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A new species of tongue sole (Pisces: Pleuronectiformes: Cynoglossidae: *Cynoglossus*) from coastal waters of the South China Sea

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Abstract.—A new tongue sole, *Cynoglossus nanhaiensis*, described from 21 specimens (101.0–133.7 mm SL) collected in coastal waters of the South China Sea, is distinguished from congeners by the following combination of characters: 3 ocular-side lateral lines; no blind-side lateral lines; 2 ocular-side nostrils; 8 caudal-fin rays; 49–51 total vertebrae; 64–73 scales in the midlateral line; 11–12 scales in diagonal series between midlateral and dorsal lateral lines; 99–108 dorsal-fin rays; 77–82 anal-fin rays; pores of lateral-line scales tubular, with conspicuously black tips posteriorly; and with light- to medium-brown ocular-side background coloration overlain by numerous, small, irregular, dark blotches forming a series of narrow, interrupted, longitudinal stripes, with many specimens also featuring two large, brown spots on their caudal region. Among congeners, *C. nanhaiensis* is most similar to *C. maccullochi* Norman, 1926, described from specimens taken off Queensland, Australia, but differs in its ocular-side pigmentation (conspicuous longitudinal series of irregular blotches and caudal spots absent in *C. maccullochi*) and body depth. Features of *C. nanhaiensis* are also reminiscent of those reported for *C. dollfusi* (Chabanaud, 1931), a poorly-known nominal species from the Red Sea, and *C. itinus* (Snyder, 1909), a better-known species occurring in marine waters off Japan and Southeast Asia. *Cynoglossus nanhaiensis* differs from both species in having two (vs. one) ocular-side nostrils. *Cynoglossus itinus* also lacks the series of conspicuous, darkly-pigmented, interrupted, longitudinal stripes on the ocular side that are characteristic of *C. nanhaiensis*. *Cynoglossus nanhaiensis* is further distinguished from *C. dollfusi* in having only a single pelvic fin (vs. two in *C. dollfusi*). *Cynoglossus nanhaiensis* occurs in coastal waters of the South China Sea off southern China and Viet Nam.

Keywords: Flatfish, Tonguefish, Cynoglossid tongue sole

Tongue soles currently assigned to the genus *Cynoglossus* Hamilton, 1822 represent highly specialized flatfishes (Menon 1977, Chapleau 1988) whose members share many morphological similarities, including sinistral asymmetry, an elongate body with continuous dorsal, anal and caudal fins, and, with a singular exception, they also feature multiple (two or three)

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lateral lines on the ocular side of the body. As presently conceived, *Cynoglossus* Hamilton, 1822 is a diverse genus comprising approximately 128 nominal species, of which 60+ are considered valid (Menon 1977; Shen 1983, 1993; Ochiai 1984; Kim & Choi 1994; Li & Wang 1995; Munroe 2001, 2005, 2015a; Yamada 2002; Yokogawa et al. 2008; Eschmeyer & Fricke 2016). Species currently assigned to *Cynoglossus* are distributed in tropical and subtropical waters including those off West Africa, and those from East Africa to the western Pacific (Menon 1977; Shen 1983, 1993; Ochiai 1984; Munroe 2015b). The greatest diversity of species occurs in the Indo-West Pacific region (Menon 1977; Munroe 2015b). In waters off China and Taiwan, approximately 25 nominal species of this genus have been recorded (Oshima 1927; Wu 1932; Chen & Weng 1965; Menon 1977; Shen 1993; Li & Wang 1995; Shen & Wu 2011).

Since establishment of *Cynoglossus* by Hamilton (1822), ten other nominal genera (Kaup 1858; Jordan & Snyder 1900; von Bonde 1922; Chabanaud 1931, 1947; Whitley 1940, 1951) have been proposed for some of the tongue soles now placed in *Cynoglossus* (Menon 1977; Li & Wang 1995; Eschmeyer & Fricke 2016). These nominal genera were established on the basis of relatively few external features, mainly the number of ocular-side nostrils and/or the number of ocular-side lateral lines or differences in scale types (Menon 1977; Chapleau 1988; Li & Wang 1995). Menon (1977) conducted the most comprehensive systematic review of cynoglossine tonguefishes (exclusive of *Paraplagusia*) in which he considered all these nominal genera as junior subjective synonyms of *Cynoglossus* Hamilton. Menon did not recognize subgenera in his classification of species of *Cynoglossus*; instead, he classified the species into a number of ad hoc species groups within the genus. Li & Wang (1995) also considered some of these nominal genera as junior synonyms of *Cynoglossus* Hamilton, but unlike Menon (1977), they continued to recognize seven former nominal genera as subgenera within a more inclusive *Cynoglossus*.

In the only phylogenetic study of cynoglossid tongue soles based on morphological characters, Chapleau (1988) was unable to demonstrate monophyly of the genus *Cynoglossus*. He recommended further study to determine whether one or more genera should be recognized among tongue soles currently placed in this genus. No subsequent studies have addressed this issue; therefore, as presently conceived, *Cynoglossus* is a non-monophyletic taxon within the subfamily Cynoglossinae.

During sampling conducted from 2010–2011 at fishing ports located along the south coast of China, 53 specimens of an interesting tongue sole were recovered among fishes landed at these ports. These tongue soles feature a distinct ocular-side pigmentation pattern unlike that of any species previously reported from these waters. A specimen (ROM 71202) also with this pigment pattern, from the Gulf of Tonkin, Viet Nam (see catalogue entry for ROM), appears in a photograph (by R. Winterbottom, 2003) on the *Fishbase* website (Froese & Pauly 2016). This specimen is identified as *C. itinus* (Snyder, 1909). The same photograph, with the same identification (*C. itinus*), is also provided in the recent work on reef fishes of the East Indies by Allen & Erdman (2012). *Cynoglossus itinus* has been reported from a variety of western Pacific locations (Ochiai 1963, 1984; Menon 1977; Shen 1983, 1993; Li & Wang 1995; Nakabo 2013). Comparisons of our specimens, including ROM 71202, with those of *C. itinus* and all other nominal species currently assigned to *Cynoglossus*, reveal that they differ distinctly from these other tongue soles and represent an undescribed species. The purpose of this paper is to provide formal description of this new species.

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Materials and Methods

Specimens examined in this study are catalogued and deposited in fish collections of the Marine Biodiversity Collection of the South China Sea, Chinese Academy of Sciences (SCSMBC), United States National Museum (USNM), Royal Ontario Museum (ROM), Academia Sinica Institute of Zoology (ASIZP), and Australian Museum, Sydney (AMS). Uncatalogued specimens (reported by their field numbers) are part of the collection of study specimens in the care of X.-Y. Kong (Key Laboratory of Marine Bio-resources Sustainable Utilization, South China Sea Institute of Oceanology). All but two of the specimens were collected in the landings of commercial fishing vessels that employ bottom trawls during fishing activities conducted in the South China Sea off the coasts of Sanya and Lingshui, Hainan Province, and off Zhanjiang, Guangdong Province. Because specimens were retrieved from landings, no specific information is available on depth of capture or substrata for these specimens. The other specimens were collected off Viet Nam, one at a rotenone station in the Gulf of Tonkin, and the other was purchased from the landings of a nearshore set-net fishery operating off Phan Thiet.

