

## THE STATUS OF TUNA FISHERY IN AGATTI ISLAND IN LAKSHADWEEP

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### ABSTRACT

Lakshadweep is the only place in India where an organised tuna fishery is in vogue. Skipjack tuna *Katsuwonus pelamis* forms the major fishery resource of the waters surrounding these islands. The annual production of 4000 tonnes of tuna from Lakshadweep makes up about 20% of the total tuna landings in India. Pole and line is the principal gear employed in fishing. The crafts used are 7.62 metres long mechanised boats. Out of the four pole and line tuna fishing Centres in Lakshadweep, about 46% of the total tuna caught is from Agatti Island. Different aspects governing this fishery in Agatti Island are discussed. The seasonal abundance, catch per unit effort, species composition, gonadial condition and feeding habits are presented in this paper.

### INTRODUCTION

LAKSHADWEEP Archipelago consisting of 36 islands including sub-merged reefs and islets lie scattered on the southwest coast of India off Kerala Coast, the distance from mainland being 125 to 300 miles. Lakshadweep Sea is rich in its fishery resources. The Skipjack tuna resource of this area is estimated to be 50,000 tonnes (George *et al.*, 1977). It is also estimated that an equal quantity of sub-surface tuna like Yellowfin, Big Eye, Northern Bluefin and Dog-toothed tuna are also available, besides about 1 lakh tonnes of shark. Till 1962 tuna fishing in Lakshadweep was confined to Minicoy Island only. In Minicoy a traditional Skipjack tuna fishery employing indigenous sailing crafts called 'Mas Odies' was in vogue since about a century with an annual catch of about 300 tonnes. In early 1960's, after Lakshadweep was formed into a Union Territory, mechanisation was introduced in tuna fishery in Minicoy which made marked improvement in tuna catch. In other islands of Lakshadweep, however, fishing continued to be the traditional harpooning for seerfish and shark with practically no fishing for tuna and the catch was even insufficient for local consumption.

In the year 1963 pole and line live-bait fishing for Skipjack tuna was introduced in other islands with the help of expert fishermen from Minicoy employing small mechanised tuna fishing crafts with live-bait tank and fishing platform. Areas like Agatti, Bitra, Suheli, Perumulpur, Valiyapani, Cheriyanani, Kadmat and Kalpeni were found high in concentration of Skipjack shoals. However, with the vast areas of sub-merged reefs around and resultant high productivity due to upwelling the areas around Agatti found to be the richest followed by Suheli, Valiyapani and Cheriyanani. Perumulpur about 30 km from Agatti is found equally rich and this forms a convenient fishing centre for Agatti fishermen at times fishing around Agatti is poor. Since live-bait is an integral part in pole and line Skipjack fishing to success of the fishery depends on its availability in adequate quantities. The vast lagoon in Agatti and close-by islands Bangaram are rich in live-bait resources. The areas of live-bait fishing is marked in Fig. 1 and 2. Both the migratory species like *Caesio laurus* and resident species like *Spratelloides* and *Apogon* are abundant, but the fishery is mainly dependent on *Spratellodes delicatulus*. Though seasonal variations have been observed, there

has not been any marked shortage in the availability of live-bait so far and it has been sufficient to operate 50 pole and line boats from October to early May. Skipjack tuna and live-bait resources are so abundant in the area that it is capable of supporting a substantial further increase in the fishing effort. The fishermen find Perumulpar and other places a reserve

other islands and commercial fishing employing large pole and line Vessels and purse seiners for Skipjack and long liners for sub-surface species. Since the fishermen from other islands are reluctant even for seasonal migration to Agatti, enhancement of activities in the existing small scale fishing is ruled out unless the attitude changes. The only alternative then left now is commercial fishing. There is tremendous scope for commercial fishing as only about 8% of the estimated resource of Skipjack is now caught leaving the bulk of this migratory resource untapped.

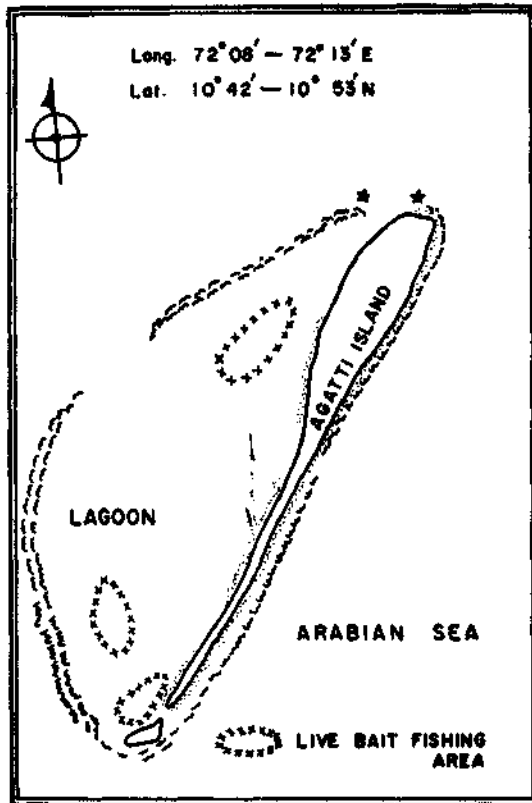


Fig. 1. Agatti Island and lagoon indicating live bait fishing area.

area for live-bait and tuna. The main constraint in the further development of fishery in this area, however, is the shortage of fishermen in Agatti where the total population is only around 4200 and almost the entire population interested in fishing is engaged in this field already. For further increase in fishing activity the alternatives are fishing in this area by fishermen from

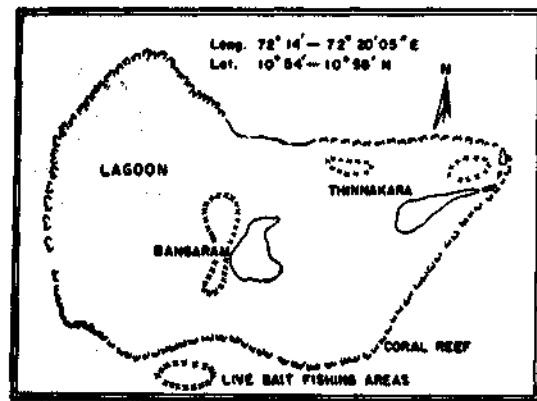


Fig. 2. Bangaram Island and lagoon indicating live bait fishing area.

