Japan. J. Ichthyol.
41(4): 409–420, 1995

魚類学雑誌
41(4): 409–420, 1995

Redescription of Two Ambiguous Japanese Bagrids, *Pseudobagrus aurantiacus* (Temminck and Schlegel) and *P. tokiensis* Döderlein

Katsutoshi Watanabe and Hiroshi Maeda[1]

Laboratory of Ichthyology, Tokyo University of Fisheries, 4–5–7 Konan, Minato-ku, Tokyo 108, Japan
[1] Present address: Ogasawara Fishery Center of Tokyo, Kiyose, Chichi-jima, Ogasawara, Tokyo 100–21, Japan

(*Received April 15, 1994; in revised form September 24, 1994; accepted December 14, 1994*)

Abstract Although known to be distinct genetically and recently treated as different species taxonomically, two Japanese bagrid catfishes, *Pseudobagrus aurantiacus* (Temminck and Schlegel) and *P. tokiensis* Döderlein, have not been previously scrutinized as to their morphological differences. Examination of morphometric and osteological characters revealed that the former species differs from the latter in having a higher dorsal fin, the pectoral spine more prominently serrated on the anterior edge, more densely serrated on the posterior edge, and with 1–3 antrorse serrations at the base, a broader supraoccipital process, the supraneural as long as or longer than the supraoccipital process, a broader posterior process of the cleithrum (posterior tip angle >20°), and the hyomandibular widely separated from the metapterygoid. In addition, the body color pattern of young fish differs in the two species.

According to recent literature, the family Bagridae (Siluriformes) in Japan is represented by the following three species: *Pseudobagrus ichikawai* (=*Coreobagrus ichikawai*), *P. nudiceps* (=*Pelteobagrus nudiceps*), and *P. aurantiacus* (Matsubara, 1955; Okada, 1960; Nakamura, 1963; Miyadi et al., 1976; Sawada, 1984). These species are allopatrically distributed, *P. ichikawai* occurring around the Ise and Mikawa Bays, Chubu District, central Honshu, *P. nudiceps* throughout western Honshu, Shikoku and eastern Kyushu, and *P. aurantiacus* discontinuously in eastern Honshu and western Kyushu. In the last-named species, Ueno (1974, 1985) found allozymatic and chromosomal differences between the Honshu and Kyushu populations, suggesting specific distinction of the two geographical forms. However, the two forms have remained treated as a single species in most subsequent papers (Miyadi et al., 1976; Sawada, 1984; Kimizuka, 1989).

Juso (1979) and Hosoya (1993) noted a few morphological differences between the two forms of *P. aurantiacus*, in addition to their genetic differences, the latter author treating the western Kyushu form as *P. aurantiacus* (Temminck and Schlegel, 1846) and the eastern Honshu form as *P. tokiensis* Döderlein, 1887, this having previously been considered a junior synonym of the former (e.g., Jordan and Fowler, 1903; Okada, 1960).

Although the genetic differences between the two forms was sufficient for their specific distinction, recognized by Hosoya's (1993) taxonomic treatment, detailed morphological comparison of the two species remained to be done. In the present study, the two species, *P. aurantiacus* and *P. tokiensis*, are redescribed and comparisons made on the basis of extensive morphometric and osteological observations on a wide range of specimens, including the lectotype of the former.

Materials and Methods

Specimens examined

Pseudobagrus aurantiacus.—Japan (locality unknown): RMNH (National Museum of Natural History, Leiden) 2952a (lectotype designated by Boeseman [1947]), 164.7 mm in standard length (SL) (collected by von Siebold). Chikugo River (Yoshii, Fukuoka Pref.): NSMT (National Science Museum, Tokyo)-P 36003, 4 (2 cleared and stained specimens [C&S]), 128.9–196.4 mm SL; NSMT-P 36004, 17 (of 30) (3 C&S), 69.7–177.0 mm SL; NSMT-P 36005, 7 (3 C&S), 56.5–88.4 mm SL. Yabe R. (Tachibana, Fukuoka Pref.): NSMT-P 36006, 11 (of 12), 41.3–90.4 mm SL; NSMT-P 36007, 18 (of 32), 54.2–123.2 mm SL. Hiwatashi R. (Sendai R. system; Togo, Kagoshima Pref.): NSMT-P 36008, 26 (of 30), 68.7–151.8 mm SL; NSMT-P 36009, 7 (of 21), 44.7–63.0 mm SL.

Pseudobagrus tokiensis.—Tokyo: ZMB (Museum für

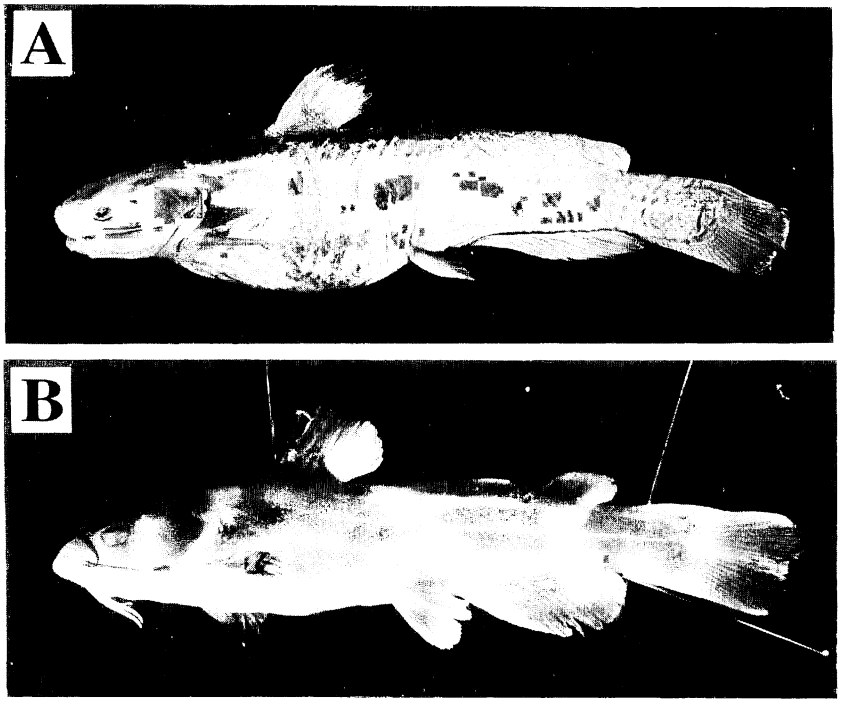

Fig. 1. *Pseudobagrus aurantiacus.* A) Lectotype (RMNH 2952a, 164.7 mm SL); B) young specimen (NSMT-P 36005-7, 56.5 mm SL; Chikugo River).