Methods for counting meristic features generally follow those listed in Menon (1977), except that counts of scales dorsal to the dorsal lateral line and number of scales between dorsal and middle lateral lines were made on the ocular-side in the body region corresponding to maximum body depth of the specimen. Lateral-line scales were counted on the middle lateral line beginning with the scale located directly dorsal to the dorsal margin of the gill opening and ending with the scale at or partially overlying the posterior end of the hypural plate (usually detected as flexure point at base of caudal fin). Counts of caudal-fin rays included all fin rays supported by elements of the caudal skeleton (epural, hypurals, parhypural) as has been traditionally done for cynoglossid fishes (Norman 1928; Menon 1977). The number of pterygiophores inserted on the erisma (the first pterygiophore of the dorsal fin), and the numbers of pterygiophores inserted into interneural spaces 1 and 2 (INS1 and INS2, respectively) were also recorded. Counts of vertebrae, fin rays and pterygiophores were made from radiographs. Other meristic features were counted directly from the specimens. Abbreviations for lateral line and scale counts are: MLL– Midlateral line; DLL-MLL– scale rows between dorsolateral line (DLL) and midlateral line (MLL); SDLL– scale rows dorsal to dorsolateral line; SADLL– scales above dorsal lateral line.

Morphometric features were measured following methods presented in Menon (1977) except: Snout length (SNL) – measured as horizontal distance from anterior tip of snout to anterior rim of orbit of lower eye; Distance between snout tip to angle of mouth (DSM) – measured as horizontal distance from anterior tip of snout to posterior margin of inner angle of mouth; Eye diameter (ED) – measured as horizontal distance between anterior and posterior margins of eyeball of lower eye; and Angle of mouth to opercular margin (AMO) – measured as horizontal distance between inner angle of mouth to posterior margin of operculum. All measurements were made using digital calipers and were recorded to one-tenth of a millimeter. All measurements were made on the ocular side, except body depth (BD), pre-anal length (PAL), and caudal-fin length (CFL). Measurements in text and tables are presented as proportions of Standard length (SL) or Head length (HL).

Sex of 55 individuals was determined macroscopically by examining shape and size of the gonad. Ovaries and testes of cynoglossid tongue soles differ in both shape and size, so that sex could easily be determined by macroscopic examination of the gonads (Munroe, pers. comm.). Males of all sizes have small, non-elongate,

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round or elliptical testes. Little change in external morphology occurs in the shape of the testes as males mature, thereby precluding determination of maturity stage for males by macroscopic examination of their gonads. Ovaries, in contrast, undergo morphological change as females mature. Immature females have a small, triangular-shaped ovary with slight posterior elongation. As the female matures, the ovary grows longer and wider with obvious posterior elongation. In mature females, ova are usually evident through the ovarian wall. Because the ovary undergoes these physical changes, maturity stage for females can be estimated macroscopically by examining the size and extent of posterior elongation of the ovaries, as well as presence of ova in the gonad. Mature females often have elongate ovaries, easily visible through the body wall, that extend caudally to about 80% of the body length.

The status of many nominal species regarded as synonyms by Menon (1977) needs further study. Therefore, all nominal species currently placed in *Cynoglossus* (not just species currently recognized as valid) that share similar meristic and morphometric features with those of *C. nanhaiensis* were included in comparisons.

Results

Cynoglossus nanhaiensis sp. nov.
(Nan hai she ta; 南海舌鳎; Nanhai tongue sole)
(Figs. 1–2, Tables 1–3)

Cynoglossus itinus (not of Snyder, 1909). *Fishbase* website 2015 (color photograph, specimen reportedly from Phuket, Thailand). Allen & Erdman 2012: 1058 (color photograph, specimen reportedly from Phuket, Thailand).

Holotype.—SCSMBC007425; male, 127.6 mm SL; Sanya fishing port (18°15.0′N, 109°21.2′E); 01 May 2011.

Paratypes.—20 specimens (101.0–133.7 mm SL) recovered from fish port landings of fishing vessels operating off coasts of Sanya, Hainan Province, and Zhanjiang, Guangdong Province. **Sanya fishing port (18°15.0′N, 109°21.2′E).** SCSMBC007428; male, 123.3 mm SL; 01 May 2011; SCSMBC007429; male, 124.1 mm SL; 01 May 2011; SCSMBC007430; mature female, 133.7 mm SL; 01 May 2011; SCSMBC007431; male, 125.7 mm SL; 01 May 2011; SCSMBC007432; male, 125.4 mm SL; 24 Nov 2011; SCSMBC007433; mature female, 111.6 mm SL; 03 Jan 2010; SCSMBC007434; mature female, 112.0 mm SL; 03 Jan 2010; SCSMBC007435; male, 123.5 mm SL; 01 May 2011; SCSMBC007436; mature female, 129.1 mm SL; 01 May 2011; SCSMBC007437; mature female, 108.6 mm SL; 01 May 2011; SCSMBC007438; male, 109.0 mm SL; 01 May 2011; SCSMBC007439; male, 123.8 mm SL. 01 May 2011; SCSMBC007440; mature female, 115.6 mm SL; 01 May 2011; SCSMBC007441; male, 126.3 mm SL; 01 May 2011; SCSMBC007442; mature female, 125.4 mm SL; 01 May 2011; USNM 437189; 2 males (101.0–116.1 mm SL); 01 May 2011. AMS I.46880-001; male, 123.9 mm SL; 01 May 2011. **Zhanjiang fishing port (20°12′N, 110°11′E).** SCSMBC007426; immature female, 104.4 mm SL; 09 Nov 2010; SCSMBC007427; mature female, 103.3 mm SL; 09 Nov 2010.

