Life History Characteristics of the Giant Mottled Eel *Anguilla marmorata* in a Temperate River Near the Northern Limit of Its Distribution

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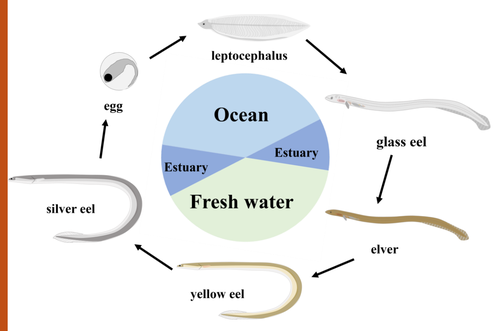
Introduction

➢ Life History of Freshwater Eels



- Freshwater eels are of cultural, commercial, and ecological importance worldwide[1].
- Many species are classified as **Threatened or Near Threatened**[2].
- Freshwater eels are **catadromous fish**.
- The freshwater stage is a preparation period for spawning migration, and **life history characteristics during this stage provide insights into reproductive mechanisms**.
- However, knowledge of the freshwater life history of anguillid eels remains limited.

➢ Giant Mottled Eel (*Anguilla marmorata*)

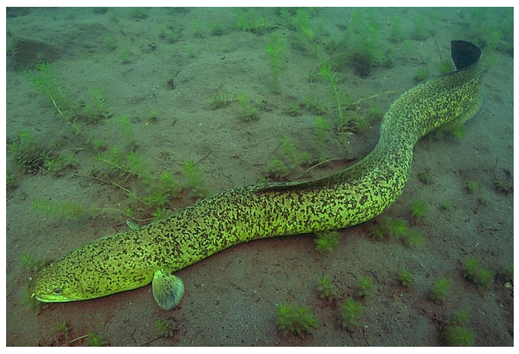


Fig 1. *A. marmorata*

- *A. marmorata* is the world's most widely distributed anguillid species
- *A. marmorata* is **a tropical species and a top predator** in freshwater ecosystems[3].
- The northern limit of its distribution is in the temperate region of southern Japan.
- Studies of its freshwater stage have focused on tropical and subtropical regions, with **no studies in temperate regions.**

➢ Hypothesis

The freshwater stage may be prolonged in temperate populations compared with tropical and subtropical populations due to environmental factors such as lower temperatures that suppress growth and maturation.

This study aimed to reveal the life history characteristics of *A. marmorata* in a temperate river near its northern distribution limit and compare them with those of populations in its main distribution range.

Materials and Methods

➢ Distribution

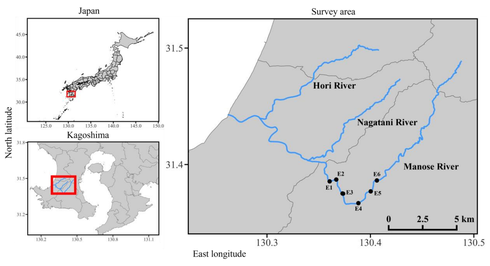
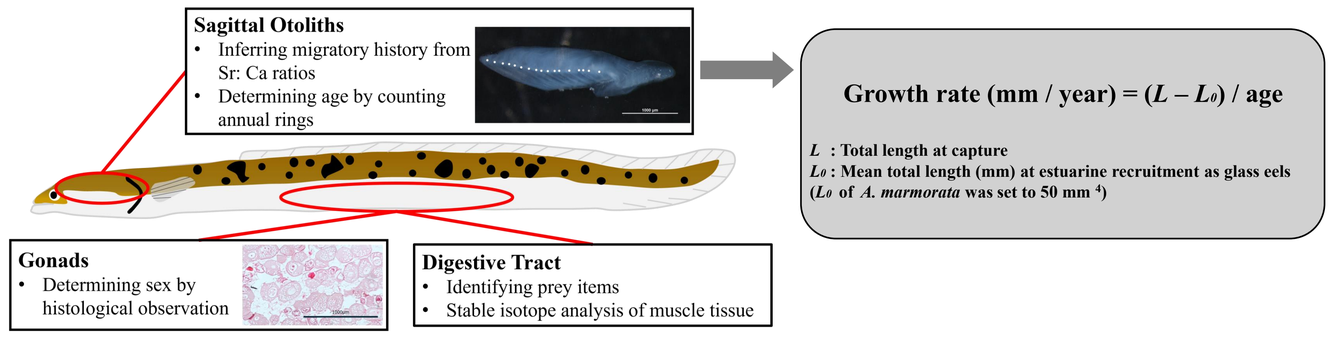


Fig 2. Maps of Manose River system, southern Japan.

