT-P 73195, male, 19.4 mm SL, off Aka-todai Lighthouse, Kashiwa-jima Island, Kochi Prefecture, Japan, 15–20 m depth, 19 Apr. 1992 (collected by N. Ohnishi and T. Hirata).

Paratypes. Total 12 specimens, 13.9–22.6 mm SL: AMS I.43860-001, 4 specimens (3 males and 1 female), 13.9–15.7 mm SL, off Matsumoto-waku, Kashiwa-jima Island, Kochi Prefecture, Japan, 28–30m depth, 27 Nov. 1991; KPM-NI 16707, 2 specimens (females), 21.5–22.6 mm SL, off Matsumoto-waku, Kashiwa-jima Island, Kochi Prefecture, Japan, sandy bottom, 25 m depth, 4 May, 1993; NSMT-P 73196, 1 specimen (cleared and stained), female, 20.1 mm SL, collected with holotype; NSMT-P 73198, 1 specimen, female, 19.7 mm SL, off Aka-todai Lighthouse, Kashiwa-jima Island, Kochi Prefecture, Japan, 14 Aug. 1991; NSMT-P 73199, 1 specimen, female, 16.4 mm SL, off Matsumoto-waku, Kasihwa-jima Island, Kochi Prefecture, Japan, 12 Aug. 1992; NSMT-P 73200, 1 specimen, female, 16.6 mm SL, Kashiwa-jima Port, Kashiwa-jima Island, Kochi Prefecture, Japan, 10 Aug. 1992; OMNH-P 31811, 2 specimens (females), 20.3–20.8 mm SL, collected with holotype.

Non-type specimens. NSMT-P 73197, 2 specimens, sex undetermined, 9.4–11.9 mm SL, collected with AMS I.43860-001; NSMT-P 73201, 2 specimens (stained with alizarin red), male and female, 13.3–15.9 mm SL, off Aka-todai Lighthouse, Kashiwa-jima Island, Kochi Prefecture, Japan, 25 Nov. 1991.

Diagnosis. *Grallenia arenicola* is readily distinguished from the only other congener, *G. lipi*, in having the following features: second dorsal-fin rays I, 7–8, usually I, 7 (vs. I, 9–10 in *G. lipi*); anal-fin rays I, 7–8, usually I, 7 (vs. I, 9); vertebrae 10+17−18=27, usually 10+17=27 (vs. 10+17−18=27−28, usually 10+18=28); dorsal-fin spines not elongated in either sex (vs. first spine of first dorsal-fin greatly elongated or filamentous in males); second dorsal fin not reaching caudal-fin base when adpressed, length of longest ray 14.0–17.6% of SL (vs. usually reaching to, or beyond, caudal-fin base when adpressed in adult, length of longest ray 17.5–21.8% of SL); length of longest ray of anal fin 8.9–13.3% of SL (vs. 12.6–18.1% of SL); scales on body extending anteriorly to just behind pectoral-fin base (vs. scales on body restricted on posterior half of body, except for isolated patch of scales just behind pectoral-fin base); weak, low pelvic frenum (vs. pelvic frenum absent); length of pectoral fin 20.7–25.9% of SL (vs. 23.2–30.6% of SL); caudal-peduncle length 24.6–28.6% of SL (vs. 20.3–23.6% of SL); cephalic sensory canals with pores C′ (unpaired), D (unpaired), E and F′ (vs. no cephalic sensory canals and associated pores); no orange line on

