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# *Acanthorhodeus gracilis*, a Junior Synonym of *Acheilognathus chankaensis* (Pisces: Cyprinidae) from Korea

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**ABSTRACT** Korean bitterling *Acanthorhodeus gracilis* Regan, 1908 is very similar to *Acheilognathus chankaensis* (Dybowski, 1872) having 12～14 dorsal fin rays, 10～11 anal fin rays and 35～36 lateral line scales. By analyzing these specimens and original descriptions, diagnostic characteristics of the genus *Acanthorhodeus* were included in the genus *Acheilognathus* and *Acanthorhodeus gracilis* was defined as a junior synonym of *Acheilognathus chankaensis*. The provisional keys are provided for identifying the nine species of *Acheilognathus* from Korea.

**Key words :** *Acanthorhodeus gracilis*, *Acheilognathus chankaensis*, synonym

## INTRODUCTION

Bitterlings (Cyprinidae, Acheilognathinae) are small and deep-bodied fresh water fishes which include about 40 species in the world. They are usually found in South-Eastern Asia, China mainland, Korea and Japan, except *Rhodeus sericeus* and *R. colchicus* (Kim, 1982; Bogutskaya and Komlev, 2001; Smith *et al.*, 2004). However, there has been much taxonomic confusion due to the large variety of the shapes resulted from frequent hybridizations of Acheilognathinae fish (Okazaki *et al.*, 2001).

Since Berg (1907) described it as *Acheilognathus signifer* from Korea, many additional species have been identified and classified by Regan (1908), Jordan and Metz (1913), Mori (1928, 1935), Kim and Kim (1990, 1991), Kim and Yang (1998) and Arai *et al.* (2001). In addition, Uchida (1939) provided more information on their taxonomical keys, morphometric characteristics and ecological features. Mori (1935) and Chyung (1977) classified the Korean bitterlings into five genera and 16 species, whereas Kim (1982) reviewed them into three genera and 15 species or subspecies.

As *Acanthorhodeus gracilis* was described by Regan in 1908 without any morphological comparison of the related species, *Acheilognathus chankaensis*, these two species are still remained confused taxonomically. In terms of this taxonomical confusion, Kim (1997) discussed that two species are separated because *Acheilognathus chankaensis* is slightly concave in the edge of the dorsal and anal fin but *Acanthorhodeus gracilis* is convex. Boutskaya and Naseka (2004) have been pointed *Acanthorhodeus gracilis* as a synonym of *Acheilognathus chankaensis*.

Therefore, we are going to clarify the taxonomic relationship between *Acanthorhodeus gracilis* and *Acheilognathus chankaensis* based upon specimens and original descriptions.

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## MATERIALS AND METHODS

Most specimens were collected by casting nets and minnow traps at several rivers in Korea from 2005 to 2006. The collected specimens were fixed in 10% formalin solution and deposited at the Faculty of Biological Science, Chonbuk National University, Chonju (CNUC). Also specimens of *Acheilognathus chankaensis* were loaned from Fisheries Research Laboratory, Mie University (FRLM) of Japan. Counting and measuring was done as described by Hubbs and Lagler (1964), and vertebral counts were done by soft-X ray photograph (Nikon, SMZ-10; Japan)

