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New record of *Chromis weberi* (Actinopterygii: Ovalentaria: Pomacentridae) from Jeju Island, southern Korea

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Abstract

Discovering tropical marine species outside of their distribution limits is important for evaluating the impact of climate change on marine ecosystems. One specimen (31.6 mm standard length) of a tropical fish, *Chromis weberi* Fowler et Bean, 1928, representing the family Pomacentridae, was first recorded from Jeju Island, Korea, on 8 December 2021. It was characterized by black posterior margins of the preopercle and opercle and black upper and lower lobes of the caudal fin. A specimen of this species collected from Munseom was distinguished from *Chromis xanthura* (Bleeker, 1854) based on distinct differences in the tips of the upper and lower caudal fin lobes, which are not black in *C. xanthura*. In addition, *C. weberi* was easily distinguished from the other four species in the genus *Chromis*, by the mitochondrial DNA cytochrome *c* oxidase subunit I gene sequence (345 bp), with genetic distances ranging from 0.130 to 0.252. This study documents the first record of *C. weberi* in temperate Korean waters, implying a poleward range expansion for this species. The Korean name ‘geom-eun-jeom-ggo-ri-ja-ri-dom’ has been proposed for *C. weberi*.

Keywords

Chromis species, mt DNA-COI, northernmost record, Northwest Pacific, Weber’s chromis

Introduction

Damselfishes (Pomacentridae) are usually distributed in the tropical Indo–Pacific region and occasionally in warm temperate seas (Allen 1991; Nelson et al. 2016). The family Pomacentridae comprises 348 species belonging to 28 genera worldwide, of which 105 species from 17 genera are distributed in Japan and adjacent sea areas (Aonuma et al. 2013). However, only 20 species from seven genera have hitherto been recorded in Korean waters (Marine Biodiversity Institute of Korea 2022). Damselfishes are morphologically deep and laterally compressed, with a relatively small body and mouth. They often have incomplete lateral line scales, and display color variation among individuals of the same species and locality (Froese and Pauly 2022). In addition, they lay elliptical demersal eggs guarded by males (Carpenter and Niem 2001; Froese and Pauly 2022).

Chromis weberi Fowler et Bean, 1928 is a tropical marine fish species widely distributed in warm Indo–

Pacific seas from the Red Sea and eastern Africa to southern New Caledonia between the latitudes 34°05′54″N and 33°11′18″S (Froese and Pauly 2022; GBIF 2023). *Chromis weberi* was described as a new species in 1928. Several studies have reported it in taxonomic checklists providing its basic biological information (Randall et al. 1998; Carpenter and Niem 2001; Nakabo 2013). Despite this and its widespread distribution, there is a lack of information regarding its biology and ecology.

Poleward range extension has increased the incursion of species of tropical origin into temperate seas due to recent climate change (Gervais et al. 2021). For example, increasing ocean temperatures allow tropical fishes, especially juveniles, to survive winter in temperate waters, which may facilitate a poleward range shift of the fishes (Figueira and Booth 2010). Considering the occurrence of warm-water species in temperate seas and their rate of introduction to these areas, the regional biodiversity and ecological processes may be impacted by such non-native species in invaded areas (Dragičević et al. 2021). Therefore, climate-driven changes in species distributions and consequent ecosystem restructuring are expected to have critical ecological, social, and economic implications (Wernberg et al. 2016).

In this study, we report a new northernmost record of *C. weberi* in Korean waters based on a specimen collected from Munseom, Jeju Island using a scoop net while SCUBA diving. Species identification was based on morphological characteristics and mitochondrial cytochrome *c* oxidase subunit I (mt-COI) sequences. The results of the presently reported study will contribute to understanding their distribution range and the management of local ecosystems experiencing the incursion of non-native marine species.

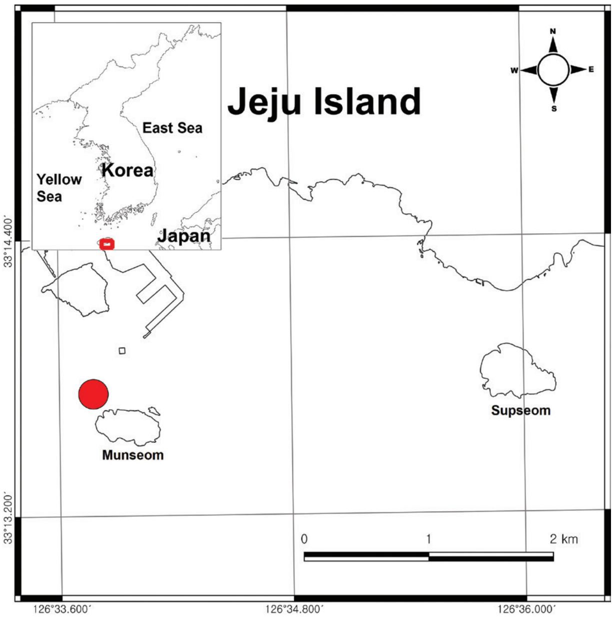

Figure 1. Map showing where the *Chromis weberi* specimen was collected off Munseom, Jeju Island, Korea Strait.

