

<http://dx.doi.org/10.11646/zootaxa.3811.1.7>
<http://zoobank.org/urn:lsid:zoobank.org:pub:B8FB851C-255E-4DC6-B14A-EC7D48570192>

On the colour types in *Lycodes nakamurae* (Tanaka, 1914) and species composition of the subgenus *Furcimanus* (Perciformes: Zoarcidae: *Lycodes*) in the Sea of Japan

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Abstract

Two colour types were revealed in a zoarcid fish of the subgenus *Furcimanus*, genus *Lycodes*, in the Sea of Japan. A comparison of morphometric, meristic and genetic characters in dark coloured and light coloured individuals suggests that the two colour morphs represent a single species, determined to be *Lycodes nakamurae* (Tanaka, 1914). Variability in colouration within *L. nakamurae* and a lack of morphological or molecular characters distinguishing *L. nakamurae* from *L. nishimurai* Shinohara & Shirai, 2005 suggest that the latter should be considered a synonym of *L. nakamurae* (Tanaka, 1914). A record of *L. pectoralis* in the waters of the Republic of Korea is regarded as a misidentification. Thus, we conclude that only one species of the *Lycodes* subgenus *Furcimanus*, *L. nakamurae*, with dark and light colour morphs as well as specimens of intermediate colouration, inhabits the Sea of Japan.

Key words: Zoarcidae, *Furcimanus*, *Lycodes*, Sea of Japan, colour variability.

Introduction

The lycodine subgenus *Furcimanus* is distinguished from other members of the genus *Lycodes* by having forked pectoral fins and a ventral lateral line configuration. Until recently, *Lycodes nakamurae* (Tanaka, 1914) was the only representative of the subgenus *Furcimanus* known from the Sea of Japan (Lindberg & Krasukova, 1975; Toyoshima, 1985; Borets, 2000; Anderson & Fedorov, 2004; Stevenson & Sheiko, 2009). However, recently two species belonging to the subgenus—*L. nishimurai* Shinohara & Shirai, 2005 and *L. pectoralis* Toyoshima, 1985 (Shinohara & Shirai, 2005; Kim *et al.*, 2006)—were added to the ichthyofauna of the Sea of Japan.

During a trawl survey conducted in 2007 in the northern Sea of Japan, several specimens of *Furcimanus* were collected, and among these were two distinct colour morphs—a light form and a dark form. Examination of preserved specimens of the subgenus *Furcimanus* from the northern Sea of Japan also displayed the presence of two colour morphs, but a preliminary investigation of this material did not allow a specific identification of the two morphs. In this work we consider the taxonomic status of the two colour types and the species composition of the subgenus *Furcimanus* in the Sea of Japan based on morphological and genetic data.

Material and methods

Morphological analysis. Specimens of the subgenus *Furcimanus* collected in the trawl surveys in the northern Sea of Japan are deposited at the Zoological Institute of the Russian Academy of Sciences (ZIN RAS, Saint-Petersburg) and in the museum collections of the Institute of Marine Biology, Far Eastern Branch of RAS (MIMB FEB RAS, Vladivostok). A total of 74 individuals were examined. Dark (D) and light (L) morphotypes were identified by colouration analysis and are described below (Figure 1).

distances calculated between the studied eelpouts and other species of this family (*L. beringi* and *L. hubbsi*) correspond to interspecific levels (7.6% and 7.1% for COI gene; 7.9% and 9.4% for cytb gene) established for many other marine and freshwater fishes (Ward *et al.* 2005; Kartavtsev & Lee 2006; Hubert *et al.* 2008).

Taking the above findings into consideration, we conclude that the two colour morphs of the subgenus *Furcimanus* in the northern Sea of Japan belong to one species—*L. nakamurai* (Tanaka, 1914). The only described distinction between *L. nakamurai* and *L. nishimurai* was the darker colour of the body and pectoral fins in the latter (Shinohara & Shirai 2005). Thus, *L. nishimurai* Shinohara & Shirai, 2005 should be regarded as a junior synonym of *L. nakamurai* (Tanaka, 1914).

Dark and light colour morphs were earlier found in other common zoarcids inhabiting this area—*Bothrocara hollandi* and *L. yamatoi*. In both cases dark-coloured fish dwelled deeper than light-coloured ones, yet no morphological or genetic differences were detected among the colour morphs in either species (Kojima *et al.* 2001; Okiyama 2004; Kodama & Kojima 2009; Balanov & Kukhlevskii 2011).

For specimens examined in this study, the depth of occurrence was closely correlated with the colour type: dark-coloured specimens were caught only on the continental slope, while light-coloured specimens were caught on the continental shelf and slope. As in *L. yamatoi*, the darker colouration may be connected with seasonal feeding migrations to the shelf (in summer) and return to the slope for winter (Balanov & Kukhlevskii, 2011).

Kim *et al.* (2006) have recently reported another species of *Furcimanus*, *L. pectoralis* Toyoshima, 1985, from the Sea of Japan. However, when describing the discovery of *L. pectoralis* from the Republic of Korea, the authors did not indicate any of the diagnostically important characters of this species (presence or absence of scales before the dorsal fin, preanal distance to TL ratio), citing instead a series of characters peculiar to almost all eelpout of the subgenus *Furcimanus* (Kim *et al.* 2006). This species has never been found either in the northern or southwestern Sea of Japan despite the other intensive investigations conducted in these areas (Hatooka 2002; Balanov & Solomatov 2008; Dolganov & Saveliev 2013; Saveliev *et al.* 2014). The upper depth limit of *L. pectoralis* (150 m) excludes its penetration into the Sea of Japan from the southern Sea of Okhotsk through the shallow La Perouse Strait (maximum depth 53 m). For these reasons, the capture of *L. pectoralis* in the southwestern Sea of Japan is unlikely and the individuals found in the waters of the Republic of Korea (Kim *et al.* 2006) are most probably *L. nakamurai*.

Thus, our data allow us to propose that *L. nakamurai* (Tanaka, 1914), represented by two colour morphs, is the only representative of the subgenus *Furcimanus* inhabiting the Sea of Japan. The colouration of this species can vary from gray or beige with dark spots on the body and fins (or without spots) to dark-brown with the presence of intermediate forms.

Acknowledgements

The authors are sincerely grateful to Dr Eric Anderson (SAIAB) and Dr Duane Stevenson (NMFS), whose invaluable aid essentially improved this work. We also thank Dr. Gento Shinohara (NSMT) and Dr Fumihito Tashiro (NSMT) for providing radiographs of *Lycodes nishimurai* types. The study was partly supported by grants of the Russian Foundation for Basic Research 12–I–OBN–04, 12–III–A–06–086, 10–III–V–06–058, 12–04–31011, 13–04–00524.

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