

First Occurrence of *Chromis albicauda* (Pomacentridae, Perciformes) from Jeju Island, and Re-assignment of Yellow Chromis Specimens from Korea

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ABSTRACT

Two specimens of *Chromis albicauda* were collected from Jeju Island, Korea. The species is most similar to *C. analis*, but is distinguishable by the presence of a white caudal fin when alive, 4–5 scale rows on the anterior portion of the preorbital, and a blackish blotch around anal opening. The results of a molecular analysis based on mitochondrial DNA 16S rRNA sequences confirm that the two individuals are not *C. analis* but *C. albicauda* as the genetic distance between the two species is 0.044. A comparison of the two individuals of *C. albicauda* with yellow chromis shows that none of the previously reported yellow chromis is *C. analis*, but rather they are *C. albicauda*. Herein, we suggest the new Korean name “Huin-ggo-ri-no-rang-ja-ri-dom” for *C. albicauda*.

Keywords: *Chromis albicauda*, first occurrence, re-identification, yellow chromis, Korean waters

INTRODUCTION

The damselfishes (Perciformes: Pomacentridae), which are widely distributed in tropical and warm temperate seas (Allen, 1991), comprise approximately 348 species in 28 genera (Nelson, 2006). The genus *Chromis* Cuvier, 1814, is one of the largest groups of damselfishes, comprising approximately 100 species (Allen and Erdmann, 2009; Froese and Pauly, 2013). Three species of *Chromis* have been reported in Korea: *Chromis analis* (Cuvier, 1830), *Chromis fumea* (Tanaka, 1917), and *Chromis notata* (Temminck and Schlegel, 1843) (see Kim et al., 2005; Kim, 2010). Damselfishes are very similar in their body shape but show diverse body color patterns, which causes a great deal of taxonomic confusion (Nelson, 2006). However, DNA sequencing has assisted in the definition of species boundaries and has permitted inferences about relationships among taxa (Koh and Park, 2007; Kim et al., 2010; Gao et al., 2011; Ji and Kim, 2011; Kwun and Kim, 2011). Recently, a new species, *Chromis albicauda* Allen and Erdmann, 2009, was reported from Indonesia; *C. albicauda* differs from *C. analis* in the color of the caudal fin and anal opening, and the number of scale rows on the

anterior portion of the preorbital. Subsequently, *C. albicauda* was also reported from Japan (Motomura et al., 2010). The present study describes two individuals of *C. albicauda* collected from Jeju Island, as the first record from Korea, and compares these specimens with yellow chromis species previously reported from Korea.

Two specimens of *C. albicauda* were collected from Jeju Island on June, 2011 and June 2012. For morphological comparison, eleven specimens of the yellow chromis, being previously reported as *C. analis* in Korea were used. Counts and measurements were conducted according to the methods of Hubbs and Lagler (2004). We observed and photographed the scale rows using microscope and attached digital camera (Moticam Pro 205A; Motic, China). Each specimen of *C. albicauda* was registered in Pukyong National University (PKU) and National Institute of Biological Resources (NIBR), respectively.

Total genomic DNAs were extracted from the muscle tissues of *C. albicauda* (PKU5803; KC767730, NIBR-P00000 19931; KC767731) using 10% Chelex 100 resin (Bio-Rad, USA). The polymerase chain reaction (PCR) was used to amplify the mitochondrial DNA 16S rRNA sequence using

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Table 1. Comparison of counts and measurements between *Chromis albicauda* and *C. analis*

