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A review of the gobiid genus *Akko* (Teleostei: Gobiidae) with description of a new species

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Abstract

Akko was originally described for a highly autapomorphic species of goby, *A. dionaea,* taken off Brazil. The genus is here recorded for the first time from the eastern Pacific Ocean. The poorly known eastern Pacific goby *Amblyopus brevis* Günther is redescribed as *Akko brevis* based on the study of numerous specimens recently collected off Panama and El Salvador, and *Akko rossi* is described as new from the coast of El Salvador. *Akko dionaea* has 11+16 vertebrae, 76 scales in the lateral series, non-overlapping scales on the caudal peduncle, and no melanophores on the pectoral fin or female genital papilla; *A. brevis* has 11+16 vertebrae, 53–60 scales in the lateral series, overlapping scales on the caudal peduncle, and no melanophores on the pectoral fin or female genital papilla; *A. rossi* has 11+17 vertebrae, 115 scales in the lateral series, overlapping scales on the caudal peduncle, and dense melanophores on the pectoral fin and female genital papilla.

Key words: Gobiidae, new species, *Akko*, *Amblyopus brevis*, eastern Pacific

Introduction

Amblyopus brevis was described by Günther (1864) from a single specimen collected along the Pacific coast of Panama. Two additional specimens were later obtained from stomach contents of a *Centropomus* and added to the collection at the British Museum. Günther (1869) placed *A. brevis* in the subgenus *Tyntlastes* based on its dentition (teeth in a single series). Jordan and Eigenmann (1886[1887]) elevated *Tyntlastes* to a genus and assigned to it the same species that comprised Günther's subgenus (*A. brevis* and *A. sagitta*). When Palmer (1952) reviewed the genus *Gobioides,* he created two subgenera: *Gobioides*, with 25–26 vertebrae and 14–16 anal-fin rays, and *Tyntlastes*, with 31 verte-

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brae and 19 anal-fin rays. He placed *A. brevis* in *Gobioides* based on its vertebral count of 26 (an incorrect count) and anal-fin count of 15.

Murdy (1998) reviewed *Gobioides* and noted that *Amblyopus brevis* Günther does not belong in *Gobioides* based on its dorsal pterygiophore pattern of 3-221110 and a vertebral count of 11+16 (not 26 as given by Palmer [1952]). Those characters would place it in the "*Gobiosoma*" or "*Microgobius*" groups of the Gobiosomatini and thus part of the Gobiinae (sensu Pezold, 1993).

Birdsong and Robins (1995) erected *Akko* for a new species, *A. dionaea*[1], from off Brazil. *Akko dionaea* has a dorsal pterygiophore pattern of 3-221110, 11+16 vertebrae, and a distinctive sensory papillae pattern in which horizontal row *b* is elongate, extending anteriorly to a vertical through the middle of the eye; dorsal row *n* is elongate, the left and right elements approaching or meeting at the dorsal midline; and rows x^1 and x^2 are continuous. Birdsong and Robins (1995) placed the genus in the Gobiosomatini but did not comment further on its relationships within the tribe because of the large number of osteological autapomorphies it possesses.

Fish collections made during a Smithsonian Institution cruise aboard the R/V *Uracca* to the Darien province of Panama in 2000 resulted in several specimens initially identified as *Gobioides brevis*. A Smithsonian expedition to El Salvador in 2002 resulted in 144 additional specimens. This species has a dorsal pterygiophore pattern of 3-221110, 11 precaudal and 16 caudal vertebrae, and the distinct papillae pattern of and most of the osteological autapomorphies present in *Akko dionaea*. Several specimens were sent to the British Museum where Anthony Gill confirmed that our specimens match those of the holotype of *Amblyopus brevis*. We therefore take the opportunity to redescribe *Amblyopus brevis* based on the new material and place it in the genus *Akko,* thus extending the range of *Akko* from the Atlantic to the eastern Pacific Ocean.

In addition, a previously undescribed gobiid species obtained during the El Salvador expedition appears to represent a new species of *Akko*. This species, which is larger than *A. brevis*, found in shallower waters (7-9 meters as opposed to 15–25 meters for *A. brevis*), and separable from *A. brevis* on the basis of numbers of lateral-line scales, vertebrae, dorsal- and anal-fin rays, and pigment pattern, is described herein.

Methods

Methods for counts and measurements follow Böhlke and Robins (1968) except for those not defined in that reference: preanus length—anterior tip of the mouth to the anteriormost point of the anus; body depth at anus – measured along a vertical at the anteriormost point

1. Birdsong and Robins (1995) spelled the name of their new species "*dionea*" in the abstract but "*dionaea*" in all other places in the paper. The species was named after the plant genus *Dionaea*. We conclude that "*dionea*" is a misspelling.

of the anus to the base of the dorsal fin; and interorbital distance—smallest distance between the median edges of the orbits. The dorsal pterygiophore formula is that of Birdsong *et al.* (1988), description of myology follows Van Tassell (2001), patterns of sensory papillae are described according to Miller (1986), and terminology of head-canal pores follows Akihito *et al.* (1984). Osteological observations were made from radiographs and specimens cleared with trypsin and counter stained for cartilage and bone (Potthoff, 1984). Institutional acronyms follow Leviton *et al.* (1985) and Leviton and Gibbs (1988).

