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THE TUNA LIVE BAIT SCARCITY PROBLEM IN LAKSHADWEEP AND THE OPTIONS FOR SOLVING IT

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Introduction

It is well-known that one of the principal methods of catching skipjack tuna, *Katsuwonus pelamis* throughout the world is the pole and line fishing using live bait. The lack of adequate supplies of live bait is a major bottleneck for the development of pole and line tuna fisheries in Lakshadweep which is the only place in India where pole and line fishing is practised for catching tuna. The results of the recent live bait resource surveys at Lakshadweep indicated that year to year fluctuations in the availability and abundance of live baits is a natural phenomenon which is caused mainly by the variability in the recruitment of the various species into the lagoon environment. One of the options for solving the live bait scarcity problem is proper utilisation of the available resources by evolving imporved methods of capture, handling, transportation and holding of bait fish. The other alternative is to supplement the natural bait fish resources by culturing suitable species of live baits. The problem of live bait scarcity and the options for solving it are discussed in this communication.

The sources of information for this account are from published accounts by scientists of CMFRI who have worked on the live bait and pole and line fishery for tunas.

Live bait resource

The chief live bait resources of Lakshadweep Islands are reef associated fishes with localised distribution comprising sprats, pomacentrids, apogonids, atherinids and juveniles of caesionids. *Spratelloides delicatulus* is the only live bait extensively exploited currently for tuna pole and line fishery in the various islands of Lakshadweep except Minicoy. At Minicoy besides *S. delicatulus* other bait fishes are also collected. The live bait fishes can be classified into two major groups based on their habitat distribution patterns : (a) resident forms which have specific habitats and mostly in association with live corals, coral sand etc, attaining sexual maturity and spawning in the same habitat and (b) migrants that are recruited into the lagoon habitat, which may stay in the lagoon for short periods ranging from a few days to about two or three months at a time and emigrate as suddenly as they appeared inside the lagoon. The chief resident forms are *Chromis caeruleus, S. delicatulus, S. gracilis* and species of apogonids. The major migrant forms are *Lepidozygus tapeinosoma* and species of caesionids.

Live bait scarcity

The scarcity of live bait at Lakshadweep, often being reported in recent years can be attributed to four main reasons : (a) increased demand for bait fish (b) dependence on single species (c) fluctuations in the seasonal recruitment of migrant bait fishes and (d) environmental degradation. These are discussed below.

(a) ***Increased demand*** **:** Consequent on the mechanisation of pole and line fishing vessels, the mechanised fishing fleet increased from nine boats in 1963 to about 300 in the eighties. There is thus certainly a greater demand for live baits than in the past.

(b) ***Dependence on single species :*** In the various islands other than Minicoy only *S. delicatulus* is being exploited at present as live bait whereas the live bait resource surveys conducted by the CMFRI have proved that reasonable good quantities of live bait fishes of both migrant and resident forms belonging to pomacentridae, apogonidae and caesionidae are available around Agatti, Bangaram, Perumul Par, Suheli Par and Bitra which are the other major tuna fishing areas of Lakshadweep. The dependence of tuna fishery on a single species *viz. S. delicatulus* creates exploitation pressure and consequent scarcity of this species.

(c) ***Fluctuations in the seasonal recruitment of migrant species*:** The live bait resource surveys conducted by the CMFRI during 1986 - '87 indicated *S. delicatulus, S. gracilis, Rhabdamia gracilis, Chromis caeruleus* and *Caesio caerulaureus* to be the abundant species in the various islands and the resurvey conducted in 1988 showed that the caesionids *viz. C. caerulaureus* and *Pterocaesio chrysozona*, the apogonid *Ostorhynchus apogonides*, the sprats *S. delicatulus* and *S. gracilis* and the pomacentrid *Chromis caeruleus* were the only abundant species in the various lagoons. The catch rate and species abundance exhibited wide variations in both the surveys. These results indicate that year to year fluctuation in the availability and abundance of live baits is a regular feature. Variability in the recruitment and settlement of the different species in the lagoons could be the main cause for the year to year fluctuation. A homogeneous reef habitat will contain an assemblage of fishes which will be drawn from a pool of species capable of occupying that habitat. The relative abundance of a species at a particular period will be subject to large scale fluctuation depending mainly on the variability in production and survival of larvae, variable patterns of force and direction of water currents and variability in the precise microhabitat requirements of different species. Chance colonisation as well as habitat sharing also play significant roles in determining the community structure.

