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Redescription of the Hawaiian Ladyfish *Elops hawaiensis* from Korea

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ABSTRACT Redescription of the Hawaiian ladyfish *Elops hawaiensis* was carried out based on four specimens collected from Busan and Gwangyang between 2008 and 2010. This species has a gular plate between the symphysis and isthmus, and the entire premaxillary tooth band is exposed when the mouth is closed. Our Korean specimens of *E. hawaiensis* are characterized by having 65~67 vertebrae, 14 anal fin rays and 95~101 lateral line scales, which values differed slightly from those given in previous studies. Molecular analysis using 480 base pairs of mitochondrial DNA cytochrome *b* sequences showed that our four specimens corresponded well with *E. hawaiensis* (99.8~100.0%). Therefore, our results suggest that there may exist regional differences in vertebrae and anal fin ray counts for *E. hawaiensis*.

Key words : Redescription, Hawaiian ladyfishes, *Elops hawaiensis*, Korea

INTRODUCTION

Family Elopidae under the order Elopiformes are distributed globally in tropical and subtropical areas, and seven species belonging to one genus (*Elops*) are recognized in the world (Eschmeyer and Fong, 2010). Of which two species, *Elops machnata* (Forsskål, 1775) and *E. hawaiensis* Regan, 1909 have been recognized in the Indo-Pacific (Whitehead, 1962), and only one species, *E. hawaiensis* has been recorded in Korea and Japan (Aizawa, 2002; Kim *et al.*, 2005). However, taxonomic study of the family Elopidae is poorly-known except for a brief description (Nelson, 2006). Mori (1928) reported *E. machnata* in the Korean waters for the first time without any morphological description. Subsequently, many Korean ichthyologists regarded the species as *E. saurus* (Chyung, 1954), *E. machnata* (Chyung, 1977; Kim, 1983) and *E. hawaiensis* (Youn, 2002; Kim *et al.*, 2005b). None of the previous authors provided any descriptions based on specimens, except the description of leptocephalus of *E. hawaiensis* by Kim *et al.* (2005a). Therefore, we redescribed the morphological characteristics of *E. hawaiensis* adult collected from Korean waters, and also compared mitochondrial DNA cytochrome *b* sequences with those of Elopidae spp.

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MATERIALS AND METHODS

The four specimens of *E. hawaiensis* were collected from Busan and Gwangyang, South Sea of Korea between 2008 and 2010, and were deposited at the Ichthyology laboratory, Pukyong National University (PKU).

Counts and measurements were made according to Hubbs and Lagler (2004), with digital vernier caliper to the nearest 0.1 mm. The vertebrae were counted from radiograph (SOFTEX HA-100, Japan), following McBride and Horodysky (2004).

Genomic DNA was extracted from muscle tissue using 10% Chelex 100 Resin (Bio-rad, Hercules). The polymerase chain reaction (PCR) was used to amplify the mitochondrial DNA cytochrome *b* gene, following McBride and Horodysky (2004). Nucleotide sequence data reported here have been submitted to the DDBJ/EMBL/GenBank nucleotide sequence databases (accession number HQ157200~HQ157201, HQ616666~HQ616667). Mitochondrial DNA cytochrome *b* sequences were aligned using BioEdit version 7 (Hall, 1999), and for the molecular comparisons, we obtained the mitochondrial DNA cytochrome *b* sequences of three *Elops* species (*E. hawaiensis*, *E. saurus* and *E. smithi*)

