

Eyestalk tag



Juveniles

Recently it has become possible to raise parent prawns in an ashore tank with tens to hundreds square meters, and in such facility the producers can raise juvenile prawns (or cultured prawns) to spawners during one year for egg collection. But the number of parent prawns is restricted by the size of the tank. For maturation of prawns, a specially prepared tank, i.e. sand spread on the bottom with feeding enough sand worms. An outdoor pond and an ashore tank have both advantages and disadvantages for producing parent prawns, and better ones should be chosen considering the scale of the existing facility and the number of parent prawns necessary for juvenile production. The artificially produced juvenile prawns are used both for aquaculture and for release into the sea. Since genetic problems should be well considered in production of juveniles for release into the sea, eggs for this purpose are now collected from the wild prawns caught in the sea area for releasing.

The FEIS of the Fisheries Research Agency is working to develop the technology of egg collection from wild prawns using the technique inducing maturation and collecting eggs from cultured prawns. It has been considered difficult to deal with wild prawns because they may be infected with viruses and their mortality rises after eyestalk excision. But, the study conducted by the Stock Enhancement Technology Development Center, National Research Institute of Aquaculture, in Kamiura, Saiki, Oita Prefecture, showed that the prawns caught in April to June had a lower rate of virus infection. Thus, it is possible to control viral diseases by collecting eggs from the individuals caught in these months.

In cultured prawns, eyestalk excision and the use of sand worms as feed have been found effective in promoting the maturation of wild prawns. It was discovered that the mortality of wild prawns after eyestalk treatment could be reduced by tying up the eyestalk with thread or burning it off with heated tweezers instead of direct cut off. We conducted maturation inducement tests for wild prawns and found the rate of appearance of mature individuals, spawning individuals and hatching being similar to those observed in cultured parent prawns with treatments previously described. Therefore, it will be quite possible to use wild prawns at the juvenile production stations in the future. For the maturation and spawning of prawns, the development of techniques has preceded the study of the mechanism of maturation and factors needed for maturation inducement. As this study is advancing, more technologies for raising parent prawns and for collecting eggs on a scientific basis, those are also generally useful for practical producers, will be discovered and established.

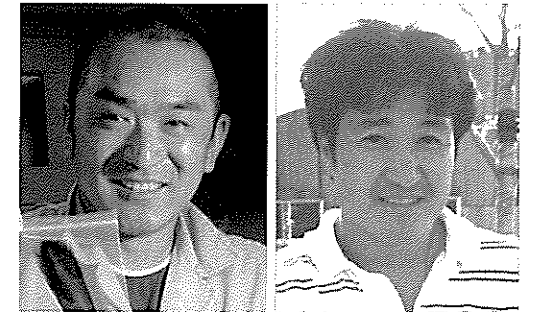
Special Articles

Success in Catching Breeding Eels in The Spawning Areas First in The World

—産卵場海域でウナギ親魚の捕獲に世界で初めて成功—

By Hiroaki KUROGI 黒木 洋明 (Left)
and Seinen CHOW 張 成年

Coastal Fisheries and Aquaculture Division,
National Research Institute of Fisheries Science,
Fisheries Research Agency,
(独)水産総合研究センター 中央水産研究所 浅海増殖部



*In the investigation on catching breeding eels conducted on the Kaiyo Maru, the fisheries research vessel of the Fisheries Agency, using a large midwater trawl net in the Pacific Ocean west of the Mariana Islands, which was thought to be the spawning waters of the eels, two mature male Japanese eels (*Anguilla japonica*) and one giant mottled eel (*A. marmorata*) were successfully caught on June 3 and 4, 2008 and two post-spawning female Japanese eels, on August 31, 2008. This was the first time that adult eels were caught in the spawning areas of anguillid eels and was an achievement that might lead to the elucidation of the migration route and spawning ecology of eels, which up to now have been totally unknown.. In addition, information on these breeding eels is expected to contribute to the production of larval eels in good-quality and improvement in artificial induction of maturation.*

1. Introduction

A total of 18 species of freshwater eels that belong to the genus *Anguilla* in the family Anguillidae are known in the world. All of these species conduct catadromous migration: they grow in the river and go down to the sea, and spawn in the open sea; their hatched larvae are carried to the coastal waters by ocean currents, metamorphose into glass eels and go upriver. Many of the eel species are important to fisheries: the European eel (*Anguilla anguilla*) has long been eaten in Europe and the aquaculture of Japanese eel (*A. japonica*) flourishes vigorously in Japan, Taiwan and China.

