PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON
132:15–34. Published 12 February 2019.

Color pattern variation, nomenclatural appraisal, and re-description of *Paraplagusia japonica* (Temminck & Schlegel, 1846) (Teleostei: Pleuronectiformes: Cynoglossidae)

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Abstract.—Fringe-lip tongue soles with three ocular-side lateral lines and different ocular-side color patterns were collected mainly at fish landing ports from east to south coastal regions of China. Specimens were divided into three groups: those with color patterns previously reported for *Paraplagusia japonica* (Temminck & Schlegel, 1846) called Color Pattern I (CPI) and Color Pattern II (CPII); and those, preliminarily identified as *Paraplagusia* sp., that featured a different color pattern (CPIII). CPI featured only pale ocelli superimposed on a greenish-brown or yellowish-brown background color; CPII featured only black spots superimposed on a brownish-black or grayish-brown background color; and CPIII featured both pale ocelli and black spots mixed over a yellowish-brown or brownish-black background color. Specimens with CPI pattern are smaller in body size (78.3–279.0 mm SL) compared to the lengths of specimens with the CPII (191.7–337.1 mm SL) and CPIII patterns (155.9–352.9 mm SL). To determine whether specimens with CPIII represent a species different from *P. japonica*, a series of morphological characters and two partial gene sequences (*COI* and *RAG1*) were analyzed. Analyses revealed that specimens with these three different color patterns overlapped in 27 morphological characters including nine meristic and 18 morphometric features. And, the K2P genetic distances of *COI* and *RAG1* fragments were 0.000–0.007 and 0.000–0.006, respectively. This study confirms that fringe-lip tongue soles inhabiting coastal waters of China that possess three lateral lines, but have different ocular-side pigmentation patterns, belong to one species, *P. japonica*. These results also caution the use of pigment features as diagnostic characters to distinguish species of *Paraplagusia*. An updated redescription and synonymy for *P. japonica*, including summaries of variation in morphological characters and pigmentation, size at maturity, and geographical distribution are provided. Results of the present study will be helpful in better understanding the taxonomic significance of color patterns of cynoglossid flatfishes.

Key words: flatfish, tongue sole, pigmentation, genetic distance, neighbor-joining tree

DOI: 10.2988/18-00002

Paraplagusia Bleeker, 1865 comprises a distinctive genus of tongue soles currently recognized in the pleuronectiform family Cynoglossidae (Bleeker 1865, Ochiai 1963, Menon 1980, Chapleau 1988, Kim & Choi 1994, Li & Wang 1995). External autapomorphic features characterizing *Paraplagusia* include: labial papillae (fringes) on ocular-side lips; a strong rostral hook whose tip reaches posteriorly to, or extends beyond, the vertical through the posterior margin of the lower eye; and a single ocular-side, and two blind-side, nostrils (Bleeker 1865, 1870; Ochiai 1963). Osteological synapomorphies of *Paraplagusia* were discussed in detail by Chapleau (1988).

Currently, six valid species are recognized in the genus *Paraplagusia* (Fricke et al. 2018). Among these is *Paraplagusia japonica* (Temminck & Schlegel, 1846), a common and valuable food species of tongue sole inhabiting coastal waters of Japan (Jordan & Snyder 1900, Jordan & Starks 1907, Jordan & Hubbs 1925, Okada 1955, Kamohara 1967, Tokiharu 1986, Ochiai 1963, Ochiai in Masuda et al. 1984; Nakabo 2000, 2013), Korea (Chyung 1954, Kim & Choi 1994, Choi et al. 2002), China (Wu 1932, Chen & Weng 1965, Li & Wang 1995), and Vietnam (Voronina et al. 2016).

Paraplagusia japonica is readily distinguished from its congeners in that it has three ocular-side lateral lines (only two ocular-side lateral lines in *P. bilineata* (Bloch, 1787) and *P. bleekeri* Kottelat, 2013), branched labial papillae (unbranched in *P. longirostris* Chapleau et al., 1991 and *P. sinerama* Chapleau & Renaud, 1993), cycloid scales on the blind side of the body (ctenoid scales in *P. guttata* Macleay, 1878), and black pigment more or less located on both sides of the vertical fins which also have whitish edges (no black pigment on those of its congeners) (Temminck & Schlegel 1846, Ochiai 1963, Chapleau & Renaud 1993, Li & Wang 1995).

In previous literature dealing with *P. japonica*, several different ocular-side color patterns have been reported. Temminck & Schlegel, for example, described *Plagusia japonica* (now *Paraplagusia japonica*) based on at least 10 syntypes collected from Nagasaki Bay, Japan, as possessing three lateral lines and uniformly olive-green coloration on the ocular side of the body (Temminck & Schlegel 1846, Fig. 1A). Boeseman (1947) examined the syntype series that included two stuffed specimens (Figs. 1B and 1C) and eight alcohol preserved specimens and pointed out that the ocular-side coloration of these specimens was the same as that recorded in the original description. Kuroda (1962) and Ohashi & Motomura (2011) likewise recorded coloration of *P. japonica* as uniformly dark olive without spots. Shen (1993, 2011) described specimens collected from Taiwan as having a uniformly grayish-black coloration without spots or ocelli.

Other researchers have reported the ocular-side color pattern of *P. japonica* as having numerous, milk-yellow or light brown, roundish or elliptical blotches (solid pigmentation with irregular shape and about 3 mm in horizontal diameter); or with ocelli (hollow, circular, eye-shaped pigmentation about 3 mm in diameter and with a spot inside) that are dispersed over the entire yellowish-brown, brownish or blackish-brown surface (Wu 1929, Wu & Wang 1933, Matsubara 1955, Kuroda 1962, Ochiai 1963, Menon 1980, Kim & Choi 1994, Li & Wang 1995). Among these researchers, all, except for Wu (1929) and Wu & Wang (1933), pointed out that this color pattern occurred either on small (<150 mm SL; when size was recorded) or 'young' specimens (age not recorded for any specimens). Additionally, some researchers have reported the color pattern of *P. japonica* with black spots (solid and round pigmentations about 1.5 mm of diameter) or dark specks (solid and round pigmentations about 1 mm of diameter)

