

## [Episode 55] Establishment of Technologies for Producing Delicious Large Female Eels and Their Application to Sturgeons

Outcome Example of Bio-oriented Technology  
Research Advancement Institution

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The Japanese custom of eating grilled eel, which is considered a stamina-boosting food, on a specific day in midsummer called “Doyo no Ushi no Hi” or the midsummer day of the ox, is said to have originated in the Edo period. Thus, eels are a very familiar fish to the Japanese. The supply of eels was approximately 60 thousand tons in 2022, one third, or 20 thousand tons, of which was domestically farmed. Even though the eels are “farmed,” the system entirely depends on natural Japanese eel (*Anguilla japonica*) fry or glass eels (photo 1). Unfortunately, the catch has been decreasing year by year, and the soaring transaction prices are putting pressure on the business operations of eel farmers.

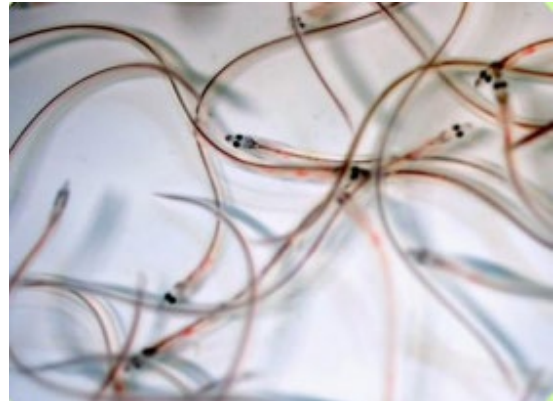


Photo1: Glass eels (provided by Aichi Fisheries Research Institute)

A research group led by Aichi Fisheries Research Institute in Nishio City, Aichi Prefecture, has been working on a project to effectively utilize the limited resources of young eels. As one of the solutions, the group aimed to grow eels to twice their usual size, enabling one eel to provide two servings of grilled eel. By adding soy isoflavones to the feed during farming, they have successfully managed to feminize nearly 100% of the farmed eels, and have established a method to produce tender and delicious

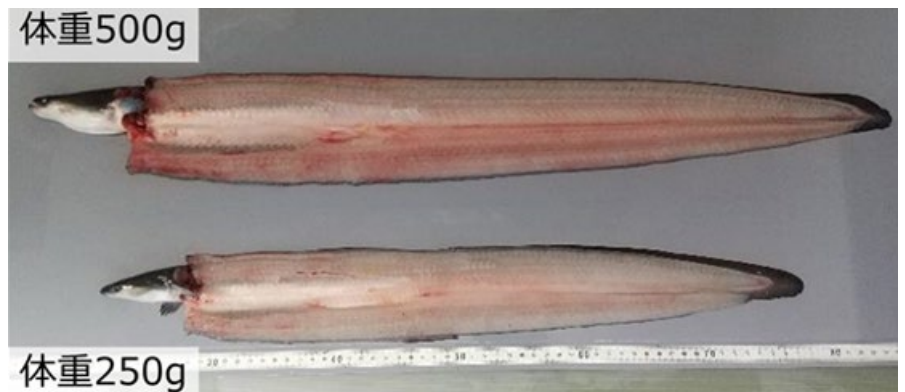


Photo 2: An eel grown to twice the normal size (top), compared with one of conventional size (bottom) (provided by Aichi Fisheries Research Institute)

eels that can grow to twice the usual size (weighing 400-500g cf. Photo 2 and 3).

### Succeeding in Raising Feminized Glass Eels

Japanese eels are not sexually differentiated while they are still young (glass eels weighing less than 0.5g). As they grow and reach a length of 30-35 cm or more, it becomes possible to distinguish between males and females.

More than 90% of farmed eels turn out to be male, and the reason for this gender bias during the farming process is not yet understood. Female eels are valued for their higher quality, as their flesh tends to stay tender even when they grow larger compared to males. Therefore, to farm large, tender eels from which two servings of grilled eel can be cooked, one approach is to produce as many female eels as possible.

So, how can we increase the ratio of females? The research group turned their attention to soy isoflavones. Isoflavones, which are abundant in soybean germ, have a chemical structure similar to estrogen, a female hormone. They are also contained in tofu and miso.



Photo 3: Large female grilled eel (above) and regular one. One large female eel, which is twice the size of a normal one, can make two servings (provided by Aichi Fisheries Research Institute)

By feeding eels a diet supplemented with these soy isoflavones during the period of sexual differentiation, nearly 100% feminization was achieved. Since the eels are fed with the isoflavone-supplemented diet only for a limited period until sexual differentiation, it has been confirmed that no isoflavones remain in the eels once they have grown to a size suitable for shipping. This new aquaculture technology was patented in November 2021.