Akko Birdsong and Robins

Diagnosis: Body elongate; vertebrae 11 + 16–17 = 27–28; first dorsal fin with seven spines; dorsal-pterygiophore formula 3-221110; second dorsal and anal fins with equal numbers of elements, 15 or 16 present in each; dorsal, caudal, and anal fins continuous, connected by a membrane; upper and lower jaws with enlarged widely spaced teeth which overlap the lips of both jaws; head with very small eyes (2–8% of head length); mouth large, the opening at an angle of 50° to the horizontal; a cephalic lateral-line canal with two pores (B',G'). Pores very reduced in size and occasionally absent. Sensory papillae pattern in a transverse pattern; horizontal row *b* elongate, extending to vertical through middle of eye; dorsal rows *n* elongate, approaching or meeting at midline; rows x^1 and x^2 continuous.

Akko rossi sp. nov.

Fig. 1

Holotype: USNM 371780, 90 mm SL, female, Gulf of Fonseca, El Salvador, trawl, 13°12.89'N, 87°51.29'W to 13°13.74'N, 87°49.81'W, 7.0–9.5 m, mud.

Description: Morphometric data for the holotype (the only known specimen) are given in Table 1. Characters given in the Diagnosis are not repeated here.

Median fins: The second dorsal and anal fins both have 16 elements, the first element a spine in both. The caudal fin is lanceolate with 17 segmented rays, 4 upper and 5 lower procurrent rays. Median fin rays are serially branched with 4 to 5 branches.

Caudal skeleton: Hypurals 1–2 are fused to one another but not to other elements in the caudal skeleton. Hypurals 3–4 are fused to one another and to the terminal half centrum. A small parhypural supports the lowermost segmented ray, hypural 5 is free, and the single epural supports the uppermost segmented ray.

Paired fins: The pectoral fin is short, ending posteriorly before the posterior extension of the pelvic fin, well in front of the anus; the pectoral fin has 19 dichotomously branched rays. Pelvic fins are united forming a disk with a well-developed anterior frenum. The

pelvic base is formed into a muscular pedicel with strong muscle bundles extending from the vicinity of the pelvic process to the vicinity of the pelvic spine, with some of the fibers inserting on the spines. Rays 1, 2, and 3 are serially branched; rays 4 and 5 dichotomously branched.

TABLE 1. Morphometric Data for *Akko rossi* and *Akko brevis*. Standard length is in mm; interorbital distance and eye diameter are in percent head length; other measurements are in percent standard length

	A. rossi	*A. brevis* males (n=12)		*A. brevis* females (n=9)	
	Holotype	range	mean	range	mean
Standard length	90.8	27.7 – 58.9	46.6	29.3 – 52.7	39.0
Preanus length	43.6	40.6 – 49.0	43.6	42.3 – 48.6	44.7
Head length	23.7	22.9 – 28.8	25.0	23.2 – 27.8	25.5
Depth at anus	12.2	13.2 – 15.3	14.4	13.6 – 16.5	14.5
Caudal-fin length	32.3	18.2 – 35.2	31.6	23.0–39.7	34.7
Pectoral-fin length	13.1	13.4 – 16.9	14.9	12.2 – 18.4	15.4
Pelvic-fin length	17.7	14.5 – 19.8	17.5	16.3 – 20.3	18.1
Interorbital distance	35.1	24.8 – 35.4	30.0	25.6 – 32.4	29.2
Eye diameter	4.8	5.4 – 6.8	6.1	5.7 – 7.6	6.5

Head: The mouth is large, the opening at an angle of 50° to the horizontal. No rostral frenum is present, and the upper jaw is only slightly protrusible. The oral velum has dorsal and ventral projections at the midline. The anterior nostril is a short thickened tube. The posterior nostril is a slit. There is no pseudobranch. The eye is tiny with a large lens occupying most of the eye. The gill opening extends from the level of the sixth pectoral fin ray ventrally to the pelvic-fin base, terminating in a membrane supported by the second branchiostegal ray. The cephalic canal system has a small pore medial and just posterior to the anterior nostril (B') and a second small pore posterior to the eye (G').

Sensory papillae: The sensory papillae are slightly abraded, and no drawing is included, but the pattern is the same as that of *Akko brevis* (Fig 2). Horizontal row *b* has an elongate anterior extension ending under the eye; row *d* is complete, not divided into two sections, and row *ot* extends ventrally onto the branchiostegals, ending just past the second branchiostegal ray. The first vertical papillae row is complete, extending from the eye to near row *d*. Additional vertical rows are divided by row *b*, with two rows above and four rows below. Only the last vertical row below row *b* extends below the level of row *d*. Dorsal rows x^1 and x^2 are continuous or nearly so as is row *n*.

Jaws: The upper jaw has a single row of large depressible teeth, 16 on each premaxilla in the holotype. The lower jaw has two rows of teeth, the outer row consisting of 11 large evenly spaced teeth, the inner row with smaller widely spaced teeth.

