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FOREWORD

India is endowed with a rich biodiversity of marine ornamental fishes along the coasts of Gujarat, southern Kerala, Tamilnadu (Gulf of Mannar and Palk Bay) and the Andaman and Lakshadweep islands. Preliminary surveys were made earlier in certain of these regions and qualitative accounts prepared. However, development of marine ornamental fish fisheries requires knowledge on their seasonal and relative abundance, the species biology, stock sizes of the individual species, management measures and above all, the impact of exploitation of these fishes on their habitat. Further, breeding techniques, nursery rearing, feed formulation and feeding, packaging, transportation, disease management and prophylaxis are unknown for most marine ornamental fish species. Such knowledge gaps have resulted in poor development of marine ornamental fish fisheries as an industry in India.

Capture fisheries research is a continuous process and requires voluminous data over a period of several years to be able to draw reasonably satisfactory conclusions and address changing management needs. The present publication is a concerted effort to address some of the above. This is the first ever attempt to assess the ornamental fish resources from a very rich yet unexploited population in the Lakshadweep. Brief accounts on the distribution in space and time and stock sizes and catch quotas of 165 species of marine ornamentals occupying the Lakshadweep lagoons are presented in this publication. Dr. V. Sriramachandra Murty, deserves all appreciation for leaving no stone unturned in the field work in the Lakshadweep islands and for bringing out this excellent publication for the use of planners, resource managers, exporters and importers of ornamental fishes and several others involved in the marine ornamental fish fisheries research and trade.

I place on record our thanks to the Ministry of Agriculture, Government of India for sponsoring this project and the Marine Products Export Development Authority, Cochin, for part-financing the printing cost.

COCHIN
28-02-2002

MOHAN JOSEPH MODAYIL
DIRECTOR

PREFACE

In the early 1987, the Ministry of Agriculture, Government of India suggested to the Central Marine Fisheries Research Institute, Cochin to implement a programme of survey and assessment of ornamental fish resources of the Lakshadweep and informed that necessary funding would be arranged if a suitable project proposal could be submitted. By then I carried out a preliminary study of these fishes in the Lakshadweep and hence I was asked to prepare and submit the research project proposal. The proposal was submitted by middle of 1987 and the project was sanctioned towards the end of 1992. I was then asked to join at Cochin to implement the project. The work was initiated towards the end of 1993.

The task of implementing the project in the islands was indeed a stupendous one; the project staff had to undergo hardships in traveling between the main land (Cochin) and the islands and between the islands with rather massive quantities of equipments, implements, jars, bins, buckets, nets, traps and of course materials for preparation of food. This resulted in the project personnel leaving the Institute and the process of recruitment of staff and training them had to be repeated. This in its turn led to the delay in implementing the project and only towards the end of 1997, all the islands could be covered with reasonable satisfaction. The analysis of the material and data took another two years as the project was closed and the staff left. In spite of all the odds, the work could be completed as proposed and this gives me a sense of fulfillment.

I am extremely grateful to Dr. P.S.B.R. James, the then Director of CMFRI for giving me the responsibility of preparing the project proposal and implement the same. Dr. P. Vedavyasa Rao, Dr. M. Devaraj and Dr. V. N. Pillai who succeeded Dr. James as the Directors of the Institute, extended the required support and I am thankful to them. Dr. Mohan Joseph Modayil, the present Director of CMFRI facilitated publication of this work. I am thankful to him for his willing support and cooperation.

The Fisheries Division of the Ministry of Agriculture has been very cooperative from the very beginning till the completion of the project. I am thankful to Dr. Y.S. Yadava, formerly the Fisheries Development Commissioner, Ministry of Agriculture for the cooperation extended in the implementation of the project and to Mr.M.K.R.Nair the present Fisheries Development Commissioner for his interest in getting the report published. Mr. Hassan Manikfan, the Director of Fisheries, U. T. of Lakshadweep during the project period, took personal interest in arranging all logistic support. Without the whole-hearted support by him and his colleagues in the Department, the project work could not have been implemented; I am thankful to him and his colleagues for their kind and hospitable attitude.

