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NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP
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(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

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Limited Circulation

TUNA POLE AND LINE (LIVE BAIT) FISHING TECHNIQUE OF LAKSHADWEEP - SOME SUGGESTIONS FOR IMPROVEMENT

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ABSTRACT

Adding some essential details to the existing scientific exposition of the Tuna Pole and Line (TPL) fishing technique with live bait of Lakshadweep, the present paper deals largely on a comparative study of this technique with the TPL technique operating in Japanese, Californian and Polynesian waters. Based on this comparative study some suggestions are given for improving the craft, gear and gear-making with regard to the TPL fishing technique of Lakshadweep. Besides the need for having better objectives of mechanisation, improvements in : Size and cruising range of fishing boats; general feature of the fishing boats; types of engines used; live-bait equipment used; onboard facilities for the operation of the fishing gear; fish preservation and handling equipment onboard; facilities for crew accommodation onboard; navigation, communication and fish finding equipments onboard; combination fishing boats; alternative fishing boat; ancillary ships; materials used for construction of boats and also improvement in patrol and transport work undertaken by the fishing boats are suggested. Also, the need for introducing the team-gear, bait-hook, lure-hook and striker and for improving the mode of angling, chumming and water splashing is stressed. The urgent need for modernising the TPL gear-making industry by indigenously making TPL hooks, lure-hooks, bait hooks and strikers; by supplying FRP Poles and quality bamboo Poles and the other fishery requisites at subsidy and by introducing quarantine and quality control measures to maintain the quality of bamboo Poles is stressed.

INTRODUCTION

The Indian Union Territory of Lakshadweep forms one of the natural oceanic regions of the World where the Skipjack tuna, *Katsuwonus pelamis* and small yellowfin tuna, *Thunnus albacares* abound in immense potential at surface layers which are being fished by the TPL (live bait) fishing technique. These species support large scale TPL (live bait) fisheries in several parts of the World, especially in the Japanese and Californian waters where a lot of technological advancements have been made in tuna fishing. A comparative study of the TPL (live bait) technique of Lakshadweep with that of other parts of the world would reveal our present and future development needs. No such comparative account is available in exising literature with regard to the TPL (live bait) fishing technique of Lakshadweep, as revealed notably from Hornell (1910, 1934 and 1950), Ellis (1924), Rao (1955), Mathew and Ramachandran (1956), Jones and Kumaran (1959), Varghese (1970), Puthran and Pillai (1972), Ben Yami (1980), Silas and Pillai (1982), Madan Mohan *et al.* (1985) and Livingston (MS), and to this method of Maldives and Sri Lanka which is reported to be the same as that of Lakshadweep (Jonklas, 1967 and FAO, 1975). Therefore, besides adding some details to the existing description of the TPL (live bait) technique of Lakshadweep, a comparison of this fishing technique with that of Japan, California and Polynesia is attempted in the present investigation and some of our craft and gear technological needs for development in this line are brought to light in this paper.

MATERIAL AND METHODS

As part of the tuna fishery biological investigations undertaken in Lakshadweep during 1975-'81, a total of 44 onboard observations were made at Minicoy during the fair tuna seasons of 1975-76 and 1980-'81.

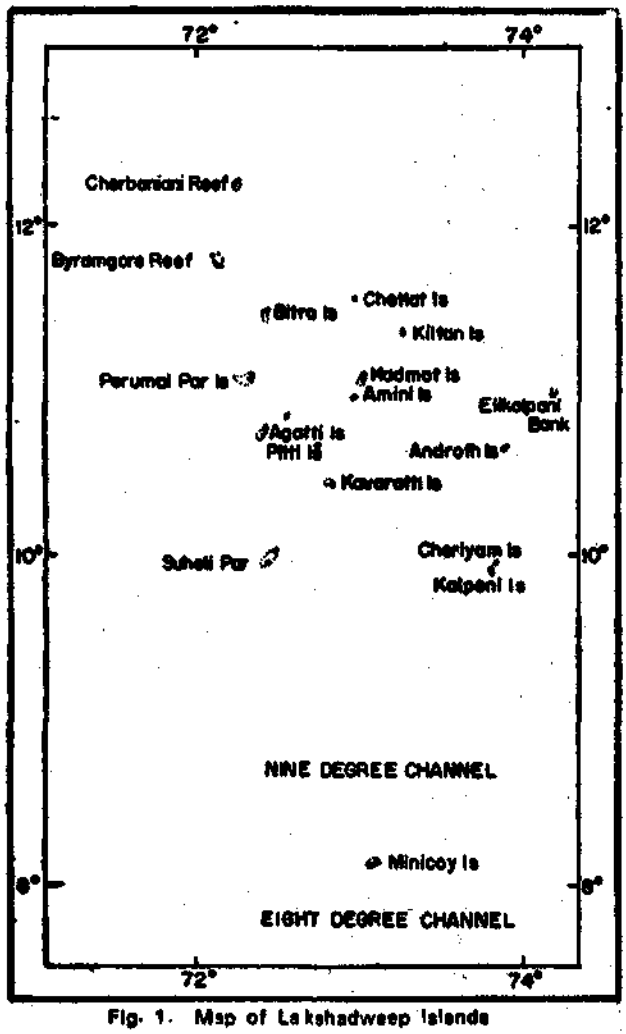

Fig. 1. Map of Lakshadweep Islands

Each trip was of about 10 hours duration between 6 a.m. and 9 p.m., conducted within 20 km radius around the islands. All the remaining nine inhabited islands in Lakshadweep (Fig 1) were also visited for craft and gear survey during the period, 10th May 1976 to 8th Dec. 1978. Information on this fishing technique gathered by extensive enquiries with local fishermen experts in each island were critically examined by the onboard observations at Minicoy. For the present comparative study scientific knowledge regarding the TPL technique operating in other areas of the world was gathered from literature.

OBSERVATIONS ON TPL (LIVE BAIT) TECHNIQUE OF LAKSHADWEEP

The TPL (live-bait) Boat and its Crew:- Details of this craft are given notably by Puthran and Pillai (1972), Ben Yami (1980) and Silas and Pillai (1982). Some more essential features are added here. Fig. 2 shows the parts of a typical boat of 9.14 m OAL. There are six gear positions fixed by convention onboard the fishing platform, three on either half of it, (P_1, P_2, and P_3 in Fig. 5). These gear positions, the operator of the gear from these gear positions, and the gear unit operated by them are locally distinguished as *bandu dhori*, *gudhu* and *enja* in order. There is an

