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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the Fishery Data Centre and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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Cover photo: Tuna (*Euthynnus affinis*) catch on board purse seiner at Mangalore.

TUNA FISHERIES IN INDIA: RECENT TRENDS*

Introduction

It is needless to point out that any information on tuna fisheries, whether pertaining to research or development assumes international importance as would be evident from the voluminous data provided by the FAO, International commissions on tuna fisheries and regional informations from developed and developing countries.

Tuna is one of the least exploited resources of the Indian seas accounting for 0.98% of the total marine fish catch of India at the 1978 level. On the other hand tuna resources have been exploited by countries such as Japan, Korea and Taiwan from the Indian Ocean. The complex and dynamic forces of the environment brings about profound influence on the movement of tuna shoals and their regional and seasonal fluctuations in the catch. Exploitation of tuna resources has received high priority in the programmes and plans for fishery development of many countries. In India, there is a growing interest for tapping this resource as a measure of diversifying our fishing effort.

In the early sixties, the symposia conducted on tunas and related species at Dakar, Senegal (12-17 Dec. 1960), Honolulu (14-19 Aug. 1961) and at Mandapam Camp, India (12-15 Jan. 1962) have made useful recommendations for the proper exploitation, utilisation and conservation of tuna resources (*FAO Fish. Rep.* No. 6, Vol.1, 1963: 89-92). Relevant portions of the recommendations of the 'Symposium on scombroid fishes' held at Mandapam camp are reproduced below:

It is recommended that:

Scientists in the countries of the world primarily concerned with the high sea fishery for tunas and bill fishes devise and publish a suitable system for gathering biologically useful statistics of yield and effort in these fisheries that will be capable of being employed on a worldwide basis, can be used uniformly by Fishery Officers and scientists everywhere, and that will be capable of yielding data useful in elucidating population dynamics of the several fish populations involved. It is considered that the devising of this statistical system might be properly initiated at the World Conference on tunas to be convened by FAO in La Jolla, California in July, 1962.

The authorities involved with the planning of the Indian Ocean Expedition give due consideration to gathering and collating the following sorts of information which should be useful in aiding the development of high seas fisheries for scombroid fishes in the Indian Ocean.

(a) surface temperature charts on a monthly basis particularly from 20°S. latitude to the continent and island chain on the north;

(b) variation in thermocline depth with monsoon change particularly within 200 miles of land in the Andaman Sea, Bay of Bengal, Arabian Sea, Persian Gulf and Gulf of Aden;

(c) variation in direction and flow of the mixed layer currents in the Indian Ocean, particularly north of 20° S. latitude, and in particular as related to variation in monsoon period and strength;

(d) variation in basic biological productivity rate in the area north of 20°S. latitude and particularly within 200 miles of shore and

(e) relationship of variations in these parameters to variations in the season and yield of the high seas fisheries of the areas.

The Central Marine Fisheries Research Institute through its publications during the sixties (Jones, S. and E. G. Silas 1960, *Indian J. Fish.,* 7: 369-393 and

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Jones, S. and E. G. Silas 1964, *Symp. Scombroid Fish.*, MBAI, Pt. I, 1-105) have drawn attention to the rich latent resources of tunas and related species lying close to our door steps and the need for exploiting them for increasing the country's marine fish production.

While research and developmental efforts towards that end were progressing, the industry, however, was fighting shy on embarking on any large scale venture as tuna fisheries in the high seas required large capital investment and the demand for red tuna meat in the internal and external markets was not encouraging.

From the middle of seventies, however, there has been a significant increase in the catches of coastal species of tunas, probably due to the small scale fishing units switching over to improved gears such as nylon gill nets. Simultaneously, exploratory fishing surveys conducted along our coasts have drawn attention to the effectiveness of using gears such as purse seines for tuna fishing in the potential fishing grounds in the shelf waters. (Silas, E. G. 1969, *Bull. Cent. mar. Fish. Res. Inst.* **12**:1-86).

In the context of these developments and the need for efficient utilisation of the resources of the Exclusive Economic Zone, a brief account on the trend in the tuna fisheries in the country is presented here.

Trend in all India tuna catches

The all India tuna landings as estimated by the Central Marine Fisheries Research Institute showed a progressive trend from 3,015 tonnes in 1970 to 19,322 tonnes in 1976 and a slight decline during 1977 and 1978 (13,005 and 13,748 tonnes respectively). The percentage contribution of tuna landings in the all India marine fish production ranged from 0.3 (1970)

