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Molecular Identification and Morphological Characteristics of the Longjaw Bonefish, *Albula argentea* Collected in Korea

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ABSTRACT One specimen of *Albula argentea* (296.3 mm in standard length), belonging to the family Albulidae, was collected in a set net in the coastal waters of Jejudo Island, Korea. As the adult *A. argentea* has not been caught from Korean waters, we described its morphological characters based on the collected specimen and compared them with those of the previous reports on *A. argentea* and *A. koreaus*. As a result, the present specimen was characterized by having 68~73 pored lateral line scales (*vs*. 77~78 for *A. koreana*), 72~73 vertebrae pored lateral line scales (*vs*. 77~80) and none streak on the check (*vs*. yellowish streak). Molecular analysis using the mitochondrial cytochrome *b* DNA sequences was also conducted to confirm the correctness of species identification and taxonomic status of the sample.

Key words: Albulidae, *Albula argentea*, morphological characteristics, molecular identification, Korea

INTRODUCTION

The family Albulidae (Order Aluliformes) is distributed in tropical and subtropical seas, and 13 species belonging to the three genera (*Albula*, *Pterothrissus* and *Nemoossis*) are recognized in the world (Nelson, 2016). The genus *Albula* is characterized by having the snout conical, upper jaw projected well beyond lower jaw, mouth small, adipose tissue present on the eye, and villiform teeth in small patches on the premaxilla, dentary, vomer and palatine. Eleven species have been reported in this genus worldwide (Froese and Pauly, 2019), four species in the Western Pacific Ocean (Kwun and Kim, 2011; Wallace, 2015), and two species from Japan (Arizawa and Douchi, 2013).

Some ambiguities have existed in the usage of the scientific name and the taxonomic status of longjaw bonefish. Mori (1952) reported longjaw bonefish in Korea as *Albula vulpes* for the first time without any morphological description, and Chyung (1977) followed Mori's taxonomic decision regarding to *A. vulpes* without any review. Almost three decades later, Kim *et al*. (2005) published the illustrated book and regarded this species (*A. vulpes*) as *A. neoguinaica* without any explanation. Kim *et al*. (2008) collected the leptocephalus larva of *Albula* sp. from the South Sea of Korea and they identified it as *A. forsteri* based on molecular data. However, Hidaka *et al*. (2008) reported that both *A. forsteri* and *A. neoguinatica* were a junior synonym of *A. argentea*. Kwun and Kim (2011) recently reported a new species of *A. koreana* using the samples collected in Korea and Taiwan, while they also sampled a leptocephalus larva of *Albula* sp. from the South Sea of Korea and identified it as *A. argentea* based on the number of myomeres. Although two species, *A. argentea* and *A. koreana*, have been reported in Korea so far (MABIK, 2017), the adult *A. argentea* has not been caught in Korean waters since Mori (1952). Recently, we caught one adult specimen of *Albula* sp. using a set net in the coastal waters of Jejudo Island (Fig. 1). The sample was identified as *A. argentea* based on the morphological characteristics previously reported (Hidaka *et al*., 2008; Kwun and Kim, 2011; Arizawa and Douchi, 2013), and molecular analysis as well. Here, we described its morphological characters based on the collected specimen.

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Fig. 1. *Albula argentea*, JNU0445, 296.3 mm SL, Shinsan-ri, Jejudo Island.