## RESULTS

***Acheilognathus chankaensis* (Dybowski, 1872)**
(Korean name: Ga-Si-Nap-Ji-Ri)
(Fig. 1A, B; Table 2)

*Devario chankaensis* Dybowski, 1872: 212 (type locality

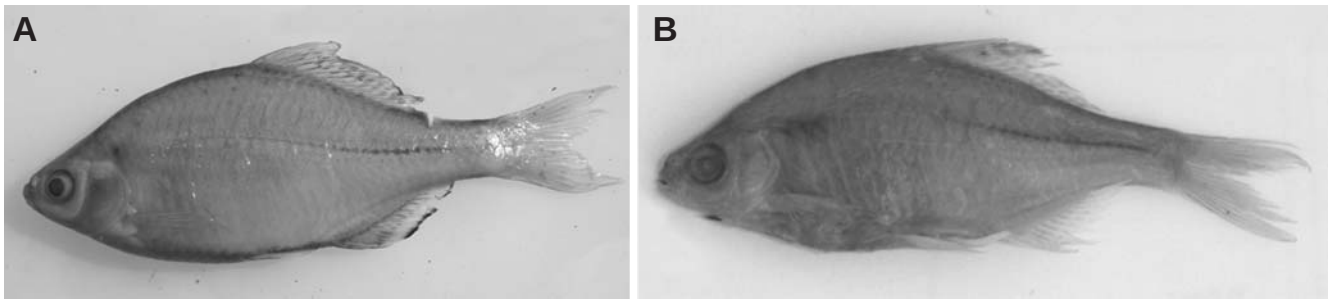


**Fig. 1.** *Acheilognathus chankaensis* (Dybowski), A : CNUC 37135, 72.3 mm SL, Geumsa-myeon, Yeoju-gun, Gyeonggi-do, Korea; B : FRLM 7983, 59.7 mm SL, Shanghai, China.

: Hanka Lake, Russia).

*Acanthorhodeus gracilis* Regan, 1908: 60 (type locality : Chongju, Korea); Uchida, 1939: 176; Mori, 1952: 54; Chyung, 1977: 197; Kim, 1982: 12; Choi *et al.*, 1990: 47; Kim, 1997: 190; Kim and Park, 2002: 92; Kim *et al.*, 2005: 107.

*Acheilognathus chankaensis*, Huang, 1984: 272; Zhu, 1995: 45; Lin, 1998: 433.

**Examined specimens.** CNUC 3757-3771 (15), 41.0 ~ 71.5 mm (SL), Yongjin-myeon, Wanju-gun, Jeollabuk-do, Apr. 27, 1975; CNUC 37083-37097 (15), 51.0 ~ 69.7 mm, Yanghwa-myeon, Buyeo-gun, Chungcheongnam-do, Apr. 13, 1986; CNUC 37098-37112 (15), 59.1 ~ 81.3 mm, Bokheung-myeon, Sunchang-gun, Jeollabuk-do, Dec. 4, 2005; CNUC 37113-37127 (15), 52.9 ~ 73.3 mm, Julpo-myeon, Buan-gun, Jeollabuk-do, Oct. 10, 2005; CNUC 37128-37142 (15), 55.3 ~ 69.4 mm, Geumsa-myeon, Yeoju-gun, Gyeonggi-do, Apr. 4, 1990; FRLM 7982-7984, 7986-7987 (5), 55.9 ~ 76.0 mm, Shanghai, China, Dec. 4, 1988.

**Description.** Dorsal fin rays iii 12 ~ 14; anal fin rays iii 10 ~ 12; lateral line scales 33 ~ 37; gill rakers 13 ~ 18; vertebrae 33 ~ 36. Body depth 40.6% (36.5 ~ 45.6%) of standard length; head length 24.8 (22.2 ~ 27.6); predorsal length 55.7 (53.3 ~ 57.7); preanal length 66.3 (63.8 ~ 71.0); body width 14.9 (12.2 ~ 18.4); caudal peduncle length 20.2 (18.0 ~ 22.2); caudal peduncle depth 12.1 (10.7 ~ 13.5). Snout length 26.6% (23.1 ~ 29.7%) of head length; eye diameter 31.8 (29.2 ~ 36.6); interorbital width 37.1 (33.7 ~ 40.2) (Table 2).

Body laterally compressed and head small. Upper jaw more projected than lower jaw. Babels absent. Two or three stripes on dorsal and anal fin rays. Lateral line complete and middle part curved to below. Edge of dorsal fin of female slightly concave. The 3rd unbranched rays of dorsal and anal fin with two to three segments.

**Color.** There is a dark spot on the middle of gill operculum. During the spawning season, the body color is metallic siver, a white band appears on the pelvic fin and black band on the outer margins of the anal fin.

**Ecology.** This species inhabits slow flowing streams with many waterweeds. The spawning season is March to May. The average number of ripe eggs were 275 ± 130 (157 ~ 449, n=20). The mean egg size was 2.04 ± 0.11 mm (1.96 ~ 2.28) in length and 1.55 ± 0.10 mm (1.47 ~ 1.77) in width.

**Distribution.** It is widely distributed throughout streams in Korea flowing into the western and southern coasts of Korea; China and Russia.

