

Zacco sieboldii, a species distinct from *Zacco temminckii* (Cyprinidae)

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Abstract Two biological types of Japanese dark chub, so-called types A and B of *Zacco temminckii*, were taxonomically inspected. A comparison of types A and B with the lectotypes of *Leuciscus sieboldii* and *L. temminckii* in Siebold's collection revealed that type A is identical to *L. sieboldii*, whereas type B matches *L. temminckii*. Hence, *Zacco sieboldii* and *Z. temminckii* were redescribed on the basis of the lectotype and additional specimens from Japan. *Zacco sieboldii* is distinguishable from *Z. temminckii* by having a narrower band on the anterior portion of both body sides, nine branched rays of anal fin (10 in *Z. temminckii*), lateral line scales not less than 53 (not more than 52 in *Z. temminckii*), and scales above lateral line not less than 13 (not more than 11 in *Z. temminckii*). A key to the species of Japanese *Zacco* is also provided.

Key words Cyprinidae · *Zacco sieboldii* · *Zacco temminckii* · Siebold's collection

The Japanese dark chub, “kawamutsu,” has been regarded as a single species by Japanese ichthyologists under the scientific name of *Zacco temminckii* or *Z. temminckii* for more than 50 years (Uchida, 1939; Nakamura, 1963; Miyadi et al., 1976). However, the morphological variation of the Japanese dark chub is so great that it can be divided into two types, so-called types A and B, which have become recognized in recent Japanese guide books (Kawanabe et al., 2001). Nakamura (1969) presented a photographic plate to show the morphotypes, representing the two types based on specimens, one from Lake Biwa and the other from Miyazaki Prefecture. Hosoya (2002) provides a key to distinguish both types; nine branched rays of the anal fin for type A compared with ten for type B. Thus, putting this information in order, type A is characterized by having more numerous lateral line scales, nine branched rays of the anal fin, and a slight longitudinal band on both sides of the body, while type B has fewer scales, ten branched rays, and a clearer band. In addition, the occurrence of genetic isolation between the two syntopic types was reported on the basis of electrophoretic data (Okazaki et al., 1991). This result was reinforced by Nagata et al. (1994), who analyzed the karyotypes of the two types ($2n = 48$, $NF = 90$ in type A; $2n = 48$, $NF = 84$ in type B).

As the two types are considered to have differentiated enough at the species level from the facts described here, it is necessary that a proper taxonomic inspection be carried out for nomenclature purposes. Specimens of type A and type B were compared with type specimens of chub-like

cyprinids described by Temminck and Schlegel (1846) based on Siebold's collection, and it was found that type A is identical with *Leuciscus sieboldii*, having about 60 scales and nine branched rays of the anal fin, and type B matches *L. temminckii*, having 50 scales and ten branched rays. In this article, *Z. sieboldii* is redescribed as valid for type A, giving a strict definition of *Z. temminckii* as type B.

Counts and measurements follow the methods of Hubbs and Lagler (1958). The abbreviations in the catalogue numbers of materials examined represent the following institutions: FAKU, Department of Fisheries, Faculty of Agriculture, Kyoto University; FKUN, Department of Fisheries, Kinki University, Nara; FRLM, Fisheries Research Laboratory, Mie University; NMHA, Museum of Nature and Human Activities, Hyogo; NSMT, National Science Museum, Tokyo; RMNH, Rijksmuseum van Geologie en Mineralogie and Natuurlijke Historie, Leiden.

Zacco sieboldii (Temminck and Schlegel, 1846)

(New Japanese name: numamutsu)

(Fig. 1, Table 1)

Leuciscus sieboldii Temminck and Schlegel, 1846: 211, pl. CI, fig. 5 (type locality: Japan).

Opsariichthys sieboldi; Günther, 1868: 295 (Japan).

Zacco sieboldi; Jordan and Fowler, 1903: 854.

Zacco mitsukurii Ishikawa, 1904: 4–5, pl. 2, fig. 2 (type locality: Kyoto, Japan).

Zacco temminckii; Okada, 1960: 506 (in part), pl. xxxv, figs. 2, 3 (Japan).

Fig. 1. *Zacco sieboldii* (Temminck and Schlegel). **A** RMNH 2545-a (lectotype), 115.0 mm SL. **B** FAKU 56845 (a non-type), Ritto-cho, Shiga Prefecture, River Yasu, 109.9 mm SL



Zacco temminckii; Nakamura, 1969: pl. 133A (Lake Biwa, Japan); Sawada, 1984: pl. 57A.

