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Biwia yodoensis, a new species from the Lake Biwa/Yodo River Basin, Japan (Teleostei: Cyprinidae)

Seigo Kawase* and Kazumi Hosoya*

Biwia yodoensis, new species, is described from the Lake Biwa/Yodo River Basin, Japan. It is distinguished from the sympatric *B. zezera* by the edge of the dorsal fin slightly convex (vs. concave) with indented margin in male and of the posterior margin of the caudal fin relatively shallow-forked (vs. deep-forked), a deep body and caudal peduncle, fewer lateral line scales (34-35 vs. 36-38) and the total numbers of vertebrae (34-35 vs. 36-38). It is distinguished from Korean *B. springeri* by the absence of barbels (vs. presence) and its very thin lip (vs. fleshy).

Introduction

The cyprinid genus *Biwia* Jordan & Fowler includes two species: *B. zezera* (Ishikawa) and *B. springeri* (Banarescu & Nalbant) (Hosoya, 1986; Kawanabe et al., 2001). *Biwia zezera* is distributed in the Nobi Plain, the Lake Biwa/Yodo River Basin, Sanyo local region and Northern Kyushu, and is confined to Japan (Nakamura, 1969; Kawanabe et al., 2001; Horikawa et al., 2007; Horikawa & Mukai, 2007) while *B. springeri* is restricted to the Korean Peninsula (Kim & Park, 2002).

Biwia zezera was originally described as *Pseudogobio zezera* by Ishikawa (1895). Jordan & Fowler (1903) established a new genus *Biwia*, on the basis of *P. zezera*. Since then, it has been accepted as *Biwia zezera* by most Japanese ichthyologists (i. e., Aoyagi, 1957; Okada, 1960; Nakamura, 1969; Hosoya, 2002). *Biwia springeri* was vaguely described as *Abbottina springeri* by Ba-

narescu & Nalbant (1973); however Hosoya (1986) placed it in the genus *Biwia* based on the cephalic lateral line systems and its osteology.

During an investigation of the fish fauna in the Lake Biwa/Yodo River Basin, several specimens of an undescribed species of *Biwia* were collected. The purpose of this paper is to describe it as *Biwia yodoensis*.

Material and methods

Counts and proportional measurements follow Hubbs & Lagler (2004), except for those of the vertebrae counts, which follow Hosoya (1983); they are counted on radiographs and included the four vertebrae of the Weberian Apparatus and hypural complex. The lateral line scale count does not include the scales on the caudal fin. The last two rays of dorsal and anal fins are counted as one ray.

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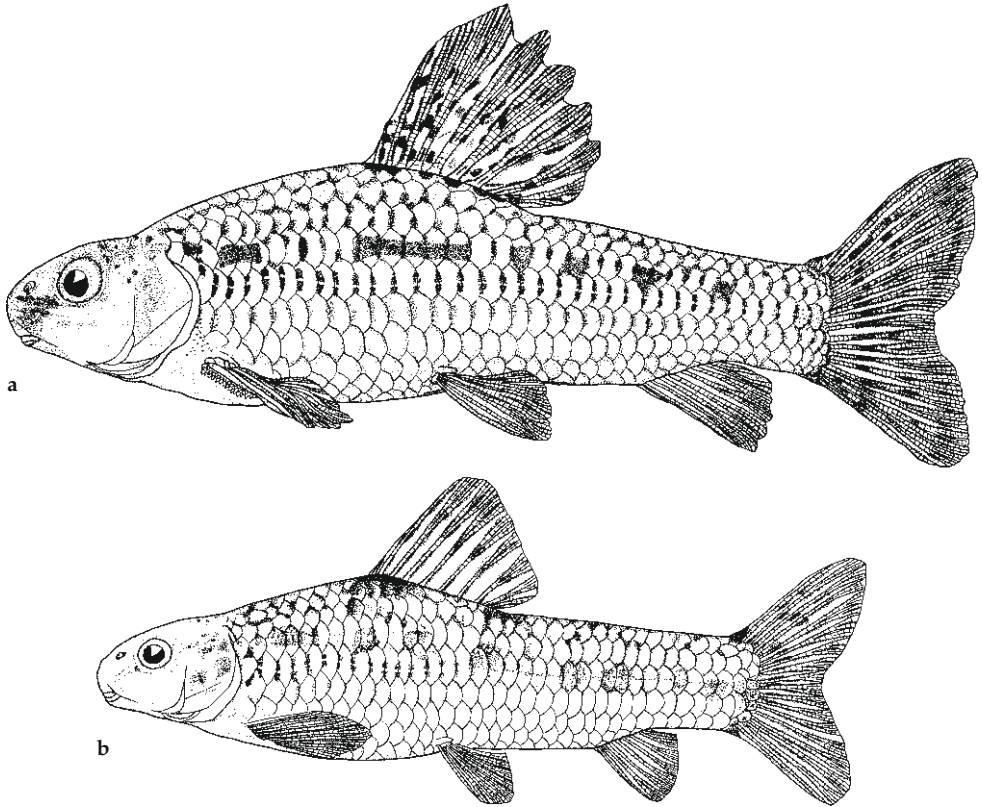


