

Four New Records of Genus *Lycodes* (Perciformes: Zoarcidae) from Korea

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A taxonomic study of the family Zoarcidae was conducted using fish collections deposited in the Department of Biology, Chonbuk National University, Jeonju, Korea and the East Sea Fisheries Research Institute, Korea. Among these collections, the following four species of the genus *Lycodes* are recognized as the first records for Korea; *L. sadoensis*, *L. japonicus*, *L. pectoralis*, and *L. sigmatoides*. These species are here redescribed and figured, with their distributions and a provisional key to five genera and eleven species of the family Zoarcidae from Korea.

Key words : Zoarcidae, *Lycodes*, eelpout, new record, Korean

Introduction

The fishes of the family Zoarcidae (eelpouts) are known to constitute a diverse group composed of about 240 species in 46 genera from continental shelves and slopes of boreal seas (Anderson and Fedorov, 2004). Among Zoarcidae, the genus *Lycodes* Reinhardt includes about 60 species distributed primary in temperate and Arctic waters of the northern hemisphere. The genus is diagnosed by the presence of a dentary bone, with a cartilaginous submental crest (Anderson, 1994).

Although there have been numerous systematic studies of the family Zoarcidae (Lindberg and Krasnyukova, 1975; Anderson, 1982, 1994; Toyoshima, 1985; Anderson and Fedorov, 2004), this group has attracted little attention in Korea. Since Jordan and Starks (1905) described the first zoarcid fish, *Zoarcetes gilli* from Korea, the family was listed as having seven species living in Korean waters (Mori, 1952; Chyung and Kim,

1959). The suborder Zoarcoidei was reported with new records from Korea (Kim and Kang, 1991a, b; Kim *et al.*, 2005) and the family Zoarcidae was reviewed with a provisional key (Kim, 2006).

In the course of investigating the coastal fish collections, we recognized four species of the genus *Lycodes* as new records for Korea. In this paper we record these species and provide a key to the species of the family Zoarcidae in Korea with their distributions.

Materials and Methods

Measurements and counts were made according to Toyoshima (1985): measurements were made to the nearest 0.1 mm with dial calipers. Radiographs by soft x-ray were used in counting the number of vertebrae. Fish specimens examined in the present study were deposited in the fish collections of the Department of Biology, Chonbuk National University, Chonju (CNUC) and from the bottom trawl surveys of the East Sea Fisheries Research Institute, Korea. The holotype and paratype of *Lycodes pectoralis* were

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examined in the Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University, Japan (HUMZ). The classification follows that of Anderson (1994).

Taxonomic accounts

Family Zoarcidae

Genus *Lycodes* Reinhardt, 1831
(Korean name: meok-gal-chi-sok)

1. *Lycodes sadoensis* Toyoshima and Honma, 1980

(Fig. 1 and Table 1)

(New Korean name: sa-do-meok-gal-chi)

Lycodes sadoensis Toyoshima and Honma, 1980: 48 (type locality: off Ishikawa Pref, Japan); Toyoshima, 1985: 189.

Material examined. CNUC 36593, one specimen, 160.4 mm in total length (TL), 27 Mar. 2006, Chuksan-myeon, Yeongdok-gun, Gyeongsangbuk-do, Korea, collected S. J. Hwang, 200~300 m depth.

Diagnosis. This species is distinguished from other members of the genus by the following combination of characters: lateral line anterolateral in position, body and head brownish in dorsal half and light in ventral half. Dorsal fin with somewhat dark margin and three spots anteriorly.

Description. Counts and measurements are given in Table 1. Body moderate elongate and deep. Head somewhat depressed. Interorbital space narrow and convex. Mouth moderate in size, lower jaw completely included. Teeth small and conical those on upper jaw in a single row laterally and two rows anteriorly; those on lower jaw in irregular two rows. Lateral line anterolateral. Small isolated scales covering body except for head, belly, and base of base of pectoral fin. Dorsal fin originating above vertebrae, anal fin inserted below 13th dorsal ray. Pectoral fin short, fan like, with round margin, its length half of

head length. Pelvic fin very short.

Color in formalin. Brownish in dorsal half and light in ventral half of body and head. Irregular three vertical lines on side of body near caudal fin. Dorsal fin having a somewhat dark margin and three dark spots anteriorly. Peritoneum blackish brown.