Eel is a familiar fish among Japanese, but its ecology has lots of mysteries. Search for the spawning grounds of eels were carried out by seeking smaller-size larvae, and it was found over 80 years ago that the spawning sites of European eel (*A. anguilla*) and American eel (*A. rostrata*) were in the Sargasso Sea (Schmidt, 1923). Then in the 1990s, it was reported that Japanese eel had its spawning grounds in the sea west of the Mariana Islands (Tsukamoto, 1992). Also, the larvae of Japanese eel presumed to be several days after hatching were collected in the sea west of the Suruga Seamount in the West Mariana Ridge. It has been assumed that Japanese eel spawns in considerably narrow sea areas near a seamount

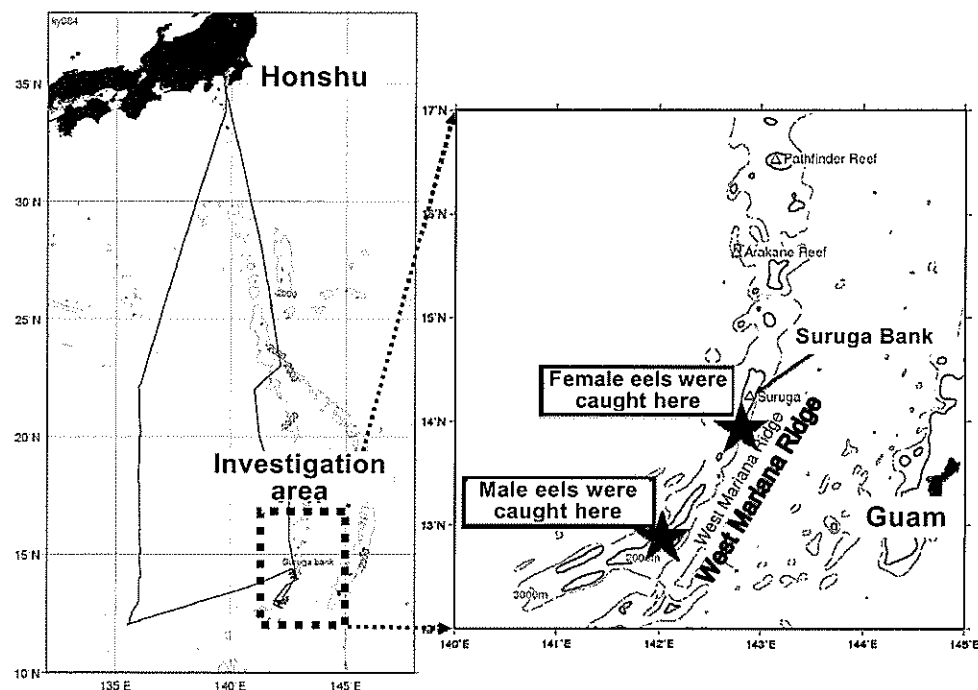


Fig. 1. Sea areas for the investigation on the spawning grounds of eels

(Tsukamoto, 2006). But no eel eggs have been caught in the ocean and no adult eel, including adult Japanese eel, have been found in the open sea. It is still unknown how closely the spawning of Japanese eel is related to a seamount and whether the spawning site differs according to the season and the year. Neither the water depth in nor the water temperature zone at which the spawning takes place, nor the water depth where hatched larvae are distributed have been found yet. From fall to winter, the eels that have gone down to the sea are sometimes caught by encircling nets, etc. in the coastal waters of Japan; but the route that they follow after going down to the sea to reach the spawning area are not known at all.

