

Mackerel and Oil Sardine Tagging Programme

1966 – 67 to 1968 – 69



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MACKEREL AND OIL SARDINE TAGGING PROGRAMME
1966-67 to 1968-69

Compiled by

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September 1970

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THE BULLETIN OF THE CENTRAL MARINE FISHERIES
RESEARCH INSTITUTE IS PUBLISHED AT IRREGULAR
INTERVALS AS AND WHEN INFORMATION OF A GENERAL
NATURE BECOMES AVAILABLE FOR DISSEMINATION.

FOREWORD

In a species supporting a commercial fishery, intensive tagging followed by successful recovery of a fairly reasonable fraction of tagged fish is an indispensable means of elucidating facts about migration, growth, recruitment, mortality rate etc. It is needless to stress that such information would help fishery development on scientific lines to ensure sustaining yields. Among the pelagic fishes of our coast the oil sardine, *Sardinella longiceps* and the mackerel, *Rastrelliger kanagurta* together contribute to over a third of the total marine fish landings. The shoals strike the coasts with almost cyclical regularity, and the harvests are subject to almost cyclical regularity, and the harvests are subject to almost unpredictable seasonal and annual fluctuations the causes for which are still not fully understood. Being shoaling fishes they should be having well defined migratory circuits, but our knowledge is confined in this regard to the period of their sojourn in the coastal waters.

Following a series of preliminary observations on tag-release experiments, a large-scale systematic tagging of the mackerel and the oil sardine was initiated by this Institute in 1967-68 at several centres using various type of tags. In this bulletin are presented the details and results of tagging of these fishes from 1966-67 to 1968-69. I wish to record my sincere appreciation of the initiative and lead taken by Dr. M.S. Prabhu and Mr. G. Venkataraman in organising this programme and also in compiling the material. It gives me immense pleasure to congratulate all the participants for the commendable work done in spite of the great odds they had to face in the implementation of the programme. I also offer my sincere thanks to all concerned in rendering necessary help in the preparation of this bulletin.

Mandapam Camp
Sept. 22, 1970.

Dr. R. V. Nair
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INTRODUCTION

The importance of mark-release experiments as a means to understand certain aspects of the biology of fish such as rate of growth, migration, age, stocks and races has long been realised by fishery scientists and considerable work has been done on these lines in the United States of America, United Kingdom and Japan. In India tagging was successfully attempted for the first time on *Hilsa* in the Hooghly estuary (Pillay, 1959) and subsequently on grey mullets and other brackish water fishes in Chilka Lake (Jhingran and Patro, 1959; Jhingran and Misra, 1962). As a part of field training, the Fisheries Officers of the Central Institute of Fisheries Education, Bombay carried out tagging on major carps (*Catla catla*, *Cirrhina mrigala* and *Labeo rohita*) in Madhya Pradesh and on lesser sardines and mackerel at Panaji, Goa, during July-September 1966 and from 11th to 20th December 1966 respectively (Johannes Hamre *et al.*, 1966). The tagging in these instances was done on large numbers of fish but confined to certain centres only.

Considerable impetus to tagging Programme was given with the taking up of this work by the staff of the Central Marine Fisheries Research Institute. To start with, experimental tagging on mackerel and oil sardine using opercular tag was tried in the year 1965 and 1966 at Karwar and Mangalore and it was found that the opercular tag had no adverse effect on the fish. Encouraged by these results, a beginning was made in 1966-67 to tag and release oil sardine and mackerel from different centres on the west coast – though the very first batch of mackerel was released off Karwar as early as November 1965 itself. As per the recommendation of the national Tagging Committee which met at Hyderabad in August, 1967, a demonstration-cum-training programme in tagging was organised at Ernakulam by the Central Marine Fisheries Research Institute under the leadership of Dr. M.S. Prabhu from 26th September to 4th October, 1967 in which personnel from the Institute and from the State Fisheries departments participated.

This Institute initiated large scale tagging on the Indian mackerel, *Restrelliger kanagurta* and the Indian oil Sardine, *Sardinella longiceps* for the first time in India in 1967-68, covering several centres on the west and east coasts. These two species were first chosen in view of their economic importance. They form a significant part of the total marine fish landings in India. But they are also subject to considerable fluctuations from year to year. It was seen that during the 18 year period since 1951, the variation of the oil sardine landings to the total marine fish catch was as wide as 1.0% to 33.8%, While for mackerel the variation for the same period was from 2.28 % to 15.22 %. In order to ascertain the causes for such fluctuations, it is essential to have adequate knowledge of the age, rate of growth, migratory pattern etc. of these fishes which have not been so far clearly determined. It is hoped, as a result of tagging, some useful information on these aspects will be obtained based on which a sound management programme of these two fisheries can be drawn up.

TAGGING EQUIPMENTS

A. TAGS USED

Five types of plastic tags were used for tagging. Diagrammatic sketches of the tags and the mode of their insertion are given in Figs. 1 & 2 respectively.

1. Opercular tag

It is a 25 mm long strip; maroon in colour bent on itself at about a third of its length like a clip, with a flattened circular head (10 mm in diameter) and a pointed tail (15 mm long), forming the two limbs of the clip (Fig. 1, A, C and D). As the opercular tags were unnumbered, a code of notation was marked on the tag to denote different numbers (Fig. 1, B). These were kindly made available to the Institute by the Fisheries Research Board of Canada.

2. Loop tag

This consists of a Plastic strip with rounded edges and with a pinhole at one end (Fig. 1, E). Through this hole a nylon monofilament is passed which is burnt at one end forming a small bulb that will not slip through the hole. The strip is numbered. The specifications are as follows:

Length of strip	...	18 mm
Width of strip	...	3 mm
Thickness of strip	...	0.8 mm
Length of monofilament	...	120 mm
Diameter of monofilament	...	0.3 mm

3. Dart trailing tag

This consists of a narrow round-edged plastic strip and a plastic dart with a backwardly directed barb connected together by a filament (Fig. 1, F). The numbers are imprinted on the plastic strip. The specifications are as follows:

Length of strip	...	18 mm
Width of strip	...	3 mm
Thickness of strip	...	0.8 mm
Length of monofilament	...	15 mm
Diameter of monofilament	...	0.3 mm
Length of dart	...	8 mm
Length of barb	...	4 mm
Width of dart	...	1.5 mm

4. Semi internal tag

It consists of two round-edged plastic strips, one longer than the other (Fig.1, G). The latter shorter strip is lodged inside the fish. The larger strip has a pin-hole at one end and the smaller at the centre. A nylon filament passing through the pin-holes connects the two strips, One end of which is fused, the other end being tied to the numbered strip. The longer strip is numbered. The specifications are as follows:

Length of strip	...	20 and 15 mm
Width of strips	...	5 and 3 mm
Length of monofilament	...	25 mm

5. Opercular button tag

This has two circular discs, placed concentrically, an outer bigger one being serially numbered and smaller inner one acting as an anchor in the fish (Fig. 1, H). When fixed, the operculum comes in between these two discs which are tightly kept in position with the help of nylon filament fused into knobs at both ends by heating.

Diameter of outer disc	.....	9 mm
Diameter of inner disc	.....	6 mm
Thickness of discs	.....	0.8 mm
Length of monofilament	.....	100mm
Diameter of monofilament	.....	0.3 mm

B. ACCESSORIES

Plastic tubs

In the absence of fish tanks on board, most of the vessels used medium sized plastic tubs as containers for live fish.

Wooden Cages

Wooden cages (3' x3 'x3 ') made out of reeper frames with sides covered by nets were used at Karwar and Mangalore for stocking and transporting live fish to the tagging spot.

Other accessories used for tagging were dip nets to transfer live fish from the net to the tubs, needles (20-21) of hypodermic syringe to insert the filament through the body of the fish, a sharp scalpel to make an incision in the body, incense sticks for sealing the filament and measuring scales. In some centres plastic buckets were used to transfer live fish from the nets to the tubs on board the fishing vessels.

TAGGING CENTRES

The tagging centres were Karwar, Mangalore, Cannanore, Calicut, Cochin and Vizhinjam on the west coast and Mandapam and Waltair on the east coast of India. For carrying out tagging work, either departmental boats or mechanised vessels belonging to Offshore Fishing Stations, Government

of india and Indo-Norwegian Project were utilised. Tagging was done on board State Government vessels also. At Calicut, Cannanore and Vizhinjam canoes were made use of for tagging work when mechanised boats were not available.

