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Success of Artificial Seedling Production of the Japanese Eel - World's First Production Using Closed Recirculating Aquaculture System in Inland Area [1)] -

We report the succession of artificial glass-eel's[2)] production using "closed recirculating aquaculture system" (CRAS) in an inland area (See Figures).

Eel farms use natural glass-eel, which migrate up the river as the seedlings[3)] in winter and spring seasons. However, the decline in number of glass-eel has become a serious problem for resource development in the eel-farming industry. Moreover, the uncertain routes of eel distribution to the consumers have been identified as a social problem in Japan. For overconsumption, the Japanese eel was assigned as an endangered species on the International Union for Conservation of Nature's Red List of Threatened Species in 2014. Therefore, there are now strong calls for the development of a large-scale artificial seedling production technology for the Japanese eel.

Within these difficult times, our company has succeeded in production of the artificial glass-eel of Japanese eel (*Anguilla japonica*). Japanese eel's adult habitats are all over Japan, and thus has been a main-stay in Japanese dining for centuries. In the 2000s, there was success in growing glass-eel of Japanese eel from hatched larvae, artificially. But, the success cases were limited to the sea-side facilities due to the need of natural seawater for the preservation of aquaculture. In the sea-side facility, the coastal water involved taking risks, for example, red tide, and disease-producing bacteria and virus problem. The breeding system at the sea-side facilities needed continuous sea water pouring down the drain into the breeding tank, and the high running cost for maintaining the water temperature becomes costly. These issues made it difficult for the sea-side facility which requires large amount of non-contaminated sea water to successfully expand into production of artificial eel seedlings.

On the other hand, our CRAS is different from previous methods for seedling production.

For example, 1) it does not require natural sea water; 2) it is much simpler to maintain the breeding tank due to low risk of contamination from disease-producing bacteria, 3) while keeping the cost of maintenance of breeding water temperature low by using recycling water. Our CRAS is the infrastructure technology of land-based seedling production, which we can expect to be the future direction for artificial glass-eel`s production. Our company established the study section for seedling production of Japanese eel in 2014, and we have established and solidified the repeatability of previous glass-eel's production technology and the low-cost seedling production technology. In this study, we developed CRAS for Japanese eel larvae. Using our CRAS, good fertilization rate and the growth rate of leptocephali[4)] were realized to be the same compared to the previous studies. In our recent study, the survival rate was about 70% at 30 day post hatching, and some of them have metamorphosed into glass-eels. In the future, based on our technology, we will expand the scale of artificial glass-eel`s production plan and establish ways to improve each section of our technology. Moreover, for the development of eel farming, we will continue to cooperate with the local farms and plan to establish the seedling production business as stable supplier of artificial glass-eels.

Remarks :

1) Closed Recirculating Aquaculture System (CRAS):
   The system makes reduced discharge of detoxify harmful waste products and a filtering (biofilter) system purifies the water of uneaten feed. The benefits of CRAS are 1) fewer burdens to the environment, 2) ease of recovery of thermal energy, 3) aquaculture facility is not required to be by the sea-side, 3) geothermal energy may be used, and etc. It enables breeding of fish at lower cost than previous methods.
2) Glass-eel: See Figure 3
   Eel larvae about 60mm in total length migrates Japan's seacoast. Almost all migrating glass-eels on the Japanese coast are Japanese freshwater eel (*Anguilla japonica*). Migrating season is winter and spring in Japan. Catching glass-eels with a lamp on the sea breaker zone in winter season of Japan is famous. During the duration of migration, it is called `glass-eel` because due to lack of pigmentation and thus is a transparent fish. Once migrating into the river, the pigmentation progress advances.
3) Seedling:
   It is indicated as larva, juvenile and/or young fish. Eel farming uses glass-eels as seedlings. Currently, the seedling used for eel farming is natural glass-eel caught at the mouth of the rivers, and currently, the artificial glass-eels are not used for eel farming.
4) Leptocehali: See Figure 1 and 2
   It is called Anguilliformes larvae, Elopiformes larvae, and etc. Leptocephli has a leaf shape and is transparent. Artificial larvae start to metamorphose once it reaches over 50

mm total length. The starting date of metamorphosis differs among each larva, but artificial larvae normally starts to metamorphosis between 5 months and over half year after hatching. While metamorphosing, the body length and height regresses and gradually transforms into the eel shape.

Figures：

Figure 1. Hatched larvae and fertilized eggs.

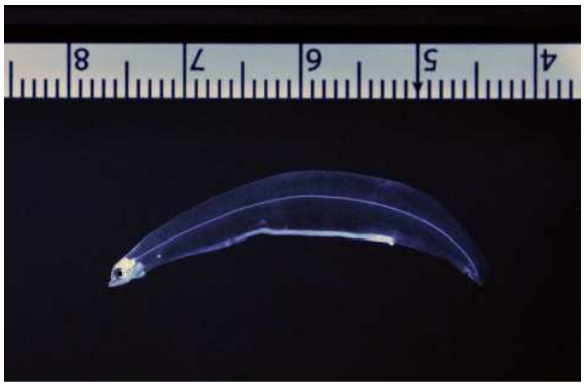

Figure 2. Artificial leptocephali. 120 days post hatching.

Figure 3. Artificial glass-eel. 156 days post hatching.