The juveniles of Japanese eel, that is, glass eels, have remarkably been decreasing recently, which has seriously affected the eel aquaculture business totally dependent on natural glass eels. A similar phenomenon has been observed for European eel, too, resulting in the policy for controlling the export of glass eels. Being anxious about the situation and in order to study the mechanism of eel propagation thoroughly, the Fisheries Agency and the Fisheries Research Agency started an investigation on the ecology of adult Japanese eels in the ocean, about which a lot is still unknown..

2. Outline of the investigation on the ecological investigation of spawning grounds of eels

The investigation was conducted by two cruises of the Kaiyo Maru (Fisheries Agency), a 2,630-ton fisheries research boat (captained by Captain Nobuyuki Nagai and carrying 39 crew members). The first leg was from May 20 to June 15, 2008 and the second one, from

August 20 to September 11, 2008. The researchers on board totaled 15: Chow and Kurogi, the authors of this article, serving chief researcher of the first and second leg, respectively; six researchers from the FRA (Shunji Kaji, Makoto Okazaki, Tadao Jinbo, Hiroshi Hashimoto, Hideyuki Shibahara and Masakazu Takahashi); Associate Professor Noritaka Mochioka and four students (Atsushi Tawa, Saeko Koga, Kohei Uno and Naoko Murakawa) at Kyushu University; and two people from the Ocean Research Institute of the University of Tokyo (Associate Professor Jun Aoyama and Researcher Akira Shinoda).

The investigation was carried out in the sea areas west of the Mariana Islands over 2,500km south of Japan situated in the exclusive economic zone of the United States. The sea area for the investigation was the area south of the West Mariana Ridge where the Suruga Bank, considered to be the spawning grounds of eels (Tsukamoto, 2006), is located (Fig. 1). It was decided that large midwater trawl nets would be used to catch breeding eels, and the surface water and midwater trawl nets developed for investigations on Pacific saury (made by Nichomo Co.; largest opening: 50m×60m) were towed in the sea 150-500m deep for 1.5 to 5 hours. In order to collect the eggs and younger larvae of eels, the investigation team also conducted studies on their collection in and around the sea areas where breeding adult eels were being searched for.

3. First Mature male eels caught in the world (first leg)

The investigation team selected the sea around the Suruga Bank (14°N. and 143°E.) as the first study site according to the theory of Tsukamoto (2006) and towed the net there from May 28 to June 1, 2008; however no eels were caught. In the small seamount southeast of the Suruga Bank, there were some strong reactions on the fishfinder that suggested the existence of groups of spawning eels, but the identification work showed that the groups were not those of eels. Thus, the team left the Suruga Bank and went southward up to the vicinity of the southern tip of the West Mariana Ridge (13°N. and 142°E.), where it towed the midwater trawl net nine times from June 2 to 9. In the two-time towing on June 3 and 4, the team finally succeeded in catching three male eels (Fig. 2) (Chow *et al.*, 2009). The analysis of the DNA revealed that the two smaller individuals (total length: 48.5cm and 51.3cm) were Japanese eel (*A. japonica*) and the largest one (total length: 62.3cm) was a giant mottled eel (*A. marmorata*). All of the three individuals had well-developed testes (Fig. 2), and their gonad somatic index (GSI: ratio of the weight of the gonad to the body weight in %) ranged from 13.4 to 18.8, which was higher than that of the eels whose maturation was artificially induced by giving hormones to them. The water depth where the eels were caught in the net was estimated at 230-300m, and the water temperature in these depths was 14-20°C.