Materials and methods

One specimen of *Chromis weberi* was collected from Munseom (33°13′39.05″N, 126°33′48.79″E) along the southern coast of Jeju Island (Fig. 1). Sampling via SCUBA diving was performed during the day for approximately 20 m in sandy and rocky bottoms on 8 December 2021. The water temperature was 19°C at the time of sampling. Immediately after capture, the specimen was transported live to the laboratory, where an image of the specimen was taken after immobilizing it. Then, meristic counts and body morphometrics were recorded following Hubbs and Lagler's (1958) method. The body morphometric characters were determined to the nearest 0.1 mm using digital vernier calipers and a stereo microscope. The specimen was then preserved in 5% formalin for 12 h and transferred to 70% ethanol for deposition at the Korea Institute of Ocean Science and Technology (KIOST).

Total genomic DNA was extracted from the muscle tissue using 10% Chelex resin (Bio-Rad, Hercules, CA, USA) to compare the molecular data. A portion of the mt-COI gene was amplified using specific primers (Radchenko et al. 2010). A polymerase chain reaction (PCR) was performed in a 30 µL reaction tube containing 3 µL genomic DNA, 5 µL 10× PCR buffer, 4 µL 2.5 mM deoxynucleoside triphosphate, 1 µL of each primer, 0.3 µL Ex-Taq DNA polymerase, and 15.7 µL sterile distilled H_2O, using a thermal cycler (MJ mini PTC-1148, Bio-Rad, USA). The PCR profile consisted of initial denaturation at 95°C for 5 min, followed by 34 cycles of denaturation at 95°C for 1 min, annealing at 50°C, extension at 72°C for 1 min, and a final extension at 72°C for 5 min. The PCR products were purified using ExoSAP-IT (United States Biochemical Corporation USA) and sequenced using an ABI PRISM BigDye Terminator v.3.1 Ready Reaction Cycle Sequencing Kit (Applied Biosystems, Inc. USA) using an ABI 3730xl DNA analyzer (Applied Biosystems Inc.). We compared our molecular data with mt-COI DNA sequences from other Pomacentridae fishes (*Chromis albicauda* Allen et Erdmann, 2009; *Chromis analis* (Cuvier, 1830); *Chromis notata* (Temminck et Schlegel, 1843); *Chromis fumea* (Tanaka, 1917); and *Chromis mirationis* Tanaka, 1917) and one outgroup (*Sillago japonica* Temminck et Schlegel, 1843) obtained from GenBank (https://www.ncbi.nlm.nih.gov/nucleotide). The sequences were aligned using ClustalW (Thompson et al. 1994) in BioEdit version 7 (Hall 1999). Genetic divergence was calculated using the Kimura 2-parameter (K2P) model (Kimura 1980) and MEGA 6 (Tamura et al. 2013). Phylogenetic trees were constructed using the neighbor-joining method (Saitou and Nei 1987) in MEGA 6 (Tamura et al. 2013), with confidence assessed based on 10 000 bootstrap replications.

In addition, the presently reported record of *C. weberi* on Juju Island was compared with previous global records based on the biological databases of the Global Biodiversity Information Facility (GBIF 2023).

Results

Family Pomacentridae Bonaparte, 1831
Genus *Chromis* Cuvier, 1814

Chromis weberi Fowler et Bean, 1928

English vernacular name: Weber's chromis

Note. (Fig. 2) Body counts, measurements, and proportions of body parts expressed as the percentage of the standard length (SL) are shown in Table 1.

Material examined. KIOST 00001, 1 specimen, 31.6 mm SL, Munseom, Jeju Island, Korea (33°13′39.05″N, 126°33′48.79″E).

Description. Body deep and laterally compressed (Fig. 2); mouth small and terminal, with conical teeth in both jaws; single dorsal fin with deeply notched fin membrane originating vertically above pelvic fin; lateral line tubular and incomplete below dorsal soft rays. Head brown, and dorsal surface of head dark brown and iridescent under eyes and anterior tip (Fig. 2). Dorsal side of body dark brown; ventral side light brown. Posterior margins of preopercles and opercles black. Spiny rays and anterior soft rays of dorsal fin, anterior part of anal fins, and tips of upper and lower lobes of caudal fin black. Base of pelvic fins slightly black and becoming transparent toward tip. Posterior soft rays of dorsal fin and anal fin and central part of caudal fin transparent.