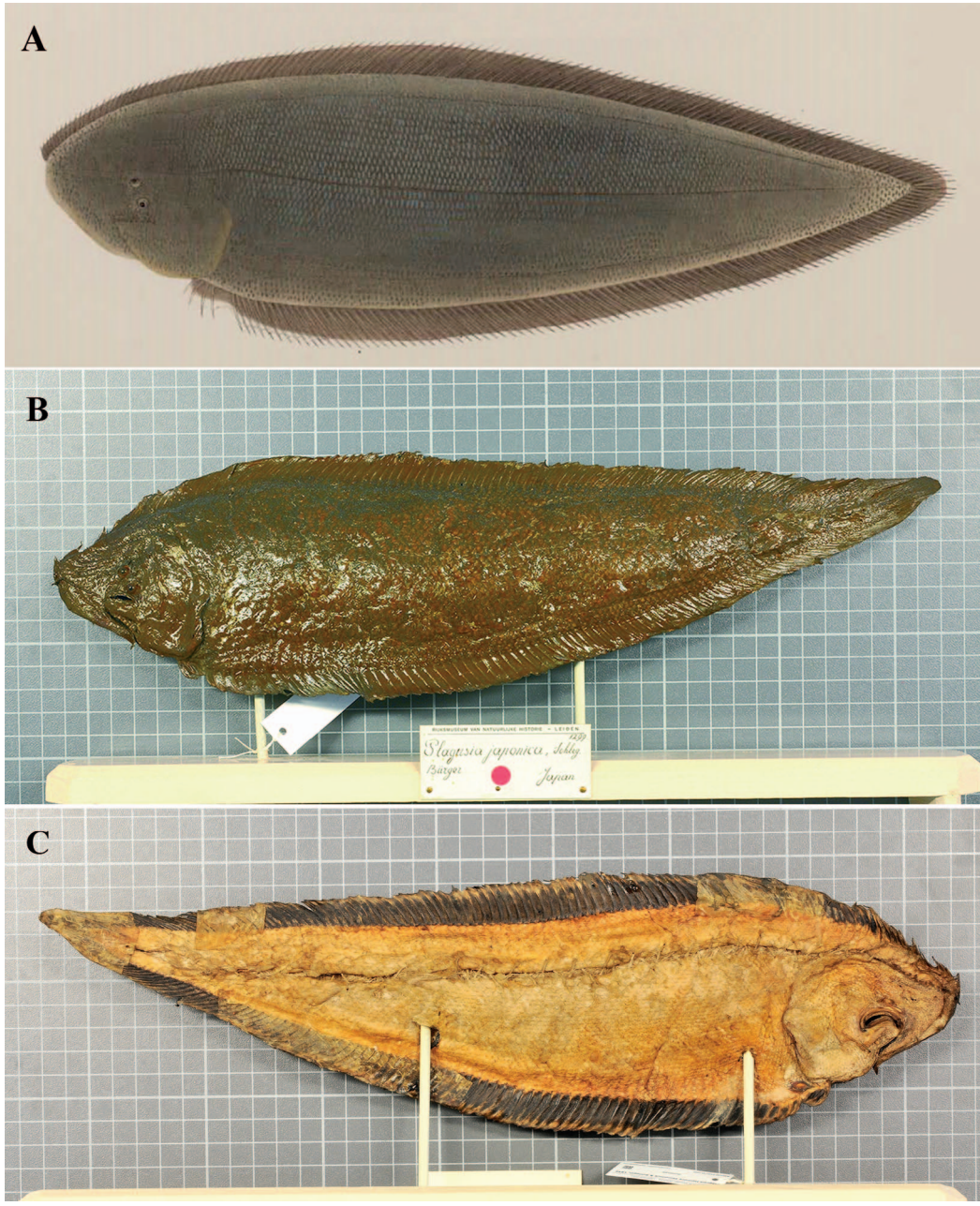


Fig. 1. Figures of types of *Paraplagusia japonica* (Temminck & Schlegel, 1846) illustrating a uniform olive-green, ocular-side coloration. A) Drawing of specimen (syntype) from the original description of Temminck & Schlegel (1846); B) Photograph of ocular side of lectotype (RMNH D1299, 465 mm SL, stuffed specimen); C) Photograph of blind side of lectotype.

irregularly or sparsely scattered over a yellowish-brown, brownish-green, brown or dark-brown ocular-side background coloration (Günther 1862, Jordan & Starks 1907, Chyung 1954, Matsubara 1955, Okada 1955, Chyung 1961, Zheng 1962, Ochiai 1963, Chu et al. 1963, Chen & Weng 1965, Menon 1980, Liao in Chu

1984, Kim & Choi 1994, Li & Wang 1995, Voronina et al. 2016). Among researchers who noted that this color pattern occurred on large or adult specimens, none recorded the ages of specimens, but most mentioned that size of their specimens exceeded 190 mm SL.

Among historical literature concerning *P. japonica*, although researchers recorded different ocular-side color patterns for specimens identified as this species, the habitats where this species has been caught have consistently been reported as muddy or sand-muddy bottoms to depths of about 100 m (Chyung 1954, Okada 1955, Ochiai 1963, Liao in Chu 1984, Li & Wang 1995).

During sampling trips conducted in 2008 to 2017 at commercial fishing ports located in coastal areas of China, we collected a quantity of specimens of *Paraplagusia* possessing three lateral lines and with ctenoid scales on the ocular side, no lateral line and with cycloid scales on the blind side, branched labial papillae, and with black pigment more or less located on both sides of the vertical fins. All of these features can be found in *P. japonica*. The interesting aspect of these specimens is that they exhibited a variety of ocular-side color patterns, including one color pattern different from any previously reported for *P. japonica*. Specimens featuring this unreported color pattern were tentatively identified as *Paraplagusia* sp.

Differences in color patterns have been used to differentiate species of flatfishes (Kuroda 1962, Zheng 1962, Li & Wang 1995), but the application of color pattern as a taxonomic character for flatfishes has also been questioned over a long period of time (Ochiai 1963, Menon 1977, Wang et al. 2014). Sometimes specimens featuring different color patterns have been identified as different species, while in other cases, they have been identified as the same species. For instance, the presence of dark-brown, cloudy blotches on the ocular side is a useful character to distinguish the tongue sole, *Cynoglossus trigrammus* Günther, 1862, from the similar appearing species, *Cynoglossus abbreviatus* (Gray, 1834) according to Li & Wang (1995). In contrast, despite obvious differences (1.8% vs 2.2% in SL) in the width of the first space between the black transverse band pairs located just behind the pectoral-fin base of the nominal species of soles, *Solea fasciatus* Basilewsky, 1855 and *Solea ommatura* Richardson, 1846, both morphological and DNA analyses (Wang et al. 2014) confirmed that these two nominal species were actually the same species, *Zebrias zebrinus* (Temminck & Schlegel, 1846).

Species of *Paraplagusia* have different ocular-side color patterns, which sometimes have been used as one of a suite of diagnostic characters to distinguish species of this genus (Ochiai 1963, Menon 1980, Chapleau & Renaud 1993). For example, presence of pale ocelli covering the entire ocular surface is a useful character to distinguish *P. bilineata* (Bloch, 1787) from another valid species, *P. bleekeri* Kottelat, 2013. However, ocular-side color patterns are not useful in clarifying the status of eight other nominal species that are currently regarded as junior synonyms of *P. bilineata* (refer to Fricke et al. 2018 for the list of nominal species regarded as junior synonyms of this species). Therefore, color pattern variations observed among specimens of *Paraplagusia* may reflect either intra-specific or inter-specific differences. To address this question and to better understand the taxonomic significance of color patterns in these flatfishes, this study combined both morphological and molecular analyses to determine whether specimens tentatively identified as *Paraplagusia* sp., i.e., those featuring a unique, previously unreported color pattern, are *P. japonica*, or if these specimens represent a different species. Based on these findings, the application of color patterns as a diagnostic character among

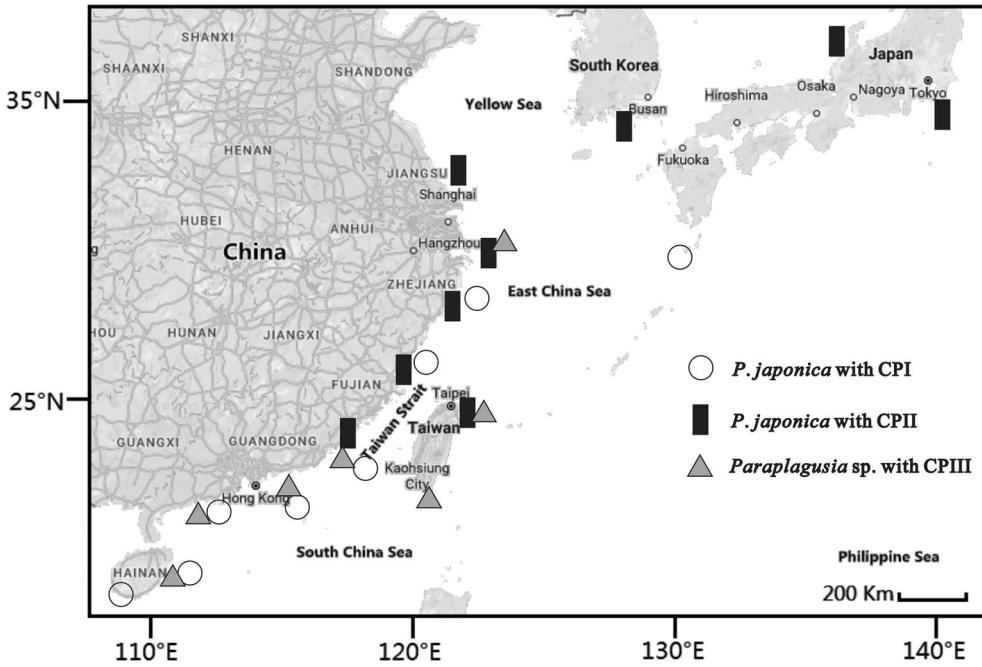


Fig. 2. Sampling localities for specimens of *Paraplagusia japonica* and *Paraplagusia* sp. examined in this study.

tongue soles of the genus *Paraplagusia* was then evaluated.

Materials and methods

Specimen information.—A total of 77 specimens of *Paraplagusia* with three lateral lines and various color patterns were examined in the present study (Fig. 2), including 65 specimens collected from east to south coastal waters off China, 11 specimens from Japan (type locality of *P. japonica*), and 1 specimen from Korea. Fresh specimens were stored in crushed ice immediately after collection, then frozen at –20°C or kept in 95% ethanol in the laboratory until ready for further processing. Voucher specimens of all color patterns were defrosted and preserved in 95% Ethanol. Detailed information for all specimens is listed below. Specimens cataloged using the acronym SCF are deposited in the fish collection of the South China Sea Institute of Oceanology, Guangzhou. All lengths are reported as standard length (SL).