Zacco temminckii, type A Katano, 1989: 234, 242–243.

Zacco sp. Hosoya, 2002: 262 (pictorial key).

Material examined. RMNH 2545-a (lectotype), 115.0 mm SL (standard length); FRLM 6452–6453, 67.3–67.8 mm SL, R. Isuzu, Kusube, Ise City, Mie Pref.; FAKU 115716, 116295–116296 and 58641–58642, 84.9–111.5 mm SL, R. Tokita, Tamaki-cho, Watarai-gun, Mie Pref.; FAKU56845, 108.2 mm SL, R. Yasu, Ritto-cho, Shiga Pref.; NMHA 1014425, 125.0 mm SL, R. Otsumo, Aino, Himeji City, Hyogo Pref.; FAKU 56816–56833, 56.2–108.0 mm SL, a pond at the Sougenji Temple, Maruyama, Okayama City, Okayama Pref.; FAKU 56834, 101.6 mm SL, R. Fushino, Ogoori-cho, Yoshiki-gun, Yamaguchi Pref.

Diagnosis. No maxillary barbels. Number of lateral line scales not less than 53 (= more than 52); scales above lateral line not less than 13. Branched rays of anal fin 9. A dark brown longitudinal band along the side of body, beginning from a point on the shoulder and extending to caudal fin base. Band anteriorly narrow, and posteriorly wide from the vertical line of dorsal fin origin. Anterior margin of the pectoral and pelvic fins when alive is poppy red, in remarkable contrast to the main part of fin. In male, some 10 minute nuptial tubercles on lateral sides of head, scattered over the postorbital region to opercle. These tubercles also found on rays of anal fin, lateral sides of the trunk from anal fin base up to the band, and the ventral side of the caudal peduncle.

Description. Based on the lectotype designated by Boeseman (1947) and non-type specimens listed above; data for the non-type specimens, when different, are given in parentheses. Proportional measurements and meristic counts of some representative specimens are shown in Table 1.

Body moderately elongated and compressed. Outline from nape to occiput almost straight. Head compressed; its length slightly greater than body depth. Mouth wide with a large gape; maxillary extending to somewhat beyond the vertical line from the front margin of orbit. No maxillary barbels. Snout length nearly 1.5 times of orbit diameter, and long, about 20.3 (28.0–35.5) % of the head length; anterior tip of snout pointed. Eye moderately large, in a medial position or in slightly high position (Fig. 1B). Interorbital width nearly 1.8 times of orbit diameter, and about 38.4 (31.2–40.7) % of head length. Cheek broad. Outline from chin to isthmus almost straight, making head a triangular shape in lateral view. Opercle posteriorly roundish. In male, some 10 minute nuptial tubercles on lateral sides of head, scattered over the postorbital region to the opercle. These tubercles also found on rays of anal fin, lateral sides of trunk from the anal fin base up to the band, and ventral side of caudal peduncle. Nuptial tubercle in female confined to head region, and less developed than in male. Body depth nearly 1.5 times of body width, and about 23.8 (23.0–27.3) % of standard length. Dorsal fin small, its origin somewhat behind ventral insertion, and nearer to caudal fin base than to the tip of snout. Second branched ray of anal fin prolonged, making the fin a triangular shape and reaching backward to caudal fin base when squeezed. Posterior margin of caudal fin sharply forked. Posterior tips of both lobes of caudal fin roundish. Pectoral fin falcate. Dorsal half brownish, ventral half grayish, with a dark brown longitudinal band along the side of body, beginning from a point on the shoulder and extending to caudal fin base. Band anteriorly narrow, becoming slightly wider caudad. A slight triangular blotch hanging at anteriormost part of band. Lateral line complete. Dorsal fin rays, iii, 7; anal fin rays, iii, 9; pectoral fin rays, i, 14 (13–14); pelvic fin rays, ii, 8; caudal fin rays, i, 9, 8,

Table 1. Measurement expressed as percentage, and counts of lectotype and selective non-types in *Zacco sieboldii*