Non-type specimens.—N=34**.** ROM 71202; male (97.0 mm SL); South China Sea, Viet Nam, Gulf of Tonkin, Haiphong near Ba Cac Gang, south coast (20°46′29.99″N, 107°04′40.8″E); 3 Jun 1997. ASIZP 74689; mature female (181 mm SL); South China Sea, Viet Nam, off Phan Thiet (10°55′20″N, 108°06′34″E); 22 Apr 2009. Uncatalogued specimens (with SCF field numbers), 102.0–143.4 mm SL. **Sanya fishing port.** SCF2011169; male, 143.4 mm SL; 01 May 2011. SCF2011175; female, 124.7 mm SL; 01 May 2011. SCF2011178; female, 120.9 mm

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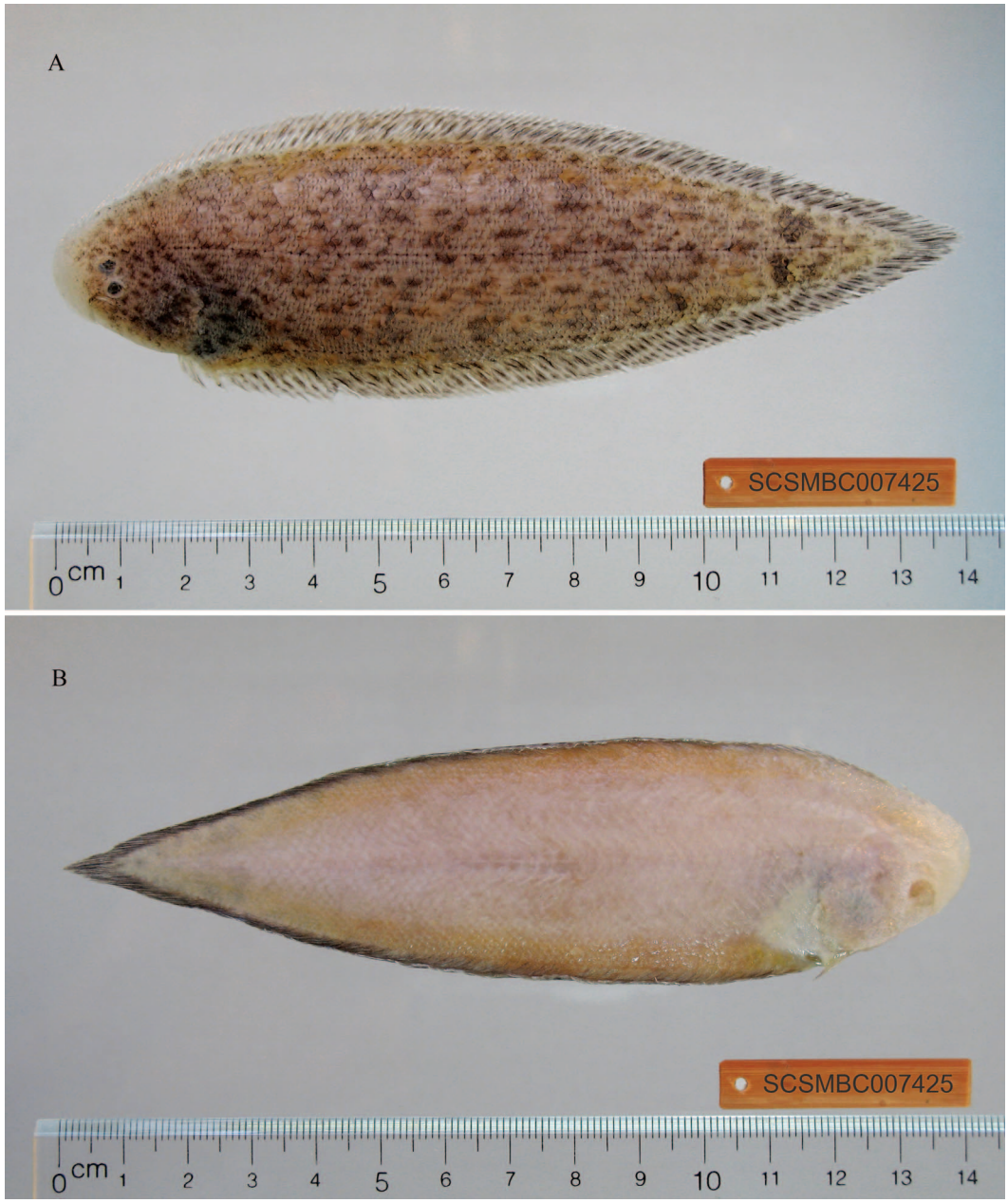


Fig. 1. *Cynoglossus nanhaiensis*, new species, holotype (fresh condition), SCSMBC007425, male, 127.6 mm SL. A. Ocular side. B. Blind side. (Photograph: Z.-M. Wang).

SL; 01 May 2011. SCF2011184; female, 114.8 mm SL; 01 May 2011. SCF2011185; male, 110.0 mm SL; 01 May 2011. SCF2011187; female, 120.1 mm SL; 01 May 2011. SCF2011189; female, 125.0 mm SL; 01 May 2011. SCF2011190; female, 105.8 mm SL; 01 May 2011. SCF2011191; male, 107.4 mm SL; 01 May 2011. SCF2011192; male, 109.2 mm SL; 01 May 2011. SCF2011194; female, 131.1

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Fig. 2. Comparison of color patterns and body shapes between *Cynoglossus nanhaiensis*, new species, and *C. maccullochi* (CSIRO H6548-01) taken off Queensland, Australia. (Photograph of *C. maccullochi* provided by D. Gledhill, CSIRO).

mm SL; 01 May 2011. SCF2011196; female, 115.5 mm SL; 01 May 2011. SCF2011197; male, 123.2 mm SL; 01 May 2011. SCF2011187; female, 120.1 mm SL; 01 May 2011. SCF2011199; female, 109.2 mm SL; 01 May 2011. SCF2011200; female 105.7 mm SL; 01 May 2011. SCF2011186; female, 129.0 mm SL; 01 May 2011. SCF2011188; female, 120.2 mm SL; 03 Jan 2010. SCF2011205; male, 122.8 mm SL; 24 Nov 2011. SCF2011206; male, 127.1 mm SL; 24 Nov 2011. SCF2011207; male, 143.2 mm SL; 24 Nov 2011. SCF2011209; male, 131.5 mm SL; 24 Nov 2011. SCF2011210; male, 126.0 mm SL; 24 Nov 2011. SCF2011211; male, 121.9 mm SL; 24 Nov 2011. SCF2011212; male, 115.1 mm SL; 24 Nov 2011. SCF2011213; female, 128.1 mm SL; 24 Nov 2011. SCF2011214; male, 133.8 mm SL; 24 Nov 2011. SCF2011215; female, 124.4 mm SL; 24 Nov 2011. SCF2011216; male, 120.5 mm SL; 24 Nov 2011. SCF2011220; female, 127.9 mm SL; 24 Nov 2011. **Zhanjiang Fishing Port.** SCF2010218; male, 107.2 mm SL; 09 Nov 2010. **Lingshui, Hainan Province (18°28′1.92″N, 110°10′52.63″E).** SCF2011201; female, 102.0 mm SL; 28 Apr 2011.