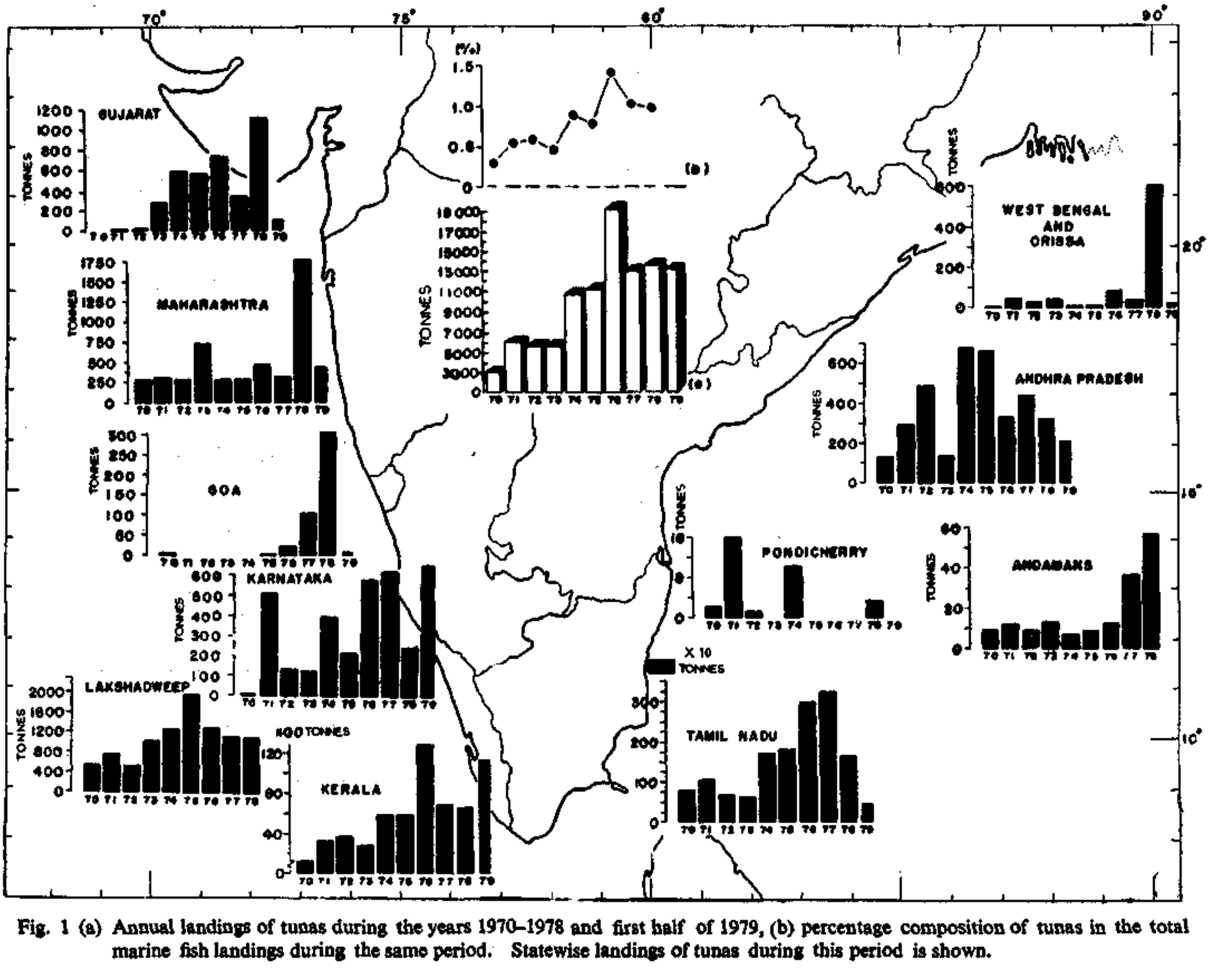

Fig. 1 (a) Annual landings of tunas during the years 1970–1978 and first half of 1979, (b) percentage composition of tunas in the total marine fish landings during the same period. Statewise landings of tunas during this period is shown.

to 1.42 (1976). The landings of tunas in the country during the first half of 1979 has been estimated as 13,285 tonnes.

State-wise tuna catches during 1970 to 1978

The State-wise distribution of tuna catches as well as the all India catches are given in Fig. 1. It would be seen that during 1970-78, Kerala State alone accounted for 50% of the total tuna catches in the country. Tamil Nadu accounted for 12-16%. In other maritime states catches were not significant. In Lakshadweep and Andaman–Nicobar islands tuna catches form 8.7 and 0.23% of the country's total tuna production during 1977-78. In Maharashtra, Goa, West Bengal and Orissa significant increases in the catches were recorded during 1978 when compared to preceding years and in Kerala, maximum catches were observed during 1976 (66%).

Tuna landings at important centres

The CMFRI furnishes the production figures of various species of marine fishes based on multi-stage stratified random sampling techniques after classifying important groups of fishes. For detailed biological investigations involving aspects of species composition, size, age, growth, maturity, spawning, food and feeding habits and other parameters, the Institute has selected certain important centres for tuna investigations which would help in monitoring the resource. The tuna landings and other gear-wise particulars for the different centres are given in Figs. 2, 5, 6 and 8 for the period 1978-79.

The common species of tunas occurring in the Indian seas are:

Euthynnus affinis	(Little tunny)
Auxis thazard	(Frigate tuna)

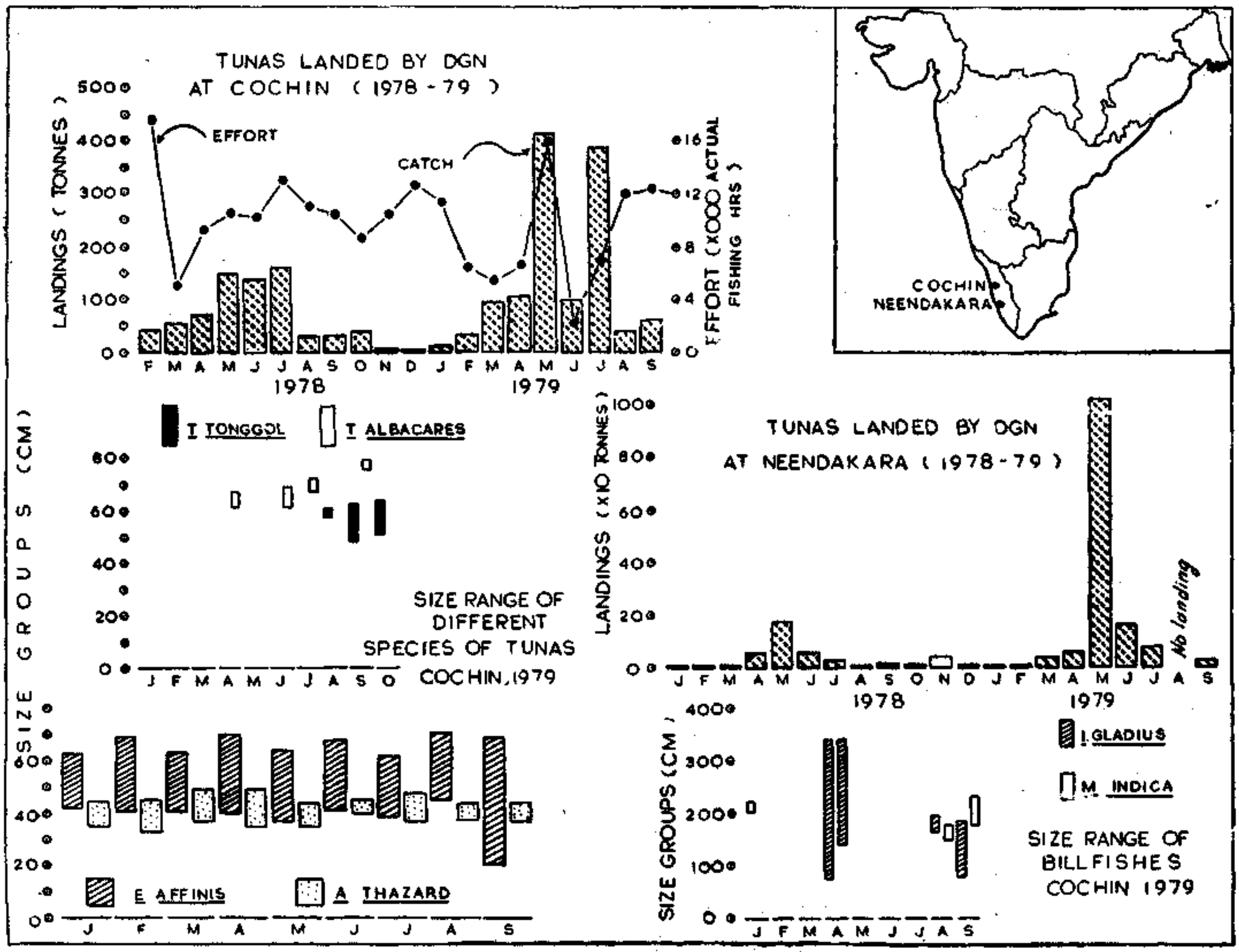

Fig. 2 Catch of tunas by drift gill nets (DGN) at Cochin, 1978 and 1979 (part) and Neendakara, 1978 and 1979 (part) and effort expended at Cochin; size range of tunas and billfishes landed at Cochin, 1979 (part).