MODE OF TAGGING

(a) Opercular tag

The fish which has been conditioned for sometime in the trough is gently held under water and its total length, measured on a measuring scale, was noted against the number of the tag to be used (Fig. 2, A). The fish is held in the left hand with its right side facing upwards. The numbered tag is inserted into the operculum in the region where the posterior part of the preoperculum overlaps the anterior margin of the operculum. The actual insertion is done by gently pushing the tail portion of the tag, which pierces the opercular bone and glides smoothly on the inner side of the operculum and projects outside. The opercular bone gets firmly set inside the notch of the tag formed by the bend of the tail with head. The head of the tag remains outside the operculum. Using this tag seems to cause the least injury to the fish, and, with some experience, 2 or 3 oil sardine or mackerel could easily be tagged within a minute.

(b) Loop tag

A hypodermic needle is passed through the hole from the side of the strip which is opposite the knob of the filament (Fig. 2, B & C) The needle is then gently pierced through the body at about $\frac{1}{2}$ cm below the posterior end of the dorsal fin in the case of oil sardine whereas in mackerel it is pierced either between the two dorsals or below the posterior end of the first dorsal. The free end of nylon filament is inserted into the bore of the needle which is then pulled back, keeping the strip pressed with fingers to the side of the fish. The free end of the filament passing through the body of the fish now emerges through the hole of the tag. This end is fused into a knob with a lighted incense stick and the tag now remains firmly on the back of the fish. The entire operation was carried out under water, except the fusing of the ends of the nylon fila-

ment. The tagged fish were either transferred to another tub or to a cage where they were conditioned before release into the sea.

(C) Dart trailing tag

The place of attachment of this tag also is the same as for the loop tag (Fig. 2, D). But here an incision is made with a scalpel. The dart is pushed into the muscle by forceps in such a way that it gets stuck in the muscle and is held firmly in the body with the numbered strip trailing behind. When it was feared that the insertion into the dorsal muscle would cause great injury, the tag was inserted into the abdominal wall as in the case of semi-internal tag.

(d) Semi-internal Tag

An incision is made with a sharp scalpel in the abdominal wall to the side in front of the anal opening (Fig. 2, E). With the help of a forceps the smaller of the strips is gently inserted inside and the nylon filament lying outside is slightly pulled forward. This makes the strip lie cross-wise to the incision and thus sets the tag securely in the body. The larger strip trails outside.

(e) Opercular button tag

A hypodermic needle is passed through the hole in the outer piece and then pierced through the operculum until the tip is brought posteriorly out of the branchial chamber through branchial opening. The free end of the filament passing through the anchor piece of the tag (the rear end is already fused into a knob) is taken through the hole in the needle. The needle is then retracted pulling the thread through the operculum and the hole of the outer disc which is pressed with the thumb on the operculum. Holding the filament tightly, it is fused into a knob close to the outer disc of the tag. The two pieces of the tag are thus kept pressed together, with the operculum in between, like a button. The fixing of such a tag was not found to be injurious to the fish and it takes only very little time.

A three men team can fix these tags to the fish – the first to hold the fish and to measure, the second to record the measurements against the numbers and the third to do the actual tagging. However the duties

assigned to each person can vary.

EXPERIMENTAL TAGGING

Some preliminary and experimental tagging with opercular tags was carried out in the 1965 and 1966 at Mangalore and Karwar to test their suitability, durability and retentiveness and to find adverse effects, if any, On the 24th March, 1965, 25 specimens of tagged and untagged oil sardine were released in two separate wooden cages in an area off Bailkampady near Mangalore where the waters were 7 m deep. The cages were kept suspended sub-surface in water by attaching floats at the top and anchor at the bottom. The results showed that for nearly 16 hours tagged oil sardine survived with no ill effects. Unfortunately, it had to be abandoned because of heavy weather and turbulent seas.

This experiment was repeated in January, 1966, this time in an area off Ullal near Mangalore in waters of the same depth. The oil sardine survived for 8 days with no ill effects whatsoever, proving the suitability of opercular tags for tagging work. In a similar experiment carried out at Karwar in 1965, the fish was found to hold the tag up to four days, beyond which the experiment could not be continued.

DETAILS OF TAGGING OPERATIONS

The place where the fish were being caught was reached by boat or canoe and live fish were transferred from fishing nets to large polythene tubs kept on board the boat (or in the canoe). The fish were either transferred to polythene tubs filled with sea water direct with the aid of dip nets or they were collected first in polythene buckets from the nets and then transferred to the tubs. The extent of the handling was kept down to the possible minimum. The conditioning of the fish took place in about 25 to 30 minutes, as the fish were being taken to the spot some distance away from the scene of procurement for carrying out tagging work. The water in the tubs was frequently changed to keep the fish healthy and active.

When the oil sardine were retained in the tubs, prior to tagging, they were found to cluster into small groups and nibble at the sides of

the tubs. Some of them were so excited as to jump out of the tubs. But these rapid movement subsided in about 10 to 15 minutes and after that they were found to resume normal swimming.

At Karwar, the fish to be tagged were transferred from an impounded *Rampani* to a netting fitted on to a frame and tied to the side of the vessel. They were slowly taken to the tagging spot which was generally near the shore out side the *Rampani* zone or an islet off the mainland. The fish were tagged and released. In the case of opercular tags, tagged fish could be kept in another net – cage, towed to a more distant place and then released. This was not practicable in the case of loop tags and semi – internal tags because the nylon thread got intertwined in the net.

In some centres, the fish were held in V- shaped wooden tagging cradle while tagging. After acclimatising the tagged fish in the troughs for sometime, they were transferred to a polythene bucket which was lowered down the side of the boat or canoe and the fish gently released into the water. As soon as the fish were released. They were observed to move away swiftly.

PUBLICITY

The success of the tagging programme depends considerably upon the co-operation extended by the fishermen and the public in returning the tagged fish with full particulars. In this connection wall-posters and hand bills were printed in different languages i.e. English, Malayalam, Canarese, tamil, Telugu and Marathi with illustrations of tagged mackerel and oil sardine. The fishermen and the public were requested to return either the tagged fish or tag alone along with relevant information regarding date, place of capture, Length etc. to any of the nearest offices of the Central Marine Fisheries Research Institute or the State Fisheries Departments. A reward of three rupee was offered to those who bring the fish with tag or one rupee to those who return the tag only.

Wide publicity was given by the distribution of wall-posters and hand bills in the fishing villages, fish landing centres, fish curing yards, fish markets and fishermen co-operative societies. The State Fisheries Departments co-operated in this work. Publicity was given through the press and all India radio also.

RESULTS

The accompanying tables (Nos. I to XII) contains details of mackerel and oil sardine tagged and recoveries made during 1966-67 to 1968-69 seasons in different centres on the west coast and at Mandapam and Waltair on the east coast. In 1966-67 season, tagging was carried out on a small scale at some of the centres. A total of 290 mackerel was tagged and released (using opercular tags) in all the centres put together, of which only 4 were recovered from Karwar. These specimens were caught near the vicinity of their release. The recovery rate here was comparatively high, being 3.57%. Mangalore and Cochin were the only two centres where tagging of oil sardine was carried out in 1966-67 season, the numbers tagged at these two centres being 1603 and 1986 respectively. These were tagged with opercular tags. Of these, only one was recovered which was released at Kannamali, Cochin and recovered in the same place in an hour's time.

During 1967-68 season, 14, 185 oil sardine were tagged and released. Of these 54 were recovered, the recovery rate for the season being 0.38%. The maximum rate was recorded at Karwar (1.32%) and it was less than 1% in all other centres. Mostly loop and dart tags were used. 2509 tagged oil sardine were released off Karwar area and of these 33 were recovered within 1 to 19 km north or south from the place of tagging after an interval ranging from 2 to 23 days. Out of 2524 fish released at Mangalore, 4 were recovered. Of these, one released off Manjeshwar-Ullal was obtained at Baikampadi after an interval of 29 days having travelled a distance of 13 km northwards. Another was recovered off Hosdurg after an interval of 11 days, the distance travelled being 70 km to the south. At Cannanore, out of 1068 tagged fish released, 5 were recovered. Of these, the one recovered at Anjanur beach (near Kanhangad) had travelled a distance of 79 km to the north from Dharmadam and was captured after 14 days. At Kozhikode, the tagged fish showed a tendency to migrate to shallower waters (5-7 m) from relatively deeper waters (7-10 m). Altogether, 2481 were released and of these, 4 were obtained from the commercial catches in the vicinity of their release, the maximum time interval being 5 days. Of 5426 oil sardine released off Cochin, 8 were recovered, one being obtained after a lapse of 70 days. The specimen was released off Narakkal, Cochin, on 30-11-1967 and recovered on 9-2-1968 off Parayakadavu 90 km

South east. The direction of movement of other recovered specimens also was towards south or south east. At Vizhinjam, only 10 oil sardine could be tagged and there was no recovery. At Mandapam, 167 oil sardine were tagged, there being no recoveries.