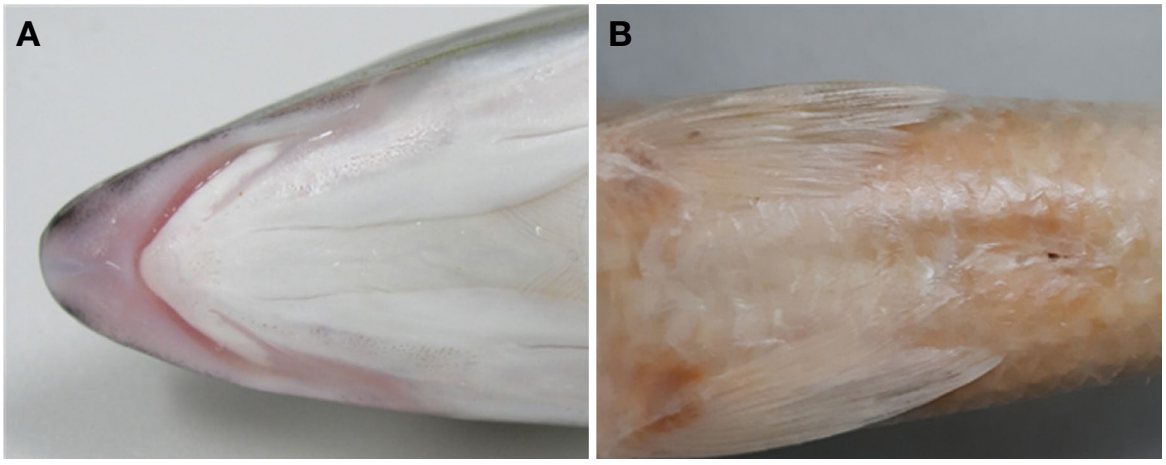

Fig. 2. The tip of lower jaw pointed and upper jaw protruding than lower jaw (A) and the tip of pelvic fin not reaching to anus (B).

MATERIALS AND METHODS

Counts and measurements followed the method of Hubbs and Lagler (2004) and Hidaka *et al*. (2008), with a Vernier caliper to the nearest 0.1 mm. Vertebral counts and tooth patch distribution were determined form digital radiographs. The examined specimen was deposited at the Fish Genetics and Breeding Laboratory, Jeju National University (JNU), Korea.

Molecular identification of the specimen was conducted by using the DNA sequences (501 bp) of mitochondrial cytochrome *b* (cyt *b*) gene. Genomic DNA extraction and PCR were performed according to Kwun and Kim (2011). The DNA sequence of cyt *b* (MN640591) obtained from the present specimen was compared with those of 10 *Albula* species and constructed phylogenetic tree with two outgroups (Fig. 2). For the molecular analysis, we used the following DNA sequences deposited at the National Center for Biological Information (NCBI) databases; *A. forsteri* (EU555519), *A. argentea* (HQ683755, HQ683758), *A. virgate* (KJ910045), *A. oligolepis* (KJ910045), *A. glossodonta* (KJ910033, AF311768), *A. goreensis* (KJ910038), *A. koreana* (MH119396), *A. giberti* (KJ910029, KJ910030), *A. vulpes* (KJ910044), *A. esuncula* (AF311762), *Megalips cyprinoides* (AB0511110), *Elops hawaiensis* (HQ157200). The genetic distances between species were calculated based on the *p*-distance model using the program MEGA 7.0 (Kumar *et al*., 2016). Phylogenetic tree was inferred with the neighbor-joining method. The analysis was conducted with the Kimura two-parameter model and 1,000 bootstrap replications using the program MEGA 7.0 (Kumar *et al*., 2016).

Table 1. Comparison of morphological characters of *Albula argentea*

Counts and measurements	Present study	Hidaka *et al*. (2008)	Kwun and Kim (2011)
Number of specimens	1	1 (Holotype)	7
Total length (mm)	344.0		
Standard length (mm)	296.3	238	217.1~291.7
Counts			
Dorsal fin	18	18	18
Pectoral fin rays	17	17	17~18
Pelvic fin rays	10	10	10
Anal fin rays	9	8	8~9
Pored lateral line scales	73	69	71~74 (n=3)
Scales above lateral lines	8	9	8~9 (n=5)
Scales below lateral lines	5	6	5 (n=5)
Predorsal scales	18	24	18 (n=1)
Branchiostegal rays	13	12	12~13 (n=5)
Vertebrae	72	72	–
In % of standard length			
Body depth	21.6		18.7~22.1
Body width	13.8		12.1~14.2
Head length	27.0		26.9~29.6
Predorsal length	47.4		47.3~49.7
Prepectoral length	24.5		25.3~28.1
Prepelvic length	54.6		58.7~62.2
Preanus length	69.0		73.3~74.6
Preanal length	81.0		84.4~86.1
Depth of caudal peduncle	7.2		7.3~8.3
Length of caudal peduncle	11.7		11.7~13.3
Length of dorsal base	15.3		15.3~17.5
Length of anal base	5.2		4.8~6.7
Length of longest dorsal ray	17.1		18.5~20.0 (n=4)
Length of longest anal ray	8.2		9.4~9.6 (n=3)
Length of pectoral fin	15.4		16.0~17.8
Length of pelvic fin	12.0		13.2~14.2 (n=6)
Snout length	11.0		9.9~11.3
Interorbital length	6.8		6.3~6.9
Length of eye	4.8		4.9~6.0
Length of upper jaw	9.9		9.6~10.8
Length of mandible	7.3		7.1~8.1
Preoral length	3.1		3.1~3.8
Length of last dorsal fin ray	6.8		5.9~7.3 (n=5)
Length of last anal fin ray	6.0		4.9~6.8
Upper caudal fin lobe length	21.5		–
Lower caudal fin lobe length	19.7		–
Width of mouth	7.3		6.6~8.5
Maxillary depth	1.8		1.6~2.4