Table 1. Comparison of counts and measurements of *Chromis weberi*.

Morphological characters	Presently reported specimen	Masuda et al. 1984	Nakabo 2013
Counts			
Dorsal rays	XIII, 11	XIII, 11	XIII, 11
Anal rays	II, 11	II, 11	II, 11–12
Pectoral rays	18	18–20	18–20
LL_P	17	17–19	17–19
GR	8–9 + 19–22	8–9 + 19–22	8–9 + 19–22
Standard length (SL) [mm]	31.61	—	—
Measurements [%SL]			
Total length	135.1	—	—
Body depth	44.6	—	—
Head length	30.6	—	—
Snout length	6.1	—	—
Orbit diameter	12.7	—	—
Upper jaw length	10.1	—	—
Pre-dorsal length	41.3	—	—
Pre-anal length	71.7	—	—
Length of dorsal fin base	49.1	—	—
Length of anal fin base	18.4	—	—
Depth of caudal peduncle	15.7	—	—
Length of caudal peduncle	18.4	—	—

Genetics. Analysis of the mt-COI gene sequence (345 bp) showed that the specimen differed from other *Chromis* species recorded in the region with a genetic distance values of 0.130–0.252 (Fig. 3).

Figure 2. *Chromis weberi*, fresh, 31.6 mm SL, off Munseom, Jeju Island, South Korea.

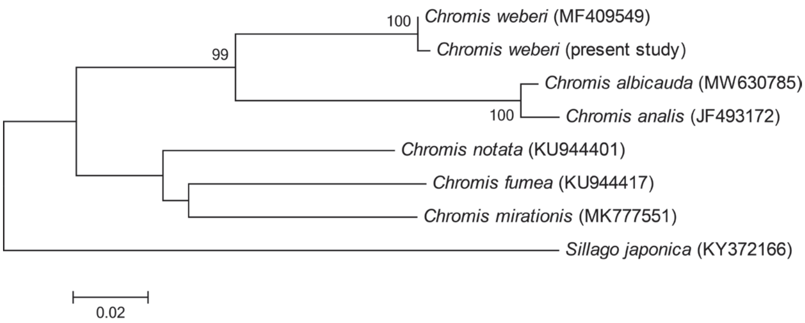

Figure 3. Neighbor-joining tree showing the relation between *Chromis weberi* (presently reported study; MF409549) and other *Chromis* spp., with one outgroup (*Sillago japonica*) using mt-COI DNA sequences. Numbers at branches indicate bootstrap probabilities in 1000 bootstrap replications. Bar indicates a genetic distance of 0.02.

Discussion

The body morphometrics of the specimen matched well the original description of *Chromis weberi* (see Fowler and Bean 1928), with black posterior margins of the preopercles and opercles and black upper and lower lobes of the caudal fin (Aonuma et al. 2013). The body morphology of *C. weberi* is similar to that of *Chromis xanthura* (Bleeker, 1854) with the only distinct difference being the tips of the upper and lower caudal fin lobes, which are not black in *C. xanthura* (see Aonuma et al. 2013). The mt-COI DNA sequence also confirmed genetic differences from other damselfishes from Korea. Therefore, this study documents the first record of *C. weberi* in Korean waters and we suggest the new Korean name of 'geom-eun-jeom-ggo-ri-ja-ri-dom'* for this species.

Chromis weberi is a typical subtropical fish species distributed mainly between 32°N and 23°S (Froese and Pauly 2022). According to the GBIF database (Fig. 4), the northernmost distribution of *C. weberi* was recorded at 34°05′54″N in 1975 on the eastern Pacific coast of Japan affected by the Kuroshio warm current (GBIF 2023). Except for this one record, the northern distribution limit of the species is 30°N, whereas the southern distribution limit is approximately 35°S (GBIF 2023). Therefore, this study reports a new and additional northernmost record of *C. weberi*, implying a poleward expansion of the species distribution.