A. rochei	(Frigate tuna)
Sarda orientalis	(Oriental bonito)
Thunnus tonggol	(Northern bluefin)
T. albacares	(Yellowfin tuna)
T. obesus	(Bigeye tuna)
Katsuwonus pelamis	(Skipjack tuna)

Kerala State

(Total annual catch of tunas—6,548 tonnes during 1978)

Cochin: Prior to 1977 tuna catches at Cochin were insignificant with occasional catches in the experimental purse seine operations conducted by the Integrated Fishery Project and in the artisanal fishery from hook and line and shore seines. The small mechanised fishing vessels (9.7 metre OAL pablo type boats) commenced operations of effective nylon drift gill nets in 1977 bringing good catches of tunas at the Fort Cochin landing centre. The Cochin Fishing Harbour was commissioned early in 1978 and in 1979 about 160 gills netters were registered. Drift gill nets of mesh size 10-15 cm are operated in depth zone 35-40 m off Cochin by the same pablo type boats.

Fig. 3 Drift gill net used in tuna fishery at Cochin

The effort expended by these boats could be seen in Fig. 2. The tuna catches proportionately increased or decreased with the fluctuations in effort. Month-wise catches show a progressive trend from January, 1978 with peak periods during June-July prior to intensification of monsoon. For coastal tunas the immediate post-monsoon months (September-December) are less productive.

Among the species of tunas landed by drift gill nets, *E. affinis* forms over 70% and *A. thazard*, *A. rochei*, *T. tonggol*, *T. albacares* and *S. orientalis* form the rest of the catches in the order of abundance. The size ranges and weights of different species observed during 1978 to 1979 are given below:

	Fork length (cm)		*Weight (kg)*	
	Min.	*Max.*	*Min.*	*Max.*
E. affinis	21	71	0.9	5.2
A. thazard	33	48	0.6	2.0
T. tonggol	38	64	0.9	3.5
T. albacares	63	78	4.8	7.1
S. orientalis	11	52	0.1	1.8

Fig. 4 Little tunny landed at Cochin

During 1979 the estimated landings of tunas were 12.8 tonnes in January which leaped to 411 tonnes in May and registered a fall during June (91.9 tonnes).

Along with tuna catches sail fish (*Istiophorus platypterus*), black marlin (*Makaira indica*), *Elacate nigra*, *Elagatis bipinnulatus*, *Coryphaena hippurus*, *Parastromateus niger*, catfishes such as *Tachysurus thalassinus*, *T. dussumieri*, *T. tenuispinis*, seer fishes such as *Scomberomorus commerson*, *S. guttatus* and *S. lineolatus* and black tipped and grey sharks are usually landed.

Calicut

At Calicut tuna catch in 1978 was estimated at 69.5 tonnes as compared to 91.5 tonnes in 1977. Drift gill nets were the main gear operated for tuna fishery and fishing is carried out in depth zone 25-55 m. 98% of the catch comprised of *E. affinis*. *T. albacares* occurred only during November (1.7 tonnes) and species such as *A. thazard* and *T. tonggol* occurred only in very small quantities. During January to October, 1979, 63.1 tonnes of *E. affinis* was landed with the best catches during January (11.6 tonnes) (Fig. 5).

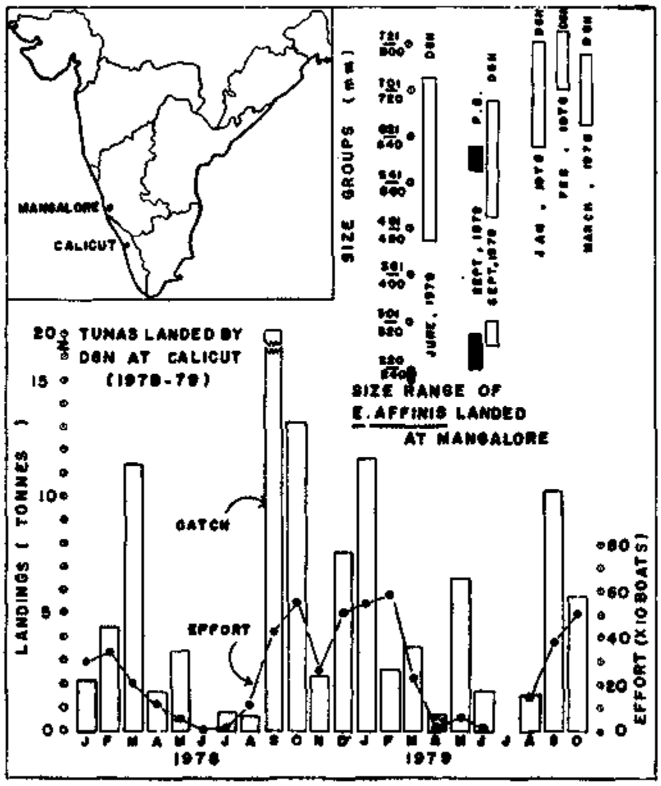

Fig. 5 Catch of tunas by drift gill nets (DG N) and effort expended at Calicut, 1978 and 1979 (part); size range of *E. affinis* landed at Mangalore, 1978 and 1979.

The number of non-mechanised boats operating drift gill nets vary from day to day with a maximum number limited to 32.

A notable facility available at Calicut for non-mechanised boats is that these boats are towed by mechanised boats to distant fishing grounds and brought back to shore.

Neendakara

Tuna catches of Neendakara, mainly from drift gill nets commenced with 2.4 tonnes in January 1978, progressed during the summer months and reached a peak in May (174.0 tonnes) and declined during monsoon months. The same trend was observed in 1979 also with peak catches in May (1,102.1 tonnes) (Fig. 2). On an average 40 mechanised boats operate gill nets at this centre with the maximum numbers during May-June period (68).

The bulk of the catches comprised of *E. affinis* followed by *A. thazard.* Incidental catches include species such as *S. orientalis* and *A. rochei.*

Vizhinjam

Total catch of tunas landed at Vizhinjam during 1978 was estimated at 397.3 tonnes which showed a decrease of 4.5% from the landings during 1977 (416.0 tonnes). Of the total catch 82.3% was landed by drift gill nets, 17.6% by hooks and lines and 0.1% by boat seines. June was the peak period. Species-wise, *E. affinis* and *A. thazard* contributed 73% and 24% respectively of the total catch and the rest were composed of stray catches of *S. orientalis, T. albacares* and *K. pelamis.*

During January to October 1979, total catch of tunas was estimated as 300.2 tonnes with the percentage of contribution from drift gill nets and hooks and lines as 75.3 and 24.5 respectively. Peak catches were observed during May (44.2 tonnes). The landings of sailfishes during the same period was estimated as 11.6 tonnes comprising *I. platypterus.* Gear-wise and species-wise distribution is given in Fig. 6.