Locality	Lectotype				Non-types				
	Japan	Mie Pref.			Shiga Pref.		Hyogo Pref.	Okayama Pref.	
			R. Isuzu	R. Tokita		R. Yasu	L. Biwa	R. Otsumo	Sougenji
Catalogue number	RMNH 2545-a	FRLM 6452	FAKU 116295	FAKU 58641	FAKU 56845	FAKU 116571	NMHA 1014425	FAKU 56816	FAKU 56817
Measurements									
Standard length (mm)	115.0	67.8	84.9	111.5	108.2	157.8	125.0	108.0	79.7
Total length (mm)	134.7	88.0	104.5	135.2	131.3	191.9	151.7	134.2	102.1
As % of SL									
Head length	26.52	27.88	28.91	26.55	23.94	27.11	25.92	28.33	30.44
Body depth	23.83	24.04	23.01	23.86	23.01	27.28	26.96	25.73	25.93
Body width	12.35	15.93	14.88	15.43	14.60	17.20	18.00	14.75	15.02
Depth of caudal peduncle	11.57	11.06	11.41	10.22	9.70	11.23	11.44	10.49	10.56
Length of caudal peduncle	19.83	17.85	20.53	17.76	19.41	18.90	19.12	16.42	16.45
Predorsal length	54.70	53.10	49.28	52.65	49.72	51.59	52.80	51.61	54.59
Preanal length	69.39	72.27	72.34	70.40	68.30	70.42	68.72	68.94	73.38
Preventral length	48.96	50.59	50.44	50.67	48.06	51.06	50.80	51.16	54.50
Dorsal origin to caudal base	51.39	50.91	50.22	49.60	50.09	50.92	51.76	50.36	49.45
Pectoral origin to pelvic insertion	26.70	25.37	23.77	26.73	24.77	26.02	27.28	25.72	26.65
Length of longest dorsal ray	19.30	21.53	20.37	17.22	18.39	20.71	24.08	23.10	21.60
Length of longest anal ray	23.39	18.58	23.51	24.04	22.64	30.02	28.64	30.29	28.44
Length of longest pectoral ray	20.00	23.30	10.17	20.09	19.32	20.69	21.84	21.59	22.91
Length of dorsal fin base	11.74	11.65	9.54	10.94	10.81	13.22	12.88	11.95	13.77
Length of anal fin base	12.35	18.58	12.17	12.74	12.48	16.91	16.48	11.63	11.98
As % of HL									
Snout length	20.33	28.04	33.10	33.11	33.20	32.30	35.49	30.96	31.33
Interorbital width	38.36	31.22	37.06	36.82	40.15	40.23	40.74	34.82	32.40
Orbit diameter	21.31	25.93	21.30	21.28	22.01	18.93	19.14	20.01	22.92
Counts									
Dorsal fin rays	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7
Anal fin rays	iii,9	iii,9	iii,9	iii,9	iii,9	iii,9	iii,9	iii,9	iii,9
Pectoral fin rays	i,14	i,14	i,14	i,13	i,14	i,14	i,14	i,14	i,13
Pelvic fin rays	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8
Principal caudal fin rays	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i
Lateral line scales	61	61	54	57	58	58	65	61	60
Scales above lateral line to dorsal fin origin	14	14	13	13	13	13	13	14	13
Scales below lateral line to anal fin origin	4	5	5	5	5	5	5	5	5
Number of total vertebrae	22 + 20	—	—	22 + 20	—	—	22 + 21	22 + 21	23 + 20

i. The number of lateral line scales 61 (53–65, mode 58); scales above lateral line, 14 (13–14); scales below lateral line, 4 (4–5). Three longitudinal series of scales between lateral line and pelvic fin. Pharyngeal teeth 1,3,5–5,3,1 (Fig. 2A). Number of total vertebrae, 42 (41–43); abdominal vertebrae including centra associated with Weberian apparatus, 22 (22–23); caudal vertebrae including terminal pleurostyle, 20 (20–21).

Coloration in life.—Body colors of the young and adult in nonbreeding season are dark grayish on the back and gradually lighter toward the belly, with a steel-blue longitudinal band. When matured, males are tinged with a nuptial coloration in poppy red on the cheek, the body from the ventral to lateral side, and the membrane of paired fins. In females, the nuptial coloration is so unclear that the

body is gray, with a steel-blue longitudinal band and light-colored fins. The anterior margin of the pectoral and pelvic fins is fringed in poppy red, in remarkable contrast with the main part of the fin, in fish more than 3 cm SL in both sexes.

Distribution. *Zacco sieboldii* is endemic to Japan. The whole range is completely included within that of *Z. temminckii*, confined to the area between the north side of the geographic zone parallel to the Median Tectonic Line and the Chugoku Mountains (see Fig. 4): Tokai District, Nobi and Ise Planes, Lake Biwa basin, San-yo Districts, the northern part of Shikoku, and the northern part of Kyushu. Distribution in several rivers in the Kanto Plain such as River Oppe and River Toki, Saitama Prefecture, is the result of transplantation.