On many occasions, I held informal discussions with my colleague Dr. M. Srinath, Head, Fishery Resources Assessment Division at the CMFRI, on collection and analysis of the data. I was greatly benefited by such interactions. I thank Dr. Srinath for his indulgence in scientific discussions. I thank all the project staff for putting up with the difficulties during the survey and assisting in implementation of the tasks. Mr. N. Rudhramurthy, Technical Assistant attached to the Demersal Fisheries Division of the CMFRI assisted me in computerizing the data, analyzing the same, making drawings and preparation of the text. He has put up with the trouble of working on holidays and staying in the office till late in the night almost every day till the document was finalised. I place on record my high appreciation for his sense of involvement and thank him for his unstinted support.

COCHIN
28-02-2002

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Contents

INTRODUCTION

The marine aquarium fishes, referred to as marine 'ornamental' fishes also in recent years, are known to be abundant in the tropical seas particularly in the regions in the sea which are rich in corals, sea weeds, sea grasses and also in the regions which have rocky bottom. The Lakshadweep islands in the eastern Arabian Sea constitute one such region.

Though there are a large number of publications dealing with marine fishes of India, the other countries bordering the Arabian Sea and the Western Indian Ocean, the fishes from the Lakshadweep Islands were not known well. It was due to the personal efforts of Late Dr. S. Jones, the former Director of the Central Marine Fisheries Research Institute, that a concerted effort to collect and describe the fishes from this region was made. Through a series of publications, Dr. S. Jones and Mr. M. Kumaran described a large number of fish species for the first time from the Lakshadweep sea, majority of which happened to be the first reports from the seas around India. These efforts ultimately culminated in the publication of the *"Fishes of the Laccadive Archipelago"* by Jones and Kumaran (1980). This publication, which gives the descriptions of 601 fish species, is an indispensable work on Taxonomy of fishes from the region. Works of this nature, as they are, cannot be expected to contain information on the distribution in time, relative abundance, biology, stock size, exploitation strategies and conservation techniques of the fishery resources. There has also not been any effort in these respects on the ornamental fishes from the Lakshadweep, particularly due to the remoteness of these islands, lack of commercial exploitation of various species (except, of course the tunas) and the consequent non-availability of any data, other priorities and the lack of any substantial demand for these fishes. With the result, virtually little was known of the various species inhabiting the lagoons of the Lakshadweep islands until very recently.

With the development of international trade for aquarium fishes, the government of India took certain initiatives to develop the aquarium fish fisheries particularly from the Lakshadweep islands (Anon.1986; Tomey, 1985, 1986). Almost simultaneously, the Central Marine Fisheries Research Institute organized a quick survey of ten inhabited islands - by deputing three teams of experts during January-March 1987 - of the fauna and fisheries of Lakshadweep islands (See Marine Living Resources of the Union Territory of Lakshadweep-an indicative survey with suggestions for development, *Bulletin of the Central Marine Fisheries Research Institute.*, 43: 256pp, 1989). This survey brought the type of information that was till then not available. During the above survey, an effort was made to obtain some knowledge on the abundance of different species of ornamental fishes; a total of 138 species was collected from different islands of which about 50 were found to be common (Murty *et al.*, 1989). This work, as could be seen from type of survey conducted, did not make any attempt to study the seasonal variations in the abundance, biology, estimation of stock size or any other study aiming at initiating at least small-scale exploitation of aquarium fishes. Though Murty (1996, 2001) dealt with this subject, an overall picture of the resources, the biology, mortality and stock size are not yet available.

The present work on ornamental fishes of the Lakshadweep was therefore initiated in November 1993 with the objectives of studying the distribution and abundance in time and space in the lagoons of different islands of the Lakshadweep, studying some aspects of biology, estimating the potential and exploitable resources of

different ornamental fish species; identifying and assessing the possible effects of exploitation of ornamental fishes on the resources and on the ecosystem and preparing an atlas, with colour photographs, of ornamental fishes of the Lakshadweep.

Implementation of the project with the above objectives in the Lakshadweep islands was by no means an ordinary task; the transport between mainland and the Lakshadweep and between different islands for men, equipments and the collections proved to be a difficult task which took away considerable part of the time at the disposal. However, the task could be implemented in the most satisfactory manner under the conditions existing.