Agatti is one of the ten inhabited islands in the UT of Lakshadweep situated at  $10^{\circ}50'N$  latitude and  $72^{\circ}11'E$  longitude. There is a vast reef around which extends at the northern end to a stretch of about 12 miles and it supports islets of Bangaram, Thinnakara, Parali at the northern end. The area between Agatti and Bangaram is a vast shallow one with depth of about six fathoms which is a suitable anchorage for bigger vessels. Both Agatti and Bangaram Lagoons are vast, the area being 15 sq. miles and 21 sq. miles respectively. These lagoons are rich and harbours coral habitat that shelters varieties of coral fishes including live-baits both

migratory and resident. The common species are:

*Spratelloides delicatulus*  
*Spratelloides japonicus*  
*Chromis caeruleus*  
*Archamia fucata*  
*Rhabdamia gracilis*  
*Ostorhynchus quadrifasciatus*  
*Apogon sangiensis* and other spp.  
*Pristiapogon fraenatus*  
*Dipterygonotus leucogrammicus*  
*Caesio chrysozona*  
*Caesio laureus*  
*Lepidozygus tapeinosoma*

The lagoons both in Agatti and Bangaram have protected anchorages for boats upto medium size and hundreds of boats can be safely anchored here during the fair season with channels safe to manoeuvre during both day and night. For centuries, fishing in Agatti was confined mainly to the lagoon by shore seiners and drag-nets for coral fishes and species of *Caranx* and snappers until tuna Skipjack fishing was introduced in 1963.

In the year 1963 the first demonstration tuna fishing vessel was introduced in Agatti. This was a 'Mas Odi' (indigenous sailing craft of Minicoy Island) constructed by the Fisheries Department and the fishing was demonstrated by expert fishermen from Minicoy. The 'Mas Odi' was soon replaced by mechanised boats of 9.14 metres provided with fishing platform and live-bait tanks. The mechanised boats were found much more efficient than 'Mas Odies', because of the freedom of movement and manoeuvrability, fastness and smaller contingent of crew. The mechanised boats were an immediate success and with the liberal subsidy, the introduction of these boats were very fast. Later 7.62 metre boats were found more

acceptable to fishing due to the shallow condition of reef, less capital investment and operational cost. There are at present 50 boats of 7.62 metre size, under operation in Agatti for pole and line tuna fishing which together landed 2054 tonnes of tuna in the year 1984. Tuna catch for the last 10 year period shows that Agatti Island caught about 63% of the total tuna landed among major centres viz. Agatti, Minicoy and Bitra (Fig. 4). The average catch per boat works out to 42 tonnes in a year for 6 months fishing period. Even at the very reasonable rate of Rs. 4/- per kg of tuna the value of catch per boat comes to Rs. 1.68 lakhs a year. At the prevailing share of 50% to the fishermen (9-10 fishermen in a boat) the income per fishermen is Rs. 8400/-. Less the running and maintenance expenditure of the boat the net earning for the owner of the boat is around Rs. 64,000/- in a year. But often the boat owners and fishermen are the same. For a fishing craft that costs around Rs. 1 lakh only at the present day cost the income above is perhaps one of the best. There had been record catches upto 105 tonnes of tuna in a season per boat in Agatti Island. In addition to tuna there is an average catch of about 1000 tonnes of other fishes in this island (Fig. 4). The total income out of the total catch is Rs. 1.22 crores, the per capita income in this island from fishing being around Rs. 3000/-. This far exceeds the income from coconut which was once the only source of income. The per capita availability of fish in this island is about 725 kg with one of the highest per capita consumption of about 100 kg per head.

Considerable information is available on the biology and fishery of tuna at Minicoy Island (Hornell, 1910; Mathew and Ramachandran, 1956; Varghese, 1970; Puthran and Pillai 1972; Silas and Pillai, 1982; Madan Mohan *et al.*, 1985; Nair, 1986; Silas *et al.*, 1986). But no published literature is available on the tuna fishery of Agatti Island.