(d) ***Environmental degradation*:** Indiscriminate dredging and blasting of the coral reef habitat seem to have caused altered current patterns, resulting in siltation in the areas of coral growth and caused the death of coral colonies and the resident live bait species. At Minicoy lagoon, corals of all genera and species have suffered mass mortality during the past few years. The large number of *Acropora* thickets that formed the habitat of many live baits are dead and disintegrated. Excessive siltation as a consequence of blasting of the reef as well as dredging the lagoon is identified to be the major cause for this mass mortality. The environmental degradation deprives the bait species of the specific microhabitats to settle at the end of their post larval pelagic life.

Options for solving the live bait scarcity

(a) ***Better Utilisation of captured bait*:** Studies were conducted on eight species of common live baits of Lakshadweep namely *S. delicatulus, S. gracilis, Chromis caeruleus, Rhabdamia gracilis, Archamia fucata, Caesio caerulaureus, Pterocaesio chrysozona* and *Pranesus pinguis* for reducing mortality at various stages of capture and handling. The results obtained one given below.

(i) ***Capture and transfer to bait tank*:** In the traditional method of capturing *S. delicatulus*, the school is first enclosed with an encircling net and then concentrated at one portion of the net which is lifted and the fishes are transferred to the bait tank. In this method, the overcrowding of the fish at one portion of the net causes considerable stress and injury to the fish. Again while transferring the fishes to the bait tank, they are exposed out of water for a few seconds and during this brief period, heavy mucous loss occurs, resulting in large scale mortality of the fish. The average mortality ranged from 30 - 80% depending mainly on the size and quantity of fish caught. When the encircled school was kept in the net immersed in water without overcrowding them for a few minutes and then slowly transferred along with sea water using buckets to the bait tanks, the average mortality was reduced to 10 - 25%. The atherinid *P. pinguis* which was also collected by the encircling net was found to be comparatively hardy and the mortality immediately after capture was negligible, even if the fish were crowded and transferred to the bait tank by lifting the net.

The other bait fishes are traditionally caught by lift net. Here also, the fishes are crowded at the middle of the net during hauling and exposed out of water for a few seconds while transferring them from net to bait tank. The average initial mortality of *S. gracilis* collected by this method ranged from 5 to 20% depending on the size and quantity of fish caught. Here, the mortality was brought down to below 5% when the fish were kept in the net immersed in water for a few minutes without overcrowding and then slowly transferred by buckets with sea water. *Chromis caeruleus, R. gracilis, A. fucata, Caesio caerulaureus* and *Pterocaesio chrysozona* were very hardy and the average mortality soon after capture was below 5% even if they were subjected to stress conditions like crowding and transferring them to bait tank by lifting the net. However, juveniles of all the species were relatively more susceptible to stress and mortality than their adults.

(ii) ***Holding and transportation in the bait tank*:** About 2 kg of *S. delicatulus* (approximately 4,000 numbers) of the common size range (30 - 45 mm (in a traditional live bait tank of 1.6 x 0.8 x 0.8 m) with continuous water circulation is the optimum level of holding this species. Overcrowding beyond 3 kg per bait tank resulted in heavy mortality of the fish. *S. gracilis* is also susceptible to overcrowding. About 3 kg of fish (approximately 3,000 numbers) of the common size range (40 - 60 mm) in the bait tank with continuous water circulation is the optimum level for this species. The other species studied exhibited better tolerance to crowding in the bait tank. These species could withstand a density of about 5kg in the bait tank without significant mortality. The approximate numbers in 5 kg of fish of *C. caeruleus, R. gracilis, A. fucata, Caesio caerulaureus, P. chrysozona* and *P. pinguis* of the common size ranges (35 - 65 mm, 45 - 55 mm, 50 - 65 mm, 45 - 70 mm, 50 - 65 mm and 35 - 65 mm respectively) were 2,000, 3,500, 2,000, 2,500, 2,500 and 3,300 respectively.

Introduction of pomacentrids, apogonids and *S. gracilis* to the bait tank containing *S. delicatulus* resulted in the mass mortality of the latter. *S. delicatulus* could co-exist only with *P. pinguis*, while *S. gracilis, R. gracilis* and *A. fucata* could co-exist in the same tank without singificant mortality to any of them. The caesionids, apogonids and the pomacentrid studied also could co-exist in the same tank provided that the tank was not overcrowded by more than 5 kg total weight of fish and continuous water circulation was maintained.