Distribution. Japan (Sado Island, off Ishigawa Prefecture) and Korea (off coast of Yeongdok-gun, Gyeongsangbuk-do).

Remarks. The specimen of *Lycodes* collected from the east coast of Korea here reported agrees precisely with the original description and figures of *L. sadoensis* (Table 1). *Lycodes sadoensis* was described from waters near Sado Island, Niigata, Japan. The species resembles *L. teraoi* in proportional measurements and counts, but differs from in having a brownish dorsal half of the head and body, some vertical lines on the body near the caudal fin and three or more dark spots on the dorsal fin (Toyoshima and Honma, 1980). This record is the first time from Korea and also from outside of Japan.

2. *Lycodes japonicus* Matsubara and Iwai, 1951

(Fig. 2 and Table 1)

(New Korean name: mu-ni-ga-si-chi)

Lycodes japonicus Matsubara and Iwai, 1951: 368 (type locality: Toyama Bay, Japan); Toyoshima, 1985: 191.

Material examined. CNUC 36505, one specimen 125.05 mm in TL, Mat 21, 2005, about 300 m depth, Samchok-si, Gangwon-do, Korea, collected by S. J. Hwang.

Diagnosis. *Lycodes japonicus* is distinguished from most other members of the genus by the longer pelvic fin, an anteroventral lateral line, and 14 pectoral-fin rays.

Description. Counts and measurements are given in Table 1. Body elongate, compressed, tapering to tail. Head moderately large with round snout and very large mouth. Teeth conical those on upper jaw in a single row and those of



Fig. 1. *Lycodes sadoensis* Toyoshima and Honma, 1980, CNUC 36593, 160.3 mm TL, from off Yeongdok-gun, Gyeongsangbuk-do, Korea.



Fig. 2. *Lycodes japonicus* Matsubara and Iwai, 1951, CNUC 36505, 125.0 mm TL, from off Samcheok-si, Gangwon-do, Korea.

lower jaw in a broad band anteriorly. Dorsal fin originating above middle of pectoral fin. Pectoral fin rounded, moderately large. Pelvic fin small, longer than eye diameter. Body covered with small cycloid scales head and belly naked. Lateral line anteroventral,

Color in formalin. Brownish body with irregular dark brown blotches on body side, head and dorsal fin. Vertical fins and anterior half of pectoral fin dark grey. Oral cavity and peritoneum dark brown.

Distribution. Japan (Toyama Bay and off Sado Island) and Korea (Samchok-si, Gangwon-do).

Remarks. Compared to the original description and figures of *L. japonicus*, the present specimen of *Lycodes* collected from Samchok, Korea is well assignable to *L. japonicus*. The species differs from most other species of *Lycodes* in having a fewer number of dorsal, anal, and pectoral rays. This species is a dwarf species among the eelpouts, the largest only about 137

mm in total length (Matsubara and Iwai, 1951).

3. *Lycodes pectoralis* Toyoshima, 1985

(Fig. 3 and Table 1)

(New Korean name: buk-gal-chi)

Lycodes pectoralis Toyoshima, 1985: 228 (type locality: southern Okhotsk Sea).

Materials examined. Holotype HUMZ 49083, 346.2 mm TL, 45°37'N, 143°53'E, southern Okhotsk Sea, 290~480 m October 8, 1975; Paratype HUMZ 33951, 266.7 mm TL, 44°47'N, 144°015'E, S. Okhotsk Sea, 200 m, October 31, 1974; CNUC 36493~36497, (5) Specimens, 217.3~329.4 mm TL, Jukbyeon-myon, Uljin-gun, Gyeongsangbuk-do, Korea, collected by S. J. Hwang.

Diagnosis. *Lycodes pectoralis* is distinguished from other members of the genus by the following combination of characters: small head, developed submental crest, deeply emerginate pectoral fin, ventral lateral line, and no blotches or bars on body and fins.

