

コイ科の希少種ウケクチウグイの耳石Sr : Ca比解析による 河川型生活史の検証

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Otolith Sr : Ca ratios of an endangered cyprinid *Tribolodon nakamurai* indicating absence of sea-migrating traits

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Abstract: The strontium : calcium concentration ratios in the otoliths of ten variously-sized *Tribolodon nakamurai* (Cyprinidae) individuals collected from the lower reaches of the Mogami River were examined and compared with those of six spawning individuals from the upper reaches of the river in order to establish the existence or otherwise of any sea-migrating traits. The ratios were relatively stable from the core to the edge of the otolith in all specimens, indicating a solely freshwater life style. Any conservation program for *T. nakamurai* should therefore be based on the premise that the species has a fluvial mode of life.

Key words: Endangered fish, Cyprinidae, *Tribolodon nakamurai*, Migration, Otolith, Sr : Ca ratios

Introduction

The Far Eastern dace (genus *Tribolodon*) is unique in the family Cyprinidae by including some anadromous species^{1,2)}. Although *T. ezoe* Okada and Ikeda lives an entirely freshwater existence, *T. brandtii* (Dybowsky) is anadromous, and *T. hakuensis* (Gunther) exhibits both life style modes. However, the life history mode of the endangered species *T. nakamurai* Doi and Shinzawa is presently uncertain^{3,4)}. *Tribolodon nakamurai* (Japanese name “Ukekuchi-ugui”) is distributed from Niigata to Akita prefectures, in some of the larger rivers flowing into the Sea of Japan, including the Shinano, Agano, Mogami and Koyoshi River systems^{2,4)} (Fig. 1). Although *T. nakamurai* is usually considered to be restricted to rivers, a single specimen collected from the Koyoshi River, Akita Prefecture⁵⁾, was suggested as having migrated there from a different river system via the sea based on analysis of otolith microchemistry^{6,7)}. Because of the rarity and restricted distribution of this species, only a few aspects of its life history, such as early development^{8,9)} and growth¹⁰⁾, have been clarified to date, and certainly little regarding migration.

The migratory history of diadromous fishes can be reconstructed through otolith microchemistry, particularly in the utilization of strontium to calcium concentration ratios (Sr : Ca ratio)¹¹⁾, the latter usually being lower in freshwater forms, higher in sea going forms. Because the otoliths of the fish collected from the Koyoshi River exhibited a fluctuating pattern of Sr : Ca ratios from the core to the edge, Sakai and Imai⁷⁾ inferred that the specimen had migrated from another river, such as the Mogami River.

Unfortunately, no further specimens have been collected from the Koyoshi River. Therefore, we collected variously-sized specimens of *T. nakamurai* from the lower reaches of the Mogami River in order to examine whether or not they exhibited any sea-migrating traits, by analyzing patterns of otolith Sr : Ca ratios. The results obtained should provide a basis for future conservation programs for the species.

Materials and Methods

Ten specimens of *T. nakamurai*, 5.9–42.0cm SL (standard length), were collected between 1997 and 1999 from the

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lower reaches (less than 25 km from the river mouth) of the Mogami River (Table 1, Fig. 1). Six individuals of spawning fish, 37.0-48.1cm SL, caught from the upper reaches (more than 150 km from the river mouth) in 1995 were also analyzed for comparative purposes.

The lapillus otolith was used for analysis because the sagittal otolith of *Tribolodon* is small and needle-shaped, and therefore unsuitable¹⁰⁾. After drying, the former was embedded in epoxy resin, cut near the core utilizing a diamond cutting disk, mounted on a glass slide and then ground using aluminum oxide paste ($0.3\ \mu\text{m}$), so as to ex-

pose the core.

Electron microprobe analysis was made using a JEOL JXA-8900R as previously described¹²⁾. Sr and Ca concentrations were measured along a line from the core to the edge at $10\ \mu\text{m}$ intervals. Wollastonite (CaSiO_3) and tausonite (SrTiO_3) were used as standards. The accelerating voltage and beam current were 15 kV and $1.2 \times 10^{-8}\ \text{A}$, respectively. The electron beam was focused on a point about $10\ \mu\text{m}$ in diameter and mean Sr : Ca ratios ($\times 1000$) calculated for every measuring point.