## DISCUSSION

Regan (1908) described *Acanthorhodeus gracilis* as the first time based on a specimen collected in the Chongju area of Korea, but it was very similar to *Acheilognathus chankaensis* of China in morphological characteristics such as counts, measurements, colors and band patterns. From this comparative study on both *Acanthorhodeus gracilis* and *Acheilognathus chankanensis*, there were not any differences in the number of dorsal and anal fin rays, the number of lateral line scales and even other characteristics of measurement (Tables 1, 2). On the other hand, Kim (1997) emphasized that *Acheilognathus chankaensis* is slightly concave in the edge of the dorsal and anal fin but *Acanthorhodeus gracilis* is convex. We examined *Acanthorhodeus gracilis* 20 specimens with 10 males and 10 females collected every month from January to December in 2006. Among them, 40 out of 120 males and two out of 120 females displayed the convex dorsal fin characteristic whereas the convex anal fin characteristic was not absolutely observed in the females but just one male on July (Table 3). Interestingly, these morphological changes are more likely to be sexual characteristics. It seems that these characteristics are not good for classification. Holick (1963) reported that *Acanthorhodeus chankaensis* is not a separate species but is a hybrid species occurring frequently between *Acanthorhodeus asmussii* and *Rhodeus sericeus sericeus*. However, Bogutskaya and Naseka (2004) regarded *Acanthorhodeus gracilis* as a synonym of *Acheilognathus chankaensis*.

**Table 1.** Proportional measurements and meristic counts of *Acheilognathus chankaensis* from Korea and China

| Characters | Korea | | | China | | | |
|---|---|---|---|---|---|---|---|
| | Regan (1908) (n=2) | Mori (1935) (n=5) | Kim (1982) (n=23) | Dybowski (1872) (n=??)** | Huang (1984) (n=22) | Lin (1998) (n=98) | Ni and Zhu (2005) (n=411) |
| Total length (mm) | 65.0～70.0 | 87.0～112.0 | – | 105.0 | – | – | – |
| Standard length (mm) | – | – | 53.5～78.2 | – | 57.0～75.0 | 32.0～94.0 | 59.0～86.7 |
| Measurements | | | | | | | |
| SL*/Body depth | 2.6～2.8 | 2.5～2.7 | 2.5～2.8 | – | 2.4～2.6 | 2.4～2.9 | 2.3～2.6 |
| SL/HL* | 4.5 | 4.5～4.9 | 3.6～4.4 | – | 4.4～4.9 | 4.1～4.8 | 4.1～4.5 |
| HL/snout length | – | 3.3～3.7 | 3.4～4.4 | – | 3.3～4.3 | 3.5～4.5 | 3.7～4.5 |
| HL/eye diameter | 3.0～3.3 | 3.1～3.3 | 3.0～3.9 | – | 2.6～3.4 | 2.7～3.5 | 2.6～3.5 |
| HL/interorbital width | 2.5 | 2.5～2.7 | 2.8～3.4 | – | 2.5～2.8 | 2.2～3.1 | 2.6～3.0 |
| Counts | | | | | | | |
| Dorsal fin rays | ii 13 | iii 13～14 | iii 12～13 | iii 12～13 | ii 12～13 | iii 10～14 | iii 12～14 |
| Anal fin rays | ii 10 | iii 10～12 | iii 10～11 | iii 10 | ii 10～11 | iii 10～11 | iii 9～12 |
| Gill rakers | – | – | 15～18 | – | 16～18 | 14～19 | 14～15 |
| Lateral line scales | 34 | 35～36 | 36～37 | 35～36 | 33～36 | 32～37 | 32～36 |

*SL : standard length, HL : head length
**investigated number was not described at original paper

**Table 2.** Proportional measurements and meristic counts of *Acheilognathus chankaensis* from Korea and China in the present study