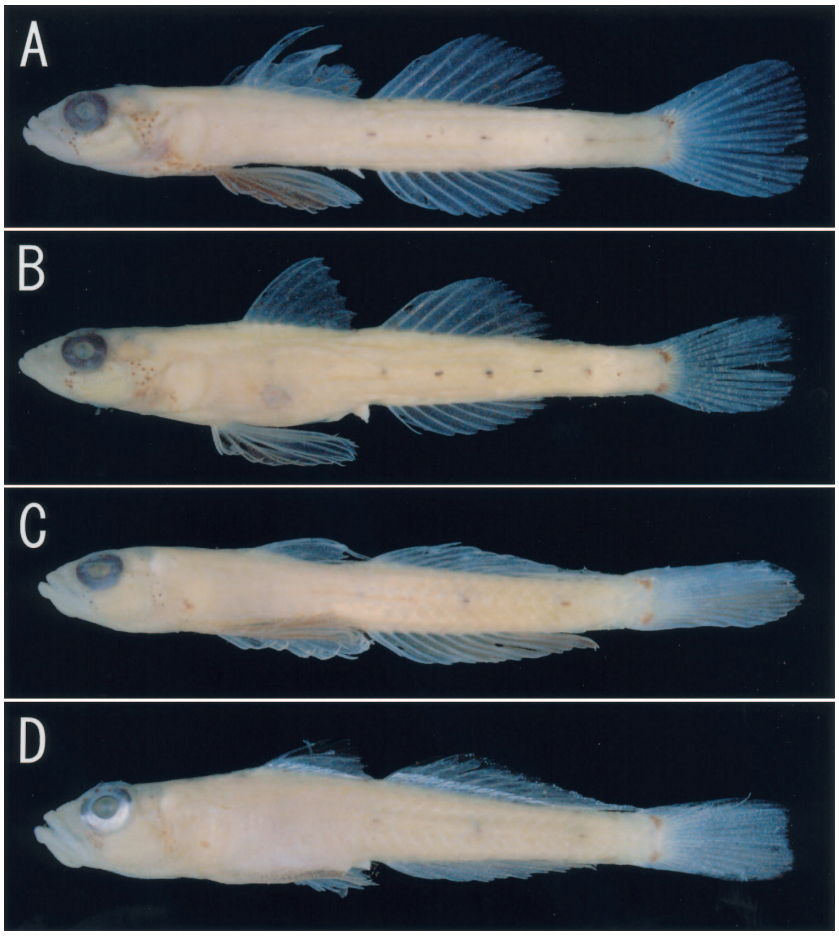

Fig. 3. Preserved specimens of 4 species of *Grallenia*. A: *Grallenia arenicola*, NSMT-P 73195, holotype, male, 19.4 mm SL, Kashiwa-jima Island, Kochi Prefecture, Japan; B: *Grallenia arenicola*, one of OMNH-P 31811, paratype, female, 20.8 mm SL, collected with holotype; C: *Grallenia lipi*, NSMT-P 56840, holotype, male, 15.5 mm SL, Ambon Island, Indonesia; D: *Grallenia lipi*, one of NSMT-P 56841, female, 16.3 mm SL, collected with holotype.

dorsal fins (vs. orange line at middle of dorsal fins in life).

Description. Dorsal-fin rays VI-I, 7* (11) or VI-I, 8 (2); anal-fin rays I, 7 (11) or I, 8* (1); pectoral-fin rays 15 (5), 16* (19) or 17 (2); pelvic-fin rays I, 5* (26); segmented caudal-fin rays 7+7 (1) or 8+7* (12), including 5+5 (1), 6+5* (10) or 7+5 (1) branched rays; upper unsegmented caudal-fin rays 7* (3), 8 (6) or 9 (3); lower unsegmented caudal-fin rays 5* (1), 6 (5), 7 (5) or 8 (1); longitudinal scales 25 (1), 26 (3), 27 (10), 28* (9) or 29* (3); transverse scales from anal-fin origin upward and forward to base of first dorsal fin 4 (1), 5 (3), 6* (10) or 7 (12); transverse scales from anal-fin origin upward and backward to base of second dorsal fin 7* (7), 8* (18) or 9 (1); transverse scales from origin of second dorsal fin downward and backward to base of anal fin 6 (1), 7* (14) or 8* (11); predorsal scales 0* (13); circumpeduncular scales 12* (13); gill rakers on outer surface of first arch 0+6 (1), 1+3* (1), 1+4 (2), 1+5 (2), 2+5 (3) or 2+7 (1); pseudobranchial filaments 4 (9) or 5* (1); vertebrae 10+17=27* (10) or 10+18=28 (2); P-V 3/II II I I 0/9* (10) or 3/II III 0 I 0/9 (2); 2* (12) anal-fin pterygiophores anterior to first