The present report deals with aquarium fishes of the Lakshadweep: their seasonal and relative abundance in the lagoons of different islands, biology, stock size and, suggestions for developing and managing the exploitation of aquarium fishes. This is the first attempt of its kind in the tropical seas dealing with a large number of species in an almost unexploited condition. Though there are two earlier reports (Edwards and Shepherd, 1992 from Maldives and Munro, 1983 from the Caribbean sea), the approach to the problem and its extent as well as the fish population situation in the present study is totally different from them. The present study is unique also because, besides being the first attempt on the study of ornamental fishes from the Lakshadweep, this is also the first attempt to study the biology, estimate the growth parameters, stock size and the maximum possible yield of such a large number of species as incorporated in this publication in a situation where all the required data are to be generated.

THE LAKSHADWEEP ISLANDS

The Union territory of Lakshadweep consists of 36 islands (Fig. 1) covering an

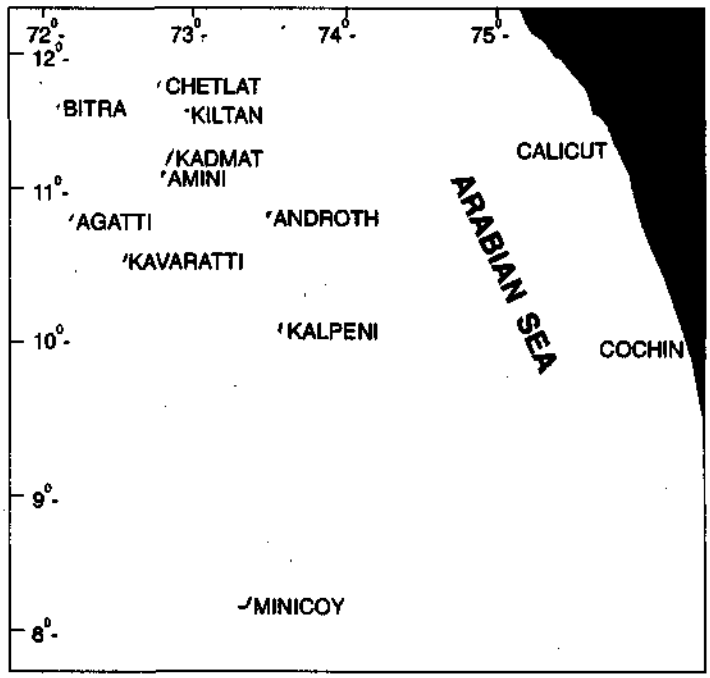

Figure 1 Map showing the Lakshadweep Islands

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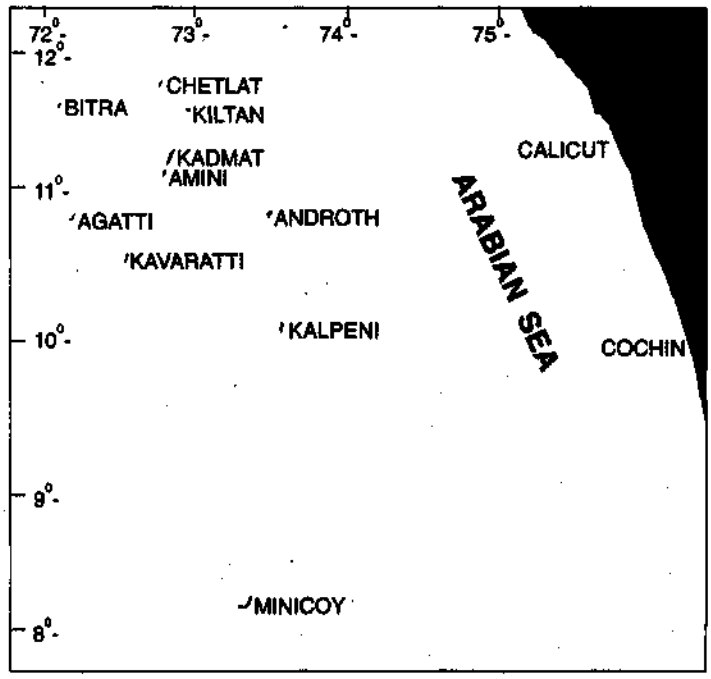