| Characters | Korea | | | | | China |
|---|---|---|---|---|---|---|
| | Dongjin R. (n=15) | Geum R. (n=15) | Seomjin R. (n=15) | Han R. (n=15) | Mangkyeong R. (n=15) | Shanghai (n=5) |
| Standard length (mm) | 52.9～73.3 | 51.0～69.7 | 59.1～81.3 | 55.3～69.4 | 52.3～71.9 | 55.9～76.0 |
| Measurements in SL* | | | | | | |
| Head length | 26.4～27.7 (27.0±0.5) | 24.6～25.6 (25.1±0.4) | 22.6～23.9 (23.3±0.5) | 24.4～25.0 (24.7±0.2) | 25.2～26.3 (25.7±0.4) | 22.2～25.1 (24.0±0.9) |
| Body depth | 36.6～39.6 (38.2±1.1) | 39.2～42.9 (41.0±1.5) | 37.6～41.5 (40.3±1.6) | 38.3～41.6 (40.2±1.4) | 36.9～40.9 (38.9±1.8) | 41.1～45.6 (42.7±1.2) |
| Predorsal length | 54.3～57.4 (55.8±1.1) | 54.3～57.2 (55.8±1.2) | 54.5～57.0 (56.0±1.0) | 53.4～55.4 (54.6±0.8) | 55.3～57.5 (56.1±0.8) | 54.3～57.8 (56.0±1.2) |
| Preanal length | 65.3～67.5 (66.1±0.9) | 64.9～68.0 (66.6±1.2) | 64.5～67.2 (66.2±1.0) | 65.1～67.0 (65.9±0.8) | 63.9～68.3 (65.6±1.7) | 64.8～71.1 (66.9±1.8) |
| Caudal peduncle length | 19.3～20.7 (20.3±0.6) | 18.5～21.6 (20.0±1.2) | 20.0～23.2 (21.1±0.9) | 19.5～22.1 (20.4±1.3) | 20.4～22.2 (21.3±0.8) | 18.0～21.3 (20.1±1.2) |
| Caudal peduncle depth | 10.7～11.7 (11.1±0.4) | 11.8～13.1 (12.4±0.5) | 11.5～12.6 (12.0±0.4) | 11.3～12.1 (11.7±0.3) | 11.2～12.3 (11.8±0.5) | 12.3～13.5 (12.7±0.4) |
| Body width | 14.4～15.9 (15.3±0.7) | 12.2～14.0 (13.2±0.8) | 14.5～15.9 (15.2±0.6) | 14.0～16.7 (15.1±1.3) | 13.7～18.4 (15.1±1.9) | 13.8～16.0 (15.0±0.7) |
| Measurements in CPL* | | | | | | |
| Caudal peduncle depth | 52.6～57.0 (54.8±1.9) | 57.4～64.0 (61.9±2.7) | 52.9～62.9 (56.9±4.4) | 52.3～62.1 (57.6±4.3) | 50.4～60.0 (55.4±3.8) | 57.6～74.7 (63.4±5.2) |
| Measurements in HL* | | | | | | |
| Snout length | 25.2～27.3 (26.0±0.9) | 23.1～28.5 (26.2±2.0) | 26.3～29.8 (27.9±1.2) | 26.8～29.4 (28.6±1.1) | 25.7～27.2 (26.4±0.7) | 24.7～27.8 (25.9±0.9) |
| Eye diameter | 33.9～36.6 (35.3±1.2) | 30.3～33.3 (31.3±1.2) | 29.2～32.0 (30.6±1.1) | 29.2～32.5 (30.2±1.4) | 31.7～35.7 (33.3±1.6) | 29.3～32.5 (31.1±1.1) |
| Interobital length | 34.8～38.2 (36.1±1.3) | 33.7～38.4 (36.0±1.9) | 35.5～38.6 (36.9±1.2) | 35.4～38.9 (36.4±1.4) | 35.9～39.6 (37.7±1.7) | 35.8～40.2 (38.1±1.4) |
| Counts | | | | | | |
| Dorsal fin rays | 12～13 | 12～13 | 12～13 | 13～14 | 13～14 | 13 |
| Anal fin rays | 9～11 | 10～11 | 10～11 | 10～12 | 10～11 | 10～11 |
| Gill rakers | 13～18 | 14～16 | 14～17 | 15～17 | 14～16 | 15～17 |
| Lateral line scales | 33～35 | 33～36 | 33～37 | 34～36 | 34～36 | 34～36 |
| Vertebrae | 33～36 | 33～35 | 34～36 | 34～36 | 33～36 | 34～36 |

*SL : standard length, HL : head length, CPL : caudal peduncle length, ( ) : mean±SD

**Table 3.** Monthly comparison of number of the individuals having convex margin at the dorsal and anal fin in *Acheilognathus chankaensis* from Korea

| | Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Total number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | No. of individuals | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 120 |
| | Dorsal fin | 2 | 1 | 8 | 5 | 4 | 3 | 2 | – | 2 | 3 | 9 | 1 | 40 |
| | Anal fin | – | – | – | – | – | – | 1 | – | – | – | – | – | 1 |
| Female | No. of individuals | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 120 |
| | Dorsal fin | 1 | – | – | – | 1 | – | – | – | – | – | – | – | 2 |
| | Anal fin | – | – | – | – | – | – | – | – | – | – | – | – | – |

