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[Introduction]

Four scombrid fishes have been spawning in the oceanic fishes exhibit tank at Tokyo Sea Life Park. I had presentation “Overview of husbandry and spawning of Bluefin tuna in the aquarium at Tokyo Sea Life Park” in the last IAC in Shanghai. Today I present the outlines of rearing those four species observed during 2007 to 2010.

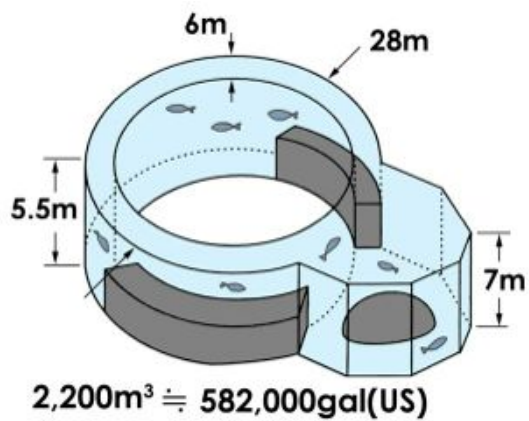
2



This is the exhibit tank looks like.

Currently, we have a total of about 200 fishes of Bluefin Tuna, Skipjack Tuna, Kawakawa, and Striped Bonito on display.

3



This diagram shows the overview of the exhibit tank.

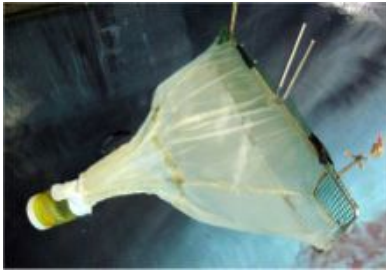
It has a partially expanded doughnut shape, and has the total volume of 2,200m<sup>3</sup>.

Basically, we feed them once a day. We feed Japanese Jack Mackerel, Sardines, Squid and such.

The system receives a One-Third water change every two to three weeks.

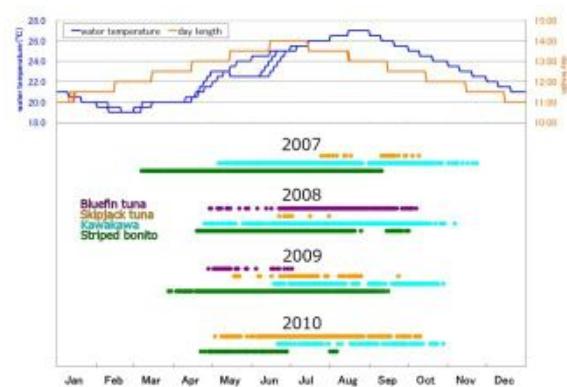
We stimulate a seasonal change by adjusting water temperature and lighting period.

4



To collect eggs, we set the collecting net at the water surface in the evening. All 4 species' eggs are free pelagic eggs, and will surface after spawn. The tank has a weak flow, so, the scattered eggs will be flowed into this net.

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The spawning status in 2007 to 2010 are as follows.

The horizontal axis shows the time period of 12 months.

The yearly water temperatures and daylight hours are shown in upper section. The blue lines are the water temperature, and the orange line is the daylight hours.

The dots in the lower section show the spawning dates. The purple dots are Bluefin Tuna's, the orange dots are Skip Jack Tuna's, the light blue dots are Kawakawa's, and the green dots are Striped Bonito's.

In each year, you can see the Striped Bonito spawning (Green dots) began in March and April.

In 2008 and 2009, Bluefin's purple dots shows the spawning starts at the end of April.

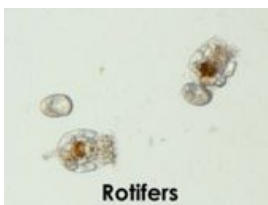
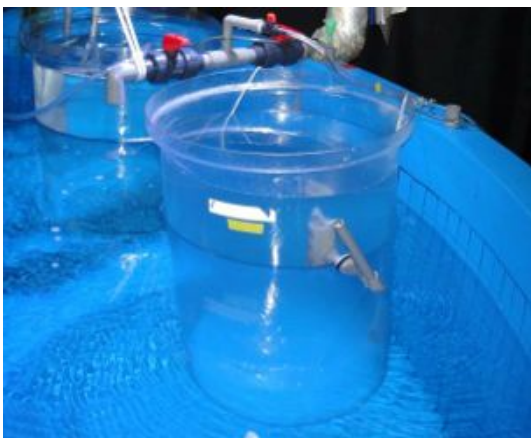
6



This is the tank we used for rearings.

