



Article

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Taxonomic study of the *Cobitis striata* complex (Cypriniformes, Cobitidae) in Japan

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Abstract

Three new species and six new subspecies of the genus *Cobitis* from the western part of the Japanese archipelago are described: *Cobitis kaibarai* sp. nov., *Cobitis magnostriata* sp. nov., *Cobitis minamorii* sp. nov., *Cobitis striata fuchigamii* subsp. nov., *Cobitis striata hakataensis* subsp. nov., *Cobitis minamorii oumiensis* subsp. nov., *Cobitis minamorii tokaiensis* subsp. nov., *Cobitis minamorii saninensis* subsp. nov., and *Cobitis minamorii yodoensis* subsp. nov. *Cobitis striata* Ikeda, 1936 was redescribed on the basis of specimens collected from the type locality. The four striated spined loaches, *C. striata*, *C. kaibarai*, *C. magnostriata*, and *C. minamorii* were clearly distinguished by the pelvic myotome number, shape of the lamina circularis, black spots at the caudal base, body shape, and egg diameter. Although these subspecies of *C. striata* and *C. minamorii* are remarkably alike in morphology, the adult males of the subspecies had different longitudinal patterns of pigmentation during the non-spawning season.

Key words: Teleostei, striated spined loach, freshwater fish, East Asia

Introduction

Spined loaches of the genus *Cobitis* Linnaeus, 1758 (Cypriniformes: Cobitidae) are small, slender freshwater fishes distributed in most of Eurasia and northwestern Africa (Sawada 1982; Kottelat & Freyhof 2007). This genus is characterized by the following features: suborbital spine erectile, mouth small and inferior with three pairs of barbels, body pigmentation usually organized in one dorsal and four lateral longitudinal zones, 14 branched caudal rays, and adult males with lamina circularis at base of pectoral-fin rays (Kottelat & Freyhof 2007; Kim 2009).

Cobitis striata Ikeda, 1936 was described as a subspecies of *Cobitis taenia* Linnaeus, 1758 on the bases of specimens collected near Takamatsu, Kagawa prefecture, Honshu, Japan (Ikeda, 1936; Okada & Ikeda, 1939; Aoyagi 1957). Later, Minamori (1955a) found that the *C. striata* divided into at least five distinguishable groups (large race, middle race, small race, Biwa small race, and spotted small race) on the bases of the results of crossing and physiological experiments, and differences in body length and size of the eggs, spermatozoa and blood cells (Minamori 1950, 1951a, b, 1952, 1953, 1955b, c). Saitoh and Aizawa (1987) and Saitoh (1989) divided the *C. striata* into three species (large race, middle race, and small race) and six subspecies of small race (Tokai small, Biwa small, Yodo small, Sanyo small, Sanin small and Kyushu small) on the basis of a detailed morphological survey. Genetic relationships among the striated spined loaches revealed by mitochondrial DNA analysis, confirmed that the *C. striata* consisted of multiple species/subspecies and all endemic loaches in the Japanese archipelago (Kitagawa *et al.* 2005, 2009; Saitoh *et al.* 2010). The striated spined loaches, characterized by a striped coloration pattern on the lateral midline, represent the *C. striata* complex (Kitagawa *et al.* 2005; Saitoh *et al.* 2010). However, the taxonomic study was not performed, and these species/subspecies remain undescribed.

Here, I have described three new species and six new subspecies of the *C. striata* complex from Japan, and have redescribed *C. striata* Ikeda 1936.

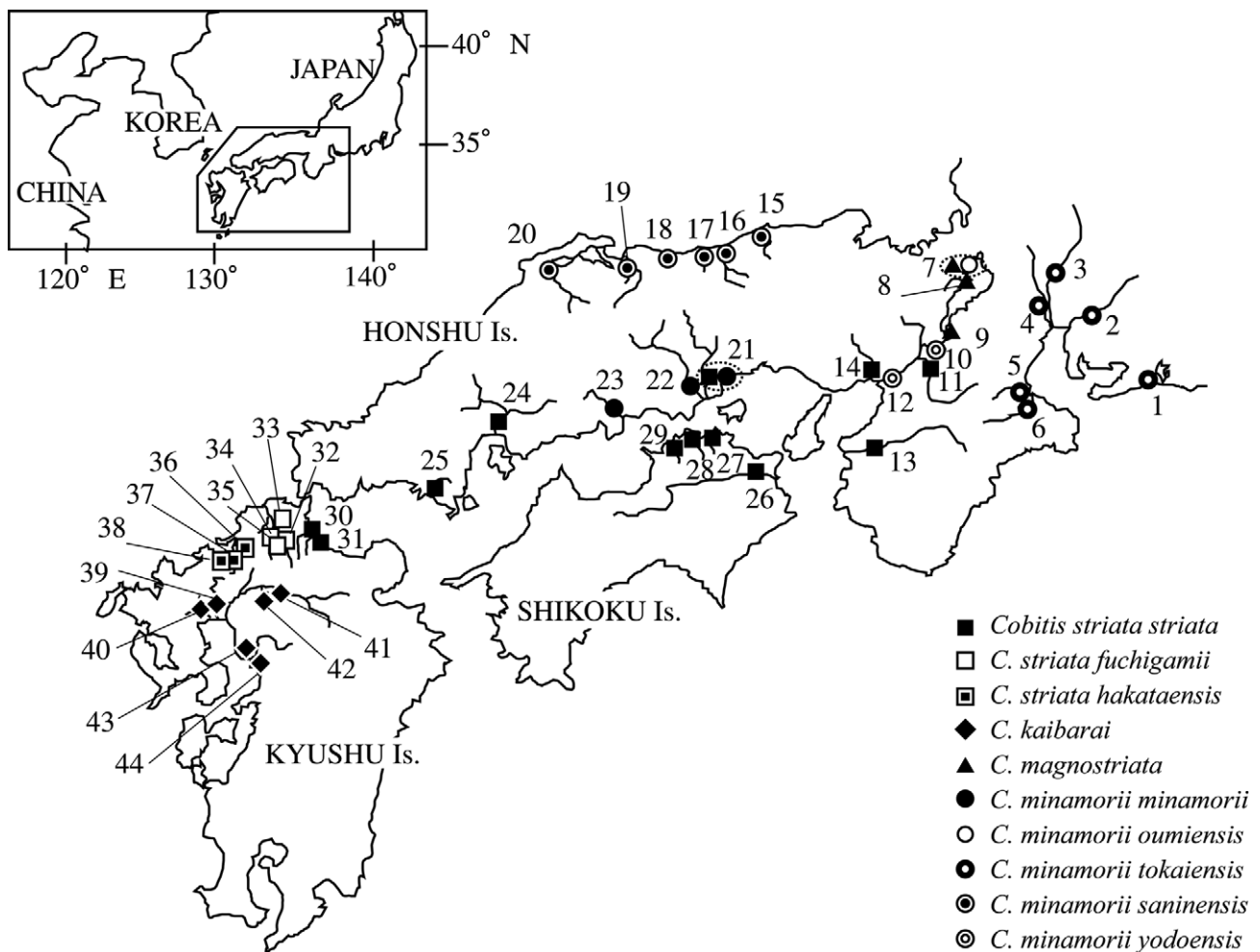


FIGURE 1. Map showing collection localities of specimens examined. 1, creek of Iride-ota River system (R.s.); 2, Shonai R.; 3, Nagara R.; 4, creek of Ibi R.s.; 5, creek of Kumozu R.s.; 6, creek of Kushida R.s.; 7, small stream flowing into Biwa Lake; 8, creek of Ado R. (near Biwa Lake); 9, small river of Yodo R.s.; 10, Uji R. (Yodo R.s.); 11, Kizu R. (Yodo R.s.); 12, Yodo R.; 13, Kino R.; 14, Muko R.; 15, Kishida R.; 16, Shimizu R. (Sendai R.s.); 17, Kouchi R.; 18, Hiwa R.; 19, Terauchi R. (Hino R.s.); 20, creek of Hii R.s.; 21, Kagato R. (Yoshii R.s.); 22, Omachi R., (Asahi R.s.); 23, Imizo R. (Ashida R.s.); 24, Ota R.; 25, Shimata R.; 26, Miyagouchitani R. (Yoshino R.s.); 27, Kasuga R.; 28, Koto R.; 29, Doki R.; 30, Kitara R. (Ima R.s.); 31, Harai R.; 32, Hikosan R. (Onga R.s.); 33, Kuro R. (Onga R.s.); 34, Kakenouma R. (Onga R.s.); 35, Chuganji R. (Onga R.s.); 36, Tataru R.; 37, Naka R.; 38, Muromi R.; 39, creek of Kase R.s.; 40, creek of Rokkaku R.s.; 41, Mitsuru R. (Chikugo R.s.); 42, Kose R. (Chikugo R.s.); 43, Sakai R.; 44, creek of Kikuchi R.s.

Materials and methods

179 specimens from 44 localities were examined (Table 1, Fig. 1). All fish to measure the body morphological features were preserved 70% ethanol after fixing in 10% formalin. Methods for counts and measurements follow those of Kottelat and Freyhof (2007) and Hosoya (2002). All measurements were made with digital calliper and recorded to 0.1 mm. Standard length (SL) was defined as the length from the tip of the snout to the end of the base of the median caudal ray. Head length (HL) was defined as the distance from the most anterior point of the snout to the most posterior point of the opercle. The last two branched rays articulating on a single pterygiophore in the dorsal and anal fins were noted as one ray. The prepelvic myotome number (PMN) was defined as the number of segmented muscle plates between the base of the pectoral fin and the origin of the pelvic fin (Fig. 2).

The rays and lamina circularis of the right pectoral fins in adult males were observed in the holotype and some paratypes. I resected the right pectoral fin and made it transparent by placing it in 4% KOH for 24 h. After staining with alizalin red S + 1% KOH for 24 h, I observed and sketched these fins under stereomicroscope.

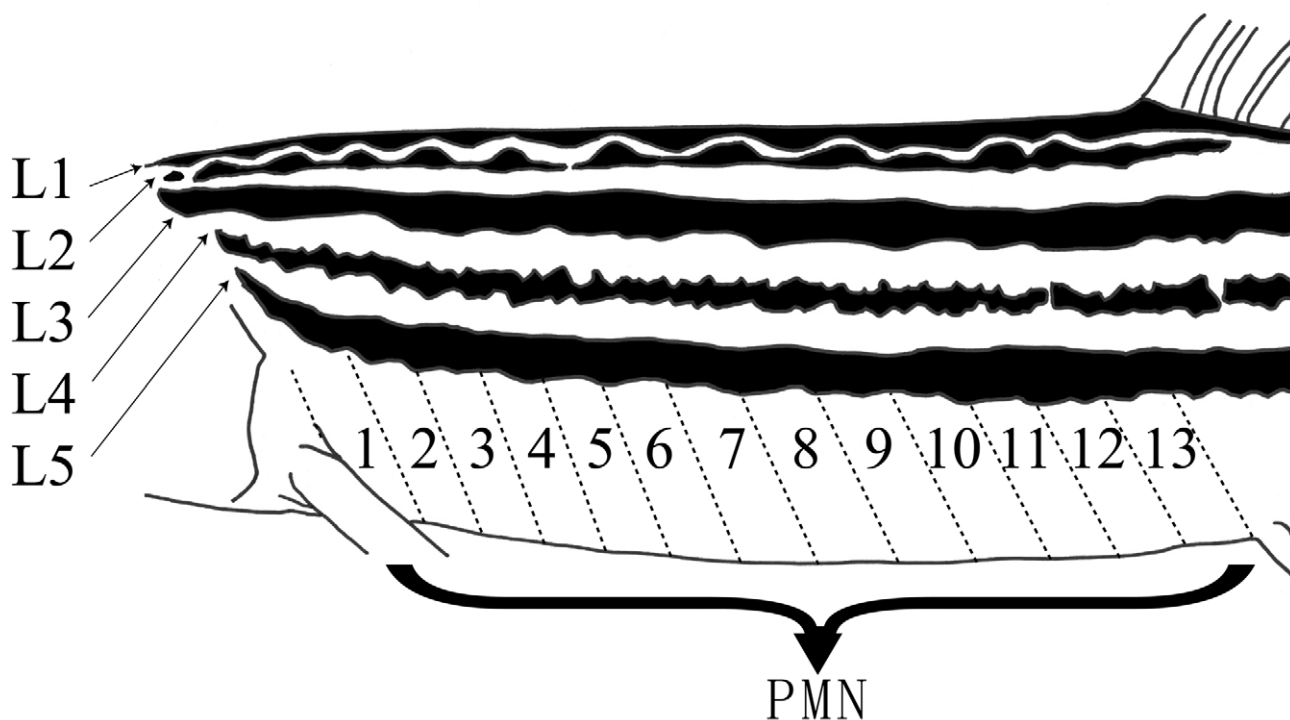


FIGURE 2. The line system (L1–L5) of Takeda and Fujie (1945) and the prepelvic myotome number (PMN).

The color pattern was organized in five longitudinal lines of pigmentation, as described by Takeda and Fujie (1945). The lines are abbreviated as lines L1 to L5 (Fig. 2). And the black spots at caudal base, marks of dorsal fin and caudal fin were also described.

I measured the diameter of the yolk of eggs from nine species/subspecies. First, I injected mature females with 100–200 units of gonadotropin per individual in the laboratory. After keeping these females in an aquarium (at 20–25 °C) for 10–12 h, I squeezed the abdomen of each one to induce egg release. After the eggs absorbed water for 60 min, I measured the yolk diameter of five eggs from each female with a profile projector (V-12, Nikon, Japan). The five eggs obtained from the same female were treated as the value of a litter.

The type series have been deposited in the following collections: TKPM - Tokushima Prefectural Museum, Tokushima, Japan; MPM - Mie Prefectural Museum, Tsu, Mie, Japan; KPM - Kanagawa Prefectural Museum of Natural History, Odawara, Kanagawa, Japan; FAKU - Kyoto University, Maizuru, Kyoto, Japan; FRLM - Fishery Research Laboratory, Mie University, Shima, Mie, Japan; FKUN, KUN - Faculty of Agriculture, Kinki University, Nara, Japan; JNC - private collection of author, Japan. R. s. = River system.

TABLE 1. List of specimens examined in 10 species and subspecies of the *Cobitis striata* complex in Japan.