Table 1. Comparison of counts and measurements between the Korean specimens and the type specimens of four *Lycodes* species

	<i>L. sadoensis</i>	<i>L. japonicus</i>	<i>L. pectoralis</i>	<i>L. sigmatoides</i>
Counts				
Dorsal fin rays	77 (72~78)	81 (79~84)	108~112 (106~115)	96 (92~96)
Anal fin rays	65 (62~65)	72 (69~73)	94~96 (91~101)	76 (72~83)
Pectoral fin rays	15 (15)	15 (14~15)	17~18 (17~18)	19 (18~20)
Vertebrae	84 (82~87)	92 (87~93)	113~116 (112~123)	103 (99~106)
Gill-rakers	12	11	12	14~15
Proportions in TL				
Body depth	10.7 (9.92~11.63)	11.34	10.8~11.2 (10.7~12.5)	11.9 (11.2~12.6)
Predorsal length	3.7	4.0 (3.64~4.25)	4.3~4.6 (4.9~5.5)	3.7 (26.6~27.6)
Preanal length	2.3 (2.16~2.65)	2.8 (2.51~2.96)	2.7~2.8 (2.8~3.2)	2.2 (44.3~50.0)
Head length (HL)	4.9 (4.33~5.21)	5.4 (4.48~5.67)	5.8~6.1 (5.7~6.4)	4.3
Proportions in HL				
Head width	2.6 (1.76~2.26)	2.6 (1.70~2.63)	2.2~2.6 (1.7~2.0)	3.6
Snout length	3.5 (2.31~3.29)	3.6 (3.50~4.09)	2.9~3.4 (2.6~3.1)	0.8
Eye diameter	5.3 (3.97~5.36)	4.0 (3.63~4.28)	5.5~5.7 (4.0~5.9)	2.3
Interorbital width	9.7	5.4 (4.97~6.06)	4.5~5.2 (3.7~4.7)	4.3
Upper jaw length	2.3 (1.86~2.36)	2.6 (2.38~3.39)	2.4~2.7 (2.4~2.7)	0.6
Lower jaw length	3.0 (2.11~3.08)	3.2	3.0~3.1 (2.6~3.2)	0.7

Numbers in parentheses are those of type specimens of the original descriptions.



Fig. 3. *Lycodes pectoralis* Toyoshima, 1985, CNUC 36493, 343.3 mm TL, from Uljin-gun, Gyeongsangbuk-do, Korea.

Description. Counts and measurements are given in Table 1. Body rather elongate and moderately deep. Head relatively small. Mouth small, posterior end of upper jaw reaching anterior half of eye. Snout somewhat pointed. Nostril tube very short. Teeth small and conical. Body densely covered with cycloid scales. Lateral line ventral, very distinct, starting from apex of gill opening, descending toward anus and then running along base of anal fin almost to base of caudal fin. Pelvic fin small, shorter than eye diameter.

Color in formalin. No bars and markings on body and fins. Margins of vertical fins blackish. Oral and peritoneum blackish.

Distribution. Okhotsk Sea and Korea

Remarks. Although this species was known from the Okhotsk Sea only since the original description of the species by Toyoshima (1985), these specimens of *Lycodes* collected from off Uljin coast, Gyeongsangbuk-do, Korea are confidently assignable to *L. pectoralis* based on the records of type specimens (Toyoshima, 1985). The specimens represent the first record of the species from Korea. This species is most closely related to *L. nakamurae* in having numerous vertical fin rays and an emarginate pectoral fin, however, it differs from the latter by lacking scales on the dorsum before the dorsal fin origin and lacking black blotches on anterior part of

dorsal fin or upper margin of the pectoral fin.

4. *Lycodes sigmatoides* Lindberg and Krasnyukova, 1975

(Fig. 4 and Table 1)

(New Korean name: gul-gok-mu-ni-chi)

Lycodes sigmatoides Lindberg and Krasnyukova, 1975: 161 (type locality: Okhotsk Sea).

Lycodes schmidtii Soldatov, 1917: 115 fig. 2 (Preoccupied by *Lycodes schmidtii* Grazianov, 1907; Okhotsk Sea).

Material examined. CNUC 36537, one specimen 506.2 mm TL, Nov. 27, 1989, Mukho fish market, Donghae-si, Gangwon-do, Korea.

Diagnosis. A species of *Lycodes* distinguished by its unique colour pattern consisting of S-shaped or worm-like spots on the dorsal fin and upper part of body sides.