Nelson (2006) reviewed that *Acheilognathus* represents three genera known as *Paracheilognathus*, *Pseudoperilampus* and *Acanthorhodeus*. In addition, there are many reports that *Acanthorhodeus* was included into *Acheilognathus* such as Eschmeyer (1990), Lin (1998), Okazaki (2001), and Kottelat (2006). Kim (2000) reviewed Korean Acheilognathinae into the 13 species by using the osteological characteristics and also divided three clades into two by replacing *Acanthorhodeus* with *Acheilognathus*. Also, Yang (2004) classified the 13 species based upon mitochondrial DNA matching using the cytochrome *b* gene, but the results were not sufficient enough to prove the relationship of the two genera. Kim (2007) discussed that two genera, *Acanthorhodeus* and *Acheilognathus* are indistinct intergeneric differences of the barbel length, the 3rd unbranched rays of dorsal and anal fin and the lateral structure of pharyngeal teeth which has been used as the diagnostic characteristics in subfamily Acheilognathinae. Accordingly, it was considered that the genus *Acanthorhodeus* of Korea would be transferred to the genus *Acheilognathus*.

### Key to the genera of the subfamily Acheilognathinae in Korea

1a. Lateral line incomplete ..... *Rhodeus*
1b. Lateral line complete ..... *Acheilognathus*

### Key to the species of the genus *Acheilognathus* in Korea

1a. Mouth without or very short barbels ..... 2
1b. Mouth with very long barbels (except *A. rhombeus*) ..... 3
2a. Mouth with very short barbels; dorsal fin with 15～19 and anal fin with 12～13 branched soft rays ..... *A. macropterus*
2b. Mouth without barbels; dorsal fin with 12～14 and anal fin with 10～12 branched soft rays ..... *A.chankaensis*
3a. No stripe or caudal peduncle with light stripe on body; no dark spot on rear of operculum opening ..... 4
3b. Clear green or dark stripe on body; a dark spot on rear of operculum opening ..... 7
4a. A light stripe along lateral line on middle caudal peduncle; silvery body ..... *A. lanceolatus*
4b. No stripe on middle caudal peduncle; greenish brown body ..... 5
5a. Body dark green; dorsal fin with yellow band broader than 1/3 or 1/2 of dorsal fin height; lateral line scales 35～38; branched soft rays in anal fin 8～9 ..... *A. signifier*
5b. Body dark brown; dorsal fin with yellow band about 1/5 of dorsal fin height; lateral line scales 33～36; branched soft rays in anal fin 9～11 ..... 6
6a. Ovipositor of female during spawning season shorter, not reaching caudal fin base; egg shape with long ellipticity ..... *A. koreensis*
6b. Ovipositor of female during spawning season longer, exceeding over caudal fin base; egg shape with short ellipticity ..... *A. somjinensis*
7a. Dorsal fin with 11～13 branched soft rays; origin of stripe on body below or behind origin of dorsal ..... *A. rhombeus*
7b. Dorsal fin with 7～9 branched soft rays; origin of stripe on body reaching dark spot on rear of operculum operning ..... 8
8a. Gill rakers with 8～13; anterior margin of ventral fin with white band ..... *A. yamatsutae*
8b. Gill rakers with 15～21; anterior margin of ventral fin without white band ..... *A. majusculus*

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# 한국산 가시납지리 *Acanthorhodeus gracilis* (Pisces: Cyprinidae), *Acheilognathus chankaensis*의 동종이명

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**요 약 :** 한국산 가시납지리 *Acanthorhodeus gracilis*는 Regan에 의해 1908년 처음으로 기재되었으나 Dybowski가 1872년 기재한 *Acheilognathus chankaensis*와 비교한 결과 등지느러미 기조수(12～14개), 뒷느러미 기조수(10～11개), 측선린수(35～36개) 등 외부형태 형질이 매우 유사하였다. 따라서 본 조사에서 관찰한 표본과 원기재를 바탕으로 비교 조사한 결과 *Acanthorhodeus*속의 주요특징은 *Acheilognathus*속에 포함되어 기존의 *Acanthorhodeus gracilis*를 *Acheilognathus chankaensis*의 *junior synonym*으로 변경하였다. 한국산 *Acheilognathus*속 어류 9종의 종 검색표를 제시하였다.

**찾아보기 낱말 :** *Acheilognathus chankanensis*, 가시납지리, 동종이명