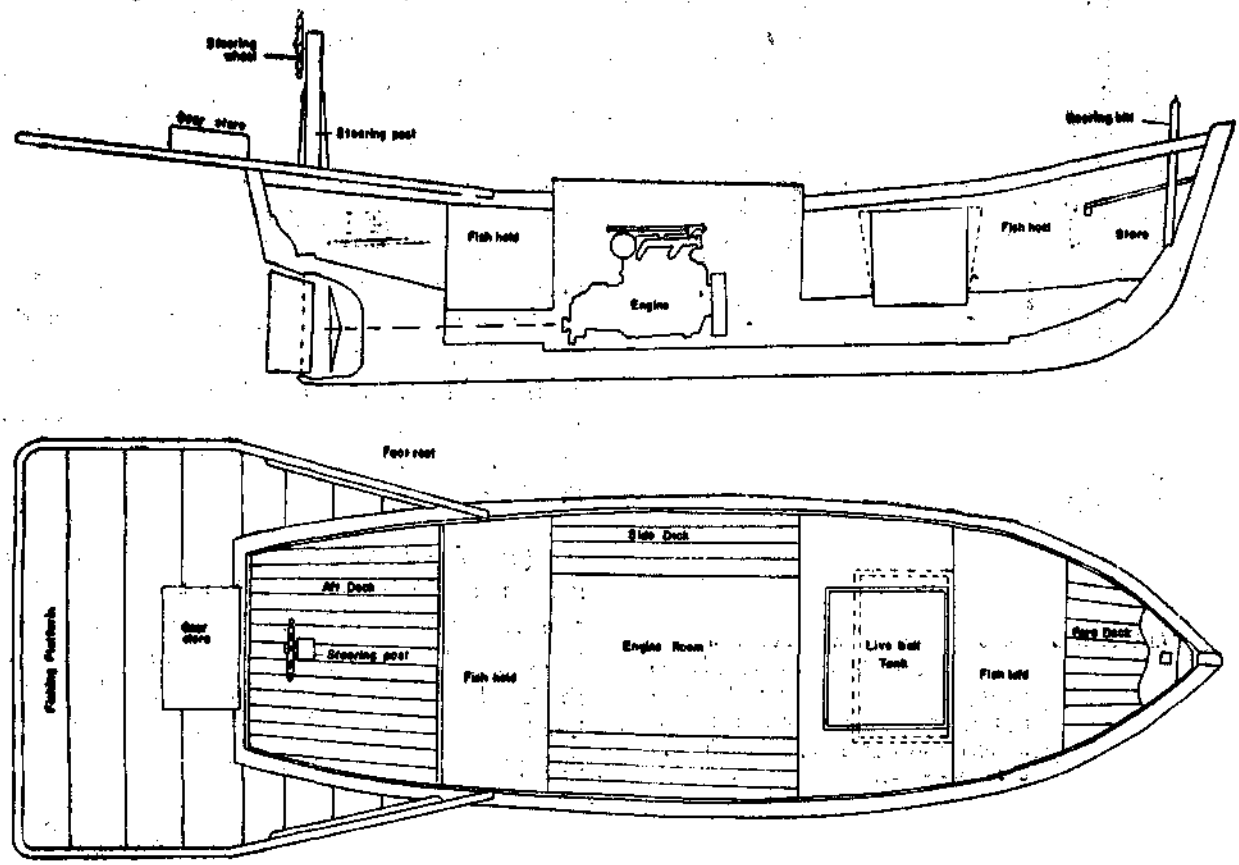

Fig. 2. Parts of typical mechanised Skipjack Tuna Pole and Line (Live bait) boat of Lakshadweep.

aft to fore reduction in length of 25-36 cm between the successive gear unit (Pole) operating from P_1 to P_3, for any of the four varieties of the gear operated from all these gear positions. Typically a crew compliment of minimum 14 men is required : the Chief fisherman, engine driver, chummer, six leading fishermen (operators of the TPL gear), four water splashing men and one man for auxiliary services onboard.

Parts of a typical pole and line gear (Fig. 3 A & B).- This gear is described originally by Jones and Kumaran (1959). However, a more detailed description is given here. A typical unit of the Pole and line gear of Minicoy consists of the following parts, *viz.*, (a) The Pole, (b) The Leader or Leader line (c) The Snood and (d) The Hook.

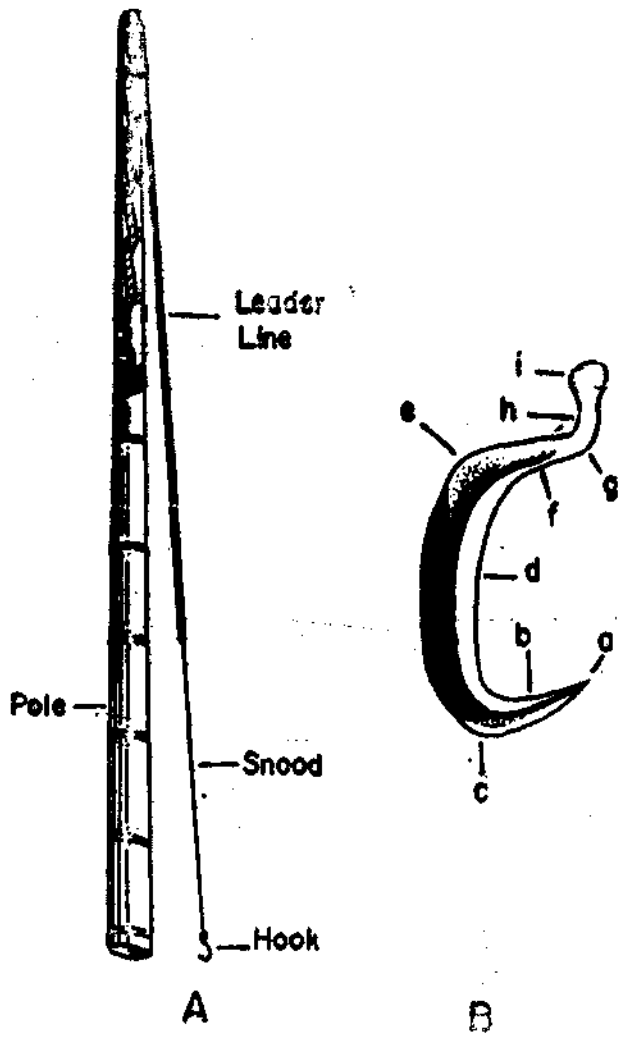

Fig. 3 A & B Parts of typical Skipjack Tuna Pole and Line (live bait) fishing gear of Lakshadweep. (a—Point; b—Fore-leg; c—Fore-bend; d—Shank; e—Aft-bend; f—Aft-leg; g—Eye-bend; h—Eye base and i—Eye).

(a) *The Pole:-* The Pole of this gear is a bamboo rod, about 2 fm (3.66 m) long. Its diameter reduces gradually from the basal end (30-35 mm) to the terminal end (25-39 mm). There are 10-12 internodes contained within the entire length of the Pole. These internodes reduce in length from the basal end towards the terminal end of the Pole. The basal butt of the pole ends just about 3 cm down the lower most node, giving a suitable internodal cup for securing the hook when the gear is at rest. The terminal end of the Pole ends just about 3 cm above the upper most node, giving a suitable marling surface for the rigging of the Leader Line. The adjoining few nodes below also provide suitable marling surfaces for the auxilliary rigging of the Leader line.

