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Oceanic Fisheries

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Introduction

India is passing through a very critical period of food crisis and consequently the necessity of exploring various fields of natural resources to augment present production weighs heavily in the minds of our Planners. The situation calls for a more rapid transition from the present stage to a more dynamic practical stage in all facets of agricultural development and this applies equally to the utilisation of renewable protein resources of the ocean–in short, the marine fisheries. The oceanic fishery resources of our high seas and the Indian Ocean at large have been well recognised by other countries, notably Japan which is at present engaged in large scale fishing for tunas and related fishes, and billfishes (marlins, spearfishes, sailfish, and swordfish) throughout the length and breadth of the Indian Ocean. Even fishing boats from Taiwan are operating in the Eastern Indian Ocean and more than once have they been apprehended in our territorial waters in the Andaman Nicobar Islands. Russian vessels have started operating in the western section of the Indian Ocean from the Black Sea ports. Of the countries bordering the Indian Ocean, Australia and the Union of South Africa are rapidly developing their oceanic fisheries. India though favourably situated has yet to make a beginning in this field on a commercial scale as we have not ventured beyond our traditional fishing grounds lying mostly within fifteen kilometres off our coastline. With the advent of highly efficient technical aids in fish finding and better fishing craft and gear, each passing year is witnessing tremendous advance both in exploration and exploitation of oceanic fishery resources. Our present and future needs, and the experience gained from other countries successfully tapping this latent resource in the Indian Ocean and other Oceans should give us the impetus to rapidly enter into this new but necessary phase of our commercial fishery development.

Methods of Fishing

As in every other fishery, practical experience has helped considerably in the evolution of fishing craft and gear used in oceanic fisheries and a brief report of the different methods employed seems appropriate.

1. *Pole-and-line fishery with live bait*: This method is used in the traditional tuna fishery in the Laccadive and Maldive Islands as in few other areas in the Pacific. Fluctuations in the availability and abundance of suitable live bait affect the fishery as we have witnessed in the tuna fishery in Minicoy Island. The skipjack (*Katswonus pelamis*) and the yellowfin tuna (*Thunnus albacares*) are caught, but the fishery touches mainly the smaller size groups as young tuna tend to shoal at the surface more frequently and are easily chummed with live bait.

2. *Long line fishing*: The gear has been evolved by the Japanese with due consideration given to the habits of the fish, especially its swimming layer, as larger size groups which generally keep to depths are caught with this gear. However, the gear fishes in addition to tunas and billfishes, sharks which abound when long lining is done close to the continental shelf or in the vicinity of islands. Besides stray catches of baracuda, wahoo, etc., lancet fishes (*Alepisaurus*) regularly figure in the catches. The details of this gear are well documented and the Japanese generally use between 2000 and 2500 hooks per operation with a schedule of 20 hours or more of working per operation if the catch is good. As much as 50 nautical miles of lines will be set for such an operation and the hooks will be fishing at different depths from about 75 to 200 metres depending upon the length of the main line, floatline and dropper, the distance between buoys and the prevalent currents.

3. *Purse seining for tunas:* The importance purse seining for tunas has gained in the last few years can be seen from the fact that the California tuna 'clipper' fleet engaged earlier exclusively in pole-and-line fishery has taken to purse seine gear. The adoption of all nylon seine; the help of Puretic 'powerblock' to increase the handling speed of the net; the use of aircraft to scout for shoals; and an understanding of favourable oceanographic conditions influencing the availability of fish have all helped towards making purse seining for tunas a success and as McNeely (1961 *Pacific Fisherman*, 59 (7): 27–58) and others foresee, this gear will have a profound effect on oceanic fisheries throughout the world.

Surface trolling, gillnets, traps, handlines, and beach seines are also used for capturing tunas in small quantities.

Development of Japanese Tuna Fishery in the Indian Ocean

After World War II, Japanese long liners first restarted operating in the South Eastern Indian Ocean south of Java late in 1952 and by 1954 they had extended the area of operation to 75°E long. and by the end of 1955 were fishing throughout the Indian Ocean from 40°E to 130°E longitude Twelve years of tuna long lining in the Indian Ocean by the Japanese have shown that the high hooked rates obtained in the initial years when grounds were first exploited tended to gradually drop year by year, the bimodal size of the principal catch also becoming smaller year after year. The decrease of the large yellowfin tuna 130 cm and more in fork length is presumed to be within the bounds of possibility that is caused by the influence of fishing, while the fluctuations in the abundance of smaller size groups are considered to be due to natural causes. Unlike the bigeye tuna (*Thunnus obesus mebachi*), the yellowfin tuna especially the larger ones appear to be localised in distribution. Large scale fishing of the 'indomaguro' (*Thunnus maccoyii* of Australia) is carried out from two centres in the Eastern Indian Ocean by Japan and recently by Australia, the first 10°S to 17°S and 113°E to 120°E and the second 20°S to 30° S and 100°E to 110°E. Based on length/weight and gonad weight of the fish caught, it is suspected that although the fish in both the areas may belong to the same population, two spawning groups may exist.