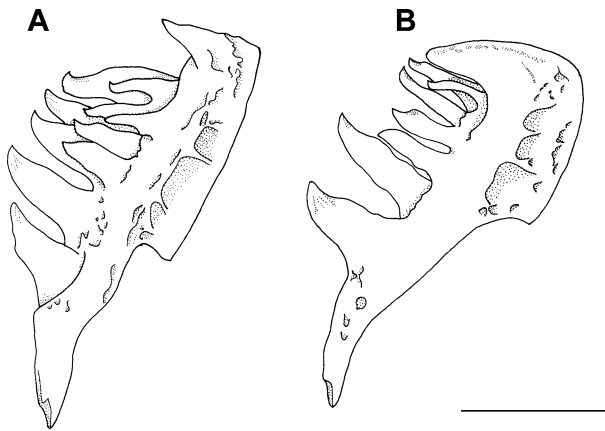


Fig. 2. Ventrolateral view of left pharyngeal bones of *Zacco sieboldii*, FAKU 115716, 91.3 mm SL (A), and *Z. temminckii*, FAKU 115899, 93.7 mm SL (B). Bar 2 mm

Habitat. As the whole range of *Z. sieboldii* is overlapped with that of *Z. temminckii*, they often coexist with *Z. temminckii* in a single river system. However, *Z. sieboldii* tends to prefer more limnetic waters than in *Z. temminckii*, inhabiting lower reaches, irrigation ditches, swamps, and ponds in rice fields. Habitat of this species is reflected to the new Japanese name, Numamutsu, literally meaning swamp-or marsh-dwelling chub.

Remarks. The genus *Zacco* was composed of eight species including the present species, viz., *Z. platypus* (Temminck and Schlegel, 1846), *Z. temminckii*, *Z. sieboldii*, *Z. chengtui* Kimura, 1934, *Z. macrolepis* Yang and Hwang, 1964, *Z. spilurus* (Günther, 1868), *Z. pachycephalus* (Günther, 1868), and *Z. barbatus* (Regan, 1908) (see Bănărescu, 1968, 1991; present study). However, *Z. spilurus* and *Z. pachycephalus* were removed from the genus *Zacco* to other genera. The Chinese *Z. spilurus* was classified into *Parazacco* by Chen (1982) and into *Carinozacco* by Zhu et al. (1982), and the Formosan *Z. pachycephalus* to *Opsariichthys* by Ashiwa and Hosoya (1998).

Zacco sieboldii is easily distinguishable with a longitudinal band on both body sides from the congeners with a series of irregular vertical lines as in *Z. platypus*, *Z. chengtui*, and *Z. macrolepis*. *Zacco sieboldii* is similar to *Z. temminckii* and Formosan *Z. barbatus* in having such a longitudinal band, but differs from *Z. temminckii* by having a narrower band on the anterior portion of both body sides, 9 branched rays of the anal fin (10 in *Z. temminckii*), lateral line scale not less than 53 (not more than 52 in *Z. temminckii*), and scales above the lateral line not less than 13 (not more than 11 in *Z. temminckii*). From *Z. barbatus*, *Z. sieboldii* is distinguishable by completely lacking a pair of barbels at the corner of the mouth (minute barbels are present in *Z. barbatus*).

In the construction of the genus *Zacco*, Jordan and Fowler (1903) first validated both *Z. sieboldii* and *Z. temminckii* for the Japanese chub-like cyprinids after the original description (Temminck and Schlegel, 1846). Soon after, Ishikawa (1904) happened to describe *Z. mitsukurii* on the basis of the specimens from River Katsura, Kyoto

Prefecture, which is identical with *Z. sieboldii*. Ishikawa (1904) also recognized a variant of *Z. sieboldii*, “var. a” in his sense from Kii, which is identical with *Z. temminckii*. However, Jordan and Hubbs (1925) concluded there was no very definite geographic correlation with the number of scales on the wide variation of scale rows, because the specimens they collected from Hamada, Shimane Prefecture, showed an intermediate number of lateral scales between *Z. sieboldii* and *Z. temminckii*. Okada (1960) extended the debate by grouping *Z. sieboldii* and *Z. temminckii* together. These inconsistent opinions have historically regarded *Z. sieboldii* together with *Z. mitsukurii* to be conspecific with *Z. temminckii* without a detailed inspection (Jordan et al., 1913; Uchida, 1939; Matsubara, 1955; Aoyagi, 1957; Okada, 1960; Miyadi et al., 1976; Katano, 1990, 1992). On the other hand, Boeseman (1947) had remarked on the discontinuity in the number of lateral line scales between two species, *Z. sieboldii* and *Z. temminckii*, described by Temminck and Schlegel (1846), and recognized that the two taxa were distinct species. Hence, it was necessary for us to examine again the specimens of *Z. temminckii* from Hamada that are a cause of the judgment of Jordan and Hubbs (1925). Our field research and taxonomic inspection of the specimens from Hamada, covering R. Shimokou, R. Hamada, R. Sufu, and R. Misumi, reconfirm the single occurrence of *Z. temminckii* around Hamada (Table 2), defined by the present study as follows.