Several studies have reported a worldwide poleward expansion in marine fish distributions in relation to climate change (Sunday et al. 2015; Park et al. 2017; Gervais et al. 2021; Azzola et al. 2022; Imamura et al. 2022). For example, on the eastern coast of Australia, a number of tropical Pomacentrids have dispersed to the southern temperate waters as a result of ocean warming (Figueira and Booth 2010; Fowler et al. 2018). In addition, several tropical marine fishes have been newly detected in Korean waters, especially around Jeju Island (Choi et al. 2013; Kim and Song 2014; Lee and Kim 2021), and these reports of such new records have gradually increased in recent years. The mechanisms of poleward range extensions of tropical marine fishes are generally based on a tendency of larval dispersal into temperate areas from natal tropical reefs, strength poleward inflow of warm current for advection of tropical larvae, recruitment to temperate reefs, and then the existence of sub-tropical breeding populations (Fowler et al. 2018). Although no data had been previously available on the occurrence of *C. weberi* larvae in Korean seas, some Pomacentrids larvae have been recorded in these regions, implying poleward extension of distribution through larval dispersal and subsequent colonization (Huh et al. 2013; Song et al. 2014).

The occurrence of these species in temperate Korean seas is attributed chiefly to the gradual increase in sea surface temperature and the northward trend of the Tsushima Warm Current as a result of global climate change (Jung et al. 2014; Son et al. 2020). Interannual trends in water temperature indicate that the marine ecosystem in Jeju Island is gradually changing into a subtropical sea (Suh et al. 2011; Seo and Park 2021). Therefore, we can expect a progressive increase in reporting of tropical and subtropical marine species to be recorded in the southern Korea Strait.

The discovery of a specimen of *C. weberi* along the southern coast of Jeju Island implies a poleward range extension of species distribution that can be attributed to the effects of climate change. Efforts to discover unrecorded species will help evaluate the influence of climate change on temperate marine ecosystems. In addition, this study

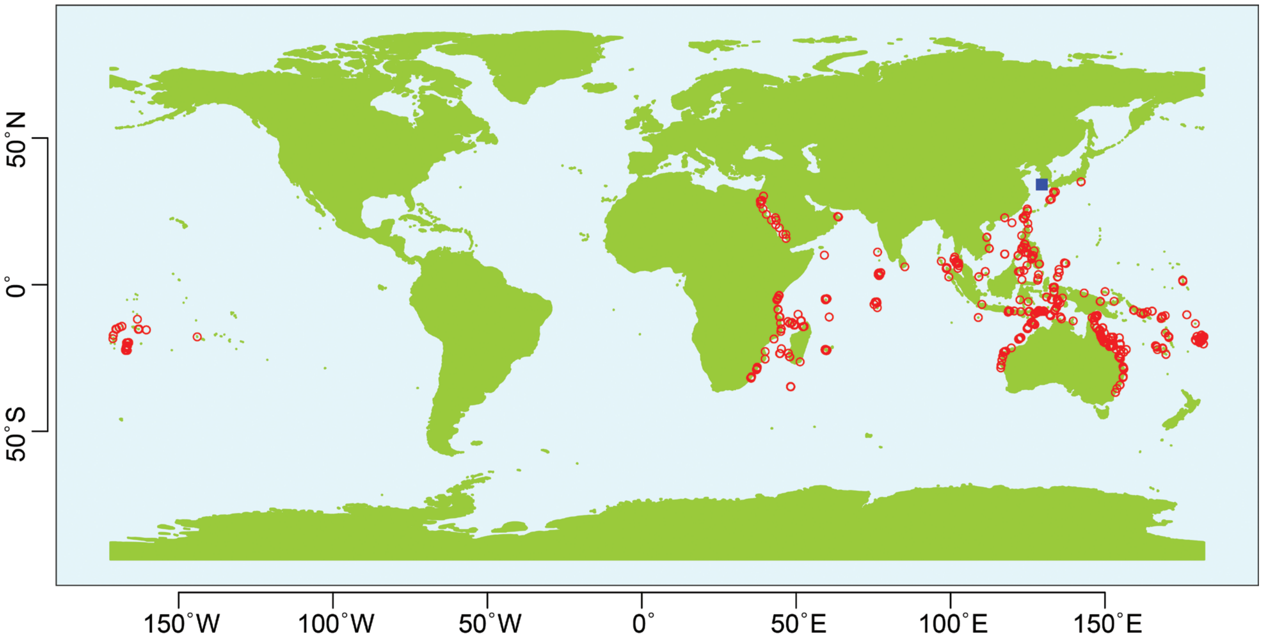

Figure 4. Distribution records of *Chromis weberi*, showing historical records (red circles) from the Global Biodiversity Information Facility (GBIF 2023) and the new record (blue square) off Jeju Island, South Korea.

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provides essential data for a better understanding of the current status of the marine ecosystem on Jeju Island and planning for future management in terms of biodiversity of local marine ecosystems in places of impending biodiversity crisis due to the introduction of tropical and/or subtropical marine species.

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