Tamil Nadu

(Total annual catch of tunas-1628 tonnes during 1978)

Tuticorin: At Tuticorin, tuna landings were observed from 5 centres. At Vaipar, Tuticorin, Punnakayal, Kayalpatnam and Veerapandiapatnam drift gill nets mainly account for tuna catches. Except at Veerapandiapatnam, hooks and lines are also operated at these places. During 1978, the total catch of tunas from all the centres progressed from 0.65 tonnes in January to 164.9 tonnes in July and 105.4 tonnes in August. Thereafter the catches declined steadily. Following the same trend during 1979, the tuna catches increased from 1.4 tonnes in January to 31.4 tonnes in June. Hooks and lines landed *E. affinis* during August (0.8 tonne) and December (0.1 tonne) in 1978; and during February to April, 1979 (0.27-0.38 tonne). There is a definite change in the pattern of fishing in this area when compared to the good catches that used to land from multiple surface trolling during early sixties (Silas E. G. 1967, *Symp. Scombroid Fish.* MBAI, Pt. III: 1083-1118). At present the bulk of tuna catches come from drift gill nets and *E. affinis* and *A. thazard* are the main components. The size range of these two species as observed during 1978-79 is given in Fig. 8. Stray catches of *I. platypterus* have also been recorded during this period.

Goa

(Total annual catch of tunas—307 tonnes during 1978)

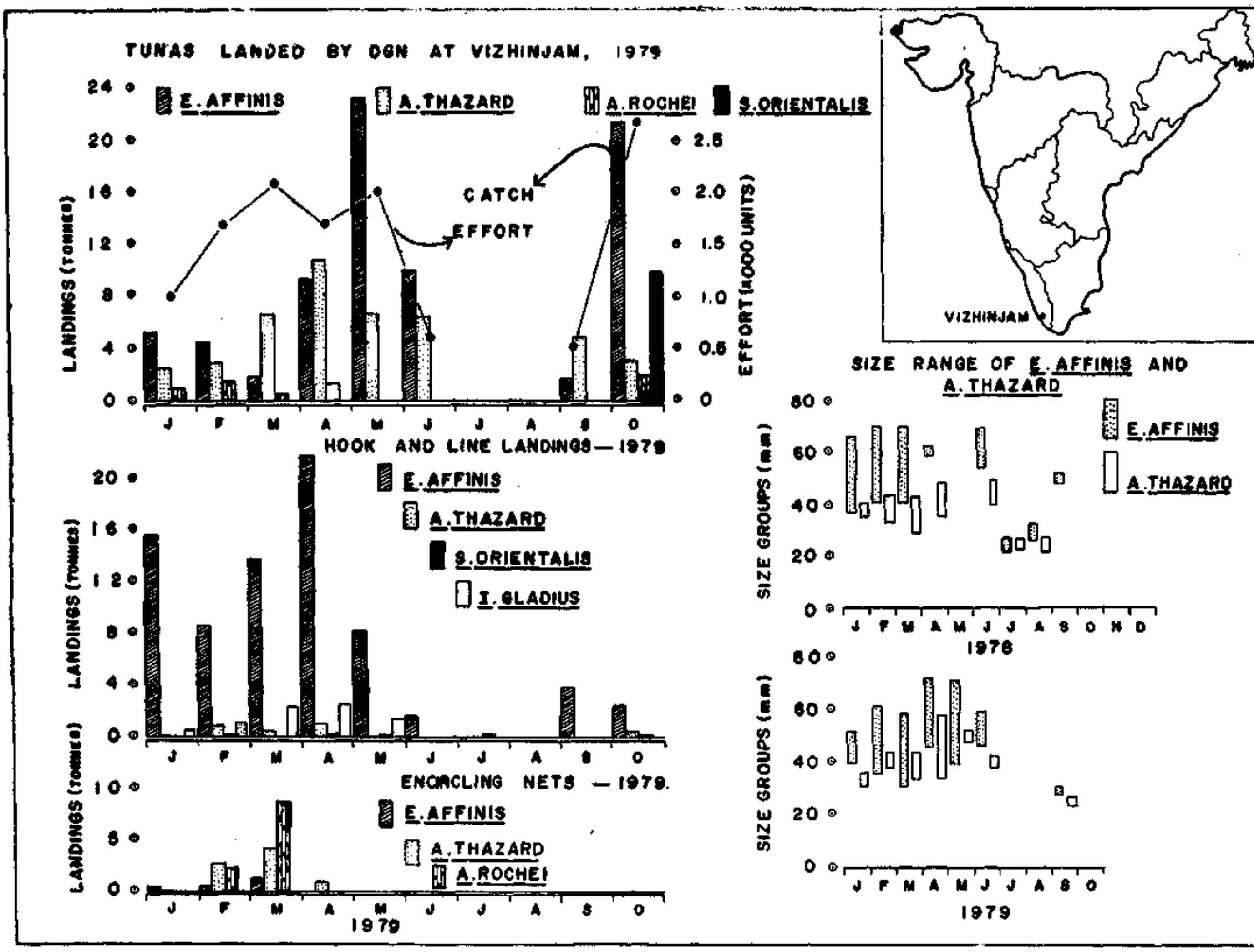

Fig. 6 Landings of tunas by drift gill nets (DGN) and other gears at Vizhinjam, 1978 and 1979 (part); effort expended in the drift gill net fishery is shown; size range of *E. affinis* and *A. thazard*, 1978 and 1979 (part).

The important landing centres for tunas around Goa are Panjim jetty, Colva and Vasco. Purse seine catches occur mainly at Panjim and drift net catches in the other two centres. Recently, a survey was undertaken in this area and enquiries made with a private canning firm at Margao revealed that about 2.2 tonnes of tunas, mainly *E. affinis* and *T. tonggol* during 1978 and 6.8 tonnes during 1979 were canned in this factory. During 1979, however, tuna catches were confined to only September-October period with total catch from all the three centres estimated at 50.5 tonnes.

Maharashtra

(Total annual catch of tunas—1,756 tonnes during 1978)

Malwan and Ratnagiri In this region, mechanised 'Satpathi' type of boats and 'machuwas' operate drift gill nets ('Vagri Jal') for tuna fishing. The fishing season is confined to September-November period with peak catches occurring in October. Total estimated catch from the landing centres at Dhabol, Budhul and Mirkerwada amounted to 310.0 tonnes during this period (1979). *T. tonggol* forms 60% of the catch and the rest by *E. affinis*. The former species fetches a good price at the landing centres and markets (Rs. 22-30 per fish with average weight 3.8-4.5 kg). Along the Ratnagiri coast it was reported earlier that the fishing season for *T. tonggol* extended from October-December and the possibility of a distinct race of this species occurring in the area was mentioned (Ranade, M.R. 1961, *J. Bombay Nat. Hist. Soc.*, 58 (2): 351-354). Even though the effort has increased in recent years the catch of this species has not improved.