Zacco temminckii (Temminck and Schlegel, 1846)

(Japanese name: kawamutsu)

(Fig. 3, Table 2)

Leuciscus temminckii Temminck and Schlegel, 1846: 210, pl. CI, fig. 4.
(type locality: Nagasaki, Japan).

Opsariichthys temminckii; Günther, 1868: 295 (Japan); Sauvage, 1883: 5
(Lake Biwa, Japan).

Zacco temminckii; Jordan and Fowler, 1903: 852 (Nagasaki, Japan);
Nakamura, 1969: pl. 133A (Miyazaki, Japan); Sawada, 1984: pl. 57B;
Hosoya, 2002: 262 (pictorial key).

Zacco mitsukurii, var. a Ishikawa, 1904: 5–6 (Kii, Japan).

Zacco temminckii; Okada, 1960: 505–506 (in part), pl. xxxv, fig. 1 (Japan).

Zacco temminckii, type B Katano, 1989: 234, 239–241.

Material examined. RMNH 2546-a (lectotype), 103.5 mm SL; FAKU 56838, 56840, and 115899, 93.7–122.3 mm SL, R. Tokita, Tamaki-cho, Watarai-gun, Mie Pref.; FRLM 16297–16298, 58.2–138.4 mm SL, R. Kamitsusa, Matsusaka City, Mie Pref.; FRLM 16299–16301, 45.2–70.2 mm SL, Gokatsura, Taki-gun, Mie Pref.; FRLM 16302, 50.6 mm SL, R. Kushida, Matsusaka City, Mie Pref.; FRLM 16303–16305, 62.5–81.3 mm SL, R. Kumozu, Fujikawa, Nozoe, Mie Pref.; FKUN 7013–7014, 117.6–131.7 mm SL, R. Kumano, Wakayama Pref.; FKUN 31738, 93.1 mm SL, L. Biwa, Ohtatsumi-cho, Nagahama City, Shiga Pref.; NMHA 1014423, 127.3 mm SL, R. Otsumo, Kami-ise, Himeji City, Hyogo Pref.; NSMT-P1548 (2 of 8 specimens in 1 lot), 89.1–100.7 mm SL, Izumo, Shimane Pref.; FKUN 31722, 84.3 mm SL, R. Hamada, Kawachi, Hamada City, Shimane Pref.; FKUN 31663, 122.4 mm SL, R. Sufu, Ushidani, Hamada City, Shimane Pref.; FKUN 31683, 110.8 mm SL, R. Shimokou, Uno-cho, Hamada City, Shimane Pref.; FKUN 31729, 162.5 mm SL, R. Misumi, Misumi-cho, Naka-gun, Shimane Pref.; FAKU

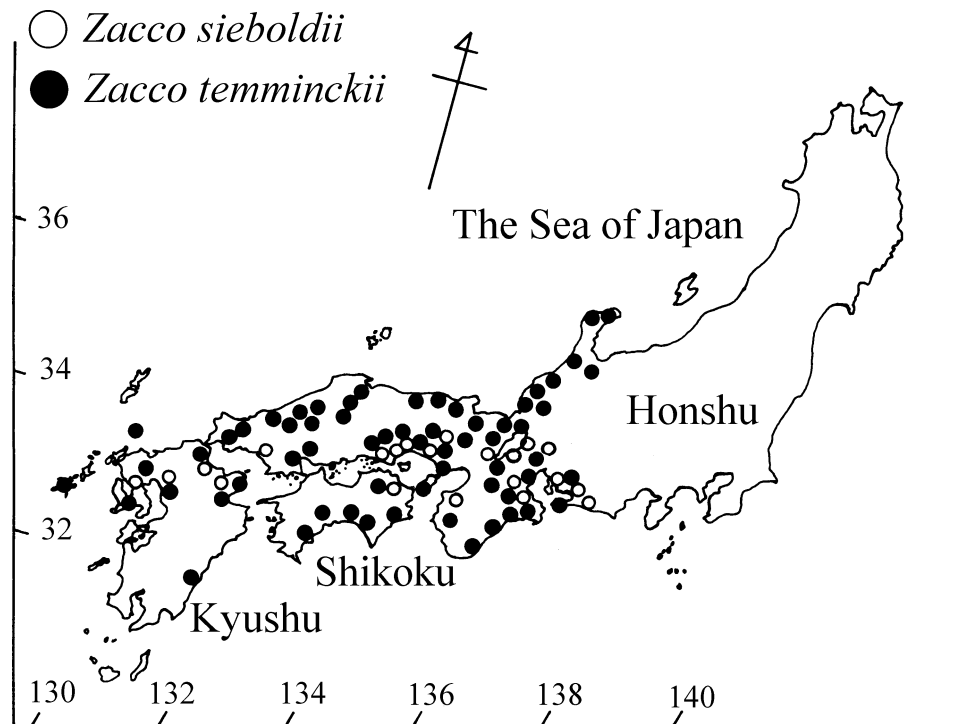
Table 2. Measurement expressed as percentage, and counts of lectotype and selective non-types in *Zacco temminckii*

