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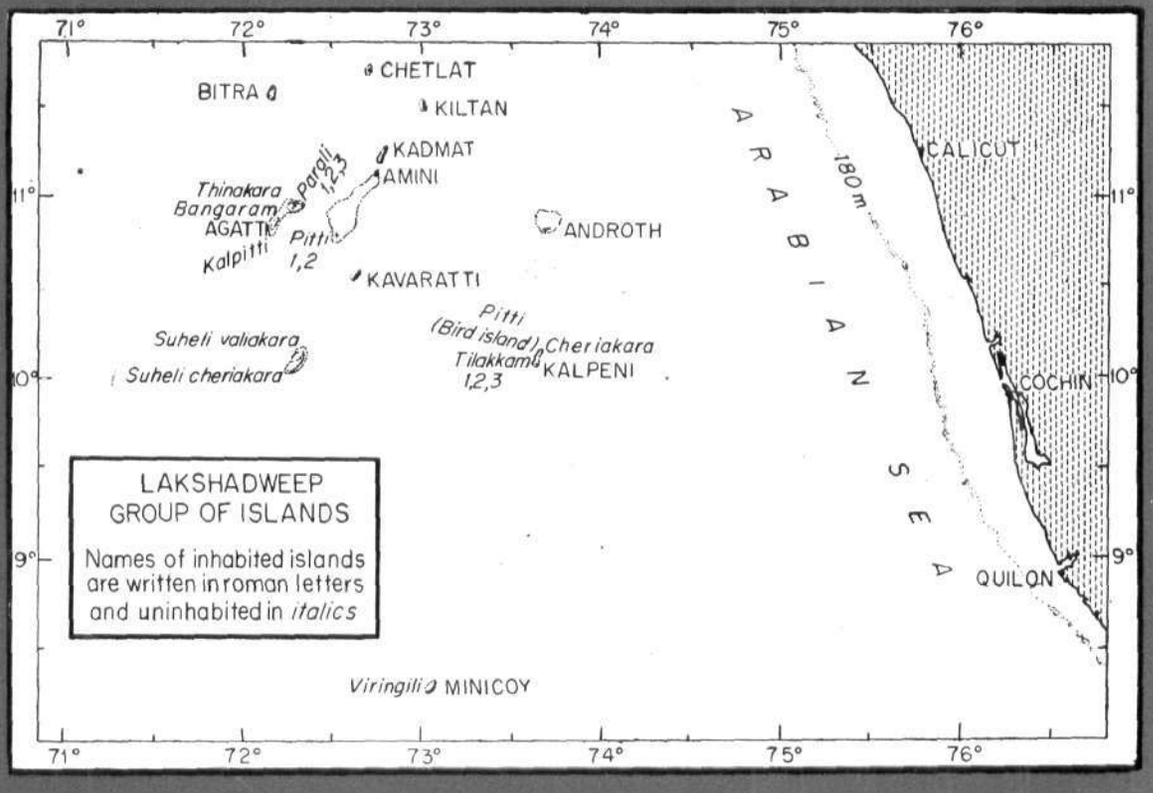

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EXPLOITED AND POTENTIAL RESOURCES OF LIVE-BAIT FISHES OF LAKSHADWEEP

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Introduction

Jones (1958) described tuna live-bait fishery of Minicoy in detail based on firsthand information collected by him during the voyage of M. V. *KALAVA* of the erstwhile Indo-Norwegian Project. Jones (1964) described 45 species of live-bait fishes belonging to 30 genera and 19 families which included all the major bait fishes, made a key for their identification and graded them according to their survival in captivity and chumming quality. A study of the monthly fluctuations in the occurrence of major tuna live-baits of Minicoy during 1960–'61 was carried out by Thomas (1964b). Silas and Pillai (1982) described in detail the live-bait for pole and line fishery and their fishing techniques, floating receivers and transportation and culture of bait fishes. Madan Mohan and Kunhi Koya (1986c) studied the biology of live-bait fishes *Spratelloides delicatulus* and *S. japonicus*.