Diagnosis.—*Cynoglossus nanhaiensis* is a relatively small species of *Cynoglossus* (reaching to ca. 181 mm SL) distinguished from congeners by the following combination of characters: 3 ocular-side lateral lines (dorsal, middle, and ventral); no lateral lines on blind side; 8 caudal-fin rays; two nostrils on each side; a single (blind side) pelvic fin; 99–108 dorsal-fin rays; 77–82 anal-fin rays; 9 + 40–42= 49–51 (usually 50–51) total vertebrae; 64–73

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Table 1.—Frequency distributions of meristic features for the holotype and 20 paratype specimens of *Cynoglossus nanhaiensis* collected in coastal waters of the South China Sea off China. Counts for the holotype (SCSMBC007425) indicated by an asterisk (*).

Dorsal-fin rays											
Count	99	100	101	102*	103	104	105	106	107	108	N
Frequency	1	1	1	6	5	3	2	1	–	1	21
Anal-fin rays											
Count			77	78	79	80	81*	82	N		
Frequency			2	–	3	3	11	2	21		
MLL											
Count	64	65	66	67	68	69	70	71	72*	73	N
Frequency	1	2	1	3	4	2	2	1	3	1	20
DLL-MLL						**Pterygiophores on Erisma**					
Count	11	12*	13	N		Count	5	6*	7	N	
Frequency	9	10	1	20		Frequency	2	16	3	21	
Pterygiophores in INS 1						**Pterygiophores in INS 2**					
Count	3*	4	5	N		Count	2	3*	4	N	
Frequency	9	8	4	21		Frequency	3	15	3	21	
Abdominal Vertebrae						**Total vertebrae**					
Count		9*				Count	49	50*	51	N	
Frequency		21				Frequency	1	16	4	21	

scales in the middle lateral line; 11–13 (usually 11–12) scales between dorsal and middle lateral lines; contiguous eyes; with posterior angle of mouth reaching point between verticals through middle and posterior margin of lower eye; ocular-side background color light to medium brown with numerous, irregular, darker blotches forming a series of narrow, interrupted, longitudinal stripes; posterior tips of tubular pores of all lateral-line scales (including those of dorsal, middle, cephalodorsal and mandibulo-opercular) conspicuously black; ocular sides of dorsal and anal fins with longitudinal series of dark-brown to blackish blotches and smaller dots streaked along their lengths; with blind sides of dorsal and anal fins dark-brown to blackish; and blind side of body with dense patches of melanophores on body regions overlying dorsal- and anal-fin pterygiophores.

Description.—Based on holotype and 20 paratypes. Data for meristic features summarized in Table 1. Dorsal-fin rays 99–108 ($\bar{X} = 102.9$). Anal-fin rays 77–82 ($\bar{X} = 80.2$). Caudal-fin rays 8 (two specimens with damaged caudal fins with only 6 fin rays not included in summary). Abdominal vertebrae 3+6=9; caudal vertebrae 40–42 ($\bar{X} = 41.2$); total vertebrae 49–51, usually 50, less frequently 51 and rarely (N=1) 49. Scales in midlateral lateral line 64–73 ($\bar{X} = 68.6$). Scales between midlateral and dorsal lateral lines 11–13 ($\bar{X} = 11.6$), usually 11–12. Number of pterygiophores inserted on the erisma 5–7, usually 6 (16/21 individuals). Number of pterygiophores inserted in INS1, 3–5, usually 3–4 (17/21 individuals). Number of pterygiophores inserted into INS2, 2–4, usually 3 (15/ 21 individuals).

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Table 2.—Proportional measurements of the holotype (SCSMBC007425) and 20 paratypes of *Cynoglossus nanhaiensis* collected in coastal waters of the South China Sea off China. Measurements 2–10 presented as percent Standard Length (SL); measurements 11–16 presented as percent Head length (HL). Abbreviations defined in text.

		Paratypes	All specimens		
Character	Holotype	Range	Mean	SD	N
1. SL (mm)	127.6	101.0–133.7	118.73	9.482	21
2. BD	27.1	24.1–27.3	26.09	0.816	21
3. PAL	16.4	14.3–20.7	17.91	1.259	21
4. PL	6.0	3.6–7.0	5.98	0.801	21
5. CFL	8.6	7.6–9.1	8.37	0.390	20
6. HL	18.4	18.3–21.1	19.70	0.870	21
7. HW	21.9	21.4–24.5	22.88	0.885	21
8. POL	9.5	9.3–11.4	10.20	0.632	21
9. UHL	14.0	10.0–15.3	13.72	1.226	21
10. LHL	11.2	9.6–11.6	10.59	0.617	21
11. SNL	37.0	29.7–43.1	35.06	2.975	21
12. UJL	21.3	17.8–24.3	20.61	1.784	21
13. ED	10.2	10.1–14.4	11.59	1.053	21
14. LED	16.2	14.2–19.0	16.17	1.121	21
15. DSM	45.5	34.3–45.7	40.18	2.950	21
16. AMO	60.0	46.0–61.5	58.28	3.244	21
17. HW/HL	1.2	1.1–1.2	1.16	0.004	21

Data for morphometric features summarized in Table 2. Body moderately elongate, strongly compressed, maximum body depth (24.1–27.3% of SL) located between anus and body midpoint, with gradual taper anterior and posterior to this point. Head length (18.3–21.1% of SL) smaller than head width (HW 21.4–24.5% of SL). HW/HL= 1.08–1.23. Snout obtusely pointed, relatively short (SNL 29.7–43.1% of HL), with short rostral hook usually extending posteriorly to point equal with vertical located just anterior to base of anterior nostril, or occasionally extending slightly posterior to vertical through posterior base of anterior nostril. Blind side of snout with numerous dermal papillae. Eyes small (ED= 10.1–14.4% of HL); unequal in position (upper eye slightly in advance of lower), usually with posterior margin of its orbit reaching vertical through middle of lower eye; eyes usually contiguous at their midpoints, occasionally with narrow interorbital space (if present, usually $<$ one-half eye diameter and covered with 3–6 scales). Two nostrils each on ocular and blind sides of snout; ocular-side anterior nostril tubular, situated anterior to anterior margin of lower eye and dorsal to mid-point of upper lip, when depressed backwards usually reaching vertical through anterior

Table 3.—Comparisons of selected morphometric (mean in parentheses) and meristic features of *Cynoglossus nanhaiensis* (N= 21 specimens), *C. ochiaii* (data from Yokogawa et al. 2008), *C. maccullochi* (data from Munroe, pers. comm.), and *C. itinus* (Ochiai 1963). Abbreviations defined in Methods section.