The 30L tank was used for eggs hatching, and the 200L Artemia hatching tank was used to start rearing the larvae.

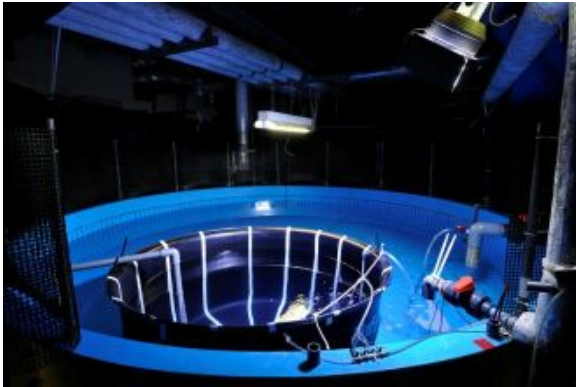
7



The 100L tank was used when we start rearing the Skip Jack Tuna.

Rotifers were used as the initial food source. And, The food series is shown.

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Larvae were moved to the 500L tank after they started feeding on Japanese anchovy larvae. Then, we transferred them to 5m<sup>3</sup> tank when the 500L tank got too small.

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The 50m<sup>3</sup> tank was also used for the grown Striped Bonito.

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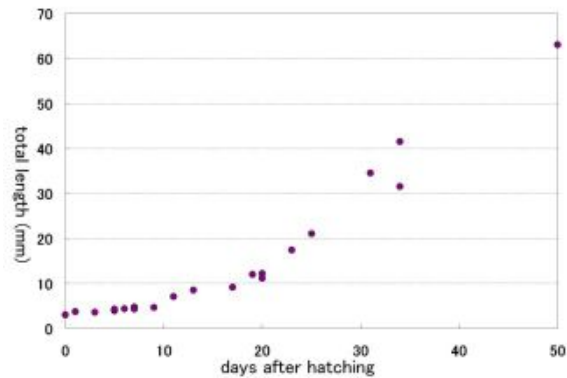
This image shows the 4 species of nearly hatching eggs and hatched larvae.

The black line on the bottom right indicates 1mm.

Among the 4 species, Striped Bonito egg is slightly larger. Its egg diameter is approximately 1.3mm while the other 3 species' egg diameters are about 1mm.

In all 4 species the mouths are closed and have the yolk sacs at the time of hatching.

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This is the graph shows the Bluefin Tuna development.

The horizontal axis is the days after hatching. The vertical axis is the total length.

TL is 2.98mm right after the hatching.

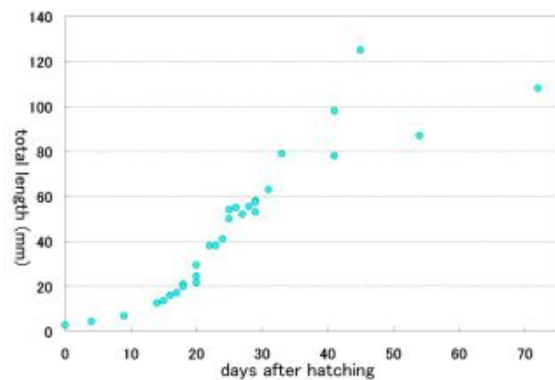
after 3days. The larvae started feeding on the rotifers.

after 9days. The larvae feed on Artemia nauplii.

They started feeding on the hatched larvae given as foods after 18days..

63mm after 50days. This is the end of the trial.

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This is the graph shows the Kawakawa development.

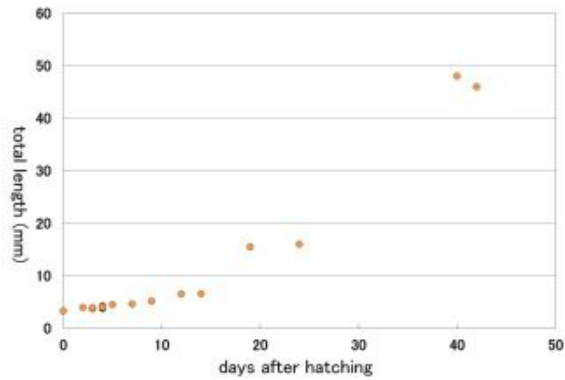
TL is 2.83mm right after the hatching.

The larvae started feeding on the rotifers after 3days, and on Artemia after 5days.

They started feeding on the hatched larvae given as foods after 10days..

125mm after 45days. This is the end of the trial, and it was the maximum individual in this trial.

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This is the graph shows the Skipjack Tuna development.