FLUCTUATIONS IN LIVE-BAIT FISH CATCH

Fishermen of Minicoy Island do not maintain any record of the quantity of live-bait used in a particular tuna fishing season. They generally complain about the regular decline in the live-bait fish catches. To ascertain whether really live-bait catches are declining year after year, live-bait catch data (in kg) were collected during 1981–'82, 1983–'84 and 1984–'85 fishing seasons.

Only 124 kg of live-bait fishes were caught during November, 1981 which was the lowest catch for the tuna fishing season as a whole. The maximum catch of 803 kg was recorded during March, 1982 followed by February (795 kg), April (404 kg), January (362 kg) and December, 1981 with 308.65 kg. It can be seen that there was gradual increase in live-bait catches from November to March, 1982.

During 1983–'84 tuna fishing season, lowest catches of live-bait were recorded in March, 1984; being 310.5 kg. Maximum catches of live-bait were recorded in January (833 kg) followed by December (679.5 kg), November (559.5 kg), April (476.5 kg) and February (364.4 kg). Though live-bait catches increased from November to January, it declined in February and March and recovered to some extent in April.

During 1984–'85 season, maximum catches were recorded during March (1039.5 kg). The lowest catch was recorded during May (281.5 kg). During the other months the catch fluctuated between 333.5 kg and 909.5 kg.

Fishing effort: During 1981-'82 season 885 boat trips were made for collecting live-bait. While minimum number of boat trips were recorded during November (80 trips), maximum of 260 trips were recorded during February followed by March (164 trips), December (153 trips), January (147 trips) and April (81 trips). The live-bait catches improved with the increase in effort in some months, but in other months namely March and April less number of boat trips provided good quantity of live-bait.

During 1983-'84 season a total of 1,268 boat trips were made. Minimum number of boat trips were recorded during April; being 173, while maximum of 279 were recorded in January followed by November (241 trips), December (206 trips), February (191 trips) and March (178 trips). Monthly effort showed gradual increase from November to January and then declined gradually from February to April, 1984.

SPECIES COMPOSITION OF LIVE-BAIT FISHES

Lepidozygus tapeinosoma which used to be the main live-bait fish during tuna fishing season was not available at all during the period under study. During 1981–'82 seasons *Spratelloides delicatulus* dominated among the live-bait catches, contributing to 64.16% of the total catches. This was followed by *Archamia lineolatus* 22.23%, *S. japonicus* 9.40%, *Chromis caeruleus* 2.34% and *Caesio caerulaureus* 1.87%. During all the months of the season blue sprat, *Spratelloides delicatulus* ranked highest in availability among all the live-bait fishes. *Archamia lineolatus* was available though in less quantities than blue sprat during all the months of the season. *S. japonicus* and *Chromis caeruleus* were also collected of which the former was available in good quantity during January and February.

During 1983-'84 season, catches of *Spratelloides delicatulus* declined. Though this species again dominated the live-bait catches, it contributed only 32.68% of the total catches. This was followed by *Archamia lineolatus* (30.56%), *S. japonicus* (12.28%), *Caesio chrysozona* (8.24%), *Chromis caeruleus* (6.81%), *Pranesus pinguis* (6.26%), *Gymnocaesio argenteus* (2.56%) and *Caesio pisang* (0.62%).

As is clear from the above description the live-bait catches improved a little during 1983–'84 season in comparison with that of 1981–'82 season. While 2,798.65 kg of live-bait fish were caught during 1981–'82 season, it was 3,223.5 kg during 1983–'84 season with an increase of 43.28%. Catch per unit of effort declined from 3.16 kg in former season to 2.54 kg in 1983–'84 season. During 1984–'85 season, a total of 5,595.2 kg of live-bait fishes were caught. During 1981–'82 season, *Spratelloides delicatulus* formed the bulk of the live-bait catches, contributing 64.16% of the total catches. Other species which were caught in good percentage were *Archamia lineolatus* and *S. japonicus*. But during 1983–'84 season *S. delicatulus* and *Archamia lineolatus* contributed almost equally with 32.68% and 30.56% respectively. Other species which supported live-bait fishery were *S. japonicus* (12.28%), *Caesio chrysozona* (8.24%), *Chromis caeruleus* (6.80%) and *Pranesus pinguis* (6.26%).