(b) *The Leader Line:* The main line through which the snood is rigged to the terminal end of the Pole forms the Leader Line of the gear. It is a three strand (16 x 3), 3-5 mm nylon twine with an S-twist. When detached from its Pole, the Leader measure about 1.5 m in stretched length. It is bent to form two almost equal limbs, each extendable from the terminal end of the Pole to a little down its middle. One limb of the lead Line hangs down freely from the point of its securing at the distal end of the Pole and extends almost upto a little down the middle of the Pole, at which level, this end of the Leader Line is rigged to the upper end the snood coming from the hook. The other limb of the Leader Line is marled around the Pole to secure the former limb in position. The colour of the Leader Line is often blue, to merge with the Sea.

(c) *The Snood:-* The snood of the gear is formed by a piece of 1.0 mm monofilament almost equal to half the length of the Pole. It is rigged to the hook at the basal end and to the Leader Line at the terminal end. Unlike the Leader Line, the Snood is more flexible and this quality of the Snood enables its stretching

upto about 2 cm downward for the securing and releasing of the attached hook in position in the butt socket of the Pole. Typically, the snood also is bue in colour to merge with the sea. The total length of the entire line, including the length of the rigged hook, the rigged snood and the rigged Leader Line together equals the length of the Pole.

(d) *The Hook (Fig. 3 b)*:- Assuming a typical pole and line tuna hook to have some atttributes of a traditional tuna boat, the Minicoy hook makers and tuna fishermen distinguish three major portions in a typical Pole and Line Tuna Hook, *Viz*, (i) the Fore End *(Thundu kolu* or *Dhurmba kolu)*, (ii) The Aft End *(Filathy kolu* or *Kolufus kolu)* and (iii) the Shank or main Body *(Thadi)*. The upper side *(Mathi farai)* of the hook (when the hook is placed in its normal trailing position in water with its projecting limbs upwards), is distinguished from the lower side *(dhe farai)*. The hook measures 4.5-5.5 cm in length. The major sections of the hook and their specific functions may be described as follows:

(i) *Spear (Thundu)* : The spear or point represents the distally narrowing fore end of the hook. It occupies about one fifth of the entire fore aft length of the hook measured along its body. It is of the barbless type. The short piercing edge or point *(thundu kuri)* forming the extreme distal tip of the spear is subconical with roundish sides whereas the remaining portion forming the major parts of the spear is four sided. The piercing tip though sharp is thickly pointed so as to enable easy retrival of tuna once it is hooked.

(ii) *Fore bend (Thundu gudhu)*:- This is the the curved portion of the hook placed between the spear and shank proper. The degree of curvature of the fore bend is considered to be an important attribute in designing hooks; it determines the retrival efficiency, stability and proper bubble formation of the hook while it is trailed in water (Fig. 6). It has an obtuse angle of about 45°. This angle is very important for the formation of bubble (around the hook) which simulates an actively vibrating prey.

(iii) *Shank (Thadi)*: The shank represents the main body of the hook, occupying about three fifth of the total length of the hook, measureable along its aft to fore along the body. Major part of the volume and about two third of the weight of the hook is concentrated in the shank, in a gradually decreasing order from its aft to fore. The shank is streamlined and pisciform in shape. It plays the most important role in forming and regulating the size of the water bubble of hook, which in turn is related to the size of livebaits selected for chumming operations. The diamensions of all other parts of the hook being fixed in proportion to the dimension of the shank, the shank serves as the most useful indicator of the size of the hook in selection of hooks. The size of shank increases as the size of hook increases. The shank is of a keeled type with four fore-aft equidistant keels, one upper, one lower and two lateral in position. The lateral keels are a little more pronounced than the other two; this aids in the floatation of the hook in water. The shank is provided with a slight downward carvature along its middle. This curvature locally referred to an amidship bend (*medhu gudhu*) of the hook, gives stability to the hook. The girth (*falami*) of the hook is measured along the broadest portion of the shank falling just at its aftward end which joins the aft bend of the hook.

(iv) *Aft bend (Filathu gudhu)*:- This bend is placed between the aft end of shank and the neck of the hook. Compared with the fore bend, the aft bend is a little more obtusely curved, this obtuse angle being about 60°. The curvature formed at this bend (aft bend curvature) is also considered important in designing hooks and also in selection of quality hooks. The nature and disposition of the aft-bend largely influence the desired stability of the hook and pisciform shape of the bubble produced by the shank while in water; the aft end of shank merging at this bend acting almost as the head of the small live-bait fish in cutting its way through the subsurface water in which the hook is tailed through.

(v) *Neck (Kanthura) or Aft Leg*:- The upwardly projecting aft limb of the hook separating its eye from the aft bend is referred to as the neck (line attachment-leg) of the hook. Unlike in many other standard hooks which do not possess a distinct neck, the neck in the present hook is markedly distinct from the shank. Unlike the shank, the neck is almost roundish throughout its length. It has no tapered keels which when present would cut the bend of the snood placed over it. The relation between the length of neck and spear with its point, is considered important in designing hooks. The desired trim aft condition of the hook and its stablised trailing position in water also are influenced by the nature and disposition of the neck which also provides a strong supporting base for the eye of the hook.

(vi) *Eye (Filathy)*:- The Eye of the hook forms its aft-most portion. It is subrectangular with its narrow base merging at the aft end of the neck and the broad apex tapering aft wardly to form a flattened knob with a gentle upward slope. The eye has no hole for fastening the snood. Instead, at the point where the base of the eye joins the neck, and aftward acute curvature is formed and this curvature enables the fastening of snood to be placed at the neck. The relatively broad and more tapered nature of the eye is considered good to ensure more safety for the attachment of the snood in position. The above curvature also is considered important in designing hooks.

Typical varieties of the TPL gear:- There are four varieties of the gear locally distinguished as *dhigu dhori, mas varu, mudeng* and *Vinna* operated from each of the 3 gear positions P_1-P_3. These in order are described as variety I to IV here below.