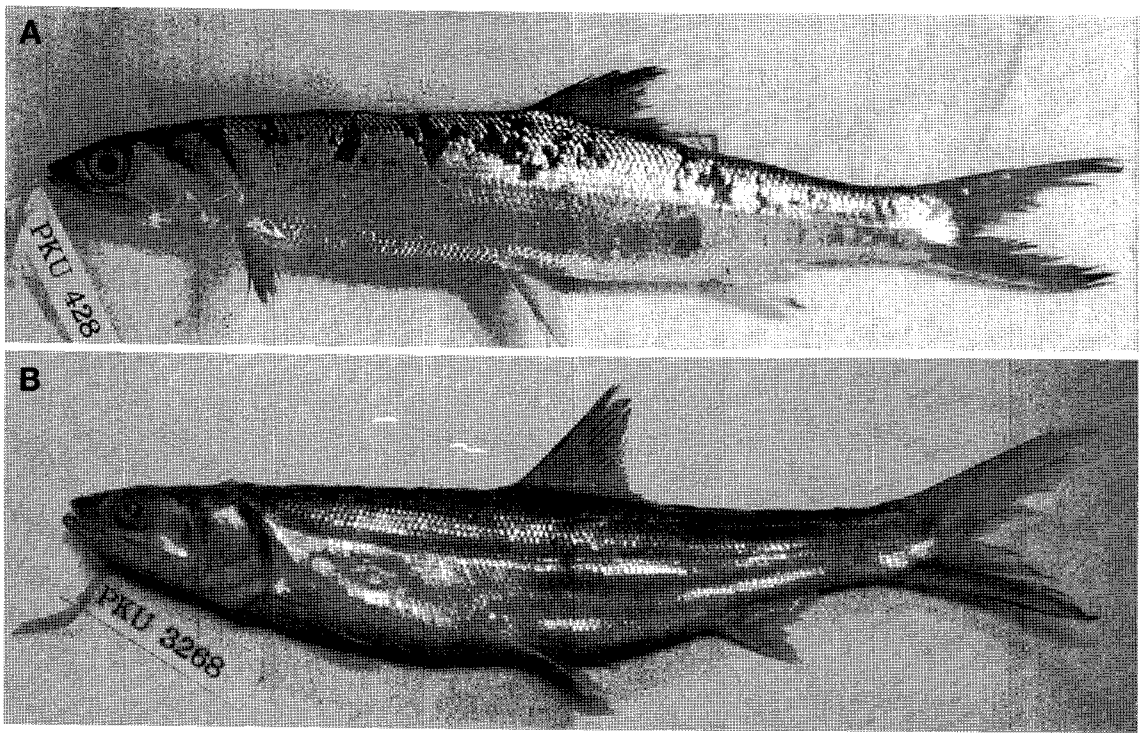

Fig. 1. *Elops hawaiensis* (A) fresh specimen, PKU 428, 247.7 mm SL; (B) preserved specimen, PKU 3268, 236.4 mm SL.

and two outgroups (*Megalops atlanticus* and *M. cyprinoides*) from the NCBI (National Center for Biotechnology Information): *Elops hawaiensis* (AB051070), *Elops saurus* (GQ183881, GQ183882), *Elops smithi* (GQ183883, GQ183894), *Megalops cyprinoides* (AB051110), *Megalops atlanticus* (NC005804). The genetic distances were calculated according to the Kimura-2-parameter model (Kimura, 1980) using pairwise distance of MEGA 4 (Tamura *et al.*, 2007).

Elops hawaiensis Regan, 1909

(Korean name: dang-myeol-chi)

(Fig. 1, Table 1)

Elops hawaiensis Regan, 1909: 39 (type locality: Hawaii); Whitehead, 1962: 328; Sato and Yasuda, 1980: 315; Kim *et al.*, 2005a: 217, fig. 1; Kim *et al.*, 2005b: 80; Aizawa, 2002: 188, 1450; Youn, 2002: 137, 488; McBride *et al.*, 2010: 32.

Elops saurus (not Linnaeus): Mori, 1952: 28; Chyung, 1954: 36.

Elops machnata (not Forsskål): Mori, 1928: 3; Chyung, 1977: 104, plate 21; Kim, 1983: 164.

Material examined. PKU 428, one specimen, Busan, 21 Jun. 2008; PKU 3268, one specimen, Gwangyang, 27 Nov. 2009; PKU 4224, one specimen, Busan, 9 Sep. 2010; PKU 4666. One specimen, Busan, 20 Oct. 2010.