Only 4122 mackerel could be tagged and released during 1967-68 season, as they were relatively scarce compared to oil sardine. Of these, 23 were recovered, the recovery rate for the season being 0.56%. Tagging of mackerel was done only at Karwar, Kozhikode, Cochin, Vizhinjam, Mandapam and Waltair. The recoveries were nil at Karwar. Though 3150 specimens were released there. Out of 345 mackerel tagged at Kozhikode, only one was recovered after two days about 3 km south-east of the place from where it was released. The tagging experiments here showed only local movements. At Cochin, 460 mackerel were released after tagging and of this 10 were recovered at place 16 to 55 km away from the place of release, the maximum time lapse being 50 days. Of the 10 recovered, 5 travelled towards south and 5 towards north. At Vizhinjam, only one mackerel was recovered out of 95 released and this was caught about 32 km north-west of Vizhinjam on the day of its release. It showed that the fish travelled 32 km in a matter of few hours. At Mandapam, 42 were tagged, but none was recovered. Out of 30 mackerel tagged and released in Lawson's Bay, Waltair, 11 were recovered near the vicinity of their release, all on the day of release itself.

During 1968-69 season, a total of 4665 oil sardine were tagged and released at different centres on the west coast. Of these 7 were recovered, the recovery rate for the season being 0.15%. Only dart and loop tags were used. Out of 125 oil sardine released at Karwar, one was recovered 1 km north of the place from where it was released after 57 days. At Mangalore 1520 were tagged, of which one was recovered 8 km north of Mangalore after a lapse of 10 days. At Kozhikode, 2175 oil sardine were tagged of which 5 were recovered. Of these, 3 were obtained within an interval of one to six days after having travelled 3 to 7 km south or north. Another oil sardine was recovered at Parappanangadi 30 km south of Kozhikode after a time lapse of 14 days. In the above cases, the length at release and recovery were the same. A dart tag from a fish which was released at Kozhikode on 20-12-1967 was brought to the Kozhikode market on 11-4-1970. It was reported that the

tag was obtained at Parappanangadi, but details regarding the date of capture, size at recovery, etc. are not available. At Cochin and Vizhinjam 747 and 98 oil Sardine tagged with loop and dart tags respectively were released, but no recoveries were reported.

In the same season, only 187 mackerel could be tagged and released as the mackerel fishery was poor during the season. At Karwar, Cochin and Vizhinjam, 160, 23 and 4 fishes respectively were tagged and released. Mostly loop tags were used. Except for one fish obtained at Vizhinjam, no other recoveries were reported. The one case of recovery reported from Vizhinjam was from a place 19 km north (Karunagapally), the number of days after liberation being 22.

Out of total of 4599 mackerel and 22439 oil sardine released, all the three seasons together, 28 mackerel and 62 oil sardine were recovered giving an overall recovery rate of 0.61% and 0.28% respectively. The low returns can be attributed to several factors as have been observed in the yellowfin tuna and skipjack whose recovery rates have been found to be 3.6% and 1.9% respectively in the Eastern Pacific where large numbers were tagged and released during the period 1955-59 (Schaefer, *et al.*, 1961). It has been noticed in yellowfin tuna that a rather high initial tagging mortality takes place despite precautions and further those that survive are subject to “additional attrition from shedding of tags, or from mortality resulting from carrying a tag” (Schaefer *et al.*, *op. cit.*). Moreover, cases of non-reporting of recovered specimens are likely to be higher in this country where a majority of fishermen are illiterate and not aware of the importance of reporting the recovery of tagged specimens.

In the following tables are given details of the number of different types of tags used and the number and percentage of each type of tag recovered separately for mackerel and oil sardine.

Mackerel

Type of tag	Opercular	Loop	Dart	Semi-Internal	Opercular button	Total
No. released	2242	979	63	1272	43	4599
No. recovered	5	19	2	2	-	28
Percentage of Recovery	0.22	1.94	3.17	0.16	-	0.61

Oil Sardine

Type of tag	Opercular	Loop	Dart	Semi-Internal	Opercular button	Total
No. released	5541	10128	5416	1354	-	22439
No. recovered	7	42	7	6	-	62
Percentage of recovery	0.13	0.42	0.13	0.44	-	0.28

It is seen that though the recovery rate was highest (3.17%) for dart tag in the case of mackerel, the total number of dart tags released was small being only 63. The recovery rate for the same tag in the case of oil sardine was poor being only 0.13%. The next best for mackerel was the loop tag, the recovery rate being 1.94%. In the case of oil sardine the recovery rates for semi-internal and loop tags were almost the same (0.44% and 0.42% respectively), the number of loop tags released being nearly eight times that of semi-internal tags. However the recovery rate of semi-internal tags for mackerel was poor being only 0.16%. The returns for opercular tags came to 0.22% for mackerel and 0.13% for oil sardine. The combined results for mackerel and oil sardine showed that maximum recoveries were obtained in the case of loop tags, followed by semi-internal, opercular and dart tags in the order of their returns. Based on the number of tags recovered and also judged from the point of causing the least injury to the fish it was found that loop and opercular tags are comparatively better suited for tagging mackerel and oil sardine.

The Particulars of the total number of different types of tags tagged and released in oil sardine in each colour, their respective recoveries and percentages are given below:

Type of tags and colour	Opercular (Red)	Loop (Red)	Loop (Blue)	Loop (Yellow)	Loop (Cream-white)	Dart (Red)	Dart (Blue)	Dart (Yellow)	Semi-internal (Red)
No. released	3238	904	775	1650	500	1582	2461	777	1273
No. recovered	2	4	3	1	1	5	1	-	5
Percentage	0.66	0.44	0.39	0.06	0.2	0.32	0.04	-	0.39

The highest percentage of recovery was observed in loop (red), followed by

loop (blue) and semi-internal (red). Dart(red) recorded the next best return. The recovery rate of loop (cream white) was 0.2%. The returns for opercular (red), loop (yellow) and dart (blue) were poor being less than 0.1%. It is seen from the above analysis that maximum recoveries were made in respect of red and blue colours.

Though the length measurements were found to be the same both at release and recovery in a large number of specimens, yet in some instances they were found to be less on recovery than on release. Such cases related mostly to lengths reported in inches by those who found the tags and subsequently converted into centimeter scale. It is also likely that the measurements furnished by them may only be approximate. Another factor which may be attributed is the possible shrinkage caused by preservation in formelin or by post-mortem changes.

Among those wherein an increase in size was recorded, it was seen that in one instance the oil sardine showed an increase in length by 5mm from 145 mm in 14 days and in another 2mm from 115mm in 20 days. In the case of mackerel, an increase in length of 3mm over a period of 50 days was noticed, the respective lengths at release and recovery being 177 and 180mm. More data have to be collected before any idea can be arrived at regarding the rate of growth.

The results obtained so far from tagging experiments show that the movements of mackerel and oil sardine are either local being caught near the vicinity of their release or coastal, migrating some kilometres north or south of the place of release parallel to the coast. The farthest distance travelled by oil sardine was 90km over a period of 70 days. In view of the limited recoveries, no conclusion could be drawn regarding the movements of the fish from south to north or *vice versa* and the existence of independent and discrete stocks even though recoveries showed local dispersal. Since commercial fishing is restricted to inshore waters, it is not possible to know if there are any offshore movements. It is hoped that further light will be thrown on the pattern of migration of these commercially important pelagic species in the coming years with the intensification of tagging programme.

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In addition to the above mentioned staff, laboratory attendants, fieldmen and peons attached to the various Sub-Stations/units also participated in the tagging work and rendered assistance. At some centres, the crew attached to the boats also helped in the tagging work.