Fig. 7 Catamarans at Vizhinjam

Karnataka

(Total annual catch* of tunas—243 tonnes during 1978)

Mangalore: During 1978, tuna landings from drift gill net operations were estimated as 20.1 tonnes comprising mostly of *E. affinis* (97.26%) from January through April. Along with this landings of sail fish, *I. platypterus* contributed 6.8 tonnes.

In 1979, the operation of drift gill nets was suspended at Mangalore during May-June period. Purse seiners fishing for sardine and mackerel accounted for 68.0 tonnes of *E. affinis* during June 1979. After the monsoon, when purse seining was resumed in September, 13.7 tonnes of *E. affinis* and 0.4 tonnes of *S. orientalis* were netted during the month. In the neighbouring centre at Kaup Tamilnadu fishermen operate about 60 canoes with drift gill nets and during September, 1979, 8.4 tonnes of *E. affinis* was landed. Size ranges of tunas occurring during 1978-79 are given in Fig. 5.

Lakshadweep

(Total annual catch of tunas—1,166 tonnes during 1978)

Minicoy: At Minicoy the total catch of tunas and related species was estimated as 326.6 tonnes in 1977, of which skipjack, yellowfin and bigeye tuna formed respectively 67.31 and 2.0 per cent. The fourth quarter was observed to be more productive for the skipjack. 18 mechanised boats and 5 small non-mechanised boats took part in the fishery and stern trolling was conducted mainly for bigeye tuna.

During 1978, 20 mechanised boats and 8 non-mechanised boats were engaged in the tuna fishery. The estimated catch for the year was 523.5 tonnes out of which tunas formed 99% and billfishes and wahoo the rest. The percentage composition of skipjack, yellowfin and bigeye tuna were respectively 72.5, 25.3 and 1.5. The second and fourth quarters yielded better catches.

Tuna environment

Tunas have very distinct behaviour patterns and shoals are known to congregate in places where special ecological and environmental characters prevail. The role of the environment in tuna fisheries is well understood by Japanese tuna fishermen who collect extensive data on temperature and salinity in all places where longlining is carried out.

The southern bluefin tuna occurs in the Frontal zones with greatest concentration of 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 boundaries of equatorial current system and their vertical distribution is nearer to surface as compared to the bigeye tuna, the spatial distribution of which corresponds with that of the yellowfin tuna. The albacore prefers temperate, offshore waters and shows seasonal north-south migration from the Polar Fronts. High surface temperature gradients where the optimum temperature zones are narrow are preferred places of concentration for albacore and bluefin

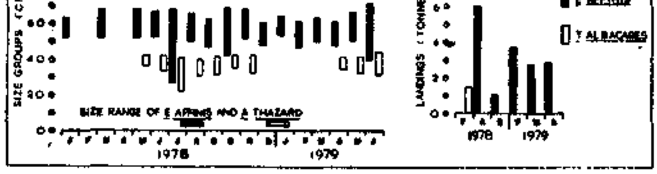

Fig. 8 Catch of tunas by different gears at Tuticorin, 1978 and 1979 (part); size range of *E. affinis* and *A. thazard*, 1978 and 1979 (part)

tunas. They also tend to aggregate on boundaries of cold and warm water eddies or intrusions. The thermocline ridges are also preferred by these fishes. The skipjack occurs just off coastal areas and on current boundaries.

Temperature by itself may not vitally affect the behaviour of tunas, but it is an easy indicator of good fishing grounds. In the tropics localised differences in surface temperature may point to show areas of 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

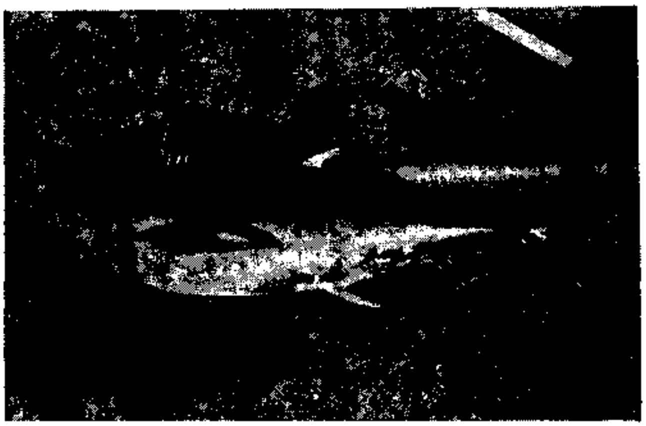

Fig. 9 Northern bluefin tuna at Ratnagiri.

current for good tuna fishery 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 thermocline level etc. (Silas E. G. 1967, *Central Marine Fisheries Research Institute, 20th Anniversary Souvenir,* pp. 51-57).

The significance and the role that the deep scattering layer plays as regards congregation of several planktonic organisms which also form forage of pelagic fishes such as tunas, billfishes and sharks has been drawn attention to (Silas, E. G. 1969: *Bull. cent. mar. Fish. Res. Inst.,* **12**:85-86).

Resources

The tuna fishery by the countries bordering the Indian Ocean shows that this is a much underexploited resource and in India it forms hardly 1% (average for 1970-1978) of the total marine fish catch. Reports published by the FAO indicate that the present exploited resource of shelf oriented species amount to 48,752

Table: 1 *Common crafts and gears used at present for tuna fishing at various centres*

Centre	Craft	Gear
Ratnagiri and Malvan	Small mechanised boats; Country crafts with OB engine.	Drift gill nets (Naijal, Vagrijal) which has three different mesh size, 115,90 and 130 mm;
Goa	Small mechanised boats (14.5 m) Small mechanised boats (9.0-9.5 m) and Dugout canoes	Purse seines (600X55 m); Drift gill nets, mesh size 115-130 mm
Mangalore	14.5m mechanised boats (common) 9.7 m mechanised boats and Dugout canoes	Purse seines (400-600X40-60 m); Drift gill nets, mesh size 110-130 mm
Calicut	Dugout canoes	Drift gill nets, mesh size 110-130 mm
Cochin	Mechanised pablo type boats. OAL 9.3—9.7 m with 16-38 HP engine	Drift gill nets, 120X8 m; mesh size 105-120 mm
Minicoy	Special type mechanised boats: 7.93 and 9.14 m OAL, 10-40 HP with bait, tank (1.6X0.8X0.8m); Non-mechanised boats, 12.5 m. length	Pole and line, 3-4 m, 35-40 mm at the butt and 20-35 mm at the top; polyethlene rope; barbless hook with lead coating.
Neendakara	Mechanised pablo type boats, OAL, 8.3-9.7 m.	Drift gill nets; mesh size 105-120 mm
Vizhinjam	Dugout canoes and Catamarans	Drift gill nets, Hooks and lines; Shore seines
Tuticorin	'Tuticorin' type boats non-mechanised, 6 m.	Drift gill nets, mesh size 140mm; Hooks and lines; Surface trolling.