Fig. 4. Underwater photographs of 2 species of *Grallenia*. A: *Grallenia arenicola*, Kashiwa-jima Island, Kochi Prefecture, Japan (photographed by H. Miyamoto); B: *Grallenia* cf. *lipi* (see "Remarks" of *G. lipi*), Tulamben, Bali Island, Indonesia (photographed by T. Kozawa).

haemal spine; epural 1* (8).

Color when alive (based on underwater photographs, e.g., Fig. 4A). Ground color of head pale, somewhat translucent; dorsal surface of snout and eyes with some or several minute black dots; iris light yellowish orange, becoming pale dorsally and ventrally; ground color of body subtranslucent, with bright white belly; posterior half of side of belly with 2 small patches of melanophores; a series of ca. 5 minute black dots along lateral midline of caudal part of body; 5 short T-shaped subcutaneous black markings along vertebral column, first one above pectoral-fin base, second one at middle of trunk, third one above anus, 4th one below end of second dorsal-fin base, and fifth and posteriormost one at middle of caudal peduncle; interspace between each black markings along vertebral column bright white; 5 minute black spots along midline from anal-fin base to end of caudal peduncle; a pair of small diagonally-elongate black spots at dorsal and ventral corner of end of caudal peduncle; all clusters of melanophores on head and body overlapping similar-sized clusters of orange brown (dorsally) to pale orange (ventrally) chromatophores, except for black dots on dorsal surface of eye; ground color of fins subtranslucent; dorsal and anal fins, pectoral-fin base and middle of pelvic fin with numerous bright white speckling.

Color in alcohol. Ground color of head and body pale yellow; minute melanophores scattered on occipital, suborbital and postorbital areas and anterior part of operculum; eye blackish, with several small black dots on dorsal surface of cornea; breast weakly (in female) or rather heavily (in male) pigmented by melanophores; several or more dense melanophores on anteroventral part of pectoral-fin base; a series of ca.13–14 black dots along dorsal profile of body from nape

to posterior part of caudal peduncle; a series of ca. 5–7 minute black dots along midlateral line of tail part of body; ca. 5–6 black dots along ventral profile of body from anal-fin origin to posterior part of caudal peduncle; a pair of distinct, black diagonally-elongate black spots at dorsal and ventral corners of end of caudal peduncle; dorsal fins translucent, weakly pigmented at ventral half (melanophores usually forming a longitudinal midline at least in second dorsal fin), with some melanophores around tip of spine of second dorsal fin; anal fin pigmented basally and posterodistally; membrane of pelvic fin with numerous coarse, minute melanophores, exclusive of connecting membrane between innermost rays; caudal and pectoral fins translucent. In small specimens (e.g., AMS I.43860-001), all fins are translucent, and head and body are less pigmented.

Sexual dimorphism. Male genital papilla pointed, truncated in female; breast heavily pigmented with coarse melanophores in large male, weakly pigmented or pale in female and/or small specimens.

Distribution and habitat. All examined specimens of *Grallenia arenicola* were collected from Kashiwa-jima Island, Kochi Prefecture, Japan; according to Senou *et al.* (2004), *G. arenicola* (as "Gobiidae, indet. gen. and sp. 11") is known from Kochi Prefecture of Shikoku and Okinawa-jima Island, Ryukyu Islands, Japan. This species is found solitary on sandy bottom around boulders or rocky reefs at depths of 10–50 m (Senou *et al.*, 2004).

Etymology. The species name, *arenicola*, is the combination of the Latin words "*arena*" (meaning "sand") and "*colo*" (meaning "I inhait"), in reference to its sandy-bottom dwelling habit.

