

First Record of Sixbar Grouper *Epinephelus sexfasciatus* (Valenciennes, 1828) in Penghu, Taiwan

Kao-Sung Chen¹, Pei-Yu Liu¹, Hernyi J. Hsieh², Chen-Te Tseng¹,
Chi-Lun Wu³ and Sheng-Tai Hsiao^{3*}

¹Planning and Information Division, Fisheries Research Institute

²Penghu Marine Biology Research Center, Fisheries Research Institute

³Marine Fisheries Division, Fisheries Research Institute

ABSTRACT

The presence of sixbar grouper *Epinephelus sexfasciatus* (Valenciennes, 1828), Perciformes: Serranidae, was reported for the first time in Penghu Archipelago, south-western Taiwan. Two specimens were caught by hook-and-line in 28 June 2012. The species was formerly unrecorded in the Penghu and all Taiwanese waters before this paper and thus extended geographical distribution at least 500 km northward of the previously reported. The probably reasons include: (1) *E. sexfasciatus* is rare species and ignored due to misidentification as the other groupers, (2) climate change and global warming made the occurrence of poleward shift.

Key words: sixbar grouper *Epinephelus sexfasciatus*, first record, Taiwan

INTRODUCTION

The genus *Epinephelus* Bloch 1973, the most species genus of serranid fishes, was placed to the subfamily Epinephelinae and the family Serranidae, comprising more than 98 species (Heemstra and Randall, 1993). These fishes widely distributed in tropical and subtropical waters and are important targeted species for coastal fisheries due to their increasing market demand and high commercial value (Sadovy *et al.*, 2013). According to the Fish Database of Taiwan (<http://fishdb.sinica.edu.tw/>), approximately 29 genera with 119 Serranid fishes have been recorded in Taiwan. Owing to this high species richness, a survey of the tribe Epinephelini was conducted during 2012 in Taiwan, a newly recorded species of

Epinephelus sexfasciatus was found.

E. sexfasciatus (Valenciennes, 1828) (Fig. 1) usually called sixbar grouper, is a small size grouper with a maximum specimen record of 30 cm standard length reported in Philippine (Schroeder, 1980). It is usually found on the silty sand or muddy bottoms at depth of 10 to 80 meters and feed on small fishes and crustaceans. The geographical distribution is known only in the tropic western Pacific Ocean, from Sumatra, Indonesia to Papua New Guinea, and from Philippines to Queensland, Australia (Craig *et al.*, 2011).

In this study, the presence of *E. sexfasciatus* in Penghu Archipelago, south-western Taiwan, that extends its geographical range (Fig. 2a) at least 500 km northward of the previously reported limit were the first reported. To date, there is no published evidence of the presence of this species in Taiwan. The purpose of this study was to provide the morphological description and DNA barcode.

*Correspondence: 199 Hou-lh Road, Keelung 202, Taiwan. TEL: (02) 2462-2101; FAX: (02) 2463-3110; E-mail: sthsiao@mail.tfrin.gov.tw

MATERIALS AND METHODS

Two *E. sexfasciatus* specimens (FRIF0127D, FRIF0128D,) were caught by hook-and-line (roughly at a depth of 50 - 60m) in Siyupin islet (23°16', 515' N, 119°30', 168' E), a small island of Penghu Archipelago, south-western Taiwan on 28 June 2012 (Fig. 2b). The two specimens were immediately frozen and brought to Fisheries Research Institute (FRI), where the specimens were identified based on morphometric characters (as shown in Table 1) described by Heemstra and Randall (1993) and Craig *et al.* (2011). Measurement was taken to the nearest mm by using a digital caliper.



Fig. 1 Specimen of *E. sexfasciatus* caught in Penghu Archipelago, south-western Taiwan.

The muscle tissue (approximately 0.5×0.5 cm) near the caudal fin was collected and stored in 95% alcohol for analysis. Total genomic DNA was extracted from the tissues using a commercial DNA isolation kit (Gentra, Minneapolis, MN, USA). The fragment of the COI gene was amplified from total DNA by PCR using the universal oligonucleotide primers FISH-BCL (5'-TCAACYAATCAYAAAGATATYGGCAC -3') and FISH-BCH (5'-TAAACTTCAGGGTGACC AAAAAATCA-3') (Baldwin *et al.*, 2011). PCR was performed in a model Veriti 96-Well Thermal Cycler (Applied Biosystems, Foster City, CA, USA). The purified PCR products were sent to Mission Biotech (Taipei, Taiwan) for DNA sequencing. Then, the sequences of mitochondrial gene *Cytochrome*

oxidase subunit I (COI) of two specimens were used to BLAST on the GenBank database for species verification. Additionally, the phylogenetic relationships of the common serranid fishes in Penghu and one *E. sexfasciatus* COI sequence obtained from NCBI (accession number: EF607564) were inferred from both neighbor-joining (NJ) and maximum likelihood (ML) that could make proof of what species were caught.