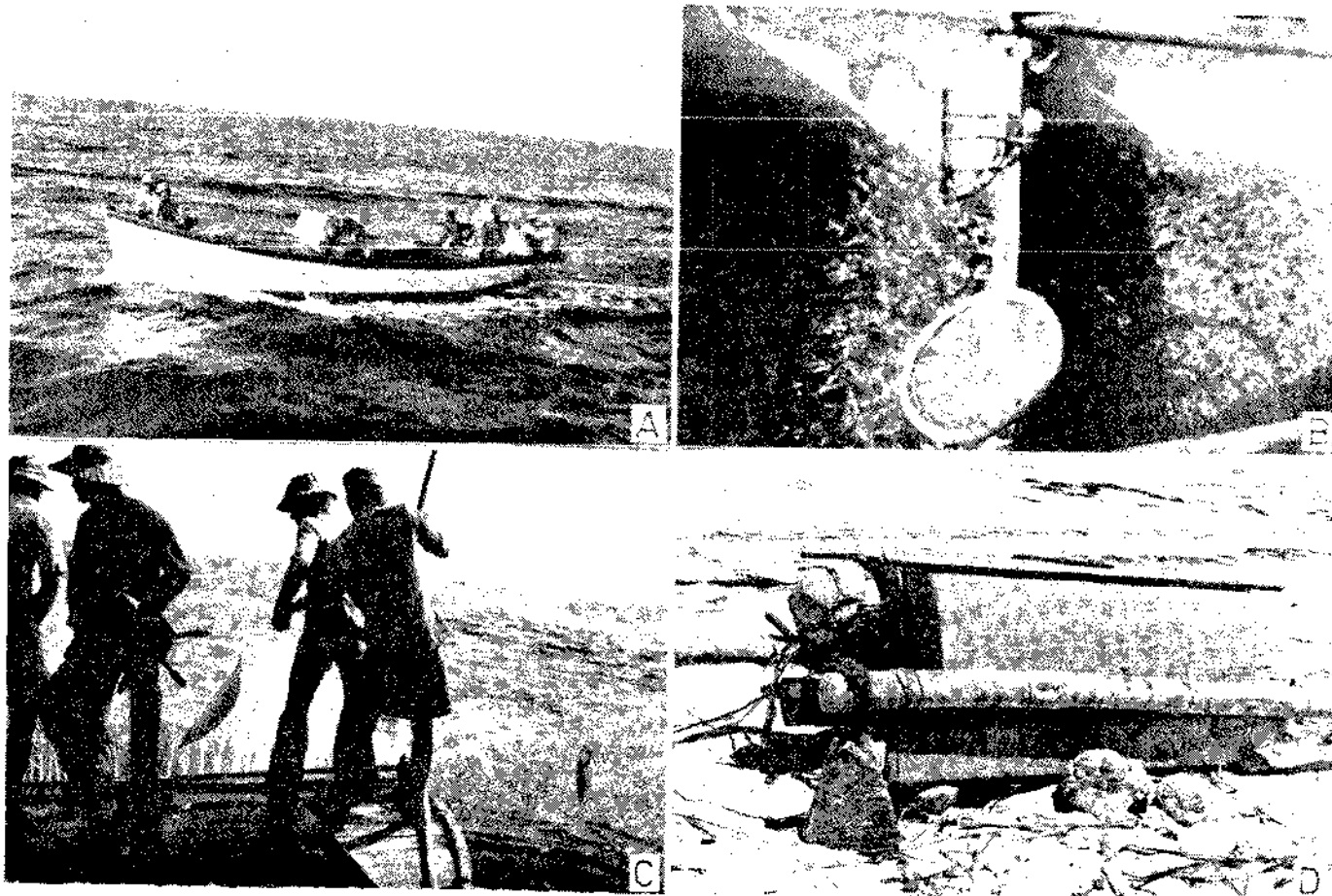


PLATE I A. Mechanised pole and line tuna fishing boat in the open sea off Agatti. B. Live-bait tank inside the boat with full of baits. C. tuna fishing by pole and line in the open sea off Agatti and D. A live-bait reservoir kept upside down on the beach at Agatti.

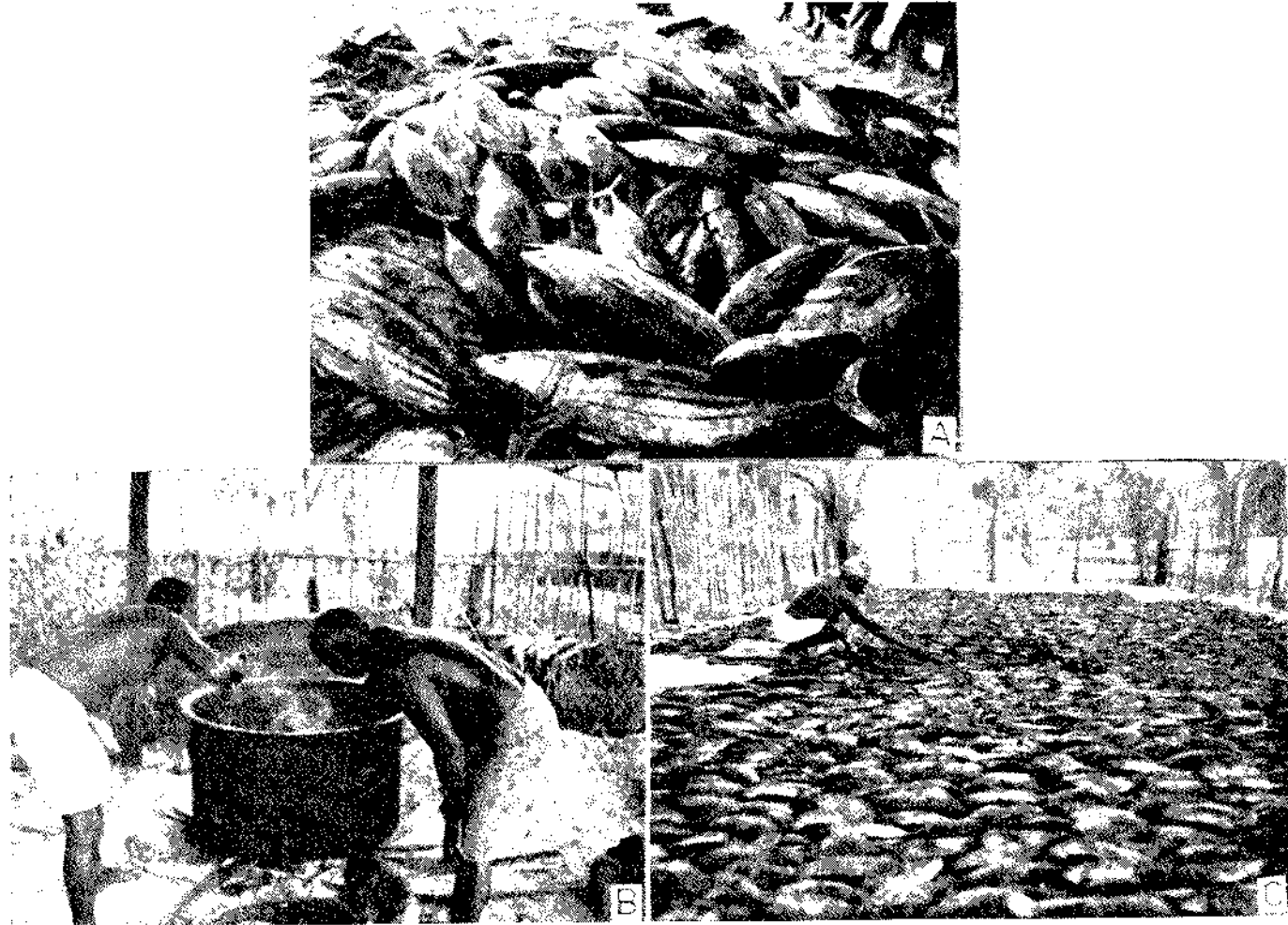


PLATE II A. Tuna (Skipjack) unloaded from pole and line fishing boat. B. Cooking of tuna filets for the preparation of 'Mas' and C. Sun drying of cooked and smoked tuna.