Fig. 1. *Biwia yodoensis*; **a**, KUN-P 40260, holotype, 58.0 mm SL, male; Japan: Kyoto: Lake Biwa/Yodo River basin, Katsura River; **b**, KUN-P 40087, paratype, 47.1 mm SL, female; Japan: Kyoto: Koga Irrigation.

The materials examined are deposited in the following collections: BMNH, Natural History Museum, London; KUN-P, Kinki University, Nara; LBM, Lake Biwa Museum, Kusatsu; NSMT-P, National Science Museum, Tokyo; OMNH, Osaka Museum of Natural History; RMNH, National Natuurhistorisch Museum, Leiden; SMWU, Sang-Myung Women's University (now rearranged to Sang-Myung University, SMU), Seoul; USNM, National Museum of Natural History, Smithsonian Institution, Washington.

Biwia yodoensis, new species
(Figs. 1-2)

Biwia zezera (not Ishikawa, 1895): Jordan & Fowler, 1903: 838-840 (in part); Okada, 1960: 453-455 (in part); Kawanabe et al., 2005: 296 (plate c), 317 (in part of plate).

Holotype. KUN-P 40260, 58.0 mm SL, male; Japan: Kyoto: Oyamazaki: the Lake Biwa/Yodo River Basin, Yodo region, Katsura River; 34°53' 53" N 135°42'3" E; S. Kawase & S. Kashiwagi, 3 Jul 2008.

Paratypes. All from the Lake Biwa/Yodo River Basin, Japan. BMNH 2009.3.27.1, 50.4 mm SL, female; Kyoto: Koga Irrigation; S. Kawase, 15 Jun 2008. – KUN-P 40086-40087, 40889-40890, 42.0-49.8 mm SL, all females; RMNH 35637, 51.1 mm SL, male; same locality as BMNH 2009.3.27.1; S. Kawase & S. Kashiwagi, 18 Apr 2008 (KUN-P 40889-40890 preserved 70 % ethanol). – KUN-P 40250, 49.9 mm SL, female; Kyoto: Souraku: Seika: Kizu River; S. Kawase, 6 Jun 2008 (cleared and stained specimen). – LBM 1210050727, 47.9 mm SL, male; Shiga: Moriyama: Lake Biwa; K. Tsuji, 19 May 2006. – NSMT-P 94297, 49.1 mm SL, male; same locality as BMNH 2009.3.27.1; S. Kawase & Y. Fujii, 9 May 2008. – NSMT-P 94298, 50.7 mm



Fig. 2. *Biwia yodoensis*, 57.8 mm SL, a mature male in life, not preserved; Japan: Kyoto: Kizugawa: Kizu River.

SL, female; USNM 395900, 48.0 mm SL, female; Kyoto: Kizugawa: Yamada River, branch of Kizu River; S. Kawase, 6 May 2008. – OMNH-P 35364, 35365, both 50.0 mm SL, females; Osaka: Takatsuki: Yodo River; S. Kawase, R. Noguchi & T. Minami, 29 Apr 2008.