FIGURE 1. *Akko rossi* n. sp., USNM 371780, holotype, 90 mm SL, female, Gulf of Fonseca, El Salvador.

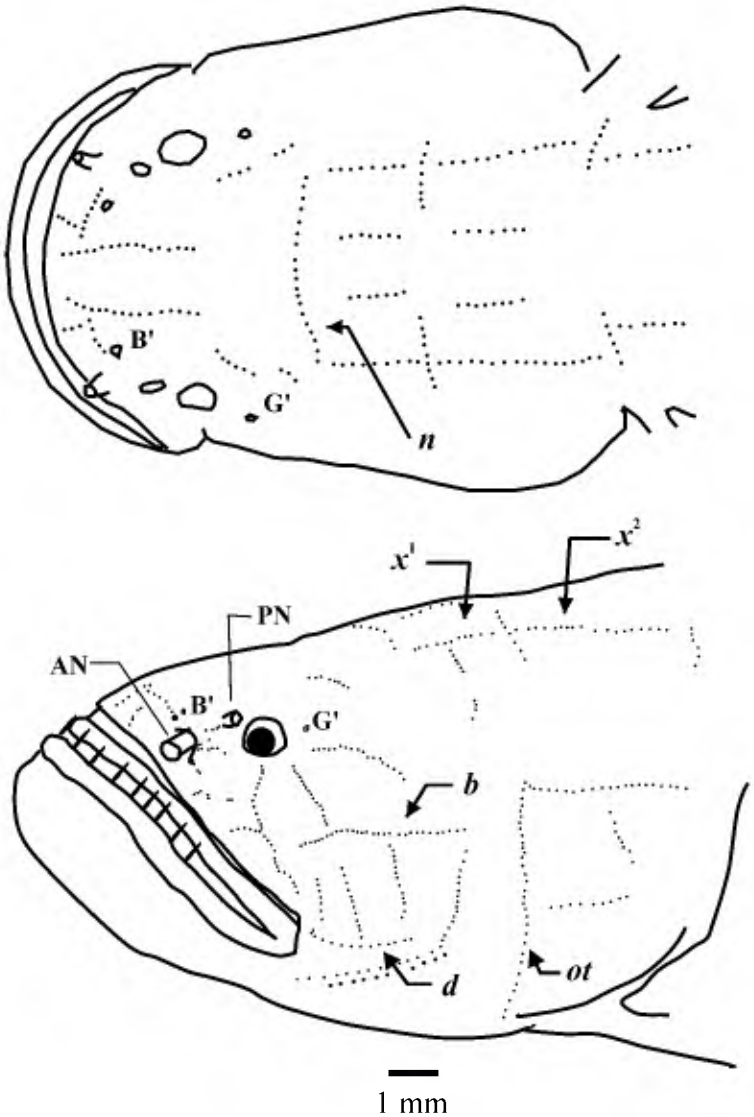

FIGURE 2. Sensory papillae pattern in *Akko brevis*, UCR 2554.011, composite of several specimens.

Vertebral column: There are 11 precaudal and 17 caudal vertebrae. Two anal-fin pterygiophores precede the anteriormost haemal spine. The dorsal pterygiophore pattern is 3-221110.

Scales: Scales are small, cycloid, embedded, and non-overlapping anteriorly, becoming larger and overlapping posteriorly. The body is scaled from the predorsal area over the operculum to the base of the caudal fin, with about 115 scales in the lateral series.

Genitalia: The female genital papilla is short and broad, opening through a slit.

Pigment: The head and dorsal portion of the trunk are brown in the preserved specimen. The ventral section, below the midline, is pale tan anteriorly, becoming tan to light brown posteriorly. The fins are dark brown, becoming light brown or speckled brown at the base only. The pigment is restricted to the interradial membranes in all fins except the first dorsal, in which the membrane covering the spines is also brown. The genital papilla is brown, the tip and remainder of the surrounding ventral area white.

Etymology: The specific epithet is in honor of our friend and colleague, D. Ross Robertson, of the Smithsonian's Tropical Research Institute in Panama, who has made substantial contributions to our understanding of diversity of tropical eastern Pacific shorefishes.

Distribution: The only known specimen of *Akko rossi* was collected from the Gulf of Fonseca, El Salvador.

Akko brevis (Günther 1864)

Fig. 3

Amblyopus brevis Günther 1864: 151, type locality Panama, Pacific coast. Holotype: BMNH 1864.1.26.416.
Gobioides brevis —Palmer 1952:55
Tyntlastes brevis Jordan and Eigenmann 1887: 511

