

PRESENT STATUS OF MARICULTURE STUDY IN JAPAN FOR TUNA SPECIES

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ABSTRACT

— The study of mariculture of tuna species started in 1969 in Japan. There have been two types of trial employed. For this (1) after stripping the eggs from naturally mature adults and artificial fertilization, the newly hatched larvae were reared indoor tank (2) on-growing of juveniles in net cages after collecting them from the open sea.

In the initial stage of research neither of the two types of trial was very successful, but year by year the technology has improved and at this time success has been achieved with several species.

In this paper recent research results are reported in details for four species—yellowfin tuna *Thunnus albacares*, bonito *Sarda orientalis*, frigate mackerel *Auxis tapeinosoma* and *A. thazard*. Bluefin tuna *Thunnus thynnus* not be successful owing to no getting mature eggs.—

STATUT ACTUEL DES ETUDES DE MARICULTURE  
 DES THONIDES AU JAPON

Les études de mariculture des espèces de thonidés ont commencé en 1969 au Japon. Il y a eu deux voies de recherches :

- (1) Après obtention d'oeufs de géniteurs naturels et fertilisation artificielle, les larves sont élevées en bassins.
- (2) Les juvéniles collectés dans l'océan sont mis en grossissement en cages flottantes.

Au départ, aucune des deux voies n'a bien réussi. Mais, au fil des ans, la technologie s'est améliorée et actuellement, plusieurs espèces marchent bien.

Dans ce papier, les résultats des recherches récentes sont décrits en détail pour quatre espèces : *Thunnus albacares*, *Sarda orientalis*, *Auxis tapeinosoma* et *A. thazard*. Pour le thon rouge *Thunnus thynnus*, le manque d'oeufs a empêché d'aller bien loin.

MOTS-CLES : Mariculture - Japon - *Thunnus albacares*, *Auxis tapeinosoma*, *Auxis Thazard*, *Thunnus thynnus*.

KEY-WORDS : Mariculture - Japan - *Thunnus albacares*, *Auxis tapeinosoma*, *Auxis Thazard*, *Thunnus thynnus*.

## INTRODUCTION

The study of mariculture of tuna species started in 1969 in Japan. There have been two types of trial employed for this : (1) after stripping the eggs from naturally mature adults and artificial fertilization, the newly hatched larvae were reared indoors in tanks ; (2) ongrowing of juveniles in net cages after collecting them from the open sea.

In the initial stage of research stage of research neither of the two types of trial was very successful, but year after year the technology has improved and at this time success has been achieved with several species.

### I. ARTIFICIAL FERTILIZATION AND INDOOR REARING IN TANKS

Artificial fertilization takes place after stripping the eggs from naturally mature adults caught in the open sea. The fertilized eggs are transported to the laboratory and the newly hatched larvae are reared in tanks and fed on food micro-organisms under suitable rearing conditions. Up to now, four species have been successfully reared up to a body length of several cm using this method. These species are yellowfin tuna *Thunnus albacares*, bonito *Sarda orientalis*, frigate mackerel *Auxis tapeinosoma* and *A. thazard* but bluefin tuna *Thunnus thynnus* has not been successful owing to the lack of mature eggs.

#### A. Yellowfin tuna *Thunnus albacares* (3.)

Following information received from purse seiners off the Kii Peninsula in July, (1) 1969, several researchers went out on these boats to collect eggs, and they were successful in collecting eggs from mature adults on 25th July. As soon as the eggs were stripped they were fertilized on board and were transported to Shirahama Fisheries Laboratory, Kinki University, and several other laboratories. Newly hatched larvae were reared indoors and fed on *Brachionus plicata* and marine copepoda. Larvae on hatching had a total length of 2.7 mm and achieved a length of 8.4 mm eighteen days after hatching.

Unfortunately, in the following five years it was not possible to experiment due to the lack of mature eggs. But on 28th July, 1976, mature eggs were obtained and fertilized on board and taken to Shirahama Fisheries Laboratory. Following these trials, the most suitable temperature for the development of the embryo was found to be 26 - 29°C. Suitable food for newly hatched out larvae was rotifer and marine copepoda in the early stages and later they were fed on small fish. After 38 days body length was 51 mm.

#### B. Bonito *Sarda orientalis* (8.)

The material for these trials was caught in set nets in Oshima, Kushimotocho, Wakayama Pref., and after stripping and fertilization on board the eggs were taken to the Shirahama Lab. The eggs had a diameter of 1.32-1.45 mm. They floated on the surface and had several oilglobules. They hatched out about 50 hours after fertilization in water at 20-24°C. The newly hatched larvae had a total length of 4.2 mm. They were fed on rotifer and copepoda and small, live fishes, frozen fish, etc. as they grew larger. Under good conditions they attained an average body length of 14 mm after 10 days, 74 mm after 20 days, 106 mm after 30 days, 219 mm after 40 days and 290 mm after 99 days. Individuals with a body length of more than 23 mm showed cannibalistic behaviour. After attaining this size they tend to attack other individuals slightly smaller than themselves, and survival of larvae decreased rapidly due to this. The growth of this species was found to be very rapid given suitable food and good environmental conditions.

#### C. Frigate mackerel *Auxis tapeinosoma*

Mature adults were caught in the same set nets in June, 1972, and eggs were stripped and fertilized and taken to Shirahama Lab. They were reared in indoors tanks up to a total length of 155mm. After this experiment, Shizuoka Pref., Tokai University and Far Sea Fishery Research Lab. carried out successful experiments with these species. Their method for rearing larvae was the same as at Shirahama Lab.