Description. Counts and measurements are given in Table 1. Body elongate, compressed, tapering to tail. Head moderately large. Snout pointed. Submental crest well developed. Nasal tube long, reach upper lip. Gill slit extending ventrally to below lower pectoral fin margin. Teeth sharp, canine-shaped, arranged in single row on upper jaw. Midlateral system. Body covered with small cycloid scales except nape, abdomen, and pectoral fin base.

Color in formalin. Characteristic light-col-

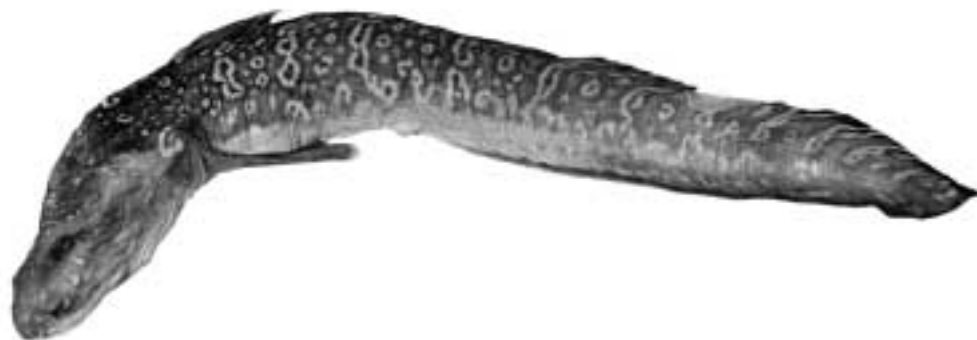


Fig. 4. *Lycodes sigmatoides* Lindberg and Krasnyukova, 1975, CNUC 36537, 506.2 mm TL, from Donghae-si, Gangwon-do, Korea.

ored S-shaped spots located on back, which continue on dorsal fin. Back and dorsal fin without dark oblique stripes. Margin of dorsal and anal fin light-colored. Occiput with a few spots (Soldatov, 1917).

Distribution. Okhotsk Sea and off Gangwon-do coast, Korea.

Remarks. This species was described under the name of *Lycodes schmidtii* by Soldatov (1918), but the species name was preoccupied treated as a homonym of *Lycodes schmidtii* Grazianov, 1907. Lindberg and Krasnyukova (1975) erected it as valid name, *L. sigmatoides*, based on specimens collected from the Okhotsk Sea. *L. sigmatoides* is similar with *L. tanakae* in external shape, however Kim (2006) reported that *L. sigmatoides* differs from *L. tanakae* in having light-colored S-shaped spots on the back and dorsal fin, 92-96 dorsal fin rays (vs. 96-98), 72~76 anal fin rays (vs. 77~79), and 103 vertebrae (vs. 104~107).

Discussions

The family Zoarcidae was comprised four subfamilies, Zoarcinae, Lycozoarcinae, Gymnelinae, and Lycodinae, of which the Lycodinae is the largest subfamily with 32 genera and 120 species (Anderson and Fedorov 2004). The taxonomic studies of the Lycodine fishes have been carried out by many ichthyologists (Schmidt, 1950; Toyoshima, 1985; Anderson, 1994; Anderson and Fedorov, 2004; Shinohara and Shirai, 2005), and Hatooka (2002) recognised 22 species of the genus *Lycodes* from Japanese waters with their pictorial keys and illustrations. After Mori (1952) reported two species of *Lycodes tanakae* and *L. nakamurae* from Korea, *Petrochmidtia toyamensis* was also included as recorded species in Korea (Chyung and Kim, 1959; Kim *et al.*, 2005). Subsequently *P. toyamensis* was transferred to the genus *Lycodes* by the osteological study of the species (Anderson, 1994), and Kim (2006)

also recognised it as the genus *Lycodes* by the observation of the Korean specimens.

The genus *Lycodes* contains a large number of species that exhibit profound character plasticity (Anderson, 1994) and it is very difficult to identify them. However the specimens observed in this paper were confirmed as the first Korean records of *Lycodes* based on their original descriptions and recent taxonomic revisions (Katayama, 1941; Matsubara and Iwai, 1951; Lindberg and Krasnyukova, 1975; Toyoshima, 1985; Anderson, 1994; Anderson and Fedorov, 2004). The following characters were ascertained to be very useful for the separation of species: fin ray and vertebral counts and lateral line patterns. Four species of *Lycodes* were specific in their lateral line forms, as follows: anterolateral in *L. sadoensis*, anteroventral in *L. japonicus*, midlateral in *L. sigmatoides*, ventral in *L. pectoralis* (Table 2).