Material examined: El Salvador —USNM 371781, 11 specimens, Gulf of Fonseca, shrimp trawler *Amancer*, Captain Francisco Antonio Lopez, 13°06.95'N, 87°52.15'W to 13°08.79'N, 87°47.79'W, 20.0 m. USNM 371782, 28 specimens, same as above except 13°09.54'N, 87°48.30'W to 13°08.42'N, 87°48.00'W. USNM 371782, 13 specimens, Gulf of Fonseca, trawl, 13°09.14'N, 87°51.89'W to 13°09.87'N, 87°50.91'W, 14.5–17.0 m, mud. USNM 371784, 20 specimens, same as above. USNM 371785, 4 specimens, Gulf of Fonseca, trawl, 13°09.99'N, 87°50.75'W to 13°11.01'N, 87°49.56'W, 14.0–12.0 m, mud. USNM 371786, 7 specimens, Gulf of Fonseca, trawl, 13°11.97'N, 87°48.30'W to 13°10.44'N, 87°47.79'W, 10.4–13.3 m, mud. USNM 371787, 94 specimens, off Las Tunas, Departmento La Union, trawl, 13°04.74'N, 88°02.82'W to 13°05.02'N, 88°01.27'W, 21.0–25.0 m, mud. EL-01-017(JVT collection), 2 specimens cleared and stained, shrimp trawler, 13°09.54'N, 087°48.30'W to 13°08.42'N, 087°48.00'N, 20.0 m,

mud. **Panama**—URC 2554.011; 7 specimens, Panama, Darien; 23 Jan 2000 San Miguel, midway between Pta. Garachine and Pta. San Lorenzo, 18 km W Pta. Patiño. BMNH 1864.1.26.416 holotype *Amblyopus brevis*, Pacific coast of Panama, radiograph. USNM 339614; 1 specimen, 1954, field number W54-326 station 47, Pacific Panama. USNM 43428; 2 specimens, Panama: U.S. Colombia (Equador to Panama) Albatross Expedition, F.C. 5577, 15 Mar 1888. **Peru**—USNM 77581; 1 specimen, Paita, Peru, 13 Apr 1907. USNM 128187; 1 specimen, Sechura Bay near Sechura 16 May 1941.

Description: Morphometric data are given in Table 1. Frequency distributions of numbers of pectoral- and caudal-fin rays are given in Table 2.

TABLE 2. Frequency distributions of numbers of pectoral-fin rays and upper and lower procurrent (unsegmented) caudal-fin rays for *Akko brevis*. Values for holotype of *Amblyopus brevis* are underlined.

Protoral-fins Rays (both sides)			Caudal-fin Rays						
			Upper Procurrent			Lower Procurrent			
19	20	21	3	4	5	2	3	4	5
21	36	3	10	87	<u>23</u>	1	11	90	<u>14</u>

Median fins: Each count is followed parenthetically by the number of specimens recorded with that count; an * indicates value for holotype. The first dorsal fin has seven spines (145*) or six (1) [specimen missing the posteriormost spine], 15 second dorsal-fin elements (146*), and 15 anal-fin elements (143*). The caudal fin is lanceolate, with 17 (133*) segmented rays, 3–5 procurrent rays in the upper lobe, and 2–5 in the lower lobe (Table 2). Rays of the median fins are serially branched three to four times.

Caudal skeleton: Hypurals 1–2 are fused to one another, and hypurals 3, 4, and the terminal half centrum are fused into a single unit. The parhypural supports the lower segmented element, hypural 5 is free, and the single epural supports the uppermost segmented element.

Paired fins: The pectoral fins are relatively short, falling just short of the posterior extreme of the pelvic fin when depressed. There are 19–21 pectoral-fin rays, all dichotomously branched except for the uppermost and lowermost rays. The pelvic fins are united, forming a disk with a well-developed anterior frenum. The pelvic base is a muscular pedicel with strong muscle bundles extending from the vicinity of the pelvic process to the vicinity of the pelvic spine, with some of the fibers inserting on the spines. All pelvic-fin rays are branched dichotomously four to five times. The pelvic fin extends posteriorly to a point that is short of the anus by a distance equal to 2–3 eye diameters.

Pectoral and pelvic girdle: The osteology is the same as that described by Birdsong & Robins (1995) for *A. dionaea*.

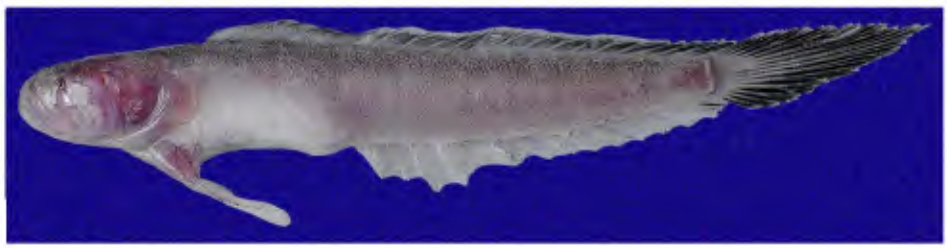

FIGURE 3. *Akko brevis*, UCR 2554.011, 53 mm SL, female, Darien, Panama.

Head: The mouth is large, capable of expanding to a complete circle equal to the body diameter in live specimens. When the mouth is closed, the opening is oriented at an angle of 50° to the horizontal. The upper jaw is slightly protrusible, and there is no rostral frenum. An oral velum is present with dorsal and ventral projections. Upper and lower lips possess 10–15 fleshy papillae along the lateral upper edges. The anterior nostril is composed internally of a thickened, U-shaped, fleshy tube (the anterior section of which forms the external nostril, the remainder is visible under the overlying skin). A histological examination of this structure shows it to possess some smooth muscle fibers. The posterior nostril consists of a short tube or raised rim with no muscular development. The gill opening extends from the fourth pectoral ray ventrally to just above the pelvic-fin base, terminating at a membrane supported by the second branchiostegal ray and extending to the ventral-most pectoral ray. No pseudobranch present. The eye is small, covered with skin, slightly recessed, and has a large lens. Head canal pores B' and G' are present. No preopercle pores are present.