#### MATERIAL AND METHODS

The data used for the studies are the boat-wise daily fish catch from the pole and line fishing boats operated for the last 15 years from 1971 to 85 in Agatti Island. The method of collection of data was on enumeration and this is the method used for collection of data in the whole of Lakshadweep. Enumeration from each boat is easily possible as the fish landing is within a stretch of 2 km in Agatti Island on the lagoon beach at fixed points. Since a days fish catch in a boat is constituted by one or two size groups, multiplying the weight of one fish with number of fish in each size group give accurate weight. During the period of study the number of boats studied increased from 10 in 1971 to 50 in 1985 and the data from the entire boats were collected to calculate the fishing effort. The samples of Skipjack observed for biological studies were collected from above boats at random. The whole data was collected by the Fisheries Department staff stationed in Agatti who are qualified for the job.

#### FISHING AREA

Tuna fishing by small mechanised crafts of the type employed in Agatti is conducted within a range of 10 miles around the islands, keeping the islands always in sight. During the period of study Agatti fishermen had their fishing operation around Agatti, Bangaram and Perumular.

#### CRAFTS, GEAR AND FISHING METHODS

The pole and line and live-bait tuna fishery as practised in Agatti is supported by a live-bait fishery which is an integral part. The craft employed for both live-bait and tuna fishing is the same which is a 7.62 metres long open type wooden mechanised boat with a beam of 2.18 metres and fitted with 14-16 HP inboard diesel engine. The boat has a shallow

draught of 0.6 metre to suit the shallow nature of the reef. In the forward cock pit of the boat is kept a live-bait tank of the dimension 1.6 x 0.8 x 0.8 metres. The tank is separated into two compartments with a perforated wooden plank and water circulation is maintained by an inlet at the forward end and an outlet pipe. These pipes pass through holes made on the tank and the hull. At the opening of the inlet pipe below water level on the outside hull a funnel-like arrangement is fixed which pushes water through the pipe into the bait tank when the boat runs. When the boat slows down for fishing or otherwise water is poured into the tank by buckets as this arrangement will not work during this time. Recently, however, water circulation by mechanical means is introduced alongwith mechanical spraying system. A pole and line fishing platform of about 50 cms in width projecting to the sea is provided on the bulwark of the boat around the rear half of the boat. Remote controls are provided on the steering post erected at the aft. This facilitates the helms-man to control the boat according to the movement of the tuna shoals. The crew requirement is 9 to 10, including the driver.

Pole and line tuna fishing gear is very simple which consists of a bamboo pole ranging from 3 to 4.8 m in length with a diameter of 3 to 4 cm at the base. The pole should be straight, strong and flexible and bamboo from West Bengal are preferred. A line equivalent to the length of the pole is tied at the tip of the pole 2/3rd of which is about 2 mm synthetic rope and the rest synthetic monofilament 0.8 to 1 mm thick. To the end of the monofilament is tied a barbless hook made of mild steel and tinned for glittering in the water. Now a days, however, mostly stainless steel hooks are used which are made by local black smiths. When the poles are not in use the hook is kept hooked to the base. Fishermen carry about 20 pole in a boat.

The success of pole and line fishing depends on the availability, catching and the preservation of live-bait in live condition. In Agatti, Bangaram and Perumulpur live-bait is available in adequate quantities and the species are mostly *Spratelloides delicatulus* locally called 'hondeli' a name adopted from Minicoy. This species appears in big shoals on the shallow water sandy areas inside the lagoon. The fishing gear consists of (1) two pieces of scaring nets locally called 'Olavala' made of coconut leaves tied on 12 mm diameter rope of about 30 m in length, (2) one piece of drag-net locally called 'adivala' of about 30 to 40 m in length and 2-3 m in depth made of nylon with mesh size 1.5 mm and (3) collection net locally called 'Kaivala' made of mosquito net 3 x 3.5 m of rectangular size to the centre of which is stitched a cotton cloth 1 x 1.5 m size to avoid complete draining out of water on lifting.

The fishing operation is that the Olavala is tied to the two ends of the drag net. When a shoal of bait fish is sighted it is surrounded by this net in a semicircle and two ends are dragged to be closed in a small circle at the centre. When the shoal is enclosed by the drag net the Olavala is removed. The trapped bait is then bailed out by the kaivala and transferred either to the live-bait tank in the fishing boat or to the live-bait reservoir available with the fishermen, in the lagoon. Eight fishermen is adequate for the above operation which will be the same fishermen going for tuna fishing. Usually bait fishing is done on the way for tuna fishing. However, at times when scarcity for bait occurs, bait is caught on the previous evening and kept in the live-bait reservoir in the lagoon.

Unlike Minicoy, where live-bait reservoir is traditionally made of local twigs, in Agatti the same is made out of GI sheets nailed to two semi-circular wooden planks. The GI sheet and planks are perforated for water cir-

ulation and the reservoir is anchored in the lagoon. Locally the reservoir is called 'Chalavatti', the life of which is 1-3 years depending on the quality of the GI sheet and maintenance. From the reservoir the live-bait is transferred to the bait tank in the boat by a square piece of cloth.

The same bait is, however caught by two other ways too. When the shoals are abundant and of high concentration it is collected by Kaivala alone just before sun rise without the help of other nets. Before sun rise the fish will have a yellowish colour which turns to bluish when sun rises. When the shoals are scarce, the net is dragged to the shore from a wider circle and bait collected.

#### POLE AND LINE FISHING CENTRE

Agatti fishermen start their fishing early in the morning as to reach the live-bait ground before day break. With enough live-bait collected the tuna boat proceeds to the fishing ground in the outer sea. By the nature of the current and tide the fishermen can guess the area of tuna shoals will appear. Tuna shoals are, most of the time, indicated by sea birds that could be located even at a distance of about 5 miles. When the boat is near a tuna shoal the bait chummer collects bait from bait tank by a colander-shaped small scoop net locally called Chalavatti (called 'em-veri' in Minicoy). The boat is manoeuvred to keep the fishing side on the lee of the fish shoal. In the mean while the fishermen take position on the fishing platform and two men sit at the two corner of the angling platform and start splashing sea water with a scoop made of coconut spathe and wooden handle locally called 'Chelli' ('Purapori' in Minicoy) to attract the fish shoal by creating artificial appearance of jumping of small fish. As soon as the fish shoal is around the stern of the boat the hook from the pole is put into water and the fishing begins.

