New record of the *Crenimugil crenilabis* (Forsskål, 1775) (Mugiliformes: Mugilidae) from Korea, as revealed by mitochondrial DNA barcoding

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**ABSTRACT**

*Crenimugil crenilabis* (Forsskål 1775) is a fish species newly identified with molecular analysis and reported in Korea for the first time. A single specimen of *C. crenilabis* was collected from a tidal pool on the southern coast of Jeju Island, Korea in August 2018. This species is characterized by several rows of papillae on both lips, no notch in the mouth corner, the presence of 36 lateral-line scales, and 24 vertebrae. The present specimen is morphologically similar to another seven mugilid species reported in Korea, but mitochondrial DNA COI gene analysis revealed that it is almost identical to *C. crenilabis*, sharing 98.9–99.3% identity, compared with 75.9–90.3% identity with other species. It’s newly proposed Korean names are ‘Dol-gi-ip-sung eo-sok’ for the genus and ‘Dol-gi-ip-sung eo’ for the species.

**Introduction**

Taxonomic studies are traditionally based on morphological analyses (Xiao et al. 2010), but there is a limit to the resolution possible for each identification. Cryptic or similarly shaped species can be especially difficult to identify based on morphology alone (Bingpeng et al. 2018).

The family Mugilidae (order Mugiliformes) is distributed in the coastal marine and brackish waters of tropical and temperate seas, and contains 20 genera and 75 species worldwide (Nelson et al. 2016). Among these, five genera and seven species occur on the coast of Korea (*Chelon affinis* Temminck and Schlegel 1845, *C. macrolepis* Smith 1824, *C. haematoocheilus* Temminck and Schlegel 1845, *Ellochelon vaigiensis* (Quoy and Gaimard 1824–1825), *Moolgarda seheli* (Forsskål 1775), and *Mugil cephalus* Linnaeus 1758) (Kim et al. 2005; Kwun, Kim, Lee, et al. 2012; Kwun et al. 2013). This family is characterized by the wide separation of the two dorsal fins, an anal fin with spines and soft rays, and a subabdominal pelvic fin (Nelson et al. 2016). However, the species in this family have similar morphological characteristics, especially in their body shape and coloration, so it is not only difficult to identify them but also to establish their taxonomy (Durand, Shen, et al. 2012). Accordingly, molecular analyses, including DNA barcoding, have been used in several studies of mugilid species (Durand, Chen, et al. 2012; Durand, Shen, et al. 2012; Kwun et al. 2013; Durand 2015; Xia et al. 2016).

In this study, a single specimen of a mugilid species was collected on Jeju Island, and we identified the specimen as *C. crenilabis* (Forsskål 1775) with mitochondrial DNA barcoding. This genus and species have not been reported in Korea until now, so a morphological description is provided for the first time.

**Materials and methods**

A single specimen of *C. crenilabis* was collected from a tidal pool on the southern coast of Jeju Island in August 2018 (Figure 1) by the second author and the whole body was fixed in 99% ethanol. All counts and measurements were made according to Hubbs et al. (2004), to the nearest 0.1 mm with a digital Vernier caliper. The vertebrae were counted on a CMB-2 radiograph (Softex, Tokyo, Japan). The specimen is stored at the Marine Fish Diversity (MFD) of the National Marine Biodiversity Institute of Korea.

The total DNA was extracted from the right eye with a DNeasy Blood and Tissue Kit (Qiagen, Hilden, Germany). The mitochondrial COI gene was amplified with a fish universal primer set (VF2_t1 and FishR2_t1) (Ward et al. 2005). The nucleotide sequence of the specimen was deposited in the DDBJ/EMBL/GenBank databases (accession number: MK659936). Sequences of *C. crenilabis* and other mugilid species downloaded from the National Center for Biological Information (NCBI) database were used for molecular comparison and were aligned with ClustalW (Thompson et al. 1994) in BioEdit ver. 7 (Hall 1999). The genetic distances were calculated and a neighbor-joining (NJ) tree was generated with MEGA 7 (Kumar et al. 2016), based on the Kimura
two-parameter model (Kimura 1980) and 10,000 bootstrap replications (Felsenstein 1985).

**Results and discussion**

**Crenimugil (Schultz 1946)**

(New Korean name: Dol-gi-ip-sung-eo-sok)

*Crenimugil* (Schultz 1946, p. 387) (type species: *Mugil crenilabis* Forsskål 1775).

*Valamugil* (Smith 1947, p. 841) (type species: *Mugil crenilabis seheli* Forsskål 1775).

**Description**

Upper and lower lips with several papillae. Upper lip broad and crenulate edge continuous with crenulate lower lip. Preorbital not notched, and posterior tip of the maxilla not exposed. Adipose eyelid poorly developed or absent. Posterior margin of each scale has a flexible membrane (Schultz 1946; Thomson 1997).

**Remarks**

The genus is easily distinguishable from most genera in the family Mugilidae, except the genus *Oedalechilus*, by its lip papillae. Only two species have been reported worldwide, *C. crenilabis* and *C. heterocheilus*, and they occur in the Indo-Pacific region (Thomson 1997). However, a molecular phylogeny suggested that this genus is a complex group and with more than two species (Durand 2015).

**Crenimugil crenilabis** (*Forsskål 1775*)

(New Korean name: Dol-gi-ip-sung-eo) (Figure 2)

*Mugil crenilabis* (*Forsskål 1775*, p. 73) (type locality: Red Sea).