- From May 2022 to August 2026, a total of 9 specimens were collected using fixed nets, crab traps, and fishing in the Manose River system, southern Japan.
- Environmental DNA (eDNA) analysis was conducted at 6 sites (E1 – E6) to determine the distribution of the species in the Manose River.
- Japanese eel (*A. japonica*) was also observed, and 15 specimens were collected.

➢ Migratory Histories, Age, Growth, Sex Ratio, and Feeding Habit



Results and Discussions

➢ *A. marmorata* inabits a specific environment

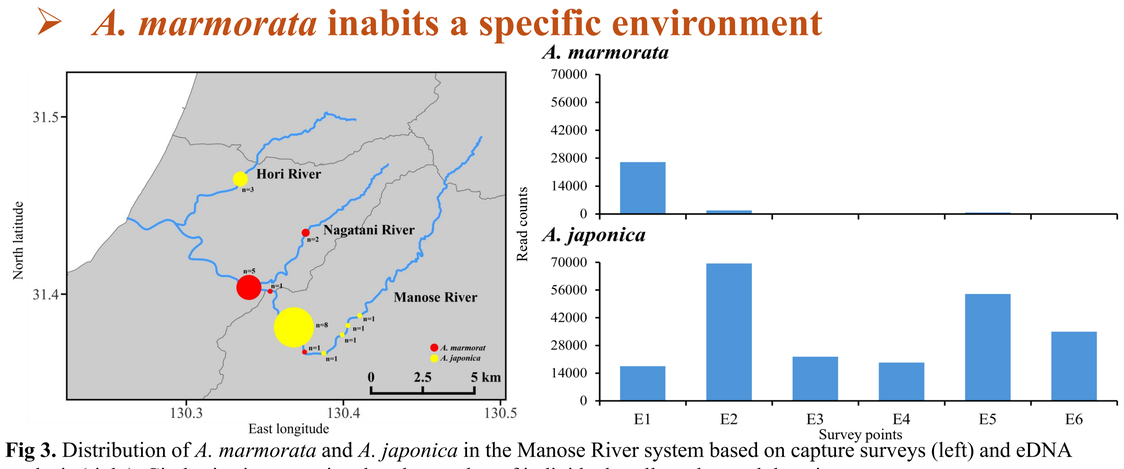


Fig 3. Distribution of *A. marmorata* and *A. japonica* in the Manose River system based on capture surveys (left) and eDNA analysis (right). Circle size is proportional to the number of individuals collected at each location.

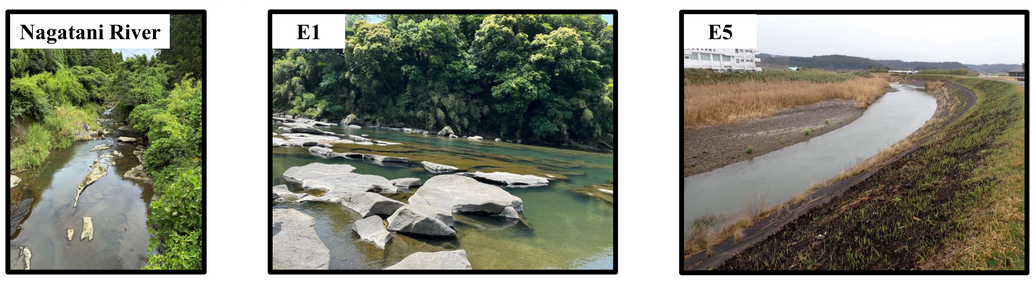


Fig 4. Habitats at each survey site.

Rivers where *A. marmorata* and *A. japonica* occur sympatrically…

A. marmorata		*A. japonica*
Preferer… • High water velocity • Rocky substrata	**Habitat isolation** (Previous study[5,6])	Preferer… • Low water velocity • Sandy substrata
Strongly preferer! • High water velocity • Rocky substrata	**No clear habitat segregation** (Present study)	**Distributed across various habitats**

➢ No evidence of estuarine migration

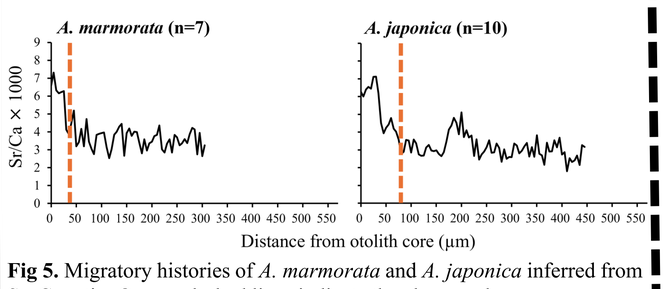


Fig 5. Migratory histories of *A. marmorata* and *A. japonica* inferred from Sr: Ca ratio. Orange dashed lines indicate the elver mark.