	Locality	Date of collection	Loc. No. See Fig. 1	No. of specimens	Catalog No.
<i>C. striata striata</i>	Yawata, Kyoto Pref., Honshu	16. V. 2009	11	1	
	Wakayama, Wakayama Pref., Honshu	29. XII. 2007	13	1	
	Sanda, Hyogo Pref., Honshu	7. VI. 2009	14	1	MPM-FI1500
	Setouchi, Okayama Pref., Honshu	6. VI. 2007	21	3	
	Hiroshima, Hiroshima Pref., Honshu	29. IX. 1996	24	1	FRLM24922
	Shutou, Yamaguchi Pref., Honshu	4. V. 1982	25	2	FAKU55767
	Kamiita, Tokushima Pref., Shikoku	18. VII. 1995	26	3	TKPM-P2283
	Takamatsu, Kagawa Pref., Shikoku	28. IX. 2008	27	2	
	Takamatsu, Kagawa Pref., Shikoku	3. XI. 2007	28	1	TKPM-P17340

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TABLE 1. (Continued)

	Locality	Date of collection	Loc. No. See Fig. 1	No. of specimens	Catalog No.
<i>C. striata fuchigamii</i>	Mannou, Kagawa Pref., Shikoku	3. XI. 2007	29	4	
	Miyako, Fukuoka Pref., Kyushu	12. XII. 2010	30	2	KPM-NI29502
	Yukuhashi, Fukuoka Pref., Kyushu	25. X. 2007	31	1	
	Oto, Fukuoka Pref., Kyushu	24. VI. 2008	32	5	
	Yahatanishi-ku, Fukuoka Pref., Kyushu	16. V. 2005	33	2	
	Yahatanishi-ku, Fukuoka Pref., Kyushu	9. VI. 2005	33	1	KPM-NI29503
	Iizuka, Fukuoka Pref., Kyushu	10. XII. 2003	34	2	
	Iizuka, Fukuoka Pref., Kyushu	17. V. 2008	34	3	
<i>C. striata hakataensis</i>	Iizuka, Fukuoka Pref., Kyushu	12. XII. 2010	34	2	TKPM-P17341, MPM-FI1501
	Kawasaki, Fukuoka Pref., Kyushu	24. IV. 2004	35	1	FKUN33734
	Kasuya, Fukuoka Pref., Kyushu	23. V. 2005	36	3	
	Kasuya, Fukuoka Pref., Kyushu	18. V. 2008	36	4	KPM-NI29504, MPM-FI1502
	Kasuya, Fukuoka Pref., Kyushu	12. XII. 2010	36	5	TKPM-P17342
	Minami-ku, Fukuoka Pref., Kyushu	20. IV. 2005	37	1	FKUN33756
	Nishi-ku, Fukuoka Pref., Kyushu	5. VI. 2006	38	3	
	Nishi-ku, Fukuoka Pref., Kyushu	13. V. 2010	38	1	
<i>C. kaibarai</i>	Saga, Saga Pref., Kyushu	16. V. 2008	39	2	
	Taku, Saga Pref., Kyushu	23. XI. 2010	40	2	
	Taku, Saga Pref., Kyushu	22. XII. 2010	40	3	KPM-NI29505
	Ukiha, Fukuoka Pref., Kyushu	15. XII. 2010	41	1	TKPM-P17343
	Ukiha, Fukuoka Pref., Kyushu	14. VIII. 2007	42	3	
	Tamana, Kumamoto Pref., Kyushu	24. XII. 1997	43	1	KPM-NI9231
	Tamana, Kumamoto Pref., Kyushu	4. VI. 2007	44	4	
	Tamana, Kumamoto Pref., Kyushu	19. III. 2008	44	3	MPM-FI1503
<i>C. magnostriata</i>	Takashima, Shiga Pref., Honshu	16. VIII. 1997	7	1	FRLM24920
	Takashima, Shiga Pref., Honshu	3. VII. 2007	7	2	
	Adogawa, Shiga Pref., Honshu	6. V. 2007	8	11	TKPM-P17344, KPM-NI29506, MPM-FI1504
	Otsu, Shiga Pref., Honshu	22. VII. 2008	9	3	
<i>C. minamorii minamorii</i>	Setouchi, Okayama Pref., Honshu	6. VI. 2007	21	12	TKPM-P17345, KPM-NI29507, MPM-FI1505
	Okayama, Okayama Pref., Honshu	23. IV. 1981	22	3	FAKU55675
	Okayama, Okayama Pref., Honshu	31. VII. 1997	22	1	KPM-NI9225
	Fukuyama, Hiroshima Pref., Honshu	2. V. 1982	23	3	FAKU55761

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TABLE 1. (Continued)

	Locality	Date of collection	Loc. No. See Fig. 1	No. of specimens	Catalog No.
<i>C. minamorii</i> <i>oumiensis</i>	Takashima, Shiga Pref., Honshu	6. VI. 1983	7	5	FAKU55876
	Takashima, Shiga Pref., Honshu	19. V. 2000	7	1	KPM-NI8989
	Takashima, Shiga Pref., Honshu	24. V. 2007	7	8	TKPM-P17346, KPM-NI29508, MPM-F11506
	Takashima, Shiga Pref., Honshu	15. V. 2009	7	3	
<i>C. minamorii</i> <i>tokaiensis</i>	Kosai, Shizuoka Pref., Honshu	9. VI. 2008	1	3	TKPM-P17347
	Kasugai, Aichi Pref., Honshu	2. VI. 2006	2	3	
	Gifu, Gifu Pref., Honshu	19. VII. 1997	3	1	FRLM24921
	Tado, Mie Pref., Honshu	21. X. 2007	4	8	KPM-NI29509
	Tsu, Mie Pref., Honshu	24. IV. 2011	5	1	MPM-FI1507
	Matusaka, Mie Pref., Honshu	7. III. 2008	6	2	
	Matusaka, Mie Pref., Honshu	11. IV. 2011	6	1	MPM-FI1508
<i>C. minamorii</i> <i>saninensis</i>	Shin-onsen, Hyogo Pref., Honshu	17. VIII. 1998	15	1	KPM-NI9218
	Shin-onsen, Hyogo Pref., Honshu	23. V. 2008	15	5	
	Tottori, Tottori Pref., Honshu	31. V. 1981	16	3	FAKU55788
	Kedaka, Tottori Pref., Honshu	16. X. 1983	17	2	FAKU55797
	Hokuei, Tottori Pref., Honshu	9. IV. 2011	18	5	KPM-NI29510, MPM-FI1509
	Nanbu, Tottori Pref., Honshu	10. IV. 2011	19	1	
	Izumo, Shimane Pref., Honshu	31. V. 2008	20	3	
	Izumo, Shimane Pref., Honshu	10. IV. 2011	20	1	TKPM-P17348
<i>C. minamorii</i> <i>yodoensis</i>	Uji, Kyoto Pref., Honshu	15. VII. 1976	10	1	FAKU55701
	Uji, Kyoto Pref., Honshu	12. V. 1978	10	1	FAKU55702
	Asahi-ku, Osaka Pref., Honshu	8. V. 1971	12	6	KUN-P41321
	Asahi-ku, Osaka Pref., Honshu	16. X. 1980	12	4	FAKU55719, FAKU134643

Results

Cobitis striata striata Ikeda, 1936

(Figs. 3A, 4A, B, 5A, 6A)

Cobitis taenia striata Ikeda, 1936: 984, figs. 10, 11, 12, 13 (original description; type locality: near Takamatsu, Kagawa Pref., Shikoku, Japan); *Cobitis taenia striata* middle race: Minamori 1952: 201, fig. 2A; *Cobitis taenia striata*: Aoyagi 1957: 170, fig. 143; *Cobitis taenia striata* middle race: Saitoh and Aizawa 1987: 336, fig. 3G; *Cobitis* sp. M: Saitoh 1989: 390; middle form: Saitoh 1990: 240, figs. 3f, g, h, i, j; 241, fig. 4 (lower four); *Cobitis taenia striata*: Sezaki *et al.* 1994: 684, fig. 1B; *Cobitis* cf. *striata*: Kim *et al.* 1999: 388, fig. 9; *Cobitis* sp. 3: Hosoya 2002: 275; *Cobitis striata* complex middle race: Kitagawa *et al.* 2005: 112, table 1; *Cobitis striata* (middle race): Nakajima *et al.* 2008: 13, fig. 2E; normal type (Setouchi form) of middle race in *Cobitis striata* complex: Kitagawa *et al.* 2009: 12, fig. 2C; *Cobitis striata* complex middle race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 3 subsp. 1: Nakajima *et al.* 2012: 92, fig. 3a.

Specimens examined. 1 male, 53.3 mm SL, Kizu River, Yodo River system, Yawata, Kyoto Pref., Honshu, 16. V. 2009, J. Nakajima; 1 male, 59.1 mm SL, Kino R., Wakayama, Wakayama Pref., Honshu, 29. XII. 2007, M. Nakatani; MPM-FI1500, 1 male, 58.6 mm SL, Muko R., Sanda, Hyogo Pref., Honshu, 7. VI. 2009, K. Tominaga; 3 males, 50.8–55.9 mm SL, Kagato R., Yoshii R. s., Setouchi, Okayama Pref., Honshu, 6. VI. 2007, J. Nakajima; FRLM24922, 1 male, 68.4 mm SL, Ota R., Hiroshima, Hiroshima Pref., Honshu, 29. IX. 1996, M. Watanabe; FAKU55767, 2 males, 58.9, 66.6 mm SL, Shimata R., Shuto, Yamaguchi Pref., Honshu, 4. V. 1982, K. Saitoh; TKPM-P17340, 1 male, 55.6 mm SL, Koto R., Takamatsu, Kagawa Pref., Shikoku, 3. XI. 2007, K. Tominaga; 1 male and 1 female, 49.6, 47.7 mm SL, Kasuga R., Takamatsu, Kagawa Pref., Shikoku, 28. IX. 2008, Y. Hashimoto; 2 males and 2 females, 55.3–73.7 mm SL, Doki R., Man-nou, Kagawa Pref., Shikoku, 3. XI. 2007, K. Tominaga; TKPM-P2283, 1 male and 2 females, 58.2–69.2 mm SL, Miyagouchitani R., Yoshino R. s., Kamiita, Tokushima Pref., Shikoku, 18. VII. 1995, Y. Sato; KPM-NI29502, 1 male and 1 female, 56.8, 61.5 mm SL, Kitara R., Ima R. s., Miyako, Fukuoka Pref., Kyushu, 12. XII. 2010, J. Nakajima; 1 male, 66.8 mm SL, Harai R., Yukuhashi, Fukuoka Pref., Kyushu, 25. X. 2007, J. Nakajima.

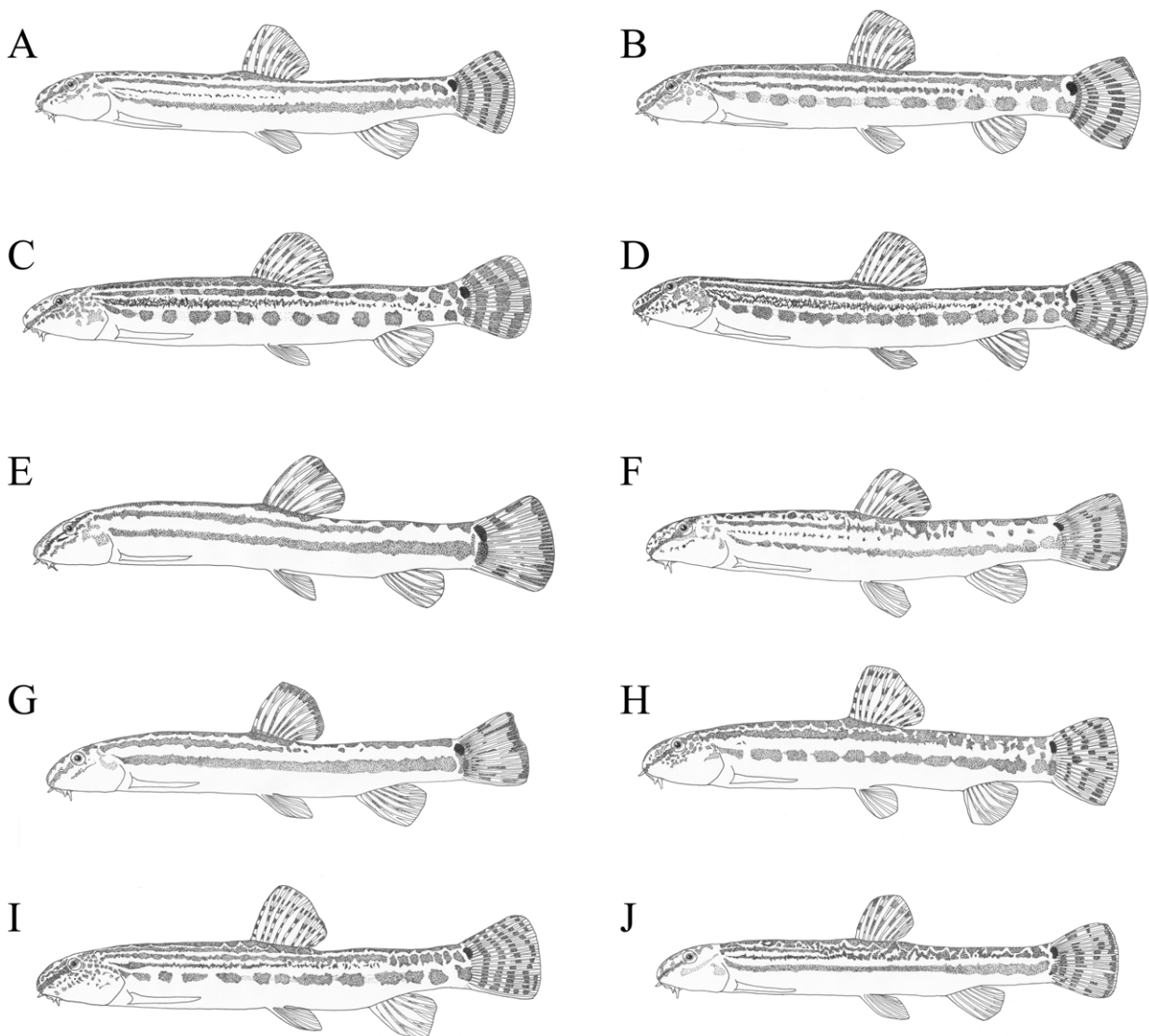


FIGURE 3. Lateral views of 10 species/subspecies of Japanese striated spined loach: (A) *C. striata striata* Ikeda, 1936, 55.6 mm SL, TKPM-P17340; (B) *C. striata fuchigamii* **subsp. nov.**, 64.8 mm SL, Holotype, TKPM-P17341; (C) *C. striata hakataensis* **subsp. nov.**, 58.0 mm SL, Holotype, TKPM-P17342; (D) *C. kaibarai* **sp. nov.**, 54.5 mm SL, Holotype, TKPM-P17343; (E) *C. magnostriata* **sp. nov.**, 62.4 mm SL, Holotype, TKPM-P17344; (F) *C. minamorii minamorii* **sp. nov.**, 48.9 mm SL, Holotype, TKPM-P17345; (G) *C. minamorii ouiensis* **subsp. nov.**, 51.7 mm SL, Holotype, TKPM-P17346; (H) *C. minamorii tokaiensis* **subsp. nov.**, 47.9 mm SL, Holotype, MPM-FI1507; (I) *C. minamorii saninensis* **subsp. nov.**, 62.1 mm SL, Holotype, TKPM-P17348; (J) *C. minamorii yodoensis* **subsp. nov.**, 45.1 mm SL, Holotype, FAKU55719.

TABLE 2. Morphometric and meristic characters of 10 species and subspecies of the *Cobitis striata* complex in Japan.