(iii) ***Survival in captivity*** : The survival in captivity of the different species was studied for a period of ten days starting from the day of capture, under laboratory conditions. Sprats exhibited the least capacity for survival in captivity. About 86% of *S. delicatulus* were dead during the first day and all the fish were dead by the third day. *S. gracilis* was more tolerant to captive conditions than *S. delicatulus*. Here, for the first three days the cumulative mortality was about 50% and then gradually decreased and from the sixth day there was no significant mortality. The cumulative mortality was 66% during the period of experiment. The caesionids namely *C. caerulaureus* and *P. chrysozona* were relatively more tolerant to captive environment. Here, for the first three days the mortality was about 20% and thereafter the mortality was insignificant. The cumulative mortality of *C. caerulaureus* and *P. chrysozona* for the period of experiment were 24 and 22% respectively. The apogonids are also very hardy and survived well in captive conditions. The mortality of apogonids was about 10% during the first day and thereafter the same was very low. The cumulative mortality of *R. gracilis* and *A. fucata* were 18 and 16% respectively. The pomacentrid *C. caeruleus* is also quite suitable for captive conditions. Here, during the first two days the mortality was about 15%. Then the mortality rate became very low and after the fifth day there was no mortality; the cumulative mortality was 19%. The atherinid *P. pinguis* also showed hardiness to captive conditions. During the first two days the mortality was about 18% and thereafter it became very low. There was no mortality after the seventh day and the cumulative mortality was 25%.

In general, it is seen that all the species studied showed proportionately high mortality during the first day of the experiment. Except *S. delicatulus* which is highly susceptible to captive conditions, the other species could overcome the initial shock and stress of capture and after the sixth or seventh day, they were fully acclimatised to captive conditions and thereafter no mortality occurred. Obviously, *S. delicatulus* is not a suitable species for storing in bait tanks or pens for longer periods whereas all the other species studied can be stored for longer periods if necessary.

(iv) ***Reduction of mortality of* S. *delicatulus by exposure to reduced salinity*** : The effect of exposure to different concentrations of sea water for reducing the osmoregulatory stress and bringing down the initial mortality of *S. delicatulus* was studied. In 100% sea water (35‰) the percentage of mortality due to shock was highest within one hour of capture, which averaged to about 70%. The respective mortality of the fish in 75% sea water and 50% sea water averaged to 24.7 and 11.0%. During the first day in the laboratory, after changing all the fish to 100% sea water (salinity 35‰) the percentage of mortality was highest for the fish exposed initially to 50% sea water which averaged to 63.1%. The same for the fish in 100and 75% sea water was 24.6 and 38.6% respectively. On the second day, the percentage of mortality was highest for the fish exposed initially to 50% sea water which averaged to 13.8%. The same for the fish in 100 and 75% sea water were 0.8 and 10.7% respectively. It can be seen that the mortality from the time of capture to the end of the second day in captivity was relatively low for the fish exposed to 75% sea water immediately after capture, which averaged to 74.1%. The percentage of initial mortality for the period for the fish exposed to 50% sea water immediately after capture averaged to 87.8%. The same was very high for the fish without exposure to reduced saline water, which averaged to 96.4%.

It is seen that, in the case of *S. delicatulus* a very high rate of mortality due to shock at capture was seen within one hour of capture when they were transferred to 100% sea water. The lowest percentage of initial mortality was in 50% sea water. However, of all the fish which were initially exposed to reduced salinities and then changed over to 100% sea water, the fish that had been exposed to 50% sea water had the highest mortality during the following two days. Hence when the cumulative mortality is taken, it is seen that the maximum survival can be had when the fishes are exposed for two or three hours immediately after capture to about 75% sea water and then transferred to 100% sea water. However, if the fishes caught are for immediate use as live bait, exposure to 50% sea water appears to be more effective.