Diagnosis. *Biwia yodoensis* has the deepest body and caudal peduncle among the species of *Biwia*, with body depth 23.4–26.0 % SL, depth of caudal peduncle 9.9–12.8 % SL (vs. 15.2–20.4 and 7.4–9.9, respectively, in *B. zezera*; 16.0–23.4 and 8.1–10.8, respectively, in *B. springeri*). *Biwia yodoensis* is distinguishable from *B. zezera* by shape of the dorsal fin (slightly convex when rays extended vs. concave) and with margin indented in male and not indented in female (Fig. 3), fork of caudal fin (shallow vs. deep), fewer lateral line scales (34–35 vs. 36–38) and fewer vertebrae (total 34–35 vs. 36–38). *Biwia yodoensis* is distinguished from *B. springeri* by the absence of barbels (vs. presence) and thickness of the lips (thin vs. fleshy) (Fig. 4).

Description. Based on holotype and paratypes; data for paratypes, when different, are given in parentheses.

Dorsal fin with 3 (3–4) simple and 7 (6–7) branched rays. Anal fin with 3 simple and 6 branched rays. Pectoral fin with 1 simple and 10 (9–10) branched rays. Pelvic fin with 2 simple and 8 (7–8) branched rays. Caudal fin with 1 simple, 9 (8–9) branched, 8 (7–8) branched, 1 simple rays. Scale rows between lateral line and dorsal-fin origin 5 (4); between lateral line and anal-fin origin 4. Scales between anal-fin origin and anus 8 (7–8). Abdominal vertebrae 17; caudal vertebrae 18 (17–18); total vertebrae 35 (34–35). Dorsal proximal pterygiophores, including a terminal stay 9; anal proximal pterygiophores 23.

Proportional measurements of holotype and paratypes are shown in Table 1. Body elongate, rather rounded, compressed, and somewhat broad forward. Nape rising backward. Head rather small, relatively wide, 23.7 % SL (23.1–24.7). Snout bluntly rounded, and short, 30.3 % HL (29.3–38.3). Mouth small, inferior and horse-shoe shaped; lip very thin; a pair of smooth pads without papillae behind lower lip; no barbels; posterior margin of maxillary not reaching to the front of the eye. Pharyngeal teeth in one row, dental formula 5–5. Eye in higher position, anterior, and shorter than interorbital width. Interor-

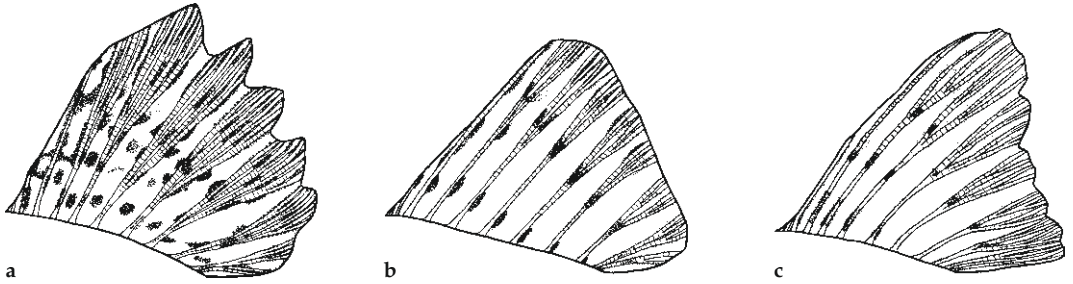


Fig. 3. Shape of dorsal fin in: **a**, *B. yodoensis*, KUN-P 40260, holotype, 58.0 mm SL, male; **b**, *B. yodoensis*, KUN-P 40087, 47.1 mm SL, female; **c**, *B. zezera* (same in both sexes), KUN-P 40307, 49.0 mm SL.

bital space flat, its width 30.6 % HL (27.1-36.6).

Body covered with large cycloid scales of more or less even size; no scales on breast. Edge of dorsal fin slightly convex; margin indented in male, straight in female. Pectoral fin reaching dorsal-fin origin. Pelvic fin not reaching anal fin. Caudal fin shallowly-forked, and rather rounded. Trunk lateral line complete, while cephalic lateral line incomplete; infraorbital canal not con-

nected to supraorbital and preoperculo-mandibular; rostral branch long; supratemporal canal of both sides not connected.