Grallenia lipi sp. nov.

(Figs. 1B, 2B, 3C–D and 5; Table 1)

Gobiidae sp 2. Kuiter and Tonozuka, 2001: 708 (Bali, Indonesia, and Mabul, Sabah; distribution, habitat, brief diagnosis, and 2 underwater photographs).

Holotype. NSMT-P 56840, male, 15.5 mm SL, Lilibooi, Ambon Bay, Ambon Island, Indonesia (3°45′S, 128°1′E), 15 m depth, 5 Dec. 1998 (collected by K. Matsuura and K. Shibukawa).

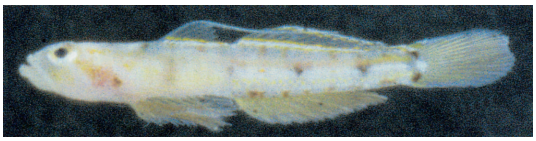

Fig. 5. Freshly collected specimen of *Grallenia lipi* (NSMT-P 56840, holotype, male, 15.5 mm SL, Ambon Island, Indonesia).

Paratypes. Total of 8 specimens, 14.6–18.8 mm SL, collected with holotype: AMS I. 43870-001, 2 specimens, male and female, 16.7–16.9 mm SL; KPM-NI 16708, 2 specimens, male and female, 15.5–15.8 mm SL; NSMT-P56841, 3 specimens, 1 male and 2 females (1 stained with alizarin red), 14.6–16.4 mm SL; NSMT-P 73202, 1 specimen (cleared and stained), female, 18.8 mm SL.

Non-type specimens. NSMT-P 73203, 2 specimens, 10.8–11.2 mm SL, sex undetermined, collected with holotype.

Diagnosis. See diagnosis of congener, *G. arenicola*.

Description. Dorsal-fin rays VI-I, 9 (3), VI-I, 10* (5) or VII-I, 10 (1); anal-fin rays I, 9* (9); pectoral-fin rays 14 (1), 15 (1), 16 (13)* or 17 (3); pelvic-fin rays I, 5* (18); segmented caudal-fin rays 8+7* (9), including 6+5* (9) branched rays; dorsal unsegmented caudal-fin rays 5 (1), 6 (1), 7* (5) or 8 (2); ventral unsegmented caudal-fin rays 6* (7), or 7 (2); longitudinal scale rows in anterior series 0 (1), 1 (1), 2 (2), 3* (3), 4* (2), 5 (4), 6 (2) or 7 (2); longitudinal scale rows in posterior series 10 (1), 11* (7), 12 (2), 13 (1) or 14 (5); total longitudinal scale rows 10 (1), 12 (1), 13 (1), 14* (3), 15* (2), 16 (2), 17 (1), 19 (4), 20 (2) or 21 (1); transverse scale rows from anal-fin origin to base of first dorsal fin 0* (9); transverse scale rows from anal-fin origin to base of second dorsal fin 0* (9); transverse scale rows from second dorsal-fin origin to base of anal fin 0* (9); predorsal scales 0* (9); circumpeduncular scales 12* (9); gill rakers on outer surface of first arch 2+7* (4), 2+8 (1), 2+9 (1), 3+8 (1) or 3+9 (2); pseudobranchial filamens 3 (1), 4* (7) or 6 (1); vertebrae 10+17=27 (1) or 10+18=28* (7); P-V 3/II II I I 0/9* (8) or 3/II II II I

Table 1. Proportional measurements of two species of *Grallenia* gen. nov.