Sensory papillae: The sensory papillae pattern is shown in Fig 2. Horizontal row *b* has an elongate anterior extension ending under the eye; row *d* is complete, not divided into two sections, and row *ot* extends ventrally onto the branchiostegals, ending just past the second branchiostegal ray. The first vertical papillae row is complete, extending from the eye to near row *d*. Additional vertical rows are divided by row *b*, with two rows above and four rows below row *b*. Only the last vertical row below row *b* extends below the level of row *d*. Dorsal rows x^1 and x^2 are continuous, or nearly so, as is row *n*.

Jaws: The upper jaw has a single row of enlarged teeth, 10–11 on each premaxilla in males and 16–18 in females. The lower jaw consists of two rows of teeth, an outer row of 6–8 enlarged teeth in males (7–10 in females), and an inner row of 13–15 small teeth in males (18–20 in females). There is an unossified extension of the ventromedial process of the dentary and the ventral margin of the anguloarticular. The lacrimal is large and ossified.

Myology: The superficial adductor mandibulae is subdivided into the A1 beta, A1 alpha, and A2 bundles (Fig. 4). The A1 beta passes under the large lacrimal and inserts directly by a broad non-ligamentous connection onto the posterodorsal margin of the maxilla. Both the A1 alpha and A2 combine via a strong tendon, which inserts on the coronoid process of the dentary. The *ramus mandibularis* V passes between the A1 and A2. The

origin of the A1 alpha is along the anterior margin of the dorsal half of the preopercle. Adductor mandibulae 2 originates along the anterior margin of the ventral half of the preopercle and along the quadrate, but the area of origin does not reach the condyle of the quadrate.

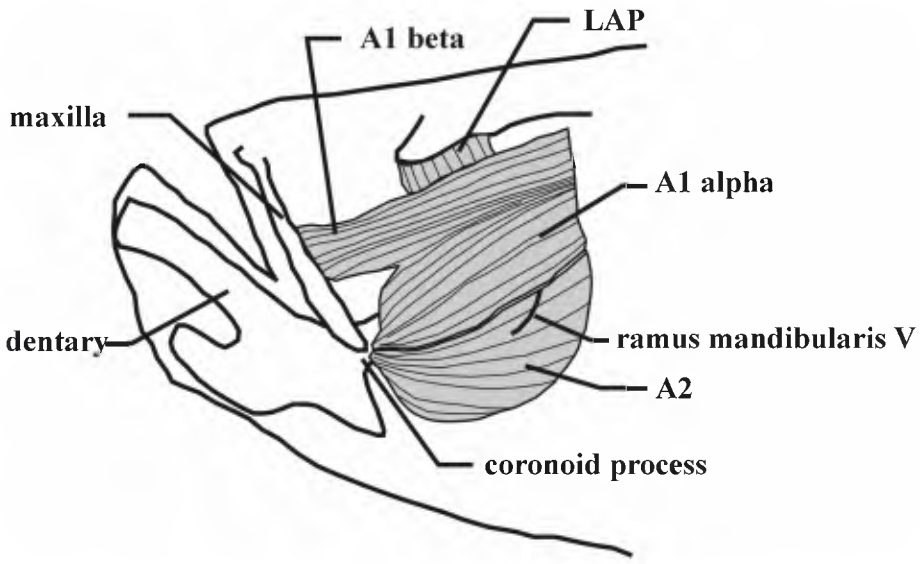

FIGURE 4. *Akko brevis*, EL-01-067 (JVT collection), El Salvador.

Braincase: The osteology of the cranial region of *Akko brevis* and *A. dionaea* is essentially the same. The primary difference is the lateral expansion of the frontals and parasphenoid in *A. dionaea,* which is absent in *A. brevis*.

Vertebral column: There are 11 precaudal and 16 caudal vertebrae (144*). Pleural ribs of vertebrae 3–11 articulate with their respective parapophyses. Epineural bones are found on vertebrae 1–21. Epineurals 1 and 2 articulate with the parapophyses, 3–10 with the pleural ribs, 11 articulates with the parapophysis dorsal to its articulation with the pleural rib, and the remaining epineurals articulate with the centrum of each vertebra. The posterior process of the neural spine present in *A. dionaea* on each of vertebrae 1–6 is variably present or absent from most of the neural spines in *A. brevis*. When present it ranges in size from very small to large, and size is not consistent between specimens. The haemal spines of caudal vertebrae 13 and 14 are broad but not bifurcated. There are 2 anal-fin pterygiophores preceding the first haemal spine.