***Albula argentea* (Forster in Bloch and Schneider, 1801)**

(Korea name: Yeo-eul-myeol)

(Fig. 1; Table 1)

Eso argenteus Forster in Bloch and Schneider, 1801: 395 (type locality: Tahiti).

Albula neoguinaica Valenciennes in Cuvier and Valenciennes, 1847: 350 (type locality: Northwestern Irian Jaya).

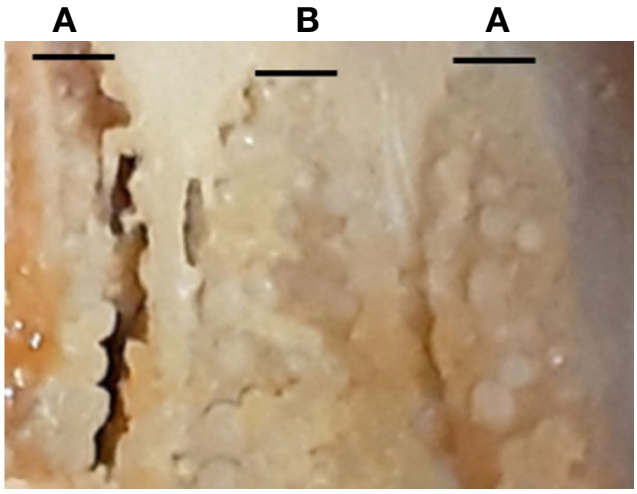

Fig. 3. The position of tip of meshopterygoid (A) and parasphenoid (B).

Albula forsteri Valenciennes in Cuvier and Valenciennes, 1847: 354 (type locality: Tahiti).

Albula argentea: Randall, 2007: 51 (Hawaiian Islands); Hidaka *et al*., 2008: 56 (Indo-Pacific); Fricke *et al*., 2011 (Southwest Pacific Ocean); Larson *et al*., 2013: 24 (Australia); Psomadakis *et al*., 2015: 144 (Pakistan).

Material examined. JNU-0445, *Albula argentea*, 296.3 mm in standard length (SL), Sinsan-ri, Jejudo Island, 18 October 2011, set net.

Description. Counts and measurements are given in Table 1.

Body moderately elongate, slightly compressed and full covered with cycloid scales except head; snout length slightly larger than upper jaw length; upper jaw protruding than lower jaw, lower jaw length slightly shorter than width of mouth, tip of lower jaw pointed (Fig. 2-A); the end of maxillary not reaching to anterior border of eye; orbit diameter shorten than interorbital width; thin transparent adipose tissue over eye; a pair of nostril, it located mid-portion between the tip of snout and the eyes; upper and lower jaw with small patches of villiform teeth; the tip of the tooth patches on the mesopterygoids protrudes slightly more than that of tooth patches on the parasphenoid (Fig. 3); dorsal fin origin at about mid-portion of the body length; dorsal fin slightly longer than pectoral fin ray and its last part slightly prolonged; anal fin rays shorter other rays and last anal fin ray slightly prolonged; pectoral fin ray started at before tip of head; pelvic fin started at below three-fifths of dorsal fin and the tip of pelvic fin not reaching to anus (Fig. 2-B); caudal fin deeply forked and length of upper caudal lobe longer than lower one.