Naturkunde der Humboldt-Universität zu Berlin) 12246, 2 specimens, 110.2–113.2 mm SL (collected by Döderlein). Koma River (Ara R. system; Hidaka, Saitama Pref.): NSMT-P 36010, 31 (of 32), 71.3–127.4 mm SL; NSMT-P 36011, 6, 36.6–136.2 mm SL. Yoro R. (Ichihara, Chiba Pref.): NSMT-P 36012, 18 (of 19), 33.0–104.6 mm SL; NSMT-P 36013, 5, 38.8–54.9 mm SL. Minato R. (Huttsu, Chiba Pref.): NSMT-P 36014, 90.4 mm SL. Sasa R. (Obitsu R. system; Kimitsu, Chiba Pref.): NSMT-P 36015, 75.2 mm SL. Isumi R. (Otaki, Chiba Pref.): NSMT-P 36016, 7, 30.5–46.2 mm SL. Kuro R. (Naka R. system; Nasu, Tochigi Pref.): NSMT-P 36017, 21 (of 23) (7 C&S), 44.6–119.0 mm SL; NSMT-P 36018, 9 (of 30) (6 C&S), 139.2–216.6 mm SL. Hienuki R. (Kitakami R. system; Osako, Iwate Pref.): NSMT-P 36019, 19 (of 30) (5 C&S), 69.1–174.0 mm SL; NSMT-P 36020, 12 (of 23), 42.1–79.2 mm SL. Mogami R. (Kita-murayama, Yamagata Pref.): ZUMT (Department of Zoology, University Museum, University of Tokyo) 8866–8871, 6, 45.3–82.1 mm SL.

Methods

Counts and measurements followed those of Hubbs and Lagler (1967), except for as follows. The last two rays of the dorsal and anal fins were counted separately, whereas the first 2–4 spiny soft rays of the anal fin were counted as a single ray, such counts thereby corresponding to the number of proximal pterygiophores in each case. The vertebral number included both the preurostyle and the anterior five vertebrae comprising the Weberian complex. Radiographs were used to count the anal fin ray (=proximal pterygiophores) and vertebral numbers. Measurements were made to the nearest 0.1 mm. Cleaning and staining followed Dingerkus and Uhler's (1977) methods.

For examining allometric differences between the two species, rates of correct discrimination by liner discriminant functions calculated on two logarithmic transformed variables, standard length and each body part, were used.

Pseudobagrus aurantiacus
(Temminck and Schlegel, 1846)
(Japanese name: Ariake-gibachi)
(Fig. 1)

Bagrus aurantiacus Temminck and Schlegel, 1846: 227–228, pl. 104, fig. 2 (Satzuma, Kuruma [misspelling of Kurume?], Higo, etc.).

Pseudobagrus aurantiacus: Bleeker, 1860: 87.
Pseudobagrus aurantiacus aurantiacus: Tanaka, 1943: 31.
Pseudobagrus (*Pseudobagrus*) *aurantiacus*: Miyadi et al., 1976: 258–260, pl. 33.

Diagnosis. A species of *Pseudobagrus* with pectoral fin rays I, 7 (rarely 6); anal fin rays 18–23; vertebrae 47–50; maxillary barbels long, extending to origin of pectoral fin; caudal fin slightly emarginated or truncated; second dorsal spine with feeble serrations on anterior edge; anterior edge of pectoral spine with conspicuous subcutaneous serrations, posterior edge with 8–17 strong serrations (1–3 serrations at base antrorse, remainder retrorse) in specimens between about 40–200 mm SL; posterior process of cleithrum broad dorsoventrally, triangular (posterior tip angle >20°); supraneural (1st proximal pterygiophores) large, extending almost to supraoccipital process.

Description. All meristic and morphometric measurements of the lectotype and other specimens are shown in Tables 1 and 2.

Dorsal fin rays II, 7 (rarely 6 or 8); anal fin rays 18–23; pectoral fin rays I, 7 (rarely 6); pelvic fin rays 6 (rarely 7); principal caudal fin rays, 8 (upper), 9 (lower). Vertebrae 47–50 (usually 47 or 48).

Body moderately elongated, mean depth 20.9 (range: 15.9–26.6) %SL; head length 25.7 (19.9–28.7) % SL, ratio decreasing with growth; caudal peduncle laterally compressed, length 16.8 (14.1–20.5) % SL, depth 9.4 (8.0–11.4) % SL.

Head broad, width 79.6 (72.3–85.3) % head length (HL); eye small, diameter 14.5 (11.0–18.4) % HL; mouth subterminal, broad, width 50.2 (44.3–58.0) % HL, bearing numerous villiform teeth on premaxillary, prevomer and dentary; supraoccipital process subcutaneous, rather broad, moderately long (Fig. 2A); supraneural large, triangular, extending almost to supraoccipital process (Fig. 2A); maxillary barbels long, 78.6 (59.4–102.5) % HL, extending to pectoral origin; outer mandibular barbels extending to branchiostegal membrane, 57.1 (45.9–68.9) % HL; inner mandibular barbels extending to isthmus, 39.6 (28.9– 51.2) % HL; nasal barbels extending to posterior margin of eye, 41.4 (32.4– 51.2) % HL.

Dorsal fin rather high, length of first soft ray 17.2 (13.7–19.9) % SL, ratio decreasing with growth; first dorsal spine small, subcutaneous; second dorsal spine with feeble serrations on anterior edge, length 12.3 (8.0–15.3) % SL; anal fin low, long, base 22.3 (18.5–25.0) % SL; length of first soft ray of pectoral fin 17.7 (13.5–20.8) % SL, decreasing with growth; pectoral spine strong, length 15.0 (11.1–18.2) % SL, bearing 8–17 strong serrations on posterior edge (1–3 serrations at base antrorse, remainder retrorse) in specimens between about 40–200 mm SL, conspicuous subcutaneous serrations on anterior edge (Fig. 3A); posterior process of cleithrum broad dorsoventrally, triangular (posterior tip angle >20°), with minute granulated ridges (Fig. 4A); length of pelvic fin 11.1 (9.1–13.2) % SL; caudal fin slightly emarginated or truncated, maximum length (from middle of caudal base to furthest point of upper lobe) 17.8 (15.4– 21.1) % SL, minimum length (from middle of caudal base to nearest point of distal margin of fin) 14.5 (11.4–17.7) % SL; adipose fin base as long as or longer than anal fin base.

Sexual dimorphism.—Males grow larger than females, the body becoming more elongated in speci-

Table 1. Meristic counts (mean±SD [range]) of *Pseudobagrus aurantiacus* and *P. tokiensis*

	P. aurantiacus		*P. tokiensis*		
	Lectotype RMNH 2952a	Non-type specimens ($n=90$)	ZMB 12246 Spm.1	ZMB 12246 Spm.2	Other specimens ($n=136$)
Soft rays					
Dorsal	7	7.0±0.1 (6–8)	7	7	7.0±0.0 (7)
Anal	20	20.2±0.9 (18–23)	20	20	20.9±1.0 (19–24)
Pectoral	7	7.0±0.1 (6–7)	7	7	7.0±0.2 (7–8)
Pelvic	6	6.0±0.1 (6–7)	6	6	6.0±0.1 (6–7)
Caudal					
upper	8	8.0±0.0 (8)	8	8	8.0±0.2 (7–9)
lower	9	9.0±0.0 (9)	9	9	9.0±0.2 (8–10)
Vertebrae	47	48.1±0.7 (47–50)[a]	46	47	47.8±0.9 (46–50)[b]

[a] $n=86$; [b] $n=129$.

mens >ca. 150 mm SL, head, eyes and dorsal and pectoral fins larger in females.