Name	Sex	N	SL; mean (range)		In % of SL; mean (range)									
			SL	mean (range)	HL	Body depth	Predorsal length	Preamal length	LPP	LPA	DCP			
<i>Cobitis striata</i>	M	36	56.6 (47.4–66.8)	20.9 (19.3–22.6)	16.0 (13.8–18.7)	49.4 (46.7–51.9)	75.3 (71.7–78.4)	31.6 (28.7–34.9)	26.2 (23.2–30.3)	9.6 (8.5–10.6)				
	F	16	62.5 (47.8–79.5)	20.7 (19.3–22.5)	15.1 (12.1–18.3)	50.6 (48.3–54.8)	75.2 (71.9–77.3)	31.8 (27.5–34.6)	25.7 (22.8–30.9)	9.1 (7.8–9.8)				
<i>C. striata striata</i>	M	15	57.2 (49.6–66.8)	21.1 (19.9–22.4)	15.9 (14.4–17.9)	49.8 (47.3–51.4)	75.6 (74.1–77.7)	32.4 (30.4–34.9)	26.3 (23.2–30.3)	9.7 (8.9–10.7)				
	F	6	64.2 (47.8–73.7)	20.4 (19.9–21.8)	15.1 (14.1–15.2)	50.7 (49.3–51.7)	75.5 (73.9–77.2)	32.9 (31.7–34.2)	25.0 (22.8–26.8)	9.4 (8.6–9.8)				
<i>C. striata fuchigamii</i>	M	10	54.1 (47.4–64.8)	21.2 (20.1–22.6)	15.7 (13.8–17.0)	49.0 (46.7–51.9)	74.7 (71.7–77.0)	31.2 (29.0–32.9)	25.7 (23.6–27.2)	9.2 (8.8–10.3)				
	F	5	60.7 (51.2–79.5)	20.9 (19.6–22.5)	13.8 (12.1–15.2)	49.9 (48.3–51.2)	74.1 (71.9–74.8)	30.8 (27.5–33.4)	25.9 (23.8–27.5)	8.6 (7.8–9.0)				
<i>C. striata hakataensis</i>	M	11	58.2 (48.8–65.7)	20.3 (19.3–21.5)	16.5 (14.6–18.7)	49.3 (47.9–50.9)	75.5 (73.2–78.4)	31.0 (28.7–32.7)	26.6 (25.3–27.5)	9.7 (8.5–10.5)				
	F	5	62.5 (55.5–69.7)	20.7 (19.3–21.8)	16.4 (15.1–18.3)	51.0 (49.0–54.8)	75.9 (74.3–77.3)	31.5 (28.2–34.6)	26.4 (23.0–30.9)	9.2 (8.8–9.8)				
<i>Cobitis kaibarai</i>	M	12	49.8 (44.4–54.5)	21.3 (20.7–22.4)	15.7 (14.1–17.4)	49.9 (47.5–51.6)	75.1 (73.4–76.7)	31.7 (29.5–33.5)	25.7 (23.4–26.5)	9.2 (7.9–9.9)				
	F	6	61.1 (55.7–68.1)	20.6 (19.3–21.7)	15.7 (13.5–18.9)	48.1 (39.9–50.7)	71.4 (57.6–75.5)	31.7 (24.3–35.7)	24.6 (20.0–26.3)	8.9 (7.5–9.5)				
<i>Cobitis magnostriata</i>	M	10	63.5 (55.4–72.5)	20.8 (20.2–22.6)	14.4 (13.3–15.9)	50.7 (49.3–52.6)	74.4 (72.1–76.0)	31.4 (30.2–33.3)	25.2 (22.8–27.4)	9.9 (9.4–10.3)				
	F	6	76.7 (58.4–93.3)	20.3 (18.8–21.5)	15.4 (13.7–16.7)	49.9 (48.0–51.5)	73.7 (71.1–76.0)	32.3 (30.8–33.7)	24.8 (22.3–25.9)	9.1 (8.3–9.8)				
<i>Cobitis minamorii</i>	M	52	45.8 (34.1–62.1)	21.5 (19.7–23.1)	16.0 (12.6–18.8)	50.0 (47.3–53.4)	73.3 (68.9–77.6)	29.6 (26.3–33.9)	24.9 (16.0–28.4)	9.7 (7.8–10.7)				
	F	32	57.9 (41.6–74.5)	20.7 (18.3–22.8)	16.5 (12.7–20.0)	50.9 (48.3–53.9)	73.5 (67.5–77.7)	30.9 (28.1–34.6)	25.2 (22.3–28.1)	9.1 (7.8–10.5)				
<i>C. minamorii minamorii</i>	M	11	42.4 (37.2–48.9)	21.8 (20.4–23.1)	17.0 (15.5–18.0)	50.1 (48.7–52.0)	73.5 (69.6–77.6)	29.2 (26.3–32.8)	25.2 (22.8–28.4)	10.0 (9.1–10.5)				
	F	7	49.1 (43.5–55.5)	21.2 (20.1–22.8)	18.2 (16.7–20.0)	50.9 (48.8–52.6)	74.4 (71.3–76.8)	30.9 (28.7–32.3)	24.3 (22.3–25.9)	9.0 (8.4–9.7)				
<i>C. minamorii oumiensis</i>	M	11	48.4 (44.4–53.2)	21.0 (19.7–21.9)	14.7 (12.6–16.4)	49.5 (47.3–50.9)	71.2 (47.3–50.9)	29.2 (26.6–32.5)	24.3 (19.0–27.3)	9.4 (8.6–10.6)				
	F	5	64.2 (50.6–74.5)	20.2 (19.6–20.8)	15.1 (14.0–15.6)	50.8 (49.5–51.6)	71.8 (70.5–73.1)	30.3 (29.0–32.2)	24.5 (23.5–25.9)	8.8 (8.1–9.4)				
<i>C. minamorii tokaiensis</i>	M	12	41.3 (34.1–47.9)	21.9 (21.1–22.9)	16.1 (14.8–17.7)	50.7 (49.6–53.4)	74.2 (72.4–76.5)	29.8 (26.5–33.1)	25.3 (22.9–27.3)	9.7 (9.2–10.4)				
	F	6	50.7 (41.6–55.5)	21.4 (20.7–22.5)	15.8 (14.5–18.1)	52.2 (50.0–53.9)	75.1 (73.6–77.7)	32.6 (28.1–34.6)	25.5 (24.1–28.1)	9.6 (9.0–10.5)				
<i>C. minamorii saninensis</i>	M	14	50.4 (43.9–62.1)	21.7 (20.2–23.1)	16.5 (14.6–18.8)	49.6 (47.8–52.0)	74.0 (72.3–77.2)	30.2 (26.9–33.9)	24.2 (16.0–25.7)	9.5 (7.8–10.7)				
	F	6	57.4 (50.5–73.0)	21.0 (19.9–22.8)	15.5 (14.7–16.7)	50.5 (49.0–53.2)	74.5 (72.7–75.8)	31.5 (29.2–33.4)	25.3 (24.1–25.9)	9.4 (9.1–9.7)				
<i>C. minamorii yodoensis</i>	M	4	45.4 (43.0–50.5)	20.8 (19.8–21.5)	15.2 (14.2–16.0)	48.9 (48.3–49.5)	73.1 (72.2–74.0)	29.2 (26.3–30.9)	26.1 (25.1–27.3)	9.9 (9.3–10.2)				
	F	8	67.4 (59.9–73.9)	19.6 (18.3–21.2)	17.3 (12.7–19.2)	50.2 (48.3–51.6)	72.1 (67.5–74.9)	29.6 (28.7–30.3)	26.2 (24.6–28.0)	8.8 (7.8–9.6)				

Abbreviations used; N, individuals number; SL, standard length; HL, lateral head length; LPP, length of between pectoral-fin base and pelvic-fin origin; LPA, length of between pelvic-fin base and anal-fin origin; DCP, depth of caudal peduncle; PMN, prepelvic myotome number.

TABLE 2. (continued)

Name	Sex	N	In % of HL; mean (range)		PMN	Egg diameter
			Snout length	Eye diameter		
<i>Cobitis striata</i>	M	36	42.8 (38.0–48.0)	19.8 (16.1–22.7)	13.1 (13–14)	0.97±0.07 (N = 9)
	F	16	43.3 (37.8–47.3)	18.9 (15.7–21.2)	13.2 (13–14)	
<i>C. striata striata</i>	M	15	42.1 (37.9–45.3)	19.6 (16.1–21.2)	13.1 (13–14)	0.98±0.05 (N = 2)
	F	6	42.1 (37.8–45.6)	18.5 (15.7–21.2)	13.2 (13–14)	
<i>C. striata fuchigamii</i>	M	10	43.5 (42.1–45.7)	20.1 (17.1–22.7)	13.1 (13–14)	0.96±0.09 (N = 4)
	F	5	43.8 (41.0–47.3)	18.9 (17.4–20.7)	13.2 (13–14)	
<i>C. striata hakataensis</i>	M	11	43.2 (40.0–48.0)	19.7 (17.7–21.9)	13.0	0.98±0.05 (N = 3)
	F	5	44.4 (42.8–46.3)	19.3 (18.5–20.3)	13.2 (13–14)	
<i>Cobitis kaibarai</i>	M	12	42.1 (39.4–44.9)	20.5 (17.4–22.6)	13.2 (13–14)	0.83±0.04 (N = 2)
	F	6	42.4 (39.9–47.2)	18.7 (16.9–20.7)	13.3 (13–14)	
<i>Cobitis magnostriata</i>	M	10	41.6 (36.2–44.6)	18.9 (15.6–22.1)	14.0	1.16±0.05 (N = 1)
	F	6	43.5 (41.0–46.6)	17.0 (16.3–18.4)	13.7 (13–14)	
<i>Cobitis minamorii</i>	M	52	39.0 (27.7–45.6)	21.0 (16.5–24.7)	12.1 (11–13)	0.85±0.06 (N = 10)
	F	32	41.3 (37.1–45.0)	19.5 (15.7–23.2)	12.5 (11–14)	
<i>C. minamorii minamorii</i>	M	11	38.6 (34.4–45.2)	23.0 (20.5–24.7)	12.0 (11–13)	0.85±0.04 (N = 3)
	F	7	40.0 (37.1–44.4)	21.3 (19.2–23.2)	12.6 (12–14)	
<i>C. minamorii oumitensis</i>	M	11	39.9 (36.9–45.0)	21.1 (20.0–22.9)	12.1 (11–13)	0.84±0.03 (N = 2)
	F	5	41.4 (37.9–43.3)	17.9 (16.7–20.4)	12.2 (12–13)	
<i>C. minamorii tokatensis</i>	M	12	37.1 (27.7–42.9)	22.1 (18.8–24.0)	12.1 (11–13)	0.84±0.04 (N = 1)
	F	6	41.0 (37.2–44.2)	21.0 (19.3–22.1)	12.7 (12–13)	
<i>C. minamorii saninensis</i>	M	14	41.1 (36.8–45.6)	19.0 (16.5–21.0)	12.4 (12–13)	0.86±0.08 (N = 4)
	F	6	42.1 (40.7–42.1)	19.0 (17.2–20.8)	12.8 (11–14)	
<i>C. minamorii yodoensis</i>	M	4	36.6 (36.0–38.2)	19.3 (17.6–21.0)	12.0 (11–13)	
	F	8	42.0 (38.8–45.0)	18.3 (15.7–21.9)	12.4 (12–13)	

Diagnosis. This species is distinguishable from other Japanese striated spined loaches by the following characteristics: body size moderate, the mature size about 50–60 mm SL in males, 60–80 mm SL in females; lamina circularis at the base of the pectoral fin of adult male simple roundish plate, the upper segments of the first branched soft ray narrow and weak; PMN commonly 13; lines L3 and L5 well developed with broad stripes in all season; line L4 faint; caudal fin and dorsal fin with 3–4 arcuate bars; upper spot at the caudal base jet-black, approximately eye diameter; lower spot at caudal base faint or missing; egg yolk diameter approximately 1.0 mm; karyotype diploid (2n = 50).

Description. Lateral view in Figure 3A illustrate body shape, form and position of fins. Morphometric and meristic data for 15 males and 6 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–8; pelvic-fin rays ii, 6; caudal-fin rays 8+8. Body elongate, laterally compressed. Head and snout elongated. Interorbital space narrow, convex. Caudal peduncle relatively compressed. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on

surface. Barbels, three pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 13 (range, 13–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male simple roundish plate (Fig. 6A). The first branched soft ray of pectoral fin longer than the others; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 93.0 mm SL male, 98.0 mm SL female (Minamori 1952).

Coloration. *Male in the non-spawning season* (Figs. 3A, 4A). Body yellowish white with light brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head covered with some amorphous spots, these spots often stringed. Opercle and snout covered with large amorphous patterns. Body pigmentation organized in one middorsal and four lateral zones. Line L1 consisting of a series of 10–20 saddles or oval-shaped blotches. Line L2 formed by few small angular spots, only present on the predorsal region, reaching dorsally to interspaces of L1, barely distinct from L1 occasionally. Line L3 formed by sharp longitudinal line, reaching to caudal base. The posterior part of L3 often intermissive. Line L4 formed by weak dots or a narrow line, reaching beyond dorsal fin, sometimes nonexistent. Line L5 formed by broad longitudinal line from upper part of pectoral fin to the caudal-fin base. Caudal fin and dorsal fin with 3–4 arcuate bars. Anal fin pigmented along the fin rays. Upper spot at the caudal base jet-black comparable in size to eye diameter, lower spot at caudal base faint or missing.

Male in the spawning season (Fig. 4B). Lines L2 and L4 not visible, L3 and L5 well developed with broad stripes from the upper part of the pectoral-fin base to the caudal-fin base.

Female (Fig. 5A). Appearance similar to males in the non-spawning season.

Sexual dimorphism. Males have roundish lamina circularis at the base of pectoral fins, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.98 ± 0.05 mm (females, $N = 2$; collected from the Yoshii River and the Asahi River, Okayama Prefecture)

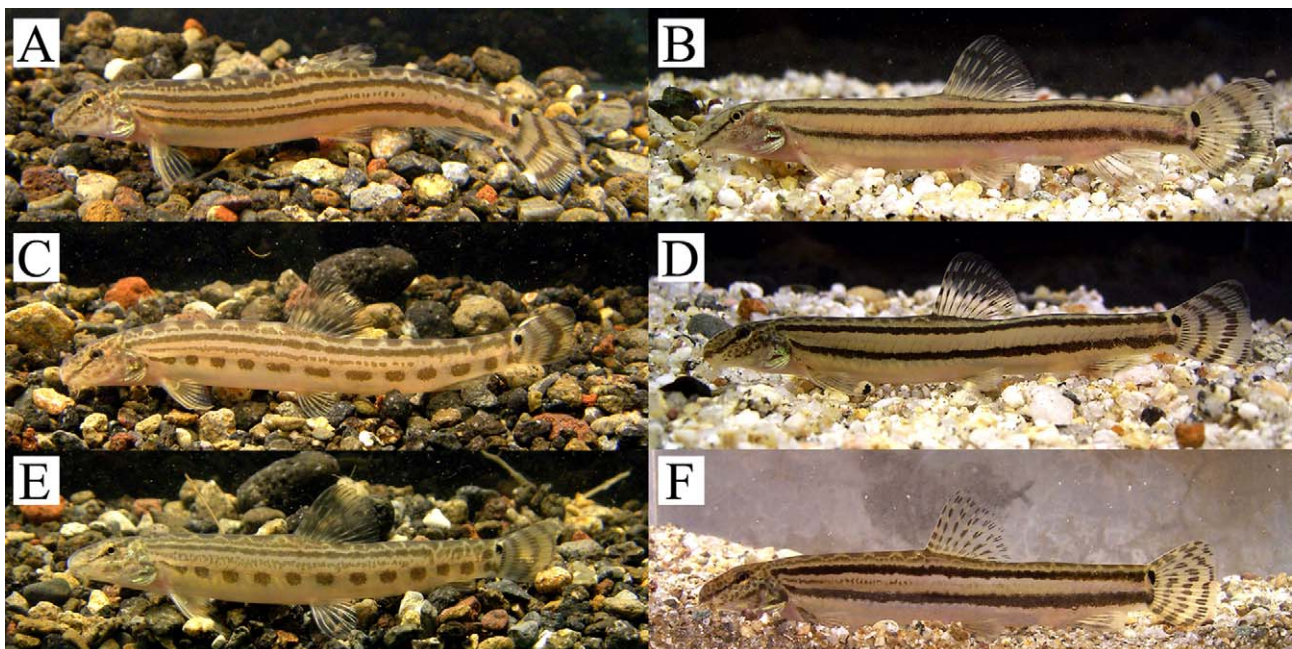


FIGURE 4. Color in life of adult male of 3 subspecies of *Cobitis striata*. (A–B): *C. s. striata*; (A) non-spawning season, Ima River system, Fukuoka Pref., 14 XII 2010; (B) spawning season, Asahi River system, Okayama Pref., 17 VI 2007, collected by Koji Tominaga; (C–D): *C. s. fuchigamii* subsp. nov.; (C) non-spawning season, Onga River system, Fukuoka Pref., 14 XII 2010; (D) spawning season, same locality, 13 VI 2007; (E–F): *C. s. hakataensis* subsp. nov.; (E) non-spawning season, Tatara River system, Fukuoka Pref., 14 XII 2010; (F) spawning season, same locality, 23 V 2005.