tonnes (1977). There is an increasing demand for tunas for consumption in the internal markets. Estimates have shown that *E. affinis, A. thazard, K. pelamis* and *T. tonggol* are underexploited and there is good possibility of increasing the production manyfold (Silas, E. G., S. K. Dharmaraja and K. Rengarajan 1976, *CMFRI Bull.,* 27: p. 22) The increasing trend in the total catch of tunas in our country is an encouraging sign. The added inputs into the fishing effort in recent years by way of introducing mechanised boats for gill netting and small purse seiners hold much promise for better exploitation of tuna resources. The northern bluefin tuna, *T. tonggol,* one of true tunas needs intensive studies on its availability and other biological parameters. At present we know that this species occur along the west coast of India and in the Gulf of Mannar.

Changing pattern of fishery

Tuna fishery is still confined to the artisanal and small scale fisheries sector. There has been a changing pattern in the fishery in some areas, notably in the Lakshadweep islands where small mechanised boats equipped with live bait tanks are engaged in pole and line live bait fishery for skipjack and stern trolling for bigeye tuna, have gradually replaced the traditional 'odums'. This has resulted in notable progress in the islands though the tuna catch rates have not increased much.

Another notable feature is the development of the use of drift gill nets for tuna fishing especially at Tuticorin, where surface trolling was the main method adopted in the fifties-sixties.

The introduction of small mechanised boats as well as nylon drift gill nets at many centres along the west coast and Gulf of Mannar has steadily improved the catches of tunas in the country.

Consumer acceptance

Consumer acceptance of tuna in the internal market is steadily increasing as indicated by the increasing demand when compared to early years. In the mainland of India, fresh tunas landed are transported to internal markets under refrigeration or packed with ice. Canning of tuna meat is also done at certain centres in the mainland as well as in Lakshadweep. At Margao, Goa a private canning factory processes tuna using aluminium can and vegetable oil and sold at Rs. 4.50 per can of 454g. net weight. Canning of tunas by a private firm at Cochin has also been reported. In Lakshadweep, canned tunas are prepared as solid packs (200 g net weight–Rs. 5 per can) flakes in oil (180g. net weight-Rs. 4 per can) and small packs in brine (180 g net weight–Rs. 2 per can). Canned tuna exports during 1977 and 1978 were 22 tonnes and 14 tonnes (value Rs. 3.49 and 2.20 lakhs respectively) which declined to 0.48 tonnes (value Rs. 15,135) during 1979. During 1978, canned tunas were exclusively exported to Belgium and Spain, and in 1979 Saudi Arabia and UAE were the countries which imported this item from India (Information furnished by the Marine Products Export Development Authority, Cochin).

In certain places red meat of tunas do not find wider acceptance. In this context there is need for better and improved post-harvest technology for processing the tuna meat in an easily acceptable form for the internal market and also the need for popularising tuna products in interior parts of the country. The price of canned tuna product should be within the reach of the weaker sections of the society.

Prospects of tuna fishery

Tuna resources are tapped principally by the following methods:

Coastal species	*Oceanic species*
Drift gill netting	Pole and line fishery using live baits
Purse seining	Purse seining
Shore based gears	Gill netting
Trolling	Longlining
Hooks and lines	

The present level of exploitation indicates great scope for exploiting the fishes using alternate and more efficient gears for coastal and oceanic species of tunas.

For coastal species in the artisanal sector there is further scope for expansion if boats could operate in the depth ranges beyond 20 fathoms. The newly developing facilities such as fishing harbours would go a long way in helping the fishery as is evident from what is happening at Cochin. Also, there are good possibilities of using purse seines in the coastal waters for tunas and bonitos. However, the development of such a fishery should be closely linked with an organised monitoring system on the stocks.

As far as the oceanic species are concerned, the pole and line fishery using live bait for tunas as practised in the Lakshadweep islands is quite effective. But limitations on the availability of live baits in the Lakshadweep is hindering the fast growth of this fishery. Use of alternate species such as *Stolephorus buccaneeri* as live baits and culture of suitable bait fishes in the vicinity of the islands will have to be examined, if the exploitation of tunas by this fishery has to be further improved from its present level.

There is also a need for locating surface and subsurface shoals of tunas and for developing the methods of tapping sub-surface shoals of tunas which may be present close to the islands. In the small scale industry sector the high cost of fuel and other operational expenditure would be discouraging factors. In this connection the utility of drift gill nets in exploring oceanic species should also be explored.

There is an established commerical fishery for larger tunas such as yellowfin, bigeye, albacore and southern bluefin tunas using longline primarily by Japan, South Korea and Taiwan. The annual production of these species and other species of tunas from the Indian Ocean for the period 1973-1977 is indicated in Table-2. The possible exploitation potential of bigeye tuna from the Indian Ocean has been dealt with in a number of assessments and new method of using deep longline is now being resorted to. Yellowfin and bigeye tunas occur in the longline catches of the Arabian Sea and Bay of Bengal besides the albacore along the equatorial belt and southwards.

Table 2 * *Production of tunas and related fishes, Indian Ocean*

1973–1977				(*Unit-metric*	*tonnes)*
	1973	1974	1975	1976	1977
Yellowfin tuna	33,900	31,445	43,877	49,204	66,292
Bigeye tuna	16,700	26,402	38,260	27,952	33,298
Albacore	22,800	27,688	10,732	7,823	5,832
Southern bluefin tuna	26,800	30,577	22,615	28,238	20,330
Skipjack	34,900	41,304	36,174	38,378	32,482
Frigate and bullet tunas	6,200	5,900	3,900	2,700	3,206
Little tunny	17,200	24,244	24,268	26,419	25,602
Longtail tuna	600	1,207	1,200	1,189	—

* FAO, *Catch Statistics* 1977: 44, Tab.c-51, pp. 213-215

Estimates of the potential yield of skipjack tuna from the Indian Ocean (160,000 T: Gulland, J.A. 1970, *Fishing News (Books) Ltd.*, 255 pp; 200,000–250,000 *T: Jap. Fish. Agency*, 1968, *Ann. Rep. Effort Catch Stat. Area, Jap. Tuna Longline Fish.*, 188 pp. indicate that this resource is hardly exploited. The pole and line fishery practised in Lakshadweep and Maldives account for only about 20,000 metric tonnes of skipjack. The potential for developing this fishery and that of young yellowfin using purse seine appears to be bright. Detailed aspects of Indian Ocean tuna fishery are being reported elsewhere (Silas, E.G. and Pillai, P.P., 1980: Resources of tunas and related fishes in the Indian Ocean).