The albacore (*Thunnus alalunga*), the most sought after species by the tuna long liners has a wide-spread distribution south of equator, though two fishing grounds for the albacore were detected by the Japanese, one along the equator (from April to September) and the other south of 8°S (from January to March).

None of the billfishes are so abundantly caught as tunas in the long line. However, the blue marlin (*Tetrapturus audax*), the striped marlin (*Makaira nigrescens*) and the black marlin (*Makaira indica*) are more frequently caught than the sailfish (*Istiophorus gladius*), the short-nosed spearfish (*Tetrapturus angustirostris*) and the swordfish (*Xiphias gladius*).

TUNA LONGLINING FROM THE U. S. RESEARCH VESSEL *ANTON BRUUN* IN THE INDIAN OCEAN

One of the outstanding features of the International Indian Ocean Expedition was the two cruises undertaken by R. V. *ANTON BRUUN* for tuna longlining, in one of which (Vth Cruise) the writer also participated. Very useful information on problems relating to spatial and depth distribution of the various oceanic species of tunas and billfishes;

V TH CRUISE OF R.V. ANTON BRUUN: JANUARY-MAY 1964

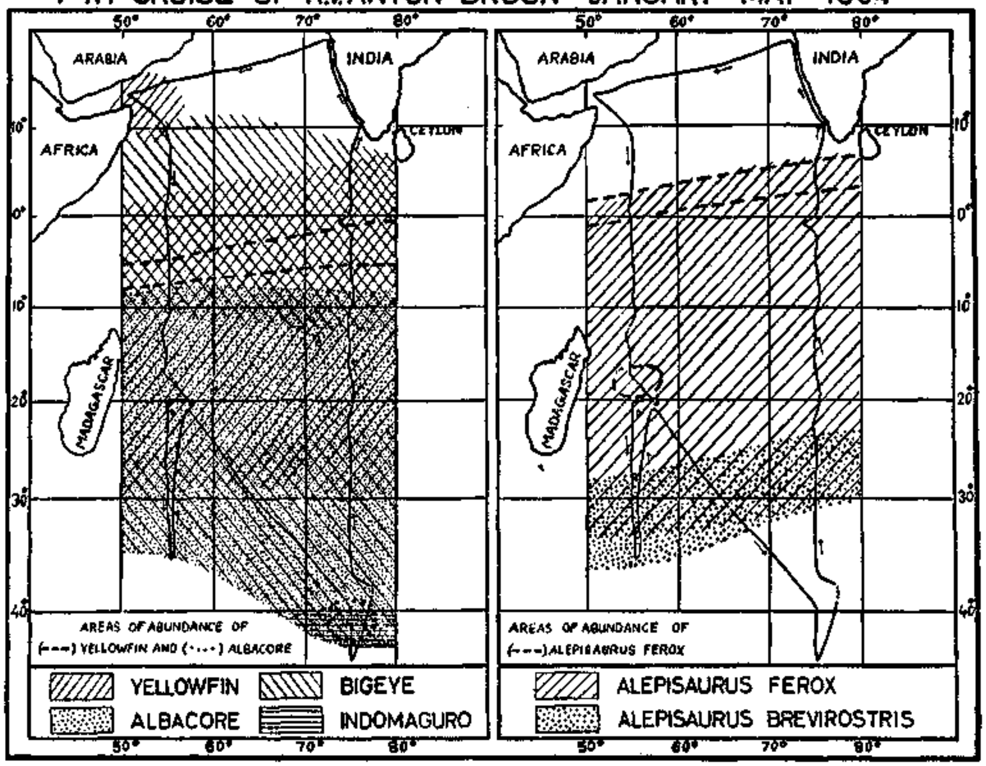

Fig. 1. Maps showing the distribution and areas of abundance of four major species of tunas and two species of lancet fishes based on longline catches obtained during the Vth Cruise of R. V. *ANTON BRUUN* in the Indian Ocean.