Body color.—In live specimens, rather deep yellow with dark blotches; in alcohol, uniformly dark, but yellowish-white with large dark blotches (also on fins) in specimens <ca. 100 mm SL (Fig. 1B).

Distribution. Western Kyushu: Chikugo River, Yabe R., Kikuchi R. (Ueno, 1974), Sendai R., Iki Island (Mori, 1937).

Remarks. Although type specimens were not designated by Temminck and Schlegel (1846) for their *Bagrus aurantiacus*, Boeseman (1947: 169) selected a specimen (RMNH 2952a [Fig. 1A], but printed incorrectly as 2955a; M. J. van Oijen, pers. comm.) from 5 specimens collected by von Siebold as the lectotype.

Pseudobagrus aurantiacus has been treated as a senior synonym of *P. tokiensis*, both having been called "gibachi," the Japanese common name (e.g.,

Table 2. Morphometric measurements (mean±SD [range]) of *Pseudobagrus aurantiacus* and *P. tokiensis*

	P. aurantiacus			*P. tokiensis*			
	Lectotype RMNH-2952a	Non-type specimens (n=90)	r[a]	ZMB-12246 Spm. 1	ZMB-12246 Spm. 2	Other specimens (n=136)	r[a]
SL (mm)	164.7	89.5±32.4 (41.3–196.4)		113.2	110.2	78.7±36.7 (30.5–216.6)	
In SL (%)							
BD	21.4	20.9±2.7 (15.9–26.6)	−0.31**	16.8	18.1	21.4±2.6 (14.9–26.8)	−0.78**
HL	24.0	25.7±1.7 (19.9–28.7)	−0.89**	24.9	24.4	25.8±1.8 (20.0–29.5)	−0.85**
CPL	17.9	16.8±1.2 (14.1–20.5)	−0.12	16.3	16.9	18.1±1.1 (15.4–23.3)	−0.13
CPD	9.1	9.4±0.8 (8.0–11.4)	−0.67**	8.6	9.4	10.4±0.6 (8.1–11.9)	−0.47**
PrDL	32.7	34.0±1.9 (27.9–38.0)	−0.80**	32.8	32.9	33.8±2.1 (27.0–37.8)	−0.86**
PrAL	62.1	62.6±1.7 (55.9–66.4)	−0.28**	61.5	62.5	60.9±1.9 (53.7–64.9)	−0.22*
PrP1L	21.1	21.9±1.5 (18.3–25.2)	−0.77**	21.2	20.9	22.7±2.0 (18.3–26.6)	−0.76**
PrP2L	54.0	51.1±1.7 (44.7–54.0)	−0.54**	50.1	49.6	50.0±1.9 (43.1–59.2)	−0.54**
DBL	11.3	10.6±1.0 (7.8–13.4)	−0.74**	9.8	10.7	9.8±0.9 (7.1–12.1)	−0.78**
DR1L	16.4	17.2±1.2 (13.7–19.9)	−0.77**	—	12.2	14.4±1.4 (10.6–17.7)	−0.72**
DSpL	12.3	12.3±1.3 (8.0–15.3)	−0.73**	10.6	11.1	9.6±1.3 (5.3–13.3)	−0.43**
ABL	21.1	22.3±1.2 (18.5–25.0)	0.15	22.1	23.1	23.1±1.3 (20.2–28.3)	−0.07
AFH	26.5	27.9±1.3 (25.2–33.1)	−0.04	26.4	29.4	27.7±1.6 (21.4–31.3)	−0.10
P1R1L	16.8	17.7±1.6 (13.5–20.8)	−0.88**	15.5	16.3	16.2±1.4 (11.5–19.9)	−0.67**
P1SpL	14.4	15.0±1.3 (11.1–18.2)	−0.66**	14.4	14.2	13.0±1.2 (8.9–15.9)	−0.30**
P2L	10.7	11.1±0.8 (9.1–13.2)	−0.61**	8.8	12.2	10.8±0.7 (8.8–12.5)	−0.20*
CLmax	18.3	17.8±1.3 (15.4–21.1)	−0.58**	14.0	17.6	17.5±1.6 (14.0–20.9)	−0.67**
CLmin	15.7	14.5±1.2 (11.4–17.7)	−0.57**	11.4	14.8	14.2±1.6 (10.6–18.7)	−0.64**
In HL (%)							
SnL	34.9	36.9±1.6 (32.7–41.1)	−0.34**	34.4	33.5	35.9±1.6 (31.3–40.8)	−0.11**
ED	13.2	14.5±1.6 (11.0–18.4)	−0.63**	13.8	12.3	14.1±1.3 (10.4–17.8)	−0.60**
HW	78.2	79.6±2.6 (72.3–85.3)	−0.11	79.1	72.1	80.3±3.3 (73.9–89.0)	−0.38**
MW	55.2	50.2±2.4 (44.3–58.0)	0.17	46.8	45.4	51.5±2.5 (44.4–58.9)	0.35**
IOW	43.0	40.0±2.0 (34.6–44.3)	0.37**	39.0	39.4	39.2±2.1 (35.1–46.7)	0.23**
MxBL	84.1	78.6±6.5 (59.4–102.5)	0.38**	96.5	—	76.6±6.9 (50.4–95.6)	0.45**
OMnBL	44.3	57.1±5.0 (45.9–68.9)	0.18	66.7	—	56.3±5.4 (42.0–70.0)	0.50**
IMnBL	39.5	39.6±3.9 (28.9–51.2)	0.32**	40.1	—	37.9±3.7 (26.7–46.1)	0.42**
NaBL	40.5	41.4±3.4 (32.4–51.2)	0.30**	47.9	—	38.7±4.0 (27.2–46.6)	0.35**

BD=body depth, HL=head length, CPL=caudal peduncle length, CPD=caudal peduncle depth, PrDL=predorsal length, PrAL=preanal length, PrP1L=prepectoral length, PrP2L=prepelvic length, DBL=length of dorsal fin base, DR1L=length of 1st soft ray of dorsal fin, DSpL=length of second dorsal spine, ABL=length of anal fin base, AFH=height of anal fin, P1R1L=length of 1st soft ray of pectoral fin, P1SpL=length of pectoral spine, P2L=length of pelvic fin, CLmax=maximum length of caudal fin, CLmin=minimum length of caudal fin, SnL=snout length, ED=eye diameter, HW=head width, MW=mouth width, IOW=interorbital width, MxBL=length of maxillary barbel, OMnBL=length of outer mandibular barbel, IMnBL=length of inner mandibular barbel, NaBL=length of nasal barbel.
[a] Correlation coefficient between SL (or HL) and ratio of each character to SL (or HL); *p<0.05, **p<0.01.