Table 1
Details of mackerel tagged at different centres during 1966-67 season

Place	Types of tags					Total	Place of release	Depth (in metres)	Size range (in mm)	Number recovered
	Opercular	Loop	Dart	Semi-internal	Opercular button					
Karwar	112	-	-	-	-	112	Karwar Bay	2	190-228	4
Mangalore	136	-	-	-	-	136	Tannirbavi Baikampady Bokkapattana Kodikal	8	197-230	-
Cannanore	-	-	-	-	-	NIL	-	-	-	-
Kozhikode	-	-	-	-	-	NIL	-	-	-	-
Cochin	42	-	-	-	-	42	Vypeen Narakkal Malippuram	8-11	204-234	-
Vizhingam	-	-	-	-	-	NIL	-	-	-	-

Table II
Details of mackerel tagged at different centres during 1967-68 season

Place	Types of tags					Total	Place of release	Depth in metres	Size range (in mm)	Number recovered
	Opercular	Loop	Dart	Semi-internal	Opercular button					
Karwar	1393	512	-	1245	-	3150	Karwar Bay Anjadiv Island Kamat Beach	2-14	146-252	-
Mangalore	-	-	-	-	-	NIL	-	-	-	-
Cannanore	-	-	-	-	-	NIL	-	-	-	-
Kozhikode	345	-	-	-	-	345	Vellayil Wesst Hill	7-18	149-210	1
Cochin	171	168	51	27	43	460	Vypeen Narakkal Malippuram Kannamali Fort Cochin Manassery	6-12	135	10
Vizhingam	-	95	-	-	-	95	Vizhingam Bay	10-20	140-220	1
Mandapam	42	-	-	-	-	42	Kundugal Point Shingle Island	5-9	132-260	-
Waltair	-	20	10	-	-	30	Lawson's Bay	-	-	11

Table III
Details of mackerel tagged at different centres during 1968-69 season

Place	Types of tags					Total	Place of release	Depth in metres	Size range (in.mm)	Number recovered
	Oper-ocular	Loop	Dart	Semi-internal	Opercular button					
Karwar	-	160	-	-	-	160	Karnagad Island	4	190-228	NIL
Mangalore	-	-	-	-	-	Nil	-	-	-	-
Cannanore	-	-	-	-	-	Nil	-	-	-	-
Kozhikode	-	-	-	-	-	Nil	-	-	-	-
Cochin	1	22	-	-	-	23	Fort Cochin Malippuram	5	207-223	NIL
Vizhingam	-	2	2	-	-	4	Neendakara	20	155-210	1

Table IV
Details of sardine tagged at different centres during 1966-67 season

Place	Types of tags					Total	Place of release	Depth in metres	Size range (in mm)	Number recovered
	Oper- cular	Loop	Dart	Semi- internal	Opercular button					
Karwar	-	-	-	-	-	Nil	-	-	-	-
Mangalore	1603	-	-	-	-	1603	Tannirbavi Baikampady Kodikal Ullal Uchila	8-12	109-202	-
Cannanore	-	-	-	-	-	Nil	-	-	-	-
Kozhikode	-	-	-	-	-	Nil	-	-	-	-
Cochin	1986	-	-	-	-	1986	Narakkal Kannamali Fort Cochin Manassery	11-12	110-190	1
Vizhingam	-	-	-	-	-	Nil	-	-	-	-

Table V
Details of sardine tagged at different centres during 1967-68 season

Place	Types of tags			Semi-internal	Opercular button	Total	Place of release	Depth in metres	Size range (in mm)	Number recovered
	Opercular	Loop	Dart							
Karwar	571	1543	395	-	-	2509	Karwar Bay Binage Kurmagad Island Devgad Island	1-25	86-174	33
Mangalore	132	2234	34	124	-	2524	Manjeswar Kulai Uchila Ullal Mangalore Someswar	6-20	48-189	4
Cannanore	196	375	-	497	-	1068	Cannanore Dharmadam Azhikode	11-18	78-185	5
Kozhikode	882	480	653	466	-	2481	Kallayi Vellayil West Hill Elathur Chemancherry	4-18	71-188	4
Cochin	171	2952	2036	267	-	5426	Fort Cochin Manassery Chellanam Malippuram	8-18	75-190	8
Vizhingam	-	10	-	-	-	10	Vizhingam	20	135-175	-
Mandapam	-	167	-	-	-	167	CMFRI Jetty Krusadai Island	5-9	117-181	-

Table VI
Details of sardine tagged at different centres during 1968-69 season

Place	Types of tags					Total	Place of release	Depth in metres	Size range (in mm)	Number recovered
	Oper- cular	Loop	Dart	Semi- internal	Opercular button					
Karwar	-	125	-	-	-	125	Kurmagad Island	15	103-171	1
Mangalore	-	1495	25	-	-	1520	Someshwar Bolur Ullal	10-15	106-167	1
Cannanore	-	-	-	-	-	-	-	-	-	-
Kozhikode	-	-	2175	-	-	2175	Elathur Pudiyappa Pudiyangadi West Hill Vellayil	7-20	80-179	5
Cochin	-	747	-	-	-	747	Narakkal Fort Cochin Malippuram Manassery	7-20	8-10	110-180
Vizhingam	-	-	98	-	-	98	Neendakara	20	110-150	-

Table VIII
Particulars of recoveries of mackerel made at different centres during 1967-68 season

Place	Type of tag	Details of release			Details of recovery			Distance Between place of recovery & release (in km)	Size at		No. of days at liberty	Direction of movement
		Date	Place	Depth (in mm)	Date	Place	Gear		Depth (in mm)	Release (in mm)		
Kawar	-	-	-	-	-	-	-	-	-	-	-	-
Mangalore	-	-	-	-	-	-	-	-	-	-	-	-
Cannanore	-	-	-	-	-	-	-	-	-	-	-	-
Kozhikode	oper- cular	14-12-67	West Hill	13	16-12-67	Vella- yil kollu	Patten- 13	3	176	176	2	SE
Cochin	Loop	30-11-67	Narkakal	7	2-12-67	Soudi Thangu- vala	11	16	203	198	2	S
	Do	30-11-67	Do	7	2-12-67	Do	11	16	203	198	2	B
	Do	30-11-67	Do	7	3-12-67	Azhi- Ayilach- Kode alavala	9	21	197	-	3	N*
	Do	30-11-67	Do	7	3-12-67	Natika	-	47	195	190	3	N
	Do.	2-12-67	Vypeen	7	5-12-67	Munabam Kollivala	7	24	194	189	3	N
	Semi Internal Loop	30-11-67	Narakkal	7	7-12-67	Manassery Thangu vala	11	16	189	186	7	S
	Loop	16-11-67	Malippuram	6	16-12-67	Thiru- varapu	-	-	166	5"@ (127)	30	S*
	Do	2-12-67	Vypeen Vala	7	17-12-67	Azhikode Kollu- vala	-	27	185	6"@ (152)	15	N

Table VIII (Contd.)

Place	Type of tag	Details of release			Details of recovery			Distance Between		Size at		No. of days at liberty	Direction of movement
		Date	Place	Depth (in mm)	Date	Place	Gear	Depth (in mm)	Recovery (in km)	Recovery (in mm)			
Cochin	Semi-Internal	23-11-67	Mali puram	11	12-1-68	Pallithode	Shore-seine	3	28	177	180@	50	S
	Loop	29-1-68	Manassery	9	23-2-68	Perinjaniam	Do.	-	55	195	195	25	N
Vizhinjam	Loop	14-11-67	Vizhinjam	20	14-11-67	St. Andrews	Gill net	20	32	-	-	Same day	NW

* Tag alone obtained.

** Thiruvapur is a market in the suburb of Kottayam Town, and interior place 24 km away from the sea. It is reported by the informer who recovered the tag that fresh fish in this market come from the landing places at Sherthala, Alleppey and Ambalapuzha which are 42, 64 and 78 km south respectively of Malippuram where it was released.

Apart from the above, 3 mackerel were reported reliably to have been caught at Cochin as mentioned below:

1. A mackerel with an opercular maroon tag was recovered at Malippuram on 2-12-67 in a gill net operated at night. The tag attached to the fish was noticed by the worker at the local fish curing yard who threw it off not knowing its importance.
2. A mackerel with a tag was recovered at kuzhipilly which is 29 km north of Fort Cochin probably on 5-2-68. The fish was kept there semi-dried, but was eaten by ants, only the skeleton remaining and the tag missing.
3. A mackerel with a tag was reported to have occurred in the catch of trawler 'Silvi', C.P. 309 operated off Cochin some day previous to 24-3-68 but not too long before. Ignoring the importance of the fish, the crew consumed it on board throwing away the tag.

@ These informations were supplied along with the tags.