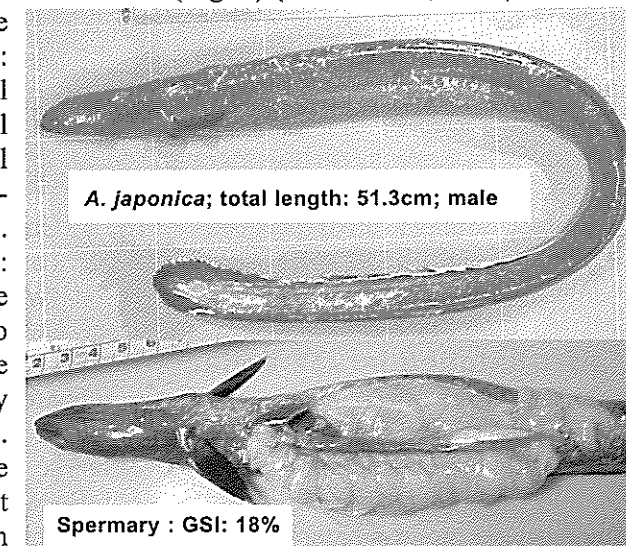


Fig. 2. Mature eel caught first in the world

The sea area in which the eels were caught was on the West Mariana Ridge where the water depth is as great as 1,200-3,000m. Thus it was supposed that eels lived not on the slope of the seamount or on the ocean bed but in the middle layers of the ocean. In addition, the sea area where the eels were caught was as distant as about 130km from the nearest seamount, which suggested that eels did not always spawn only in the sea area near a seamount.

4. Post-spawning female eels caught (in the second leg)

Midwater trawl investigations were carried out in the sea area where the mature eels were caught (Fig. 1; about 13°N. and 142°E.) during August 25 to 30, 2008, but the investigation team was unable to catch any eel. Considering that they should change the sea area for investigation, the team moved, on August 31, northward by about 100km along the West Mariana Ridge. At 20:51 on that day, they started to tow the net in the course crossing the Ridge from the point 14°00'N. and 142°52'E. (Fig. 1; about 30km south of the Suruga Bank) (ocean floor depth: 1,600-3,500m) in a northwestern direction. The mid water trawl net was towed twice, first for two hours and 30 minutes in the layers 180-230m deep and

second for two hours and 30 minutes in the layers 180-230m deep (for five hours in total), and two *Anguilla* individuals (total length: 55.5cm and 66.2cm) were successfully caught (Fig. 3). Because both of the eels were caught not by the cod end but

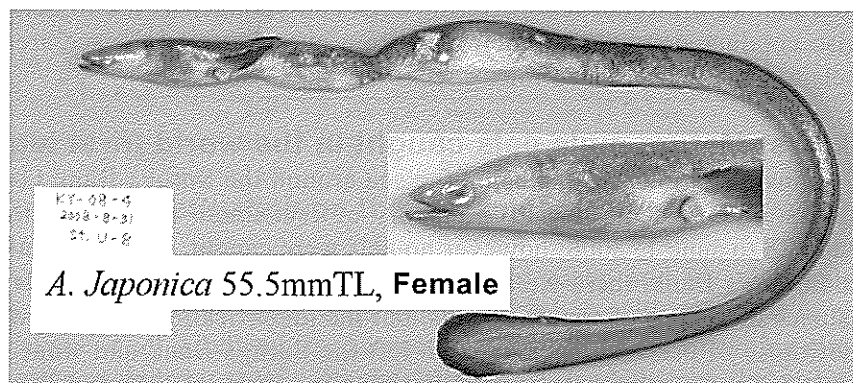


Fig. 3. Post-spawning female eel caught

by the main body of the net where the meshes are larger, it was assumed that they had lost any great ability to swim when they were caught. Both of the two individuals were identified as females by the DNA analysis and the histological observation of the gonad. They had almost no eggs left in their abdominal cavity and were thus thought to have finished spawning.

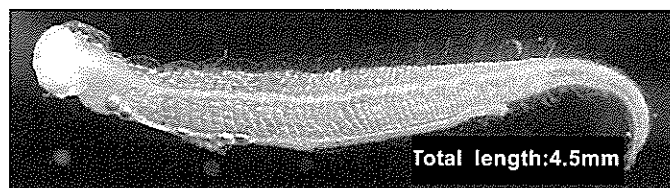


Fig. 4. Eel larva at the preleptocephalic stage (preleptocephalus) presumed to be two to three days after hatched

5. Just-hatched larvae collected

In the sea area near the course where the midwater trawl net was towed and the two female eels were caught, the investigation team carried out a plankton net study on September 2 and 3, 2008. In this study, at least 31 eel larvae (preleptocephalus; Fig. 4), estimated to be 2-5 days after hatching, were collected. Because both the female breeding eels after spawning and the just-hatched larvae were caught in the sea area for the investigation, it is almost certain that the sea area was a spawning site of eels. In addition, five individuals of

the larvae were caught by a plankton net capable of performing stratified collection, and the water depth of distribution of eel larvae was identified as a range of 100-150m. The water temperature of the water depth zone was 26.5-28.0°C; this was the first time when the water temperature suited for the life of just-hatched eel larvae was found.