Caesio chrysozona, Pranesus pinguis and *Gymnocaesio argenteus* which contributed to the betterment of the live-bait catches during 1983–'84 were not caught during 1981–'82 season at all. Since major live-bait fishes were not available and could not meet the bait fish demand during 1983-'84 season, about 550 kg of *Caesio chrysozona, Pranesus pinguis* and *Gymnocaesio argenteus* together were caught and used as live-bait.

During 1984–'85 season, a total of 12 species were recorded of which *S. japonicus* constituted 36.1%, *Caesio caerulaureus* 18.5%, and *C. chrysozona* 12.2% followed by other species (Table 1).

Table 1. *Species composition of tuna live-bait at Minicoy during* 1981–'82, 1983–'84 *and* 1984–'85 *seasons (Kg)*

Species	1981–'82	1983–'84	1984–'85
1. *Spratelloides delicatulus*	1,795.65	1,053.5	2,019.0
2. *S. japonicus*	263.00	395.0	435.0
3. *Archamia lineolatus*	622.00	985.0	—
4. *Chromis caeruleus*	65.50	—	119.1
5. *C. ternatensis*			41.5
6. *Caesio caerulaureus*	52.50	219.0	1,031.9
7. *C. chrysozona*		265.5	722.1
8. *C. pisang*		20.0	
9. *Gymnocaesio argenteus*		82.5	683.9
10. *Lepidozygus tapeinosoma*			26.0
11. *Apogon sangiensis*			118.7
12. *Rhabdamia gracilis*			63.0
13. *Archamia fucata*			98.6
14. *Dussumieria hasselti*			124.0
15. *Pranesus pinguis*		202.0	

OBSERVATIONS ON THE HABITS AND HABITATS OF TUNA LIVE-BAIT FISHES

Fishermen of Minicoy fully depend for their live-bait fish requirements on the lagoon which provides them a variety of fishes. It is a well known fact that at Minicoy some of the live-bait fishes appear in the lagoon all of a sudden, remain there for some days and then disappear. Some of the live-bait fishes reside inside the lagoon, while others enter the lagoon and support the fishery during tuna fishing season. Therefore, observations were made on the different habitats at the time of their availability in the lagoon.

Sprats

Spratelloides delicatulus: This species is locally known as 'Hodeli'. It is found in scattered shoals near the inner reef area at Ragandi point in the western part of the lagoon. It can easily be found on the shoal sand and coral flats nearthe clear and moving water and in shallow water area inside the fringing reef. It enters the Minicoy lagoon during the southwest monsoon and are fished during the tuna season. Only young and immature fish are caught and used as live-bait. Mature specimens in stray numbers can be caught from the coastal area of the lagoon.

S. japonicus: This species is locally known as 'Rehi' at Minicoy. It is found in the deeper part of the lagoon north of Ragandi point and are found associated with the corals. During high tide, this species gathers on the top of the coral heads but during low tide it moves to deeper waters away from the corals.

Apogonids

These are locally known as 'Bodi'. *Archamia lineolatus* accounts for more than 90% of the *Apogon* catches at Minicoy. This species lives around coral heads, mostly forming thick layer little away from the corals. They are found motionless in the deeper waters of Minicoy lagoon but whenever they are disturbed at the time of live-bait catching, they move for shelter among coral branches. These are available in the deeper waters in the central and northern part of the lagoon.

Pomacentrids

Few years back, *Lepidozygus tapeinosoma* (locally known as 'Bureki') used to enter Minicoy lagoon from December onwards. It was the most important pomacentrid which used to rank first in availability among all the bait fishes. But from 1981–'82 tuna fishing season onwards this species was not available. *Chromis caeruleus* (locally known as 'Nelamahi') which is now the major pomacentrid caught from the lagoon, is found closely associated with the corals in the southern part of the Minicoy lagoon and also in the deeper part of the lagoon.