(i) *Variety I (Fig. 4.a)*:- This variety represents the longest variation of the Pole and line gear. Its pole as well as line measures 2.5 fm (4.58 m) in total length. The hook

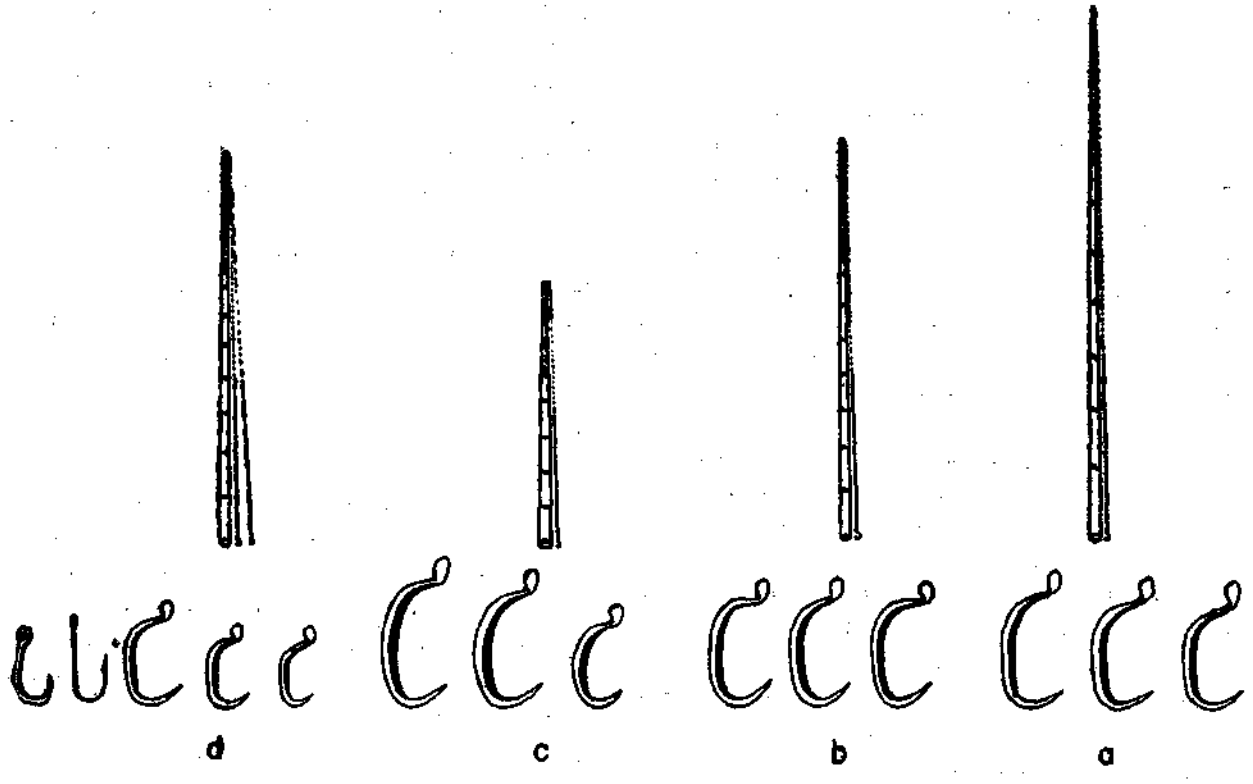

Fig. 4 Four varieties of of Skipjack Tuna Pole and Line (live bait) fishing gear of Lakshadweep (a, b, c & d — Variety I, II, III & IV of the gear

measures 4.5 cm to 5.5 cm in length. The leader line as well as snood shows the thinnest diameter when compared to the other varieties of the gear. Typically, the leader line and the snood measure 1.5 : 1 in length. This variety of the gear is used typically, at a time, as soon as a tuna school is approached by chumming, as well as when tunas are not in good appetlite and feeding frenzy and hence when tunas of the chummed school are keeping a little distance away from the boat in water. Two sub-varieties of this variety of the gear are met with, *Viz.*, the 'long' and 'short' which are used according to (i) degree of proximity of the tuna school to the chummer boat (which first starts chumming with live-baits), within the range or territory of operation of the gear, and (ii) to the degree of skill of the crew operating this sub-variety of the gear; the tall and/or more skillful of the crew preferring a 'long' sub-variety to a 'short' one from the same gear position.

(ii) *Variety II (Fig. 4 b)*:- This may be considered as the medium or typical variety of the Pole and Line gear. Typically, the Pole as well as the line measures 2 fm (3.66 m). The hook measures 4.5 cm to 5.5 cm. The Leader line as well as the snood is a little thicker when compard to Variety I. The hook also is a little thicker and heavier than the previous variety. The obtuse angle of the fore bend of hook is less pronounced in the present variety. This condition favours the relatively quick retrieval of the hooked tuna by this variety than by variety I. As the hooked tuna is taken from relatively short distance from the boat, when compared to variety I, the hooked tuna needs only a relatively short duration of retainment in the gear in variety II, before the hooked game is passed on from the territory of the hook to the boat where it is retrieved.

Variety II is the most commonly used and typical variety of the Pole and line gear. It is used only when the operator crew are sure that the tuna school responds well to chumming and comes nearer the chummer boat showing visibly detectable sings of better appettite and feeding frenzy, and biting hooks indiscriminately at relatively quick intervals. Here also, two sub-varieties, *viz.*, 'long' and 'short' are met with as in the previous case. The use of these sub-varieties also is done in the similar manner, as it is described above for sub-varieties under variety I.

(iii) *Variety III (Fig 4 c)* :- This is the shortest of all varieties of the Pole and line gear. The Pole as well as line typically measures 1.5 fm (2.75 m). The hook typically measures 5.0 cm to 6.5 cm length. The leader line and snood show approximately 2:1 ratio in length. They are a little thicker than their counter parts in variety II and the thickest of all when compared to their counterparts in all varieties of the gear. The Pole though the shortest, is the stoutest, strongest and heaviest of all poles used in different varieties of the gear. The hook also is the biggest and heaviest of that in all varieties of the gear. Its fore bend is relatively a little more obtuse than in variety II, giving maximum retrieval feasibility. This variety is used when the tuna school in the hooked territory is in very good appettite and feeding frenzy, approaching very near the boat and biting hooks in the most indiscriminate manner, and supporting a very handsome tuna fishery. No Sub-varieties of variety II is met with.

(iv) *Variety IV (Fig. 4 d)*:- This is the most lean weakest and lightest of all varieties. Typically, the Pole as well as the line measures almost equal to that of variety I or II in length. But the Pole in this case is a little more lean than that in the above two varieties and also that of variety III. The leader and snood length ratio as well as thickness of leader and snood also is the same as in variety I or II. The hook is the smallest of all varieties. It measures 3.0 to 4.0 cm in length. It is the lightest and smallest of all varieties of hooks. The angle of fore bend of the hook also resembles that of hook of variety I or II. The variety of the gear is used only towards the end of fishing from a school of chummed tunas, when the tuna refuses to take live-baits supplied to it during chumming operations,

when being chummed for a while, tunas get their appetite mitigated considerably and hence they start discriminating hooks and avoiding biting them. Stray numbers of such tunas are taken by this variety of gear towards the tail end of chumming operation.