Description. Counts and proportional measurements are shown in Table 1. Body elongated, compressed. Snout short, slightly pointed and mouth terminal. Maxilla covered side of lower jaw; posterior tip of maxilla beyond posterior margin of eye. Both jaw, vomer and palatine with small conical teeth. Whole premaxillary tooth band exposed when mouth closed. Gular plate present between symphysis and isthmus. Developed adipose tissue covered eye except pupil. Interorbital region concaved. All fins comprise of only soft rays. Axillary scales present at pectoral and pelvic fins. Pectoral fin located at ventral region of body and pelvic fin abdominal, located below origin of dorsal fin. Caudal fin deeply forked, length of both lobes equal. Lateral line extended to caudal fin base in a straight line. Body covered with small cycloid scales, but head exposed.

Coloration. When fresh, head and body lustrous silvery white and bluish dorsally. Pupil black, adipose tissue around eyes transparent. Tip of dorsal and caudal fins blackish, a lot of small melanophores present. Pectoral, pelvic and anal fins transparent, yellowish partially. After fixation, head and body lose luster; ventral body, upper jaw, anal fin and base of caudal fin dark yellowish. Adipose tissue semitransparent yellowish. Pectoral, pelvic and anal fins darkish.

Distribution. *E. hawaiensis* occurs in Busan (Mori, 1928, 1952; present study), Gwangyang (present study) and Jeju (Kim *et al.*, 2005a) from Korea. It occurs in the Indo-Pacific (Whitehead, 1962), Hawaii (Regan, 1909) and Japan (Aizawa, 2002).

Remarks. Two *Elops* species (*E. hawaiensis* and *E.*

Table 1. Comparison of counts and measurements of *Elops hawaiensis* species

	Elops hawaiensis		*Elops machnata*
	Present study	Whitehead (1962)*	Whitehead (1962)
Number of specimens	4	5	7
Standard length (mm)	163.4~247.7	155.0~370.0	100.0~319.0
Counts			
Dorsal fin	22~23	22~24	23~24
Anal fin	14	15	14~18
Pectoral fin	17	16~18	17~19
Pelvic fin	13~15	14~15	14~16
Lateral line scales	95~101	88~98	83~99
Scale above lateral line	11~12	–	–
Scale below lateral line	9~10	–	–
Vertebrae	65~67	68~69	63~64
Measurements (% SL)			
Body depth	17.9~19.6	17.9~22.0	17.3~21.7
Predorsal length	51.4~53.6	52.5~56.0	51.4~56.0
Prepelvic length	52.1~53.5	51.5~55.0	52.4~55.2
Head length	24.2~27.8	23.6~27.4	23.4~29.5
Snout length	5.5~6.7	5.3~6.7	5.1~6.8
Eye diameter	4.9~5.7	5.1~7.3	5.5~6.7
Postorbital length	14.4~15.8	13.8~15.5	13.2~16.2
Interorbital width	4.4~5.5	4.3~5.3	4.3~5.1
Upper jaw length	13.7~14.5	13.2~17.0	13.8~16.1
Lower jaw length	13.8~15.4	13.7~17.5	14.3~17.2
Caudal peduncle length	14.4~17.6	12.9~15.8	12.0~14.9
Caudal peduncle depth	8.1~9.2	8.4~9.6	8.5~9.2
Pectoral fin length	12.4~14.0	12.4~14.3	10.4~13.8
Pelvic fin length	12.2~13.8	12.6~15.0	8.6~14.1
Origin of pectoral to pelvic	28.8~29.9	28.0~30.6	25.2~32.1
Origin of pectoral to anal	53.6~55.1	52.9~56.5	49.3~57.0
Gular plate length	7.9~9.2	8.4~11.0	8.5~10.3
Gular plate width	1.9~2.3	1.9~2.7	2.0~3.5