Because specimens were collected from fish markets or from landings of fishing activities conducted by artisanal bottom-trawling, no specific information is available on depth of capture, substrata, or longitude and latitude for these specimens.

Material Examined: 77 specimens (78.3–352.9 mm SL) organized by three color patterns (CPI, CPII, CPIII) with gender of specimens indicated as follows: M = male; Ms = males; F = female; and Fs = females.

CPI: 35 specimens (78.3–279.0 mm); **24 immature:** Japan (N = 1): USNM 072063; (163.5 mm, F); Feb 1912; Kagoshima. China (N = 23): SCF20100000553; (126.2 mm, F); Sep 2010; Zhoushan. SCF20100000554; (139.3 mm, F); Sep 2010; Zhoushan. SCF20160419548; (174.1 mm, M); Apr 2016; Zhoushan. SCF20101000533; (136.4 mm, F); Oct 2010; Wenling. USNM 085984; 2(78.3 mm, M and 109.1 mm, F); Sep 1922;

Fuzhou. SCF20111000535; (153.8 mm, F); Oct 2011; Pingtan. SCF20111000536; (152.4 mm, F); Oct 2011; Pingtan. SCF20111000537; (158.8 mm, F); Oct 2011; Pingtan. SCF200910363; (129.8 mm, F); Oct 2009; Meizhoudao. SCF20151029539; (119.1 mm, M); Oct 2015; Longhai. SCF20151029540; (118.0 mm, M); Oct 2015; Longhai. SCF20151029541; (115.9 mm, F); Oct 2015; Longhai. SCF20151029542; (154.1 mm, F); Oct 2015; Longhai. SCF20151029543; (128.2 mm, M); Oct 2015; Longhai. SCF201512406; (149.6 mm, F); Dec 2015; Longhai. SCF20151030546; (106.7 mm, F); Oct 2015; Dongshandao. SCF201512408; (141.5 mm, M); Oct 2015; Chaozhou. SCF20130316547; (147.4 mm, M); Mar 2013; Shenzheng. SCF201512409; (127.4 mm, F); Oct 2015; Shenzheng. SCF20111229549; (167.2 mm, M); SCF20111229551; (157.4 mm, M); Dec 2011; Zhuhai. SCF201410473; (148.1 mm, M); Oct 2014; Lianjiang. **11 maturing:** China (N = 11): SCF20111000538; (210.7 mm, F); Oct 2011; Pingtan. SCF20151028531; (206.7 mm, F); Oct 2015; Xiamen. SCF20151028532; (210.4 mm, F); Oct 2015; Xiamen. SCF20151028534; (279.0 mm, M); Oct 2015; Xiamen. SCF20151030544545; (198.2, F); Oct 2015; Dongshandao. SCF20111229550; (188.6 mm, F); Dec 2011; Zhuhai. SCF2011244; (203.2 mm, F); Apr 2011; Wenchang. SCF201512397; (206.1 mm, F); Dec 2015; Wenchang. SCF201512399; (193.7 mm, M); Dec 2015; Wenchang. SCF20151130552; (235.6 mm, M); Nov 2015; Sanya.

CPII: 27 specimens (191.7–337.1 mm); **1 immature:** China: SCF20100000516; (194.8 mm, F); Oct 2010; Pingtan. **8 maturing:** China (N = 8): SCF20100507520; (241.9 mm, F); May 2010; Lianyungang. SCF20151021510–512; 3(194.7–221.6 mm, Ms); Oct 2015; Chongming. SCF200812472; (191.7 mm, F); Dec 2008; Ningbo. SCF2008120006; (223.7 mm, M); Dec 2008; Zhoushan. SCF20151023527; (224.7 mm, M); Oct 2015; Zhoushan. SCF20151028524; (257.7 mm, F); Oct 2015; Xiamen. **18 mature:** Japan (N = 10): USNM 077174; 2(256.6, 257.4 mm, Ms); Jun 1916; Nanao. USNM 151832; (243.5 mm, M); Aug 1950; Tokyo. USNM 56387; 3(297.9–313.2 mm, M and Fs); Oct 1906; Tokyo. USNM 022576; (284.2 mm, F); Apr 1879; Musashi. NSMT-P1145559; (280.1 mm, F); May 2013; Shimane. USNM 072063; 2(261.1, 274.7 mm, Ms); Feb 1912; Kagoshima. Korea (N = 1): USNM 143417; (236.6 mm, M); Dec 1947; Fusan. China (N = 7): SCF201512405; (234.7 mm, F); Nov 2015; Chongming. SCF20151023528; (275.8 mm, F); Oct 2015; Zhoushan. SCF20100000526; (337.1 mm, F); Sep 2010; Zhoushan. SCF20101002514; (263.1 mm, F); Oct 2010; Wenling. SCF20151020515; (294.7 mm, F); Oct 2015; Wenling. SCF20100000517; (272.5 mm, F); Oct 2010; Pingtan. TW-14; (267.4 mm, F); Sep 2009; Da Shi.

CPIII: 15 specimens (155.9–352.9 mm). China (N = 15); **1 immature**: SCF201410412; (169.7 mm, M); Oct 2014; Lianjiang. **8 maturing**: SCF20151021513; (155.9 mm, F); Oct 2015; Chongming. SCF20160419529; (219.5 mm, M); Apr 2016; Zhuhai. SCF201512410; (254.8 mm, F); Nov 2015; Zhanjiang. SCF20111000518; (204.5 mm, M); Oct 2011; Pingtan. SCF20111000519; (269.6 mm, F); Oct 2011; Pingtan. SCF20151023521–523; 3(225.1–235.8 mm, Ms); Oct 2015; Xiamen. **6 mature**: SCF20151028530; (242.9 mm, M); Oct 2015; Xiamen. SCF201512407; (352.9 mm, M); Oct 2015; Dongshandao. TW-03–04; 2(269.7, 314.3 mm, Fs); Aug 2009; Nanfang Ao. LMY-58; (310.5 mm, F); Aug 2009; Nanfang Ao. SCF20151129525; (243.3 mm, F); Nov 2015; Haikou.

Morphological analysis.—Twenty-seven morphological characters were analyzed, including nine meristic features, and 18 morphometric features. Definitions and abbreviations of counts and measurements follow below.

Methods for counting meristic features generally follow those listed in (Wang et al. 2016), including caudal-fin rays (CFR), pelvic-fin rays (PFR), dorsal-fin rays (DFR), anal-fin rays (AFR), total vertebrae (TV), abdominal vertebrae (AV), midlateral-line scales (MLL), and scale rows between the dorsolateral line and midlateral line (DMLL). Additionally, numbers of branched and unbranched labial papillae (LPP) were counted. Counts of fin rays and vertebrae were made from radiographs; other meristic features were counted directly from the specimens.

Methods for measuring morphometric features generally follow those presented in (Wang et al. 2016), including standard length (SL), body depth (BD), preanal length (PAL), head length (HL), head width (HW), pelvic-fin length (PFL), caudal-fin length (CFL), postorbital head length (POL), upper head lobe (UHL), lower head lobe (LHL), snout length (SNL), length of ocular-side upper jaw (UJL), diameter of orbit of lower eye (LED), interorbital width (IOW), distance between snout tip to angle of mouth (DSM), and distance between angle of mouth to opercular margin (AMO). In addition, length of rostral hook (RHL) was measured as the distance from the point opposite the mandibular joint to the posterior tip of the rostral hook. All measurements were made on the ocular side, except for PAL and CFL made on the blind side, using digital calipers and were recorded to one-tenth of a millimeter. In text and tables, the measurements from BD to LHL are presented as proportions of SL; those from SNL to RHL are presented as proportions of HL; additionally, HW is presented as proportions of both SL and HL.

Sex of specimens was determined macroscopically by examining shape and size of the gonads (Wang et al. 2016). Males have small, non-elongate, round or elliptical testes, and little change in external morphology occurs in the shape of the testes as males mature. In contrast, ovaries undergo obvious morphological change as females mature. Three maturity stages were described in females: immature females have small, triangular-shaped ovaries with only slight posterior elongation; maturing females have elongate ovaries that reach to approximately the body midpoint; and mature females have elongate ovaries that extend posteriorly beyond the body midpoint and are evident (usually) and easily observed through the body wall, and often also have developing ova.