There are three sub varieties recognised under variety IV *'viz.* big'(*Vinna bodu*), *'small'* (*Vinna kudu*) and *'Gatha'*. In all these sub-varieties, the pole as well as the leader line is the same in length but the hook differs in size. Sub-variety 'big' has 4.0 cm hook typical of this variety and sub-variety 'small' has 3.5 cm hook. The third sub-variety uses a 2.5 – 3.0 cm hook of Minicoy, or an ordinary 2.0 cm to 2.5 cm Japanese hook or an ordinary 3.5 cm Indian (mainland) hook whose barb is removed and the hook dressed with a live fish. Often the pole bears two lines, each rigged with a hook at its free end.

'Techniques of operation :- In order to effect a smooth and orderly operation of each unit of the gear from the onboard gear positions, P_1 to P_3, a definite area of hook action (hook territory) in water is assigned conventionally with respect to each gear position. Accordingly, the hook of respective gear unit from positions P_1 to P_3 on each half of the fishing platform should be trailed in water only along a straight line trailing course as the boat moves forward in 1.5 – 3 knots speed. The hook may be moved in the form of an arc to left or right only for a transverse distance of about 0.5 m. This limited range of the hook territory is always maintained for avoiding snagging of successive gear units. The gear operator stands at the main strength of his backbone on each gear position in a definite manner for operating the gear unit held in both hands. The angle between his heels and toes is fixed and it is indicated by the foot prints marked at P_1 to P_3 in Fig. 5. While shooting the gear unit, the terminal end of the pole is not raised above the eye level of the

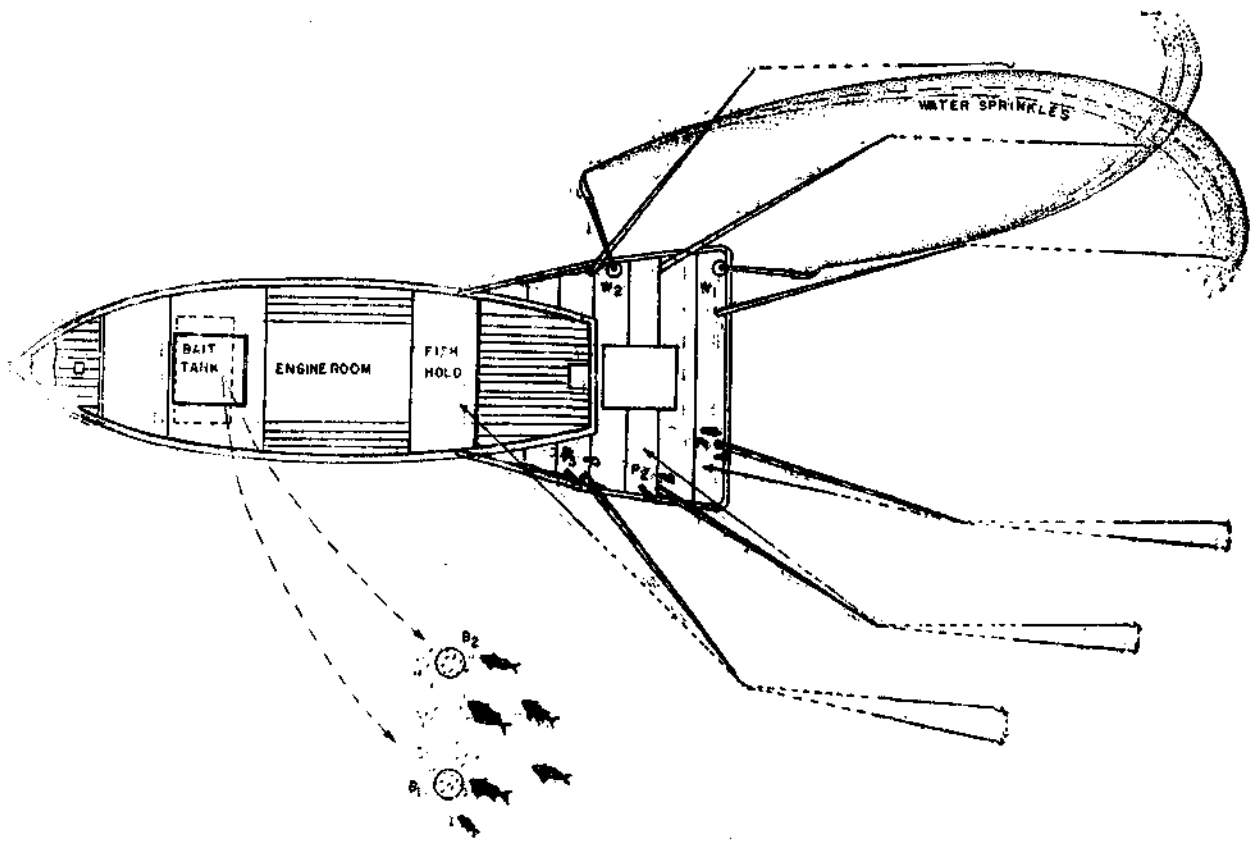

Fig. 5. Operation of the Skipjack Tuna Pole and Line (live bait) gear at Lakshadweep. P_1, P_2, P_3 — Gear positions; W1, & W2 — Positions for the water-splashing men; B1, B2 Chumming positions in water.

operator. There is a defenite slope of the pole held in hands. This slope (Shooting angle) ranges from 20-25° when measured from the imaginary line passing through the butt end of the pole. In order to effect an orderly hauling of the gear unit and quick retrival of the hooked tuna, specific retrival directions are fixed conventionally onboard the fishing platform. These directions as indicated by arrows in Fig. 5 for gear positions P_1, P_2 and P_3 are an anticlockwise, clockwise and anticlockwise in order.

Chumming with live baits as well as water splashing are integral operations of the TPL fishing technique. The purpose of chumming is to attract a sub-school of tuna from the main school to follow the fishing boat (chummer) near the gear positions P_1 to P_3 on either side of the fishing platform. As soon as a tuna school is sighted or its presence indicated, the speed of the boat is reduced to 1.5-3 knots and chumming with live bait starts at the instructions of the chief fisherman. Initially trial chumming is done by the chummer throwing scoopfuls of live baits at the extreme seaward of his stretch on either side of the boat at position marked B_1 in Fig. 5. In case tuna rise to surface to bite the thrown live baits (chum), handfulls or even 5 to 6 specimens of livebaits are thrown in a sustained manner nearer the boat at position B_2 Fig 5, on either side of the boat so as to make the chum available in hook territories of gear position P_1 initially and from there subsequently by the wake to the hook territaries of P_2 and P_3. The positions W_1 and W_2 in indicate the sitting positions of the two water splashing men onboard on the half of the fishing platform. When done correctly, the splashes of water produced from these positions dash each other in air and disintegrate into profuse sprays in the hook territories. The purpose of providing these water sprays appears to be for enhancing the vibrations of the air-bubble around the hook, trailed in water just below the surface (Fig 6), for attracting the tuna; the vibrating air-bubble simulating an agile prey (fast moving squid or small fish). The air-bubble serves as a

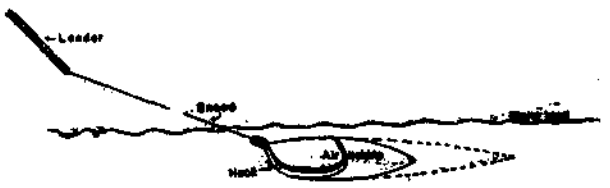

Fig. 6. Air bubble formation of the hook under water in the Skipjack Tuna Pole and Line (live bait) fishing technique of Lakshadweep.

novelty vibrating in the midst of the chum for the tuna to be attracted by the novelty to bite it including the concealed hook.