Figure 1 Map showing the Lakshadweep Islands

Table 1. Geographic location and area of inhabited Islands

S. No	Name of island	Geographic Location	Area in sq km	Lagoon area sq km
1	Agatti	Lat. 10° 51′ N; Long. 72°11′ E	2.71	8.80
2	Amini	Lat. 11° 07′ N; Long. 72°44′ E	2.59	3.60
3	Androth	Lat. 10° 49′ N; Long. 73° 41′ E	4.80	———
4	Bitra	Lat. 11° 36′ N; Long. 72° 10′ E	0.10	2.29
5	Chetlat	Lat. 11° 41′ N; Long. 72°43′ E	1.04	1.40
6	Kadmat	Lat.11° 13′ N; Long. 72° 47′E	3.13	13.30
7	Kalpeni	Lat. 10° 05′ N; Long. 73° 39′ E	2.28	5.20
8	Kavaratti	Lat. 10° 33′ N; Long. 72° 38′ E	3.63	6.75
9	Kiltan	Lat. 11° 29′ N; Long. 73° E	1.63	2.02
10	Minicoy	Lat. 8° 17′ N; Long. 73° 04′ E	4.37	21.80

Table: 2 Particulars of gillnets used in the survey
(Nylon monofilament, white webbing, diameter of filament 0.23 mm)

S. No	Stretched mesh size (mm)	Number of meshes vertically	Number of meshes horizontally	Total no of meshes	Length of head rope (m)
1	20	205	1020	209100	10
2	30	135	680	91800	10
3	40	105	525	55125	10
4	50	85	425	36125	10

area of 32 sq km of which 10 islands are inhabited. These islands lie between 8° and 12° 30′ N latitude and 71°-74° E longitudes. The islands consist of coral formations built on a submarine ridge rising steeply from a depth of about 1500 m to 4000 m off the west coast of mainland of India (Jones, 1986). These islands are formed by the accumulation of coral sand in the form of sand bars with the action of wind, waves and currents. The height of the land above the sea level in the islands is about 1-2 meters.

The inhabited islands (Table 1, Fig. 2) are Amini, Agatti, Bitra, Chetlat, Kadmat, Kalpeni, Kavaratti, Kiltan and Minicoy. Androth is also an inhabited island but does not have lagoon, hence this island was not covered. Among the uninhabited islands, Bangaram is a tourist resort and Suheli and Valiyapanniam are used as fish landing centres. The lagoons are shallow except the one in Minicoy, which is relatively deep. The outer edges of the reef flats bordering the lagoons are very deep dropping precipitously to the ocean floor. The islands being oceanic in nature, the continental shelf is small extending to an area of 4336 sq km. With the total lagoon area of about 4200 sq km, territorial water area of 20, 000 sq km and an exclusive economic zone of 400, 000 sq km (Anon. 1993), the Lakshadweep islands offer vast scope for development of ornamental fish fisheries and oceanic fisheries such as tunas and sharks.

Important Fauna and Flora: The lagoons and reef flats of the Lakshadweep are rich in corals represented by 104 species belonging to 37 genera (Pillai, 1989). About 78 species of echinoderms are also reported from these islands (James, 1989). Thomas (1989) reported 91 species of sponges from the region. Kaliaperumal *et al.*, (1989), reported 114 species of seaweeds and 6 species of sea grasses from the region. Besides, there is a wide range of other invertebrate fauna like ornamental and edible molluscs (Appukuttan *et al.*, 1989) and hermit crabs known from the lagoons. This abundance and diversity of flora and fauna in the lagoons offer wide variety of habitats for a wide variety of fishes, which are smaller in length, brightly colored and well-suited for aquarium purposes, offering great potential for developing a fishery for these fishes which have great demand in export market as live fishes. Murty *et al.*, (1989) reported 138 species of ornamental fishes belonging to 33 families from the Lakshadweep. Jones and Kumaran (1980) reported 601 species of fishes belonging to 126 families from the region of which about 400 species occurring in the lagoons can be of interest for aquarium purposes.

Studies on ornamental fishes of Lakshadweep: The first account under the name of ornamental fishes of Lakshadweep is that of Murty *et al.*, (1989) followed by Murty (1996, 2001). Vijayanand and Varghese (1990) gave some notes on these fishes from the Lakshadweep. However there was no study on biology of ornamental fishes of Lakshadweep until Madanmohan *et al.* (1987) published an account of the biology of *Chromis caeruleus* from Minicoy. This was followed by studies on *Dascyllus aruanus* by Pillai *et al.*, (1987 b), *Acanthurus triostegus* by Madanmohan *et al.*, (1988) and *Abudefduf glaucus* by Pillai and Madanmohan (1990). Studies on distribution of *Ctenochaetus strigosus* and, *Chromis caeruleus* and *Dascyllus aruanus* were made by Pillai *et al.*, (1983, 1987 a, 1992). All these studies were limited to Minicoy Island only. While these studies constitute pioneering accounts on the particular species from the region, detailed investigations on the basis of data from other inhabited islands incorporating seasonal