many aspects of the biology such as size, maturity, food, sex ratio, reproduction, spawning grounds, etc., behaviour of the fish, specially shoaling as seen from the distribution of the fish caught in the lines; and associated fishes in the eco-system were obtained. It will not be out of place to mention here that very good fishing grounds for the albacore and the bluefin (indomaguro) were discovered in the southern Indian Ocean in southern latitudes in the zone between the Polar Front and the Subtropical convergence around 42°S and 75°E. In the accompanying figure (Text-figure 1), I have shown the distribution of tunas and lancet fishes in part of the Indian Ocean investigated during the Vth Cruise of R. V. *ANTON BRUUN* between January and April end 1964. Inverse relationship in the abundance in the catch of tunas, especially yellowfin and the albacore on the one hand and lancet fishes on the other has been evident apparently as they compete for food. As we found, pelagic sharks, especially the whitetip shark, the silky shark, the great blue shark, the thresher shark, and the mako shark also play an important role in tuna longlining as they cause considerable damage to the hooked fish (plate I, fig. B). The lesser toothed whales such as the Killer whale also cause damage to tuna caught in long lines. Serological studies based on samples of tunas and other fishes collected during the cruise will give us useful information on subpopulations of pelagic fishes in the Indian Ocean.

Tuna Ecology

The success of oceanic fisheries depends to a large measure on our understanding of the chain of events affecting the environment of the fish from meteorological conditions, the ocean currents, primary production, secondary production to the fishable stock of fish. The marine environment is so complex and diversified that an area which has proved very productive may not yield good catches during some years and only investigations over a period of time will help us understand such vagaries. Some of the problems connected with oceanic fisheries are of such magnitude that they call for international co-operation as well as co-operation between organizations dealing with different branches of marine sciences. The success of such ventures in the results obtained through the efforts of The Inter-American Tropical Tuna Commission, The Pacific Oceanic Fisheries Investigations, The California Co-operative Fisheries Investigations and the Nankai Regional Fisheries Research Laboratory programmes, are now well known. To tackle many problems of oceanic fisheries such as tuna ecology and to obtain quicker results which could be made use of by the fishing fleets in the Indian Ocean, international co-operation will be necessary. The role of the environment in oceanic fisheries is well understood by Japanese tuna fishermen who collect extensive data on temperature and salinity in all places where longlining is carried out. Much of what little we know about the ecology of tunas and other pelagic fishes in the Indian Ocean we owe to the Japanese and some of their more significant findings are pertinent in this connection.

The bluefin tuna (indomaguro) occurs in the Frontal zones with greatest concentrations in the cold water pockets in this zone and show seasonal north and south migration with the zones. The yellowfin tuna is more abundantly distributed in the offshore areas and in the vicinity and on boundaries of the equatorial current system and their vertical distribution is nearer to the surface as compared to the bigeye tuna, the spatial distribution of which corresponds with that of the yellowfin tuna. Like the bluefin tuna the albacore prefers temperate waters occurring chiefly in offshore waters and shows seasonal north-south migrations from the Polar Fronts. High surface temperature gradients where the optimum temperature zones are narrow are preferred places of concentration for the albacore as well as the bluefin tuna. They also tend to aggregate on boundaries of cold and warm eddies and cold and warm water intrusions. The thermocline ridges are also preferred places of aggregation due to the concentration of abundant food. The skipjack occurs just off coastal areas and on current boundaries.

Although temperature by itself may not vitally affect the behaviour of tunas, it is an easy indicator of good fishing grounds. The surface temperature in the tropics is fairly uniform throughout the year and localised differences may point to areas of slow upwelling, current boundaries, etc. The mixing zones of areas of convergence and divergence in the current system where forage will be abundant are also places where tunas will tend to congregate. The optimum current for good tuna fishing has been found to be 0.5 to 1.0 knots. Areas such as oceanic islands, sea mounts and continental slopes with higher bottom topography are also good tuna fishing grounds as they affect the surface currents and internal waves giving rise to eddies, rise in the thermocline level, etc.

The biotic part of the tuna food chain is least known. The data obtained by the various expeditions which investigated the Indian Ocean during the last five years should give us a better picture of areas of high productivity, relationships between abundance of phytoplankton, zooplankton and micronekton and possibly abundance of tuna forage.

Tagging of tunas and billfishes for understanding their growth and migrations; serological investigations to delimit subpopulations; and behaviour studies should also be given priorities in any oceanic fisheries research programme.

Oceanic Fisheries Investigations At The Central Marine Fisheries Research Institute

Investigations on tunas and billfishes were initiated chiefly through individual efforts towards the end of the last decade when two species of the genus *Auxis* were recorded from off the west coast of India. From this humble beginning, the subsequent growth of the work at the Institute relating to tunas and billfishes may be summarised as follows.