Scales: Scales are cycloid, small, embedded, and non-overlapping anteriorly, becoming larger and overlapping on the caudal peduncle. There are 53–60 in the lateral series. Predorsal scales extend forward to the region above the anterior portion of the opercle. The pectoral-fin base, operculum, and breast are naked. No modified basicaudal scales are present.

Viscera: A small gas bladder is located in the posterior 1/3 of the body cavity and is characterized by a thick tunica interna. The intestine is coiled twice, and its total length is about equal to ¾ body length. A single gravid female contained about 700 eggs in one of the ovaries, each about 0.5 mm in diameter.

Genitalia: In males the genital papilla is short, thin, and pointed. Gravid females possess a short, rounded, bulbous papilla with a rounded opening and a narrow slit along the dorsal margin. Non-gravid females do not have a bulbous papilla.

Pigment: The general body color is whitish with a light pink overtone in live specimens. The upper body has numerous densely packed melanophores, the pigment becoming less dense ventrally and ending at the lateral midline. The belly is whitish from the ventral surface to the lateral midline. The head and upper lip have densely packed small melanophores dorsally that become less concentrated ventrally and terminate at the ventral midline. The pectoral, pelvic, and anal fins are transparent. The caudal fin is black except for the midbasal area, which is whitish with a few scattered melanophores. The dorsal fins have scattered melanophores restricted to the membranes between the fin elements that become more concentrated towards the margin of the fin. Neither males nor females possess any genital pigmentation.

Discussion

All species of *Akko* are easily recognized by their large teeth, elongate body, small eyes, anterior nostril located within a fleshy tube, and by having the dorsal, caudal, and anal fins connected by membrane. The species can be differentiated by numbers of lateral scales, vertebrae, and fin rays, and by color. In *A. dionaea* the lateral scales do not overlap on the caudal peduncle, and there are approximately 76 in the series; *A. brevis* and *A. rossi* both have overlapping scales on the caudal peduncle, with 53–60 and 155 scales, respectively, in the lateral series. Color patterns are distinctive, even in preserved specimens. *Akko dionaea* has no trunk or head melanophores, and only the distal two-thirds of the caudal fin and posterior portion of the anal fin have some melanophores; *A. brevis* possesses melanophores on the upper portion of the trunk, on the interradial membranes of the dorsal fin, and on the caudal fin; *A. rossi* has a heavily pigmented dorsal trunk, and all fins are dark brown. Vertebral counts in *A. dionaea* and *A. brevis* are 11 precaudal and 16 caudal, 11+17 in *A. rossi;* additional specimens of *A. rossi* are needed to determine if this vertebral count is characteristic for the species. *Akko dionaea* can be separated from the Pacific species by having fewer pectoral-fin rays: 17 in *A. dionaea*, 19–21 in *A. brevis*, and 19 in *A. rossi*. The second dorsal and anal fins both have 15 elements in *A. dionaea* and *A. brevis* but 16 in *A. rossi*. The pelvic-fin rays are branched in the three species, with *A. dionaea* and *A. brevis* having all rays dichotomously branched. In *A. rossi*, rays 1,2,3 are serially branched, and rays 4,5 are dichotomously branched. Differences that readily separate the three species are given in Table 3.

TABLE 3: Comparisons of key diagnostic features among the species in the genus *Akko*.

Character	*dionaea*	*brevis*	*rossi*
2nd Dorsal elements	15	15	16
Anal-fin elements	15	15	16
Pelvic-fin rays	Dichotomous branching	Dichotomous branching	1,2,3 serially branched; 4,5 dichotomous
Pectoral rays	17	19–21	19
Pectoral-fin color	No melanophores	No melanophores	Dense melanophores
Teeth upper jaw	9–10 males; 16 females	10–11 males; 16–18 females	16 female
Teeth outer row lower jaw	6 males; 8 females	6–8 males; 7–10 females	11 female
Caudal fin color	Distal 2/3 dusky	Fin black	Fin dark brown
Body color	Colorless	Dorsal trunk with some melanophores	Dorsal trunk dark brown
Vertebrae	11+16	11+16	11+17
Lateral scales	76	53–60	115
Scales on caudal peduncle	Non-overlapping	Overlapping	Overlapping
Female genital papilla	No melanophores	No melanophores	Dense melanophores, except at tip
Frontals	Laterally expanded	No lateral expansion	Unknown
Parasphenoid	Laterally expanded	No lateral expansion	Unknown
Haemal spines	Haemal spine of caudal vertebra 14 bifurcate and expanded	Haemal spine of caudal vertebrae 13 & 14 expanded but not bifurcate	Haemal spine of caudal vertebrae 13 & 14 not appearing expanded in radiograph

The head pores in all species of *Akko* are very small and difficult to observe. All species of *Akko* have a short cephalic head canal with two pores, B' and G'. Pore G' was reported as absent by Birdsong and Robins (1995) in *A. dionaea,* and, although it is absent in the holotype, we have observed it in several of the paratypes. The three species also possess small fleshy flaps on the posterior dorsal edges of the upper and lower lips, a character not mentioned in the original description of *A. dionaea.* Birdsong and Robins (1995) stated that row *ot* in *A. dionaea* has a disjunct extension on the branchiostegals. Our examination of the types of *A. dionaea* with 0.5mm fiber optic lighting shows this row to be complete, not disjunct, and similar to our Figure 2 of *A. brevis.* A large ossified lacrimal is present in all species of *Akko*. In all other Gobiosomatini and most members of the Gobiinae the lacrimal is small. *Akko brevis* has the ability to open its mouth in a complete circle equal to the body diameter. The large lacrimal, which is attached to the maxilla by a broad tendinous sheath, may play a role in this movement.