	<i>Chromis albicauda</i>		<i>Chromis analis</i>
	Present study	Allen and Erdmann (2009)	Iwatsubo and Motomura (2010)
No. of specimens	2	6	3
Standard length (mm)	100.9–109.3	79.6–133.7	81.8–117.9
Counts			
Dorsal fin rays	XIII, 11	XIII, 11–12	XIII, 12
Anal fin rays	II, 12	II, 11–12	II, 10–11
Pectoral fin rays	18	18–20	19
Pelvic fin rays	I,5	I,5	I,5
Pored lateral line scales	18–19	17–19	15–16
Preorbital scales lows	4–5	4–5	1–2
Suborbital scales lows	1–2	–	1
Measurements (%SL)			
Body depth	50.7–56.4 (53.6)	51.8–55.5 (54.2)	52.3–53.9 (53.2)
Head length	31.0–31.0 (31.0)	30.6–32.4 (31.7)	28.8–33.1 (30.2)
Snout length	7.0–7.2 (7.1)	6.9–9.1 (8.2)	7.5–9.3 (8.3)
Orbit diameter	10.2–11.0 (10.6)	9.6–11.3 (10.3)	9.1–10.2 (9.5)
Interorbital width	10.2–10.8 (10.5)	9.4–10.9 (10.2)	10.3–12.2 (11.4)
Depth of caudal peduncle	14.7–15.6 (15.2)	15.4–17.2 (16.2)	13.7–14.5 (14.0)
Length of caudal peduncle	8.6–13.1 (10.5)	10.3–12.2 (11.2)	12.6–14.5 (13.5)
Upper jaw length	8.8–9.1 (9.0)	9.8–11.0 (10.4)	9.2–9.6 (9.4)
Predorsal length	43.5–44.4 (43.9)	41.3–43.4 (42.6)	41.8–44.6 (42.9)
Preanal length	68.9–70.6 (69.7)	69.4–74.4 (71.8)	71.5–75.7 (73.1)
Pepelvic length	42.7–43.5 (43.1)	42.0–47.1 (43.9)	42.2–44.9 (43.2)
Length of dorsal fin base	60.4	58.5–63.7 (62.1)	59.9–60.7 (60.3)
Length of anal fin base	22.5–23.4 (22.9)	23.6–25.6 (24.5)	21.4–22.4 (21.9)
Pectoral fin length	33.3–33.5 (33.4)	33.4–36.2 (34.8)	31.0–35.0 (33.3)

Parenthesis indicates average.

Table 2. Comparison of counts and measurements of *Chromis albicauda*, among present study, compare with references

	Present study		Kim et al. (1994)
	PKU 5803, NIBR-P0000019931	MRIC 1133–1144 (except 1134)	NFUP 04130–04137
No. of specimens	2	11	8
Standard length (mm)	100.9–109.3	51.8–106.8 (79.3)	82.8–102.4
Counts			
Dorsal fin rays	XIII, 11	XIII, 11–12	XIII, 12–13
Anal fin rays	II, 12	II, 11–12	II, 11–13
Pectoral fin rays	18	18	18–20
Pelvic fin rays	I,5	I,5	–
Pored lateral line scales	18–19	18–20	18–19
Preorbital scales lows	4–5	4–5	–
Suborbital scales lows	1–2	1–2	–
Measurements (%SL)			
Body depth	50.7–56.4 (53.6)	50.1–55.9 (52.7)	53.1–58.4
Head length	31.0–31.0 (31.0)	30.3–32.8 (31.6)	28.4–32.6
Snout length	7.0–7.2 (7.1)	6.5–8.7 (7.5)	5.6–7.4
Orbit diameter	10.2–11.0 (10.6)	10.0–13.9 (11.5)	10.0–11.4
Interorbital width	10.2–10.8 (10.5)	11.0–12.4 (11.7)	10.7–13.0
Depth of caudal peduncle	14.7–15.6 (15.2)	14.4–16.1 (15.3)	15.3–16.5

Parenthesis indicates average.

primers 16Sar-5' (5'-CGC CTG TTT ATC AAA AAC AT-3') and 16Sbr-3' (5'-CCG GTC TGA ACT CAG ATC ACG T-3') (Ivanova et al., 2007). PCR was conducted on a thermal cycler (Bio-Rad MJ mini PTC-1148), with PCR solu-

tions containing 10 µL of genomic DNA, 5 µL of 10 × PCR buffer, 4 µL of 2.5 mM dNTP, 1 µL of each primer, 0.5 µL of FR taq polymerase (Biomedic, Korea), and 28.5 µL of distilled water. The PCR proceeded under the following the



Fig. 1. Materials examined. A, *Chromis albicauda*, PKU 5803, 109.3 mm standard length (SL), collected from Jeju Island; B, Blackish blotch around anal opening (PKU 5803); C, Underwater photograph of *Chromis albicauda*, Jeju Island (photo by H.J. Kwun).

conditions: initial denaturation at 95°C for 5 min, 35 cycles of denaturation at 95°C for 1 min, annealing at 50°C for 1 min, and extension at 72°C for 1 min, and a final extension at 72°C for 5 min. The amplification products of the target DNA were checked with agarose gel electrophoresis. The PCR products were purified with ExoSAP-IT (United States Biochemical Corp., USA). The DNA was sequenced using an ABI 3730XL sequencer and an ABI PRISM[®] BigDye[™] Terminator v3.0 Ready Reaction Cycle Sequencing Kit (Applied Biosystems, USA). Mitochondrial DNA 16S rRNA sequences were aligned and edited with Clustal W (Thompson et al., 1994) using BioEdit version 7.0.0 (Hall, 1999). The genetic distances were calculated according to Kimura