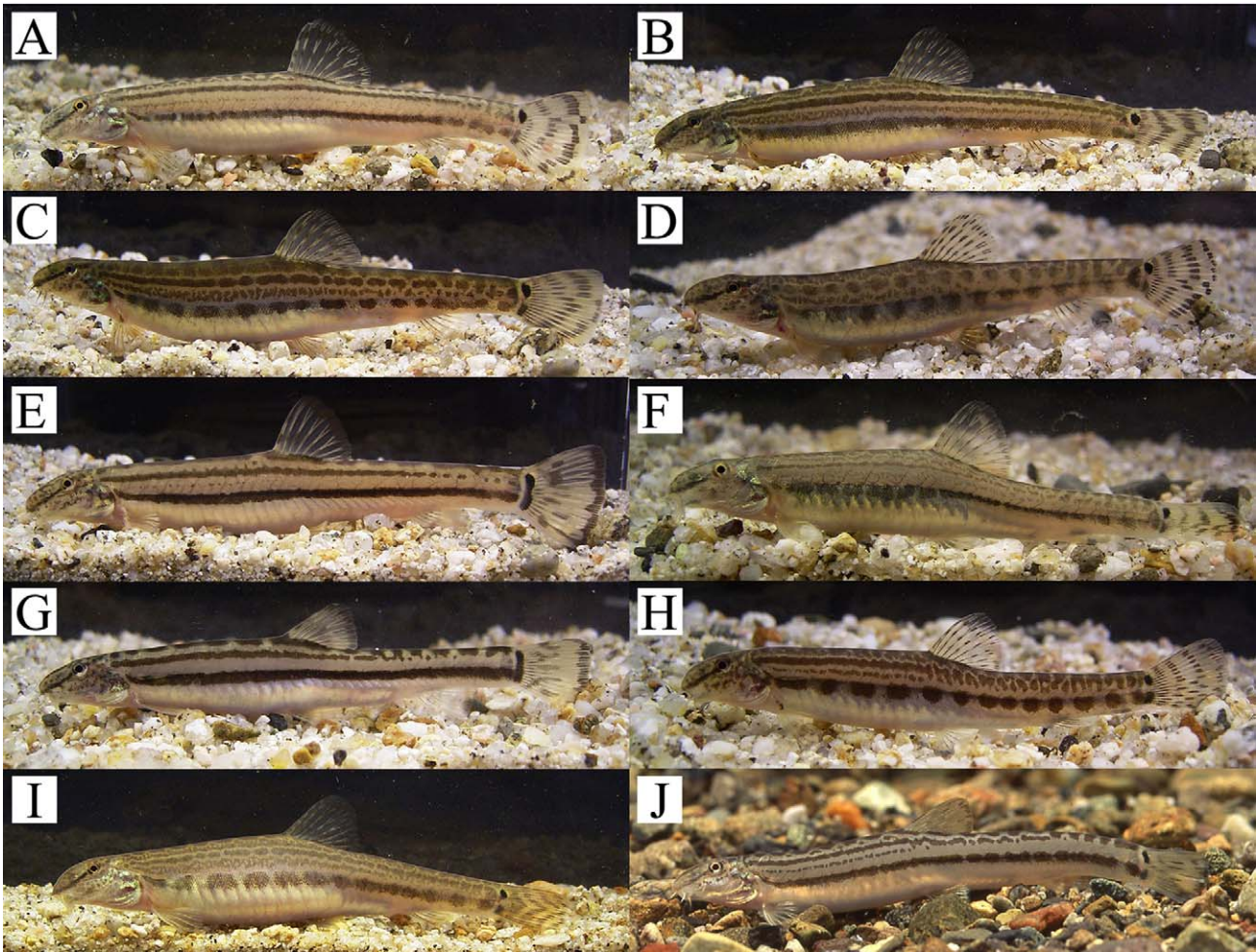


FIGURE 5. Color in life of adult females: (A) *C. striata striata*, Yoshii River system, Okayama Pref., 7 VI 2010; (B) *C. striata fuchigamii* subsp. nov., Onga River system, Fukuoka Pref., 12 VI 2007; (C) *C. striata hakataensis* subsp. nov., Tatara River system, Fukuoka Pref., 13 VI 2007; (D) *C. kaibarai* sp. nov., Rokkaku River system, Saga Pref., 28 VI 2007; (E) *C. magnostriata* sp. nov., near Biwa Lake, Shiga Pref., 13 VI 2007; (F) *C. minamorii minamorii* sp. nov., Yoshii River system, Okayama Pref., 7 VI 2007; (G) *C. minamorii oumiensis* subsp. nov., near Biwa Lake, Shiga Pref., 17 VI 2007; (H) *C. minamorii tokaiensis* subsp. nov., Iride-ota River system, Shizuoka Pref., 13 VI 2007; (I) *C. minamorii saninensis* subsp. nov., Hii River system, Shimane Pref., 1. VI 2008; (J) *C. minamorii yodoensis* subsp. nov., Yodo River system, Kyoto Pref., VIII 1996, collected by Fumitoshi Mori, photographed by Ryu Uchiyama.

Karyotype. Diploid ($2n = 50$) (Ueno & Ojima 1976; Ueno *et al.* 1980; Ueno 1981; Saitoh *et al.* 1984, 2000; Kimizuka 1987)

Distribution. Rivers flowing into the Seto Inland Sea in Honshu, Shikoku, and Kyushu, and rivers flowing into the Japan Sea in Honshu: Kyoto, Osaka, Wakayama, Hyogo, Okayama, Hiroshima, Yamaguchi, Kagawa, Tokushima, Ehime, and Fukuoka Prefectures (Saitoh & Aizawa 1987; Nakajima *et al.* 2008).

Habitat and biology. This species inhabits sandy-mud bottoms of the middle and lower reaches of rivers. Saitoh (1990) described the spawning ecology of this species as the middle form of *Cobitis striata*.

Remarks. Although this loach had been previously described as a subspecies of *C. taenia* Linnaeus, 1758, some recent genetic analysis refuted this designation (Šlechtová *et al.* 2008; Nakajima *et al.* 2011a). It has been confused what is the true *C. striata* described by Ikeda (1936) because the original description of this loach has ambiguous information on the type locality, and the type series is missing and feared lost (Saitoh & Aizawa 1987). However, the author, Dr. Hyoji Ikeda, had stated that the type locality of *C. striata* is ‘near Takamatsu, Kagawa’ in his other literature (Okada & Ikeda 1939; Aoyagi 1957) (Ikeda and Aoyagi are names of the same person). The results obtained in my field and literature surveys confirm that there is only one species, *Cobitis* sp. 3 subsp. 1 (*sensu* Nakajima *et al.*

2012), near this type locality. In addition, the description of *C. striata* is consistent with the morphological characters of *Cobitis* sp. 3 subsp. 1. Therefore, I conclude that *C. striata* Ikeda, 1936 is identical to *Cobitis* sp. 3 subsp. 1. The genetic features have been already reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. Chûgata-suji-shima-dojoyô.

Subspecies of *Cobitis striata*

Cobitis striata fuchigamii Nakajima, subsp. nov.

(Figs. 3B, 4C, D, 5B, 6B)

Onga form of *Cobitis striata* (middle race): Nakajima *et al.* 2008: 13, fig. 2F; Onga form of middle race of *Cobitis striata* complex: Kitagawa *et al.* 2009: 12, fig. 2D; *Cobitis striata* (the Onga form of the middle race): Nakajima *et al.* 2011b: 320, fig. 1C; *Cobitis* sp. 3 subsp. 2: Nakajima *et al.* 2012: 92, fig. 3b.

Holotype. TKPM-P17341, male, 64.8 mm SL, Japan: Kakenouma River, Onga River system, Iizuka, Fukuoka Pref., Kyushu, 12. XII. 2010, J. Nakajima.

Paratypes. MPM-FI1501, 1 male, 55.6 mm SL, same data as holotype; KPM-NI29503, 1 male, 57.2 mm SL, Kuro R., Onga R. s., Yahatanishi-ku, Fukuoka Pref., Kyushu, 9. VI. 2005, J. Nakajima; JNC042, 1 male, 56.0 mm SL, Hikosan R., Onga R. s., Oto, Fukuoka Pref., Kyushu, 24. VI. 2008, J. Nakajima; FKUN33734, 1 female, 63.4 mm SL, Chuganji R., Onga R. s., Kawasaki, Fukuoka Pref., Kyushu, 24. IV. 2004, J. Nakajima.

Non-type specimens. 3 males, 47.4–59.5 mm SL, Kakenouma R., Onga R. s., Iizuka, Fukuoka Pref., Kyushu, 17. V. 2008, J. Nakajima; 2 females, 51.2, 61.1 mm SL, Kakenouma R., Onga R. s., Iizuka, Fukuoka Pref., Kyushu, 10. XII. 2003, J. Nakajima; 2 males and 2 females, 49.6–59.5 mm SL, Hikosan R., Onga R. s., Oto, Fukuoka Pref., Kyushu, 24. VI. 2008, J. Nakajima; 1 male and 1 female, 59.5, 79.5 mm SL, Kuro R., Onga R. s., Yahatanishi-ku, Fukuoka Pref., Kyushu, 16. V. 2005, J. Kawahara.

Diagnosis. This subspecies is distinguishable from other Japanese striated spined loaches by the following characteristics: body size moderate, the mature size about 50–60 mm SL in males, 50–70 mm SL in females; lamina circularis at the base of the pectoral fin of adult male simple roundish plate, the upper segments of the first branched soft ray narrow and weak (Fig. 6B); PMN commonly 13; line L3 formed by sharp longitudinal line, reaching to caudal base; line L4 formed by narrow longitudinal line, reaching beyond dorsal fin, narrower than L3 in male of non-spawning season; line L5 organized in 11–14 roundish, oblong or ovoid blotches in non-spawning season; caudal fin and dorsal fin with 3–4 arcuate bars; upper spot at the caudal base jet-black comparable in size to eye diameter; lower spot at caudal base faint or missing; egg yolk diameter approximately 1.0 mm; karyotype diploid.

Description. Lateral view in Figure 3B illustrate body shape, form and position of fins. Morphometric and meristic data for 10 males and 5 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–8; pelvic-fin rays ii, 6; caudal-fin rays 8+8. Body elongate, laterally compressed. Head and snout elongated. Interorbital space narrow, convex. Caudal peduncle relatively compressed. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 13 (range, 13–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male simple roundish plate (Fig. 6B). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 64.8 mm SL male, 79.5 mm SL female.

Coloration. *Male in the non-spawning season* (Figs. 3B, 4C). Body yellowish white with light brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head covered with some amorphous spots, these spots often stringed. Opercle and snout covered with some large amorphous patterns. Body pigmentation organized in one middorsal and four lateral zones. Line L1

consisting of a series of 10–16 saddles or oval-shaped blotches. Line L2 formed by convex semicircular spots, only present on the middorsal body, reaching dorsally to interspaces of L1. Line L3 formed by sharp longitudinal line, reaching to caudal base. The posterior part of L3 often intermissive. Line L4 formed by narrow longitudinal line, reaching beyond dorsal fin, narrower than L3. Latter part of L4 often interrupted. Line L5 organized in 11–14 blotches from upper part of the pectoral fin to the caudal-fin base; blotches roundish, frequently oblong or ovoid. Caudal fin and dorsal fin with 3–4 arcuate bars. Anal fin pigmented along the fin rays. Upper spot at the caudal base jet-black comparable in size to eye diameter, lower spot at caudal base faint or missing.

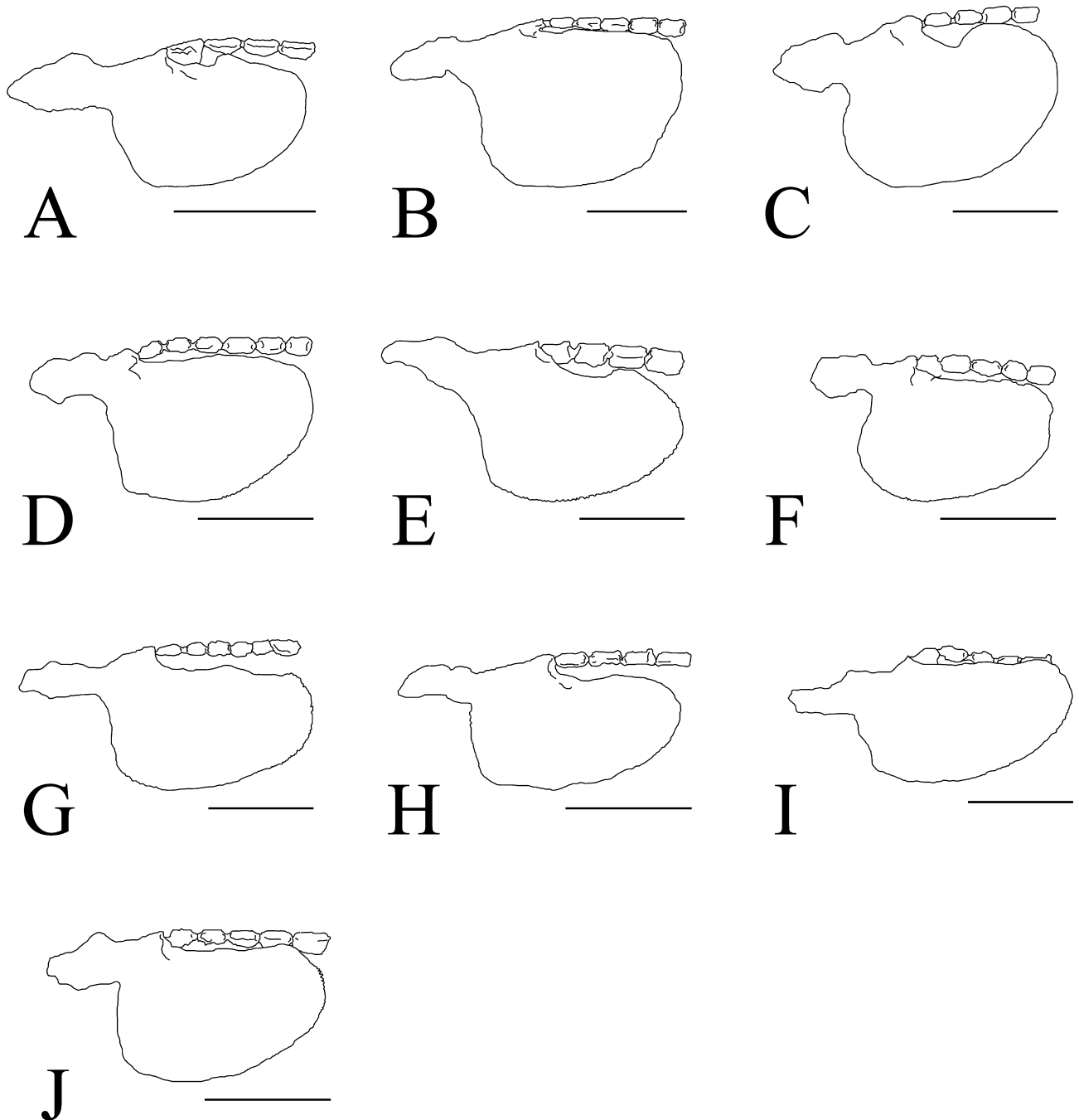


FIGURE 6. Dorsal views of lamina circularis and upper segment of the first branched ray at the base of the pectoral fin of adult males: (A) *C. striata striata* Ikeda, 1936; (B) *C. striata fuchigamii* **subsp. nov.**; (C) *C. striata hakataensis* **subsp. nov.**; (D) *C. kaibarai* **sp. nov.**; (E) *C. magnostriata* **sp. nov.**; (F) *C. minamorii minamorii* **sp. nov.**; (G) *C. minamorii oumiensis* **subsp. nov.**; (H) *C. minamorii tokaiensis* **subsp. nov.**; (I) *C. minamorii saninensis* **subsp. nov.**; (J) *C. minamorii yodoensis* **subsp. nov.**. Bars equal to 1.0 mm.