While appraising the stock position of tunas in the Indian Ocean by FAO it was stated that the catches of skipjack as well as those of smaller tunas particularly *Auxis* spp. (Frigate tunas) could be substantially expanded. The potential and current yield of tunas and related species have been summarised thus:

	Potential	*Current* ($\times 10^3$t.)
Large tunas:		
Present longline fishery	125	110
Possible addition from surface fishing	50	25
Skipjack	225–400	60
Billfishes	10	8
Small tunas	100–200	20

(FAO: IOFC/77/Inf.ll, July 1977, p.9)

Longlines engaged in tuna fishery usually brings good quantities of billfishes and pelagic sharks, the economic utility of which should be raised to the level of tunas (Pillai, P.P. and M. Honma 1977, *Bull. far Seas Fish. Res. Lab.*, **16**: 33-49). Drift gill net catches comprise along with tunas, fishes such as pomphrets, seer fishes, *Chorinemus* spp., cat fishes and coastal species of sharks. These are also commercially important and contribute to better economic returns in tuna fishery.

The artisanal or small scale fishery as is developing today using drift gill net and pole and line fishery using live bait will need further encouragement combined with an active programme on post-harvest technology and marketing of tuna products within the country and partly for exports. Major developments will be going in for deep longlining for the bigeye tuna among larger tunas which is a least exploited resource in the Indian Ocean, and purse seining for the surface swimming species such as skipjack.

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ON THE OCCURRENCE OF *ACANTHASTER PLANCI* (THE CROWN-OF-THORNS) AT MINICOY ATOLL.*

The predation of coral-polyps by the multi-armed star fish *Acanthaster planci* is identified during the last two decades as a major biological factor that causes large scale death to reef corals at several parts of the Indo-Pacific. Though this starfish is known to enjoy a wide distribution from Hawaii to Red Sea its large scale occurrence or plague is mainly reported from the Pacific. In the last 15 years the infestation and large scale mortality to reef corals are reported from Tuamotu Archipelago, Fiji, Cook Islands, Samoa, Society Islands, Hawaii, Japan, Philippines, Solomon Islands, Great Barrier Reef, New Caledonia, New Britain and Malaysia in the Pacific Ocean. They are also known from Red Sea and there is unconfirmed (till 1977)

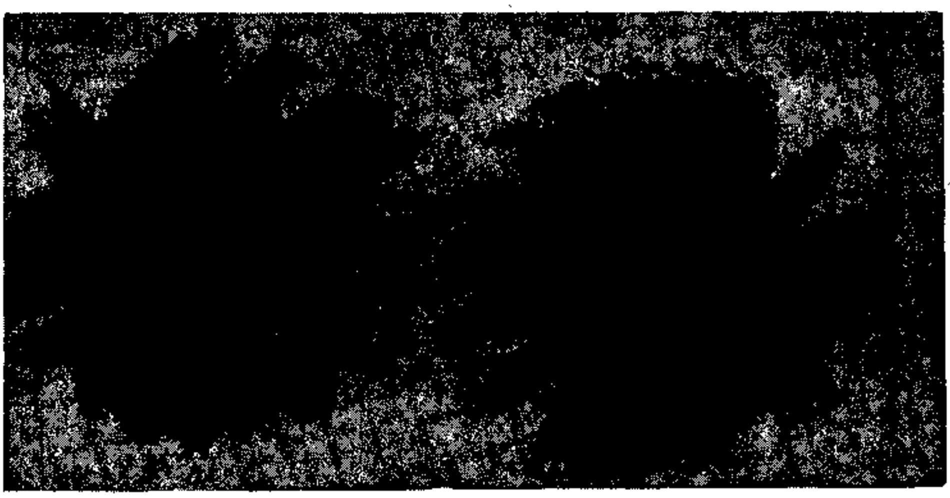
* Prepared by A. V. S. Murty, G. Subbaraju, C. S. G. Pillai, V. Josanto, P. Livingston and R. Vasantha Kumar.

report on its occurrence in the form of infestation in Seychelles and Maldives. Though, 2 to 5 individuals per sq. km of reef surface is regarded as a harmless population of *Acanthaster planci* in any region, 40 to 100 individuals that could be collected or spotted during a 20 minutes search in a rowing boat would be a positive case of infestation, detrimental to reef corals.

The aboral surface and the arms of this star fish possess large, pointed spines, 3 to 4.5 cm long, which gave rise to the popular name, Crown-of-Thorns. The general colour of this animal shows regional variation and ranges from gray, bluish-green, reddish to brown. Adult individuals attain a size of up to 60 cm in diameter. The number of arms varies from 9 to 21, depending on the size of the animal. The animal is capable of movement from one spot to another, sometimes over sandy stretches, or climbing on arborescent corals mostly with the aid of the arms than the tube feet. They feed on coral polyps of almost all genera of reef corals leaving white patches on the coral skeleton.

presence of this star fish in the lagoon of Minicoy Atoll was noticed in November, 1979. The details of this find are briefly reported here.

A general paucity of the Echinoderm fauna was noticed throughout Minicoy lagoon, though rarely *Culcita, Linkia* and *Holothuria atra* are found on the sandy bottom or on coral shoals along with *Acanthaster planci*. A few specimens of sea-urchins and brittle stars are seen under the stones or corals. Five specimens of adult *Acanthaster* were collected at the south-western part of the lagoon near Bosh Point. The area is with a luxuriant growth of corals, chiefly, *Acropora corymbosa, A. intermedia, A. hebes, A. humilis* and *A. hemprichi* that cut large thickets intermittent with sandy areas. The depth of water at low tide range from 25 to 50 cm, some of the coral thickets being partly exposed. Other corals include a few faviids and poritids. One of the specimens of *Acanthaster* was seen on sandy bed away from any coral while others were observed on *Acropora* thickets. Small white



The star fish is mostly cryptic during day time, hiding under the branches and crevices of coral colonies and they are nocturnal feeders. The nocturnal feeding habit could be a behavioural adaptation, for many of the coral colonies are said to expand their polyps more at night than day time. An adult star fish is estimated to be capable of feeding on the polyps of nearly 6 sq. m of reef coral coverage on a reef surface. The large patches of corals fed by them at several areas of their infestation have caused a world awareness of the problem in the last 20 years.

During a recent visit by a team of scientists from Central Marine Fisheries Research Institute, the

patches at the site of the star-fish on corals clearly indicate predation of the polyps. However, no significant dead area of corals due to star-fish predation was observed. Two of the specimens brought to the laboratory (Photo) have greater diameters of 40 and 36 cm in dried condition. The general colour in the living condition was reddish-brown which turned a deep-pink on sun drying after killing with formalin. Both the specimens have 17 arms each. The spines on the aboral side measure 3.5 to 4 cm.