two-parameter model (Kimura, 1980) using Mega 5 (Tamura et al., 2011). The neighbor-joining (NJ) tree was constructed using the Kimura two-parameter model (Kimura, 1980), where its confidence was assessed via 5,000 bootstrap replications. For molecular comparison, we further analyzed the mitochondrial DNA 16S rRNA sequences of the two *Chromis* spp. [*Chromis notata* (PKU 5566; KC767732) and *Chromis fumea* (PKU 5535; KC767733)] and one outgroup [*Silago japonica* (PKU 228; KC767734)]. In the case of *Chromis analis* (FJ616423), DNA sequences were obtained from the National Center for Biotechnology Information (NCBI) database.

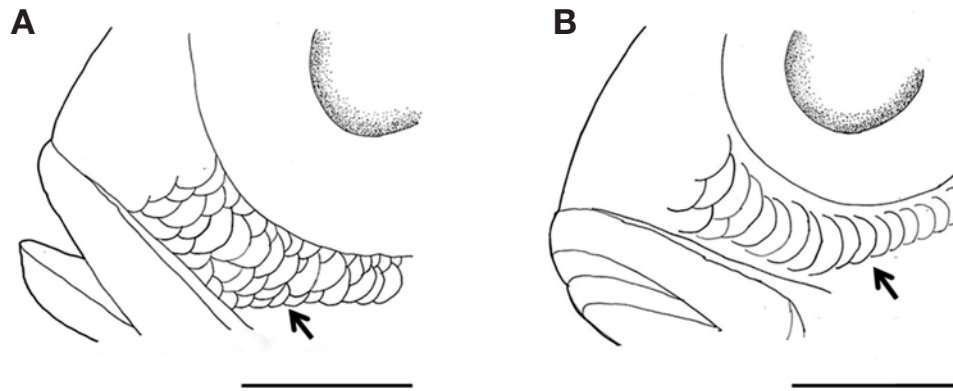


Fig. 2. Comparison of preorbital and suborbital scale patterns. A, *Chromis albicauda*, PKU 5803 (present study); B, *Chromis analis* (cited from Allen and Erdmann, 2009). Scale bars: A, B=5 mm.

SYSTEMATIC ACCOUNTS

Order Perciformes
 Family Pomacentridae
 Genus *Chromis*

¹**Chromis albicauda* Allen and Erdmann, 2009
 (Table 1, Fig. 1)

(new Korean name: Huin-ggo-ri-no-rang-ja-ri-dom)

Chromis albicauda Allen and Erdmann, 2009: 123, figs. 1, 2, 4, 5 (type locality: Penida Island, Indonesia); Motomura et al., 2010: 148; Allen and Erdmann, 2012: 576.

Chromis analis (non Cuvier): Kim et al., 1994: 193; Koh et al., 1997: 173; Kim, 2010: 59.

Material examined. PKU 5803, 1 specimen, 109.6 mm in standard length (SL), Korea, Jeju-do, Seogwipo-si, Daejeong-eup, Moseulpo, 9 Jun 2011, NIBR-P0000019931; 1 specimen, 100.9 mm SL, Jeju-do, Seogwipo-si, Daejeong-eup, Moseulpo, 23 Jun 2012.

Comparative materials examined. MRIC 1133-MRIC 1144 (except for MRIC 1134), 11 specimens, 51.8–106.8 mm SL, Korea, Jeju-do, Seogwipo-si, Bomok-dong, 26 Apr 2003 (all specimens were identified as *C. analis*: for more information see Kim, 2010).

Description. D. XIII, 11; A. II, 12; P₁. 18; P₂. I, 5; LLp. 18–19; Vert. 25; GR. 24. Counts and measurements are shown in Tables 1 and 2.

Body compressed; moderately deep, steeply inclined from frontal region to origin of dorsal fin. Mouth small and terminal. Snout shorter than orbit diameter. Posterior edge of maxilla reaching middle of orbit axis. Two pairs of nostrils; posterior nostrils larger than anterior nostrils. Conical teeth

on both jaws. Well-developed sensory pores around eyes. Margin of preopercle extending to ventral region of jaw. Small scales on interorbital space; 4–5 irregular rows of small scales on the preorbital; 1–2 rows of relatively large scales on the suborbital (Figs. 1, 2). Operculum covered with large scales. Origin of dorsal fin vertically above upper axis of pectoral fin; dorsal spinous portion and soft portion smoothly connected. Pectoral fin, extending posteriorly to below 6th or 7th dorsal spine. Lateral line scales tubular, abruptly interrupted below the 1st dorsal soft ray. Caudal fin forked; three upper and lower procurent caudal rays. Body covered with ctenoid scales; small scales present on bases of dorsal, anal, and caudal fins.