Molecular analysis.—Two gene fragments, one of mitochondrial cytochrome c oxidase subunit I gene (*COI*) and the other of nuclear recombination activation 1 gene (*RAG1*) were sequenced based on 14 specimens selected from 77 specimens, including five specimens of *Paraplagusia* sp. with the unreported color pattern (CPIII), nine specimens of *P. japonica* with previously reported color patterns (CPI and CPII), and one specimen of *P. japonica* (CPII) collected from Japan (type locality). Total genomic DNA was extracted from the muscle of these specimens using a marine animal tissue DNA kit (TIANGEN Biotech, Beijing, China) following the manufacturer's protocol. Primers for amplification of the two fragments were as follows: F-COI: 5′-CTAAGC CATCCTACCTGTG-3′, R-COI: 5′-TCAACTCCTCCCTTTCTCG-3′, and RAG-1F: 5′-AGCTGTAGTCAGTA YCACAARATG-3′, RAG-RV1: 5′-TCCTGRAAGATYTTGTAGAA-3′ (Wang et al. 2014, Randall & Page 2015).

The PCR reaction of 20 μl contained 1 μl of 0.2–0.5 g/l DNA template, 1 μl each of 10 μM primer, 0.2 μl of 5 U/μl LA Taq (Takara, Dalian, China), 2 μl of 10 × LA Taq Buffer II (Mg^{2+} Plus), 3.2 μl of 2.5 Mm dNTP Mixture, and 12.6 μl of sterile distilled water. The thermal cycling conditions were an initial denaturation at 95°C for 3 min, followed by 35 cycles of a denaturation at 95°C for 30 s, an annealing

at 48°C for 40 s, and elongation at 68°C for 1–2 min, with a final extension at 72°C for 10 min. The PCR products were detected in 1.0% agarose gels, purified using a Takara Agarose Gel DNA Purification Kit (Takara, China), and sequenced subsequently with an ABI 3730 DNA sequencer in both directions (Applied Biosystems, USA). The GenBank accession numbers are MH590294 to MH590323.

Sequences were analyzed using online NCBI-BLAST (https://blast.ncbi.nlm.nih.gov/Blast.cgi), and aligned in ClustalX V 1.8.3. The Kimura two-parameter (K2P) genetic distances of intra- and inter-species were calculated in MEGA V 5.2. The neighbor joining tree (NJ) was constructed by MEGA V 5.2 based on 14 *COI* fragments and 13 *RAG1* fragments with *P. bilineata*, *P. bleekeri* and *Cynoglossus semilaevis* as outgroups, respectively.

Paraplagusia bleekeri and *P. bilineata* were chosen as outgroups in the molecular analyses because they share many morphological similarities with those of *P. japonica*. Because the ocular-side pigmentation of *P. bilineata* is consistent with that of small specimens of *P. japonica*, we hypothesized that these similarities in color pattern might indicate closer relationships between *P. bilineata* and *P. japonica*.

Results

Color patterns.—The 77 specimens of *Paraplagusia* examined were assigned to two different groups based on color pattern: 62 specimens featured color patterns previously described for *P. japonica*; 15 other specimens had a color pattern not previously reported for this species and these were tentatively identified as *Paraplagusia* sp.

The color patterns previously reported for *P. japonica* have two different variations: one color pattern (CPI) consists of numerous pale ocelli or blotches spread over the entire, greenish-brown or yellowish-brown background coloration. These ocelli and blotches vary in size ranging from those smaller than, to those two times larger than, the eye diameter. Ocelli differed in shape ranging from round to elliptical; blotches also differed in shape ranging from irregular to round or elliptical (Fig. 3A). The other color pattern (CPII) has few to many black spots and dark specks or blotches dispersed over a uniformly brownish-black or grayish-brown surface. Spots and specks were smaller than the eye diameter, whereas blotches were the same size as, or were larger than the eye diameter, and these have different shapes ranging from irregular, to round, or elliptical (Fig. 3B). Specimens featuring CPII usually also have a few inconspicuous pale ocelli scattered only on the anterior snout and also at the ventral margin of the abdomen.

Comparing specimens revealed that lengths of most specimens with CPI were shorter than those with CPII (Fig. 4). Worth noting is that lengths of two specimens with CPI were distinctly larger (235.6 and 279.0 mm SL) than not only the maximum size of specimens with CPI ($<$150 mm SL), but they also exceeded the minimum size of specimens with CPII ($>$190 mm SL) reported in previous works. One other specimen (206.1 mm SL) with CPI was unusual in that even at this large size it features an olive-green coloration (Fig. 3C), but also has a few subtle, pale ocelli, that are present only on the anterior portion of the snout and at the ventral margin of the abdomen.

The previously unreported color pattern (CPIII) features pale ocelli spread over the entire yellowish-brown or brownish-black body surface, and also includes obvious black spots or small dark blotches scattered over the trunk. The size of the pale ocelli varied from those the same as, to those two times larger than, the eye diameter, which is larger than the diameters of black spots and dark blotches (Fig. 3D). Compared to lengths of specimens

Table 1.—Morphological data of specimens in this study and those in previously published works. Abbreviations defined in text.

			Paraplagusia japonica with CPI, CPII	
Characters[1]		*Paraplagusia* sp. with CPIII (15)[2]	This study (62)	Previous works (>106)
1	CFR	8	8	**6–10**[3]
2	PFR	4	4	**4–5**
3	DFR	107–123	107–123	103–120
4	AFR	85–97	84–96	83–97
5	TV	52–55	52–57	50–56
6	AV	9	9	
7	MLL	99–118	91–114	88–115
8	DMLL	17–20	16–19	16–21
9	LPP	(10–13) + (8–9)	(10–13) + (8–9)	
10	SL	155.9–352.9	78.3–337.1	75.0–465.0
11	BD	22.3–27.5 (25.9)	23.2–29.9 (26.0)	22.2–33.3
12	PAL	17.6–22.9 (20.9)	17.4–25.5 (21.5)	
13	HL	19.0–22.2 (21.0)	18.8–23.6 (21.4)	19.1–25.0
14	HW	20.0–24.2 (22.1)	20.4–26.4 (22.6)	
15	PFL	3.0–4.9 (4.1)	2.9–6.4 (4.4)	3.7–4.6
16	CFL	5.7–8.3 (7.0)	5.6–9.4 (7.2)	6.3–9.2
17	POL	8.1–10.2 (9.0)	8.3–11.2 (9.2)	
18	UHL	11.6–14.7 (13.7)	11.5–16.5 (13.8)	
19	LHL	8.5–11.2 (9.7)	8.3–14.3 (10.1)	
20	SNL	46.3–54.6 (51.0)	40.1–55.7 (49.9)	35.8–64.3
21	UJL	17.3–23.9 (21.5)	18.1–25.8 (21.8)	
22	LED	5.4–13.2 (7.9)	5.3–11.1 (7.8)	5.1–11.5
23	IOW	3.5–9.5 (7.6)	2.7–9.5 (7.5)	2.9–8.6
24	DSM	51.4–63.7 (58.7)	51.5–63.4 (57.7)	48.6–62.5
25	AMO	40.0–47.7 (42.9)	35.9–50.0 (43.3)	43.8–51.4
26	RHL	20.0–38.0 (31.8)	23.4–40.2 (32.3)	29.3–33.6
27	HW	95.7–111.8 (105.4)	89.9–129.0 (105.8)	