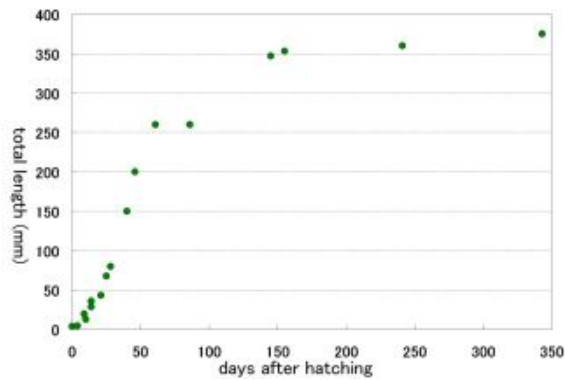
TL is 3.27mm right after the hatching.

after 2days. The larvae started feeding on the rotifers.

after 7days. They started feeding on the Artemia.

46mm after 42days. This is the end of the trial, and it was the maximum individual in this trial.

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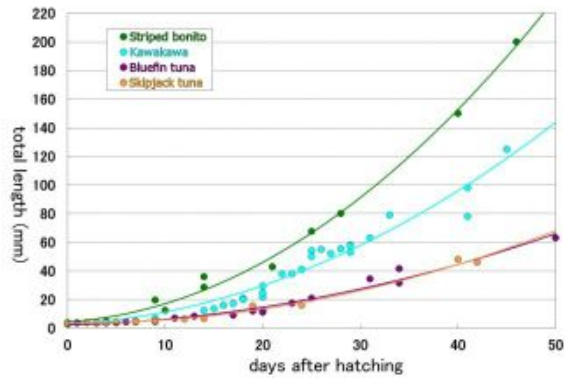
This is the graph shows the Striped Bonito development.

TL is 3.62mm right after the hatching.

TL is 4.64mm after 4days. Observed to prey on one another.

We were able to rear for 343days, 375mm in TL.

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This is the graph combined the developments of the 4 species until 50 days of hatching. Striped Bonito development was the fastest, and Kawakawa was the second. Bluefin Tuna and Skipjack Tuna were about the same.

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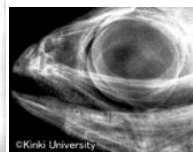
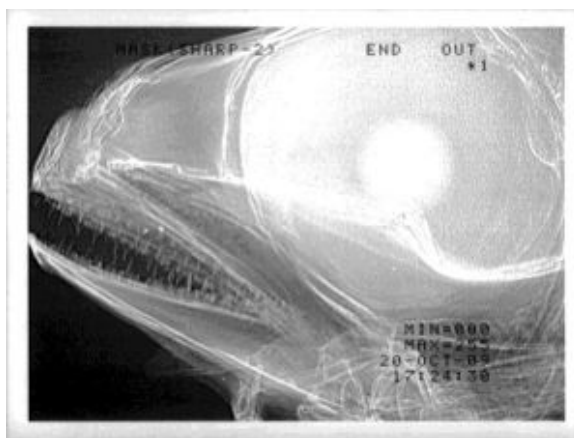
[Video image]

In Skipjack Tuna, hiding behavior was observed which the other 3 species didn't show.

This is the video footage of the larva 19-days-old.

The fish showed a behavior of hiding in and out of the strainer pipe's in the tank.

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This is the picture of a Bluefin Tuna.



It lived for 50days and the TL reached to 60mm.

In Bluefin Tuna and Kawakawa, we observed some cases of sudden deaths even the fishes were feeding within a few hours.

Collision into the wall was suspected as the cause, and a soft x-ray picture was taken to observe the bone structures.

This is the x-ray of the head area. Let' s take a close up look.

This elongated bone is a parasphenoid bone. Normaly, Bluefin Tuna has a straight parasphenoid bone, but in this case, this part is bent.

It is broken. We have taken the soft x-ray pictures on 2 Bluefin Tunas, 4 Kawakawas, 2 Skipjack Tunas. All specimens showed a parasphenoid bone or other bone damage.

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[Result]

We were able to raise a Bluefin tuna to 63mm in TL, 50days after hatching. Kawakawa to 125mm, 45days after hatching. Skipjack tuna to 46mm, 42days after hatching. and Striped bonito to 375mm, 343days after hatching. Striped bonito grew most quickly among the 4 species.

Skipjack tuna showed a hiding behavior which wasn' t observed in the other 3 species. Sudden deaths were observed, and abnormal deformations of their bones were recognized by radiographs. The collisions in to the wall were suspected.

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Currently, we have made a modification to prevent the wall collision in the 50m<sup>3</sup> tank I showed previously. Hopefully we can show you our house bred adult Bluefin Tunas in the near future.

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This is the end of my presentation.

Thank you very much.