*Including *Elops hawaiensis* and *Elops australis* with holotype

Table 2. Genetic divergence among three *Elops* species with outgroups

	Species	1	2	3	4	5	6	7	8	9	10	11
1	*Elops hawaiensis* (PKU 428)											
2	*Elops hawaiensis* (PKU 3268)	0.002										
3	*Elops hawaiensis* (PKU 4224)	0.000	0.002									
4	*Elops hawaiensis* (PKU 4666)	0.000	0.002	0.000								
5	*Elops hawaiensis* (AB051070)	0.000	0.002	0.000	0.000							
6	*Elops saurus* (GQ183881)	0.017	0.019	0.017	0.017	0.017						
7	*Elops saurus* (GQ183882)	0.019	0.022	0.019	0.019	0.019	0.002					
8	*Elops smithi* (GQ183883)	0.009	0.011	0.009	0.009	0.009	0.013	0.011				
9	*Elops smithi* (GQ183894)	0.011	0.013	0.011	0.011	0.011	0.019	0.022	0.011			
10	*Megalops cyprinoides* (AB051110)	0.162	0.162	0.162	0.162	0.162	0.156	0.159	0.159	0.156		
11	*Megalops atlanticus* (NC005804)	0.164	0.164	0.164	0.164	0.164	0.156	0.156	0.162	0.161	0.111	

machnata) are distributed in the Indo-Pacific region. They are distinguished by the number of vertebrae (68~70 in *E. hawaiensis* vs. 63~64 in *E. machnata*) and exposure of the premaxillary tooth (whole tooth exposed vs. anterior tooth covered by lower jaw) (Whitehead, 1962). In this study, morphological characteristics of observed specimens correspond well with those of *E. hawaiensis*, especially in whole premaxillary tooth exposed. The number of vertebrae of observed specimens (65~67) slightly differs from those of the original description (68: Regan, 1909) and taxonomic review (68~70: Whitehead, 1962). However, Kim *et al.* (2005a) reported that *E. hawaiensis* leptocephalus from Jeju Island has 66 total myomeres, and Uyeno (1984) and Sato and Yasuda (1980) reported that it has 66~70 and 66~68 total vertebrae, being corresponded to those of observed specimens (see Table 1). To clarify the taxonomic status of our four specimens, we analyzed 470 base pairs of mitochondrial DNA

cytochrome *b* sequences, and compared them with those of three *Elops* species. The results showed that DNA of observed specimens corresponds to DNA of *E. hawaiensis* (99.8 ~ 100.0%), but slightly differed to *E. saurus* (97.8 ~ 98.3%) and *E. smithi* (98.7 ~ 99.1%) from the western North Atlantic. Our molecular results suggest that there may exist regional differences in vertebrae and anal fin counts between Korean *E. hawaiensis* and those by Whitehead (1962) (Table 2). Although *E. hawaiensis* and *E. smithi* are well distinguished by the number of vertebrae (68 ~ 70 in *E. hawaiensis* vs. 73 ~ 80 in *E. smithi*) and distribution (Indo-Pacific vs. Western Atlantic) (McBride *et al.*, 2010), genetic distance between them was considerably small. It has a considerable attraction for their evolutionary history of the genus *Elops*.

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한국산 당멸치, *Elops hawaiensis*의 재기재

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요 약 : 2008~2010년 사이에 우리나라 부산 및 광양에서 채집된 당멸치, *Elops hawaiensis* 4개체의 형태특징을 상세히 재기재하였다. 본 종은 아래턱의 봉합부와 협부 사이에 후판을 가지며, 입을 닫았을 때 전상악골의 치대 전체가 노출된다. 한국산 당멸치는 척추골수이 65~67개, 뒷지느러미 연조수가 14개, 측선비늘이 95~101개를 가지는 것이 특징적이었으며 이전 연구결과와 약간 달랐다. 미토콘드리아 DNA cytochrome *b* 480 bp의 염기서열을 분석한 결과, 우리의 4개체는 *E. hawaiensis*와 99.8~100% 일치하였다. 따라서, 우리 결과는 당멸치가 척추골 및 뒷지느러미 계수에서 지역적 변이가 존재할 것이라는 사실을 제시한다.

찾아보기 낱말 : 재기재, 당멸치, *Elops hawaiensis*, 한국