Coloration. When alive: overall yellowish; head dark-colored; small brown spot on origin of pectoral fin; caudal fin white (Fig. 1C). After fixation in formalin: overall yellowish tan; blackish blotch around anal opening (Fig. 1B); body dark brown dorsally and light yellowish ventrally; pectoral and pelvic fins yellowish tan, except dark brown at base of dorsal fins (Fig. 1A).

Distribution. Distributed in Indonesia (Allen and Erdmann, 2009), southern Japan (Iwatsubo and Motomura, 2010), and on the southern coast of Jeju Island, Korea (present study).

Remarks. *Chromis albicauda* was recently reported as a new species from Indonesia by Allen and Erdmann (2009), as showing remarkable differences from its most similar species, *C. analis* (Cuvier, 1830). *Chromis analis* was first named “No-rang-ja-ri-dom” (meaning yellow-colored damselfish) in Korean, on the basis of eight specimens collected from Jeju Island, Korea (Kim et al., 1994). However, our study shows that they are not *C. analis*, but are rather *C. albicauda*, based on morphological differences such as the number of pored lateral line scales, the number of scale rows

Korean name: ¹* 흰꼬리노랑자리돔

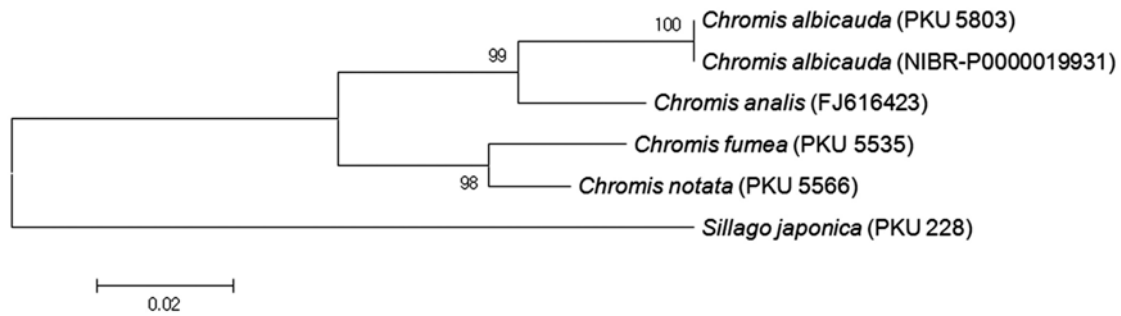


Fig. 3. Neighbor-joining tree showing the relationship between *Chromis albicauda* (PKU 5803; NIBR-P0000019931) and other *Chromis* spp., with one outgroup (*Sillago japonica*) using mtDNA 16S rRNA sequences. Numbers at branches indicate bootstrap probabilities in 5,000 bootstrap replications. Bar indicates genetic distance of 0.02.

on the preorbital (see Tables 1, 2), and caudal fin color. According to the results of molecular analyses of 519 base pairs of mtDNA 16S rRNA sequences, *C. albicauda* also differs significantly from *C. analis* (genetic distance, $d=0.044$); similarly, the genetic distance between *C. notata* and *C. fumea* is 0.032, which shows a reciprocal relationship between *C. albicauda* and *C. analis* (Fig. 3). Comparisons of *C. albicauda* with literature descriptions of *C. analis* from the Korean waters (Kim et al., 1994; Koh et al., 1997; Kim, 2010) and with 11 specimens of *C. analis* deposited show that all *C. analis* specimens in Korean waters should be assigned to *C. albicauda*, not to *C. analis*. In all Korean specimens, the number of scale rows on the preorbital, the number of pored lateral line scales, and the blackish blotch covering the anal opening all correspond to the characteristics of *C. albicauda*, and not to those of *C. analis* (Tables 1, 2, Figs. 1, 2). However, these observations notwithstanding, Kim et al. (2005: 369) provide underwater photographic evidence of *C. analis* in Korea, which indicates the broad geographic distribution of *C. analis* (from Indonesia to Japan) and the possibility of increased future occurrences of *C. analis* in Korean waters on account of changes due to global warming. We propose a new Korean name, “Huin-ggo-rino-rang-ja-ri-dom”, for *C. albicauda*. In the future, DNA sequences from specimens of *C. albicauda* from Korea and Indonesia should be compared to examine the population dynamics and evolutionary histories of *C. albicauda* and *C. analis* populations and those of related taxa.

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