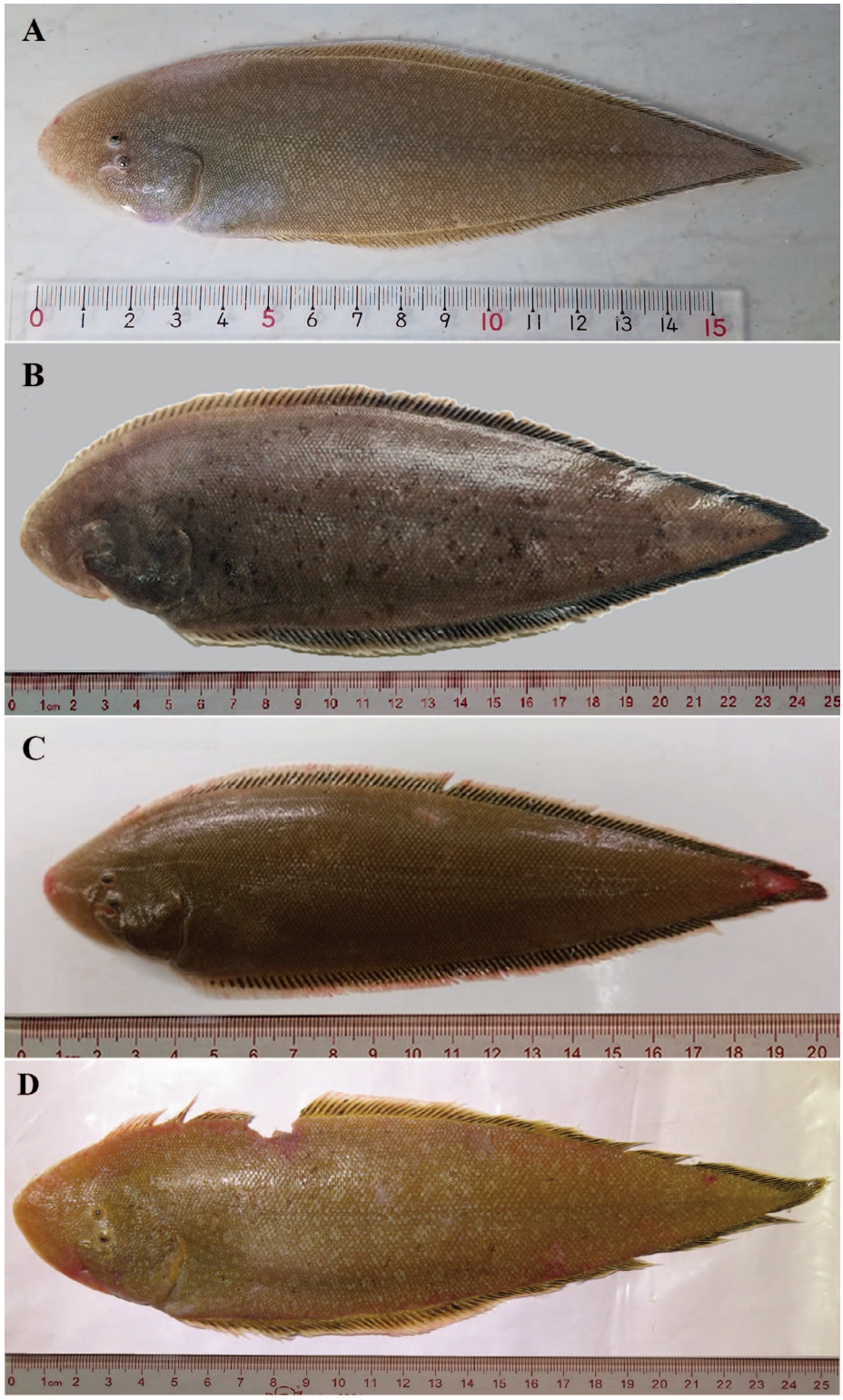
[1] Characters 11–19 expressed as percent of SL; characters 20–27 expressed as percent of HL.
[2] Numbers in parentheses represent the number of specimens measured.
[3] Numbers in bold are discussed in *Remarks* section of redescription.

with the CPII and CPIII, lengths of specimens with CPI were smaller (Fig. 4).

Morphological features.—Eighteen morphological characters were compared for more than 106 specimens of *P. japonica* reported in previous works and for 62 specimens examined in this study. Additionally, 27 morphological characters (including the 18 listed above) were compared between 15 specimens of *Paraplagusia* sp. and *P. japonica* reported previously, and in our work, respectively (Table 1).

Firstly, results comparing 18 characters of *P. japonica* between previous studies and our work revealed that the values of five of seven meristic characters and all 11 morphometric characters were consistent with, or overlapped (Table 1). The only difference in meristic features occurred in the number of caudal-fin rays and pelvic-fin rays reported in this study (8 and 4, respectively) compared with that reported (range from 6–10 and 4–5 fin rays, respectively) in previous works (Hubbs 1915, Wu 1929, Zheng 1962, Ochiai 1963, Chen & Weng 1965, Li & Wang 1995). These differences are discussed below in the *Remarks*.

Secondly, results of comparisons of 18 characters between those of *Paraplagusia* sp. from this study and those of 106+ specimens of *P. japonica* from previous works were similar to the results mentioned in the paragraph above. Values of


A
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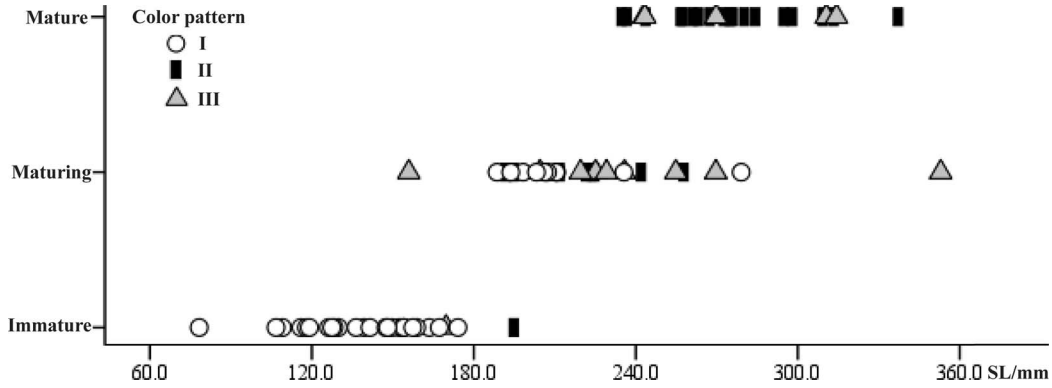

Fig. 4. Plot of stage of maturity versus standard length according to the three color patterns in specimens of *Paraplagusia* examined in this study.

27 characters of specimens of *Paraplagusia* sp. compared with those of 62 specimens of *P. japonica* from our study were similar to, or overlapped considerably (Table 1).

Thirdly, to further understand the amount of overlap in meristic features between specimens of *Paraplagusia* sp. and *P. japonica* in our study, frequency distributions of DFR, AFR, TV, MLL and DMLL were examined for 15 specimens of *Paraplagusia* sp. and 62 specimens of *P. japonica*. Ranges in frequency distributions for these features between specimens identified as *Paraplagusia* sp. and *P. japonica* showed extensive overlap. Results also revealed that modal values for each character were the same or very similar (Table 2).

Molecular sequence analyses.—The length of 14 *COI* and 13 *RAG1* gene sequences of specimens of *Paraplagusia* sp. and *P. japonica* for comparison were 545 bp and 638 bp, respectively.

The K2P genetic distances of *COI* sequences among five specimens of *Paraplagusia* sp. and among nine specimens of *P. japonica* were 0.002–0.006 and 0.000–0.007, respectively; that between specimens of *Paraplagusia* sp. and *P. japonica* were 0.000–0.007. The difference in K2P genetic distance values between the valid species, *P. bilineata* and *P. bleekeri*, was 0.169, which was significantly larger (by more than 24 times) than differences between *Paraplagusia* sp. and *P. japonica*. Based on *COI* barcoding standards (Hebert et al. 2003), inter-specific genetic distances are commonly more than 0.02. Therefore, specimens identified as *Paraplagusia* sp. and *P. japonica* exhibit no inter-specific differentiation, and are considered to be the same species.

Likewise, K2P genetic distances based on *RAG1* sequences among four specimens of *Paraplagusia* sp. were 0.000–0.003, while those for nine specimens of *P. japonica* were 0.000–0.008. The K2P genetic distances between specimens of these two groups were 0.000–0.006, which is remarkably lower that between *P. bleekeri* and *P. japonica* (0.031–0.039). Therefore, *RAG1* sequences also support recognizing *Paraplagusia* sp. and *P. japonica* as the same species.

Additionally, the topology of two phylogenetic trees based on *COI* and *RAG1*

←

Fig. 3. Photographs of *Paraplagusia japonica* and *Paraplagusia* sp. collected in Chinese waters with different color patterns (CP). A) *P. japonica* with CPI featuring pale ocelli; B) *P. japonica* with CPII featuring black spots; C) *P. japonica* with CPI featuring subtle pale ocelli; D) *Paraplagusia* sp. with CPIII featuring pale ocelli mixed with black spots.

Table 2.—Frequency distributions of meristic features for specimens of *Paraplagusia japonica* and *Paraplagusia* sp. Abbreviations defined in the text.