Akko belongs within the tribe Gobiosomatini based on the presence of seven spines in the first dorsal fin, a dorsal-pterygiophore formula of 3-221110, and a vertebral count of 11 precaudal and 16 caudal vertebrae (17 in *rossi*). Although Birdsong and Robins (1995) placed *Akko* within the tribe, they did not comment further on its relationships within the group because of the large number of autapomorphies possessed by *A. dionaea*. Additional information now available from mtDNA places *Akko* within the "*Microgobius*" group of the Gobiosomatini (Birdsong *et al.* 1988) and provides support for a sister-group relationship with *Microgobius* (Ruber *et al.* 2003).

Further supporting the placement of *Akko* within the "*Microgobius*" group are patterns of sensory papillae. There are two general categories of sensory papillae patterns within the Gobiosomatini: In the "*Gobiosoma*" group, row *n* on the dorsal surface of the head is short, the right and left elements never joining at the dorsal midline, and rows x^1 and x^2 are not connected to form a continuous row (Fig. 5A); in the "*Microgobius*" group row *n* is generally elongate, the left and right elements frequently joining at the dorsal midline, and rows x^1 and x^2 are united to form a single row (Fig. 5B). This arrangement of sensory papillae has been observed in most species of *Microgobius*, *Bollmannia*, and *Parrella* of the "*Microgobius*" group by one of us (JVT). All species of *Akko* possess a papillae pattern similar to that of the "*Microgobius*" group.

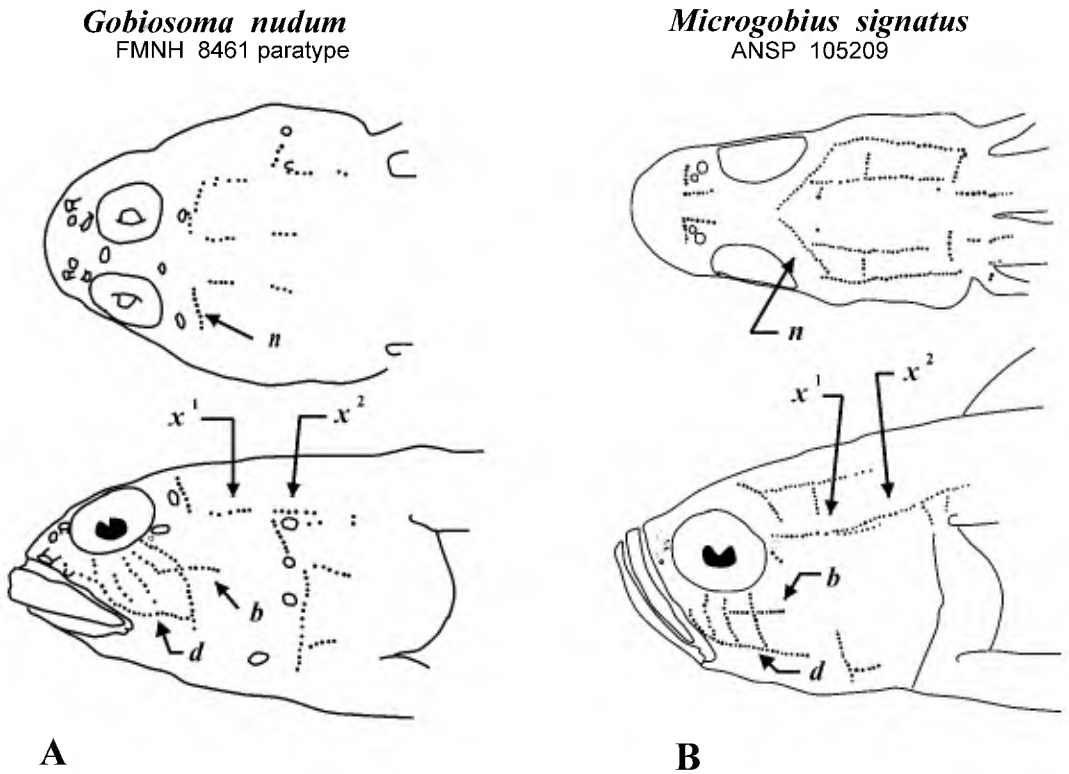

FIGURE 5. Sensory papillae patterns of A) *Gobiosoma nudum* (FMNH 8461 paratype) and B) *Microgobius signatus* (ANSP 105209)