TPL (live bait) Gear-making:- The hook used for rigging the TPL (live bait) gear is made in an organised manner only at Minicoy from where it is sold to all the Islands. Three inch M.S. rod used for making hooks is brought from mainland at the cost of hook-maker. Traditional hand forging method is used to make hooks. Fig. 7 shows four successive stages in the hand forging of hooks. Hooks are tempered and lead coated to give them

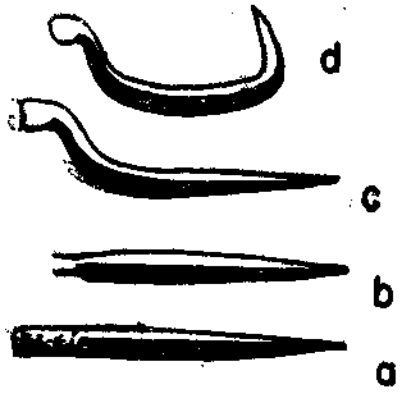

Fig. 7 (a—d) For successive stages in making the Tuna hook of Minicoy, Lakshadweep by hand-forging method.

strength and the characteristic silvery shining. Bamboo poles used for making the gear are brought from Calcutta at the cost of the boat owner, mostly through Minicoy Seamen. Line materials are procured from mainland at the cost of the chief fisherman of each boat. Pliability, handling feasibility, strength and weight are the common citteria used in

selection of Poles. Srength, elasticity, diameter and colour are the common criteria based on which the double strand Polyvinile yarn and monofilament are selected for making the leader and snood in order. Hooks without any structural defects are selected according to the variety of the Pole, size of tuna to be caught, species of live bait used and skill of crew operating the gear. The construction details of the gear are given in Fig 8. The hook maker gets one share of the crew's portion of the daily tuna catch of a boat as hire charges for the entire hooks

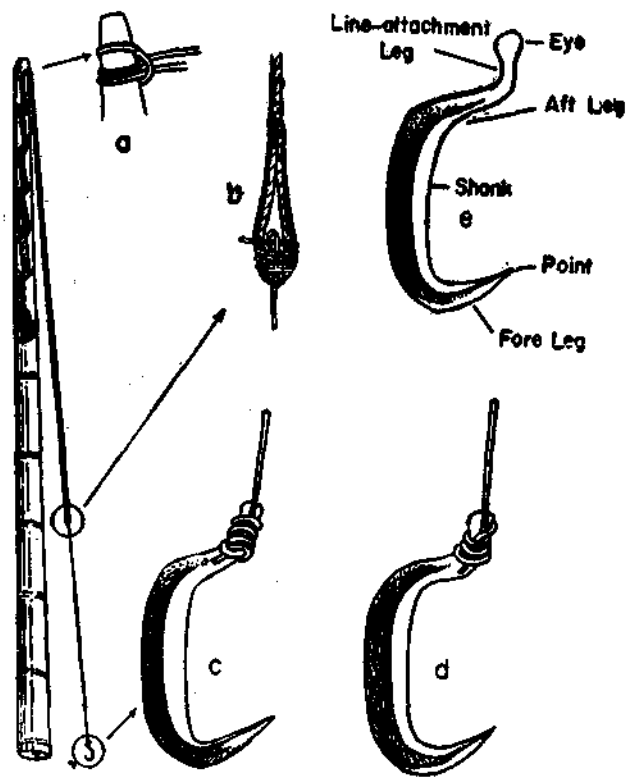

Fig. 8 Construction details of the Skipjack Tuna Pole and Line (live bait) gear of Lakshadweep a—Marling hitch, b, c & d—Double Sheet bend; e — Parts of a hook in relation to rigging of the gear.

he supplies to the boat. The chief fisherman gets half share of the crew's portion of the daily tuna catch as his additional wages for supplying the snood and leader and for rigging the TPL (live bait) gear required by his boat.

SOME DEVELOPMENTAL NEEDS AND SUGGESTIONS FOR IMPROVEMENT

some of the present and future developmental needs of the Lakshadweep TPL (live bait) fishing techniques are pointed out herebelow. Some of the restraints for fisheries development and suggestions for improvement also are discussed in this connection.

(a) *Craft Technological needs* :- (1) It is clear that Japan and California have gained over 90 and 100 year's, experience in the mechanization of their respective fisheries. Their respective TPL (live bait) fisheries have been mechanized since the turn of the present century with the definite goal of developing the oceanic fisheries for the skipjack tuna and the yellowfin tuna for local consumption, export or for reducing import. Their objectives of promoting production of these tuna have been achieved by a step-by-step progress through several developmental plans and governmental aids to fishermen under proper legislation. There is urgent need, in Lakshadweep for licencing the oceanic skipjack tuna and yellowfin tuna fisheries under revised fisheries law and under this law to make available to local fishermen governmental aid in the form of bank loans for constructing medium and large-type TPL (live bait) vessels, combination fishing boats, alternative fishing boats and ancilliary ships supporting the fishing fleet. The local boat building industry should be further expanded with the introduction of advanced technology of naval architecture in building vessels. Necessary improvements should be brought in, in the boat law, port law, and fishermen co-operative law to make available to the fishing industry several modern facilities and infrastructure like the fishing Harbour, Ice plants and canning factories in selected Islands. Until, modern fishing Harbour facilities become available in selected islands, medium and large-scale fishing operations in the offshore and oceanic

waters around the islands may be based at one or two selected mainland ports of the west coast like Cochin and Bombay.

2. Japan and California have achieved step-by-step progress in increasing the size of their respactive fishing craft and their cruising ranges. As the fishing operation extended from the coastal to offshore, oceanic and distant water environments, the size and quality of the fishing craft also gradually expanded over several decades from the small and medium type country crafts to the small-medium-and large-type mechanized vessls. There is urgent need in Lakshadweep to extend the fishing operation to offshore waters lying between the adjacent landmasses and submerged banks. The present day fishing operation is more or less coastal in character. It extending only one day per trip. This is to be enhanced to 3 to 10 days and over 30 days fishing at a stretch in the sea. Medium-type and large-type mechanized fishing vessels, are therefore to be introduced. The submerged banks in the northern reaches, viz. *Basses de Pedro*, Byramgore reef, *Cherbanrani Eli Kalpeni*, etc. are to be fished for live baits and tunas. Also the numerous bays and gulfs along the southwest coast of India including the wadge Bank region are to be fished for potential live baits such as the anchovies and sardines for use as the live baits. Each trip from the west coast port may cover at least a few of the neighbouring islands in Lakshadweep, a distance ranging from about 400-1000 km per trip. Also some fishing trips may be extended to over a few thousand km beyond the islands, in the continguous high seas outside our Exclusive Economic Zone.