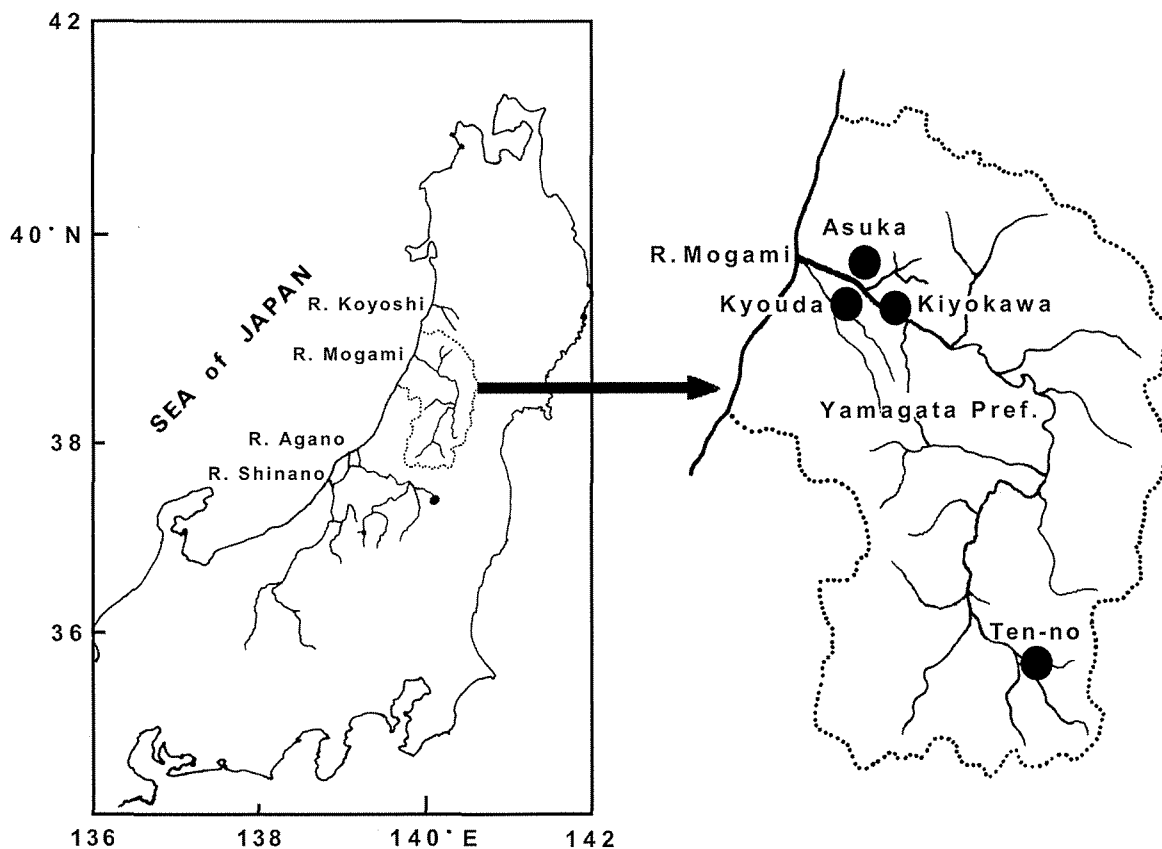


Fig. 1. Distribution of *Tribolodon nakamurae* (left) and collection sites in the Mogami River system, Yamagata Prefecture, Japan (right).

Table 1. Samples of *Tribolodon nakamurae* collected from the Mogami River, Yamagata Prefecture

Date	Locality	Abbreviation	N	Standard length (cm)
May 1995	Oitama, Ten-no River	Ten-no	6	37.0 - 48.1
October 1997	Outlet channel, Asuka Pond	Asuka	5	5.9 - 6.5
June 1998	Miyasone, Kyoda River	Kyoda	4	13.6 - 21.5
February 1999	Kiyokawa, Mogami River	Kiyokawa	1	42.0

Results and Discussion

Representative Sr : Ca ratios for four localities are shown in Fig. 2. Spawning *T. nakamurai* from the upper reaches showed relatively stable Sr : Ca ratios around 2 (UK13R in Fig. 2, also shown in Fig. 3), indicating a wholly fresh-water life style. All ten specimens from the lower reaches of the Mogami River also showed relatively stable Sr:Ca ratios around 2 (UK17R, UK18R and UK19R in Fig. 2) indicating similarly fluvial life style to that point.