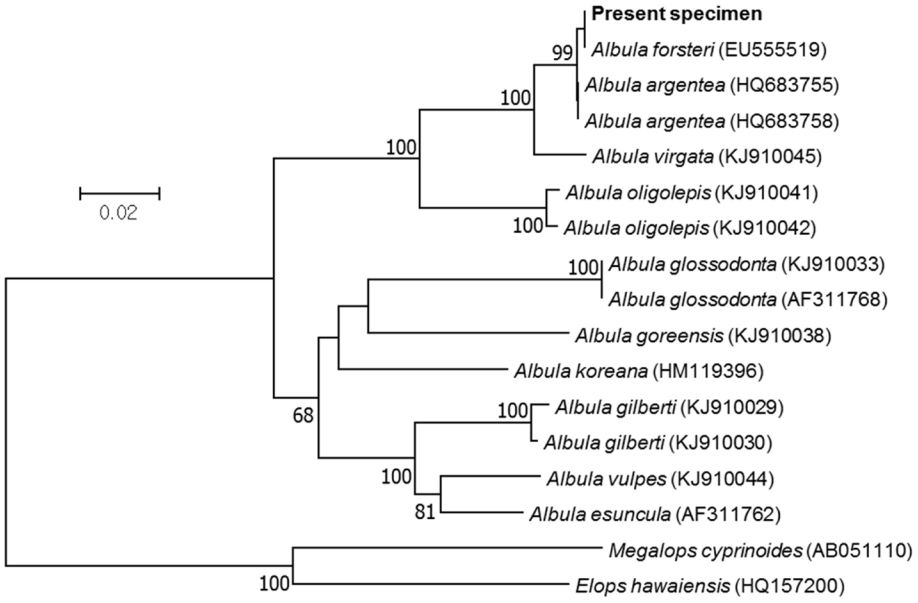

Fig. 4. Neighor-Joining (NJ) tree based on cytochrome *b* DNA sequences obtained from 10 species of *Albula* fishes and two outgroups (*Megalops cyprinoides* and *Elops hawaiensis*). Boostrap values (over 50%) are displayed on internal nodes.

Colorations. When fresh, head and body silvery white; dark longitudinal lines between dorsal scale rows; tip of snout and nostrils black; posterior margin of caudal fin black; ventral margin of lower caudal lobe white; first pelvic fin ray white; base of pectoral and pelvic fins slightly yellow; anal fin white. After preservation, head and body dark grayish dorsally and ventrally; black longitudinal lines between dorsal scale row; tip of snout and nostrils black.

Distribution. Known from Indo-Pacific Ocean: Australia, Indonesia, Vietnam, Taiwan, Korea, Hawaiian Islands (Randall, 2007; Hidaka *et al*., 2008; MABIK, 2017).

Remarks. The present specimen was characterized by having snout length slightly larger than upper jaw length; mandible length slightly shorter than the width of mouth, the tip of lower jaw pointed, 73 pored lateral line scales and 72 vertebrae. The morphological characters of the specimen were compared with those in the previous studies (Hidaka *et al*., 2008; Kim *et al*., 2011), which revealed that all morphological characteristics examined clearly fit the previous species descriptions of *A. argentea* (Table 1). Thus, we identified our specimen as *A. argentea* based on the morphological characters.

We adopted molecular identification method based on cytochrome *b* DNA sequences to clarify the taxonomic status of our specimen. The DNA sequence of our sample was compared with those of 10 *Albula* species. The results indicated that DNA sequence of present specimen was almost identical (99.8%) to those of *A. argentea* from NCBI (Fig. 4). Thus, we identified our specimen to be *A. argentea* based on both morphological and molecular characters. In addition, our specimen was 100% identical in DNA sequence with the leptocephalus larva of *Albula* sp. (EU555519, Kim *et al*., 2008) collected from South Sea of Korea.

This species morphologically resembles *A. koreana* inhabiting Korean waters, but it is easily distinguishable from the latter by having 68~73 pored lateral line scales (*vs*. 77~78 for *A. koreana*), 72~73 vertebrae pored lateral line scales (*vs*. 77~80) and none streak on the check (*vs*. yellowish streak) (Kwun and Kim, 2011).

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한국산 여울멸의 분자동정과 형태적 특징

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요 약 : 여을멸과에 속하는 *Albula* sp. 1개체를 제주도 연안의 정치망에서 채집하여 형태적 특징을 기술하였다. 이 개체는 73개의 측선공과 72개의 척추골, 그리고 뺨에 무늬가 없는 특징으로 형태적으로 *Albula argentea*로 동정되었다. 보다 명확한 종 동정을 위해서 표본조직으로부터 미토콘드리아 사이토크롬 *b* 염기서열을 얻은 후 기존에 보고된 10종의 *Albula* spp.와 비교 분석한 결과, 분자생물학적으로도 *A. argentea*와 동일종으로 나타났다.

찾아보기 낱말 : 여을멸과, 여을멸, 형태적 특징, 분자동정, 한국