When the weight of the fish is felt on the pole the fish is lifted above the boat and with a jerk on the pole, the fish is dropped at the aft deck of the boat. The lifting and jerking needs real skill and the release of the fish from the hook is possible as the hook is barbless. If the fisherman is a skilled one and the tuna shoal is in good biting mood the fishing could be so fast that while one fish is dropped in the boat the second would be in the air with a third one on the hook from the same pole. At such times fishing will be so fast and thrilling that it is possible to catch a thousand fish by 5-6 fishermen within half an hour. The fishing from each shoal normally last upto 20 minutes and the success of the fishing depends on the skill to retain the shoal around the boat to the maximum time possible and the skill of the fishermen.

#### PROCESSING AND MARKETING

Tuna is popular all over the world and is consumed as fresh, canned and dried. Due to the remoteness of the islands of Lakshadweep, away from mainland, the surplus catch of tuna in Agatti, after local consumption, cannot be sold as fresh and is hence processed as 'Mas' the traditional product of Minicoy. 'Mas' is a cooked, smoked and dried product with a shelf life of one year with excellent taste, good for many recipes. As the processing possible with the use of local materials and ordinary packing enough, the product is ideal for the limitations inherent in the island. 'Mas' is almost similar to the traditional Japanese Skipjack product 'Katsuwobushi' so popular there.

The processing of Skipjack tuna into 'Mas' starts with the filleting of the fish. The meat is cut along the back bone to form two pieces and each piece is again cut longitudinally to form 4 pieces from a fish. It is cooked in sea water with little salt in aluminium or tinned

copper vessels. After cooking for 2-3 hours the cooked fish is left over night in the vessel to be smoked next morning. Smoking is done spreading the cooked fish on iron grills over pits burned with coconut husks. Smoking is continued till fish gets smoke colour. Besides being preservative, smoking gives particular taste and firmness to the flesh. After smoking, the fish filets are spread on coconut mats on the sea shore under the sun until it is dried hard like a wood which takes about 7 to 9 days. The conversion from fresh whole fish to 'Mas' is about 18% in weight.

In Agatti about 300 tonnes of 'Mas' is produced in a year. The 'Mas' is packed in gunny bags and transported to mainland in mechanised vessels or ships and sold to merchants in Calicut, Mangalore or Tuticorin. The price of 'Mas' ranges from Rs. 20/- to 35/- per kg depending on the catch and season.

#### FISHING EFFORT, CATCH AND CATCH PER UNIT EFFORT

In this study the fishing effort is considered in terms of boat days. All the pole and line fishing boats leave for fishing early in the morning and return by the afternoon same day.

The relationship between effort and catch and CPUE is presented in Fig. 3. During the period from 1971 to 1985 there has been marked increase in the total catch mainly due to the increase in the effort resulted by the introduction of more boats for fishing. However, certain years showed declining trend in fishing with the fishery picking up in recent past. This is illustrated by the following.

In 1971 the tuna catch was 179 tonnes. In 1972 the catch was 144 tonnes which was increased to 419 tonnes in 1973. The catch increased to 518 tonnes in 1974 and to 718 tonnes in 1975, with increase in effort. In



1976 the catch was declined to 542 tonnes and further declined to 392 tonnes in 1977. There was decline in the fishing effort also in that year. In 1978 increase in the catch is observed. In 1979 the catch leaped to 1313 tonnes with increase in fishing effort, but again dropped to 820 tonnes in 1981. A decline in the catch

same as 1984. The tuna formed 96.6% and 96% respectively of the total fish production at Agatti during 1984 and 1985. There has been a considerable increase in effort which increased to 4486 in 1984 from 816 in the year 1971.

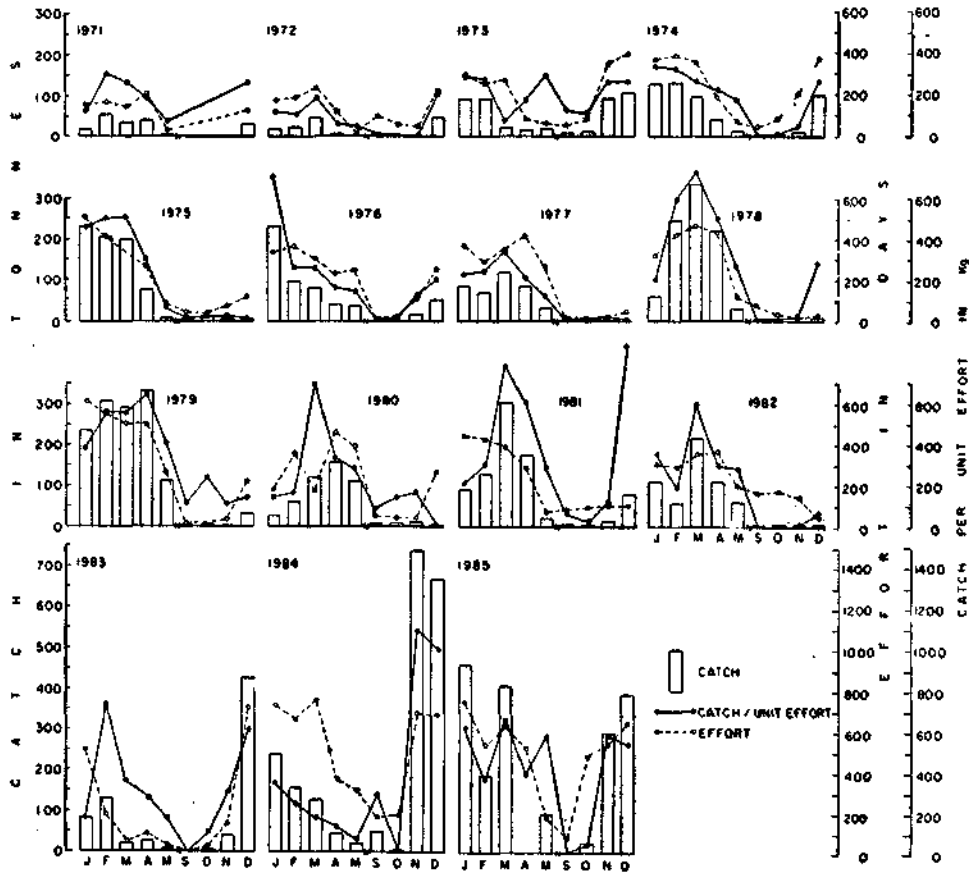


Fig. 3. Catch — Effort relationship and catch per unit effort (CPUE) of tuna in the pole and line fishery at Agatti from 1971 to 1985.