For the first time, a comprehensive review of the scombroid fishes of the Indian Ocean was made. The Indo-Norwegian Project fishing vessel *KALAVA* was the Institute's first 'Research Vessel' and investigations carried out with this vessel in the Laccadive Sea and off the west coast of India resulted in a detailed study of the tuna fishing industry in Minicoy Island and for the first time the larvae of tunas and billfishes were described from the plankton of this area. Later, regular observations on tuna fisheries in Minicoy Island were initiated which have resulted in the accumulation of very useful data on the food and feeding habits of the skipjack and the yellowfin tuna; fecundity of the skipjack in the Minicoy waters; livebait resources of the Laccadive Sea; seasonal fluctuations in the abundance of livebait fish in Minicoy; and the introduction of *Tilapia mossambica* as a tuna livebait in the Laccadives.

In our coastal waters, a survey of the troll fishery for tunas and billfishes in the Gulf of Mannar was carried out. The fishery and aspects of the biology of the oriental bonito (*Sarda orientalis*) and the little tunny (*Euthynnus a. affinis*) which form minor fishery along the south west coast of India were investigated.

For the first time a comprehensive review of the helmith and copepod parasites of scombroid fishes was carried out.

Exploratory fishing and planktological investigations carried out from the Indo-Norwegian Project Research Vessel *VARUNA* off the south west coast of India and the Laccadive Sea have confirmed that the skipjack, yellowfin tuna, little tunny, oriental bonito, and frigate mackerels spawn in this area, the peak period being February—March and May—June. Larvae and stray catches of early juveniles of billfishes have been obtained in the course of these investigations.

^{14}C experiments conducted in tuna fishing grounds in the Laccadive Sea point to high organic productivity.

Over 3500 'oceanographic stations' have been occupied during the cruises of R. V. *VARUNA*. Fluctuations in the thermocline levels; areas and seasons of upwelling; convergence and divergence zones of the south west coast of India and south east of Minicoy are but a few of the findings relevant to our oceanic fisheries. These investigations which are being continued should make the waters off the south west coast of India one of the best understood in the region of the Indian Ocean and be basic to any future studies in other parts of the Indian Seas and its resources.

Conclusion

The steady growth of oceanic fisheries of the world may be seen from the following gleaned from the FAO Year Book of Fishery Statistics for the year 1964. The landings are in thousand metric tons.

	1948	1957	1964
Tunas and related species	390	920	1,310
Billfishes (excluding swordfish)	7	41	77
Swordfish	4	18	34
Total	401	979	1,421

The same report also indicates that the Indian Ocean and adjacent areas accounted in 1964 for only 4% of the world's total fish landings of 51.6 million metric tons, the Atlantic and adjacent seas and the Pacific ocean and adjacent seas accounting for 35% and