Mature eggs were 0.95-1.0 mm in diameter, and hatched out about 40 hours after fertilization in water of 23°C. The larvae which were fed on rotifer, copepoda and small fishes achieved normal growth. Under good conditions the newly hatched larvae, 3.5 mm in total length attained 49 mm in 18 days, and about 140 mm in 40 days.

#### D. *Auxis thazard*

Adults were caught in the same set net in May 1972, and after stripping, the fertilized eggs were taken to the Shirahama Lab. The eggs had a diameter of 0.93mm-0.98mm with one oil globule, and hatched out 30-54 hours after fertilization, in water of 21.4-23.5°C. The larvae were given the same diet of rotifer, copepoda and small fishes and from a total length of 0.34 mm on hatching they reached 64 mm after 17 days, 120 mm after 33 days, in a large aquarium under good conditions.

#### E. Other species

At this time experiments are being carried out using the same method with bigeye tuna *Thunnus obesus* and skipjack *Katsuwonus pelamis* but due to lack to mature eggs no successful experiments have been carried out for bluefin *Thunnus thynnus*.

The author has carried out experiments of hybridization with four species, frigate mackerel, bonito *Auxis thazard*, and little tunny *Euthynnus affinis* (female) hatched out about twenty two hours after fertilization in water at 24.8-28.7°C. Newly hatched larvae had a total length of 2.3 mm and reached 178 mm after 68 days. For tuna and related species the experimental method used has been successful, but it is not yet employed for large scale artificial production of larvae. There are two main bottlenecks : (1) the uncertain supply of mature eggs, (2) the low survival rate of larvae in indoor culture. Research is needed to secure mature adults for stripping using floating net cages in order to maintain a constant supply of eggs. Study of the most suitable foods and environmental conditions is needed to achieve good survival rates.

## II. ONGROWING IN FLOATING NET CAGES

The method used for ongrowing is based on that used for yellowtail *Seriola* culture. Trials for rearing tuna and related species up to commercial size have been carried out since 1969 at Mie, Nagasaki, Shizuoka, Kochi and Kagoshima Prefectural Research Stations, and by Kinki and Tokai Universities. The species used for these trials have been : bluefin, yellowfin, skipjack, bonito, little tunny, frigate mackerel, etc...

#### A. Bluefin tuna

Ongrowing of these species encountered many difficulties in the first several years, but survival rates have improved year by year with the improvement of the facilities used and in the handling of fish. Kinki University has successfully reared fish for five years in wire net floating cages.

Circular or octagonal floating cages having a diameter of 8-30 m were found suitable, but small size synthetic fiber net was not suitable due to high mortality caused by the net deformation and the necessity of requent net changes. In future, further improvement of culture facilities for oceanic species such as bluefin tuna is necessary.

In ongrowing trials under suitable conditions bluefin with a size of about 25 cm in total length, 0.23 kg in body weight were caught in the period August-September, and attained 50-60 cm, 2-3 kg, by December, 80-90 cm, 10-15 kg by December of the following year. A year later they had reached 100-125 cm, 20-30 kg and the fourth year 120-135 cm, 25-45 kg, and the fifth year 130-160 cm, 40-80 kg.

Food was anchovy, sand eel and jack mackerel for young tuna, and later raw, frozen sardine, saury, horse mackerel, etc.

The food efficiency was about 13-15 % for the first year and after that the efficiency tended to decrease year by year. It is very difficult to determine the exact efficiency due to the danger of damaging the fish during measurement, and therefore the above figures are only approximate. The actual feeding efficiency

for young and older tuna is just now under study.

High mortality occurs in the first month after placing the fish in net cages in the range of 13-58 % for fish caught in the range of 50-100 %. This is an important bottleneck for developing commercial tuna culture. The amount of young tuna available for culture caught in set nets is small but the amount caught by angling is much larger.

Therefore study of techniques for improving tuna angling is needed to increase the supply of young tuna for culture.

In order to study the ecology and physiology of this fish some were reared in ponds on land, and their resistance to poor environmental conditions and fundamental biology were studied in detail.

#### B. Yellowfin tuna

Since 1970, ongrowing experiments with this species have been carried out at Kagoshima Prefectural Fishery Laboratory and Kinki University Laboratory using juveniles caught in the open sea.

High mortality occurs during the first month while the fish are adapting to feeding and mortality also occurs during winter. The growth of this species is slower than that of the bluefin.

Young fishes attained 85 cm, 11 kg, after two years and four months of rearing. This result is half that of bluefin tuna in weight increase.

#### C. Other species

Bonito : in 1971, at Nagasaki Prefectural Fishery Research Station, and 1972, 1974, 1976 at Kinki University, experiments were carried out and the survival rate was higher than for bluefin.

Initial size was 40 cm, 0.67 kg and fish attained about 65 cm, 3 kg, after three years and three months.

Little tunny : studied at Kinki University Laboratory in 1974, and 1975. Mortality in the first acclimating period is very low, 3-17 %, and later mortality is also low compared to bluefin and bonito.

Skipjack : experiments carried out since 1975 and still under study at Kinki University Laboratory.

The author has carried out experiments for ongrowing with the above mentioned species in order to get mature adults and enough material for artificial fertilization in the near future.

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