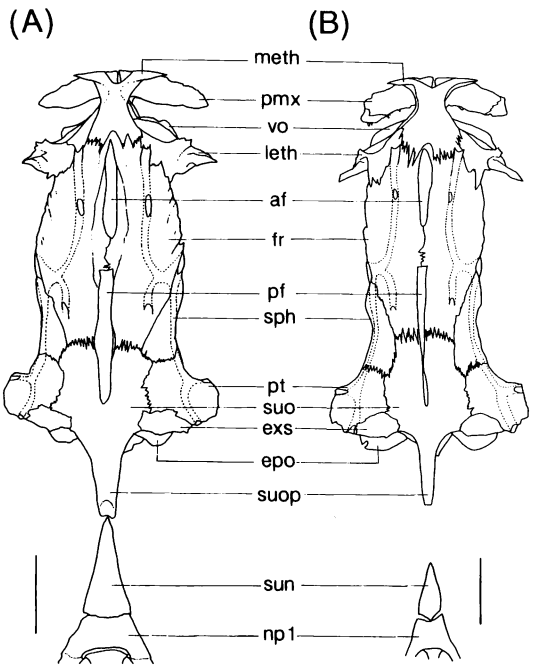

Fig. 2. Cranium and anterior part of dorsal fin supports (dorsal view). A) *Pseudobagrus aurantiacus* (NSMT-P 36004-13, 125.2 mm SL, male); B) *P. tokiensis* (NSMT-P 36018-7, 140 mm SL, female). Scale bar indicates 5 mm; *af*—anterior fontanelle; *epo*—epioccipital; *exs*—extrascapular; *fr*—frontal; *leth*—lateral ethmoid; *meth*—mesethmoid; *npl*—nuchal plate 1; *pf*—posterior fontanelle; *pmx*—premaxillary; *pt*—pterotic; *sph*—sphenotic; *sun*—supraneural; *suo*—supraoccipital; *suop*—supraoccipital process; *vo*—prevomer.

Okada, 1960; Nakamura, 1963; Miyadi et al., 1976). However, Tanaka (1943) recognized them as two subspecies, *P. aurantiacus aurantiacus* (Japanese name: ariake-gibachi) and *P. a. tokiensis* (Japanese name: gibachi). As did Hosoya (1993), we follow Tanaka's (1943) Japanese names, since "gibachi" is originally a local name from around Tokyo (Döderlein in Steindachner and Döderlein, 1887; Ichthyological Society of Japan, 1981).

Pseudobagrus tokiensis Döderlein, 1887
(Japanese name: Gibachi)
(Fig. 5)

Pseudobagrus tokiensis Döderlein in Steindachner and Döderlein, 1887: 288 (Tokyo).
Pseudobagrus aurantiacus tokiensis: Tanaka, 1943: 31.

Diagnosis. A species of *Pseudobagrus* with pectoral fin rays I, 7 (rarely 8); anal fin rays 19–24; vertebrae 46–50; maxillary barbels long, extending to origin of pectoral fin; caudal fin emarginated or truncated; both sides of second dorsal spine smooth; anterior edge of pectoral spine with feeble subcutaneous serrations, posterior edge with 4–14 strong, retrorse serrations in specimens between about 40–200 mm SL; posterior process of cleithrum narrow dorsoventrally, needlelike (posterior tip angle $< 15°$); supraneural small, widely separated from supraoccipital process.

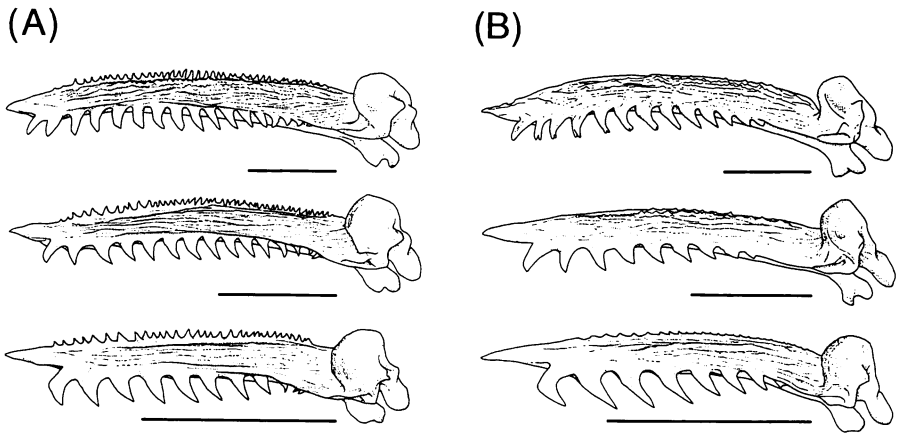

Fig. 3. Pectoral spine (dorsal view). A) *Pseudobagrus aurantiacus* (NSMT-P 36003-1, 196.4 mm SL; 36004-13, 125.2 mm SL; 36005-5, 63.1 mm SL); B) *P. tokiensis* (NSMT-P 36018-15, 216.6 mm SL; 36018-7, 140.1 mm SL; 36017-13, 64.1 mm SL). Scale bar indicates 5 mm.

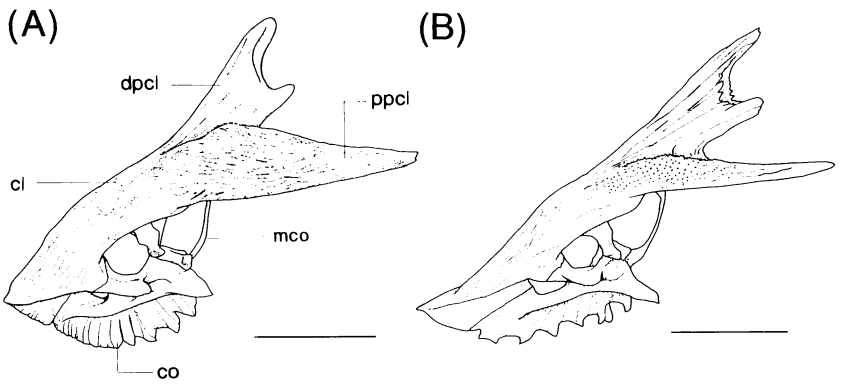

Fig. 4. Left pectoral girdle (lateral view). A) *Pseudobagrus aurantiacus* (NSMT-P 36004-13, 125.2 mm SL, male); B) *P. tokiensis* (NSMT-P 36018-7, 140.1 mm SL, female). Scale bar indicates 5 mm; *cl*—cleithrum; *co*—coracoid; *dpcl*—dorsal process of cleithrum; *mco*—mesocoracoid; *ppcl*—posterior process of cleithrum.