is noticed in 1982 inspite of increase in efforts in that year. A progress in the catch is seen in 1983 even though effort decreased considerably. A record catch of 2054 tonnes of tuna was made in the year 1984 which was the highest annual production in Agatti during the period from 1971 to 1985. In 1985 also the tuna landing and the level of effort remained almost

High efforts are recorded during January to March and December in 1972, 73, 74, 76, 79 and 84. During 1971, 75, 77, 78, 81, 82 and 85 high efforts are seen from January to April. During 1980 February, April and May have maintained high efforts while in 1983 January, February, November and December were the months of peak efforts. Maximum

efforts are seen for the months of November and December for the year 1973, 84 and 85. There was no effort for September, October and November for the year 1971. No efforts are seen in September for the year 1976, 77,

February, April, March, January, April, January, April, December, March and January respectively. A sharp decline in the effort is noticed from April to May and during September and October in all the years.

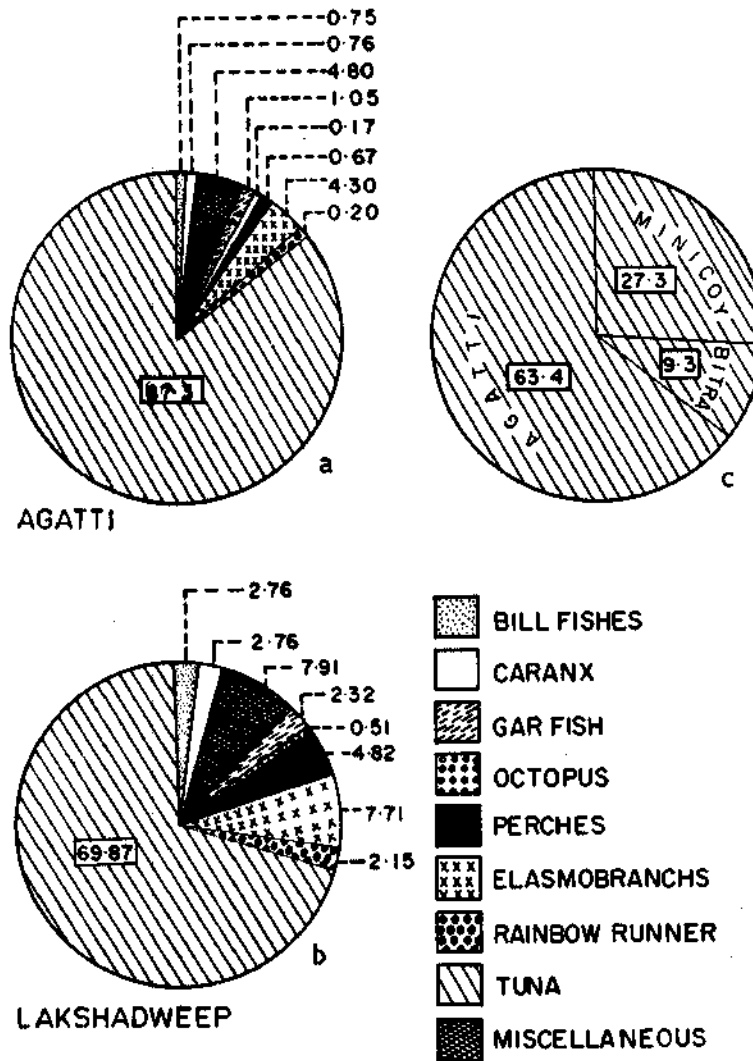


Fig. 4. Catch composition based on average for the years 1976 to 1985: a. at Agatti, b. in Lakshadweep and c. Tuna catch of Agatti, Minicoy and Bitra based on average for the years 1976 to 1985.

78 and 83. The months which recorded maximum efforts in each year from 1971 to 85 were April, March, December, February, January,

Relatively high catches were recorded from January to April and in December in almost

all years from 1971 to 85. November has however, registered high catches in the year 1973, 84 and 85.

The catch data analysis made above indicates that the tuna fishing season at Agatti commences from December and lasts upto April with a possibility of starting in the month of November. It also reveals that the period from December to March to be the peak fishing months.

The CPUE in 1971 was high from February to April and in December, maximum being 306 kg in February. Next year higher CPUE was obtained in March and December and lowest from September to November. In 1973 peak months were January, February, May, November and December with highest value of 296 kgs in January, the lowest being 74 kg in March. In 1974, 76 and 77 CPUE were high from January to March ranging between 346 kg

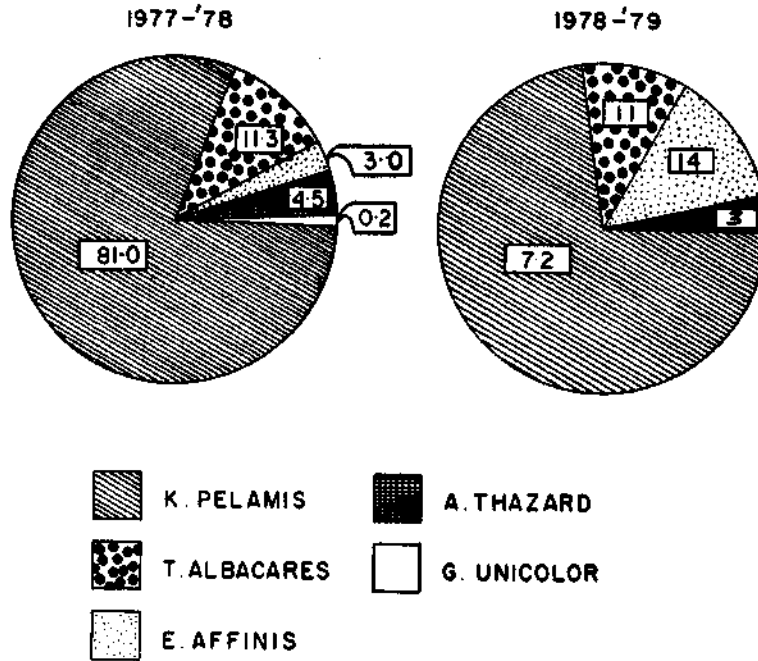


Fig. 5. Percentage composition of different species of tuna in the pole and line fishery at Agatti during 1967-1969.