	G. arenicola sp. nov.			*G. lipi* sp. nov.		
	Holotype	All 13 type specimens		Holotype	Holotype+8 paratypes	
	Male	4 males*	9 females	Male	4 males*	5 females
Standard length (mm)	19.4	13.9–19.4	14.9–22.6	15.5	14.6–16.7	15.8–18.8
In% of standard length						
Head length	26.3	26.3–29.8	25.8–28.7	26.1	26.0–27.9	27.3–29.2
Head width	14.6	14.6–15.2	13.6–16.1	16.0	14.6–16.2	15.4–17.7
Head depth	13.3	12.6–13.3	12.3–13.6	14.0	13.2–14.3	14.1–15.7
Snout length	7.0	6.7–7.7	6.0–7.7	6.1	5.2–6.2	5.7–6.3
Eye diameter	7.6	7.6–9.0	7.1–7.9	8.3	8.3–9.1	8.7–9.4
Interorbital width	1.5	1.0–1.5	1.4–1.9	1.7	1.2–1.7	1.2–1.7
Nape width	9.5	9.5–11.3	9.9–11.4	11.0	11.0–13.2	12.4–13.6
Jaw length	10.2	10.2–11.5	10.4–12.4	11.8	11.1–11.8	11.3–12.0
Body depth	10.9	10.9–13.3	11.5–13.5	11.9	11.9–14.0	12.3–13.6
Body width	9.5	9.5–11.0	11.5–13.5	9.2	9.2–11.3	11.8–13.8
Predorsal length	34.1	34.0–35.0	34.1–36.7	33.6	33.6–36.4	35.4–36.6
Prepelvic length	30.3	30.1–31.7	29.7–31.6	28.7	28.1–29.9	29.9–32.9
Preanal length	54.7	54.0–56.1	55.2–59.0	53.5	53.5–54.0	55.1–56.9
Caudal-peduncle length	26.3	26.2–28.6	24.6–27.8	23.6	22.3–23.6	20.3–22.5
Caudal-peduncle depth	8.1	7.6–8.1	7.3–8.3	8.8	8.4–8.8	7.5–8.6
Length of D_1 base	18.9	16.4–18.9	15.6–19.6	17.2	17.2–19.3	14.9–18.4
Length of D_2 base	19.4	18.4–20.4	17.9–20.4	25.4	24.5–27.1	24.6–26.3
Length of longest ray of D_2	16.0	14.0–17.4	14.4–17.6	20.0	19.0–21.8	17.5–20.1
Length of A base	19.2	16.5–19.2	16.5–18.3	25.1	22.6–25.1	22.5–24.7
Length of longest ray of A	12.8	8.9–12.8	10.5–13.3	17.4	12.6–18.1	13.4–15.7
P_1 length	25.9	23.0–25.9	20.7–23.7	28.9	28.9–30.6	23.2–28.
P_2 length	24.0	24.0–25.2	21.8–26.7	26.6	25.1–26.6	21.8–26.7
Length of fourth segmented ray of P_2	20.9	20.9–22.4	19.5–25.2	25.2	23.3–25.2	19.7–24.3
Length of fifth segmented ray of P_2	21.6	21.6–23.1	20.2–24.6	22.4	22.4–24.3	18.6–23.7
C length	22.3	22.3–24.3	19.9–23.9	26.0	24.9–27.2	22.3–23.9

* Including holotype. Abbreviations: A, anal fin; C, caudal fin; D_1, first dorsal fin; D_2, second dorsal fin; P_1, pectoral fin; P_2, pelvic fin.

0/9 (1); 2* (9) anal-fin pterygiophores anterior to first haemal spine; 1* (9) epural.

Color when alive (based on underwater photographs, e.g., Kuiter and Tonozuka, 2001: 708). Ground color of head and body subtranslucent; belly bright white; a series of ca. 5 short subcutaneous black lines along dorsal surface of vertebral column, as well as yellow or orange line; a series of ca. 5 narrow horizontally-elongate rectangular white blotches on midlateral body; iris pale; dorsal surface of eyes and snout with several minute black dots; vague black spots at dorsal and ventral corners of end of caudal peduncle; an orange longitudinal line, sandwiched between narrow white longitudinal bands, at middle of dorsal fins; distal margin of dorsal fins white, edged ventrally by orange-yellow; ventral, anal and caudal fins tinged with orange-yellow.