DFR	107	108	110	111	112	113	114	115	116	117	118	119	120	121	122	123	**N**
P. japonica	3	3	2	3	3	6	3	9	10	3	5	4	3	2	2	1	62
Paraplagusia sp.	1		1		2	1		3	1		1	1	2		1	1	15
AFR		84	85	86	87	88	89	90	91	92	93	94	95	96	97		**N**
P. japonica		3	1	8		5	8	7	3	8	4	8	3	1	3		62
Paraplagusia sp.			1		1	1	2	1	3	2	1	1	1		1		15
TVR	52	53	54	55	56	57	**N**		**DMLL**		15	16	17	18	19	20	**N**
P. japonica	1	6	13	15	4	1	40				1	5	3	26	22	5	62
Paraplagusia sp.	1	1	2	3			7						1	1	8	5	15
MLL			91	93	94	95	96	98	99	100	101	102	103	104			
P. japonica			1	1	1	2	1	2	2	4	1	4	9	7			
Paraplagusia sp.									1				1	1			
			105	106	107	108	109	110	111	113	114	116	118				**N**
P. japonica			6	4	3	5	4	1	2	1	1						62
Paraplagusia sp.			1	1	2	2	1	1	1		1	1	1				15

sequences showed that specimens with CPI, II and III clustered into one clade with high support (99% and 94%, respectively), which was distinct from their outgroups, *P. bilineata*, *P. bleekeri* and *C. semilaevis* (Fig. 5).

Furthermore, the phylogenetic tree of the *COI* gene showed the clade containing *Paraplagusia* sp. and *P. japonica* has a closer phylogenetic relationship to *P. bleekeri* than it does to *P. bilineata*. This result refutes the hypothesis that similarities in color pattern might indicate closer relationships between *P. bilineata* and *P. japonica*.

Results of analyses of both a variety of morphological characters as well as the differences between two molecular markers confirm that specimens of *Paraplagusia* sp. (CPIII) and *P. japonica* (CPI and II) are conspecifics. These results verify that *P. japonica* has a greater diversity of color patterns than those previously reported.

Comparisons of geographical distribution, sex, and gonadal maturity of P. japonica *with various color patterns.*—In this study, the correlations among 77 specimens of *P. japonica* featuring different color patterns (CPI, II and III) with different collection localities in coastal waters off China and with the different sexes were compared. Results of these comparisons did not reveal any correspondence between the appearance of various color patterns with the different localities or with different sexes.

The relationships between gonadal maturity and presence of the three color patterns were also analyzed. Results showed that specimens with CPI were mostly immature with only a few specimens having maturing ovaries; in comparison, all specimens featuring the CPII or CPIII were either maturing or were mature (Fig. 4).

Discussion

Temminck & Schlegel (1846), the original describers of this species based on stuffed and preserved syntype specimens, and Boeseman (1947), who selected the lectotype (stuffed specimen), both recorded the ocular-side coloration of *P. japonica* as uniformly olive-green. Because of the length of time since these specimens were stuffed or were placed in preservatives, it is not possible to determine how accurately their reported coloration reflects the live pigmentation of these specimens. A similar uniform color pat-

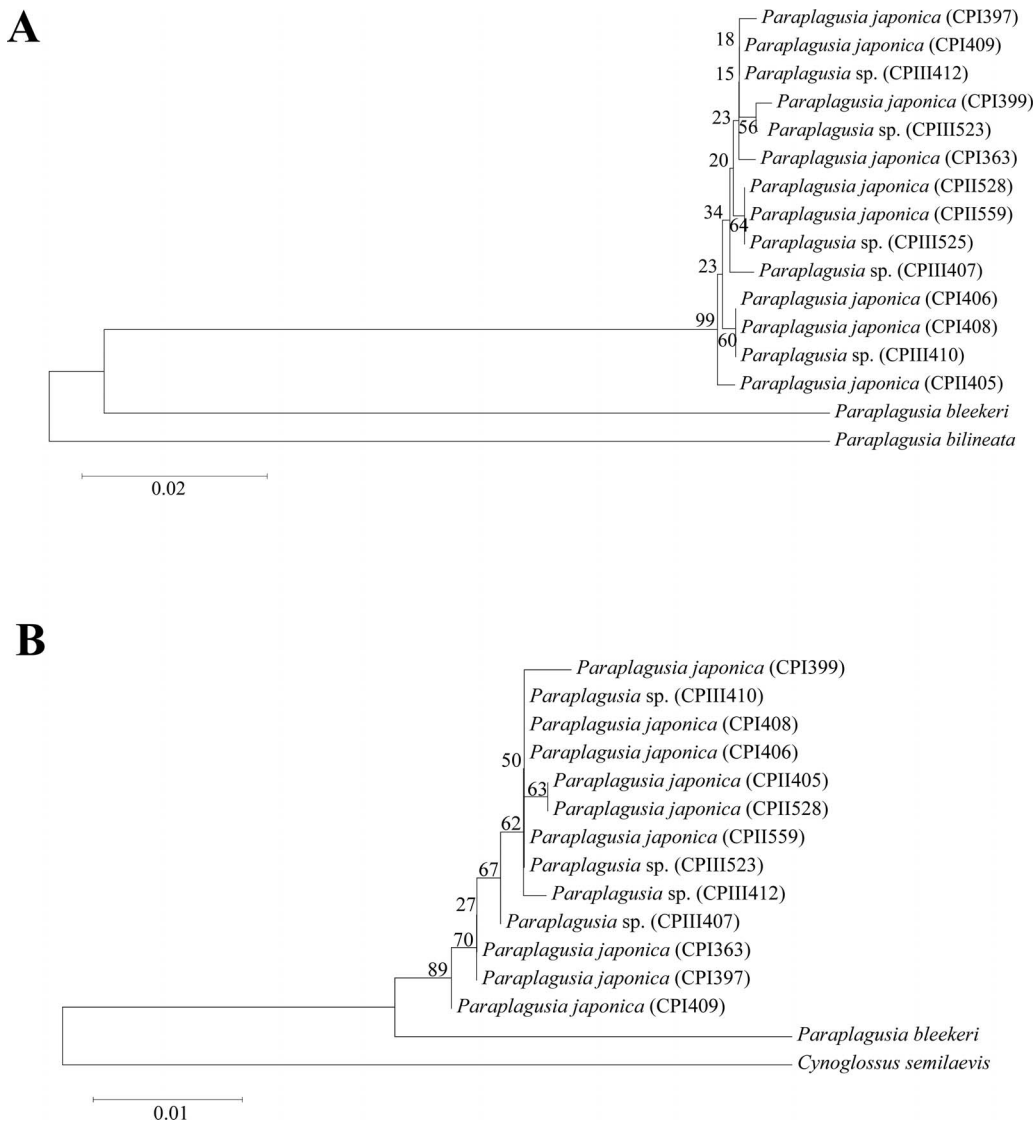

Fig. 5. Neighbor-joining trees based on *COI* (A) and *RAG1* (B) genes of *Paraplagusia japonica* and *Paraplagusia* sp., with *P. bleekeri*, *P. bilineata* and *Cynoglossus semilaevis* as outgroups. Numbers beside the branches indicate posterior probabilities; numbers in parentheses are the last three digits of catalog number; CPI, II and III are abbreviations of color pattern as defined in the text.

tern was also described by Kuroda (1962) for specimens he had examined. And Shen (1993, 2011), who referred to the same photograph in both of his studies, also reported this species as having a uniformly grayish-black coloration. Given the length of time specimens examined by Kuroda (1962) and Shen (1993, 2011) had also been stored in preservatives, it is difficult to know what the coloration patterns were of these fishes when they were freshly collected. Additionally, Ohashi & Motomura (2011) described the background coloration of *P. japonica* as uniformly olive-green, but the fish photographed actually has several, readily observed, small black spots scattered over the olive-green background.

So, given that several previous studies report a uniform coloration for this species, the question remains, do specimens of *P. japonica* really have a uniform ocular-side color pattern? Among nearly 100 fresh specimens collected in our study, examination of the ocular-side coloration revealed that, of these, only one specimen (206.1 mm SL, maturing) appeared to have a uniform olive-green coloration (Fig. 3C). However, upon closer examination, even this specimen has a few inconspicuous pale ocelli located on the anterior snout and at the ventral margin of the abdomen. Therefore, results of both this study and reliable previous reports indicate that a uniform ocular-side pigmentation does not exist on fresh specimens of *P. japonica*, at least not for specimens collected in Chinese waters. Additionally, uniform ocular-side coloration of *P. japonica* has been reported by only a few previous researchers, and subtle pale ocelli (CPI) or spots (CPII) usually have gone unreported in much of the previous literature as features of the ocular-side color pattern of this species.