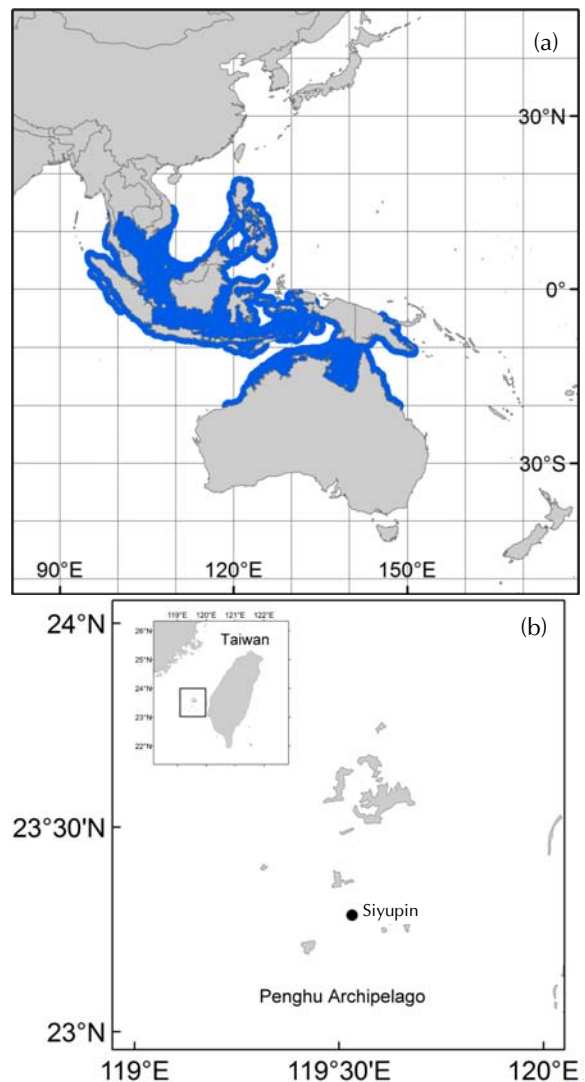


Fig. 2 (a) The geographical distribution of *E. sexfasciatus*, modification according to Heemstra and Randall (1993), Taiwan is out of its distribution; (b) The location of two *E. sexfasciatus* specimens were caught (Siyupin) (black dot).

Table 1 Morphometric characters of *E. sexfasciatus*

Morphometric characters	Specimen 1		Specimen 2	
	Measurement (mm)	% of SL	Measurement (mm)	% of SL
Total length (TL)	175		186	
Standard length (SL)	145		153	
Greatest body depth	48	33%	53	35%
Head length (HL)	61	42%	60	39%
Pectoral fin length	37	26%	40	26%
Pelvic fin length	26	18%	27	18%
Caudal peduncle length	20	14%	20	13%
Caudal peduncle depth	16	11%	16	11%
First dorsal spine length	9	6%	10	6%
Second dorsal spine length	18	13%	20	13%
Third dorsal spine length	21	15%	22	14%
Third dorsal soft ray length	22	15%	23	15%
Anal fin length	38	26%	42	27%
First anal spine length	8	6%	9	6%
Second anal spine length	16	11%	17	11%
Second anal soft ray length	25	17%	25	16%
Pelvic fin spine length	16	11%	19	12%
Snout length (% of HL)	13	21%	13	22%
Orbit length (% of HL)	14	24%	13	22%
Inter orbital width (% of HL)	8	13%	9	14%
Upper jaw length (% of HL)	25	41%	26	43%
Maxilla depth (% of HL)	7	11%	8	13%

RESULTS AND DISCUSSION

In this study, two *E. sexfasciatus* individual caught in Penghu Archipelago were reported as a newly recorded *Epinephelus* species in Taiwan. According to the results of morphological and genetic data, two specimens were identified as *E. sexfasciatus* (Valenciennes, 1828) unquestionably. The dimension of these two specimens was shown in Table 1. A description of systematics and morphology for *E. sexfasciatus* was as follows:

1. Systematics

Kingdom ANIMALIA

Phylum CHORDATA

Class ACTINOPTERYGII

Order PERCIFORMES

Family Serranidae

Genus *Epinephelus*

E. sexfasciatus (Valenciennes, 1828)

2. Synonym(s)

Cephalopholis sexfasciatus (Valenciennes, 1828);

Epinephelus sexfasciatus (Valenciennes, 1828);

Epinephelus sexfaciatus (Valenciennes, 1828);

Serranus sexfasciatus (Valenciennes, 1828)