Color when freshly collected specimen (Fig. 5). Similar to live coloration, except as follow: ground color of head and body whitish; black spots at dorsal and ventral corners of end of caudal peduncle vivid and distinct.

Color in alcohol. Ground color of head and body pale yellow; minute melanophores scattered on occipital, suborbital and postorbital areas and anterior part of operculum; eye blackish, with several small black dots on dorsal surface of cornea; breast weakly (in female) or rather heavily (in male) pigmented by minute melanophores; anteroventral part of pectoral-fin base pigmented by various sized melanophores (a part of melanophores usually forming a small diagonally-elongate dark brown spot); a series of 10–12 black dots along dorsal profile of body from nape to posterior part of caudal peduncle; a series of ca. 6–7 minute black dots on midlateral body in large specimens; ca. 5–8 black dots along ventral profile of body from anal-fin origin to posterior part of caudal peduncle; a pair of distinct, black diagonally-elongate black spots at dorsal and ventral corners of end of caudal peduncle; dorsal fin translucent with an indistinct black line at middle (submarginal part of second dorsal fin sometimes weakly pigmented by minute melanophores); membrane of anal and pelvic fins and ventral half or more of caudal fin with numerous coarse, minute melanophores (exclusive of connecting membrane between innermost rays very weakly pigmented); pectoral fin pale or weakly pigmented by quite minute melanophores. In small specimens, all fins are entirely translucent or very weakly pigmented, and head and body less pigmented.

Sexual dimorphism. Male genital papilla pointed, while truncated in female; first spine of first dorsal fin greatly elongate and filamentous in male, not elongate in female.

Distribution and habitat. All examined specimens of *Grallenia lipi* were captured from Ambon Bay in Ambon Island, Indonesia. They were collected around an isolated, relatively large coral patch on flat, clean and fine sandy bottom at a depth of 15 m; the other fishes found in the same habitat are the typical sandy-bottom dwellers, e.g., the gobiid *Fusigobius inframaculatus* and the creediid *Limnichthys nitidus*; like the congener *G. arenicola*, they did not display symbiotic association with any other organisms (pers. obs., KS). According to Kuiter and Tonozuka (2001), this species (as "Filamented Pigmy Sand-goby") is widespread in Indonesia, and usually found on light coloured sand or rubble to about 15 m depth; they also provided an underwater photograph taken at Mabul, Sabah.

Remarks. Based on underwater photographs from Indonesian waters, Kuiter and Tonozuka (2001) reported 2 unidentified goby species, assignable to *Grallenia* (as unidentified genus of the Gobiidae). One of their species, named "Filamented Pygmy Sand-goby" or "Gobiidae sp 2," is very similar and likely conspecific with *Grallenia lipi*. The other Kuiter and Tonozuka's (2001) species, named "Pygmy Sand-goby "or "Gobiidae sp 1," appears to differ from typical specimens of *G. lipi* in having heavily pigmented, darkened coloration of head and body; it has larger and more vivid black spots (especially those on caudal-fin base representing a pair of large longitudinally-elongate ovoid spots). A species probably identical with Kuiter and Tonozuka's "Pygmy Sand-goby" was pho-

tographed by T. Kozawa off Bali Island, Indoensia, and one of his images is presented in Fig. 4B. The position of each cluster of melanophores is similar to that of typical specimens of *G. lipi*, their "Pigmy Sand-goby" is possibly a darkened color variant of *G. lipi*, linked to the coloration of substratum in the habitat. Kuiter and Tonozuka (2001: 708) noted that it is found, "Usually on black sand flat," whereas the lighter-colored "Filamented Pygmy Sand-goby" is found, "Usually on light coloured sand or rubble." Further detailed comparisons based on actual specimens are needed to clarify their taxonomy.