Some other pomacentrids are also collected from near the coral colonies of the deeper part of the lagoon. They include *Dascyllus aruanus, Pomacentrus pavo, Abudefduf biocellatus* and *Abudefduf* spp. These species are available only as stray specimens along with the major live-bait fishes.

Caesio spp.

These are locally known as 'Mugurang'. They are found in the deeper area of the northern part of Minicoy lagoon, crevices and small caves of shallow reef area. They are caught during the latter half of the tuna fishing season from the Kodi point area and outer part of the lagoon and northern side of Ragandi point. Their occurrence is very erratic and every year one or the other species occur. For example *Caesio caerulaureus* was available during 1981–'82 season in good numbers but during 1983–'84 season *Caesio chrysozona* occurred in good quantity.

Atherina spp.

These are locally known as 'Fitham'. Two species are common at present, namely *Prenesus pinguis*

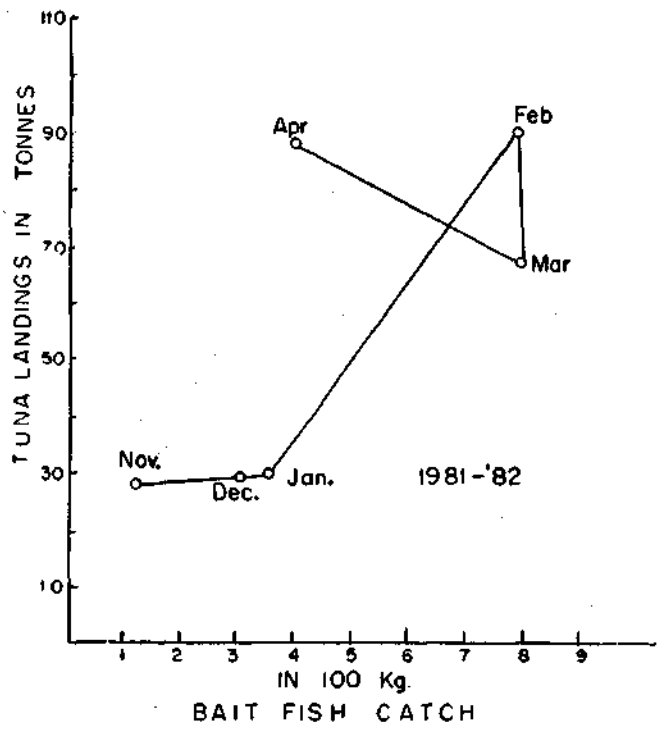

Fig. 1. Relationship between bait-fish catch and tuna landings at Minicoy, 1981–'82.

and *Stenatherina tammincki* out of which the former formed the bulk of the catch. These are found near lagoon shore area specially where algal blooms occur. These are seen swimming near the Minicoy jetty and in a little deeper part of the lagoon. *Atherina* spp. were caught in good percentage and used as live-bait during 1983–'84 season.

Other live-bait fishes

Two species of mullets, namely *Crenimugil crenilabis* and *Velamugil seheli* are found along sandy beach area. Usually *Atherina* and mullets are found together. Some of the parrot fishes like *Helichoeres* spp. juveniles of *Thalassoma* spp. are found associated with corals in shallow water area. They are caught and used as bait during the end of the tuna fishing season.

BIOLOGY OF LIVE-BAIT FISHES AT MINICOY

While collecting data on live-bait fish catches at Minicoy during 1981 to 1984, it was felt that investigation on the biology of major live-bait fishes is of prime importance. Biological studies on the length-frequency, age and growth, sex and maturity, and feeding were carried out on *Spratelloides delicatulus, S. japonicus* and *Pranesus pinguis*.

Spratelloides delicatulus: Studies on this species are based on material collected during 1981–'82. Total length of the individual fish ranged between 18 and 59 mm. Based on the length-frequency studies, the length of the one year old fish was estimated to be 46 mm. Since bigger specimens of more than 59 mm long were not available during the year as a whole, it can be stated that fish are available upto 1+year age.