Regardless of the size variations in the specimens sampled, the fish from the lower reaches of the Mogami River did not show any sea-going traits. Although spawning of *T. nakamurai* occurs in upper river reaches, young fish are usually found in the lower reaches¹³⁾, the species probably

having an intra-river migration life cycle: adults spawn in the upper reaches of the river, and juveniles migrate down stream and grow in the lower reaches, before returning to the upper reaches for spawning. The otolith data indicated that *T. nakamurai* usually maintains a fluvial life style, but can survive accidental transportation to the sea, the specimen from the Koyoshi River probably being a rare example of the latter. Therefore, any conservation program for *T. nakamurai* should be based on the premise that the species has a fluvial mode of life. Because of rarity of the species, merely a little information on populations had been taken. Taking further ecological information on populations at not only Mogami River and also other habitat rivers is important.

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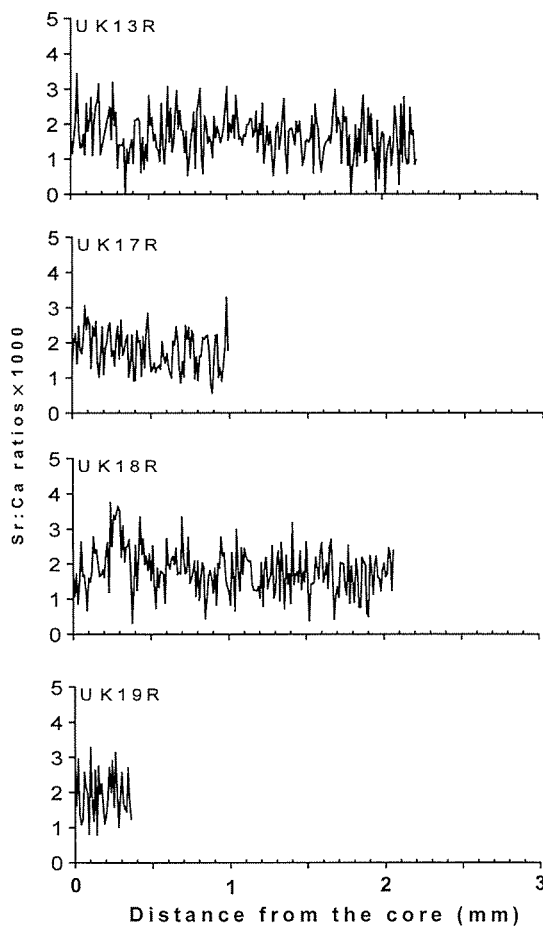


Fig. 2. Strontium to calcium concentration ratios (Sr : Ca ratio, x 1000) in *Tribolodon nakamurai*, along a line from the core to the edge of the otolith. UK13R, 45.0 cm SL, Ten-no River ; UK17R, 13.8 cm SL, Kyoda River ; UK18R, 42.0 cm SL, Kiyokawa, main stream of the Mogami River ; UK19R, 6.4 cm SL, outlet channel from Asuka Pond.