Etymology. The specific name, *lipi*, is derived from the abbreviation of the Lembaga Ilmu Pengetahuan Indonesia (=Indonesian Institute of Science), referring that all examined specimens of this new species were captured during the JSPS-LIPI cooperative research on marine science in Ambon Island in 1999.

Acknowledgments

We express our sincere thanks to the following persons and institutions for specimen loans and/or registration, providing the photographs, and help in field collection: M. McGrouther (AMS); H. Senou (KPM); N. Ohnishi (Kyoto Gakuen University, Japan); T. Peristiwardy (Lembaga Ilmu Pengetahuan Indonesia: LIPI); S. Kimura (Mie University, Japan); K. Matsuura and G. Shinohara (NSMT); S. Hosoya (Okinawa, Japan); K. Hatooka (OMNH); W. Hiramatsu (Ehime, Japan); T. Hirata (Kochi, Japan). T. Kozawa (Aichi, Japan) and Y. Miyamoto (Kanagawa, Japan) kindly provided the underwater photographs. E.O. Murdy (National Science Foundation, U.S.A) read the manuscript and offered helpful comments. This study was financially supported partially by the Japan Society for the Promotion of Science (JSPS) and the Japan Ministry of Education, Science, Sports and Culture Grant-in-Aid for Scientific Research on Priority Areas (#319), Project "Symbiotic Biosphere: An Ecological Interaction Network Promoting the Coexistence of Many Species."

Literature Cited

Akihito, Prince. 1984. Suborder Gobioidei. Pages 236–238 *in* H. Masuda, K. Amaoka, C. Araga, T. Uyeno and T. Yoshino, eds. The Fishes of the Japanese Archipelago. English text. Tokai University Press, Tokyo.

Akihito, Prince and K. Meguro. 1975. Description of a new gobiid fish, *Glossogobius aureus*, with notes on related species of the genus. *Japanese Journal of Ichthyology*, 22(3): 127–142.

Akihito, Prince and K. Meguro. 1981. A gobiid fish belonging to the genus *Hetereleotris* collected in Japan. *Japanese Jounal of Ichthyology*, 28(3): 329–339.

Akihito, K. Sakamoto, Y. Ikeda, K. Sugiyama. 2002. Gobioidei. Pages 1139–1310 *in* T. Nakabo, ed. Fishes of Japan with Pictorial Keys to the Species. Tokai University Press, Tokyo.

Allen, G., R. Steen, P. Humann and N. DeLoach. 2003. Reef Fish Identification, Tropical Pacific. New World Publications, Inc., Florida. 480 pp.

Birdsong, R.S., E.O. Murdy, F.L. Pezold. 1988. A study of the vertebral column and median fin osteology in gobioid fishes with comments on gobioid relationships. *Bulletin of Marine Science*, 42: 174–214.

Goren, M. 1991. A new *Coryogalops* species (Pisces: Gobiidae) from South Africa. *J.L.B. Smith Institute of Ichthyology*, *Special Publication*, (52): 1–7.

Harrison, I. J. 1990. A revised synonymy of *Nematogobius maindroni* (Sauvage, 1880) (Teleostei, Gobiidae). *Cybium*, 14(1): 27–35.

Hoese, D. F. 1986a. Family No. 240: Gobiidae. Pages 774–807 *in* M. M. Smith and P. C. Heemstra, eds. Smith's Sea Fishes. Macmillan South Africa, Johannesburg.

Hoese, D. F. 1986b. Descriptions of two new species of *Hetereleotris* (Pisces: Gobiidae) from the western Indian Ocean, with discussion of related species. *J.L.B. Smith Institute of Ichthyology*, *Special Publication*, (41): 1–25.

Hoese, D. F. and A. C. Gill. 1993. Phylogenetic relationships of eleotridid fishes (Perciformes: Gobioidei). *Bulletin of Marine Science*, 52(1): 415–440.

Hoese, D. F. and H. K. Larson. 2005. Description of two new species of *Hetereleotris* (Gobiidae) from the south Pacific, with a revised key to species and synonymization of the genus *Pascua* with *Hetereleotris*. *Zootaxa*, (1096): 1–16.