The soy isoflavone product developed by the research group for addition to the feed started sales in May 2022, and a brochure explaining how to feed the soy isoflavone product to eels has also been published. The soy isoflavone product was initially used in Aichi, Mie, and Shizuoka prefectures, then sales began nationwide in December 2023. It is expected that its use will spread to aquaculture operators in various prefectures in the future.

### **Branding and Dissemination**

In Aichi Prefecture, a public competition was held in autumn 2023 to name and design a logo for this large female eel, with the results announced on January 12, 2024. The brand name chosen was “AOI Unagi”, a play on the initials of “Aichi-no (Aichi’s), Ookina (large), Olshii (delicious) Unagi (eel)” and a tribute to Tokugawa Ieyasu, a famous Shogun in Edo period who was born in the Mikawa region of Aichi Prefecture, where eel farming is thriving, and used the leaves of Aoi (hollyhock in Japanese) for his family crest.

From January 27 to February 12 in 2024, a limited-time sale of grilled Aoi Unagi was held at three stores in Nishio City, Aichi Prefecture, directly run by the fisheries companies and cooperatives which have cooperated with this research and product development, including the Isshiki Unagi

Gyogyou Kyoudou Kumiai (Isshiki Eel Fisheries Cooperative Association). Each store offered 20 servings per day. Customers who tasted it commented that it was “large and tender” and “well-fatted”.

Yuzumi Toda, the representative of the research group at the Aichi Fisheries Research Institute, said, “The project has reached a milestone. Soy isoflavone products are now on the market, and large female eel production by eel farmers has begun. First, we want many people to know its deliciousness and hope this will lead to an expansion of the production.”

For the fiscal year 2024, the Fisheries Cooperative Association is aiming to produce 1.5 to 2 tons (about 4,000 eels), which is 1% of their annual production volume (150 to 200 tons).

**Applying to Sturgeon**

Research is also underway to apply this technology to other species of fish. Caviar, known as a luxury item, is made from sturgeon eggs, so the goal of the research is to feminize as many farmed sturgeons as possible. Associate Professor Shigeho Ijiri of the Graduate School of Hokkaido University said, “It is certain that we can induce genetically male sturgeons to become female with soy isoflavones, and at present, we believe the rate of induction is about 80%.” It seems that it will still take some time for domestically farmed caviar to become widely available, but we can expect that one day, luxury caviar will become a little more accessible to consumers.

URL for the "Short Read: Intro to Tech Achievements" series:  
<https://www.naro.go.jp/laboratory/brain/english/press/stories/index.html>

This research project was applied to BRAIN’s “Research Program on Development of Innovative Technology” by the “Innovation platform for aquaculture industries,” which was organized in the “Field for Knowledge Integration and Innovation,” a mechanism for interdisciplinary fusion and industry-academic collaboration operated by the Ministry of Agriculture, Forestry and Fisheries.

URL for “Field for Knowledge Integration and Innovation:”  
<https://www.knowledge.maff.go.jp/en/fkii.html>

Project name	Research program on development of innovative technology (development stage)
Project period	FY2018-2020
Title	Establishment of Technologies of Eel Feminization and Production of Large Female Eels with Superior Taste
Leading research institutes	Aichi Fisheries Research Institute (representative institution), Kumamoto University, Hokkaido University, Kyoritsu Seiyaku Corporation

Research management organization	Specified Non-profit Organization for the Research and Development of Advanced Biotechnology in Tokai Region
Contributing institutes	Isshiki Unagi Gyogyou Kyoudou Kumiai (Isshiki Eel Fisheries Cooperative Association)

Project name	Research program on development of innovative technology (applied research stage)
Project period	FY2021-2023
Title	Establishment of Production Technology for Large Female Eels with Superior Taste and Application of Feminization Technology to Sturgeons
Leading research institutes	Aichi Fisheries Research Institute (representative institution), Kumamoto University, Hokkaido University, Kyoritsu Seiyaku Corporation, Fujikin Incorporated
Research management organization	Specified Non-profit Organization for the Research and Development of Advanced Biotechnology in Tokai Region
Contributing institutes	Isshiki Unagi Gyogyou Kyoudou Kumiai (Isshiki Eel Fisheries Cooperative Association), The Town of Bifuka, Hokkaido, The Town of Shikaoi, Hokkaido, Shibetsu Salmon Museum, Yamada Suisan Co., Ltd., Kanemitsu-Tansuigyo Inc., Mikawatansuigyo Inc., Nosan Corporation, Kaburaya Group Co., Ltd.