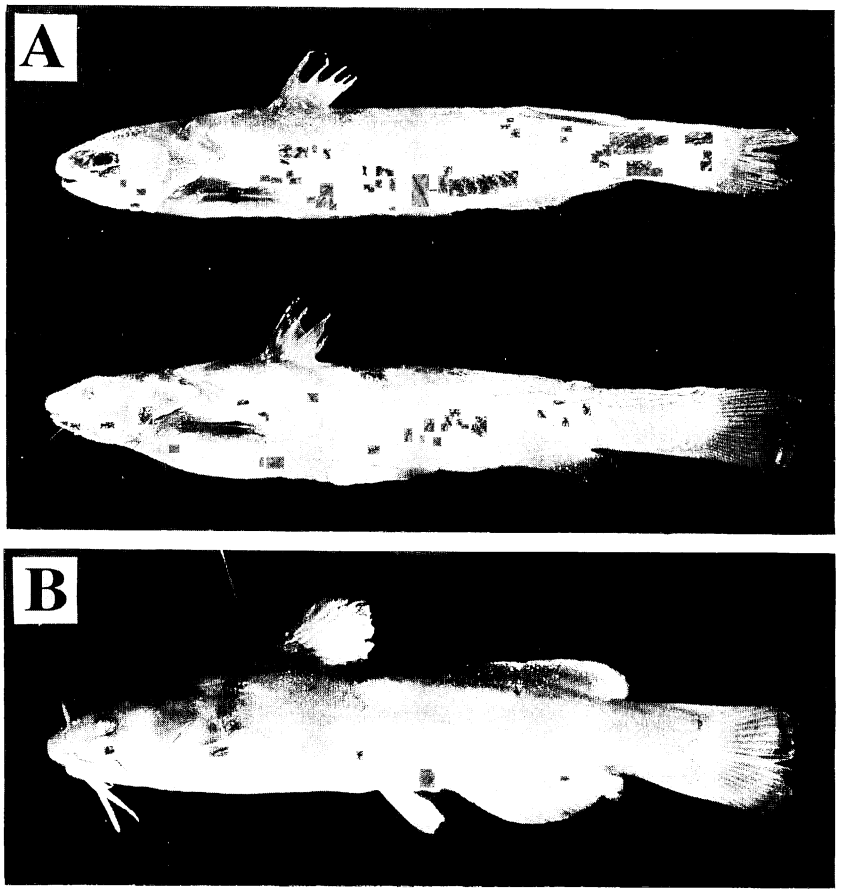

Fig. 5. *Pseudobagrus tokiensis.* A) Specimens collected by Döderlein (ZMB 12246, 113.2 and 110.2 mm SL; Tokyo); B) young specimen (NSMT-P 36017-17, 60.0 mm SL; Kuro River).

Description. All meristic and morphometric measurements of the specimens collected by Döderlein and other specimens are shown in Tables 1 and 2.

Dorsal fin rays II, 7; anal fin rays 19–24; pectoral fin rays I, 7 (rarely 8); pelvic fin rays 6 (rarely 7); principal caudal fin rays, 8 (upper) (rarely 7 or 9), 9 (lower) (rarely 8 or 10). Vertebrae 46–50 (usually 47–49).

Body moderately elongated, mean depth 21.4 (range: 14.9–26.8) % SL; head length 25.8 (20.0–29.5) % SL, ratio decreasing with growth; caudal peduncle laterally compressed, length 18.1 (15.4–23.3) % SL, depth 10.4 (8.1–11.9) % SL.

Head broad, width 80.3 (73.9–89.0) % HL; eye small, diameter 14.1 (10.4–17.8) % HL; mouth subterminal, broad, width 51.5 (44.4–58.9) % HL, bearing numerous villiform teeth on premaxillary, prevomer and dentary; supraoccipital process subcutaneous, narrow, moderately long (Fig. 2B); supraneural small, triangular, widely separated from supraoccipital process (Fig. 2B); maxillary barbels long, 76.6 (50.4–95.6) % HL, extending to pectoral origin; outer mandibular barbels extending to branchiostegal membrane, 56.3 (42.0–70.0) % HL; inner mandibular barbels extending to isthmus, 37.9 (26.7–46.1) % HL; nasal barbels extending to posterior margin of eye, 38.7 (27.2–46.6) % HL.

Dorsal fin rather low, length of first soft ray 14.4 (10.6–17.7) % SL, ratio decreasing with growth; first dorsal spine small, subcutaneous; second dorsal spine smooth on both sides, length 9.6 (5.3–13.3) % SL; anal fin low, long, base 23.1 (20.2–28.3) % SL; length of first soft ray of pectoral fin 16.2 (11.5–19.9) % SL, decreasing with growth; pectoral spine strong, length 13.0 (8.9–15.6) % SL, bearing 4–14 strong, retrorse serrations on posterior edge in specimens between about 40–200 mm SL, feeble, subcutaneous serrations on anterior edge (Fig. 3B); posterior process of cleithrum narrow dorsoventrally, needlelike (posterior tip angle $<15°$), surface granular (Fig.4B); length of pelvic fin 10.8 (8.8–12.5) % SL; caudal fin slightly emarginated or truncated, maximum length from middle of caudal base 17.5 (14.0–20.9) % SL, minimum 14.2 (10.6–18.7) % SL; adipose fin base as long as or longer than anal fin base.

Sexual dimorphism.—As in *P. aurantiacus.*

Body color.—In live specimens, light brown or creamy-yellow with dark blotches; in alcohol, uniformly dark, but yellowish-white with obscure dark blotches (also on fins) in specimens $<$ ca. 100 mm SL (Fig. 5B).

Distribution. Eastern Honshu (Kanto and Tohoku districts): Tsurumi River (Kimura et al., 1982), Tama R. (Ueno, 1974), Ara R., Yoro R., Minato R., Obitsu R., Isumi R., Naka R., Kitakami R., Mogami R.

Remarks. In the original description of *Pseudobagrus tokiensis*, Döderlein in Steindachner and Döderlein (1887) neither designated a type specimen(s), nor gave information about the material on which his description was based, such as number and size of specimen(s), pertinent to subsequent recognition. Although type material of this species was searched for at several institutions, including Naturhistorisches Museum, Wien, where type specimens of some species described in Steindachner and Döderlein (1887) were deposited (B. Herzig, pers. comm.), it was not apparent. Although two *P. tokiensis* specimens collected by Döderlein were found at Museum für Naturkunde der Humboldt-Universität zu Berlin (ZMB 12246; Fig. 5A), it was impossible to determine whether or not they were used by Döderlein for describing *P. tokiensis.*

P. tokiensis has long been treated as a junior synonym of *P. aurantiacus* (e.g., Jordan and Snyder, 1901; Jordan and Fowler, 1903; Aoyagi, 1957; Okada, 1960; Miyadi et al., 1976). However, Ueno (1974, 1985) revealed allozymatic and chromosomal differences between the two forms; that from eastern Honshu (=*P. tokiensis*) having $2n=56$ chromosomes, and the other, from Kyushu, having $2n=48$. Juso (1979), in a preliminary report, indicated some differences in the suspensorium between the two forms, although these included individual variations as discussed below. Recently, Hosoya (1993) treated *P. tokiensis* as a distinct species based on the discontinuous distribution patterns, and genetic and morphological differences, giving the length of the second dorsal spine in relation to the length of the dorsal fin base as a diagnostic character in his key, i.e., *P. tokiensis* ≤ 1.3 vs. *P. aurantiacus* ≥ 1.4. However, analysis of this character in the present study indicated its unsuitability as a diagnostic character (*P. tokiensis*: 0.99 ± 0.12, 0.65–1.25, $n=136$, and *P. aurantiacus*: 1.17 ± 0.10, 0.95–1.48, $n=90$ [mean$\pm$SD, range, number of specimens]), although the

shape of the dorsal fin can be used for distinguishing between the two species, so far as allometric differences are concerned (see below).