The CPUE remained at a low level ranging from 209 kg to 384 kg during the period from 1971 to 74. From 1975 onwards a sharp rise in the CPUE is noticed. The reason for low CPUE during early seventies is that it was during this period a substantial number of new boats were introduced for fishing and naturally it took 2-3 years for the fishermen to become proficient in pole and line fishing.

to 707 kg and the lowest months were September to November. The maximum of 707 kg was recorded in January during the above period. The CPUE represented a unimodal trend in March 1977 (346 kg). In 1978 CPUE was good in February March and April with maximum in March (724 kg) and lowest in September to November. In 1979 CPUE were high in February to April and lowest in

November/December. In 1980 the highest CPUE was in March and lowest in December. In 1981 CPUE was high in March and December and lower in September to December. The major peaks of CPUE were in March, February and November for the years 1982, 83 and 84 respectively. In 1985 higher CPUE around 600 kg were recorded in January, March, May, November and December and lower months were September and October. 1091 kg recorded in November 84 was the maximum CPUE during the 15 year period.

#### BIOLOGICAL OBSERVATIONS

Some studies on the biological aspects of tuna landed at Agatti during the period 1977-79 were made. Sex ratio, species composition and analysis of gut contents were the main aspects on which investigations were made. The results of the observations are given below.

contribution of *Thunnus albacares* has been 11.4% and 10.5% for the above years. *Euthynnus affinis* formed 3.1% and 14% during these years. The share of *Auxis thazard* in the catch is very less forming 4.8% and 3.1%. *Gymnosarda unicolor* formed only 0.2% during 77-78 and during 78-79 the contribution was nil.

#### Sex ratio

The ratio between males and females was found to be 1:1.11 for the year 77-78 and 1:1.52 for the year 78-79. The ratio of males and females for the two year period was 1:1.29. The monthwise percentage of males and females during both years are given in Table 1. It is seen from the data that in 77-78 during the month of January, April and May females were dominating over males and during December and March males dominated over females. During February both sexes were

TABLE 1. Percentage of males and females of Skipjack tuna from Agatti during 1977-79

| Months and year | Total No. of fishes | 1977-78             |                       | 1978-79             |                     |                       |
|-----------------|---------------------|---------------------|-----------------------|---------------------|---------------------|-----------------------|
|                 |                     | Percentage of males | Percentage of females | Total No. of fishes | Percentage of males | Percentage of females |
| November, 1977  | —                   | —                   | —                     | 79                  | 45.6                | 54.4                  |
| December, 1977  | 61                  | 52.5                | 47.5                  | 57                  | 43.8                | 56.2                  |
| January, 1978   | 46                  | 43.5                | 56.5                  | 96                  | 57.3                | 42.7                  |
| February, 1978  | 114                 | 50.9                | 49.1                  | 15                  | 40.0                | 60.0                  |
| March, 1978     | 66                  | 54.5                | 45.5                  | 39                  | 33.3                | 66.7                  |
| April, 1978     | 374                 | 46.0                | 54.0                  | 22                  | 18.2                | 81.8                  |
| May, 1978       | 144                 | 37.5                | 62.5                  | —                   | —                   | —                     |

#### Species composition

The species of tuna contributing to the fishery are Skipjack (*Katsuwonus pelamis*), Yellowfin (*Thunnus albacares*) frigate tuna (*Auxis thazard*) Little tunny (*Euthynnus affinis*) and dog-tooth tuna (*Gymnosarda unicolor*). *Katsuwonus pelamis* contributed to the major share of tuna landed at Agatti (Fig. 5) with 80.6% and 72.37% during the year 1977-78 and 78-79 respectively. The

almost equal. During 78-79 females dominated over males in November, December, February March and April and males dominated over females, only in January.

#### Spawning season

Condition of eggs were examined daily and classified into stages I to V according to the maturity conditions. The females were also

divided into three categories on the basis of maturity stages viz. immature (stage I and II) maturing (stage III) and mature (stage IV and

TABLE 2. Percentage occurrence of female *Katsuwonus pelamis* in Immature, Maturing and Mature stages during 1977-79 in Agatti

| Month    | year | Immature | Maturing | Mature |
|----------|------|----------|----------|--------|
| December | 1977 | 20.9     | 39.5     | 39.6   |
|          | 1978 | 77.3     | 18.2     | 4.5    |
| January  | 1978 | 21.0     | 68.5     | 10.5   |
|          | 1979 | 42.2     | 43.8     | 14.0   |
| February | 1978 | 3.5      | 51.3     | 45.2   |
|          | 1979 | 29.7     | 56.3     | 14.0   |
| March    | 1978 | 19.2     | 23.0     | 57.8   |
|          | 1979 | 48.5     | 42.15    | 9.0    |
| April    | 1978 | 12.9     | 19.4     | 67.7   |
|          | 1979 | 30.0     | 42.5     | 27.5   |
| May      | 1978 | 10.0     | 20.0     | 70.0   |
|          | 1979 | —        | —        | —      |
| October  | 1978 | 65.0     | 32.5     | 2.5    |
|          | 1979 | —        | —        | —      |
| November | 1978 | 94.5     | 3.5      | 2.0    |
|          | 1979 | —        | —        | —      |

above). 263 Skipjack females were examined during 1977-78 and 273 of female Skipjacks were examined during 1978-79 to study the maturity conditions. The data is furnished in Table 2. The data has indicated that the mature fish is observed throughout the tuna

fishing season. During 77-78 season the matured fish is found abundant in February to May. During the next year (78-79) comparative abundance of matured fish was noticed in January to April. The quantity of matured fish was found declined during October and November. The maturing females are found to be in abundance in all the months except November in both fishing season.