Locality	Lectotype										Non-types									
	Nagasaki		Mie Pref.		Wakayama Pref.		Shiga Pref.		Hyogo Pref.		Shimane Pref.		Izumo		R. Hamada		R. Simokou		R. Misumi	
	RMNH 2546-a	FRLM 16303	FRLM 16305	R. Kumozu	R. Kumano	FKUN 7014	FKUN 31738	L. Biwa	NMHA 1014423	R. Otsumo	FKUN 31697	NSMT P1548(8)-1	FKUN 31712	FKUN 31683	FKUN 31729	FKUN 31739	FKUN 162.5	FKUN 200.6	FKUN 26.71	FKUN 26.22
Catalogue number																				
Measurements																				
Standard length (mm)	103.5	81.3	62.5	29.19	25.13	131.7	93.1	127.3	127.3	107.5	100.7	84.3	110.8	162.5	138.2					
Total length (mm)	125.6	65.2	79.5	163.2	163.2	163.2	116.3	155.4	155.4	133.0	122.8	106.2	149.0	200.6	173.8					
As % of SL																				
Head length	27.15	29.13	29.19	25.13	25.13	131.7	93.1	27.42	27.42	28.00	26.91	27.05	29.24	26.71	27.06					
Body depth	24.83	23.84	23.22	26.12	26.12	26.12	26.10	26.63	26.63	23.72	26.42	23.37	25.54	26.22	25.11					
Body width	10.72	15.29	15.11	14.50	14.50	14.50	19.66	15.24	15.24	14.42	10.33	14.35	15.97	17.54	14.40					
Depth of caudal peduncle	10.14	9.66	8.66	9.26	9.26	9.26	10.31	10.60	10.60	10.51	10.13	9.73	11.46	10.89	9.33					
Length of caudal peduncle	18.07	18.12	19.89	17.39	17.39	17.39	19.33	20.03	20.03	17.77	18.67	18.98	19.68	17.17	18.16					
Predorsal length	51.88	55.49	53.69	50.72	50.72	50.72	49.84	52.24	52.24	51.63	49.85	52.08	57.13	52.74	51.95					
Preanal length	70.05	71.97	68.86	66.67	66.67	66.67	69.71	70.07	70.07	70.51	71.30	69.16	76.62	68.00	68.67					
Preventral length	48.89	52.12	51.94	48.44	48.44	48.44	49.41	50.43	50.43	49.77	50.15	50.18	55.96	50.15	50.87					
Dorsal origin to caudal base	48.21	49.10	50.47	53.38	53.38	53.38	53.17	52.24	52.24	49.58	52.83	49.47	53.97	51.69	52.53					
Pectoral origin to pelvic insertion	24.64	26.49	25.81	26.12	26.12	26.12	25.56	26.16	26.16	23.63	24.93	26.10	29.69	25.85	24.96					
Length of longest dorsal ray	19.90	22.07	21.86	22.40	22.40	22.40	21.70	23.64	23.64	19.26	21.65	19.34	20.49	24.92	20.12					
Length of longest anal ray	27.54	28.45	20.90	37.05	37.05	37.05	25.13	32.29	32.29	29.49	30.29	24.56	29.96	36.00	32.78					
Length of longest pectoral ray	20.68	21.61	20.80	23.01	23.01	23.01	19.44	19.80	19.80	21.21	22.54	20.05	20.40	20.92	23.23					
Length of dorsal fin base	9.47	10.50	9.68	14.73	14.73	14.73	10.85	12.41	12.41	10.98	12.02	10.56	11.82	13.17	11.87					
Length of anal fin base	14.01	13.16	12.13	18.53	18.53	18.53	12.67	14.30	14.30	11.53	15.99	12.46	14.26	15.45	14.83					
As % of HL																				
Snout length	30.25	26.86	31.74	30.82	30.82	30.82	33.06	32.66	32.66	32.56	31.00	32.02	34.57	33.64	32.62					
Interorbital width	37.37	30.11	30.87	35.65	35.65	35.65	35.48	39.54	39.54	35.22	36.90	35.53	37.96	39.63	37.43					
Orbit diameter	25.98	29.52	30.92	21.45	21.45	21.45	22.18	20.34	20.34	26.25	25.46	28.51	23.15	19.12	20.59					
Counts																				
Dorsal fin rays	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7	iii,7					
Anal fin rays	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10	iii,10					
Pectoral fin rays	i,14	i,14	i,14	i,13	i,13	i,13	i,14	i,14	i,14	i,14	i,14	i,14	i,14	i,14	i,13					
Pelvic fin rays	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8	ii,8					
Principal caudal fin rays	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i	i,9,8,i					
Lateral line scales	50	51	47	52	52	52	47	51	51	50	52	50	50	48	52					
Scales above lateral line to dorsal fin origin	10	11	10	10	10	10	11	11	11	11	10	10	11	10	11					
Scales below lateral line to anal fin origin	4	4	4	5	5	5	5	5	5	4	4	4	4	5	4					
Number of total vertebrae	22 + 21	22 + 21	22 + 21	23 + 21	23 + 21	23 + 21	22 + 21	22 + 21	22 + 21	21 + 21	22 + 21	22 + 21	22 + 21	22 + 21	22 + 21					