"Gibachi" is retained as the Japanese common name for *P. tokiensis* (see Remarks under *P. aurantiacus*).

Comparisons

Meristics and morphometrics

There were no remarkable differences in fin ray and vertebral counts between *Pseudobagrus aurantiacus* and *P. tokiensis* (Table 1). However, a

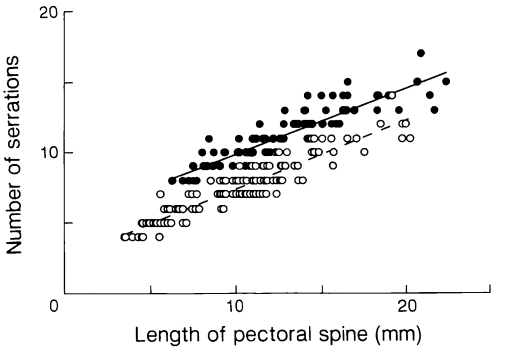

Fig. 6. Relationships between pectoral spine length and number of serrations on posterior edge in *Pseudobagrus aurantiacus* (●) and *P. tokiensis* (○).

Table 3. Allometry and discriminant analysis of morphometric characters of *Pseudobagrus aurantiacus* and *P. tokiensis*

SL (mm)	*P. aurantiacus* (n=90) 41.3–196.4			*P. tokiensis* (n=136) 30.5–216.6			Discriminant function[1]		
	a	b	r	a	b	r	a	b	rate (%)[2]
BD	0.882	−0.456	0.927	0.779	−0.263	0.976	−0.507	2.169	53.1 T
HL	0.824	−0.252	0.994	0.865	−0.340	0.995	0.789	−0.192	64.2 A
CPL	0.977	−0.733	0.980	0.982	−0.710	0.990	1.037	−0.831	75.7 T
CPD	0.846	−0.731	0.980	0.937	−0.869	0.992	0.952	−0.914	77.9 T
PrDL	0.867	−0.212	0.993	0.875	−0.241	0.996	0.834	−0.157	69.5 A
PrAL	0.978	−0.161	0.997	0.985	−0.187	0.998	0.954	−0.123	68.1 A
PrP1L	0.846	−0.365	0.989	0.848	−0.365	0.989	1.147	−0.932	57.5 T
PrP2L	0.946	−0.188	0.996	0.954	−0.215	0.997	0.920	−0.145	69.5 A
DBL	0.791	−0.575	0.972	0.829	−0.694	0.987	0.801	−0.364	79.2 A
DR1L	0.838	−0.453	0.987	0.846	−0.558	0.985	0.827	−0.477	96.0 A
DSpL	0.757	−0.443	0.959	0.866	−0.773	0.952	0.791	−0.572	92.0 A
ABL	1.023	−0.697	0.989	0.991	−0.622	0.992	1.092	−0.818	61.5 T
AFH	0.996	−0.547	0.997	0.987	−0.534	0.991	0.668	0.069	61.5 A
P1R1L	0.769	−0.309	0.987	0.856	−0.540	0.985	0.804	−0.402	84.1 A
P1SpL	0.822	−0.484	0.971	0.933	−0.765	0.975	0.854	−0.581	84.1 A
P2L	0.868	−0.704	0.981	0.970	−0.913	0.989	0.816	−0.615	61.5 A
CLmax	0.880	−0.520	0.982	0.858	−0.495	0.984	0.762	−0.305	63.3 A
CLmin	0.866	−0.583	0.976	0.838	−0.549	0.975	0.706	−0.290	65.5 A
SnL	0.782	−0.605	0.985	0.855	−0.767	0.989	0.776	−0.606	69.0 A
ED	0.617	−0.697	0.927	0.740	−0.960	0.965	0.578	−0.640	62.4 A
HW	0.813	−0.332	0.988	0.830	−0.371	0.995	0.724	−0.167	61.5 A
MW	0.848	−0.599	0.982	0.903	−0.699	0.989	1.179	−1.223	60.2 T
IOW	0.877	−0.755	0.983	0.893	−0.799	0.991	0.803	−0.622	63.7 A
MxBL	0.914	−0.533	0.967	0.959	−0.632	0.979	0.712	−0.158	57.1 A
OMnBL	0.871	−0.588	0.957	0.977	−0.800	0.978	0.519	0.069	53.1 A
IMnBL	0.920	−0.843	0.950	0.960	−0.939	0.972	0.813	−0.637	67.7 A
NaBL	0.898	−0.780	0.963	0.949	−0.910	0.972	0.716	−0.468	57.5 A

a, b: log Y=a log SL+b (r: regression coefficient), where SL=standard length, Y=morphometric characters (abbreviations as in Table 2). [1]Liner discriminant functions on two logarithmic transformed variables, SL and each character, between the two species. [2]Species showing greater value than discriminant function; A=*P. aurantiacus*, T=*P. tokiensis*.