Table IX
Particulars of recoveries of mackerel made at different centres during 1968-69 season

Place	Type of tag	Details of release			Details of recovery			Distance Between place of recovery & release (in km)	Size at		No. of days at liberty	Direction of movement	
		Date	Place	Depth (in mm)	Date	Place	Gear		Depth (in mm)	Re-lease (in mm)			Recovery (mm)
Karwar	-	-	-	-	-	-	-	-	-	-	-	-	
Mangalore	-	-	-	-	-	-	-	-	-	-	-	-	
Cannanore	-	-	-	-	-	-	-	-	-	-	-	-	
Kozhikode	-	-	-	-	-	-	-	-	-	-	-	-	
Cochin	-	-	-	-	-	-	-	-	-	-	-	-	
Vizhingam	Loop	28-11-60	Neendakara	20	20-12-68	Karunagapally	Gill net	14	19	155	-	22	N

Table XI
Particulars of recoveries of oil sardine made at different centres during 1967 - 68 season

Place	Type of tag	Details of release		Details of recovery			Distance Between place of recovery & release (in km)	Size at		No. of days at liberty	Direction of movement	
		Date	Place	Depth (in mm)	Date	Place		Gear	Depth (in mm)			Re-lease (in mm)
Karwar	Loop	4-9-67	Karwar Bay	1	-	-	-	99	-	-	*	
	Do	24-11-67	Kurumagad Island	3	27-11-67	Karwar	Rampan	4	130	130	3	S
	Do	Do	Do	3	17-12-67	Majali	Do	4	130	130	23	N
	Do	25-11-67	Do	3	29-11-67	Karwar	Do	4	140	140	4	N
	Do	Do	Do	3	Do	Do	Do	4	124	124	4	S
	Dart	Do	Do	3	Do	Devgad	Cast net	16	152	152	4	S
	Loop	Do.	Do.	3	Do	Karwar	Rampan	4	133	133	4	S
	Do.	Do	Do	3	30-11-67	Do	Do	4	135	135	5	S
	Do	28-11-67	Do.	3	5-12-67	Do.	Cast net	7	133	133	7	S
	Do.	Do	Do	3	5-12-67	Do.	Do.	7	129	129	7	S
	Do	Do.	Do.	3	6-12-67	Do.	Do.	4	137	137	8	S
	Do.	Do.	Do.	3	6-12-67	Do.	Do.	4	135	135	18	S
	Do.	Do.	Do.	3	20-12-67	Majali	Rampan	4	142	142	22	-
Opercular		14-12-67	Do.	6	20-12-67	Do.	Do.	4	140	140	6	-
Do.		28-11-67	Do.	3	4-1-68	Karwar	Do.	4	125	-	?	*
Do.		Do.	Do.	3	2-6-68	Do.	Do.	4	141	-	?	*

Table XI (Contd.)

Place	Type of tag	Details of release			Details of recovery			Distance Between place of recovery & release (in km)	Size at		No. of days at liberty	Direction of movement
		Date	Place	Depth (in mm)	Date	Place	Gear		Depth (in mm)	Re-lea-se (in mm)		
Karwar	Oper- cular	21-12-67	Devgad Island	16	24-12-67	Karwar	Rampan-	-	138	-	2	*
	Do.	14-12-67	Kurmagad Island	25	25-12-67	Majali	Do.	4	133	133	11	-
	Loop	21-12-67	Devgad Island	16	Do.	Do.	Do.	4	131	131	4	N
	Do.	Do.	Do.	16	26-12-67	Karwar	Do.	4	125	125	5	N
	Do.	Do.	Do.	16	Do.	Do.	Do.	4	137	137	5	N
	Do.	Do.	Do.	16	28-12-67	Do.	Do.	4	130	130	7	N
	Do.	Do.	Do.	16	30-12-67	Majali	Do.	4	138	139	9	N
	Do.	Do.	Do.	16	Do.	Do.	Do.	4	143	143	9	N
	Do.	Do.	Do.	16	Do.	Do.	Do.	4	129	129	9	N
	Do.	Do.	Do.	16	2-1-68	Do.	Do.	4	125	125	12	N
	Do.	Do.	Do.	16	Do.	Do.	Do.	4	140	140	12	N
	Do.	Do.	Do.	16	4-1-68	Do.	Do.	4	130	130	14	N
	Do.	Do.	Do.	16	Do.	Do.	Do.	4	140	140	14	N
	Do.	Do.	Do.	16	Do.	Karwar	Do.	4	126	126	14	S
	Do.	5-1-68	Karwar	16	7-1-68	Binage	Do.	4	104	104	2	S
	Do.	Do.	Do.	16	Do.	Amadalli	Do.	4	108	108	2	S
	Do.	25-11-68	Kurmagad Island	3	21-1-68	Majali	Do.	4	129	Tail broken	5	N

Table XI (Contd.)

Place	Type of tag	Details of release			Details of recovery			Distance Between place of recovery & release (in km)	Size at		No. of days at liberty	Direction of movement
		Date	Place	Depth (in mm)	Date	Place	Gear		Depth (in mm)	Re-lease (in mm)		
Mangalore	Loop	3-11-67	Off Kulai	8	4-011-67	Kulai <i>Rampani</i>	-	2	140	140	1	N
	Do.	Do.	Do.	Do.	Do.	Do.	-	Do.	148	148	Do.	Do.
	Do.	2-12-67	Manjeswar & Ullal	8	6-1-68	Baikam-padi	Do.	13	138	-	29	N
	Do.	11-1-63	Mangalore	20	22-1-68	Hosdurg <i>Arakolli-Vala</i>	-	70	138	127	11	S
Cannanore	Semi-Internal	18-1-68	Cannanore	13	223-1-68	Cannanore	-	Same Place	135	-	5	-
	Do.	23-1-68	Ahzikode	18	1-2-68	Kuriadi (Near Badagara)	-	43	110	110	10	S
	Loop	1-2-68	Cannanore	13	2-2-68	Cannanore <i>Arakolli-Vala</i>	-	Same Place	140	134	1	-
Kozhikode	Do.	1-2-68	Do.	13	6-2-68	Pazhayangadi (Near Madai)	-	-	146	140	4	N
	Do.	1-2-68	Dharmadam	18	15-2-68	Anjanur Beach (Kanhangad)	-	79	145	150	14	N
	Opercular	26-10-67	West Hill	7	26-10-67	Vellayil	-	2	83	83	1 1/2 hr.	S
Semi-Internal	14-11-67	South Pier	9	16-11-67	Do. <i>Kolli Patten-</i>	7	2	108	108	2	NE	

Table XI (Contd.)

Place	Type of tag	Details of release			Details of recovery			Depth (in mm)	Distance Between place of recovery & release (in km)	Size at Recovery (in mm)	No. of days at liberty	Direction of movement	
		Date	Place	Depth (in mm)	Date	Place	Gear						
Kozhikode	Semi-Internal	15-11-67	West Hill	10	16-11-67	Vellayil	<i>Pattenkollai</i>	7	3	135	135	1	SE
	Do.	15-11-	Do.	10	20-11-67	Do.	Do.	5	3	131	131	5	SE
Cochin	Loop	8-11-67	Malippuram	10	20-11-67	Manassery	<i>Thanguvala</i>	11	13	132	128	12	SE
	Do.	30-1-67	Narakkal	8	15-12-67	Chellanam	Shore Seine	4	24	133	129	15	SE
	Do.	30-11-67	Do.	8	9-2-68	Paraya-Kadavu	<i>Koru Vala</i>	6	90	143	137	70	SE
	Dart	8-12-67	Narakkal	10	14-1-68	Kannamali	<i>Thanguvala</i>	12	20	131	-	27	*
	Loop	6-2-68	Do.	12	9-2-68	Malipuram	<i>Kolli vala</i>	8	4	137	-	3	*
Semi-Internal	Loop	13-2-68	Mararikulam	10	26-2-68	Chellanam	<i>Thanguvala</i>	6	20	128	128	13	S
	Do.	29-2-68	Do.	14	22-3-68	Manassery	Do.	16	13	162	160	22	N
	Loop	18-4-68	Fort Cochin	16	8-5-68	Mararikulam	Do.	6	13	115	117	20	S
Vizhingam	Do.	-	-	-	-	Nil	-	-	-	-	-	-	-

* Tag alone recovered

Table XII
Particulars of recoveries of oil sardine made at different centres during 1968-69 season

Place	Type of tag	Details of release			Details of recovery			Depth (in mm)	Distance Between place of recovery & release (in km)	Size at		No. of days at liberty	Direction of movement
		Date	Place	Depth (in mm)	Date	Place	Gear			Recovery leaf (in mm)	Recovery (mm)		
Karwar	Loop	25-11-67	Kurmagad Island	15	21-1-68	Majali	Rampan	4	1	129	Tail broken	57	N
Mangalore	Do.	21-11-68	Bolur	12-15	1-12-68	Hosabettu	Rampani	6-8	8	125	-	10	N
Cannanore	-	-	-	-	-	-	-	-	-	-	-	-	-
Kozhikode	Dart	4-1-69	Elathur	11	5-1-69	West Hill	Pattankolli	7	7	132	132	1	S
	Do.	7-2-69	West Hill	11	13-2-69	Vellayil	Do.	4	3	124	124	6	S
	Do.	7-2-69	Pudiyangadi	7	13-2-69	Elathur	Do.	5	6	136	136	6	N
	Do.	7-2-69	West Hill	13	21-2-69	Parapanangadi	Do.	9	30	116	-	14	S*
	Do.	20-12-67	Vellayil	11	11-4-70	Do.	Do.	-	24	103	-	-	S*
Cochin	-	-	-	-	-	-	-	-	-	-	-	-	-
Vizhingam	-	-	-	-	-	-	-	-	-	-	-	-	-