3. Material examined

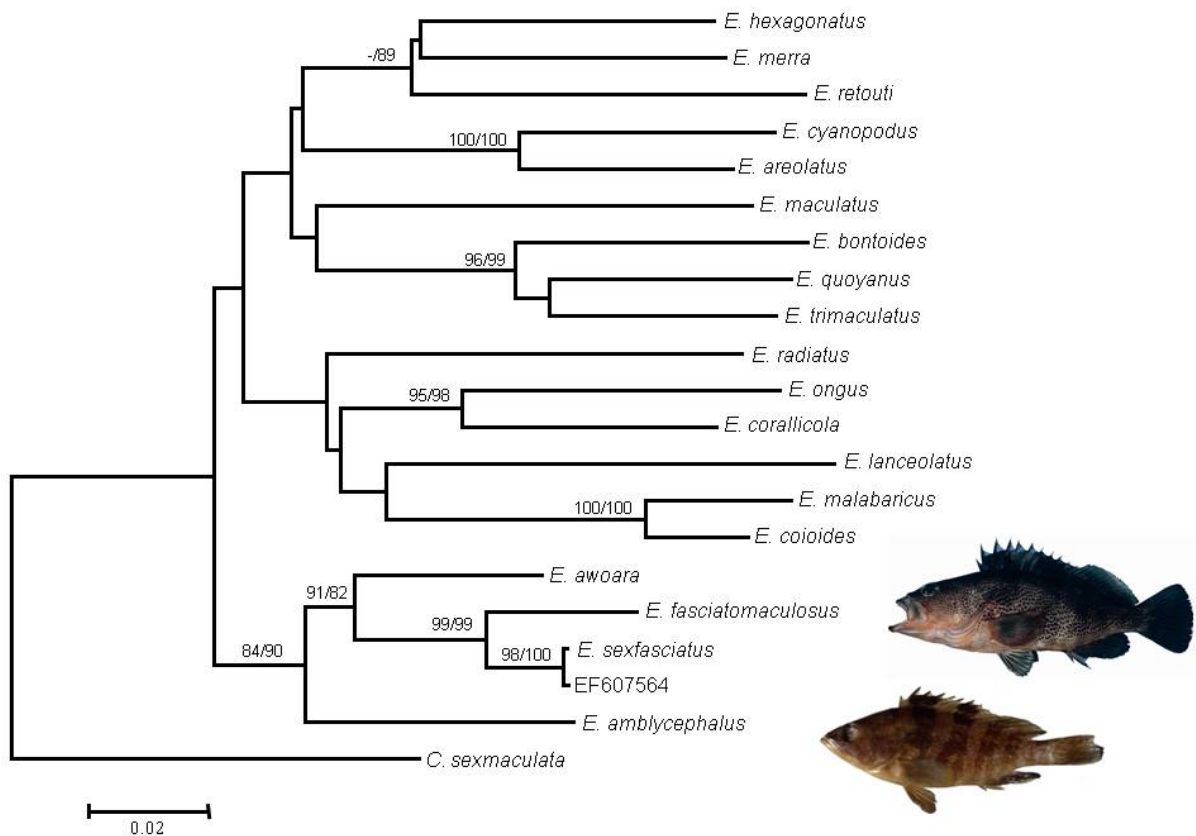


Fig. 3 Phylogenetic tree reconstructed using COI sequences of the genus *Epinephelus*. Maximum likelihood (ML) tree and Neighbor joining (NJ) tree have the identical topology. Values above each branch indicate the bootstrap (>80%, 1000 replicates) for the analysis.

FRIF0127D, FRIF0128D, 2 specimens, 18.7 - 19.7 cm SL, coll. C. C. Chen, June 28, 2012, GPS 23°16', 515' N, 119°30', 168' E, 50 - 60 m depth, Siyupin islet, Penghu Archipelago, south-western Taiwan.

4. Morphological description

The morphometric characters of these two specimens were consistent with the description of Heemstra and Randall (1993) as follows: body elongate and body depth contained 2.7 to 3.2 times in standard length. Head length contained 2.4 to 2.6 times in standard length. Preopercle with 2 to 4 greatly enlarged serrae at the angle; gill rakers 7 or 8 on the upper limb, 13 to 15 on the lower limb; dorsal fin with XI spines and 14 to 16 rays, the third or

fourth spine is the longest, the interspinous membranes are distinctly incised; anal fin with III spines and 8 rays; pectoral fin with 17 to 19 rays; caudal fin rounded. Lateral scales are ctenoid, with few auxiliary scales; lateral-line scales are 46 to 51. Head and body are pale grayish brown, 5 dark brown bars on the body and 1 on the nape. Scattered pale spots on the body and some faint small brown spots are often visible on the edges of the dark bars; soft dorsal, caudal, and pelvic fins are dusky gray, and the pectoral fin is grayish or dusky orange-red.