Male in the spawning season (Fig. 4D). Line L4 not visible or formed by faint longitudinal line, L3 and L5 well developed with broad stripes from the upper part of the pectoral-fin base to the caudal-fin base.

Female (Fig. 5B). Appearance similar to males in the non-spawning season. But line L4 often formed by longitudinal jagged line, reaching anterior anal-fin base, broader or as wide as L3. Latter part of L4 often interrupted. Lines L3 and L5 tend to be developed with broad stripes in spawning season in large individual.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally the body size of the female is larger than that of the male. The L4 of the male tends narrower than that of the female.

Egg diameter. 0.96 ± 0.09 mm (females, N = 4; collected from the Onga River system, Fukuoka Prefecture)

Karyotype. Diploid. (Kitagawa *et al.* 2009)

Distribution. Onga River system, northern Kyushu: Fukuoka Prefecture. (Nakajima *et al.* 2008)

Habitat and biology. This species inhabits sandy-mud bottoms of the middle and lower reach of rivers. Although the spawning ecology is unknown, it is suggested that this subspecies needs a well-vegetated zone as a spawning site (Nakajima *et al.* 2011b).

Etymology. The subspecific name is dedicated to Mr. Nobuyoshi Fuchigami, discoverer of this spined loach in the Onga River system.

Remarks. The genetic features have been already reported by Kitagawa *et al.* (2009). This is a subspecies endemic to the Onga River system.

Japanese name. Onga-suji-shima-dojoyô.

***Cobitis striata hakataensis* Nakajima, subsp. nov.**

(Figs. 3C, 4E, F, 5C, 6C)

Hakata form of *Cobitis striata* (middle race): Nakajima *et al.* 2008: 13, fig. 2G; Hakata form of middle race of *Cobitis striata* complex: Kitagawa *et al.* 2009: 12, fig. 2E, F; *Cobitis* sp. 3 subsp. 3: Nakajima *et al.* 2012: 92, fig. 3c.

Holotype. TKPM-P17342, male, 58.0 mm SL, Japan: Tatara River, Kasuya, Fukuoka Pref., Kyushu, 12. XII. 2010, J. Nakajima.

Paratypes. JNC005, 1 male, 54.4 mm SL, same data as holotype; JNC041, 1 male, 60.4 mm SL, Tatara R., Kasuya, Fukuoka Pref., Kyushu, 23. V. 2005, J. Nakajima; KPM-NI29504, male, 55.0 mm SL, Tatara R., Kasuya, Fukuoka Pref., Kyushu, 18. V. 2008, J. Nakajima; MPM-FI1502, 1 male, 48.8 mm SL, same data; FKUN33756, 1 female, 87.4 mm SL, Naka R., Minami-ku, Fukuoka, Fukuoka Pref., Kyushu, 20. IV. 2005, J. Nakajima; JNC006, 1 male, 59.1 mm SL, Muromi R., Nishi-ku, Fukuoka, Fukuoka Pref., Kyushu, 13. V. 2010. E. Miyamura.

Non-type specimens. 1 male and 2 females, 56.4–63.4 mm SL, same data as holotype; 1 male and 2 females, 64.0–69.7 mm SL, Muromi R., Nishi-ku, Fukuoka, Fukuoka Pref., Kyushu, 5. VI. 2006, J. Nakajima; 2 males, 65.0, 65.7 mm SL, Tatara R., Kasuya, Fukuoka Pref., Kyushu, 23. V. 2005, J. Nakajima; 1 male and 1 female, 52.6, 55.5 mm SL, Tatara R., Kasuya, Fukuoka Pref., Kyushu, 18. V. 2008, J. Nakajima.

Diagnosis. This subspecies is distinguishable from other Japanese striated spined loaches by the following characteristics: body size moderate, the mature size about 50–60 mm SL in males, 55–80 mm SL in females; lamina circularis at the base of the pectoral fin of adult male simple roundish plate, the upper segments of the first branched soft ray narrow and weak (Fig. 6C); PMN commonly 13; line L3 formed by incomplete longitudinal line, reaching to caudal base; line L4 formed by longitudinal jagged weblike line, reaching to postanal body, broader than L3 in male of non-spawning season; line L5 organized in 11–14 roundish or ovoid blotches in non-spawning season; caudal fin and dorsal fin with 3–4 arcuate bars; upper spot at the caudal base jet-black comparable in size to eye diameter; lower spot at caudal base faint or missing; egg yolk diameter approximately 1.0mm; karyotype diploid.

Description. Lateral view in Figure 3C illustrate body shape, form and position of fins. Morphometric and meristic data for 11 males and 5 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–8; pelvic-fin rays ii, 6; caudal-fin rays 8+8. Body elongate, laterally compressed. Head and snout elongated. Interorbital space narrow, convex. Caudal peduncle relatively compressed. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well

developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 13 (range, 13–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male simple roundish plate (Fig. 6C). The first branched soft ray of pectoral fin longer than the others; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 65.7 mm SL male, 69.7 mm SL female.

Coloration. *Male in the non-spawning season* (Figs. 3C, 4E). Body yellowish white with dark brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head, opercle and snout covered with oval or amorphous shape spots. Body pigmentation organized in one middorsal and four lateral zones. Line L1 consisting of a series of 14–16, saddles or oval-shaped blotches, irregularly chained to each other. Line L2 formed by longitudinal jagged line, reaching to middorsal region, often fused with L1. Line L3 formed by incomplete longitudinal line, reaching to caudal base. Line L4 formed by longitudinal jagged weblike line, reaching to postanal body, broader than L3. Line L5 organized in 11–14 blotches from upper part of the pectoral fin to the caudal-fin base; blotches roundish or ovoid. Caudal fin and dorsal fin with 3–4 arcuate bars. Anal fin pigmented along the fin rays. Upper spot at the caudal base jet-black comparable in size to eye diameter, lower spot at the caudal base faint or missing.

Male in the spawning season (Fig. 4F). Line L4 not visible or formed by faint longitudinal line, present only in anterior half of body. Lines L3 and L5 well developed with broad stripes from the upper part of the pectoral-fin base to the caudal-fin base.

Female (Fig. 5C). Appearance similar to males in the non-spawning season, but number of blotches of line L5 tends to be more than in the male, line L5 of female organized in 11–17 blotches.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.98 ± 0.05 mm (females, N = 3; collected from the Tatara River system, Fukuoka Prefecture).

Karyotype. Diploid (Kitagawa *et al.* 2009).

Distribution. Rivers flowing into Hakata Bay, northern Kyushu: Fukuoka Prefecture (Nakajima *et al.* 2008).

Habitat and biology. This species inhabits sandy-mud bottoms of the middle and lower reach of rivers. Life histories are unknown.

Etymology. The subspecific name is derived from the popular common name of the Fukuoka City area in which the type locality is situated.

Remarks. The genetic features have been reported by Kitagawa *et al.* (2009).

Japanese name. Hakata-suji-shima-dojyô.

***Cobitis kaibarai* Nakajima, sp. nov.**

(Figs. 3D, 5D, 6D, 7A, B)

Cobitis sp. S Kyushu-gata: Saitoh 1989: 389; *Cobitis* sp. 2 subsp. 3: Hosoya 2002: 275; *Cobitis striata* complex Small race, Kyushu form: Kitagawa *et al.* 2005: 112, table 1; Kyushu form of *Cobitis striata* (small race): Nakajima *et al.* 2008: 13, fig. 2D; *Cobitis striata* complex Kyushu form: Saitoh *et al.* 2010; 1003, table 1; *Cobitis* sp. 4: Nakajima *et al.* 2012: 92, fig. 3d.

Holotype. TKPM-P17343, 1 male, 54.5 mm SL, Japan: Mitsuru River, Chikugo River system, Ukiha, Fukuoka Pref., Kyushu, 15. XII. 2010, J. Nakajima.

Paratypes. MPM-FI1503, 1 male, 52.3 mm SL, creek of Kikuchi R. s., Tamana, Kumamoto Pref., Kyushu, 19. III. 2008, J. Nakajima; JNC015, 1 male, 47.2 mm SL, same data; JNC016, 1, male, 44.4 mm SL, same data; KPM-NI29505, 1 male, 48.3 mm SL, creek of Rokkaku R. s., Taku, Saga Pref., Kyushu, 22. XII. 2010, E. J. Kim; JNC018, 1 male, 46.9 mm SL, same data; KPM-NI9231, 1 female, 47.4 mm SL, Sakai R., Tamana, Kumamoto Pref., Kyushu, 24. XII. 1997, M. Watanabe.

Non-type specimens. 2 males and 2 females, 49.4–56.1 mm SL, creek of Kikuchi R. s., Tamana, Kumamoto Pref., Kyushu, 4. VI. 2007, J. Nakajima; 2 males, 51.9, 52.3 mm SL, Kose R., Chikugo R. s., Ukiha, Fukuoka Pref., Kyushu, 14. VIII. 2007, J. Nakajima; 1 female, 63.9 mm SL, same data; 1 male and 1 female, 47.9, 68.1 mm SL, creek of Kase R. s., Saga, Saga Pref., Kyushu, 16. V. 2008, J. Nakajima; 1 male and 1 female, 50.1, 65.8 mm SL, creek of Rokkaku R. s., Taku, Saga Pref., 23. XI. 2010, Y. Suzawa; 1 female, 56.7 mm SL, creek of Rokkaku R. s., Taku, Saga Pref., Kyushu, 22. XII. 2010, E. J. Kim.

Diagnosis. This species is distinguishable from other Japanese striated spined loaches by the following characteristics: body size relatively small, the mature size about 45–55 mm SL in males, 55–65 mm SL in females; lamina circularis at the base of the pectoral fin of adult male simple roundish plate, the upper segments of the first branched soft ray narrow and weak (Fig. 6D); PMN commonly 13; line L3 formed by incomplete longitudinal line, reaching to caudal base, fused with L1 and L4 on posterior part of body; line L4 formed by longitudinal jagged line, reaching beyond dorsal fin in male of non-spawning season; line L5 organized in 10–16 roundish or ovoid blotches, fused with L4 on caudal body in non-spawning season; caudal fin and dorsal fin with 4–5 arcuate bars; upper spot at the caudal base jet-black approximately eye diameter; lower spot at caudal base faint or missing; egg yolk diameter approximately 0.8 mm; karyotype diploid ($2n = 50$).

Description. Lateral view in Figure 3D illustrate body shape, form and position of fins. Morphometric and meristic data for 12 males and 6 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7; pelvic-fin rays ii, 5–6; caudal-fin rays 8+8. Body elongate, laterally compressed. Head and snout elongated. Interorbital space narrow, convex. Caudal peduncle relatively compressed. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 13 (range, 13–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male simple roundish plate (Fig. 6D). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 54.5 mm SL male, 68.1 mm SL female.

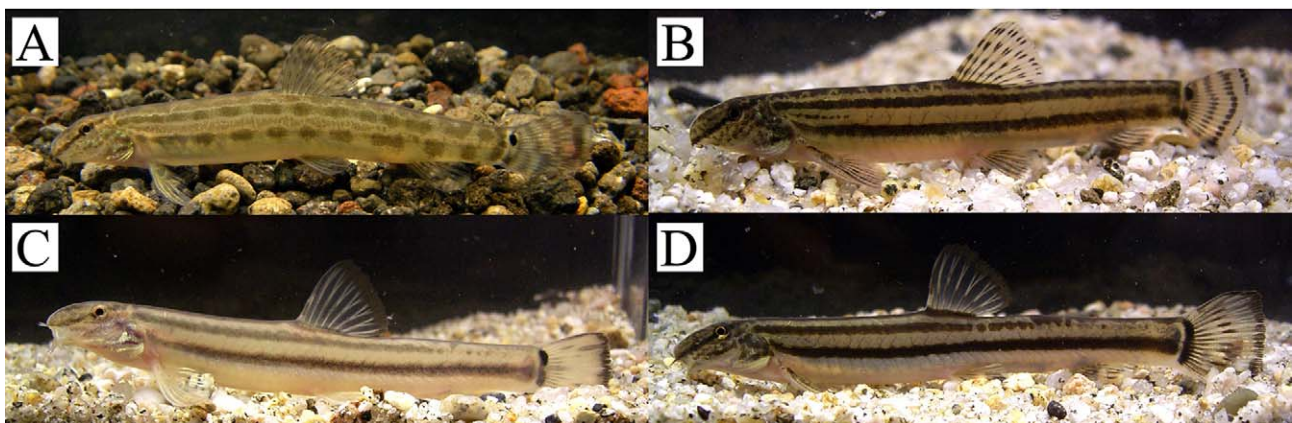


FIGURE 7. Color in life of adult male. (A–B): *C. kaibarai* sp. nov.; (A) non-spawning season, Chikugo River system, Fukuoka Pref., 16 XII 2010; (B) spawning season, Rokkaku River system, Saga Pref., 27 VI 2007; (C–D): *C. magnostriata* sp. nov.; (C) non-spawning season, Biwa Lake, Shiga Pref., 6 VII 2007; (D) spawning season, Biwa Lake, Shiga Pref., 13 VI 2007.

Coloration. Male in the non-spawning season (Figs. 3A, 7A). Body yellowish white with brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head, opercle and snout covered with oval or amorphous shaped spots. Body pigmentation organized in one middorsal and four lateral zones. Line L1 consisting of a series of 12–25 blotches; blotches saddle or oval-shaped. Line L2 formed by longitudinal jagged line or small angular blotches, reaching to postdorsal region, often fused

with L1. Line L3 formed by incomplete longitudinal line, reaching to caudal base, fused with L1 and L4 in postdorsal region. Line L4 formed by longitudinal jagged line, reaching beyond dorsal fin, width variable. Line L5 organized in 10–16 blotches from upper part of the pectoral fin to the caudal-fin base; blotches roundish or ovoid, fused with L4 on caudal body. Caudal fin and dorsal fin with 4–5 arcuate bars. Anal fin pigmented along the fin rays. Upper spot at the caudal base jet-black comparable in size to eye diameter, lower spot at caudal base faint or missing.

Male in the spawning season (Fig. 7B). Line L4 not visible or formed by narrow longitudinal line, present only in anterior half of body. Lines L3 and L5 well developed with broad stripes from upper part of the pectoral-fin base to the caudal-fin base.

Female (Fig. 5D). Appearance similar to males in the non-spawning season.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.83 ± 0.04 mm (females, N = 2; collected from the Kikuchi River system, Kumamoto Prefecture).