This study also confirms that ocular-side coloration of *P. japonica* changes with maturity stage. Previous opinions considered that pigmentation of mature specimens featured only black spots without pale ocelli, whereas, that of immature specimens featured only pale ocelli without black spots. In contrast, the present study documented the presence of black spots on maturing specimens, including some where pale ocelli were also present. This indicates that ontogenetic change in color pattern happens gradually, not suddenly, as reflected in the appearance of CPIII on both medium- and large-sized specimens (>200 mm SL).

Although pigmentation can be an important diagnostic character to distinguish species of flatfishes, this character is not suitable for all species. Results of the present investigation reveal that caution should be used when assessing color patterns as a diagnostic character for species of *Paraplagusia*. In terms of the taxonomic significance for species of Cynoglossidae, the usefulness of color pattern depends not only on the individual species, but also, for those species where color pattern exhibits variability, it may also depend on different stages of maturity. Given that size at maturity remains unknown for the majority of species in this family, occurrence of ontogenetic changes in color pattern is largely unknown for these fishes.

Based on these new data, a comprehensive redescription of *P. japonica*, including an updated synonymy, as well as updated summaries of morphological characters, pigmentation variation, size at maturity, and geographical distribution, is provided for this species in the following section.

Paraplagusia japonica (Temminck & Schlegel, 1846)

Plagusia japonica Temminck & Schlegel, 1846:187. Günther 1862:492. Otaki 1896:34. Boeseman 1947:151.

Usinostia japonica. Jordan & Snyder 1900:380.

Usinosta japonica. Jordan & Snyder 1901:123.

Usinosita japonica. Jordan & Evermann 1903:366. Jordan & Starks 1907:237.

Rhinoplagusia japonica. Snyder 1912:441. Hubbs 1915:494. Reeves 1927:14. Chu 1931:94. Chyung 1954:489. Matsubara 1955:1285. Okada 1955:396. Chyung 1961:660. Kuroda 1962:5.

Areliscus abbreviatus (not *Plagusia abbreviatus* of Gray, 1834). Wu 1929:71. Wu & Wang 1933:303.

Paraplagusia japonica (Temminck & Schlegel, 1846). Wu 1932:141. Wu & Wang 1933:302. Zheng 1962:1001. Chu et al. 1963:536. Ochiai 1963:72. Chen & Weng 1965:49. Kamohara 1967:112. Menon 1980:18. Li 1981:11. Shen 1983:109. Ochiai in Masuda et al. 1984:355. Liao in Chu 1984:551. Chapleau & Renaud 1993:805. Shen 1993: 580. Kim & Choi 1994:809. Li &

Wang 1995:330. Choi et al. 2002:554. Ohashi & Motomura 2011:114. Nakabo 2013:1693. Voronina et al. 2016:405.

Misidentification:

Paraplagusia japonica (Houttyn). (not *Plagusia japonica* Temminck & Schlegel). Based on Pleuronectes *japonicus* Houttyn, 1782. Fowler 1934:211.

Diagnosis.—*Paraplagusia japonica* is a medium- to large-sized fringe-lip tongue sole, reaching lengths to at least 465 mm SL. This species is distinguished from congeners by the following combination of characters: three ocular-side lateral lines; ctenoid scales on the ocular side, cycloid scales on the blind side; 10–13 shorter, unbranched, upper lip papillae and 8–9 longer, branched, lower lip papillae; and vertical fins with black pigment more or less located on both sides and with white margins.

Description.—Based on 77 specimens (78.3–352.9 mm SL) from this study and 106+ specimens (75.0–465.0 mm SL) from previous works. Meristic features are summarized in Tables 1 & 2. Caudal-fin rays 8; pelvic-fin rays 4; dorsal-fin rays 103–123; anal-fin rays 83–97; total vertebrae 50–57 (abdominal vertebrae 9, and caudal vertebrae 41–48); lateral-line scales 88–118; scale rows between dorsolateral and midlateral lines 16–21.

Morphometric features are summarized in Table 1. Body moderately elongate and strongly compressed laterally; maximum body depth 22.2–33.3% of SL, greatest depth located at point between verticals through anus and body midpoint, with gradual taper anterior and posterior from this point. Head length (HL = 18.8–25.0% of SL) slightly smaller than head width (HW = 20.0–26.4% of SL). HW/HL = 0.90–1.29. Snout obtusely pointed, relatively long (SNL = 35.8–64.3% of HL), with conspicuous rostral hook (RHL = 20.0–40.2% of HL); usually posterior tip of rostral hook reaching to, or slightly beyond, vertical through posterior margin of lower eye, or occasionally extending posterior to vertical through posterior margin of lower eye by distance about equal to one diameter of lower eye.

A single, tubular, ocular-side nostril situated anterior to lower eye and dorsal to mid-point of upper lip; when depressed backwards usually reaching vertical through anterior margin of lower eye. Two nostrils on blind side; anterior nostril long and tubular, situated above anterior half of upper jaw; posterior blind-side nostril simple, concave, situated above midpoint of upper jaw. Eyes small (LED = 5.3–13.2% of HL); unequal in position with upper eye slightly in advance of lower eye and usually with posterior margin of its orbit reaching vertical through middle of lower eye; ventral margin of upper eye and dorsal margin of lower eye with two rows of minute scale-shaped pigmentation; interorbital space usually narrow (IOW = 2.7–9.5% of HL) and nearly flat, with 3–4 rows of minute ctenoid scales at its narrowest point; IOW slightly narrower than vertical diameter of eye. Mouth subterminal; upper jaw relatively short (UJL = 17.3–25.8% of HL); ocular-side mouth cleft nearly straight; blind-side mouth cleft more semi-circular; jaws usually extending posteriorly to point between verticals through middle and posterior margin of lower eye, occasionally to posterior margin of lower eye; posterior half of lower jaw with prominent dermal ridge. Interior angle of mouth located closer to posterior margin of gill-cover than to snout tip (AMO = 35.9–51.4% of HL vs DSM = 48.6–63.7% of HL). Ocular-side lips each with single row of fringed papillae; upper lip with 10–13 shorter, unbranched papillae; lower lip with 8-9 longer, branched papillae. Blind-side lips smooth, without fringes, but with series of fine dermal plicae. Postorbital head length (POL) 8.1–11.2% SL. Upper head lobe (UHL = 11.5–16.5% of SL) wider than lower head lobe (LHL = 8.3–14.3% of SL). Posterior

margin of opercle with distinct indentation at, or near, its midpoint. Teeth absent on ocular-side jaws; blind-side jaws with narrow band of small, villiform teeth. Gill membranes united ventrally forming shallow fold; gill membranes free from isthmus. Gill arches without gillrakers.

Dorsal-, anal-, pelvic- and caudal-fin rays soft, unbranched. Dorsal-fin origin on dorsal margin of head nearly reaching vertical through anterior margin of snout; anal-fin origin on ventral midline, just posterior to vent. Unpaired (blind side) pelvic fin (PFL = 2.9–6.4% of SL) located posterior to the isthmus; posteriormost pelvic-fin ray with strong membranous connection to first (anteriormost) anal-fin ray. Caudal fin pointed with central rays longer than their counterparts, relatively long (CFL = 5.6–9.4% of SL).

Three lateral lines on ocular side; middle lateral line nearly straight along its length and ending at distal tip of caudal fin; dorsal and ventral lateral lines undulating slightly and extending posteriorly along dorsal and ventral contours of body, and usually exiting body at point equal to fin rays 8–10 counted from posterior end of dorsal and anal fins. Dorsal and middle lateral lines connected by supraorbital commissure. Cephalodorsal line well developed along anterior margin of snout and ending at tip of rostral hook, connected with supraorbital line and preorbital line. Preopercular and mandibulo-opercular lines separated from each other; mandibulo-opercular line ending at or near posterior margin of opercle. No lateral lines on blind side. Ocular-side scales ctenoid, including those on lateral lines and head, except for small cycloid scales on anterior snout. Blind-side scales cycloid, scales on head approximately four times smaller than those on trunk. Anus on blind side, located dorsal to first or second anal-fin ray. Genital papilla a short tube connected to first anal-fin ray.

Pigmentation features at different sizes and maturity stages.—Color of fresh specimens and specimens preserved in alcohol for a short-term are similar, except color of preserved specimens not as bright as that of fresh specimens.