Coloration in life. Top of head and snout brownish; body surface yellowish; edge of most scales dark brown, lateral line scales especially dark; all fins yellowish-white, a row of 4 dark brown small spots on dorsal and caudal surfaces. A series of

Table 1. Measurements expressed as percentages of holotype and selected paratypes in *Bivovia yodoensis*.

	holotype male	holotype + paratypes					
		males (n=4)			females (n=7)		
		range	mean	SD	range	mean	SD
Standard length (mm)	58.0	47.9-58.0			47.1-50.7		
Total length	71.0	59.4-71.0			58.4-61.9		
Percentage of standard length							
Head length	23.7	23.7-24.7	24.1	0.5	23.1-24.6	23.7	0.5
Body depth	25.3	25.1-25.4	25.3	0.1	21.9-26.0	24.5	1.5
Body width	16.7	16.7-18.2	17.5	0.8	16.5-21.2	18.5	1.9
Depth of caudal peduncle	11.0	11.0-12.8	11.7	0.8	9.9-11.7	10.9	0.9
Length of caudal peduncle	15.7	14.8-15.7	15.3	0.4	14.1-16.8	15.5	1.1
Predorsal length	43.3	43.3-46.0	44.5	1.9	43.5-45.6	44.7	0.8
Preanal length	74.8	74.8-79.6	77.3	2.0	76.3-78.8	77.5	1.0
Prepelvic length	50.5	50.5-56.7	53.4	2.6	52.2-57.0	53.9	1.7
Height of dorsal fin	26.8	23.6-26.8	24.6	1.5	16.6-22.8	20.6	2.6
Length of depressed dorsal	29.3	25.8-29.3	27.5	1.5	23.2-27.1	24.6	1.4
Length of dorsal fin base	17.8	16.1-19.4	17.6	1.4	15.5-18.8	16.6	1.1
Height of anal fin	18.4	15.1-18.4	16.6	1.4	14.4-16.7	15.4	0.9
Length of depressed anal	19.1	15.2-19.1	17.0	1.6	14.9-17.0	15.8	0.7
Length of anal fin base	11.9	9.6-11.9	10.6	1.0	7.6-10.0	9.1	0.8
Pectoral fin length	22.0	20.6-22.0	21.2	0.7	18.5-22.0	20.1	1.3
Pelvic fin length	17.5	14.6-17.5	16.1	1.4	14.1-16.5	15.8	1.0
Percentage of head length							
Head depth	73.9	73.9-82.6	78.7	3.7	69.0-77.3	73.1	3.3
Head width	64.8	63.8-74.5	68.6	5.1	65.5-70.6	67.9	1.6
Snout length	30.3	30.3-36.2	33.8	2.7	29.3-38.3	33.0	3.6
Orbit diameter	25.8	25.5-26.8	26.2	0.6	23.5-30.2	27.0	2.4
Interorbital width	30.6	30.6-36.6	33.4	2.8	27.1-36.2	32.4	4.0

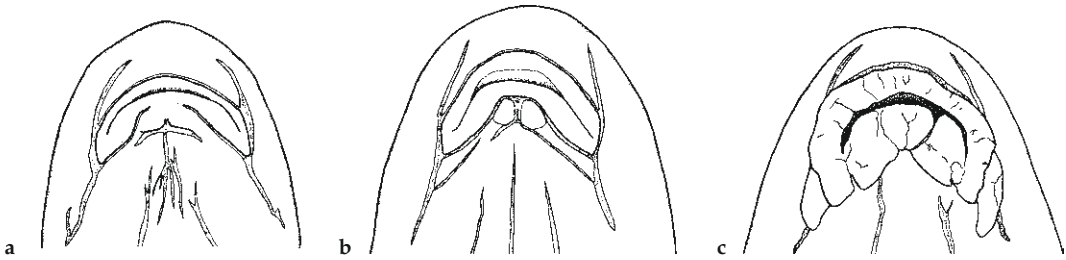


Fig. 4. Ventral views of mouth of *Biwia* species: a, *B. yodoensis*, KUN-P 40260, holotype, 58.0 mm SL; b, *B. zezera*, KUN-P 40316, 62.2 mm SL; c, *B. springeri*, SMWU 34403, 45.3 mm SL.

7 (6-9) roundish blotches on lateral sides, a series of 6 (6-7) saddles on back, and an obscure row of dark brown mottling on dorsal region.