Karyotype. Diploid ($2n = 50$) (Ueno & Ojima 1976; Ueno *et al.* 1980; Ueno 1981; Saitoh *et al.* 2000).

Distribution. Rivers flowing into Ariake estuary, northern Kyushu: Saga, Fukuoka, and Kumamoto Prefectures (Nakajima *et al.* 2008).

Habitat and biology. This species inhabits sandy-mud bottoms of the middle and lower reaches of rivers and small streams. Life histories are unknown.

Etymology. The specific name is dedicated to the late Mr. Ekiken Kaibara who was the first real naturalist and biologist in Japan. He recorded the distribution of spined loaches from Chikushi (modern-day Fukuoka Prefecture), Kyushu Island for the first time (Kaibara 1709).

Remarks. The genetic features have been reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. Ariake-suji-shima-dojoyô.

***Cobitis magnostrata* Nakajima, sp. nov.**

(Figs. 3E, 5E, 6E, 7C, D)

Cobitis taenia striata: Okada and Nakamura 1948:185, fig. 113; *Cobitis taenia striata* large race: Minamori 1956: 91, fig. 1; ?*Cobitis taenia striata*: Aoyagi 1957: 169, fig. 142; *Cobitis taenia striata*: Okada 1960: 562, figs. 93a, 93b; *Cobitis taenia striata*: Nakamura 1963: 161, figs. 97a, b; *Cobitis taenia* f. *striata*: Miyadi *et al.* 1976: 247, pl. 31; *Cobitis taenia striata* large race: Saitoh and Aizawa 1987: 336, fig. 3A; *Cobitis* sp. L: Saitoh 1989: 386; *Cobitis* sp. L: Saitoh and Matsuda 1990: 19, fig. 1; *Cobitis* sp. 1: Hosoya 2002: 276; *Cobitis striata* complex large race: Kitagawa *et al.* 2005: 112, table 1; *Cobitis striata* complex large race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 1: Nakajima *et al.* 2012: 90, fig. 2a.

Holotype. TKPM-P17344, male, 62.4 mm SL, Japan: small stream flowing into Biwa Lake, Adogawa, Shiga Pref., Honshu, 6. V. 2007, K. Tominaga.

Paratypes. FRLM24920, 1 male, 63.3 mm SL, Chinai R., Takashima, Shiga Pref., Honshu, 16. VIII. 1997, Y. Fujioka; KPM-NI29506, 1 male, 64.3 mm SL, same data as holotype; MPM-FI1504, 1 male, 63.8 mm SL, same data as holotype; JNC049, 1 female, 93.3 mm SL, same data as holotype; JNC040, 1 male, 72.5 mm SL, small stream flowing into Biwa Lake, Takashima, Shiga Pref., Honshu, 3. VII. 2007, J. Nakajima.

Non-type specimens. 5 males and 3 females, 60.4–84.0 mm SL, same data as holotype; 1 male and 2 females, 55.4–60.4 mm SL, small river of Yodo R.s., Otsu, Shiga Pref., Honshu, 22. VII. 2008, K. Tominaga.

Diagnosis. This species is distinguishable from other Japanese striated spined loaches by the following characteristics: body size large, mature size about 60–70 mm SL in males, 70–90 mm SL in females; lamina circularis at the base of the pectoral fin of adult male simple roundish plate, the upper segments of the first branched soft ray broad and strong (Fig. 6E); PMN commonly 14; caudal peduncle relatively deep; line L1 organized in longitudinal line from snout tip to dorsal-fin base, and formed by some oval- or saddle-shaped blotches on postdorsal body; line L2 lacking commonly; line L3 formed by sharp longitudinal line, reaching beyond dorsal fin; line L4 lacking or formed by weak dotted line; line L5 well developed with broad stripe; caudal and dorsal fins margined by a broad black band; upper and lower spot at caudal base connected into dumbbell-shape; egg yolk diameter approximately 1.1 mm; karyotype tetraploid ($2n = 98$).

Description. Lateral view in Figure 3E illustrate body shape, form and position of fins. Morphometric and meristic data for 10 males and 6 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–8; pelvic-fin rays ii, 6; caudal-fin rays 8+8. Body elongate, laterally compressed. Head and snout elongated. Interorbital space narrow, convex. Eye diameter slightly small. Caudal peduncle relatively deep. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 14 (range, 13–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male simple roundish plate (Fig. 6E). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin broad and strong. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 72.5 mm SL male, 93.3 mm SL female.

Coloration. *Male in the non-spawning season* (Figs. 3E, 7C). Body yellowish white with black pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Opercle and snout covered with some large amorphous patterns. Line L1 organized in longitudinal line from the snout tip to the dorsal-fin base, and formed by some oval- or saddle-shaped blotches on postdorsal body; uncommonly formed by 4–6 predorsal and 4–6 postdorsal blotches. Line L2 lacking; uncommonly formed by tiny oval blotches, reaching to subdorsal body. Line L3 formed by sharp longitudinal line, reaching beyond dorsal fin. Line L4 lacking or formed by weak dotted line, present only in anterior half of body. Line L5 well developed with broad stripe from upper part of the pectoral fin to the caudal-fin base. Caudal fin and dorsal fin margined by a broad black band; various cloudy blotches or broken marks on other regions. Anal fin pigmented along the fin rays. Upper and lower spot at caudal base connected into dumbbell-shape; upper spot jet-black, larger than eye diameter.

Male in the spawning season (Fig. 7D). Line L3 well developed with broad stripe from upper part of the pectoral-fin base to the posterior part of the dorsal fin. Line L5 well developed with broad stripe from upper part of the pectoral-fin base to the caudal-fin base. Lines L2 and L4 lacking.

Female (Fig. 5E). Appearance similar to males in the non-spawning season.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fins, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 1.16 ± 0.05 mm (female, N = 1; collected from the Biwa Lake, Shiga Prefecture).

Karyotype. Tetraploid ($2n = 98$) (Ueno & Ojima 1976; Ueno *et al.* 1980; Ueno 1981; Saitoh *et al.* 1984, 2000; Kimizuka 1987).

Distribution. Biwa Lake and tributary rivers, central Honshu: Shiga Prefecture (Saitoh & Aizawa 1987).

Habitat and biology. This species inhabits sandy-mud bottoms 1–3 meters below the surface of the lake, and migrates to small streams in the spawning season (Saitoh & Matsuda 1990).

Etymology. This species has the largest body and the most awesome appearance in the Japanese *Cobitis striata* complex; this is reflected by the specific epithet *magno-*, which in Latin means ‘large’ or ‘great’.

Remarks. Although this is an endemic species of Biwa Lake and tributary rivers, it has been introduced in some rivers in Honshu Island (Kitahara 2007; Matsuzawa & Senou 2008). The genetic features have been reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. Ôgata-suji-shima-dojyô.

***Cobitis minamorii* Nakajima, sp. nov.**

(Figs. 3F, 5F, 6F, 8A, B)

Cobitis taenia striata small race: Minamori 1952: 201, fig. 2B; *Cobitis taenia striata* small race: Saitoh and Aizawa 1987: 336, fig. 3D; *Cobitis* sp. S (Sanyo-gata): Saitoh 1989: 388; small form: Saitoh 1990: 240, figs. 3a, b, c, d, e: 241, fig. 4 (upper four); *Cobitis* sp. 2 subsp. 1: Hosoya 2002: 275; *Cobitis striata* complex small race, Sanyo form: Kitagawa *et al.* 2005: 112, table 1; *Cobitis striata* complex small race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 2 subsp. 1: Nakajima *et al.* 2012: 90, fig. 2b.

Holotype. TKPM-P17345, 1 male, 48.9 mm SL, Japan: Kagato River, Yoshii River system, Setouchi, Okayama Pref., Honshu, 6. VI. 2007, J. Nakajima.

Paratypes. KPM-NI29507, 1 male, 42.0 mm SL, same data as holotype; MPM-FI1505, 1 male, 37.2 mm SL, same data as holotype; KPM-NI9225, female, 33.4 mm SL, Asahi R., Okayama, Okayama Pref., Honshu, 31. VII. 1997, T. Okazaki and M. Watanabe.

Non-type specimens. FAKU055761, 3 males, 38.1–46.4 mm SL, Imizo R., Ashida R. s., Fukuyama, Hiroshima Pref., Honshu, 2. V. 1982, K. Saitoh; FAKU055675, 3 males, 40.1–47.6 mm SL, Omachi R., Asahi R. s., Okayama, Okayama Pref., Honshu, 23. IV. 1981, K. Saitoh; 2 males and 7 females, 40.0–55.5 mm SL, same data as holotype.

Diagnosis. This species is distinguishable from other Japanese striated spined loaches by the following characteristics: body size small, the mature size about 35–45 mm SL in males, 45–55 mm SL in females; lamina circularis at the base of the pectoral fin of adult male a roundish plate, somewhat narrowing toward the outer part; upper segments of the first branched soft ray of pectoral fin narrow and weak (Fig. 6F); PMN commonly 12; snout short; eye diameter relatively large; body depth and caudal peduncle relatively deep; line L1 consisting of a series of 15–25 blotches; blotches saddle or oval-shaped; line L2 formed by longitudinal jagged line or angular blotches, reaching to pre- or middorsal region, often fused with L1; line L3 formed by incomplete longitudinal narrow line, reaching beyond dorsal fin; line L5 formed by narrow incomplete longitudinal line or organized in chained tiny 15–20 blotches; caudal and dorsal fin with 3–4 irregular vertical bars and exterior bar weak margined; upper spot at the caudal base black, smaller than eye diameter; lower spot at caudal base existing but faint; each spots not connected; egg yolk diameter approximately 0.8 mm; karyotype diploid ($2n = 49$ in male, 50 in female).

Description. Lateral view in Figure 3F illustrate body shape, form and position of fins. Morphometric and meristic data for 11 males and 7 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–8; pelvic-fin rays ii, 6; caudal-fin rays 8+8. Body some what waistless, laterally compressed. Snout short comparatively. Interorbital space broad, convex. Eye diameter relatively large. Body depth and caudal peduncle relatively deep. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 12 (range, 11–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part (Fig. 6F). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 48.9 mm SL male, 55.5 mm SL female.

Coloration. *Male in the non-spawning season* (Figs. 3F, 8A). Body pearl white with dark brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head covered with 3–5 roundish. Opercle and snout covered with oval and amorphous shaped spots. Body pigmentation organized in one middorsal and four lateral zones. Line L1 consisting of a series of 15–25 blotches; blotches saddle or oval-shaped. Line L2 formed by longitudinal jagged line or angular blotches, reaching to pre- or middorsal region, often fused with L1. Line L3 formed by incomplete longitudinal narrow line, reaching to beyond dorsal fin, fused with L1 and L4 on posterior part. Line L4 formed by tiny blotches or narrow longitudinal line, reaching to dorsal fin. Line L5 formed by narrow incomplete longitudinal line or organized in chained tiny 15–20 blotches from upper part of the pectoral fin to the caudal-fin base. Caudal fin and dorsal fin with 3–4 irregular vertical bars and exterior bar often margined. Anal fin pigmented along the fin rays. Upper spot at the caudal base black, smaller than eye diameter, lower spot at caudal base faint; spots not connected.

Male in the spawning season (Fig. 8B). Line L4 not visible or formed by narrow longitudinal line, present only in anterior half of body. Lines L3 and L5 well developed with narrow stripes from upper part of the pectoral-fin base to the caudal-fin base; the posterior part often intermissive.

Female (Fig. 5F). Appearance similar to males in the non-spawning season.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.85 ± 0.04 mm (females, $N = 3$; collected from the Yoshii River system, Okayama Prefecture).

Karyotype. Diploid ($2n = 49$ in male, $2n = 50$ in female) (Saitoh *et al.* 1984, 2000).

Distribution. Rivers flowing into Seto Inland Sea, Sanyo district, western Honshu: Okayama and Hiroshima Prefectures (Saitoh & Aizawa 1987).

Habitat and biology. This species inhabits sandy-mud bottoms of the lower reach of rivers and small stream. Saitoh (1990) described the spawning ecology of this species as small form of *C. striata*.

Etymology. The specific name is dedicated to Dr. Sumio Minamori who was the pioneer of the study of speciation of loaches in Japan.

Remarks. The genetic features have been reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. Sanyô-kogata-suji-shima-dojoyô.

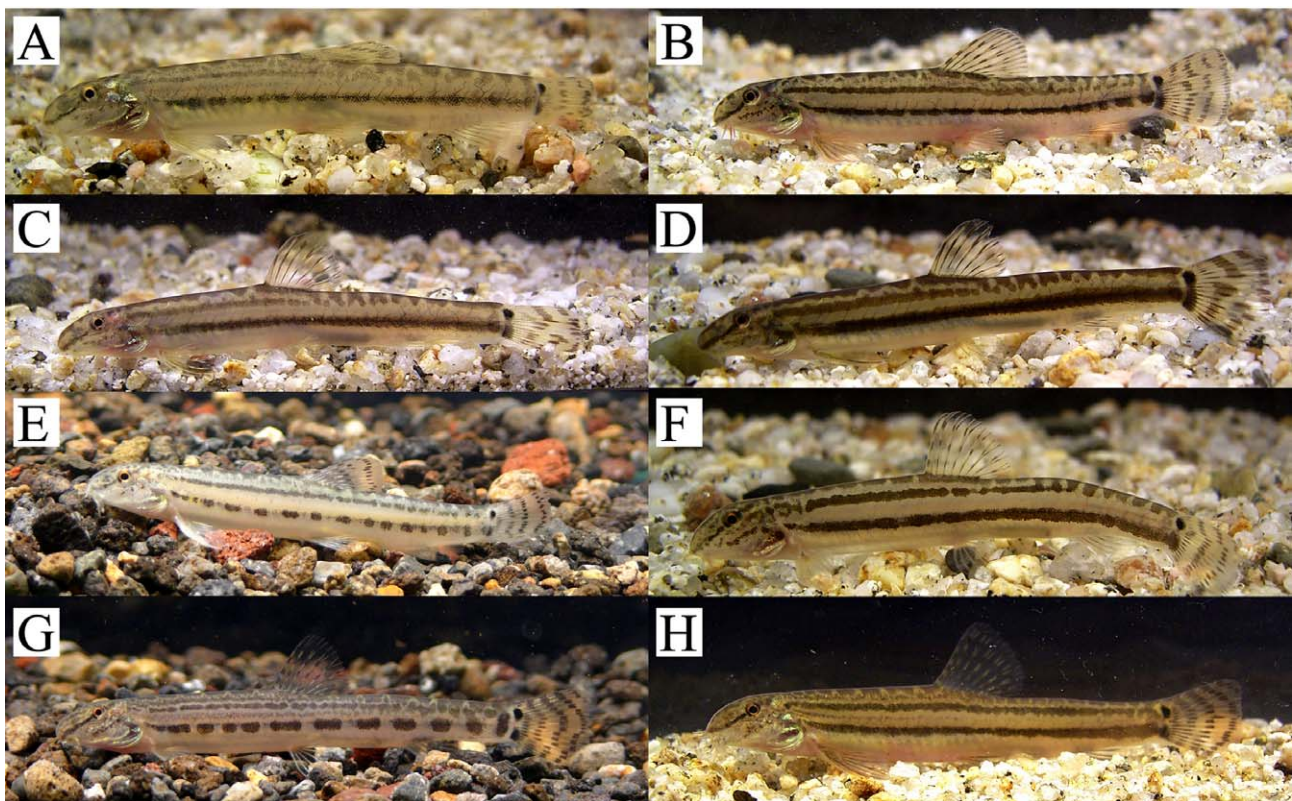


FIGURE 8. Color in life of adult males of four subspecies of *Cobitis minamorii*: (A–B) *C. m. minamorii* **sp. nov.**: (A) non-spawning season, Yoshii River system, Okayama Pref., 8 IX 2007; (B) spawning season, same locality, 17 VI 2007; (C–D) *C. m. oumiensis* **subsp. nov.**: (C) non-spawning season, near Biwa Lake, Shiga Pref., 4 IV 2007; (D) spawning season, same locality, Shiga Pref., 13 VI 2007; (E–F) *C. m. tokaiensis* **subsp. nov.**: (E) non-spawning season, Kushida River system, Mie Pref., 22 IV 2011, collected by Jyun-ichi Kitamura; (F) spawning season, Iride-ota R., Shizuoka Pref., 13 VI 2007; (G–H) *C. m. saninensis* **subsp. nov.**: (G) non-spawning season, Hii River system, Shimane Pref., 11 IV 2011; (H) spawning season, same locality, 31 V 2008.