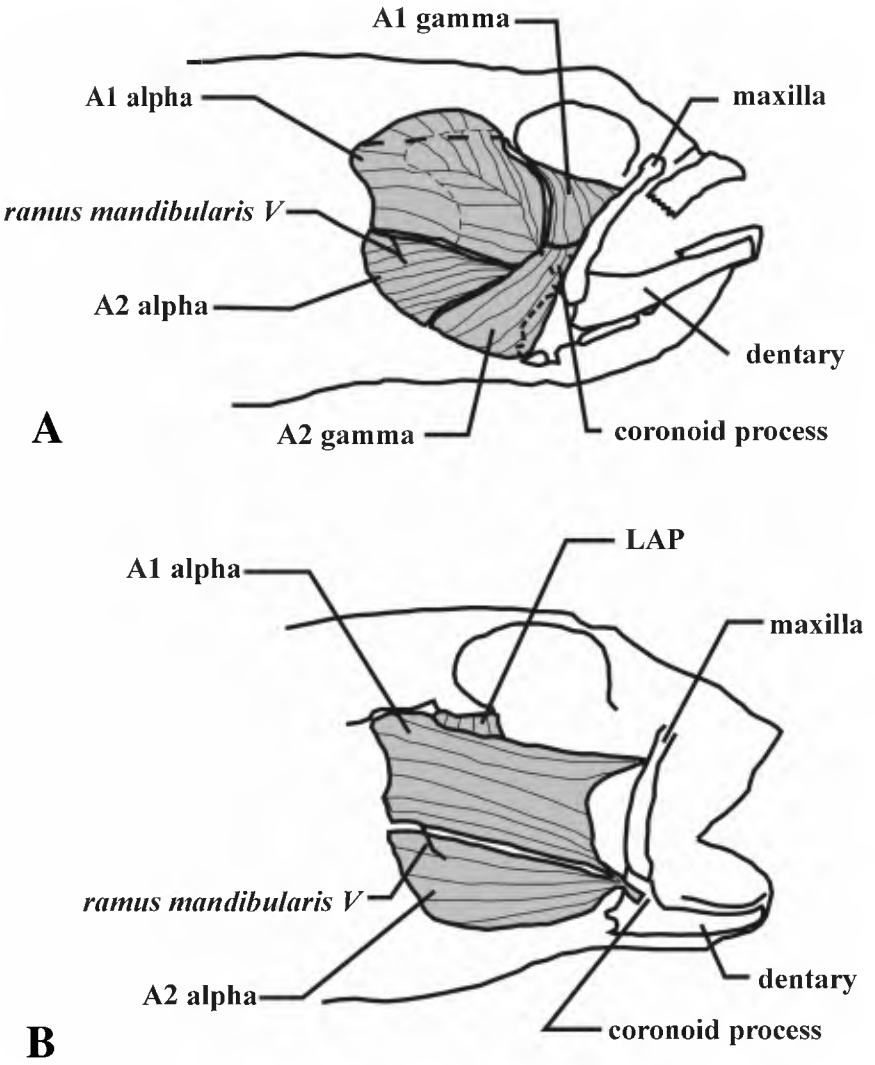

FIGURE 6. Cheek myology of A) *Gobiosoma hildebrandi* (GCRL 12730) and B) *Bollmannia chlamydes* (CAS 42777).

Myological features, particularly origin and insertion patterns within the adductor mandibulae complex, also support the proposed relationship between *Akko* and other species of the "*Microgobius*" group. In the "*Gobiosoma*" group (Fig. 6A) the adductor mandibulae 1 complex (A1) originates along the dorsal half of the preopercle and along the lateral edges of the pterotic and sphenotic. The A1 complex separates into A1 beta and A1 alpha sections. An additional separation of the A1, the A1 gamma, occurs in all genera of the "Gobiosoma" group except *Aruma*, *Barbulifer*, *Gymneleotris*, *Chriolepis*, *Eleotrica*, *Pycnomma*, *Gobulus*, *Nes* (Van Tassell, 1998). The A1 gamma inserts on the maxilla and on the A2 gamma, the A1 beta inserts on the maxilla, and the A1 alpha inserts on the coro-

noid process of the dentary. The adductor mandibulae 2 (A2) originates on the ventral half of the preopercle and on the quadrate. The A2 separates into two sections, one inserting along with the A1 alpha on the coronoid process and the other inserting on the maxilla and A1 gamma, near or at the insertion of the primordial ligament.

In the "*Microgobius*" group the A1 complex does not originate along the sphenotic, and the A1 gamma is absent. In *Bollmannia* (Fig. 6B) the A1 originates along the dorsal half of the preopercle and on the pterotic; it inserts via two heads, one on the maxilla, in conjunction with the A1 beta, and the second via a tendon on the coronoid process of the dentary. An A1 beta is present medial to the large A1 alpha, originating on the hyomandibular and inserting with the A1 alpha on the maxilla. In *Microgobius* there is a partial separation of an A1 beta from A1 alpha anteriorly, just prior to the insertion on the maxilla; otherwise, the A1 remains a single muscle mass. The adductor mandibulae 2 is a single mass originating along the ventral half of the preopercle and on the quadrate. It inserts, along with the A1 alpha, via a tendon onto the dentary. The cheek myology pattern of *Akko* is most similar to that of the "*Microgobius*" group (Fig. 4). Cheek myology of *Parrella* and *Palatogobius* in the "*Microgobius*" group has not been examined.

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