Character	*C. nanhaiensis* (N=21)	*C. ochiaii*	*C. maccullochi* (N=7)	*C. itinus*
SL (mm)	101.0–133.7	84.0–180	95.8–174.0	to 143
Body depth (% SL)	24.1–27.3 (26.1)	27.9–32.2 (30.4)	24.2–28.9 (26.1)	25.6–30.3
Preanal length (% SL)	14.3–20.7 (17.9)		18.2–21.6 (20.2)	
Head Length (% SL)	18.3–21.1 (19.7)	18.8–22.5 (20.8)	19.9–21.5 (20.4)	17.9–21.7
Snout length (% HL)	29.7–43.1 (36.1)	28.6–36.7 (32.1)	31.9–39.2 (36.1)	26.3–38.5
Eye diameter (% HL)	10.1–14.4 (11.6)	13.4–16.5 (14.8)	13.6–16.1 (14.7)	9.1–20.0
DSM (% HL)	34.3–45.7 (40.2)	39.6–50.5 (46.6)		
Ocular-side nostrils	2	2	2	1
Dorsal-fin rays	99–108	104–112	102–107	100–114
Anal-fin rays	77–82	83–88	73–83	79–87
Caudal-fin rays	8	10	8	8
MLL	64–73	67–73	68–76	68–77
DLL-MLL	11–12	11–12	10–13	12–14
SDLL	3	3–4		
Total Vertebrae	49–51	52–54	50–51	50–54
Abdominal vertebrae	9	8–9	9	9
Caudal vertebrae	40–42	43–45	41–42	41–45

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margin of orbit of lower eye; ocular-side posterior nostril simple, located in anterior interorbital region between anterior margins of eyes. Mouth sub-terminal; upper jaw length (UJL) relatively small (17.8–24.3% 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 pupil, occasionally to posterior margin of eye; posterior half of lower jaw with prominent dermal ridge. Interior angle of mouth extending posteriorly to vertical through middle of lower eye; interior angle of mouth located closer to snout tip than to posterior margin of gill-cover (compare DSM vs. AMO in Table 2); distance between angle of mouth and anterior tip of snout (DSM) 34.3–45.7% of HL. Lips smooth, without fringes or dermal flaps; lips on blind side incrassate compared with ocular-side counterparts. Teeth absent on ocular-side jaws; blind-side dentary with narrow band of small, villiform teeth; blind-side premaxilla with single row of small villiform teeth. Upper head lobe (UHL= 10.0–15.3% of SL) wider than lower head lobe (LHL= 9.6–11.6% of SL). Posterior margin of operculum with deep indentation at, or near, its midpoint. Gill membranes united ventrally forming shallow fold; gill membranes free from isthmus. Gill arches without gillrakers.

Dorsal-, anal- and caudal-fin rays soft, unbranched; dorsal- and anal-fin rays without scales on both their ocular and blind sides; blind side of caudal fin with small patch of scales on proximal one-third to one-half of fin. Dorsal-fin origin on mid-snout at point about 3–5 scale rows dorsal to horizontal through middle of upper eye; anal-fin origin just posterior to vent. Unpaired (blind side) pelvic fin (PL= 3.6–7.0% of SL) with 4 rays and located ventral to preopercular angle; posteriormost pelvic-fin ray with strong membranous connection to first (anteriormost) anal-fin ray.

Three lateral lines on ocular side; middle lateral line nearly straight along its length from vertical at posterior margin of opercle to tip of caudal fin; dorsal and ventral lateral lines undulating slightly and extending posteriorly along dorsal and ventral contours of body, but not reaching posterior end of body (usually exiting body at point equal to fin rays 5–16 counted from posterior end of dorsal and anal fins). Dorsal and middle lateral lines connected by supraorbital commissure; cephalodorsal lateral line ending dorsal to midpoint of upper eye, not connected with supraorbital lateral line; preopercular and mandibulo-opercular lateral lines separated from each other; preorbital line present. No lateral line system on blind side.

Scales small, ctenoid on both sides of body including those on lateral lines and head, except for small cycloid scales on both sides of anterior snout.

Anus on blind side dorsal to first or second anal-fin ray. Genital papilla a short tube connected to first anal-fin ray.

Coloration of freshly-collected specimens.—Ocular-side background coloration uniformly light to medium brown and overlain with numerous, conspicuous, irregular, darker blotches arranged in series of several, narrow, interrupted longitudinal stripes (Fig. 1). Some specimens also with two conspicuous, irregular, dark spots on caudal region of body located dorsal and ventral to middle lateral line, respectively. Ocular sides of dorsal- and anal-fin rays streaked with series of 2–3 darker brown blotches along their lengths. Ocular sides of dorsal- and anal-fin membranes dark brown, densely pigmented with numerous, small melanophores.

Blind side uniformly white except for narrow band of conspicuous orange pigment in body musculature near base of dorsal fin from just posterior to head nearly to caudal fin, and in musculature along nearly entire base of anal fin from its origin to its posterior end; width of orange regions approaching lengths of dorsal- and

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anal-fin rays, respectively. Blind sides of membranes of dorsal and anal fins dark brown, densely pigmented with numerous tiny melanophores; melanophores sometimes extending onto body regions overlying pterygiophores.

Coloration of specimens preserved in alcohol.—Coloration of preserved specimens similar to that of freshly-collected specimens, except that colors are not as bright (Fig. 2).

Size and maturity.—Based on 55 specimens: 29 are males ranging in size from 97.0 to 143.4 mm SL, and 26 are females with a size range of 102.0–181 mm SL. The largest fish in the study is a female of 181 mm SL; the two largest males are 143.2 and 143.4 mm SL. Only seven *C. nanhaiensis*, including four males and three females, attained sizes >130 mm SL. Most fishes (18 males, 16 females) examined in this study ranged in size from 110.0–129.1 mm SL.

Of females examined, only two (102.0 and 104.0 mm SL) are immature with non-elongate ovaries. All other females (103.3–181 mm SL) are sexually mature with elongate ovaries reaching posteriorly to nearly 3/4ths of the SL. Based on these limited data, sexual maturity in females begins at sizes of ca. 103 mm SL, and reaches 100% by about 110 mm SL, as all females of this size and larger are mature.

Distribution.—Based on fishery landings, this species occurs in coastal waters off Sanya and Lingshui, Hainan Province; Zhanjiang, Guangdong Province, China; two specimens were collected off Viet Nam, one in the Gulf of Tonkin (20°46′29.99″N, 107°04′40.8″E) and the other off Phan Thiet (10°55′20″N, 108°06′34″E).

Etymology.—The name, *nanhaiensis*, is derived from the Chinese word, *Nanhai*, meaning South China Sea, in reference to localities where most specimens were collected.

Zoobank.—This work has been registered in ZooBank with the registration number D82F3274-C9CD-4E80-AA71-27B43C6D5BE5.

Other material examined.— *Cynoglossus maccullochi*, seven specimens collected off Queensland, Australia: AMS E.2693 holotype (mature female, 174 mm SL); AMS I.27525-003 (male, 112.3 mm SL); AMS I.27536-003 (immature female, 95.8 mm SL); AMS I.27532-004 (male, 128.5 mm SL); AMS I.34361-025 (male, 128.9 mm SL); CSIRO A.2699 (female, 109.5 mm SL); QM I.17444 (mature female, 123.0 mm SL).