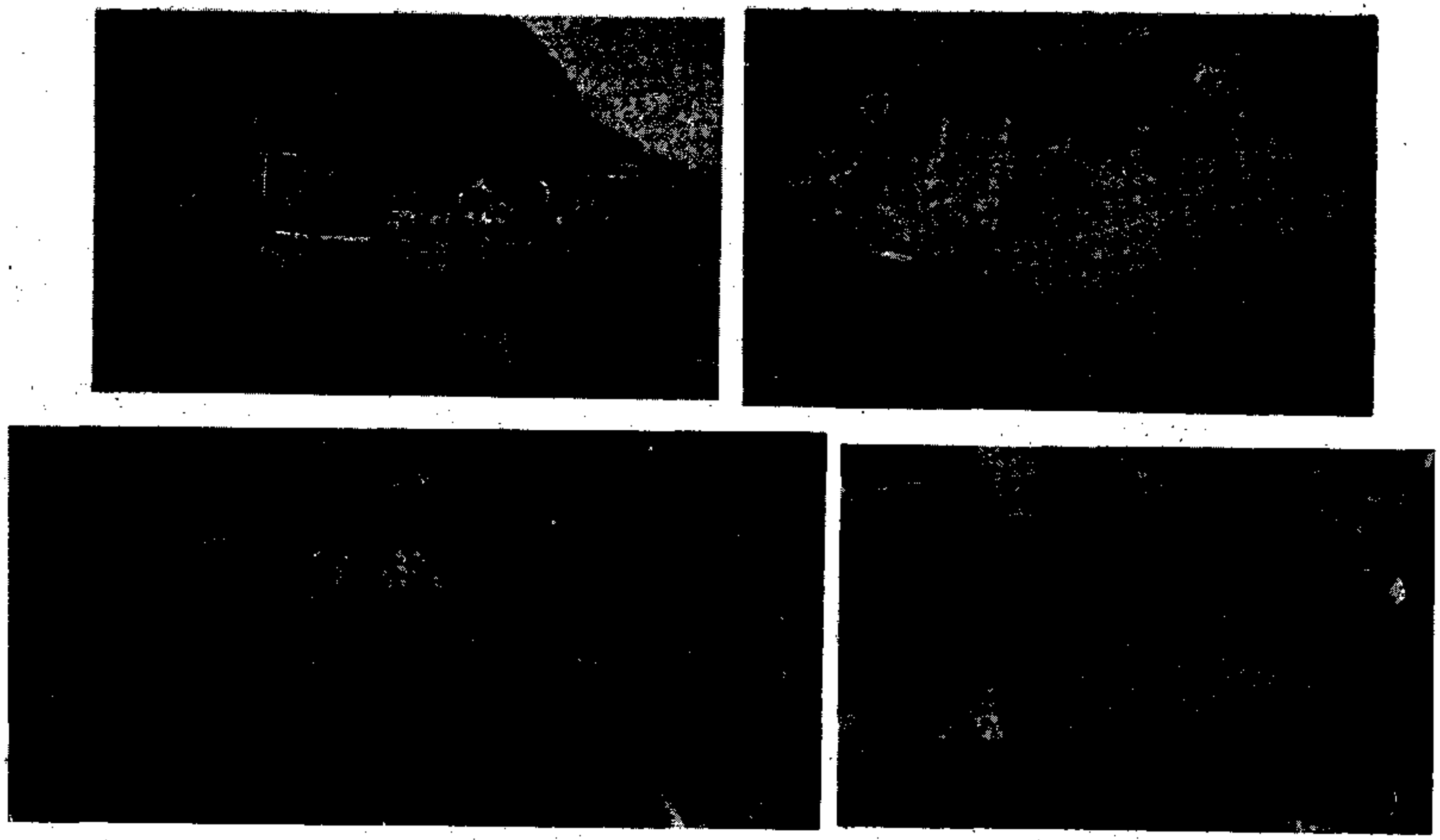

PLATE 1: A. Japanese tuna longliners and factory ships at Port Louis, Mauritius; B. Shark damaged bigeye tuna; C. Striped marlin (*Tetrapturus audax*); D. Part of longline catch of tuna (*bluefin*) on deck of R. V. *ANTON BRUUN*. (All photographs were taken by the author during the Vth Cruise of R. V. *ANTON BRUUN* in the Indian Ocean.

49% respectively and the rest being made up of landings from inland waters. These figures clearly indicate that the fishery resources of the Indian Ocean are under exploited and some even untouched. As for oceanic fisheries resources, this is glaringly evident when we look at the area of the three major oceans (Data after Sverdrup *et. al.* 1942. The Oceans, its Physics, Chemistry and General Biology) and the landings of tunas:

	Pacific Ocean	Atlantic Ocean	Indian Ocean
Area in Km^2	165,246,000	82,441,000	73,443,000
Landings of tuna for 1964 (Metric tons)	@ 840,000	@ 257,000	@ 150,000

Assuming that the environmental conditions in the Atlantic and the Pacific Oceans, being more or less similar as far as tunas are concerned, Shomura (1966: *Comm. Fish. Rev.*, 28 (5): 1–11) opines that the Atlantic being approximately 50% the size of Pacific Ocean, we may assume that the potential yield of the resource could be 50% of the yield of the Pacific. This criteria cannot be strictly applied to estimate the fishery resources of the Indian Ocean as its northern half is greatly restricted in area, though the Ocean itself is about 44% of the area of the Pacific Ocean. Except for the yellowfin tuna in the Eastern Tropical Pacific the landings of the other species of tunas in the Pacific as a whole have been less than the maximum sustainable yield of the Pacific stocks and as such the scope for still further expansion of the fisheries is indicated. In the Indian Ocean, the yellowfin tuna and the bigeye tuna constitute the bulk of the tuna catch, but it is unlikely that they are over exploited, though in some areas intensive fishing is being carried on. Considering these it may not be wrong to assume an eventual increase in tuna and billfish landings in the Indian Ocean to at least three times the present level to reach the maximum sustainable yield. The demand for tunas in the world market is so great that there will be considerable scope for exporting the catch either as frozen or canned products. Thus as tunas and billfishes constitute the most potentially important groups of oceanic fishes of the Indian Ocean and as the outlook for the future is bright, every effort should be made to catch up in this field of fisheries development where we have lagged thus far.