* Tag alone recovered

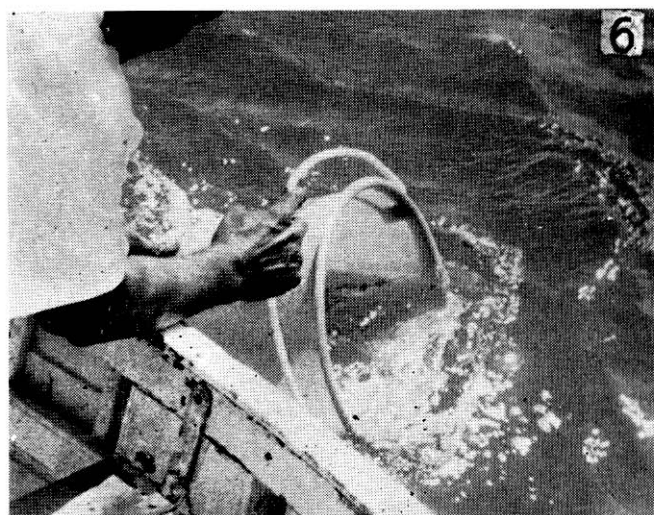
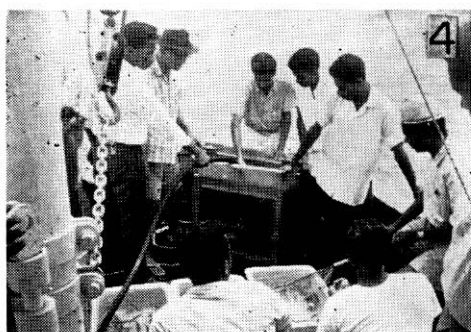
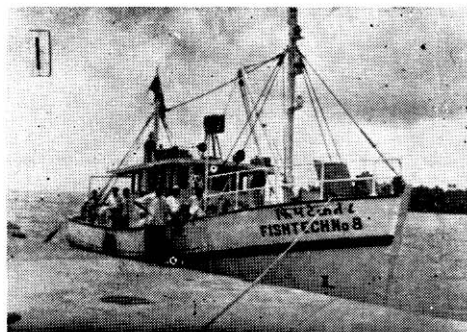


Plate I. 1. "FISHTECH No. 8" — 45' vessel of the Central Institute of Fisheries Technology used during the tagging-cum-demonstration programme at Cochin
2. "Kollivala" operation
3. Conditioning of live fish on board.
4. General view of tagging operation.
5. Insertion of tag.
6. Release of tagged fish.

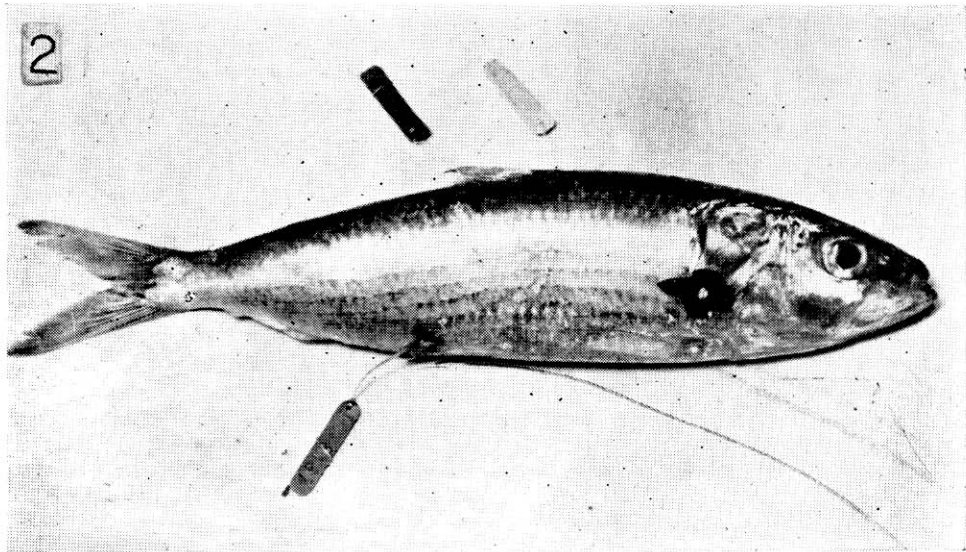
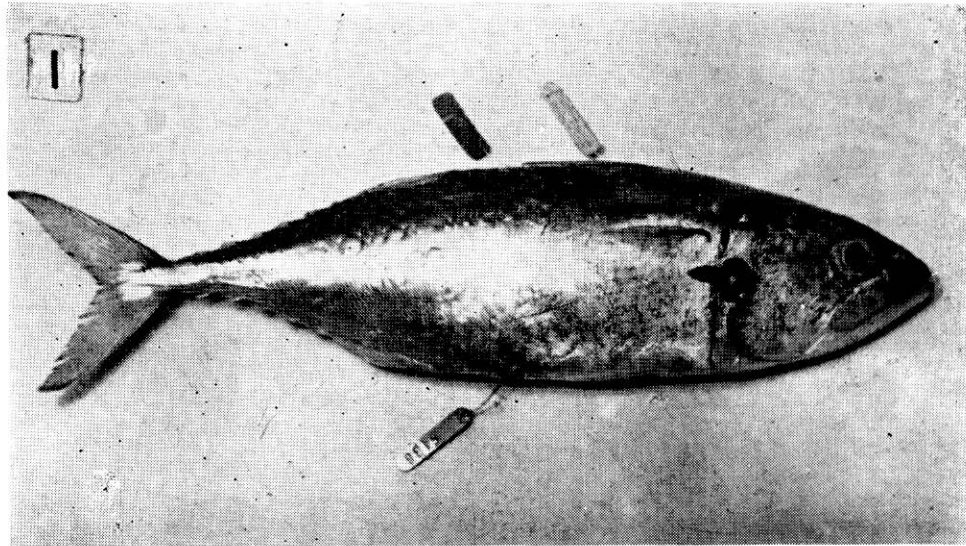


Plate II. 1. Mackerel with different types of tags.

2. Oil sardine with different types of tags.

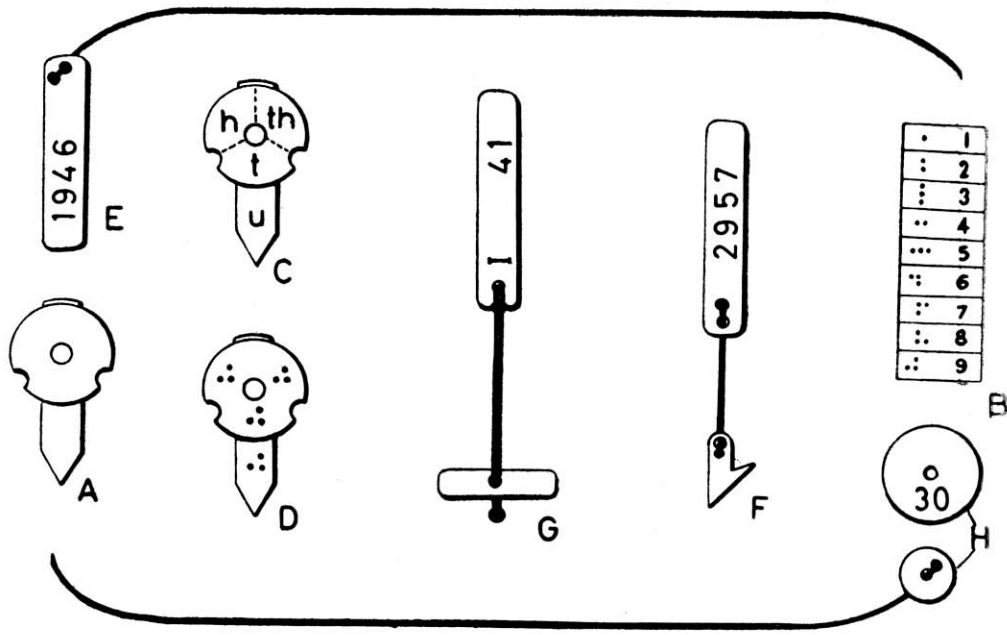


Fig. 1. A. Opercular tag. B. Notations. C. Opercular tag showing places where notations for units, tens, hundreds and thousands are marked. D. Opercular tag with notations. E. Loop tag. F. Dart trailing tag. G. Semi-internal tag. H. Opercular button tag. (Sketches by A Noble)