Fig. 3. *Zacco temminckii* (Temminck and Schlegel). **A** RMNH 2546-a (lectotype), 103.5 mm SL. **B** FAKU 56838 (a non-type), Tamaki-cho, Watarai-gun, Mie Prefecture, River Tokida, 122.3 mm SL



Fig. 4. Sampling records of *Zacco sieboldii* and *Z. temminckii* from the original distribution. Data based on Ashiwa et al. (1994), Kato (1998), Nakamura (1969), Nakatani and Yoshida (1993), Sano and Yamamoto (1996), Sato (1994, 1995), Suzuki (1996), Temminck and Schlegel (1846), and our private collections



56854–56872, 56.6–135.4 mm SL, R. Ohkawa, Kumasaka, Miyano, Yamaguchi City, Yamaguchi Pref.; FKUN 31739–31740, 138.2–138.6 mm SL, R. Kikuchi, Kikusui-cho, Tamana-gun, Kumamoto Pref.

Diagnosis. No maxillary barbels. Number of lateral line scales not more than 52; scales above lateral line not more

than 11. Branched rays of the anal fin 10. Anterior margin of the pectoral and pelvic fins yellow or reddish-yellow, in slight contrast with the main part of fin. In male, nuptial tubercles confined to anterior lateral sides on the head region, snout, and infraorbital region.

Description. Based on the lectotype designated by Boeseman (1947) and selective non-type specimens listed

earlier. Proportional measurements and meristic counts of representative specimens are shown in Table 2.

Body moderately elongated and compressed. Outline from nape to occiput, convex. Head moderately compressed; its length slightly less than body depth. Mouth wide; maxillary extends to somewhat beyond the vertical from the front margin of eye. No maxillary barbels. Snout length a little longer than orbit diameter, and about 30.3 (26.9–34.6) % of head length; anterior tip of snout roundish. Eye large, in a high position. Interorbital width nearly 1.8 times orbit diameter, and about 37.4 (30.1–39.6) % of head length. Cheek broad. Outline from chin to isthmus slightly de-curved. Opercle posteriorly roundish. Nuptial tubercles in male well developed, but absent on opercle, pattern of its distribution almost same as in *Z. sieboldii*. Nuptial tubercles of head region in female fewer than in male; tubercles on body surface and anal fin absent in female. Caudal peduncle much compressed. Body depth nearly 1.5 times body width, and about 24.8 (23.2–26.6) % of standard length. Dorsal fin small, its origin somewhat behind ventral insertion and nearer to caudal fin base than to the tip of snout. Second branched ray of anal fin considerably prolonged, making fin triangular in shape and reaching backward to the caudal fin base when squeezed. Posterior margin of caudal fin sharply forked. Dorsal half brownish, ventral half grayish, with a dark brown longitudinal band along the side of body, beginning on shoulder and extending to caudal fin base. Anterior margin of the cleithrum, just behind the gill cleft, fringed by a dark vertical band (see Fig. 3B). Lateral line complete. Dorsal fin rays, iii, 7; anal fin rays, iii, 10; pectoral fin rays, i, 14 (13–14); pelvic fin rays, ii, 8; caudal fin rays, i, 9, 8, i. Number of lateral line scales 50 (45–52, mode 48); scales above lateral line, 10 (10–11); scales below lateral line, 4 (4–5). Three longitudinal series of scales between lateral line and pelvic fin. Pharyngeal teeth 1,3,5–5,3,1 (see Fig. 2B). Number of total vertebrae, 43 (42–44); abdominal vertebrae including centra associated with Weberian apparatus, 22 (21–23); caudal vertebrae including terminal pleurostyle, 21 (19–22).