Subspecies of *Cobitis minamorii*

Cobitis minamorii oumiensis Nakajima, **subsp. nov.**

(Figs. 3G, 5G, 6G, 8C, D)

Cobitis taenia striata Biwa-small race: Minamori 1956: 91, fig. 1; *Cobitis taenia striata* Biwa small race: Saitoh and Aizawa 1987: 336, fig. 3B; *Cobitis* sp. S (Biwako-gata): Saitoh 1989: 387; *Cobitis* sp. S: Saitoh and Matsuda 1990: 19, fig. 1; *Cobitis* sp. 2 subsp. 4: Hosoya 2002: 276; *Cobitis striata* complex small race, Biwa form: Kitagawa *et al.* 2005: 112, table 1; *Cobitis striata* complex Biwa small race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 2 subsp. 4: Nakajima *et al.* 2012: 90, fig. 2e.

Holotype. TKPM-P17346, 1 male, 51.7 mm SL, Japan: small stream flowing into Biwa Lake, Takashima, Shiga Pref., Honshu, 24. V. 2007, S. Yodo.

Paratypes. JNC037, 1 male, 48.2 mm SL, small stream flowing into Biwa Lake, Takashima, Shiga Pref., Honshu, 15. V. 2009, J. Nakajima; KPM-NI29508, 1 male, 48.9 mm SL, same data as holotype; MPM-FI1506, 1 male, 48.6 mm SL, same data as holotype; KPM-NI8989, 1 female, 69.3 mm SL, Imazu, Takashima, Shiga Pref., Honshu, 19. V. 2000, T. Satou.

Non-type specimens. FAKU55876, 5 males, 45.2–53.2 mm SL, Takashima, Shiga Pref., Honshu, 6. VI. 1983, K. Saitoh; 2 males and 3 females, 44.4–68.7 mm SL, same data as holotype; 2 females, 63.4, 74.5 mm SL, small stream flowing into Biwa Lake, Takashima, Shiga Pref., Honshu, 15. V. 2009, J. Nakajima.

Diagnosis. This subspecies is distinguishable from other Japanese striated spined loaches by the following characteristics: body size small, the mature size about 45–55 mm SL in males, 50–60 mm SL in females; lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part; upper segments of the first branched soft ray of pectoral fin narrow and weak (Fig. 6G); PMN commonly 12; snout short; line L1 consisting of a series of 14–16 blotches; blotches oval-shaped, often chainlike longitudinal jagged line; line L2 lacking; line L3 formed by sharp longitudinal line, reaching beyond dorsal fin; line L4 lacking or formed by weak dotted line; line L5 well developed with broad stripe in all season; caudal and dorsal fins margined by a broad black band; Upper and lower spot at caudal base black, upper sharpen, lower somewhat pale; spots slightly connected; egg yolk diameter approximately 0.8 mm; karyotype diploid ($2n = 50$).

Description. Lateral view in Figure 3G illustrate body shape, form and position of fins. Morphometric and meristic data for 11 males and 5 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7; pelvic-fin rays ii, 5–6; caudal-fin rays 8+8. Body elongate, laterally compressed. Snout short comparatively. Interorbital space narrow, convex. Caudal peduncle relatively compressed. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 12 (range, 11–13). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part (Fig. 6G). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 53.2 mm SL male, 74.5 mm SL female.

Coloration. *Male in the non-spawning season* (Figs. 3G, 8C). Body pearl white with black pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Head, opercle and snout covered with some large amorphous patterns. Line L1 consisting of a series of 14–16 blotches; blotches oval-shaped, often chainlike longitudinal jagged line. Line L2 lacking. Line L3 formed by sharp longitudinal line, reaching beyond dorsal fin. Line L4 lacking or formed by weak dotted line, present only in anterior half of body. Line L5 well developed with broad stripe from upper part of the pectoral fin to the caudal-fin base. Caudal fin and dorsal fin margined by a broad black band; various cloudy blotches or broken marks on other regions. Anal fin pigmented along the fin rays. Upper and lower spot at caudal base black, upper sharpen, lower somewhat pale; spots slightly connected.

Male in the spawning season (Fig. 8D). Line L3 well developed with broad stripe from upper part of the pectoral-fin base to the posterior part of the dorsal fin. Line L5 well developed with broad stripe from upper part of the pectoral-fin base to the caudal-fin base. Lines L2 and L4 lacking.

Female (Fig. 5G). Appearance similar to males in the non-spawning season.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.84 ± 0.03 mm (females, $N = 2$; collected from small stream flowing into the Biwa Lake, Shiga Prefecture).

Karyotype. Diploid ($2n = 50$) (Ueno & Ojima 1976; Ueno *et al.* 1980; Ueno 1981; Kimizuka 1987; Saitoh *et al.* 2000).

Distribution. Lake Biwa, central Honshu: Shiga Prefecture (Saitoh & Aizawa 1987).

Habitat and biology. This subspecies inhabits sandy-mud bottoms of small streams, and spawns in paddy field (Saitoh & Matsuda 1990).

Etymology. The subspecific name is derived from Oumi, the old name of Lake Biwa, the type locality.

Remarks. The genetic features have been reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. Biwa-kogata-suji-shima-dojyô.

***Cobitis minamorii tokaiensis* Nakajima, subsp. nov.**

(Figs. 3H, 5H, 6H, 8E, F)

Cobitis taenia: Aizawa 1981: 188, fig. 2A, B, C; *Cobitis taenia striata* Tokai small race: Saitoh and Aizawa 1987: 336, fig. 3E; *Cobitis* sp. S (Tokai-gata): Saitoh 1989: 389; *Cobitis* sp. 2 subsp. 2: Hosoya 2002: 275; *Cobitis striata* complex small race, Tokai form: Kitagawa *et al.* 2005: 112, table 1; *Cobitis striata* complex Tokai small race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 2 subsp. 2: Nakajima *et al.* 2012: 90, fig. 2c.

Holotype. MPM-FI1507, 1 male, 47.9 mm SL, Japan: creek of Kumozu River system, Tsu, Mie Pref., Honshu, 24. IV. 2011, J. Kitamura.

Paratypes. KPM-NI29509, 1 male, 43.2 mm SL, creek of Ibi R. s., Tado, Mie Pref., Honshu, 21. X. 2007, J. Nakajima; MPM-FI1508, 1 male, 39.3 mm SL, creek of Kushida R. s., Matsusaka, Mie Pref., Honshu, 11. IV. 2011, J. Kitamura; TKPM-P17347, 1 male, 39.0 mm SL, creek of Iride-ota R. s., Kosai, Shizuoka Pref., Honshu, 9. VI. 2008, J. Nakajima; FRLM24921, 1 male, 52.4 mm SL, Ohtani R., Nagara R. s., Gifu, Gifu Pref., Honshu, 19. VII. 1997, T. Okazaki.

Non-type specimens. 3 males and 4 females, 42.5–55.5 mm SL, creek of Ibi R. s., Tado, Mie Pref., Honshu, 21. X. 2007, J. Nakajima; 2 males, 41.2, 42.3 mm SL, Harai R., Kushida R. s., Matsusaka, Mie Pref., Honshu, 7. III. 2008, K. Tominaga; 1 male and 1 female, 37.5, 50.3 mm SL, creek of Iride-ota R. s., Kosai, Shizuoka Pref., Honshu, 9. VI. 2008, J. Nakajima; 2 males and 1 female, 34.1–41.6 mm SL, Shonai R., Kasugai, Aichi Pref., Honshu, 2. VI. 2006, T. Oonaka.

Diagnosis. This subspecies is distinguishable from other Japanese striated spined loaches by the following characteristics: body size small, the mature size about 35–45 mm SL in males, 40–50 mm SL in females; lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part; upper segments of the first branched soft ray of pectoral fin narrow and weak (Fig. 6H); PMN commonly 12; snout short; line L1 consisting of a series of 15–25 blotches; line L2 formed by sparse angular blotches, reaching to pre- or middorsal region, often fused with L1; line L3 formed by a longitudinal line, reaching to caudal base, fused with L1 and L4 on postdorsal body; line L5 organized in 10–16 blotches in non-spawning season; caudal and dorsal fin with thin 3–4 arcuate bars; upper spot at the caudal base black, smaller than eye diameter; lower spot at caudal base faint; spots not connected; egg yolk diameter approximately 0.8 mm; karyotype diploid ($2n = 50$).

Description. Lateral view in Figure 3H illustrate body shape, form and position of fins. Morphometric and meristic data for 12 males and 6 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–8; pelvic-fin rays ii, 5–6; caudal-fin rays 8+8. Body somewhat waistless, laterally compressed. Snout short comparatively. Interorbital space broad, convex. Eye diameter relatively large. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 12 (range, 11–13). Very small cycloid scales on the trunk. Lamina circularis at the base of pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part (Fig. 6H). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 47.9 mm SL in male, 55.5 mm SL in female.

Coloration. *Male in the non-spawning season* (Figs. 3H, 8E). Body pearl white with dark brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head covered with some roundish blotches or by longitudinal line. Opercle and snout covered with oval and amorphous shaped spots. Body pigmentation organized in one middorsal and four lateral zones. Line L1 consisting of a series of 15–25 blotches; blotches saddle or oval-shaped. Line L2 formed by sparse angular blotches, reaching to pre- or middorsal region, often fused with L1. Line L3 formed by longitudinal line, reaching to caudal base, fused with L1 and L4 on postdorsal body. Line L4 formed by tiny blotches or narrow incomplete longitudinal line. Line L5 organized in 10–16 blotches from upper part of the pectoral fin to caudal-fin base; blotches roundish or ovoid. Caudal fin and dorsal fin with thin 3–4 arcuate bars. Anal fin pigmented along the fin rays. Upper spot at the caudal base black, smaller than eye diameter; lower spot at caudal base faint; spots not connected.

Male in the spawning season (Fig. 8F). Lines L2 and L4 not visible. Line L3 well developed with broad stripe from upper part of the pectoral-fin base to posterior part of body, fused with L1 on postdorsal body. Line L5 well developed with broad stripe from upper part of the pectoral-fin base to the caudal-fin base.

Female (Fig. 5H). Appearance similar to males in the non-spawning season, but zone L4 tends to be better developed than in males.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.84 ± 0.04 mm (female, N = 1; collected from the Iride-ota River system, Shizuoka Prefecture).

Karyotype. Diploid ($2n = 50$) (Ueno *et al.* 1980; Kimizuka 1987; Saitoh *et al.* 2000).

Distribution. Rivers flowing into Ise Bay, Mikawa Bay, and western part of Enshu-nada coast, Tokai District, central Honshu: Shizuoka, Gifu, Aichi, and Mie Prefectures (Saitoh & Aizawa 1987).

Habitat and biology. This subspecies inhabits sandy-mud bottoms of the lower reaches of rivers and small streams. Life histories are unknown.

Etymology. The subspecific name is derived from the Tokai District of Central Honshu, which is the main distribution area of this subspecies.

Remarks. The genetic features have been reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. Tokai-kogata-suji-shima-dojyô.

***Cobitis minamorii saninensis* Nakajima, subsp. nov.**

(Figs. 3I, 5I, 6I, 8G, H)

Cobitis taenia striata spotted-small race: Minamori 1956: 91, fig. 1; *Cobitis taenia striata* spotted small race: Saitoh and Aizawa 1987: 336, fig. 3F; *Cobitis* sp. S (San-in-gata): Saitoh 1989: 389; *Cobitis* sp. 2 subsp. 3: Hosoya 2002: 275; *Cobitis striata* complex small race, San-in form: Kitagawa *et al.* 2005: 112, table 1; *Cobitis striata* complex spotted small race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 2 subsp. 3: Nakajima *et al.* 2012: 90, fig. 2d.

Holotype. TKPM-P17348, 1 male, 62.1 mm SL, Japan: creek of Hii River system, Izumo, Shimane Pref., Honshu, 10. IV. 2011, J. Nakajima.

Paratypes. KPM-NI29510, 1 male, 53.8 mm SL, Hiwa R., Hokuei, Tottori Pref., Honshu, 9. IV. 2011, J. Nakajima; MPM-FI1509, 1 male, 43.9 mm SL, same data; JNC034, 1 male, 47.6 mm SL, same data; JNC036, 1 male, 48.4 mm SL, Terauchi R., Hino R. s., Nanbu, Tottori Pref., Honshu, 10. IV. 2011, J. Nakajima; KPM-NI9218, 1 male, 59.3 mm SL, Tai R., Kishida R. s., Shin-onsen, Hyogo Pref., Honshu, 17. VIII. 1998, T. Kitagawa.

Non-type specimens. FAKU55788, 3 males, 44.1–52.1 mm SL, Shimizu R., Sendai R. s., Tottori, Tottori Pref., Honshu, 31. V. 1981, K. Saitoh; FAKU055797, 2 females, 50.9, 73.0 mm SL, Kouchi R., Kedaka, Tottori Pref., Honshu, 16. X. 1983, K. Saitoh; 3 males and 2 females, 49.0–52.1 mm SL, Tai R., Kishida R. s., Shin-onsen, Hyogo Pref., Honshu, 23. V. 2008, K. Tominaga; 3 males, 50.4–54.0 mm SL, creek of Hii R. s., Izumo, Shimane Pref., Honshu, 31. V. 2008, J. Nakajima; 2 females, 50.9, 73.0 mm SL, Hiwa R., Hokuei, Tottori Pref., Honshu, 9. IV. 2011, J. Nakajima.

Diagnosis. This subspecies is distinguishable from other Japanese striated spined loaches by the following characteristics: body size relatively small, the mature size about 40–60 mm SL in males, 50–70 mm SL in females; lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer

part; upper segments of the first branched soft ray of pectoral fin narrow and weak (Fig. 6I); PMN commonly 12; snout elongated; line L1 consisting of a series of 15–20 blotches; line L2 formed by longitudinal jagged line, reaching to postdorsal region, fused with L1; line L3 formed by incomplete longitudinal line, reaching to caudal base, fused with L1 and L4 on postdorsal body in non-spawning season; line L5 organized in 11–13 blotches in non-spawning season; caudal and dorsal fins with thin 4–6 arcuate bars; upper spot at the caudal base black, approximately eye diameter; lower spot at caudal base faint; spots not connected; egg yolk diameter approximately 0.8 mm; karyotype diploid ($2n = 50$).

Description. Lateral view in Figure 3I illustrates body shape, form and position of fins. Morphometric and meristic data for 14 males and 6 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7–9; pelvic-fin rays ii, 6; caudal-fin rays 8+8. Body elongate, laterally compressed. Head and snout elongated. Interorbital space broad, convex. Snout elongated. Caudal peduncle relatively compressed. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 12 (range, 11–14). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part (Fig. 6I). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 62.1 mm SL male, 73.0 mm SL female.