(b) ***Rearing of bait fishes*** **:** The second option for solving the live bait scarcity is to supplement the natural baitfish resources by cultured live baits. Though fragile, many species of whitebait anchovies are reported to possess most of the qualities of good bait fish. Since there is a good resource potential of whitebait anchovies in the southwest coast of India, investigations were undertaken at Vizhinjam to develop suitable methods for their capture, transport and stocking. Rearing of some species of *Stolephorus* and few other small-sized fish was done within the breakwater area at Vizhinjam. 'Well-type' cages made of nylon netting were employed for the purpose. The fish were collected from lift net operated during night using lights and during morning hours, as well as from commercial boat seines. They were transported to the cages in large plastic cans and buckets. The period of transportation of fish from fishing site to the rearing cages ranged between ten minutes and one hour, mortality in respect of *Stolephorus buccaneeri* during transportation and during the first two days after stocking put together ranged from 10 - 20% and low thereafter. Transporting about 100 fish of about 75 mm average length in cans of 50 litre capacity and continuous changing of sea water during transportation were found to reduce the initial mortality of the fish. It survived in the cages for about three months. Similarly *S. devisi* was also found to be hardy; it survived in captivity for about two months. In the case of *S. bataviensis* and *S. indicus*, the initial mortality was very high and the fish hardly lived for more than a few hours after stocking. The periods for which other fishes were reared in the cages were : *Ambassis gymnocephalus* for nine months; *Pranesus duodecimalis* for five months; *Sardinella gibbosa* for two months and *S. longiceps* for four months. Initial mortality on capture, during transportation and stocking was negligible for the foregoing four species of fish.

Mortality of the fish is the major problem for the utilisation of *Stolephorus* spp. as live bait. It occurs at several stages *viz.* at capture, during transfer of fish from net to bait tank, during transportation and during stocking in cages. Injury caused to the fish during capture would lead to large scale mortality later. Since the different species of *Stolephorus* exhibit varying degrees of hardiness, mortality of fish varies with the species composition of collection. The most hardy whitebait anchovy in the area was found to be *S. buccaneeri* followed by *S. devisi*. Hence it is suggested that any attempt to utilise the whitebait anchovies of Indian seas as live bait should be directed towards utilising *S. buccaneeri* and *S. devisi*.

Recommendations

1. The fishermen of different islands other than Minicoy need training for the rational exploitation of live bait fishes other than the currently fished *S. delicatulus*. Exploitation of the species belonging to pomacentridae, apogonidae, caesionidae and atherinidae in addition to sprats, which is being practised at Minicoy can reduce the bait fish scarcity at Agatti, Bangaram, Perumul Par, Suheli Par and Bitra.

2. Maximum utilisation of available bait resources by reducing the mortality of baits during capture and transporation is of prime importance for solving the live bait scarcity. Among the bait fishes of Lakshadweep, the sprats are highly prone to large scale mortality by the crude methods of capture, handling and holding which induces the maximum stress environment. The following precautions can minimise the mortality of sprats at the different stages : keeping the captured bait in the net itself immersed

in water without overcrowding them for a few minutes and then slowly transferring them in small quantities by buckets along with sufficient sea water; allowing the fish to swim from one captive condition to another; keeping the fish in reduced saline water immediately after capture; stocking only the optimum quantity of fish in the bait tank; avoiding introduction of different groups of bait fishes in the same tank; maintaining a continuous circulation of sea water to ensure the required dissolved oxygen, temperature and pH range; using a live bait tank of dark blue or green colour and removing predators from bait tanks. The present tendency of the fishermen to capture large quantities of baits when they are available and overcrowd them in the bait tank which induces the lethal stress environment and consequent loss of bait should be discouraged by fisheries development agencies in the islands.

3. Bait fishes which were conditioned to captive environment were found to acquire increased resistance to injury which significantly reduced their mortality during subsequent handling. Hence holding the fish in pens for a few days to acclimatise them to captive environment can be advantageous if the bait fishes are to be transported to distant areas for tuna fishing. The feasibility of large scale bait fish holding experiments at Lakshadweep in order to condition the fish to withstand the stress of transportation to areas bait fish scarcity needs to be investigated.

4. Intensive culture of suitable live bait fish is another option for solving the bait fish scarcity. But it is felt that a substantial initial capital investment is required for the construction of brood ponds, wells, water storage tanks, the land for locating these facilities and costs of equipments such as pumps, compressors, generators etc. Recurring expenditures such as maintenance of equipments, electricity, food, labour etc are also involved. At Lakshadweep, the cost involved for capturing natural baits is meagre and hence it is felt that the economic feasibility of utilising cultured baits has to be investigated before venturing into intensive culture programmes.

5. The delicate coral reef ecosystem which provides the microhabitat requirement for the recruitment and settlement of live bait fishes should be protected from degradation while implementing developmental programmes in the islands.