These two specimens were originally misidentified as rock grouper *E. fasciatomaculosus*, which is one of the most common groupers in Penghu Archipelago, due to similar color pattern and body size. Until the results of a BLAST mitochondrial DNA COI sequence and phylogenetic

tree, these two samples were identified as *E. sexfasciatus* rather than former. Both phylogenetic trees of the common *Epinephelus* fishes based on the NJ and ML methods have an identical topology, as shown in Fig. 3, also supported these two specimens are distinctly species from the other *Epinephelus* species and as same as *E. sexfasciatus* specimen obtained from NCBI. Phylogenetic trees also revealed *E. fasciatomaculosus* and *E. sexfasciatus* are genetic relationship closely species, it could be reason why these two species are so similar and easy to misidentification.

The genus *Epinephelus* Bloch 1973 contains the greatest number of species in the family Serranidae (Heemstra and Randall, 1993) and includes several complexes of sympatric and parapatric *Epinephelus* species that have overlapping geographical distributions and share similar color patterns and overlapping morphomeric characters, result to difficulty in species identification (Baldwin and Johnson, 1993; Heemstra and Randall, 1993). Within genus *Epinephelus*, some closely related species could only differ in their color pattern, on the contrary, markedly different color patterns could exist in a single species with a wide geographic distribution (Heemstra and Randall, 1993). These complex morphological characters not only result in species misidentification and underestimation of cryptic diversity (Hubert *et al.*, 2012) but also result in troublesome situations in fishery management and conservation (Morris *et al.*, 2000; Sadovy *et al.*, 2013).

Penghu Archipelago, located in the boundary between tropical and subtropical area with stretches in an area of about 70 km from south to north, is well known for abundant and diverse coral reef community and fishery resource (Hsieh, 2008). According to the Fish Database of Taiwan, there are 39 *Epinephelus* species in Taiwan, almost a half of the number of 70 species distributed in the Indo-Pacific Ocean (Craig *et al.*, 2011), that suggests it could have higher *Epinephelus* species diversity in Taiwan. To date, there is no published evidence about this species in Taiwan before, therefore, this report indicated that *E. sexfasciatus* exist in Penghu

Archipelago not only increase the number of *Epinephelus* species, but also extends its original geographical range, northern Philippine, at least 500 km northward were the first reported. Such situation of poleward shift also has been reported in other serranid fish, e.g., *Hyporthodus niveatus* (Trobiani *et al.*, 2013) and *E. marginatus* (Irigoyen *et al.*, 2005). However, because of only two *E. sexfasciatus* specimens caught, it is too early to say whether it has a self-sustaining population in Penghu Archipelago quite a while or occurrence of poleward shift recently.

Climate change and global warming could be another reason attributed to *E. sexfasciatus* occurred in Penghu Archipelago. There are increasing studies indicated that climate change could change latitudinal distribution of several marine creatures (Feary *et al.*, 2013), make some temperate marine community tropicalisation (Cheung *et al.*, 2012), that dominate by tropical fishes and the other creatures (Nakamura *et al.*, 2013) and even affect global marine biodiversity (Belkin, 2009; Jones and Cheung, 2014). In the past 50 years, the sea surface temperature (SST) of Taiwan strait rising from 0.98 to 2.03 °C among different subareas, especially there were also a warming of 2.02 °C in Penghu Archipelago (Belkin and Lee, 2014), thus could increasing potential habitat (Tseng *et al.*, 2011; Terazono *et al.*, 2012). Whatever which above reason is true, it indeed revealed that the high diversity of genus *Epinephelus* in Taiwan, which is the worthy and important treasures. Further investigations about the impact of climate change on these valuable coral reef fishes are required to apply to marine conservation and fishery management.

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澎湖海域發現之臺灣新記錄種石斑魚—六帶石斑

陳高松¹·劉姍妤¹·謝恆毅²·曾振德¹·吳繼倫³·蕭聖代^{3*}

¹行政院農業委員會水產試驗所企劃資訊組

²行政院農業委員會水產試驗所澎湖海洋生物研究中心

³行政院農業委員會水產試驗所海洋漁業組

摘 要

本研究於 2012 年 6 月 28 日在澎湖南方的西嶼坪共釣獲 2 尾六帶石斑，經外部形態與粒線體 COI 基因序列進行種類鑑定後，證實為臺灣的石斑魚新記錄種，使該種的地理分佈北界從菲律賓往高緯度延伸。可能原因包括：(1) 原已存在澎湖，但因數量稀少及石斑魚的鑑定不易導致未被發現；(2) 氣候變遷與海水暖化導致該魚種往高緯度遷移。

關鍵詞：六帶石斑 *Epinephelus sexfasciatus*、新記錄、臺灣