Coloration. *Male in the non-spawning season* (Figs. 3I, 8G). Body yellowish white with brown pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Upper part of head, opercle and snout covered with oval or amorphous shaped spots. Body pigmentation organized in one middorsal and four lateral zones. Line L1 consisting of a series of 15–20 blotches; blotches saddle or oval-shaped, often chained. Line L2 formed by longitudinal jagged line, reaching to postdorsal region, fused with L1. Line L3 formed by incomplete longitudinal line, reaching to caudal base, fused with L1 and L4 on postanal body. Line L4 formed by longitudinal jagged weblike line, reaching to postanal body. Line L5 organized in 11–13 blotches; blotches roundish or ovoid. Caudal fin and dorsal fin with 4–6 arcuate bars. Anal fin pigmented along the fin rays. Upper spot at the caudal base jet-black comparable in size to eye diameter, lower spot at caudal base faint or missing.

Male in the spawning season (Fig. 8H). Line L4 not visible or formed by narrow longitudinal line, present only in anterior half of body. Lines L3 and L5 well developed with broad stripes from upper part of the pectoral-fin base to the caudal-fin base.

Female (Fig. 5I). Appearance similar to males in the non-spawning season. But line L4 often formed by longitudinal jagged line, broader or as wide as L3.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. 0.86 ± 0.08 mm (females, $N = 4$; collected from the Hii River system, Shimane Prefecture).

Karyotype. Diploid ($2n = 50$) (Kimizuka 1987; Saitoh *et al.* 2000).

Distribution. Rivers flowing into Japan sea, San-in District, western Honshu: Hyogo, Tottori, and Shimane Prefectures (Saitoh & Aizawa 1987).

Habitat and biology. This subspecies inhabits sandy-mud bottoms of lower reaches of rivers and small streams. Life histories are unknown.

Etymology. The subspecific name is derived from the San-in District of eastern Honshu, which is the main distribution area of this subspecies.

Remarks. The genetic features have been reported by Kitagawa *et al.* (2005) and Saitoh *et al.* (2010).

Japanese name. San-in-kogata-suji-shima-dojoyō.

***Cobitis minamorii yodoensis* Nakajima, subsp. nov.**

(Figs. 3J, 5J, 6J)

Cobitis taenia striata Yodo small race: Saitoh and Aizawa 1987: 336, fig. 3C; *Cobitis* sp. S (Yodogawa-gata): Saitoh 1989: 388; *Cobitis striata* complex Yodo small race: Saitoh *et al.* 2010: 1003, table 1; *Cobitis* sp. 2 subsp. 5: Nakajima *et al.* 2012: 90, fig. 2f.

Holotype. FAKU55719, 1 male, 45.1 mm SL, Japan: Yodo River, Asahi-ku, Osaka Pref., Honshu, 16. X. 1980, K. Saitoh.

Paratypes. FAKU134643, 1 male, 43.0 mm SL, same data as holotype; FAKU134643, 1 male, 43.1 mm SL, same data as holotype; FAKU134643, 1 female, 70.6 mm SL, same data as holotype; FAKU55701, female, 64.9 mm SL, Uji R., Yodo R. s., Uji, Kyoto Pref., Honshu, 15. VII. 1976, K. Saitoh; FAKU55702, 1 male, 50.5 mm SL, Uji R., Yodo R. s., Uji, Kyoto Pref., Honshu, 12. V. 1978, K. Saitoh; KUN-P41321, 6 females, 59.9–73.9 mm SL, Yodo R., Asahi-ku, Osaka Pref., Honshu, 8. V. 1971, collector unknown.

Diagnosis. This subspecies is distinguishable from other Japanese striated spined loaches by the following characteristics: body size small, the mature size about 50 mm SL in males, 60 mm SL in females; lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part; upper segments of the first branched soft ray of pectoral fin narrow and weak (Fig. 6J); PMN commonly 12; snout elongated; eye diameter relatively small; line L1 consisting of a series of 14–17 blotches; line L2 formed by tiny angular blotches, reaching to pre- or middorsal region, often fused with L1; line L3 formed by incomplete longitudinal narrow line, reaching beyond dorsal fin, fused with L1 and L4 in posterior part; line L5 formed by narrow longitudinal line; caudal and dorsal fins margined by a narrow black band, two or three speckles on other regions; upper spot at the caudal base black, smaller than eye diameter; lower spot at caudal base existing but faint; spots not connected; karyotype diploid ($2n = 50$).

Description. Lateral view in Figure 3J illustrate body shape, form and position of fins. Morphometric and meristic data for 4 males and 8 females are summarized in Table 2. Dorsal-fin rays iii, 7; anal-fin rays iii, 5; pectoral-fin rays i, 7; pelvic-fin rays ii, 5–6; caudal-fin rays 8+8. Body elongate, laterally compressed. Snout short. Interorbital space narrow, convex. Eye diameter relatively small. Caudal peduncle relatively compressed. Eye diameter small. Mouth small, inferior, arched with fleshy lips; lower lip divided with two well-developed lobes; upper lip with transverse wrinkles on surface. Barbels, 3 pairs, first on rostrum, second on maxillae, third on maxillomandibula; each barbel well developed, length of maxillary barbel same as eye diameter; length of rostral and mandibular barbels shorter than that of maxillary barbel. Lateral line short, reaching the central region between the pectoral-fin base and the tip of the fin. PMN commonly 12 (range, 11–13). Very small cycloid scales on the trunk. Lamina circularis at the base of the pectoral fin of adult male roundish plate, somewhat narrowing toward the outer part (Fig. 6J). The first branched soft ray of pectoral fin longer than the other rays; pectoral fin of the male relatively longer than that of the female. The upper segments of the first branched soft ray of pectoral fin narrow and weak. Dorsal-fin base equidistant from the base of the caudal fin and the tip of the snout. Pelvic-fin origin below first or second branched dorsal-fin ray. Anal fin not reaching caudal-fin base. Margin of anal and dorsal fins slightly roundish. Caudal fin slightly roundish. Largest recorded specimens: 50.5 mm SL male, 73.9 mm SL female.

Coloration. *Male* (Fig. 3J). Body pearl white with black pigmentation in fresh specimens. Clear streak running from the tip of snout to the occiput, crossing to the eye. Head, opercle and snout covered with some large amorphous patterns. Body pigmentation organized in one dorsal and four lateral zones. Line L1 consisting of a series of 14–17 blotches; blotches saddle shape. Line L2 formed by tiny angular blotches, reaching to pre- or middorsal region, often fused with L1. Line L3 formed by incomplete longitudinal narrow line, reaching beyond dorsal fin, fused with L1 and L4 in posterior part. Line L4 formed by narrow longitudinal line, reaching near caudal base, fused with L1 and L3 in posterior part. Line L5 formed by narrow longitudinal line from upper part of the pectoral fin to the caudal-fin base. Caudal fin and dorsal fin with 3–4 bars of small speckles, exterior bar often margined. Anal fin pigmented along the fin rays. Upper spot at the caudal base black, smaller than eye diameter; lower spot at caudal base faint; spots not connected.

Female (Fig. 5J). Appearance similar to males. But line L4 more developed than males.

Sexual dimorphism. Males have roundish lamina circularis at the base of the pectoral fin, but females do not. Generally, the body size of females is larger than that of males.

Egg diameter. Unknown.

Karyotype. Diploid (2n = 50) (Ueno & Ojima 1976; Ueno *et al.* 1980; Saitoh *et al.* 2000).

Distribution. Middle and lower reaches of Yodo River system, central Honshu: Kyoto and Osaka Prefectures (Saitoh & Aizawa 1987).

Habitat and biology. This subspecies inhabits sandy-mud bottoms of lower reaches of rivers and wando-pools (Saitoh & Aizawa 1987; Saitoh 1989).

Etymology. The subspecific name is derived from the type locality.

Remarks. The subspecies is endemic to the middle and lower reaches of the Yodo River system; however, the last known individual of this subspecies was collected in August 1996. It points out that the decline of the subspecies has been attributed to river improvement and urbanization (Saitoh 1989, 2005). The morphology of this subspecies has been well studied by Saitoh and Aizawa (1987). The genetic features have been reported by Saitoh *et al.* (2010).

Japanese name. Yodo-kogata-suji-shima-dojyô.

Key to 10 species and subspecies of Japanese *Cobitis striata* complex

1. Upper segments of first branched soft ray of pectoral fin broad and strong; prepelvic myotome number commonly 14; egg diameter over 1.1 mm. *C. magnostriata* sp. nov.
- Upper segments of first branched soft ray of pectoral fin narrow and weak; prepelvic myotome number commonly equal to or less than 13; egg diameter about or less than 1.0 mm. 2
2. Lamina circularis of adult male simple roundish plate; prepelvic myotome number commonly 13; black spot on lower caudal-fin base inconspicuous or absent. 3
- Lamina circularis of adult male roundish plate, somewhat narrowing toward outer part; prepelvic myotome number commonly 12; black spot on lower caudal-fin base small. 6
3. Caudal fin and dorsal fin with 4–5 arcuate bars in adult; mature size small, 45–55 mm SL in male, 50–60 mm SL in female; egg diameter 0.8–0.9 mm. *C. kaibarai* sp. nov.
- Caudal fin and dorsal fin with 3–4 arcuate bars in adult; mature size moderate, 60–70 mm SL in male, 60–90 mm SL in female; egg diameter 0.9–1.0 mm. 4
4. Line L4 formed by weak dots or narrow line in non-spawning season; line L5 formed by longitudinal line in all seasons. *C. striata striata*
- Line L4 formed by dots or weblike line in non-spawning season; line L5 organized in 11–14 roundish or ovoid blotches in non-spawning season. 5
5. Line L4 formed by narrow longitudinal line, narrower than L3 in male in non-spawning season; light brown pigmentation in fresh specimens. *C. striata fuchigamii* subsp. nov.
- Line L4 formed by longitudinal, jagged weblike line, broader than L3 in male in non-spawning season; dark brown pigmentation in fresh specimens. *C. striata hakataensis* subsp. nov.
6. Lines L3 and L5 well-developed broad stripes in all seasons. *C. minamorii oumiensis* subsp. nov.
- Lines L3 and L5 formed by narrow longitudinal line or organized blotches in non-spawning season 7
7. Line L5 formed by narrow longitudinal line or organized in connected tiny blotches in non-spawning season. 8
- Line L5 organized in 10–16 blotches in non-spawning season. 9
8. Line L5 formed by narrow incomplete longitudinal line or organized in 15–20 connected tiny blotches; body depth 15.5–20.0% in SL. *C. minamorii minamorii* sp. nov.
- Line L5 formed by narrow longitudinal line; body slender, body depth 12.7–19.2% in SL. *C. minamorii yodoensis* subsp. nov.
9. Line L2 formed by sparse angular blotches; L4 formed by tiny blotches or narrow incomplete longitudinal line in male in non-spawning season; caudal and dorsal fins with 3–4 thin arcuate bars in adult. *C. minamorii tokaiensis* subsp. nov.
- Line L2 formed by longitudinal jagged line; L4 formed by longitudinal jagged weblike line, reaching to postanal body in male in non-spawning season; caudal and dorsal fins with 4–6 thin arcuate bars in adult. *C. minamorii saninensis* subsp. nov.

Discussion

In this study, *C. striata* Ikeda, 1936 has been redescribed, and three new species and six new subspecies have been described. Four species, *C. striata*, *C. kaibarai*, *C. magnostriata*, and *C. minamorii*, were clearly distinguishable by various morphological features (Table 3). However, the three subspecies of *C. striata* and five subspecies of *C. minamorii* are very similar in morphology, and the most important distinguishable features between the subspecies were the pigmentation patterns of the adult males in the non-spawning season. Although the subspecies of *C. striata* and *C. minamorii* are distinguishable by genetic features, the genetic distance is small between the subspecies (Kitagawa *et al.* 2005, 2009; Saitoh *et al.* 2010). Furthermore, some of them are not reproductively isolated (Minamori 1950, 1951a, b, 1952, 1953, 1955b, c), and it is adequate to classify them as subspecies.

TABLE 3. Synopsis of main diagnostic features of four species of Japanese striated spined loaches.

	<i>C. striata</i>	<i>C. kaibarai</i>	<i>C. magnostriata</i>	<i>C. minamorii</i>
Mature size of male	Medium, 50–60 mm SL	Small, 45–55 mm SL	Large, 60–70 mm SL	Small, 40–50 mm SL
Lamina circularis	Simple roundish plate	Simple roundish plate	Simple roundish plate	Roundish plate, somewhat narrowing toward outer part
Upper segments of first branched soft ray of pectoral fin	Narrow	Narrow	Broad	Narrow
Prepelvic myotome number	13	13	14	12
Average egg yolk diameter	Medium, 0.97 mm	Small, 0.83 mm	Large, 1.16 mm	Small, 0.85 mm
Zone Z4 of male in spawning season	Striated	Striated	Striated	Striated
Zone Z4 of male in non-spawning season	Dotted or striated	Dotted	Striated	Dotted or striated
Karyotype	Diploid	Diploid	Tetraploid	Diploid

The lamina circularis at the base of pectoral-fin rays of the adult male is an important taxonomical feature in spined loaches (Vladykov 1935; Nalbant 1963; Kim *et al.* 1999). The results of this study showed that the shape of the lamina circularis is important taxonomically in the *C. striata* complex. In addition, the shape of the upper segments of the first branched soft ray of the pectoral fin is broad in *C. magnostriata* but narrow in the other three species. *Cobitis magnostriata* is tetraploid, and the other three species are diploid (Saitoh *et al.* 2000). Similarly, the Japanese tetraploid cobitid loach, *Cobitis* sp. 'yamato' complex (*sensu* Saitoh *et al.* 2000), often known as *C. matsubarae* Okada & Ikeda, 1939, has broad and strong upper segments of the first branched soft ray (Okada & Ikeda 1939; Nakajima *et al.* 2011a). This may be conjugation of thickness of the fin ray with genome duplication. This feature needs further study.

The number of prepelvic myotomes and the diameter of the egg yolk are taxonomically useful characteristics to distinguish between species of striated spined loaches. Hosoya (2002) mentioned the importance of PMN as a taxonomical character for spined loaches. The prepelvic myotome is easy to count in specimens fixed by formalin or alcohol; this allows for gathering such information from preserved specimens in future studies. There are remarkable variations in egg diameter that reflect interspecific differences in spined loaches (Minamori 1951b, 1952, 1955a, 1956). Although it is difficult to obtain mature females and their eggs, egg size is a very important characteristic to identify species.

In the Japanese *C. striata* complex, lines L3 and L5 are well developed, with broad stripes in males during the spawning season (Figs. 4, 7, 8). This could represent the nuptial color of the males. Therefore, the pigmentation pattern of males in the spawning season is very similar among these loaches. The basic pigmentation pattern is observed on males only in the non-spawning season; this indicates that specimens must be collected during this period to be identified.

The genetic relationships among species in previous studies reveal that *C. magnostriata* is most distantly related to the other three species, and *C. striata* and *C. kaibarai* are the most closely related species (Shimizu *et al.* 2004; Kitagawa *et al.* 2005; Saitoh *et al.* 2010). In this study, the shape of the lamina circularis and the PMN could

be divided into three types (Table 3). The shape of the pectoral fin (lamina circularis + upper segments of first branched ray) and the PMN were the same in *C. striata* and *C. kaibarai*. These results suggest that the most important morphological characteristics of this species complex are the shape of the lamina circularis and PMN. On the other hand, egg diameter and pigmentation pattern could be less relevant to phyletic.

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