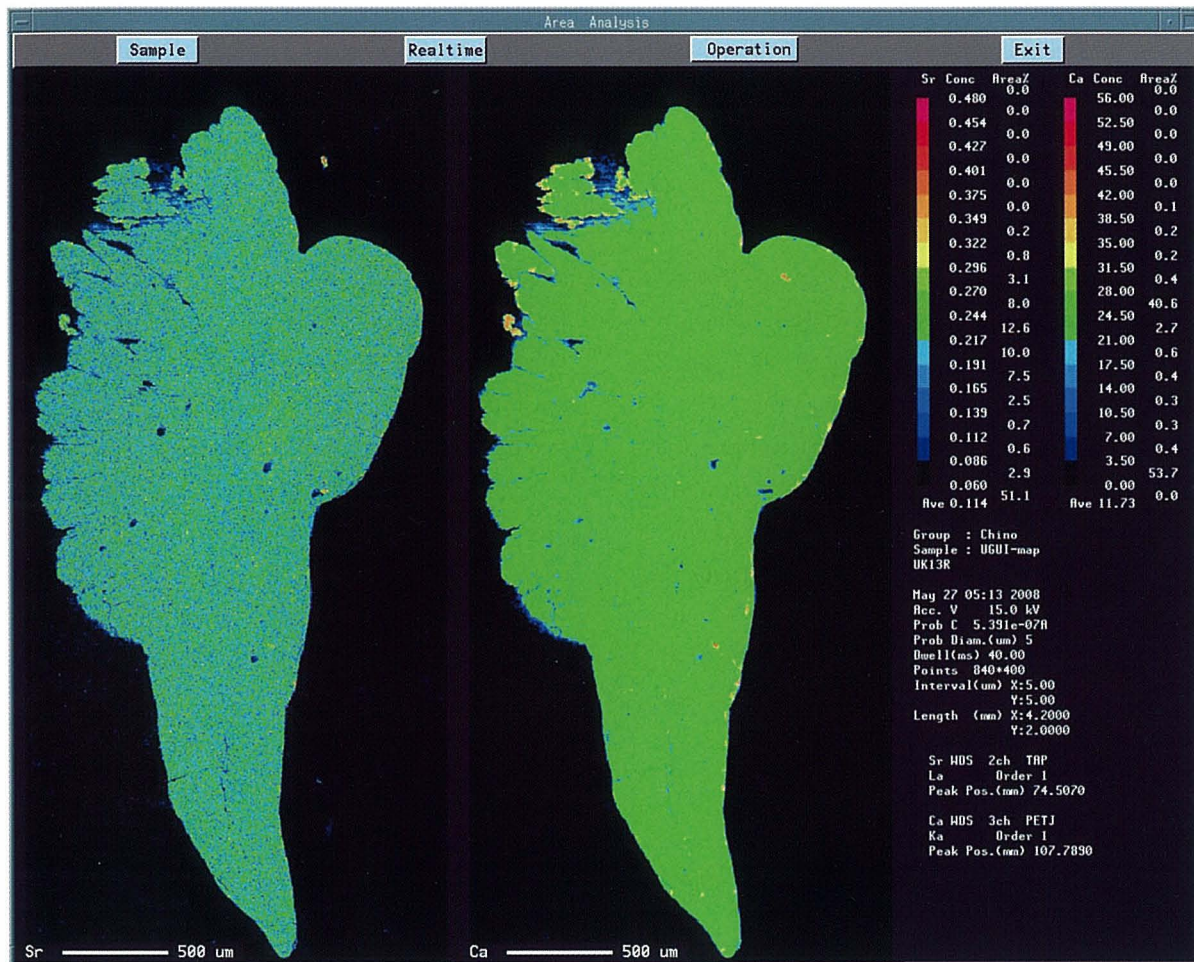


Fig. 3. Two-dimensional imaging of Sr (left) and Ca (right) concentrations in a cross section of the lapillus otolith of *Tribolodon nakamura*, UK13R, 45.0 cm SL, Ten-no River, Mogami River system, Yamagata Prefecture, Japan. Values corresponding to Sr and Ca concentrations are represented by 16 colors from red (highest), yellow, green through blue (lowest).

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コイ科の希少種ウケクチウグイの耳石Sr:Ca比解析による河川型生活史の検証

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新潟, 山形および秋田県の日本海流入河川にのみ生息するコイ科の希少種ウケクチウグイについて, 降海回遊の有無を確認する目的で, 最上川下流域で採集された若齢魚を含む10個体および上流域産の産卵個体群6個体の耳石(礫石)のSr:Ca比を解析, 比較した。全16個体のSr:Ca比は耳石核から縁辺まで低い値で安定していて, 降海回遊の兆候は認められなかった。ウケクチウグイの保全策は, 本種が降海しないことを前提に策定するべきである。