Specimens with six stages of maturity were recorded during the studies. Spent specimens were not available. Ripe group of ova ranged in diameter from 0.47 mm to 0.71 mm with mode at 0.56 mm. The species spawn during southwest monsoon season which may extend upto December and because of this young fishes are available from October to April. Sex ratio of males to females was found to be 1:0.79. The fish spawn more than once in a spawning season. Number of mature ova in an ovary ranged from 286 to 1,005 when 15 ripe ovaries were examined.

The food of this species was composed mainly of crustaceans which were represented by post larvae of decapods, copepods mainly herpacticoides and calanoides, mysids, gammarids, fish eggs and algal filaments.

S. japonicus: Since this species is available usually for a few months only during the tuna fishing season

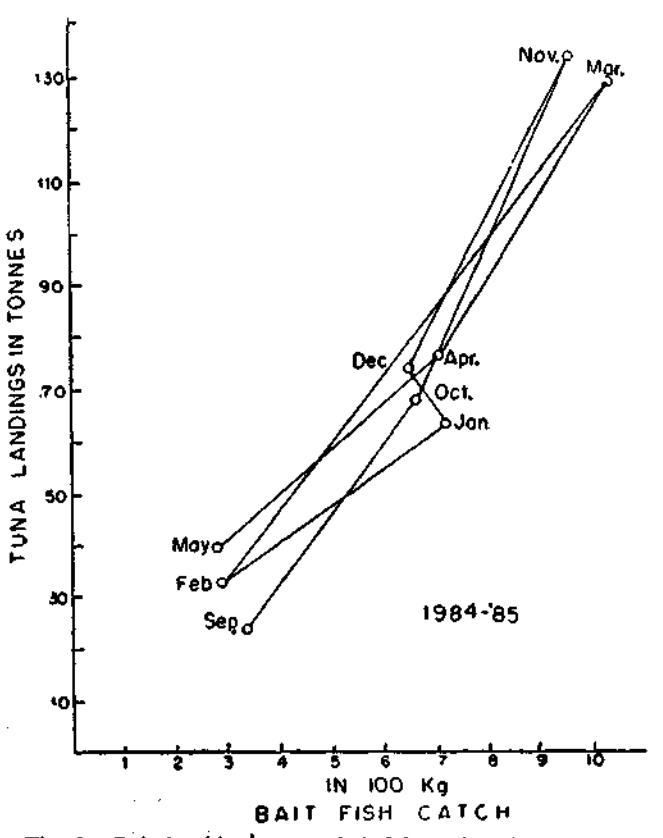

Fig. 2. Relationship between bait-fish catch and tuna landings at Minicoy, 1984–'85.

at Minicoy, a few samples from December, 1981 to March, 1982 were collected and studied.

Total length of the individual fish ranged between 35 and 60 mm. The length data are available for a few months only. But since they resemble *S. delicatulus*, in growth pattern, it is estimated that *S. japonicus* also will be about 46 mm long when it becomes one year old.

Six maturity stages in males and females were identified. Spent specimens were not available. Ripe ova ranged in diameter between 0.38 mm to 0.56 mm with mode at 0.42 mm. Since mature ovary contains three types of ova namely immature, maturing and mature, it can be stated that fish may spawn more than once in a spawning season. Number of mature ova in a mature ovary ranged from 381 to 1,181. Ratio of males to females was found to be 1:0.71.

Pranesus pinguis: This species is used as live-bait generally towards the end of the tuna fishing season. It was collected from the shore area of lagoon for biological investigations. A total of about 1,325 specimens were collected and biological parameters studied.

Total length of the individual fish ranged between 12 mm to 102 mm. Young fishes of about 40 mm in length were available in the samples throughout the year.

Fishes of seven stages of maturity were available; sometimes in one sample itself. During both the years indeterminates made bulk of the specimens examined. Since mature fishes are available along with spent specimens and indeterminate young fishes throughout the year, it can be concluded that *Pranesus pinguis* spawns throughout the year in the Minicoy lagoon itself.