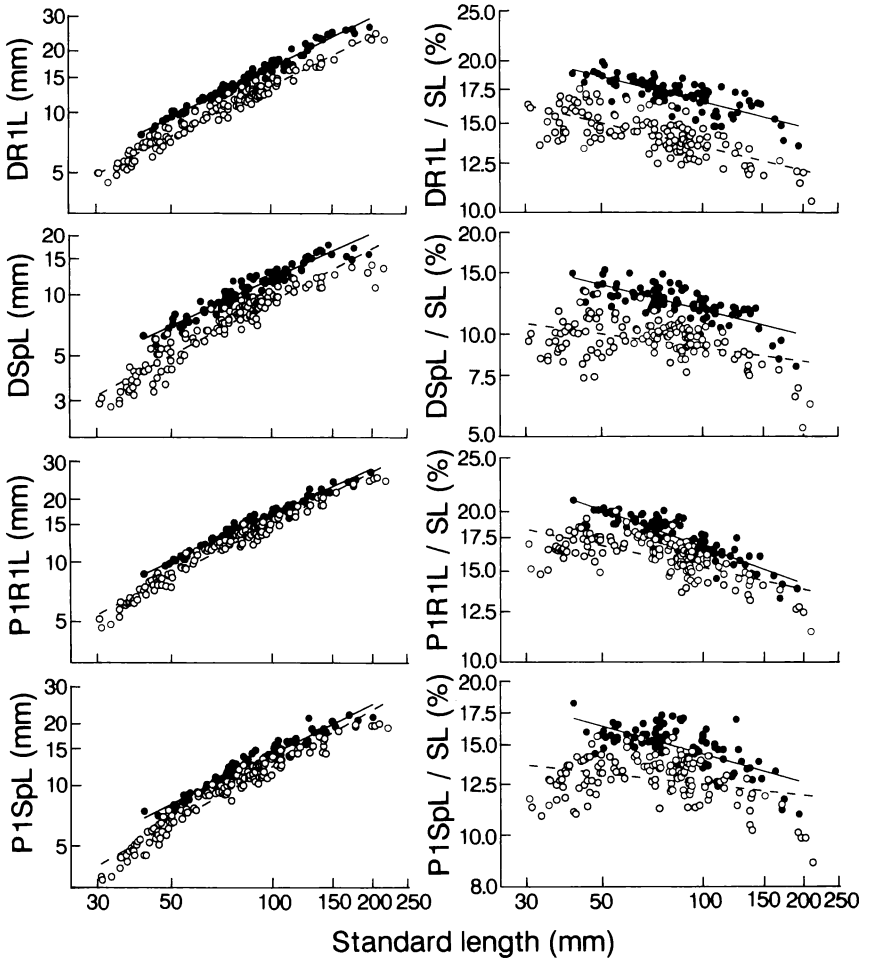

Fig. 7. Allometric relationships (left) and ontogenetic changes in ratios (right) of 4 body parts in *Pseudobagrus aurantiacus* (●) and *P. tokiensis* (○). Solid and broken lines indicate regression lines of *P. aurantiacus* and *P. tokiensis*, respectively. *SL*—standard length; *DR1L*— length of 1st soft ray of dorsal fin; *DSpL*—length of 2nd dorsal spine; *P1R1L*—length of 1st soft ray of pectoral fin; *P1SpL*—length of pectoral spine.

significant difference occurred in the number of serrations on the posterior edge of the pectoral spine (Fig. 6), *P. aurantiacus* having greater number of posterior serrations in a given length of the spine than *P. tokiensis* (*P. aurantiacus*: $Y=0.465\ X+5.24$, $r=0.890$; *P. tokiensis*: $Y=0.485\ X+2.53$, $r=0.938$ [X: length of pectoral spine, mm; Y: number of posterior serrations]; analysis of covariance, slope: $df=1, 221, F=0.5, p>0.1$; intercept: $df=1, 222, F=450.9, p<0.001$).

Allometric relationships between standard length and 27 morphometric characters are shown in Table 3. The rates of correct discrimination by liner discriminant functions were greater than 80% in the following 4 characters: length of the first soft ray of dorsal fin (96.0%), length of the second dorsal spine (92.0%), length of the first soft ray of pectoral fin (84.1%) and length of the pectoral spine (84.1%). In particular, the lengths of the first soft ray and second spine of the dorsal fin were good discriminants (Fig. 7). However, since allometric changes in the ratios were apparent in all of the

above characters (Fig. 7, right side), the size of specimens should be taken into consideration when discrimination is by the above ratios.

Osteology

In addition to the morphometric characters, conspicuous differences were found in some osteological characters as shown bellow.

Cranium and supraneural (Fig. 2).—The cranium and supraoccipital process of *P. aurantiacus* were broader than those of *P. tokiensis* in dorsal view. In addition, the supraneural was large, as long as or larger than the supraoccipital process, extending almost to the latter in *P. aurantiacus*. The narrower supraoccipital process of *P. tokiensis* was widely separated from the supraneural, which was shorter than the former.

Pectoral spine (Fig. 3).—As mentioned above (Fig. 6), the posterior edge of the pectoral spine was serrated more densely in *P. aurantiacus* than in *P. tokiensis*, the former having about 1–3 small serrations directed outwards near the base of the spine. Serrations on the anterior edge of the spine, which was covered with skin, were more developed in *P. aurantiacus* than in *P. tokiensis*. Even in specimens of the latter with relatively developed serrations, such did not cover the entire anterior margin of the spine, the opposite being the case in *P. aurantiacus*.

Pectoral girdle (Fig. 4).—The posterior process of the cleithrum was exposed on the lateral surface of the body, being broader dorsoventrally (triangular shape; posterior tip angle $>20°$) in *P. aurantiacus* than in *P. tokiensis* (needlelike; posterior tip angle $<15°$). This character seemed to be the best for distinguishing between the two species, because the shape of the process could be clearly observed externally. In addition to the shape, although granulation of the surface of the process was clearly visible in both species, it was finer and tended to form numerous ridges in *P. aurantiacus*.

Suspensorium (Fig. 8).—The anterior part of the hyomandibular nearly extended to the metapterygoid in *P. tokiensis*, being widely separated in *P. aurantiacus*, as mentioned by Juso (1979). The anteromedian process of the hyomandibular (crest for insertion of the levator arcus palatini muscle) was prominent in *P. tokiensis*, but rudimentary in *P. aurantiacus*. The presence of a distinct, posterodorsal concavity on the hyomandibular of *P. aurantiacus*, considered by Juso (1979) to have diagnostic significance, is apparently subject to individual variation.

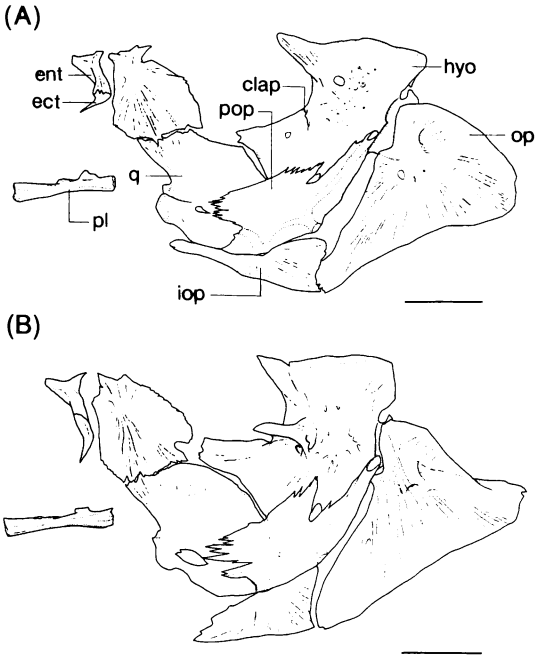

Fig. 8. Suspensorium and opercles (dorsolateral view). A) *Pseudobagrus aurantiacus* (NSMT-P 36003-1, 196.4 mm SL, male); B) *P. tokiensis* (NSMT-P 36018-1, 204.9 mm SL, male). Scale bar indicates 5 mm; *clap*—crest for insertion of levator arcus palatini muscle; *ect*—ectopterygoid; *ent*—entopterygoid, *hyo*—hyomandibular; *iop*—interopercle; *met*—metapterygoid; *op*—opercle; *pl*—palatine (detached); *pop*—preopercle; *q*—quadrate.

Coloration

Some differences in color pattern were apparent between the two species, the most conspicuous being the blotches on the dorsal and anal fins. The dark dorsal fin blotch was broader and the anal fin blotch narrower in *P. aurantiacus* than in *P. tokiensis* (Figs. 1B and 5B). The dark lateral blotches on the body and fins were more distinct in smaller *P. aurantiacus*, but in both species such blotches became unclear in specimens exceeding about 100 mm SL. Furthermore, the ground body color of live *P. aurantiacus* was a rather intense yellow, but creamy-yellow in *P. tokiensis*.