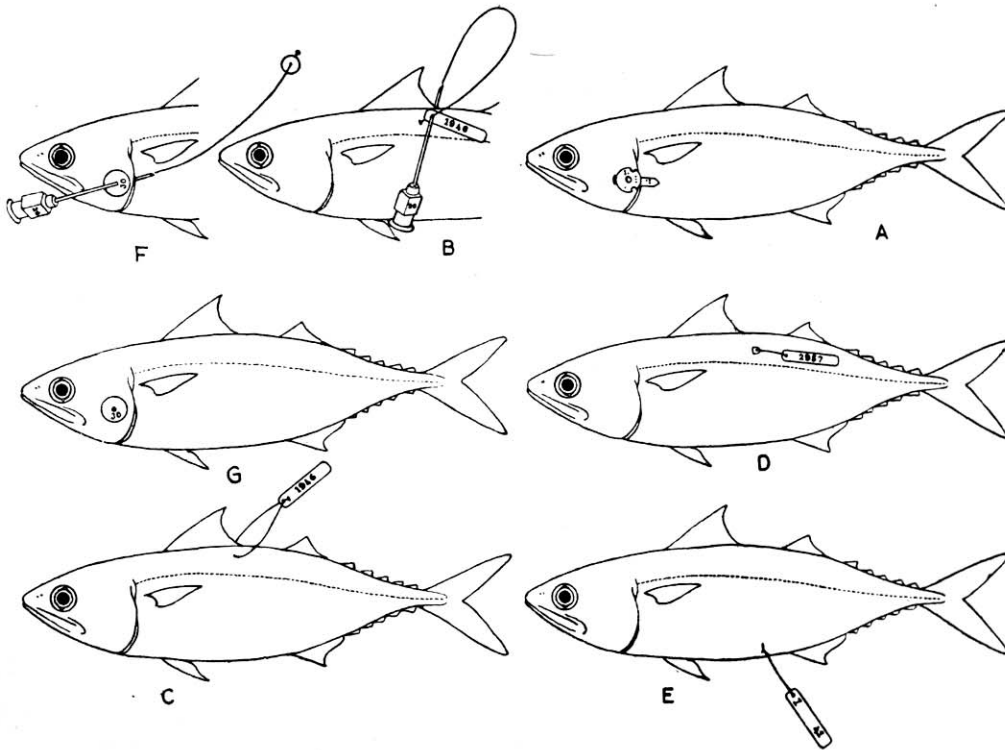


Fig. 2. A. Fish with opercular tag. B. Mode of insertion of loop tag. C. Fish with loop tag. D. Fish with dart trailing tag. E. Fish with semi-internal tag. F. Mode of insertion of opercular button tag. G. Fish with opercular button tag. (Sketches by A. Noble)

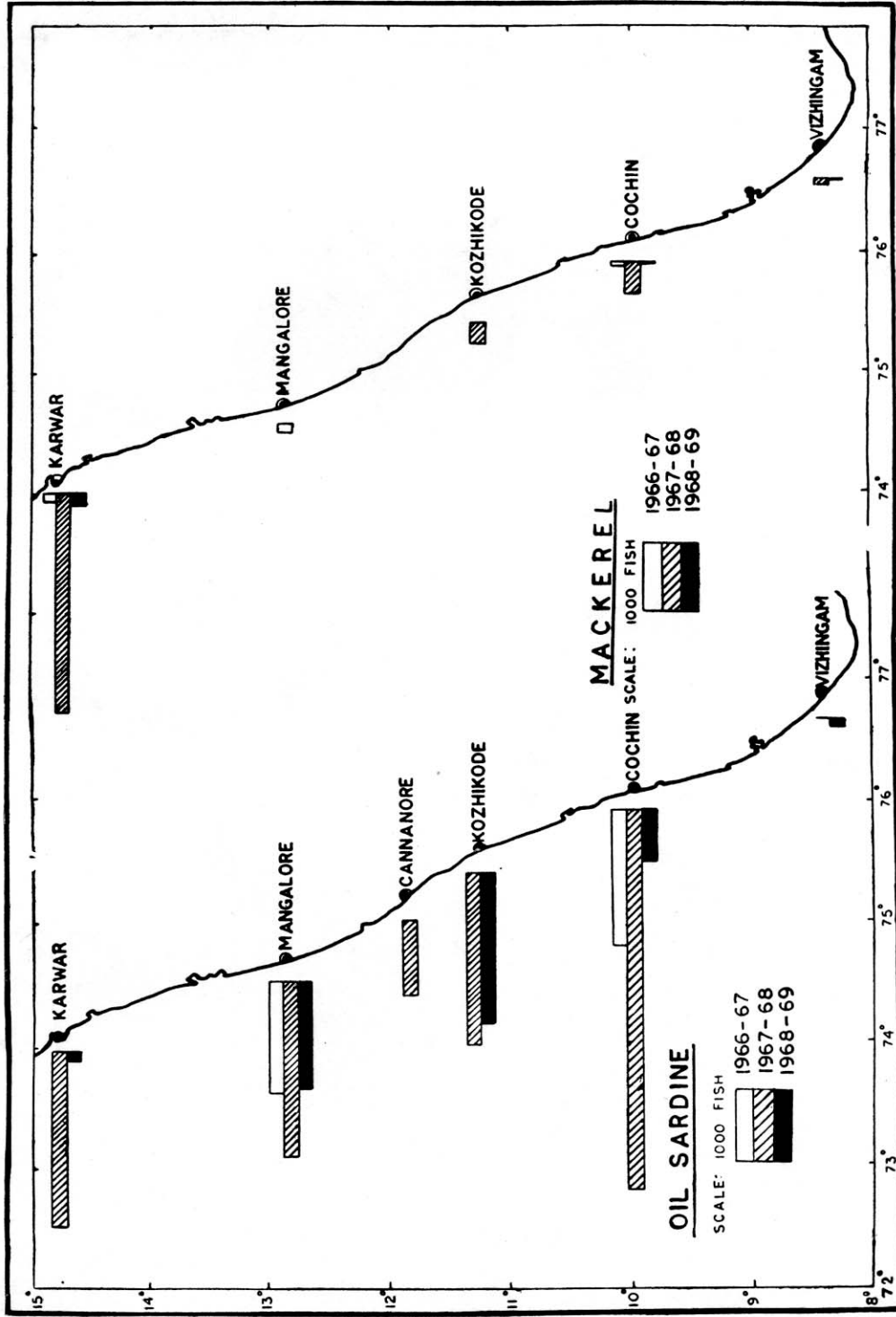


Fig. 3. Showing the total number of mackerel and oil sardine tagged at different centres during the seasons 1966-67 to 1968-69.