This species is very hardy during transportation and is supposed to be the second best live-bait in Hawaiian islands in Pacific Ocean. But at Minicoy this is used as live-bait when other major live-bait fish are not available. During 1983–'84 season a good amount of this species was used as live-bait.

STUDIES ON THE COMPARATIVE EFFICIENCY OF LIVE-BAIT FISHES

Different fish species associated with corals are used as live-bait at Minicoy. Whichever species is available in good numbers are made use of as live-bait. But only a few of them are considered superior for pole and line operations. A live-bait fish can be more successful on one occasion in a particular area than at others. Therefore based on species-wise live-bait catch and tuna catch data, relative effectiveness of major live-bait fishes was studied during 1981–'82 and 1984–'85 seasons.

Since *Spratelloides delicatulus* formed bulk of the live-bait fish catches with reasonably good average tuna catch per unit of live-bait for the season, it was taken as standard bait to work out the relative effectiveness of other live-bait fishes. Average CPUB of other individual species was divided by the average CPUB of *Spratelloides delicatulus* for this purpose. Relative efficiency of *Archamia lineolatus* was calculated as 1.38, *S. japonicus* 1.53, *Chromis caeruleus* 0.49 and for *Caesio caerulaureus* 0.85.

For *Spratelloides delicatulus* CPUB ranged from 39 kg to 76.4 kg with an average of 62.53 kg for two seasons. For *Archamia lineolatus* CPUB varied from 55 kg to 239 kg with an average of 86.3 kg for the two seasons. For *S. japonicus* it ranged from 41 kg to 400 kg with an average of 95.57 kg. For *Chromis caeruleus* it ranged from 23 kg to 116 kg with average of 31 kg. For *Caesio caerulaureus* CPUB ranged from 14 kg to 64 kg with an average of 53.10 kg.

But there are some factors which can effect tuna catch per unit of bait such as size and species of tuna caught, number of men fishing, size and number of fish per one kilogram of live-bait, relative abundance of tunas and above all response of tunas to live-bait fishes.

Though *Spratelloides japonicus* proved to be the most efficienct live-bait fish during 1981–'82 season followed by *Archamia lineolatus*, the former species contributed only 9.40% to the total live-bait fish catches and latter 22.23%. *Spratelloides delicatulus* with CPUB of the 62.53 kg also proved good in efficiency and it contributed 64.16% of the total live-bait catches and was available to tuna fishing boats during all the months of 1981–'82 season.

STUDIES ON CORRELATION AMONG LUNAR CYCLE, LIVE-BAIT AND TUNA CATCHES AT MINICOY

It is believed at Minicoy by the local fishermen that some live-bait fishes appear in the lagoon during certain phases of the moon and after that live-bait catches generally show decreasing trend. There was no record of

Fig. 3. *Spratelloides delicatulus*

Fig. 4. *Rhabdamia gracilis*

Fig. 5. *Apogon sangiensis*

Fig. 6. *Gymnocaesio argenteus*

live-bait fish landings at Minicoy prior to 1981. This study was undertaken during 1983–'84 season to see whether moon phases are really playing an important role in the availability of live-bait fishes in sufficient quantities at Minicoy.