The intensity of population is roughly 2 to 3 adult individuals per sq. km at the site of their present occurrence, which is nothing but a natural, harmless condition. However, a word of caution is necessary. There were past cases of *Acanthaster* plguae occurring all on a sudden, causing severe destruction of reef corals in several parts of the Pacific in the recent past. The exact reason for such population explosion is not known, though many plausible biological factors such as, a release on the predation-prey relationship, evolution, of mutant strains capable of prolific reproduction, introduction of large number of individuals as larvae or adult from other areas by water currents or migration, may be suggested.

The corals of Lakshadweep are a very valuable natural wealth, particularly in view of the associated reef fishes, of which good many are used as live baits for traditional *Tuna* fishing. Any considerable destruction to corals of the lagoons of the Lakshadweep atolls will certainly have a deleterious long term effect on the reef associated icthyofauna. In the event of a population explosion of *Acanthaster*, destruction to reef corals is a possibility that would deserve attention. Therefore a careful watch on the *Acanthaster* population is necessary for which a local awareness of the problem among the fishermen is necessary. Many control measures of star fishes have been practised elsewhere in the Pacific. However, hand-picking of the adults with the aid of pointed spears and killing them with formalin or ammonia solution is the most effective. Careful search among the corals is required, since the crown-of-thorns hide under the crevices during day time.

NEWS—INDIA AND OVERSEAS

Survey of 200 mile zone

The Government of India is planning to survey the resources of its 200 mile exclusive economic zone with the object of providing precise information to commercial trawler operation. Orders have been placed with Goa Shipyards to build six survey vessels to be used for the survey. These vessels are intended for exploration of the deep sea and identification of new fishing grounds and the types and quantities of fish available. The lack of such information is at present preventing many Indian trawler owners from venturing out into the deeper waters, though the potential resources in this area is believed to be vast. Several of South Korean, Japanese, Russian and Taiwanese trawlers found it extremely profitable to fish in the area, despite the distance and the risk involved.

Prospects of tuna fishery in Ivory coast

While fishing in general remains an undeveloped sector, tuna fished off the coastal waters, has made the Ivory Coast Africa's leading tuna producer and ranking among the world leaders in tuna fishing. The port of Abidjan handles more than 70,000 tonnes of tuna every year, mainly caught by Ivorian, French and Spanish fishing fleets. Although at present tuna is exported to France, from where it is reimported for sale in Abidjan's super markets at very high prices, this will change with the development of the Ivory coast's own canning factories. Development plans for the tuna canning factories are expected to double the production soon. By 1980 it is estimated that over 2,000 people will be directly involved in the fishing and processing of tuna in the Ivory Coast.

World Fishing 27 (12): Dec. 1978

Russians discover new fish resources off New Zealand

A chance trawl by three Russian trawlers working along the Chatham Rise towards the Campbell Plateau off the New Zealand coast took a school of fishes containing both black and smooth oreos. The black oreo has never been previously scientifically described while some specimens of smooth oreos are available as museum species obtained in deep water trawling experiments conducted around New Zealand by the Japanese some time back. The Russians estimated this resource in depths of up to 1000 metres amounting to 60,000 to 70,000 tonnes.

The black oreos range from 31 to 44 cm in length, weighing on an average of 1 kg and the smooth oreos range from 31 to 57 cm in length, averaging 1.4 kg. The most distinguishing feature is their large eyes, used in the darkness for detecting phosphoresence on other fish. Both species had ripe eggs when caught and it is believed that they were congregating for spawning. According to New Zealand sources the total stock may be only 10,000 tonnes.

World Fishing 27 (12): Dec 1978.

New protein fish feed in Israel

A new development in growing algae in waste water ponds is producing protein food for fish at Haifa Technion. In the process of reclamation of waste water the protein food is developed that can be fed to fish, cattle or poultry. By a photosynthetic process, using solar energy, high quantities of oxygen are released by the algae and the organic matter of the wastes oxidised. Nutrients from the effluent are incorporated into the algae.

The algae contain between 40 to 50 per cent proteins and the yield is 150 tonnes per ha of dry matter. The algae are separated, dried and pelletised with other ingredients. The pelletised feed can entirely replace fish meal, of whih Israel imports 50,000 tonnes per year. Experiments in feeding cultured fish with this feed has shown improved growth rates in the fish. Algae also serves as food for the growth of crustaceans such as *Daphnia* and *Artemia* used as feed in aquaculture.

World Fishing 27 (12): Dec. 1978.

Shrimp farming expansion in Costa Rica

Mariculture SA, a Coasta Rican company and one of the world pioneers in shrimp farming will expand its facilities in Chanes, on the Pacific coast of Coasta Rica. This expansion, costing approximately US$ 10 million is to be financed by investors and financial institutions from Coasta Rica and the United States.

The project will involve an increase in the company's grow-out pond area from the existing 112 ha to 400 ha, improvement in hatchery facilities and increase in the facilities for producing fertilized shrimp eggs. A seven fold increase in annual production, from approximately 320,000 pounds of shrimp tails to at least 2,275,000 pounds is envisaged.

World Fishing 28 (5): June 1979

Chinese aid fish culture in Sri Lanka

A large fresh water fish breeding and experimental station at Uda Walawe, in the Eastern Province of Sri Lanka has been developed and expanded with aid from China, both financial and in the form of fish culture expertise. The main varieties of fish bred there are grass carp, big head carp and the common carp or red carp. *Tilapia* too have been imported from China and bred at the station.

The station was set up with Chinese aid and was originally manned by Chinese experts, who trained Sri Lanka fish culturists who have later taken over running of the station which was handed over to Sri Lanka's Minister of Fisheries Mr. Festus Perera by the Chinese Ambassador recently.

World Fishing 28 (5): June 1979

BOOKS

Introduction to oceanography. By David A. Ross, Prentice-Hall International, Inc. London, pp 433, 1977.

In this book the author has attempted to describe and explain oceanography in a manner that is understandable to non-scientists. The book covers all the branches of oceanography, viz., chemical, biological, physical and marine geology and geophysics. As the last few years have witnessed an increasing legal interest in the ocean, an interesting chapter on the laws of the sea is also included.

Ion exchange for pollution control. Edited by C. Calmon and H. Gold. CRC Press Inc. USA. Vol I.pp 272 and Vol.II. pp 288, 1979.

Present status and future developments of ion exchange for treatment of industrial waste water effluents is discussed with numerous examples from most fields presented by practising specialists to illustrate the capabilities and limitations of the process. Volume I deals with ion exchange process with limitations and problems, brackish water and waste effluent treatment, removal of mercury, ammonia and nitrates and precious metal recovery. Volume II contains chapters like sorption of organic substances, decolourizing wood pulp bleaching effluents, removal of organic materials from waste water with polymeric absorbents, nuclear plant water treatment, municipal waste effluents, ion exchange as an analytical tool and new developments in the field.

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