Therefore a new generation of two types of fishing vessels is to be introduced in Lakshadweep *viz.*, a medium-type (20 g. t.) and large-type (100 g. t.) vessels, the former for fishing between the mainland and the outlier islands and the latter to fish in the highseas beyond the outlier islands. Experience in California indicates clearly that TPL (live bait) vessels above 100 g. t. are very expensive for maintenance of staff onboard and for procuring live-baits. Japan also is finding it very expensive to maintain large vessels above 100 g. t. since more recent years. Therefore, it is advisable for Lakshadweep not to introduce TPL (live bait) fishing vessels above 100 g. t. for the present even on an investigation basis. Further, as long as the live-bait availability remains scanty in islands, introduction of any medium-and large-type TPL (live bait) boat also may be made only on an investigation-basis to start with. Proper resources survey of the potential live-bait around the Islands submerged banks and also the southwest coast of the mainland and Wadge Bank area and experimental feeding of tuna with potential new live baits like sardine and anchovies from onboard the survey vessel are inevitable for the successful introduction of considerable number of medium and large TPL (live bait) boats in the Islands.

3. While bringing about future improvements in the general feature of the TPL (live bait) boat at Lakshadweep, it would be interesting to provide a crews' nest on the deck, for enabling spotting of tuna schools based on observations on sea-birds. Further, there is no closed drinking water supply system in the islands. The subterranean water table is scarce in islands, it being absent typically on either ends of the landmass. There is no pump system installed to carry the water from the Island to the boat. Therefore it would be ideal to provide sufficiently large water storage tanks in these boats to store sufficient water from the mainland port. The fuel oil tank onboard also should be large to store more fuel oil from the mainland port. The brine tanks should be sufficiently large to serve as fish-hold during the return voyage to the canning factory at Minicoy or at the selected insular or mainland port. As in the case of the clippers, the vessel may be designed to carry the maximum load and the necessary mechanical and electrical equipment in the minimum overall length of hull.

4. High speed diesel is reported to be suitable for 100 g. t. TPL (live bait) boats. This results in reduced weight, saving in space, and greater cargo capacity. The high speed

diesel is also suitable for the 20 g.t. and still smaller boats and for auxiliary services in the tuna fleet.

5. There is urgent need to provide efficient system of live bait storage and handling onboard the Lakshadweep TPL (live bait) boats. As the local supply of live baits available from around the islands is not adequate, live baits (anchovies and sardines) are to be exploited from near the mainland southwest coast. A better system of preservation with large tanks, engine-driven replenishment of the medium by pumps and carrying live baits on board by pumps are essential. Hydraulic pumps are reported to be superior to pumps driven by electric systems. Plastic pipes are considered to be free from corrosion, marine fouling hazards and from electrolysis. Necessary caution should be exercised in not selecting or inventing top-heavy designs of bait boxes which would upset the overall stability of the vessel, as it happened in California during 1926-30.

6. Mechanised power should be used for the operation of the fishing gear in Lakshadweep. More onboard space and facilities are to be provided for the operation of the TPL (live bait) gear, in large number of units. At present a typical number of only 6 units are operated from each small boat. There is considerable scope to increase this number of operable units by providing additional working space at the fore and sides of the hull. Installation of engine driven water sprayer and automatic angling machines in medium and large-type fishing vessels would increase fishing efficiency and reduce the crew requirement.

7. Installation of refrigerated fish-holds and the fish preservation machinery onboard is highly essential in the Lakshadweep boats for extending the preset-day fishing limits. The ammonia compression system is reported to be more suitable than the compression-Freon system for the tuna fishing fleet, almost universily. Brine-freezing being a cheaper method for mass preservation of tuna, this would be suitable for preserving the skipjack catch taken bulk quantities. The air-blast-freezing may be more useful to preserve the yellowfin tuna and bigeye tuna which are taken in relatively small quantities. Therefore, it would be advisable to have both the brine-freezing and air-blast freezing machinery fitted onboard the same vessel.

8. Providing proper crew accommodation onboard is a difficult problem faced in the Japanese and Californian TPL (live bait) boats. The Skipjack TPL (live bait) fishing technique of Lakshadweep takes in a relatively high proportion of onboard crew per size of boat. As such the problem of providing onboard accommodation for crew becomes a more difficult problem in these boats. Therefore, in view of acute scarcity for fishermen in the islands, there is urgent necessity to reduce the number of onboard crew by automation. As many of the Lakshadweep fishermen are not accustomed for prolonged separation from their homes, provision of convenient crew accommodation onboard the medium-and large-type vessels is highly essential to attract the fishermen on long voyages and continued absence from the port.

9. Small-type Pole and liners in Lakshadweep are to be equipped with standard equipments such as radio, radio-telephone, thermometer, echo-sounder, Secchi disc and navigation instruments. Electronic equipments such as Radar, Loran and Radio-telephone to search for fish and to receive information on oceanographic, meteorological and fishing conditions and to report to shore and to other vessels, should be installed in medium-and large-type vessels. As the islands are remote and geographically isolated from mainland, provision of telecommunication facilities onboard the fishing boats would be a boon for fishing operations. As these islands are prone to periodic attack by Cyclones, special weather-warning and rescue operations also can be effected with the help of improved navigational equipments and facilities. Provision of evaporators onboard would enable conversion of Salt water into fresh water at emergent situations. A few of the large-type vessels would be provided with onboard

facilities for the landing of spotter planes used in aerial survey of tuna schools.

10. Combination fishing with pole and line (live bait) and tuna long line would be an ideal plan to ensure year-round tuna catches in Lakshadweep. There are several spells falling within the far tuna season (November to May) in which the Skipjack is not biting the hook and/or chum of the Pole and line gear, thus giving a poor fishery. During the monsoonal months from June to October, the Pole and line (live bait) gear is seldom operated owing to non-availability of live baits. Tuna long line can be operated at such times to augment the catches. The yellowfin tuna and the bigeye tuna which can be fished profitably by the tuna long line gear are available in plently in these waters. Therefore, there is scope for introducing combination fishing vessels in these Islands. At present, head of skipjack tuna is largely being used as long line bait for tuna in the Islands by some of the live-bait boats. Shark is largely attracted by this bait. Therefore, there is urgent need to to use new baits like frozen mackerel and Sardine from along the mainland west coast, as tuna long line bait in the Islands. As the vessel and onboard crew are to be maintained throughout the year at high cost, combination fishing would engage the Vessel and the onboard crew year round in fishing operations, thereby reducing the number of idling days of the vessel in the port.