Small, immature specimens (<180 mm SL) with numerous pale ocelli scattered over entire greenish-brown or yellowish-brown background coloration; vertical fins with black pigment concentrated on both membranes and fin rays; posterior dorsal and anal fins to tip of caudal fin with a higher density of black pigmentation. Medium-sized, maturing specimens (180–240 mm SL) with yellowish-brown or brownish-black background coloration, sometimes also with numerous pale ocelli, or with pale ocelli mixed with a few black spots, other specimens in this size range without pale ocelli, but with some scattered black spots. Vertical fins of medium-sized specimens with black pigment concentrated on fin rays and membranes beginning with those at vertical through posterior margin of opercle and continuing posteriorly to tips of caudal-fin rays. Large, mature specimens (>240 mm SL) with few to many black spots or dark blotches superimposed over yellowish-brown, brownish-green, brown, or dark-brown background, sometimes also accompanied with a few light blotches; vertical fins with similar black pigment as that of medium-sized specimens (Fig. 4).

Pigmentation features common to all sizes and maturity stages.—Pelvic fin usually white, with a few scattered pepperdots (small, round and dark chromatophores) on its membrane. Both sides of all vertical fins black with white margins. Inside upper and lower oral cavity grey or black. Isthmus white on both sides. Outer surfaces of both ocular-side and blind-side opercula with same color as that on ocular and blind sides of body, respectively. Inner lining of ocular-side opercle dark-brown; inner lining of blind-side opercle white, except for dark-brown blotch on ventral region.

Distribution.—Paraplagusia japonica has widespread distribution in the western Pacific Ocean, including Japan, Korea, China, and Vietnam. This species lives on sandy-mud bottoms from shallow water to depths of about 100 m. In coastal waters off China, *P. japonica* is widely distributed from the East China Sea to the South China Sea, including coastal waters off Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, and Hainan provinces, and Taiwan Island.

Remarks.—Pleuronectes japonicus Houttuyn, 1782 was described from a specimen collected in Nagasaki, Japan. No types are known for this nominal species (Boeseman 1995). In his synopsis of the fishes of China, Fowler (1934:211) incorrectly transferred the nominal species *Pleuronectes japonicus* Houttuyn, 1782 to the genus *Paraplagusia*, and listed the species as *Paraplagusia japonica* (Houttuyn). The brief redescription of the species that Fowler listed as *Paraplagusia japonica* (Houttuyn) was based in part on the record of *Usinosita japonica* (Temminck & Schlegel, 1846) in Jordan & Starks (1907), and also on the partial meristic data for *Plagusia japonica* Temminck & Schlegel, 1846 that appeared in Günther's (1862) work. In his synonymy for *Paraplagusia japonica* (Houttuyn), Fowler also included the name *Rhinoplagusia japonica* with reference (but not authorship) to the works of Reeves (1927) and Chu (1931). However, Reeves (1927) and Chu (1931) treated *Rhinoplagusia japonica* as a combination for *Plagusia japonica* Temminck & Schlegel,1846.

Based on his synonymy and redescription, Fowler (1934) considered there to be only one nominal species represented by both of the names, *Pleuronectes japonicus* Houttuyn, 1782 and *Plagusia japonica* Temminck & Schlegel, 1846, and he chose *Paraplagusia japonica* (Houttuyn) as the appropriate name for this nominal species. Fricke et al. (2018) recently expressed the opinion that the names *Plagusia japonica* Temminck & Schlegel, 1846 and *Pleuronectes japonicus* Houttuyn, 1782 were likely not independent. And, according to Fricke et al. (2018), if *Pleuronectes japonicus* Houttuyn 1782 refers to the same species of *Paraplagusia* described by Temminck & Schlegel, then Houttuyn's name, since it predates the description of *Plagusia japonica* Temminck & Schlegel, 1846, would have priority. However, Fricke et al. further noted that *Pleuronectes japonicus* Houttuyn 1782 has not been used as a valid name since 1899 and they recommended that it be suppressed if representing a valid name for a species of *Paraplagusia*.

To resolve this nomenclatural problem requires critical information regarding whether one or two nominal species are represented by these names. The answer to this question is provided in the original description of *Pleuronectes japonicus* by Houttuyn (1782). According to that description, *Pleuronectes japonicus* Houttuyn, 1782, is described as having an ocular-side pectoral fin consisting of nine fin rays and this specimen was also reported to have 16 caudal-fin rays. Since members of Cynoglossidae do not have pectoral fins as adults, the species described by Houttuyn is absolutely not a member of this family. Additionally, no members within the Cynoglossidae have more than 14 caudal-fin rays and no members of *Paraplagusia* have more than eight caudal-fin rays (Ochiai 1963, Menon 1980, Chapleau 1988, Li & Wang 1995), providing further evidence that the species described by Houttuyn is absolutely not a member of any genus within the Cynoglossidae. To which pleuronectiform family Houttuyn's nominal species should be referred requires further investigation that is beyond the scope of this paper. For our purposes, however, based on available information gleaned from the description provided in Houttuyn (1782), *Pleuronectes japonicus* Houttuyn, 1782 represents a species different from *Plagusia japonica*

Temminck & Schlegel, 1846, as well as representing a species belonging to a different family. Additionally, because *Pleuronectes japonicus* Houttuyn, 1782 does not refer to a member of the Cynoglossidae, no action to suppress this name is required at this time since this name does not have priority over other names proposed for species within this family.

Wu (1929) used the name *Areliscus abbreviatus* (Gray, 1834) in redescribing a tongue sole he examined. Later, Wu & Wang (1933) re-identified the specimen of Wu (1929) as *P. japonica* (Temminck & Schlegel, 1846), and placed Wu (1929)'s reference to *Areliscus abbreviatus* in their synonymy of *P. japonica*. Since both the redescription and figure of this specimen match those of *P. japonica* (Temminck & Schlegel, 1846), and not that of *Cynoglossus abbreviatus* (Gray, 1934), we agree with Wu & Wang (1933) that this specimen is *P. japonica*.

Caudal-fin ray counts in members of the Cynoglossidae are relatively conservative, especially when fishes with obviously missing rays or damaged caudal fins are excluded from ranges reported for a species. The reported counts for caudal-fin rays have varied in previous studies, ranging from six to ten fin rays. In summarizing information for this character from previous studies of *P. japonica*, we found caudal-fin ray counts varied as follows: 6 (7.1%), 6–7 (7.1%), 7–8 (35.7%), 8 (28.6%), 7–9 (14.3%) and 8–10 (7.1%), respectively. Results from our study reveal that 94.8% (73 of total 77 specimens) have eight CFR. Variations observed in this feature between our study and others more likely result from different methods of counting these rays employed by the authors (e.g., counts made directly from specimens vs counts made from radiographs), or are a result of some authors including counts from specimens with damaged caudal fins or those with missing fin rays. Considering the symmetrical arrangement of caudal-fin rays exhibited by species of tongue soles, and the high frequency of individuals of *P. japonica* in this and other studies that have eight CFR, we consider eight CFR to be the typical count for this species.

Pelvic-fin ray counts in members of *Paraplagusia* are also conservative; only the pelvic fin on the blind side is present, and it has four fin rays. Among previous records of pelvic-fin ray counts for *P. japonica*, only one study (Wu 1929) records this count as five; all others consistently reported four pelvic-fin rays. Results from our study also reveal that all 77 examined individuals have four PFR. Variation reported for this feature between Wu (1929) and others (including our study) more likely result from misidentification, and thus we consider four PFR to be the typical count for this species.

Acknowledgments

This study was financially supported by the National Nature Science Foundation of China (grant numbers 31872570, 31071890, 31471979) and the UCAS Joint PhD Training Program (UCAS [2015] 37). We gratefully acknowledge the help of J.-X. Dong, S.-X. Chen, and W. Shi in conducting molecular experiments and analyzing data. The authors would also like to express their gratitude to M. Price and staff of the Smithsonian Institution's Office of International Relations, to M. S. Nizinski and L. Willis (NOAA's National Systematics Lab), and to J. Clayton and S. J. Raredon (Division of Fishes, Natural History of National Museum, Smithsonian Institution) for their help with administrative logistics, loans and cataloging specimens, and for providing radiographs. Appreciation is also expressed to R. de Ruiter (Regional Museum and Natural History, Naturalis Biodiversity Center, Leiden, Netherlands) for his efforts in providing information and a photograph of the lectotype of *P. japonica*, and to Dr.

G. Shinohara (National Museum of Nature and Science, Japan) for the loan of a tissue sample and specimen of *P. japonica* collected in Japanese waters. The authors are also very grateful to Z.-C. Zhou and X.-L. Yu for providing assistance in collecting field samples.

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Associate Editor: Antony S. Harold