Hubbs C. L. and K. F. Lagler. 1958. Fishes of the Great Lakes Region. Cranbrook Institute of Science, Bloomfield Hills, Michigan. vii+213 pp., 44 pls.

Kuiter, R. H., T. Tonozuka. 2001. Indonesian Reef Fishes. Zoonetics, Australia. 893 pp.

Larson, H. K. 1985. A revision of the gobiid genus

Bryaninops (Pisces), with a description of six new species. *The Beagle, Occasional Papers of the Northern Territory Museum of Arts and Sciences*, 2(1): 57–93.

Larson, H. K. 1986. *Phyllogobius*, a new generic name for *Cottogobius platycephalops* Smith (Pisces: Gobiidae), and a redescription of the species. *The Beagle*, *Occasional Papers of the Northern Territory Museum of Arts and Sciences*, 3(1): 131–136.

Larson, H. K. 1990. A revision of the commensal gobiid genera *Pleurosicya* and *Luposicya* (Gobiidae), with descriptions of eight new species of *Pleurosicya* and discussion of related genera. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences*, 7(1): 1–53.

Larson, H. K. 2001. A revision of the gobiid fish genus *Mugilogobius* (Teleostei: Gobioidei), and its systematic placement. *Records of the Western Australian Museum,* Supplement, (62): 1–233.

Larson, H. K. 2002. A new genus of small coral-reef goby (Teleostei: Gobiidae) from the Indo-west Pacific, with discussion of its relationships. *The Beagle, Records of the Museums and Art Galleries of Northern Territory*, 18: 63–71.

Larson, H. K. and E. O. Murdy. 2001. Gobiidae. Pages 3578–3603 *in* K. E. Carpenter and V. H. Niem, eds. FAO Species Identification Guide for Fisheries Purpose. The Living Marine Resources of the Western Central Pacific. Volume 6. Bony Fishes Part 4 (Labridae to Latimeriidae), Estuarine Crocodiles, Sea Turtles, Sea Snakes and Marine Mammals. FAO, Rome.

Leviton, A. E., R. H. Gibbs, Jr., E. Heal and C. E. Dawson. 1985. Standards in herpetrogy and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia*, 1985(3): 802–832.

Miller, P. J. 1978. The status of the west African fish *Gobius nigricinctus* with reference to New World autochthones and an Old World colour-analogue. *Zoological journal of the Linnean Society*, 64(1): 27–39.

Miller, P. J. 1986. Gobiidae. Pages 1019–1085 *in* P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, eds. Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris.

Murdy, E. O. and K. Shibukawa. 2003. A revision of the Indo-Pacific genus *Caragobius* (Gobiidae: Amblyopinae). *Zootaxa*, (301): 1–12.

Pezold, F. 1993. Evidence for a monophyletic Gobiinae. *Copeia*, 1993(3): 634–643.

Potthoff, T. 1984. Clearing and staining techniques. Pages 35–37 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall Jr. and S. L. Richardson, eds. Ontogeny and Systematics of Fishes. American Society of Ichthyologists and Herpetologists Special Publication 1.

Randall, J. E. 2005. Reef and Shore Fishes of the South Pacific: New Caledonia to Tahiti and the Pitcairn Islands. University of Hwai'i Press. x + 707 pp.

Senou, H., T. Suzuki, K. Shibukawa and K. Yano. 2004. A Photographic Guide to the Gobioid Fishes of Japan. Heibonsha, Tokyo. 536 pp.

Smith, J. L. B. 1959. Gobioid fishes of the families Gobiidae, Periophthalmidae, Trypauchenidae, Taenioididae and Kraemeriidae of the western Indian Ocean. *Ichthyological Bulletin*, (13): 185–25, pls 9–13.

Manuscript received 26 March 2006; revised 29 January 2007; accepted 7 February 2007.

Associate editor: K. Matsuura.