11. Introduction of tuna purse seining as an alternative fishing method to overcome the problems of bad baiting of Skipjack and scarcity for live bait in Lakshadweep need proper investigation. Purse seining appears to have good scope in Lakshadweep, especially in Islands other than Minicoy, Agatti and Bitra where there is acute scarcity for live baits year round. Purse seining may prove suitable to develop an year-round tuna fishery. Experimental fishing with purse seining for tuna around all these Islands, inter-island waters submerged banks and in the high seas beyond the EEZ is urgently needed in this connection.

12. The services of a pair of Factory Mothership one after another, to co-operate with the tuna fleet of small boats in the different Islands in Lakshadweep, are highly essential. A mother ship can co-ordinate fishing by the small boat-fleets in neighbouring Islands, by supplying fuel oil, gear, provision and fresh water to the catcher fleet and by procuring the catches of the catcher fleet at the close of the day for processing and preservation onboard. Consignments of the frozen fish can be reached to the canning Factory at Minicoy or at any other Island or mainland ports periodically. Spare parts for the engine and medicine for the crew can be reached to the catcher fleet. A base ship which could serve as a floating work shop would be a boon to fisheries development in the Islands. Its services would mitigate the problem of idling of fishing boats for want of work-shop facilities in different Islands.

13. Hulls made of local coconut timber at Minicoy stand motorization. The cost of these hulls is relatively less when compared to wooden hulls made in the department boat building yards using timber brought from the mainland. However, there is a dearth for coconut trees above 16 m in height in the Islands to get good quality timber There is urgent need to use non-traditional material for construction of boats in Lakshadweep. Besides wood, steel should be used as material for building boats. As in Japan, G. R. P. or F. R. P. may be used for building small-and medium - type boats. Goldworthy (1955) observes that aluminium alloy is used to make bridge and upper deck structures and funnal casings, etc. Aluminium linking over wood is given in the fish holds. Materials derived from glass, cellulose acetate or rubber are used as insulation material. Synthetic materials like 'Isoflex', 'Onazate' and fibreglass etc. also are used as insulating material. Such new materials for construction and operation should be made use of by the Lakshadweep boat-building industry to make medium and large type boats.

14. Wartime co-operation of the fishing fleet in rendering auxiliary services to the Navy is well-known in literature (Board of Agriculture and Fisheries, 1920; Asia Kyokai, 1957 and Anderson and Stolking 1952), Fishing

boats of robust construction in Lakshadweep can render additional services of Petrol and transport duties at times of emergency. As per suggestions contained in Rao Plan (Rao, 1948), for developing Deep Sea fishing as a cottage industry, there is need for mechanised vessels which can serve in the Defence service at times of emergency and in fish production at time of peace. It would be proper to make available in Lakshadweep, a special fleet of mechanised vessels which can serve as Honorary Fishery Petrol Vessels at time of peace and as Defence Vessels at times of Emergency under the Navy or Coastal Guard.

(b) *Gear Technological needs:-* The proper type bait-hook, striker, lure-hook and jigs should be introduced in toe TPL (live bait) technique of Lakshadweep to mitigate the problem of tuna not biting the hook or the chum. Special type hook with round and slender type shank is to be introduced for making bait-hook because the Minicoy-type hook with its stout point-leg and stout and keeled shank is detrimental to the live specimen used on it for making the bait-hook. With the introduction of medicm and large type pole and line vessels in Lakshadweep, the two-poles, three-pole etc. team gear as used in the Californian and Polynesian tuna fishery may be introduced. This would prevent the present problem of heavy breaking of bamboo Poles when large tuna above about 0-10 kg average individual weight are lifted out of water.

Introduction of the Polynesian type of yellowfin TPL technique in Lakshadweep for taking medium size yellowfin tuna using the two pole gear is worth consideration. This TPL technique requires relatively much less number of crew per boat and no live bait. This technique, if found successful would open new fisheries for medium yellowfin tuna and skipjack tuna in certain Islands like Ameni and Androt where there is much demand for fiesh tuna but the fishery is beset with the problem of acute scarcity for live baits. Rao (1955) recommends this method for the small Ports along the Indian west coast.

There is much scope to improve the operation technique in the Lakshadweep Skipjack TPL (live bait) technique. With the introduction of medium and large type Pole and liners, improvements may be made in the angling technique by (i) providing more onboard space and facility for operating more number of the TPL gear including the team-gear, (ii) installing the angling machine and mechanical water spray system, and by (iii) provision of chum tanks and connected facilities for chumming tuna with live baits.

(c) *Gear-making and supply needs:* There is urgent need to develop the traditional TPL (live bait) gear-making industry by establishing a modern hook-making factory at Minicoy or Agati Island and by giving training to local hook makers in modern technology of making hooks using machines. Besides the the Pole and line hook, lure-hooks, strikers, jigs and bait-hooks may be manufactured indegenously by borrowing initially designs and technology from Japan, California and Polynesia where these tackles are used in plenty. Raw materials such as horn, hoof, synthetic feathers, bird-feathers, plastic rubber, pearl-shell, stainless steel etc. required for making these implements may be procured from mainland. Insect-proof FRP or GRP Poles may be introduced to replace the bamboo Poles which are vulnerable to heavy insect attack. Indigenous manufacture of FRP Poles would enable tuna fisheries development in the long run. The insects damaging the bamboo Poles may be scientifically studied and control measures adopted against breaking of Poles due to insect attack. Quarantine and quality control measures to maintain quality of the bamboo Poles brought from mainland may be introduced. A centralised subsidy scheme to supply the various fishing implements including the leader and snood material may be made available to Islander fishermen as a measure of encouragement to Oceanic tuna fishing using TPL (live bait) or other combination or alternate fishing techniquee.

(d) *Fishermen training needs :* Acurate knowledge regarding the conventional gear positions P_1 to P_5 and positions of water splashing men W_1 and W_2 onboard the fishing platform, the ethnological identity of the hook, the four varieties of the gear, concept of hook territory, shooting angle, hauling direction, underwater air bubble formation of the hook, the spraying effect involved in water splashing, effect of water splashing in vibrating the air bubble of the hook etc. reported for the first time here are the unique features of the Lakshadweep TPL (live bait) technique. Therefore these aspects are to be taught to the local fishermen in comparison with the TPL (live bait) fishing techniques of other parts of the World. Thus there comes the need for improved fishermen training in Pole and line (live bait) tuna fishing centres in the Islands. The use of lure-hooks, strikers, bait-hooks and jigs also is to be taught to these fishermen by experimental and demonstration fishing and by practical gear-fabrication training. The use of angling machines, mechanical sprayers and the operation of team gear, large-scale live bait storage handling and chumming etc. are also to be taught to these fishermen for a better tuna fisheries development.

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