- All *A. marmorata* remained in freshwater after river entry.
- Some individuals of *A. japonica* moved between brackish and freshwater habitats.

➢ Dietary difference between species

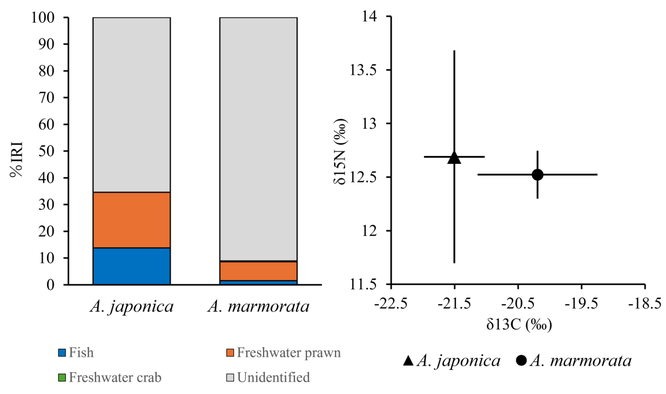


Fig 6. Diet composition (left) and δ13C and δ15N values (± SD) (right) of *A. marmorata* and *A. japonica*

➢ Prolonged freshwater residence at the northern range limit

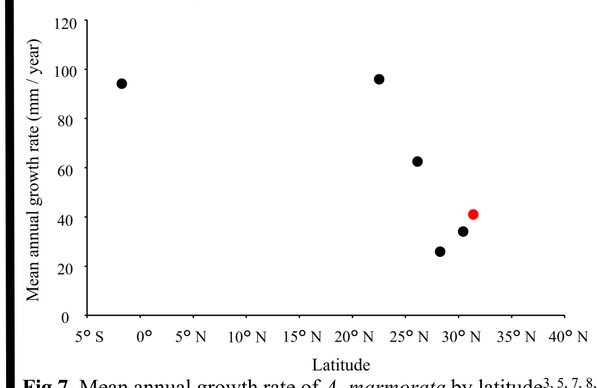
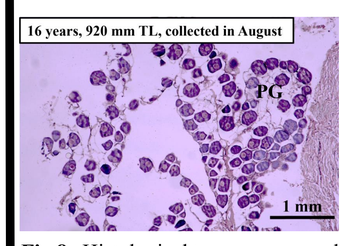


Fig 7. Mean annual growth rate of *A. marmorata* by latitude[3, 5, 7, 8, 9]. The red circle indicates the result of the present study.

Table 1. Comparison of maximum total length, maximum age, and sex ratio among six different locations.

Locality	TL_{max} (mm)	Age_{max} (years)	Sex ratio (male : female)
Sulawesi[7]	1,630	23	1 : 3.39
Hong Kong[8]	1,800	16	All females
Okinawa-jima Island[3]	1,437	20	1 : 1.15
Amami-Oshima Island[9]	1,320	30	1 : 0.13
Yakushima Island[5]	1,173	33	1 : 0.82
Manose River system (present study)	**1,530**	**42**	**All females**



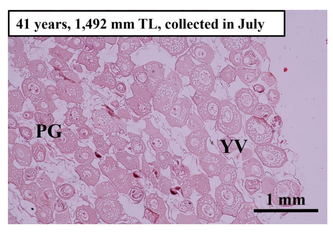


Fig 8. Histological transverse gonadal sections of *A. marmorata.* Showing primaly growth stage (PG), and yolk vesicle (YV).

Table 2. Comparison of maximum total length, maximum age, sampling month and developmental stage of oocyte among silver eel, early silvering eel, and yellow eels.

	Number of individuals	TL_{max} (mm)	Age_{max} (years)	Sampling month	Developmental stage of oocyte
Silver eel	1	1,296	39	October	Yolk vesicle stage
Early silvering eel	1	1,492	41	July	Yolk vesicle stage
Yellow eel	6	534 – 1,530	16 – 42	May – August	Primaly growth stage



Fig 9. A silvered *A. marmorata* collected around E3 in October.

- Low temperatures in winter may suppress growth in temperate regions.
- Sex ratios vary substantially among populations, suggesting a stronger association with habitat than with latitude.
- The estimated age at silvering was approximately 40 years.
- Spawning migration may occur throughout the year.

The northernmost population contributes to reproduction of the species despite the long time required to reach spawning migration.

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