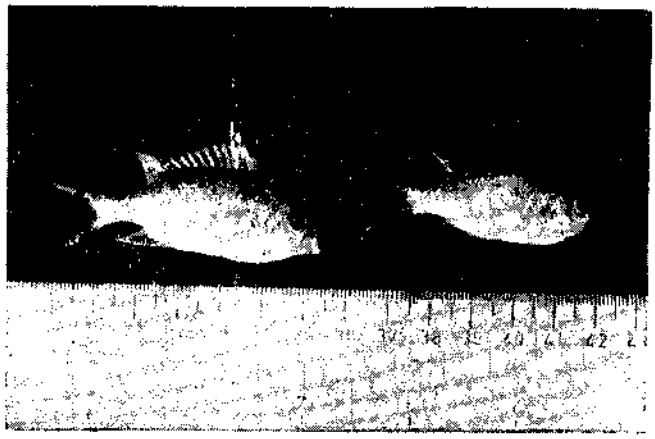

Fig. 7. *Chromis caeruleus*

By this study, the dependence of live-bait fish and tuna catches on the four phases of moon namely new moon, first quarter, full moon and last quarter during 1983–'84 tuna fishing season has been demonstrated. Out of the six months of fishing season, live-bait fish catches were higher during new moon phase in four months but when considered for the whole season, the live-bait catches and tuna catches were greatest during new moon phase and lowest in last quarter. Tuna catches per kilogram of bait fish were found highest during the last quarter and lowest during new moon phase. Effort for live-bait fishing and tuna fishing, and catch per unit of effort of live-bait fishes and tunas were highest during new moon phase and lowest in the last quarter.

LIVE-BAIT FISH REARING EXPERIMENTS

At Minicoy, specimens of *Chromis caeruleus* were collected from the southern part of the lagoon and were brought to Research Centre laboratory for rearing experiments. They were kept in plastic aquarium tanks and were reared for about three months by providing them supplementary food. They were fed by crab body parts, fish flesh and occasionally zooplankton.

Since the catch of *Chromis* sp. is diminishing year after year, there is an urgent need to protect this bait fish resource by their large scale production. The survival of this species in captivity has opened up the way for the planning of its large scale rearing.

The relationship between tuna catch and live-bait fish landings during the period 1981–'82 and 1984–'85 are presented in figures 1 and 2. It is very clear from the figures that a positive relationship exists between the total landings of tunas and live-bait fish catch.

PRESENT STATUS OF LIVE-BAIT FISHERY IN MINICOY

Pillai (1983 and 1985) described in detail the ecological crisis in the Minicoy lagoon.

There is a general feeling among the fishermen of Minicoy that the live-baits are not as plenty at present as they used to be in the past. The condition at the other islands is not fully realised. To obtain the views of a few well experienced fishermen, the CMFRI interviewed them and their opinions were taken into consideration, as a prelude to an attempt to find a scientific interpretation of the problem.

It is rather difficult at this stage to find, figure-wise, any decline in the live-bait catches at Minicoy or at

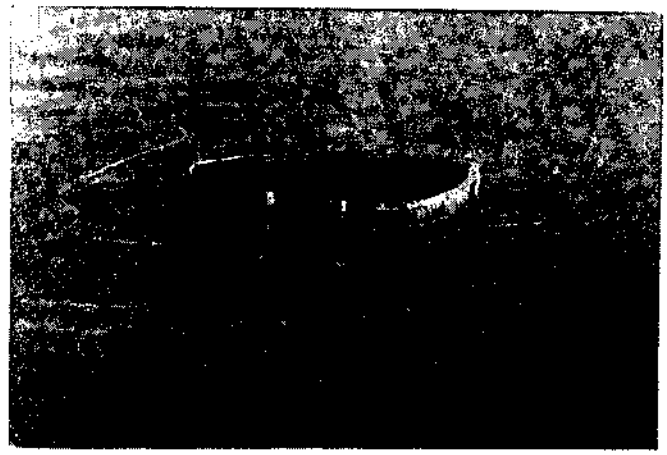

Fig. 8. Floating basket for tuna live-baits

other islands in the recent past due to non-availability of much needed quantitative data over the span of many years. Such data collected by the CMFRI at Minicoy during the fishing season 1981–'82, 1983–'84 and 1984–'85 show that the catches of live-baits were in the order of 2,799 kg, 3,224 kg and 4,270 kg respectively. These catches were mainly sustained by *Spratelloides delicatulus* (64.2%), *S. japonicus* (9.4%), *Archamia lineolatus* (22.2%) and *Chromis caeruleus* (2.3%) in 1981–'82 season; by *S. delicatulus* (32.7%), *A. lineolatus* (30.6%), *S. japonicus* (12.3%) *Caesio chrysozona*

(8.2%), *Caesio caerulaureus* (6.8%), *Pranesus pinguis* (6.3%) and *Gymnocaesio argenteus* (2.6%) in 1983–'84 season and by *S. delicatulus* (36.1%), *C. caerulaureus* (18.5%), *C. chrysozona* (12.9%), *G. argenteus* (12.2%) and *S. japonicus* (7.8%) in 1984–'85 season. However,