Comparisons.—*Cynoglossus nanhaiensis* features the combination of 3 ocular-side lateral lines, 8 caudal-fin rays, a single (blind side) pelvic fin, and 2 ocular-side nostrils. Nominal species of *Cynoglossus* featuring this combination of characters include the following (Menon 1977; Li & Wang 1995): *C. abbreviatus* (Gray), *C. acutirostris* Norman, *C. gracilis* Günther (including *Areliscus hollandi* Jordan & Metz and *C. microps* Steindachner as synonyms), *C. maccullochi* Norman, *C. microlepis* (Bleeker), *C. trigrammus* Günther, and *C. xiphoideus* Günther. With exception of *C. maccullochi*, these other species have higher, and non-overlapping, meristic features compared with those of *C. nanhaiensis* (values presented in Table 1), including numbers of dorsal-fin rays (114–137), anal–fin rays (90–108), total vertebrae (55–64), midlateral-line scales (94–150), and scales between midlateral and dorsolateral lines (17–26).

Of all other nominal species currently placed in *Cynoglossus* (sensu Menon 1977), *C. nanhaiensis* is most similar in its morphometric and meristic features (see Table 3 for comparisons of selected features) to *C. maccullochi*, a species occurring off the east coast of Queensland, Australia (Norman 1926). *Cynoglossus nanhaiensis* differs from *C. maccullochi* by its conspicuous series of narrow, rectangular and darkly-pigmented blotches forming a series of several interrupted longitudinal stripes on the ocular-side body (some freckling and diffuse

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blotches present, but stripes absent in *C. maccullochi*; compare color patterns of specimens in Fig. 2). Additionally, many *C. nanhaiensis* also feature two prominent spots on the caudal region of the ocular side, whereas none of the *C. maccullochi* examined have these spots. And in *C. nanhaiensis*, the dorsal, anal and caudal fins have a series of darkly-pigmented blotches on both the fin rays and connecting membranes, whereas in *C. maccullochi* the fin pigmentation is much lighter in color and mostly on the fin rays. When expressed as proportions of their standard lengths, these two species have similar body depths; however, they differ with respect to where this greatest body depth occurs relative to their body lengths (Fig. 2). For example, *C. nanhaiensis* tends to have a more elongate shape with greatest body depth occurring over most of its postcephalic body length and with only slight tapering posteriorly. In contrast, the greatest body depth in *C. maccullochi* is at a point closer to the body midpoint, beyond which occurs more rapid posterior tapering than that in *C. nanhaiensis*. Of 14 other morphometric features measured in these species, nearly complete overlap occurred in 12 of these. The greatest differences in morphometric features between these species occurred in measurements of PAL and ED, both of which were slightly smaller in *C. nanhaiensis* (PAL 14.3–20.7% of SL, $\bar{X} = 17.91$; ED 10.1–14.4% of HL, $\bar{X} = 11.59$, respectively) compared to those of *C. maccullochi* (PAL 18.2–21.6% of SL, $\bar{X} = 20.20$; and ED 13.6–16.1, $\bar{X} = 14.69$, respectively). Although somewhat less overlap was noted in these two features compared with other characters measured, these differences were not sufficient to clearly separate all specimens of these species analyzed in this study. More data are needed for *C. maccullochi* to determine what, if any, morphometric features differ significantly to distinguish these species.

Some features of *C. nanhaiensis* are also reminiscent of those of *C. itinus* (Snyder, 1909), a species occurring in coastal seas off Japan and Southeast Asia, as well as those of *C. dollfusi* (Chabanaud, 1931), a poorly-known species described from a single specimen (now lost) from the Red Sea. *Cynoglossus nanhaiensis* differs from both *C. itinus* and *C. dollfusi* in having two ocular-side nostrils (vs. one in these others). *Cynoglossus itinus* also lacks the conspicuous series of narrow, darkly-pigmented, interrupted, longitudinal stripes on the ocular side that feature so prominently in *C. nanhaiensis* and *C. itinus* has modally higher counts for dorsal- and anal-fin rays (see Table 3).

Cynoglossus dollfusi, considered a junior subjective synonym of *C. sealarki* Regan, 1908 by Chabanaud (1947, 1954), also has some features similar to those of *C. nanhaiensis*, including 3 ocular-side lateral lines, 8 caudal-fin rays and similarities in some other meristic features. However, *C. nanhaiensis* differs markedly from *C. dollfusi* in having two ocular-side nostrils and in possessing only a single pelvic fin (vs. one ocular-side nostril and two pelvic fins in *C. dollfusi*).

Another recently-described species from Japanese waters that features three ocular-side lateral lines and two ocular-side nostrils is *C. ochiaii* Yokogawa et al., 2008. Although *C. ochiaii* shares these features with *C. nanhaiensis*, these two species are easily distinguished by differences in their ocular-side coloration patterns (*C. ochiaii* is uniformly dark brown without the interrupted longitudinal stripes so conspicuous in *C. nanhaiensis*). *Cynoglossus nanhaiensis* also differs from *C. ochiaii* in having 8 (vs.10 in *C. ochiaii*) caudal-fin rays, and *C nanhaiensis* has fewer dorsal-, and anal-fin rays (compare values in Table 3). *Cynoglossus nanhaiensis* also has a more slender body (BD 24.1–27.3% in SL) than that of *C. ochiaii* (27.9–32.2% in SL), and its lower eye is also smaller (ED 10.1–14.4% in SL) than that of *C. ochiaii* (13.4–16.5% in HL).

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Cynoglossus kopsii (Bleeker, 1851) has been described as having two or three ocular-side lateral lines due to the presence and/or degree of development of the ventrolateral line (Menon 1977; Li & Wang 1995; Munroe 2001). Chabanaud (1951) designated the form with two lateral lines as *Cynoglossus kopsi digramma* without further description. This designation was not accepted by later authors, and *C. kopsi digramma* was subsequently synonymized under *C. kopsii* (Menon 1977). *Cynoglossus nanhaiensis* differs from *C. kopsii* in having a long and continuous ventrolateral line (vs. absent or incomplete), and it possesses more scales on the midlateral line and in the scale rows between the dorsolateral and midlateral lines (55 and 9 in *C. kopsii*, respectively).

Four other nominal species also share some features similar to those observed in *C. nanhaiensis*. One species, currently regarded as a synonym of *C. kopsii* following Norman (1928) and Menon (1977), is *Cynoglossus brachycephalus* (Bleeker, 1870). *Cynoglossus brachycephalus* has only two ocular-side lateral lines and the midlateral and dorsolateral lines are separated by fewer scale rows (8) compared with three lateral lines and 11–12 scales between lateral lines observed in *C. nanhaiensis*. Also, *C. brachycephalus* has different ocular side pigmentation (brownish-green and diffused with small dark spots) than that of *C. nanhaiensis*, and this nominal species has more anal-fin rays (90) and fewer mid-lateral line scales (60) than comparable features in *C. nanhaiensis*.