Sexual dimorphism. In spawning season, males develop secondary sexual characteristics (Fig. 1a): nuptial tubercles on anterior margin of first pectoral ray on two rows; first row 12 (6-12); second row 15 (10); total 27 (16-22); dorsal-, pectoral- and anal-fin rays extended, especially dorsal fin with more convex and indented margin resulting from rays longer than membranes (Fig. 3a); grey nuptial color all over body surface. Series of roundish blotches on flank mostly disappear.

Genetics. The 1137 bp nucleotide sequences of the mitochondrial cytochrome *b* gene for holotype of *B. yodoensis* with a right pelvic fin are deposited in DDBJ (DNA Data Bank of Japan) with accession number AB499046.

Distribution and ecology. *Biwia yodoensis* is known from the Yodo River, Kizu River, and the irrigation system connected to the Yodo River system and the southern part of Lake Biwa, Japan (Fig. 5). In the Yodo River and the southern part of Lake Biwa, it is sympatric with *B. zezera*. *Biwia yodoensis* prefers a muddy bottom such as pools; 'tamari' (temporal waterholes produced by river

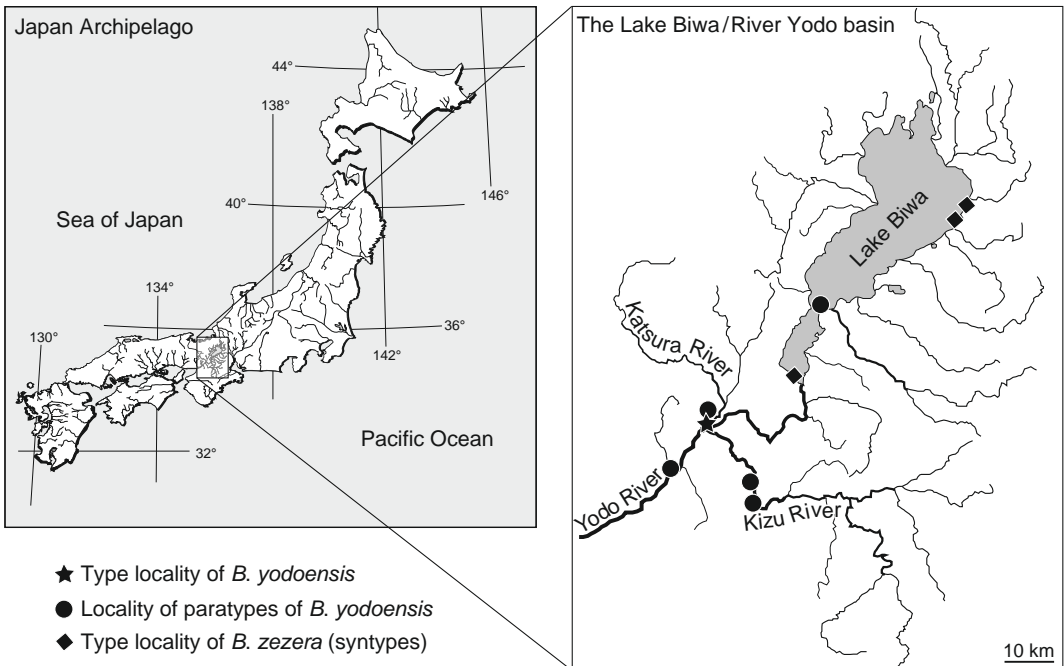


Fig. 5. Distribution of *Biwia yodoensis* and *B. zezera* in the Lake Biwa/Yodo River Basin, Japan.

flood), 'wando' (similar to tamari but distinguished by having connection to river), pools in river, and the southern part of Lake Biwa. The spawning season extends from April to early July, reaching a peak between May and June. *Biwia yodoensis* is considered adapted to flood plain, because the main habitats such as tamari and wando have unsteadily fluctuating condition.

The eggs of *B. yodoensis* appear large and stick together, because each egg is enclosed in material of gelatinous texture. The eggs are spawn in temporary waters, and protected by the male.

Conservation. Populations of the new species are decreasing as a result of habitat disappearance caused by land reclamation in the flood plains, river modification such as straightening and concrete lining of river banks, habitat deterioration, and introduction of invasive species such as largemouth bass, *Micropterus salmoides*. Therefore, biological research (e. g. ecology, genetics) is urgently needed for conservation.