#### Food and feeding

Guts of 468 specimens of *Katsuwonus pelamis* were cut opened to examine the contents during the period 1977-79. The results of the examination is given in Table 3. The predominant food items were prawn, *Apogon* sp., *Spratelloides* sp. and cuttlefish. Out of these, prawn and cuttlefish were dominant, occurring almost throughout the year. *Apogon* sp. and *Spratelloides* sp. found in the guts were the live-baits churned from the pole and line fishing boats. The prawns were found in greater quantities in January, February May and December. The percentage of prawn ranged from 12 to 69%. Comparatively higher quantities of cuttlefish were found during January and February in both seasons.

TABLE 3. Food items in the gut contents of *Katsuwonus pelamis* from Agatti 1977-79 (Values are expressed in percent. Figures in brackets indicate number of fish examined)

| Food items                       | 1977-78      |              |              |              |              |             |              | 1978-79      |              |              |              |              |
|----------------------------------|--------------|--------------|--------------|--------------|--------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|
|                                  | Dec.<br>(24) | Jan.<br>(16) | Feb.<br>(36) | Mar.<br>(36) | Apr.<br>(44) | May<br>(16) | Oct.<br>(16) | Nov.<br>(32) | Dec.<br>(28) | Jan.<br>(44) | Feb.<br>(32) | Mar.<br>(56) |
| Prawn                            | 34           | 20           | 20           | 12.70        | —            | 75          | —            | 20           | 14.28        | 41.2         | 68.75        | —            |
| <i>Apogon</i> sp.                | 18           | 32.5         | 28           | 30           | 6.36         | —           | —            | 12.5         | 44.28        | 7.27         | 2.5          | —            |
| Cuttlefish                       | 9            | 25           | 18.7         | 20.5         | 19.40        | —           | —            | 17.5         | 14.28        | 15.9         | 20           | 7.14         |
| Unidentified fish larvae         | 28           | 12.5         | 3.3          | —            | 23.6         | 25          | —            | 17.5         | 1.43         | 9.09         | —            | —            |
| Trigger fish                     | 2            | —            | —            | 31.2         | 8.18         | —           | —            | —            | 14.31        | 3.18         | —            | —            |
| <i>Spratelloides delicatulus</i> | 5            | —            | 8.8          | —            | 14.54        | —           | 100          | 20           | 11.42        | —            | —            | 44.44        |
| Unidentified semidigested food   | —            | 2.5          | 10           | 3.38         | 9.09         | —           | —            | —            | —            | 20           | —            | 3.0          |
| Miscellaneous                    | —            | 7.5          | —            | 2.22         | 2.72         | —           | —            | —            | —            | —            | 3.75         | —            |
| <i>Squilla</i> sp.               | —            | —            | 9.6          | —            | —            | —           | —            | —            | —            | —            | —            | —            |
| <i>Chirocentrus</i> sp.          | 1            | —            | 1.6          | —            | —            | —           | —            | —            | —            | —            | —            | —            |
| <i>Upeneus</i> sp.               | —            | —            | —            | —            | 12.72        | —           | —            | —            | —            | 3.36         | 5            | 6.14         |
| Crustacean Larvae                | —            | —            | —            | —            | —            | —           | —            | 12.5         | —            | —            | —            | 39.28        |
| <i>Caranx</i> sp.                | —            | —            | —            | —            | 3.36         | —           | —            | —            | —            | —            | —            | —            |

The other items of food which were occasionally found in certain months were Trigger fish *Upeneus*, *Chirocentrus*, *caranx*, *Squilla*, larva of fish and crustaceans.

The visual grading of the fullness of the stomach for 468 specimens was as follow:

| Grading                 | Percentage |
|-------------------------|------------|
| Empty                   | 66.45      |
| $\frac{1}{4}$ and above | 0.64       |
| $\frac{1}{2}$ and above | 15.17      |
| Full                    | 17.74      |

The Table indicates that crustaceans and fishes constitute the most important items of

food of the oceanic *Katsuwonus pelamis* around Agatti Island in Lakshadweep.

#### CONCLUSION

The above studies show that there is tremendous scope for further development of Skipjack tuna fishery in Lakshadweep concentrating at Agatti. Both the Skipjack tuna and the live-bait resources are potentially great capable of sustaining a fishery even with effort increased to many folds. Small-scale tuna fishing as practiced now in Agatti is highly economical. Besides small-scale fishing, it is essential that commercial fishing operation with large vessels is to be immediately introduced to tap the bulk of the migratory tuna resources now lost for the country.

#### REFERENCES

- GEORGE, P. C., B. T. ANTONY RAJA AND K.C. GEORGE 1977. Fishery resources of the Indian Economic Zone. *Silver Jubilee Souvenir, IFP*, pp. 79-116.
- HORNELL, J. 1910. Report on the results of a fishery cruise along the Malabar Coast and the Laccadive Islands in 1908. *Madras Fish. Bull.*, 4: 71-126.
- MATHEW, M. J. AND T. B. RAMACHANDRAN 1956. Notes on the survey of fishing industry of the Laccadive and Aminidivi Islands. *Fisheries Station Reports and Year Book, Madras*, 1954-55. pp. 125-137.
- NAIR, K. S. 1986. Fisheries development in Lakshadweep. *Fishing chimes*, 6 (2): 20-25.
- PUTHRAN, V. A. AND V. N. PILLAI 1972. Pole and line fishing for tuna in the Minicoy waters. *Seafood Exp. Jour.*, 4: 11-18.
- SILAS, E. G. AND P. P. PILLAI 1982. Resources of tunas and related species and their fisheries in the Indian Ocean. *Bull. cent. mar. Fish. Res. Inst.*, 32: 1-174.
- , K. V. N. RAO, P. P. PILLAI, MADAN MOHAN, G. GOPAKUMAR, P. LIVINGSTON AND M. SRINATH 1986. Exploited potential resources of tunas of Lakshadweep. *Mar. Fish. Infor. Ser. T & E Ser.*, 68: 15-25.
- VARGHESE, G. 1970. Comparative merits of mechanised boats over non-mechanised boats on oceanic skipjack tuna live-bait fishery. *Seafood Exp. Jour.*, 3: 115-121.