Cynoglossus praecisus Alcock, 1890 differs from *C. nanhaiensis* in having only a single ocular-side nostril and only two ocular-side lateral lines, with the dorsolateral line ending about in the middle of the body. This species also has a different ocular-side pigmentation (ocular side uniformly sepia-brown) and greater numbers of dorsal- (112) and anal-fin rays (88).

Cynoglossus versicolor Alcock, 1890 was originally described as having two lateral lines and one ocular-side nostril, but Norman (1928), in re-examination of the type, later observed a second ocular-side nostril and a third incomplete ventrolateral line in this species. This nominal species has a yellowish-brown ocular side profusely marbled with dark brown, but differs from *C. nanhaiensis* in having slightly higher counts of dorsal- (112) and anal-fin rays (88), and has more scales (75) in the midlateral line.

Cynoglossus sibogae Weber, 1913, recognized as a valid species by Li & Wang (1995), has coffee-brown ocular-side coloration with darker, irregular spots on the scales. It differs from *C. nanhaiensis* in having two ocular-side lateral lines separated by fewer rows (10) of scales, and also has fewer scales (60) in the midlateral line.

Remarks.—On the *Fishbase* website, and also appearing in Allen & Erdman (2012: p. 1058), is a photograph (by R. Winterbottom) of a specimen (catalogued as ROM 71202) that has been identified in both cases as *C. itinus* with a collection locality of Phuket, Thailand. However, our examination of this specimen reveals that it is a specimen of our new species that was misidentified in these earlier works. This specimen has two ocular-side nostrils (vs. one in *C. itinus*), and has meristic and morphometric features and ocular-side coloration consistent with corresponding features in *C. nanhaiensis*. Collection locality information reported for this specimen in these works also is incorrect. According to catalogue information associated with the specimen, the correct locality information is the Gulf of Tonkin, Viet Nam (see locality information for ROM 71202 in material examined section above).

Discussion

The conservative body plan and resulting extensive morphological similarity among nominal species currently placed in *Cynoglossus* presents many problems to

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investigators studying these fishes. These problems are reflected in the large number of synonyms for nominal species listed in this genus (i.e., Menon 1977; Eschmeyer & Fricke 2016). Some important characters historically found useful in differentiating species of *Cynoglossus* include numbers of ocular-side nostrils (1–2), numbers of lateral lines on either side of the body (1–3 on the ocular side, 0–2 on the blind side), counts of caudal-, dorsal-, and anal-fin rays, counts of lateral-line scales and scale rows between middle and dorsal lateral lines, differences in scale type (ctenoid or cycloid) on ocular and blind sides of the body, as well as differences in morphometric features. In the only global revision of species of the genus *Cynoglossus*, Menon (1977) considered that numbers of ocular-side lateral lines and numbers of ocular-side nostrils were unreliable for differentiating species within this genus. Menon also did not utilize color features as important diagnostic characters for recognizing species. Instead, he placed great emphasis on the number of diagonal scale rows between the midlateral and dorsolateral lines and considered this feature to be among the most important for distinguishing species of *Cynoglossus*, and again in Menon (1980) when diagnosing nominal species in the related genus *Paraplagusia* Bleeker. This character is a useful diagnostic when used in combination with other characters, but many nominal species have overlapping counts for diagonal scale rows and this feature cannot be used exclusively as the only character to diagnose species in either genus (Munroe, pers. comm.). By overweighting the importance of scale rows between lateral lines, Menon (1977) unnecessarily placed a number of valid nominal species of *Cynoglossus* into synonymy (Li & Wang 1995; Yokogawa et al. 2008; Munroe, pers. comm.).

Menon's taxonomic decisions, relying on a small number of specific characters to diagnose species, consequently have resulted in considerable confusion regarding the number of valid species that should be recognized among the 128 nominal species already described and currently placed in *Cynoglossus*. More studies are needed to fully evaluate and resolve problems regarding the status of many of the nominal species treated by Menon (1977). Until such thorough review is conducted, it is recommended that when potential new species of *Cynoglossus* are discovered, all nominal species that share similar features to the potential new species, and not just those presently considered to be valid (following Menon 1977), be compared to avoid redescribing previously-described nominal species currently residing in synonymy.

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Literature Cited

Alcock, A. W. 1890. Natural history notes from H. M. Indian Marine Survey Steamer 'Investigator,' Commander R. F. Hoskyn, R. N., commanding. No. 20. On some undescribed shore-fishes from the Bay of Bengal. Annals and Magazine of Natural History (Series 6) 6(36):425–443.

Allen, G. R., & M. V. Erdmann. 2012. Reef fishes of the East Indies, Volume 3., pp. 856–1292. Tropical Reef Research, Perth, Australia.

Bleeker, P. 1851. Natuurkundig Tijdschrift voor Nederlandsch Indië, volume 2., pp. 469–497. Bijdrage tot de kennis der ichthyologische fauna van Riouw. Batavia.

Bleeker, P. 1870. Atlas ichthyologique des Indes Orientales Néêrlandaises, publiés sous les auspices du Gouvernement colonial néêrlandais. Tome VI, Pleuronectes, Scombrésoces, Clupées, Clupésoces, Chauliodontes, Saurides, pp. 1–170.

Chabanaud, P. 1931. Sur divers poissons soléiformes de la région Indo-Pacifique. II. Descriptions de trois nouvelles espéces de la Mer Rouge. Bulletin de la Société Zoologique de France 56:296–305.

Chabanaud, P. 1947. Notules ichthyologiques (suite). XXX. Additions a la faune de la Mer Rouge. Bulletin du Muséum national d'Histoire naturelle (Second Series) 19:156–157.

Chabanaud, P. 1951. Sur divers *Cynoglossus* de la région Indo-Pacifique. Annals and Magazine of Natural History (Series 12) 4:268–273.

Chabanaud, P. 1954. Notules Ichthyologiques. Notule 47. Présence inédite d'un *Cynoglossus* dans la Méditerranée orientale. Bulletin du Muséum national d'Histoire naturelle (Second Series) 26(4):464–467.

Chapleau, F. 1988. Comparative osteology and intergeneric relationships of the tongue soles (Pisces; Pleuronectiformes; Cynoglossidae). Canadian Journal of Zoology 66(5):1214–1232.

Chen, J. T. F., & H. T. C. Weng. 1965. A review of the flatfishes of Taiwan. Biological Bulletin Tunghai University Ichthyology (Series 5) 25, 27:1–103.