Fishes of the family Zoarcidae primarily inhabit mud bottoms of the continental shelves and slope of northern boreal seas and most species in the West Pacific Boreal Region are found in the Okhotsk and Kuril Provinces (Anderson, 1994).

Although *Lycodes sadoensis* and *L. japonicus* were previously known to be distributed only in the Japanese waters and *L. pectoralis* and *L. sigmatoides* from only the Okhotsk Sea, it is remarked that the four species of *Lycodes* were found from off the east coast of Korea. Therefore the genus *Lycodes* of Korea contains 7 species including 4 species newly recorded in this time and the eelpout fishes of the family Zoarcidae known Korean waters are classified by 11 species in 5 genera as the following provisional keys.

Key to genera and species of family Zoarcidae from Korea

- 1a. No pelvic fin 2
 1b. Pelvic fin present 3
 2a. Head and body with scales; oval scales present of body *Bothrocarra hollandi*

Table 2. Lateral line patterns, number of dorsal and anal rays, and vertebrae in the species of *Lycodes* in Korea

Species	Lateral line patterns	Dorsal fin rays	Anal fin rays	Vertebrae
<i>L. sadoensis</i>	Anterolateral	72~78	62~65	82~87
<i>L. japonicus</i>	Anteroventral	80~84	69~73	87~93
<i>L. toyamensis</i>	Midlateral	90~100	74~84	97~108
<i>L. sigmatoides</i>	Midlateral	93~96	72~76	99~106
<i>L. tanakae</i>	Midlateral	96~98	77~79	104~107
<i>L. nakamurae</i>	Ventral	105~109	91~97	110~118
<i>L. pectoralis</i>	Ventral	108~112	91~101	113~116

- 2b. Head and body without scales round scales present only in caudal part of body *Gymnelopsis brashinikovi*
- 3a. Posterior part of dorsal fin without short spiny rays. No dark spot on anterior part of dorsal fin 4
- 3b. Posterior part of dorsal fin with short spiny rays. Dark spot on anterior part of dorsal fin *Zoarces gillii*
- 4a. Mental crest present on lower side of head, without H-shaped dark brown marks along sides of body 5
- 4b. Mental crest absent on lower side of head, with H-shaped dark brown marks along sides of body *Davidjordania poecilimon*
- 5a. Palatine teeth present, body with some markings 6
- 5b. Palatine teeth absent, body without markings *Lycodes toyamensis*
- 6a. Lateral line restricted to preanal region 7
- 6b. Lateral line extending onto caudal region 8
- 7a. Three irregular vertical lines on side of body near caudal fin and dorsal fin with 3 or more dark spots *L. sadoensis*
- 7b. No vertical lines, body with irregular blotches and dark markings dorsal fin with irregular dark spots *L. japonicus*
- 8a. Pectoral fin rounded 10
- 8b. Pectoral fin deeply emarginate 9
- 9a. Spot present on anterior margin of dorsal fin and upper part of pectoral fin *L. nakamurae*
- 9b. No markings on anterior margin of dorsal fin and upper part of pectoral fin *L. pectoralis*
- 10a. Body with O, I-shaped brown marking. D 96~98 *L. tanakae*
- 10b. Body with S-shaped white marking. D 93~96 *L. sigmatoides*

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한국산 먹갈치속 *Lycodes* (농어목, 등가시치과) 어류 4 미기록종

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우리나라 동해안에서 채집된 등가시치과 어류 표본을 검토한 과정에서 먹갈치속 (*Lycodes*)에 포함되는 다음 4종 *Lycodes sadoensis* (국명신청: 사도먹갈치), *L. japonicus* (국명신청: 무늬가시치), *L. pectoralis* (국명신청: 북갈치), *L. sigmatoides* (국명신청: 굴꼭무늬치)는 한국미기록종으로 확인되어 사진과 함께 재기재하고 한국 등가시치과 (Zoarcidae) 5속 11종의 속 및 종검색표를 제시하였으며 지리적 분포에 대하여 기록하였다.