*Mugil rüppellii* (Günther 1861, p. 458) (type locality: Red Sea).

*Mugil cirrhostomus* Forster in Bloch and Schneider (1801, p. 121) (type locality: Pacific).

*Mugil fasciatus* Valenciennes in Cuvier and Valenciennes (1836, p. 125) (type locality: Red Sea).

*Crenimugil crenilabis*: (Shen and Wu 2011, p. 265 [Taiwan]; Allen and Erdmann 2012, p. 156 [East Indies]; Senou 2013, p. 637 [Japan]).

**Material examined**

MFD-1317, 1 specimen, 61.0 mm standard length (SL), 33°14′25.60″ N, 126°23′48.36″ E, Yerae-dong, Seogwipo, Jeju Island, hand net, 31 Aug 2018 (Figure 1).

**Description**

Meristic characters are listed in Table 1. Proportions as % SL: head length (HL) 28.0; head width 18.9; body depth 27.2; predorsal length 52.0; prepelvic length 41.8; preanal length 72.1; pectoral fin length 25.2; pelvic fin length 18.5. Proportions as %HL: snout length 19.9; eye diameter 28.1; postorbital length 46.2; interorbital width 45.6; upper jaw length 22.8.

Head is broad and flat. The body is compressed posteriorly. The snout is short and bluntly pointed. Mouth terminal

**Table 1. Comparison of meristic characters of *C. crenilabis***

| Character                  | Present study | Thomson (1997)* | Senou (2013) |
|----------------------------|---------------|------------------|--------------|
| Number of specimens        | 1             | –                | –            |
| Standard length (mm)       | 61.0          | –                | –            |
| Dorsal fin                 | IV-9          | IV-9             | IV-8-9       |
| Anal fin                   | III, 9        | III, 9           | III, 8-9     |
| Pelvic fin                 | I, 5          | –                | –            |
| Lateral line scales        | 36            | 38-40            | 36-40        |
| Vertebrae                  | 24            | –                | –            |

*Including holotype of *M. rüppellii*, *M. cirrhostomus*, and *M. fasciatus*. 

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Figure 1. Collecting site (red circle) of *C. crenilabis*.

Figure 2. *Crenimugil crenilabis*, MFD-1317, 61.0 mm SL.
with no notch in the posterior end of mouth corner. The posterior tip of the maxilla is visible when the mouth is closed. The upper lip is broad and much thicker than the lower lip. Both lips are surrounded with papillae, and bottom half of the upper lip is covered with several rows of papillae. Adipose eyelid is absent. The interorbital region is somewhat convex. No keel on the head or body dorsally. Two dorsal fins are completely separated, and the origin of the first dorsal fin is located in the middle of the body. The pelvic fin is located in front of the first dorsal fin. The pectoral fin is with the axillary scale. The caudal fin is truncate. Head and body are covered in ctenoid scales.

Coloration
When fresh, the head is silvery and the body is dark bluish dorsally. All fins are semi-transparent, and dark melanophores are present on the membranes. Pectoral fin base is with a darkish spot. After alcohol fixation, head and body are pale white.

Molecular identification
Based on an analysis of the mitochondrial cytochrome oxidase subunit I gene (COI) sequence (568 bp), the present specimen is almost identical to C. crenilabis, at a genetic distance of 0.005–0.011, but differs from another seven mugilid fishes with genetic distances of 0.097–0.241. On an NJ tree, the specimen clustered with C. crenilabis rather than with other mugilid fishes, which is supported by a high bootstrap value (Figure 3).

Distribution
Crenimugil crenilabis is distributed in the Indo-Pacific region, including the Red Sea and East Africa (Froese and Pauly 2018), Australia (Allen and Erdmann 2012), Taiwan (Shen and Wu 2011), and Japan (Senou 2013). The species also occurs on the southern coast of Jeju Island, Korea (present study).

Remarks
A single specimen of the family Mugilidae was collected from a tidal pool on Jeju Island, Korea, and identified as C. crenilabis with both morphological and molecular analyses. Morphologically, the specimen belongs to the genus Crenimugil Schultz 1946, based on a combination of characters: several rows of papillae present around the mouth (Forsskål 1775), although some meristic characters of the present specimen differ from those reported in previous taxonomic research (Table 1). However, when mitochondrial DNA sequences were compared, it displayed 99.3% identity with C. crenilabis, but differed from seven other mugilid species recorded in Korea. Therefore, the present specimen was clearly identified as C. crenilabis, and its meristic differences are attributed to geographic variations.

When C. crenilabis is compared morphologically with the seven other mugilid species recorded in Korea, the species differs from six mugilid species in the shape of its lips (lips with papillae in C crenilabis vs. smooth lips in six mugilid species), and from Oedalechilus labiosus by the shape of the mouth corner and lips (no notch and several rows of papillae in C. crenilabis vs. notch and file-like margin in O. labiosus) (Thomson 1997; Kwun et al. 2013). The new Korean names “Dol-gi-ip-sung-eo-sok” and “Dol-gi-ip-sung-eo” are proposed for the genus Crenimugil and C. crenilabis, respectively.

Figure 3. Neighbour-joining tree of mitochondrial DNA COI for eight species of the family Mugilidae. Number of branches (> 80) correspond to bootstrap probabilities in 10,000 bootstrap replications. Bar indicates genetic distance of 0.02.
Disclosure statement

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