Coloration in life.—Body colors of young and adult in nonbreeding season are dark grayish on back and gradually lighter toward the belly, with a dark gray longitudinal band in both sexes. When matured, males are tinged with a nuptial coloration in buff-yellow on anteroventral body side and in reddish-yellow on anteroventral side. In females, nuptial coloration is so unclear that the body is dark gray, with a dark gray longitudinal band and light yellow fins. The anterior margin of the pectoral and pelvic fins is yellow or reddish-yellow in slight contrast with the main part of the fin, in fish more than 3 cm SL, in both sexes; the membrane of those fins is yellowish. The dorsal fin has a slight brown mark in the lower position, which radiates distally to the fin membrane.

Distribution. *Zacco temminckii* is widely distributed in the western part of Japan and adjacent islands: Tokai District, the Noto Peninsula, the Nobi and Ise Plains, the Lake Biwa basin, San-yo and San-in Districts, northern part of Shikoku, Awaji, and Shodo Islands, and Kyushu including Iki and Goto Islands (Fig. 4).

Habitat. *Zacco temminckii* occurs in various types of habitats such as rivers, ponds, and lakes. Compared with *Z. sieboldii*, the present species can tolerate more rapid waters in streams or upper reaches of large rivers; this enables them to exclusively inhabit short rivers on small islands.

Remarks. The Korean form described previously by Uchida (1939) basically accords with *Z. temminckii* by having 7 branched dorsal fin rays, 10 branched anal fin rays, and 48–51 lateral scales, specimens of which were collected from the range covering the entire distribution of the Korean form. We also examined specimens from Samchok City, Korea (FKUN 31882–31883), and confirmed the concordance of meristic counts (D, iii, 7; A, iii, 10, lateral scale, 50) to those of *Z. temminckii*. However, Choi et al. (1990) showed different counts for the anal and dorsal fin rays (Sc, 48–55; D, iii, 7–8; A, iii, 9–10), which are wider than in *Z. temminckii* (Sc, 45–52; D, iii, 7; A, iii, 10). In addition, the mature male in the color plate presented by Choi et al. (1990: 98) has a different coloration; a remarkable black band running parallel to the fin base at the lower position of the dorsal fin (in the Japanese form, the band is slightly brown, radiating to the fin membrane); the antero-lateral sides of body are tinted in brilliant yellow, and anteroventral sides are red (in the Japanese form, the anterolateral sides of the body are tinted in buff-yellow and the anteroventral sides in reddish-yellow). Such a color pattern in Choi et al. (1990) is quite different from that of *Z. sieboldii*, also. Thus, all the species composing the genus *Zacco* having the foregoing characteristics are called the Korean form for taxonomic comparison.

Key to the species of Japanese *Zacco*

- A1 A series of irregular vertical lines present on both body sides; scales above the lateral line not more than 9
Zacco platypus (Japanese name: oikawa)
- A2 A dark brown longitudinal band present along the mid-line on both body sides; scales above the lateral line not less than 9 B
- B1 The band is anteriorly narrow and posteriorly wide from the vertical line of the dorsal fin origin; anal fin ray, iii, 9, the number of lateral line scales not less than 53; scales above lateral line not less than 13 *Zacco sieboldii* (New Japanese name: numamutsu)
- B2 The band is equally wide from the shoulder to the caudal fin base; anal fin ray, iii, 10; the number of lateral line scales not more than 52; scales above the lateral line not more than 11 *Zacco temminckii* (Japanese name: kawamutsu)

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