Etymology. The epithet *yodoensis* is a reference to its core distribution: the "Yodo" region and Yodo River in the Lake Biwa/Yodo River Basin near Kyoto. New Japanese name: Yodo-zezera.

Remarks. The new species is endemic to the Lake Biwa/Yodo River Basin and is partly sympatrically with *B. zezera* in the Yodo River and the southern part of Lake Biwa. *Biwia yodoensis* is very similar to *B. zezera* in general characteristics, but differs by the edge of the slightly convex dorsal fin (vs. concave in *B. zezera*), the shallow-forked caudal fin (vs. deep in *B. zezera*), deeper body (23.4-26.0 vs. 15.2-20.4 % SL) and caudal peduncle (9.9-12.8 vs. 7.4-9.9 % SL), fewer lateral line scales (34-35 vs. 36-38), fewer total number of vertebrae (34-35 vs. 36-38) and mitochondrial and nuclear DNA sequences (Watanabe et al., unpubl. data). *Biwia yodoensis* is distinguished from *B. springeri* by the absence of barbels (vs. presence in *B. springeri*) and the thin lip (vs. fleshy). In the spawning season, secondary sexual characteristics also distinguish *B. yodoensis* from the two other species of *Biwia*; nuptial tubercles only occur on the anterior margin of first pectoral ray (vs. also on the lower surface of the head in *B. springeri*); nuptial tubercles developed as more stout (vs. undeveloped in *B. zezera*); first-row of nuptial tubercles 6-12 (vs. 15-27 in *B. zezera*).

Key to species of *Biwia*

- 1 - Barbels present; lips fleshy; nuptial tubercles on anterior margin of first pectoral ray and on lower surface of head. Korean Peninsula.
.....*B. springeri*
- Barbels absent; lips thin; nuptial tubercles only on anterior margin of first pectoral ray. Japan.
.....2
- 2 - Edge of dorsal fin slightly convex; fork of caudal fin depthless; deep body and caudal peduncle; 34-35 lateral line scales; 34-35 total vertebrae; first row of nuptial tubercles 6-12. Lake Biwa/Yodo River Basin.
.....*B. yodoensis*
- Edge of dorsal fin concave; fork of caudal fin deep; shallow body and caudal peduncle; 36-38 lateral line scales; 36-38 total vertebrae; first row of nuptial tubercles 15-27. Nobi Plain, Lake Biwa/Yodo River Basin, Sanyo local region and North Kyushu.
..... *B. zezera*

Comparative materials. *Biwia zezera*: NSMT-P 261, 2 syntypes, 48.2-57.9 mm SL; Japan: Shiga: Hikone: Matsumura, Lake Biwa. - NSMT-P 262, 16 syntypes, 45.6-60.0 mm SL; Japan: Shiga: Maibara, Lake Biwa. - NSMT-P 264, 1, 4.2 mm SL; Japan: Okayama. - NSMT-P 2007, 9, 4.5-5.9 mm SL; Japan: Shiga: Lake Yogo. - KUN-P 40044-40084, 41, 39.9-62.0 mm SL; KUN-P 40094-40099, 6, 50.7-57.6 mm SL; KUN-P 40268-40298, 31, 44.3-61.9 mm SL; same locality with KUN-P 40044-40084; Japan: Shiga: Moriyama: Lake Biwa. - KUN-P 40307-40339, 33, 42.7-65.7 mm SL; Japan: Shiga: Yasu: Ayame: Lake Biwa. - KUN-P 40420-40421, 2, 42.7-65.7 mm SL; Japan: Shiga: Takashima: Sanwa: Lake Biwa. - KUN-P 40479-40480, 2, 55.2-55.3 mm SL; Japan: Shiga: Higashiomori: Daidou River. - KUN-P 40481-40500, 20, 46.3-68.7 mm SL; Japan: Shiga: Moriyama: Yasu River. - KUN-P 40501-40506, 6, 38.4-51.4 mm SL; Japan: Kyoto: Heian Shrine.

B. springeri: USNM 204079, 2 paratypes, 32.1-38.9 mm SL; Korea. - SMWU 34396-34423, 28, 42.6-59.7 mm SL; Korea: Gyeonggi: Pyeongtaek: Gunmun: Anseong River.

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Biwia yodoensis

Seigo Kawase and Kazumi Hosoya
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