b

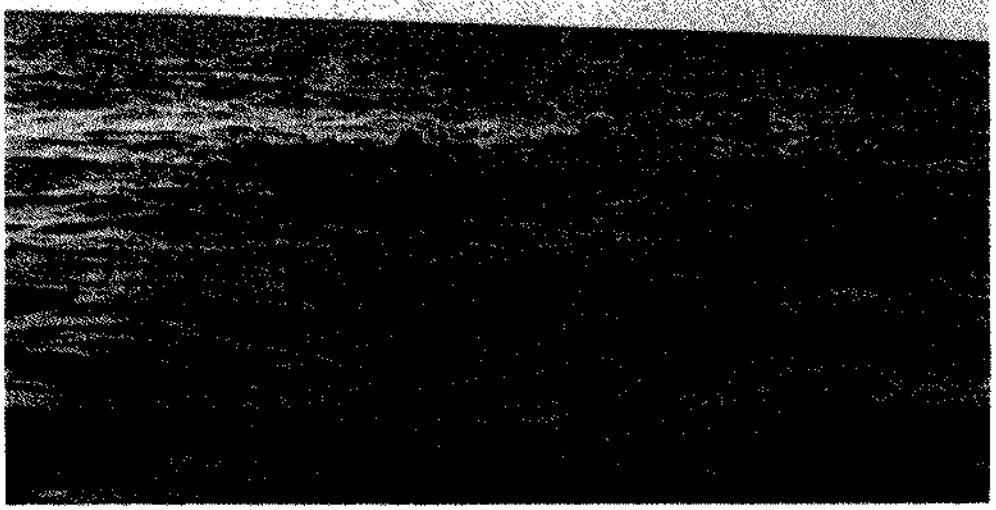

Plate 1 a. Lagoon and a part of Minicoy Island
b. Fishing with gillnets in the Agatti Lagoon

b

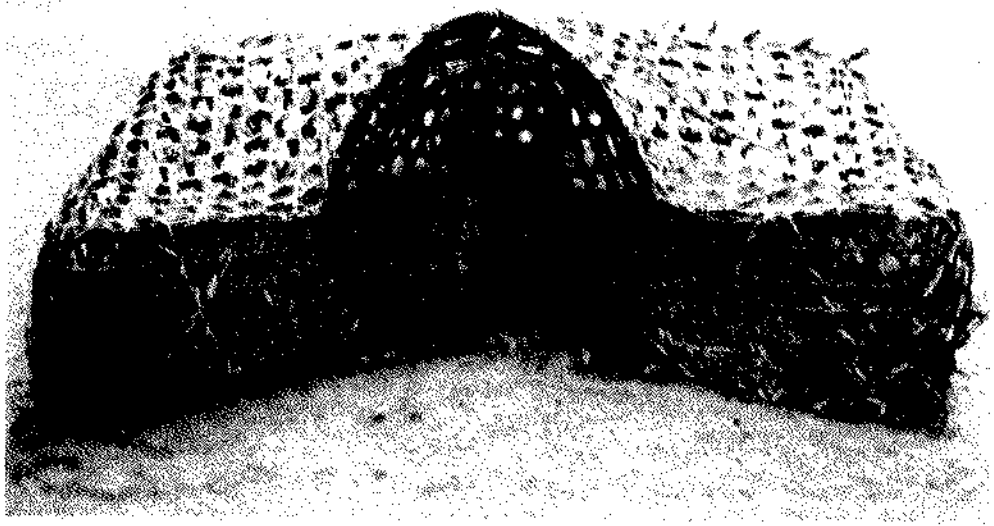

Plate 2 a. Catch of ornamental fishes in the gillnet in the Minicoy Lagoon
b. Perch trap used in the survey