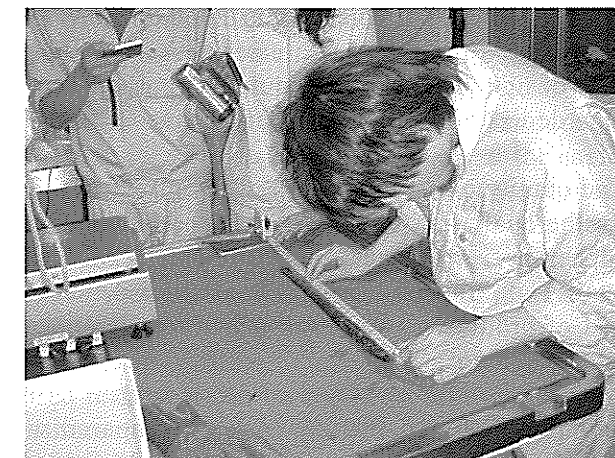
6. Meanings of the investigation results and future tasks

Numbers of Natural glass eels are decreasing, and it has thus been greatly hoped that glass eels cultured using artificial larvae will be supplied. The research group composed mainly of researchers from the FRA's National Research Institute of Aquaculture continued studies steadily and succeeded in rearing the fertilized eggs obtained from breeding eels whose maturation was artificially induced into glass eels. But at present, the survival rate of these glass eels is so low that it is difficult to expand artificial glass eel production to an industrial scale. Thus considerably improving the survival rate is the most important goal, and it will be very meaningful that "natural" breeding eels and larvae, which can be regarded as the ultimate models of artificial juvenile production, were caught in the spawning sea area. The information on the environment of the sea area where the breeding eels were caught and the information on the ecology and physiology of eels obtained by the analysis of otoliths, gonads, etc. are considered very important to the culture of good-quality breeding eels for the purpose of producing artificial juveniles. In addition, the data on water depth and temperature of the area where the just-hatched larvae lived will contribute to the optimization of the environment for cultivating eel larvae.

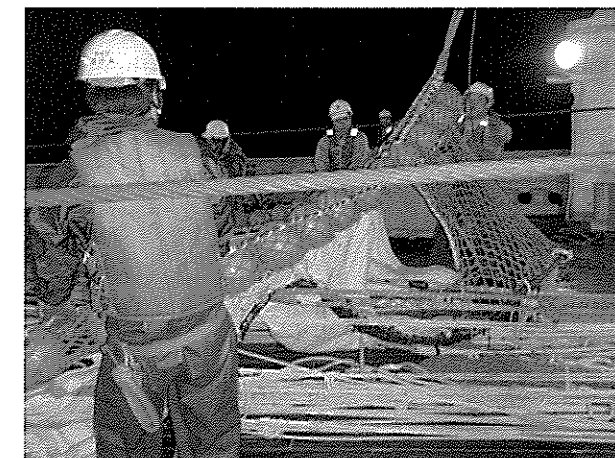
Only four Japanese eels were caught in the investigation, and the future task is to get the most possible information from these eels by conducting various types of analyses. The investigation also showed that it is possible to catch breeding eels using a midwater trawl net. If we continue our investigation in the years ahead, we will be able to catch breeding eels at the growth stages not yet obtained, such as pre-spawning female eels, and to get more information about eels.

References

- Schmidt, J. (1923) Nature 111:51-54.
- Tsukamoto, K. (1992) Nature 356:789-791.
- Tsukamoto, K. (2006) Nature 439:929.
- Chow, S. *et al.* (2009) Fish. Sci. 75:257-259.



Measurement work



Trawling