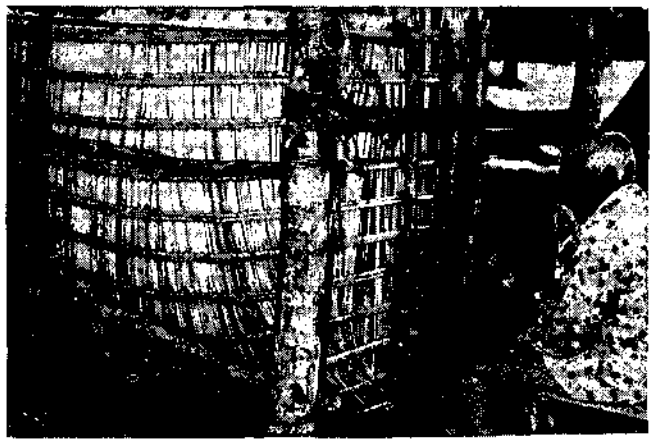

Fig. 9. Tuna live bait basket

the fact remains that the demand for live-baits now-a-days exceeds the fishable stock in the atoll regions. At least, three major reasons can probably be attributed to this shortage.

(a) *Environmental deterioration:* This has been dealt with in detail in another article in this issue by C. S. Gopinadha Pillai and Madan Mohan (P. 33).

(b) *Fluctuations in the seasonal recruitment of migrant bait fishes:* The recruitment of live-bait fishes to a small geographic area like Minicoy and other islands as well involves an element of chance mostly controlled by the meteorological conditions. For the last three or four years some of the important live-baits such as *Lepidozygus tapeinosoma* which was considered as much prefered and abundant live-bait in the earlier period (Jones, 1964a and Thomas, 1964b), have not entered the lagoon in any appreciable quantities. This, along with the seasonal fluctuations in the recruitment of the other migrant species belonging to *Spratelloides* and *Caesio* as evident from the catches of the bait fishes, form another reason for the recent probable paucity of live-baits. The migratory forms have exerted much pressure on the available stocks of resident forms. It is also probable that the deterioration of the habitat is not conducive for the proper survival of the new recruits of the resident species.

(c) *Demand exceeds available stock:* A third reason which is of much significance on the reported dwindling of live-baits seems to be over exploitation of the resources consequent on the introduction of mechanised vessels in pole and line tuna fishery in most of the inhabited islands of Lakshadweep. This fleet which consisted of nine boats in 1963 has increased to 94 boats in 1973 and to 263 in 1983. This has resulted in the increase in the production of tuna by the pole and line fishery from about 566 tonnes in 1963 to 1,020 tonnes in 1973 and to a record production of 3,037 tonnes in 1983. There is, thus, certainly a greater demand for the live-baits than in the past; and the fishermen exploit the available resident species to the possible level. This is very clearly observed in the case of *Chromis caeruleus*, a species which was very dominant throughout the lagoon of Minicoy till the beginning of 1980 started dwindling thereafter. Similar situation probably prevails at Agatti, Androth, Bitra, Kavaratti and Suheli as could be judged by the increased tuna production by the mechanised pole and line fishery.

The cumulative effect of these, is an apparent shortage of live-baits not only at Minicoy but probably also at the other islands of Lakshadweep. It is to be watched whether the situation will improve by the increased recruitment of the non-resident migratory species. The chances of resident species showing improvement appear to be very little, because of the deterioration of the environment caused by human interference.

Errata based on subsequent communication

1. Page 27, Table 1. The species name *Archamia lineolatus* may be deleted.
2. In the same Table the catch details given against *Archamia lineolatus* are referable to *Archamia fucata*.
3. Page 27, column 1, para. 2, line 2. 'Hodeli' may be read as 'Hondeli'.
4. Page 28, column 1, line 1, *Stenatherina tammincki* may be read as *Stenatherina temmincki*.
5. Throughout the article *Archamia lineolatus* may be read as *Archamia fucata*.