Eschmeyer, W. N., & R. Fricke (eds.).2016. Catalog of Fishes: Genera, Species, References. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (Electronic version accessed 1 February 2016)

Froese, R., & D. Pauly (eds.). 2016. FishBase: *Cynoglossus itinus*. Worldwide web electronic publication. Version 01/2016. Available from: http://www.fishbase.org (Electronic version accessed 7 May 2016)

Hamilton, F. 1822. An account of the fishes found in the river Ganges and its branches. Edinburgh and Hurst, London, 405 pp.

Jordan, D. S, & J. O. Snyder. 1900. A list of fishes collected in Japan by Keinosuke Otaki, and by the United States steamer *Albatross*, with descriptions of fourteen new species. Proceedings of the United States National Museum 23:335–380.

Kaup, J. J. 1858. Uebersicht der Plagusinae, der fünften Subfamilie der Pleuronectidae. Archiv für Naturgeschichte 24(1):105–110.

Kim, I. S., & Y. Choi. 1994. A taxonomic revision of the family Cynoglossidae (Pisces, Pleuronectiformes) from Korea. Bulletin of the Korean Society of Fisheries and Aquatic Science 27(6):803–813.

Li, S.-Z., & H.-M. Wang. 1995. Cynoglossidae. Pp. 324–384 *in*: S.-Z. Li & H.-M. Wang eds., Fauna Sinica, Osteichthyes: Pleuronectiformes. Science Press, Beijing. (in Chinese).

Menon, A. G. K. 1977. A systematic monograph of the tongue soles of the genus *Cynoglossus* Hamilton-Buchanan (Pisces: Cynoglossidae). Smithsonian Contributions to Zoology 238:1–129.

Menon, A. G. K. 1980. A revision of the fringe-lip tongue soles of the genus *Paraplagusia* Bleeker, 1865 (Family Cynoglossidae). Matsya No. 5(for 1979):11–22.

Munroe, T. A. 2001. Cynoglossidae. Tongue soles. Pp. 3890–3901 *in* K. E. Carpenter & V. H. Niem eds., Species identification guide for fishery purposes. The living marine resources of the Western Central Pacific, vol. 6. Bony fishes, part 4. (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine mammals. FAO, Rome.

Munroe, T. A. 2005. Systematic diversity of the Pleuronectiformes. Chapter 2, Pp. 10–41 *in* R.N. Gibson ed., Flatfishes: Biology and Exploitation. Blackwell Science Ltd., Oxford.

Munroe, T. A. 2015a. Systematic diversity of the Pleuronectiformes. Chapter 2, pp. 13–51 *in* R. N. Gibson, R. M. Nash, A. J. Geffen, & H. Van der Veer eds., Flatfishes: Biology and Exploitation, 2nd edition. Fish and Aquatic Resources (Series 16). John Wiley & Sons, Ltd., Chichester.

Munroe, T. A. 2015b. Distributions and biogeography. Chapter 3, Pp. 52–82 *in* R. N. Gibson, R. M. Nash, A. J. Geffen, & H. Van der Veer eds., Flatfishes: Biology and Exploitation, 2nd edition. Fish and Aquatic Resources (Series 16). John Wiley & Sons, Ltd., Chichester.

Nakabo, T. 2013. *Cynoglossus*. Pp. 1694–1697 *in* T. Nakabo ed., Fishes of Japan: with pictorial keys to the species. 3rd edition. Tokai University Press, Tokyo.

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Norman, J. R. 1926. A report on the flatfishes (Heterosomata) collected by the F.I.S. "Endeavour," with a synopsis of the flatfishes of Australia and a revision of the subfamily Rhombosoleinae. Biological Results Endeavour 5(5):219–308.

Norman, J. R. 1928. The flatfishes (Heterosomata) of India, with a list of the specimens in the Indian Museum, part 2. Records of the Indian Museum (Calcutta) 30(2):173–215.

Ochiai, A. 1963. Fauna Japonica, Soleina (Pisces). Biogeographical Society of Japan, Tokyo, 114 pp.

Ochiai, A. 1984. Family Cynoglossidae. Pp. 355–356 *in* H. Masuda, K. Amaoka, C. Araga, T. Uyeno, & T. Yoshino eds., The fishes of the Japanese Archipelago. Tokai University Press, Tokyo.

Oshima, M. 1927. List of flounders and soles found in the waters of Formosa, with descriptions of hitherto unrecorded species. Japanese Journal of Zoology 1(5):177–204.

Regan, C. T. 1908. Report on the marine fishes collected by Mr. J. Stanley Gardiner in the Indian Ocean. Transactions of the Linnaean Society of London (2nd Series: Zoology) 12, part 3.:217–255.

Shen, S. C. 1983. Cynoglossid fishes (Pleuronectiformes: Cynoglossidae) of Taiwan. Bulletin of the Institute of Zoology Academica Sinica 22(1):105–118.

Shen, S. C. 1993. Pleuronectiformes. Pp. 565–585 *in* S. C. Shen ed., Fishes of Taiwan. The National Taiwan University, Taipei (in Chinese).

Shen, S.-C., & K.-Y. Wu. 2011. Cynoglossidae. Pp. 763–767 *in* S.-C. Shen & K.-Y. Wu eds., Fishes of Taiwan, National Museum of Marine Biology & Aquarium, Pingtung, Taiwan.

Snyder, J. O. 1909. Descriptions of new genera and species of fishes from Japan and the Riu Kiu Islands. Proceedings of the United States National Museum 36:597–610.

von Bonde, C. 1922. The Heterosomata (flat fishes) collected by the S. S. "Pickle." Fisheries and Marine Biological Survey, Union of South Africa, Report 2:1–29.

Weber, M. 1913. Die Fische der Siboga-Expedition. E. J. Brill, Leiden, 710 pp.

Whitley, G. P. 1940. The Nomenclator Zoologicus and some new fish names. Australian Naturalist 10(7):241–243.

Whitley, G. P. 1951. New fish names and records. Proceedings of the Royal Zoological Society of New South Wales 1949-50:61–68.

Winterbottom, R. 2003. Fishbase: *Cynoglossus itinus*. Available from http://www.fishbase.org/summary/Cynoglossus-itinus.html (Electronic version accessed 09 May 2016)

Wu, H.-W. 1932. Contribution à l'étude morphologique, biologique et systématique des poissons hétérosomes (Pisces, Heterosomata) de la Chine. Ph.D. thesis, Université Paris, Paris, 178 pp.

Yamada, U. 2002. Cynoglossidae. Pp. 1388–1392 *in* T. Nakabo ed., Fishes of Japan with pictorial keys to the species, Second English edition. Tokai University Press, Tokyo.

Yokogawa, K., H. Endo, & H. Sakaji. 2008. *Cynoglossus ochiaii*, a new tongue sole from Japan (Pleuronectiformes: Cynoglossidae). Bulletin of the National Museum of Natural Sciences (Series A) Supplement 2:115–127.

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