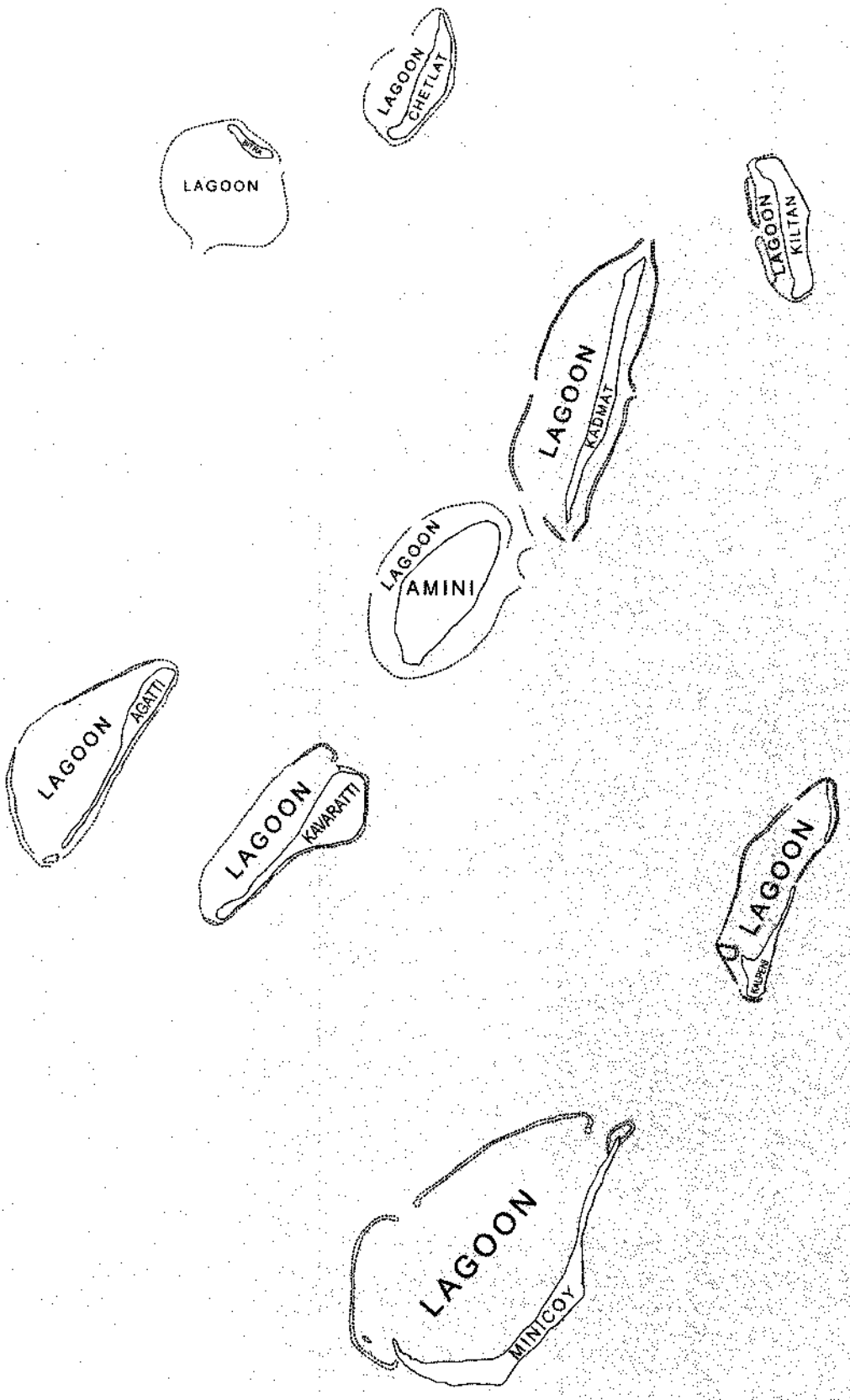

Figure 2. Inhabited Lakshadweep Islands where the survey was conducted

variations in distribution of different species, the length range of each species available for exploitation from the lagoons, spawning, growth and stock assessment are made in the present study only.

METHODS

Of the ten inhabited islands, only nine have lagoons. It was hence decided to carry out the survey in the lagoons of these nine islands (Table 1). The survey was conducted keeping Cochin on the mainland as the base in view of the availability of laboratory space, computing and library facilities. The personnel traveled to different islands by the regular ship service with all the implements and returned to Cochin base with the materials and data after every trip. In each trip, 1-4 islands were covered depending upon the ship schedule. The work was carried out during November 1993 to January 1997.