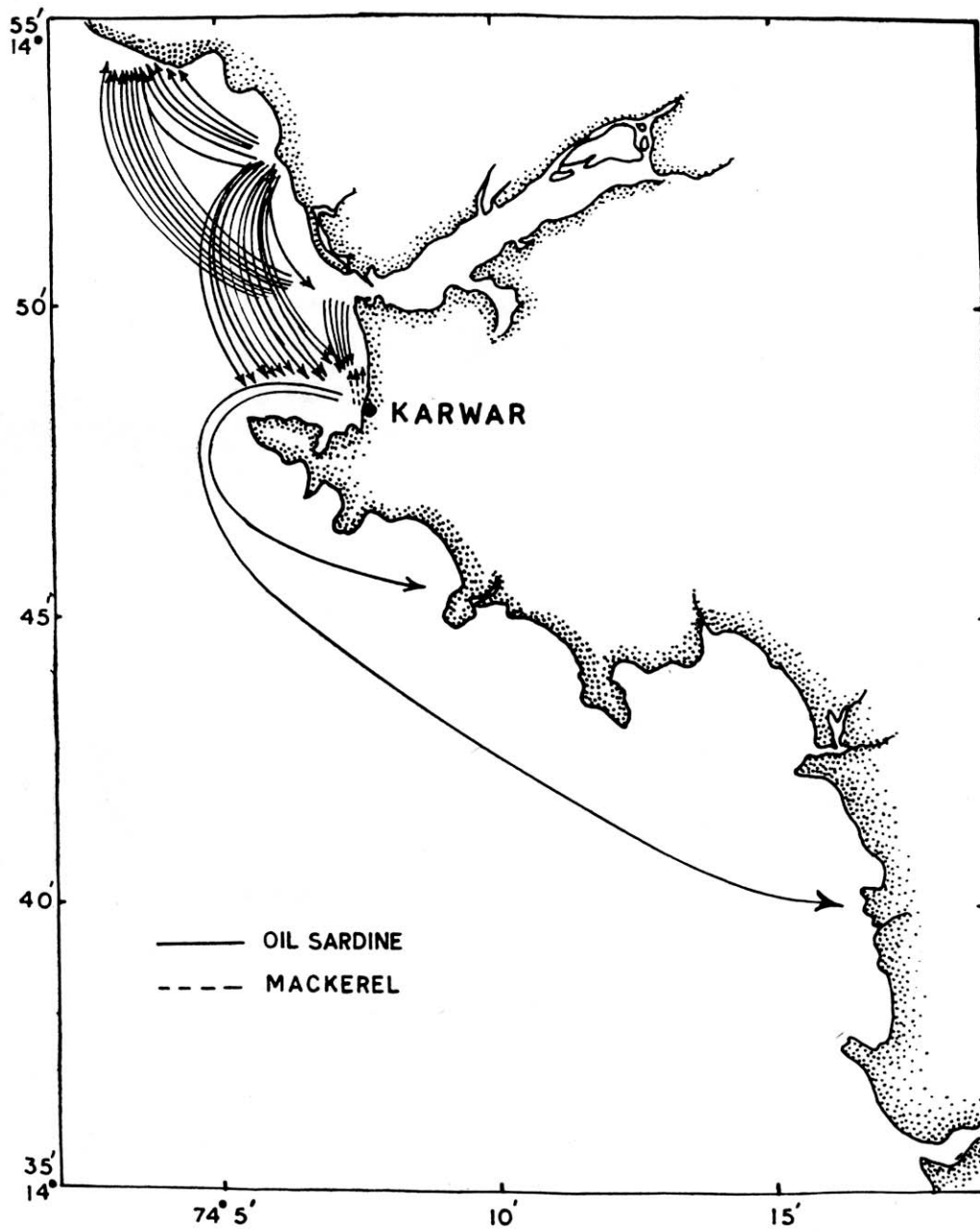


Fig. 4. Showing recoveries of tagged mackerel and oil sardine in the Karwar region.

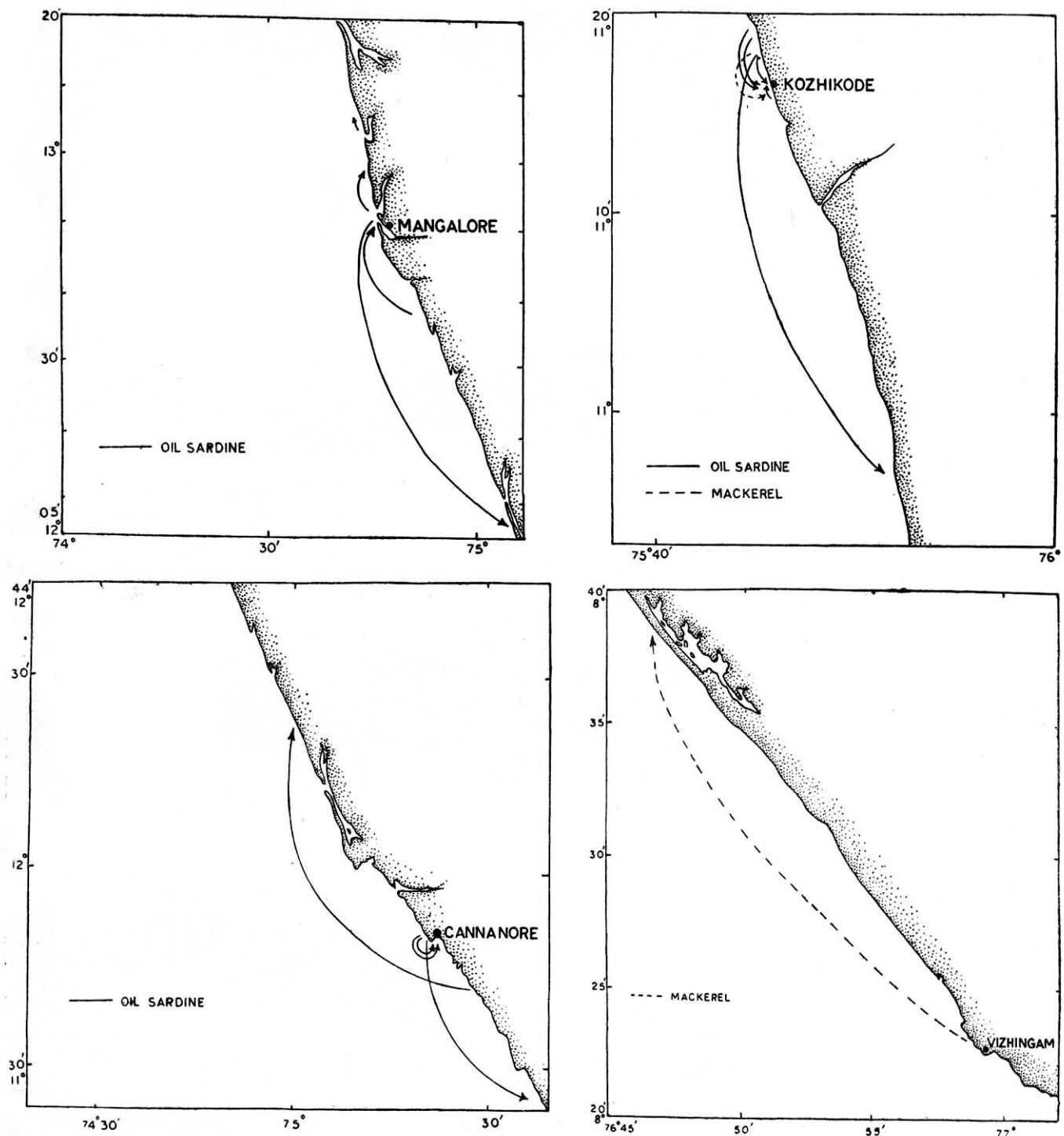


Fig. 5. Showing recoveries of tagged mackerel and oil sardine in the Mangalore, Cannanore, Kozhikode and Vizhinjam regions.

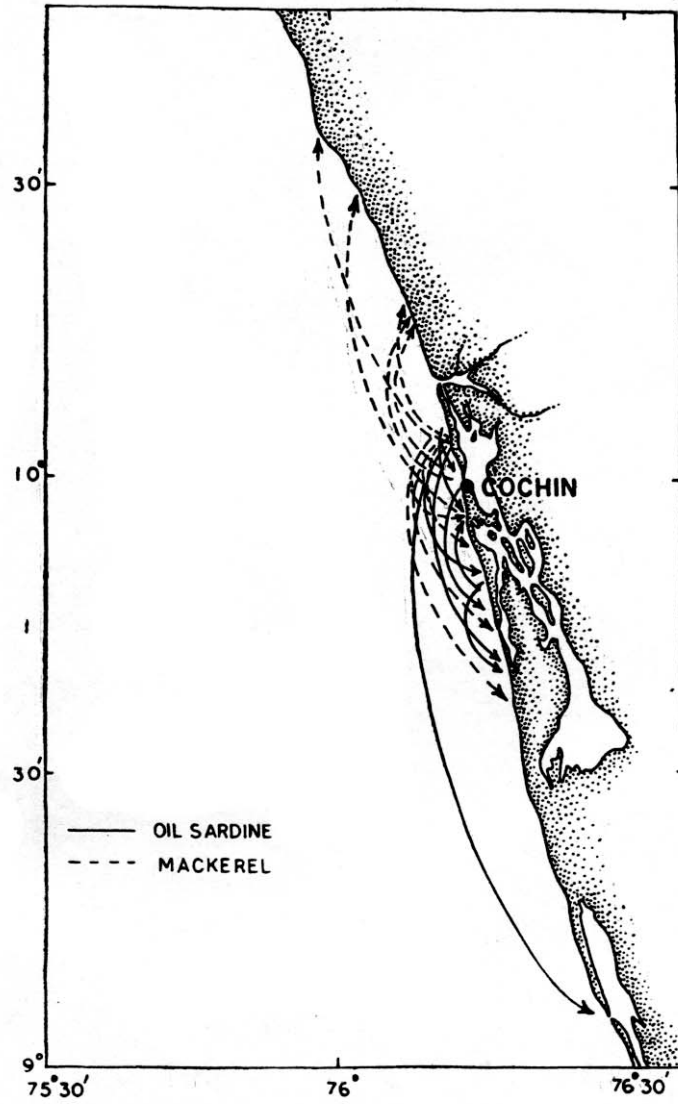


Fig. 6. Showing recoveries of tagged mackerel and oil sardine in the Cochin region.