Key to Japanese Bagrid Fishes

1a. Caudal fin truncated or slightly emarginated 2
1b. Caudal fin forked 3
2a. Posterior process of cleithrum broad, triangular (posterior tip angle $>20°$); base of pectoral spine with 1–3 antrorse serration posteriorly; distributed in western Kyushu ..... *Pseudobagrus aurantiacus*
2b. Posterior process of cleithrum narrow, needle-like (posterior tip angle $<15°$); base of pectoral spine lacking antrorse serrations posteriorly; distributed in eastern Honshu (Kanto and Tohoku districts) ..... *P. tokiensis*
3a. Caudal fin incompletely forked; anal fin rays 13–18; distributed in the rivers flowing into Ise and Mikawa Bays ..... *P. ichikawai*
3b. Caudal fin deeply forked; anal fin rays 18–24; distributed in western Honshu except around Ise and Mikawa Bays, Shikoku and eastern Kyushu (but introduced to other regions from Lake Biwa) ..... *P. nudiceps*

Acknowledgments

We wish to express our sincere gratitude to Dr. Y. Taki (Tokyo University of Fisheries) for his invaluable help and advice in this study. We are also grateful to Drs. K. Fujita, H. Kohno, Mr. A. Doi (all of Tokyo University of Fisheries) and an anonymous reviewer who read the manuscript and gave suggestions. Assistance in collecting specimens provided by Mr. K. Hoshino, Mr. Y. Kimizuka, Dr. S.-R. Kimura, Dr. S. Mori, Mr. T. Nakamura, Mr. S. Ota, Dr. A. Shinomiya, Dr. N. Takeshita and Mr. M. Watanabe is greatly appreciated. For the loan of specimens and information, we also thank the following individuals: Drs. B. Herzig (NMW), M. J. van Oijen (RMNH), H.-J. Paepke (ZMB) and Y. Tominaga (ZUMT).

Literature Cited

Aoyagi, H. 1957. General notes on the freshwater fishes of the Japanese Archipelago. Taishukan, Tokyo. 272+20 pp. (In Japanese.)

Bleeker, P. 1860. Zesde bijdrage tot de Kennis der Vischfauna van Japan. Acta Soc. Sci. Indo Neerl., 6: 1–104.

Boeseman, M. 1947. Revision of the fishes collected by Burger and von Siebold in Japan. E. J. Brill, Leiden. viii+242 pp., 5 pls.

Dingerkus, G. and L. D. Uhler. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. Stain Technol., 52: 229–232.

Hosoya, K. 1993. Bagridae. Pages 236 and 1261–1262 *in* T. Nakabo, ed. Fishes of Japan with pictorial keys to the species. Tokai Univ. Press, Tokyo. 1474 pp. (In Japanese.)

Hubbs, C. L. and K. F. Lagler. 1967. Fishes of the Great Lakes Region. Univ. Michigan Press, Ann Arbor. 213 pp.

Ichthyological Society of Japan (ed.). 1981. Dictionary of Japanese fish names and their foreign equivalents. Sanseido, Tokyo. 834 pp. (In Japanese.)

Jordan, D. S. and H. W. Fowler. 1903. A review of the siluroid fishes or catfishes of Japan. Proc. U. S. Natl. Mus., 26: 897–911.

Jordan, D. S. and J. O. Snyder. 1901. A list of fishes collected in Japan by Keinosuke Otaki, and by the United States Steamer Albatross, with descriptions of fourteen new species. Proc. U. S. Natl. Mus., 23: 335–380, pls. 4–20.

Juso, Y. 1979. On the two types of *Pseudobagrus aurantiacus*. Tansuigyo, (5): 104. (In Japanese).

Kimizuka, Y. 1989. *Pseudobagrus aurantiacus*. Page 406 *in* H. Kawanabe and N. Mizuno, eds. Freshwater fishes of Japan. Yama-kei Publ., Tokyo. 720 pp. (In Japanese.)

Kimura, Y., Y. Araki, N. Akiyama and M. Sohuchi. 1982. Fishes in the Tsurumi River system. Pages 13–36 *in* Kanagawa Shizen-hozen Kenkyu-kai, ed. Reports of Kanagawa Shizen-hozen Kenkyu-kai, (2). Kanagawa Shizen-hozen Kenkyu-kai. (In Japanese.)

Matsubara, K. 1955. Fish morphology and hierarchy. I–III. Ishizaki Shoten, Tokyo. xii+1605 pp., 135 pls. (In Japanese.)

Miyadi, D., H. Kawanabe and N. Mizuno. 1976. Coloured illustration of the freshwater fishes of Japan. Hoiku-sha, Osaka. 462 pp. (In Japanese.)

Mori, T. 1937. Freshwater fishes in Iki Island. Korean J. Nat. Hist., (22): 94–95. (In Japanese.)

Nakamura, M. 1963. Keys to the freshwater fishes of Japan fully illustrated in colors. Hokuryukan, Tokyo. 258 pp. (In Japanese.)

Okada, Y. 1960. Studies on the freshwater fishes of Japan, II. Special Part. J. Fac. Fish. Pref. Univ. Mie, 4: 267–588.

Sawada, Y. 1984. Bagridae. Page 59 *in* H. Masuda, K. Amaoka, C. Araga, T. Uyeno and T. Yoshino, eds. The fishes of the Japanese Archipelago. English text. Tokai Univ. Press, Tokyo. 456 pp.

Steindachner, F. and L. Döderlein. 1887. Beiträge zur Kenntniss der Fische Japan's. IV. Denkshr. Acad. Wiss. Wien, 47: 257–296, pls. 1–4.

Tanaka, S. 1943. Trends in taxonomy (3). Shokubutsu oyobi Dobutsu, 11: 29–32. (In Japanese.)

Temminck, C. J. and H. Schlegel. 1846. Les Bagres. Pages 227–228, pl. 104 *in* von P. F. Siebold, ed. Fauna Japonica. Lugduni Batavoru.

Ueno, K. 1974. Chromosomal polymorphism and variant of isozymes in geographical population of *Pseudobagrus aurantiacus*, Bagridae. Japan. J. Ichthyol., 21: 158–164. (In Japanese with English abstract.)

Ueno, K. 1985. Karyotypes of Japanese and Korean bagrid fishes. Kaiyo-kagaku, 17: 102–108. (In Japanese.)

日本産ギギ科魚類2種 *Pseudobagrus aurantiacus* と *P. tokiensis* の再記載

渡辺勝敏・前田洋志

遺伝学的に別種であることが示されている日本産ギギ科魚類2種，*Pseudobagrus aurantiacus* (Temminck and Schlegel)（アリアケギバチ）とそのシノニムとして扱われてきた *P. tokiensis* Döderlein（ギバチ）について，模式標本を含む多数の標本を基に両種を再記載し，形態比較を行った．その結果，*P. aurantiacus* は，より高い背鰭，胸鰭棘前縁を広く覆う顕著な鋸歯列，外向きの1–3歯を伴うより高密度な同後縁鋸歯列，より幅広い上後頭骨突起，上後頭骨突起と同程度の長さの大きな上神経骨，幅広い擬鎖骨後方突起（後端 >20°），外翼状骨から大きく離れた舌顎骨前縁，より明瞭な若魚の体斑パターン，等によって *P. tokiensis* から区別された．

（〒108 東京都港区港南4-5-7　東京水産大学魚類学研究室；前田　現住所：〒100-21 東京都小笠原村父島字清瀬　東京都小笠原水産センター）