The Survey: In a particular survey trip to the islands, the period of survey in each island was determined taking into account the ship transport from the mainland to the Lakshadweep and between the different islands. After covering certain islands in a trip, the next trip was drafted to visit the other islands, again taking into account the availability of transport from the mainland and between the islands. The staff for the survey was not always available in full compliment. Hence it was not possible to visit all the islands in all the months of a particular year. The dependence on ship for interisland transport also affected the coverage of all the islands in every year. Therefore the survey programmes were fixed in such a manner as to cover maximum number of islands in a year ensuring the data availability in all the calendar months in all the years together.

In each island, a boat with outboard motor was hired and 2-4 fishermen were engaged to conduct the fishing using different gears. The fishermen in Lakshadweep will not go to the sea during Ramzan period, which generally falls in February. During the monsoon period of June-September the travel to the islands with all the equipments and, fishing in the lagoons is difficult. Hence the work was carried out during January, March-May and October-December (i.e., seven months in each year; in one year, the work was carried out in August also; thus data for eight months could be collected). The survey was conducted by actually fishing in the lagoons at different fixed stations for periods ranging from 3 to 11 days in each island in each trip. Perch traps (Plate 2b) and gillnets (20, 30, 40 and 50 mm mesh size, Table 2) were used. At every station the four gillnets were set in a line for a period ranging from 6 to 12 hours. The objective of the survey is to assess the resources, species wise. It is therefore necessary to obtain representative samples of the populations. To meet this requirement, trial fishing was conducted by different gears. After several trials, it was found that gillnets of different mesh sizes would yield satisfactory samples of different species for detailed studies. Hence the entire work was carried out using data generated from gillnets of 20, 30, 40,50mm mesh sizes (Table 2, Plate 1a). Fishing was conducted for 260 days using the gillnets in all the ten islands during the entire period of survey.

Identification: The specimens were identified with the help of the work of Jones and Kumaran (1980); occasionally, the work of Smith and Heemstra (1986) and Burges (1978) were also consulted for confirming the identification and nomenclature of certain species.

Photography: Immediately on capture, the

fishes were thoroughly cleaned and identified to species level. Then 5% formalin was injected into the body cavity. The fins were well spread and fixed with needles on cardboard and a few drops of formalin placed on these to prevent the fins from folding back. This process took about five minutes for each specimen. Then, photographs were taken using close-up lenses of different magnifications depending upon the size of the fish. Photographs were taken in the open using flash by keeping the specimen on a glass fixed to a stand and keeping the background (cloth) one foot below the glass.

Length data: After completing the photography, all the specimens of each species collected were measured for total length, injected with 5% formalin and then preserved in five percent formalin.

Analysis of data: As there is no fishing for ornamental fishes on a commercial scale, it is not possible to generate time series data on catch and effort for studies on population dynamics. Fishing was conducted for varying periods in different islands. Moreover different islands were covered in different months in different years depending upon the availability of transport. To make the data suitable for assessment and comparison between islands, the following procedure was adopted.

The catch obtained from the four nets (of different meshes ranging from 20 to 50 mm) for a particular period (in a month) of survey in an island, was taken as the total catch for the period and weighted to that month to obtain an estimate of the catch in that month from the island. The length data of each species were also similarly weighted to obtain the monthly length frequency distribution of the catch. This gave the estimated catch, species composition and length frequency distribution of catch of a species from an island for the month.

The estimated values in a particular calendar month of a year from different islands were then pooled. The values thus obtained in the corresponding months of different years were then pooled and averaged. This gave the average monthly species composition, length frequency distribution of each species and the fishing effort for the nine islands covered. The monthly data on these variables were then pooled to obtain annual estimates for all the islands. These data formed the basis for further studies. Since the ornamental fishes are not exploited for food purposes and their trade is carried out in terms of number of fish, their estimates have to be made in numbers. Hence all the estimates of catch are made in numbers.

All the specimens collected were injected with and preserved in 5% formalin and brought to Cochin by the Ship. In the laboratory at Cochin, they were thoroughly cleaned, sorted out to species level and data on total length (mm), weight (g), sex, stage of maturation were collected for each specimen. The gonads were removed and preserved separately for detailed studies.

Maturation and spawning: The females were classified into immature (stage I), maturing (stage II), mature (stage III), gravid (stage IV) and ripe (stage V) on the basis of appearance of gonads and also on the basis of the microscopic examination of the gonads. The length at first maturity was determined for different species considering the specimens in mature, gravid and ripe condition together as mature and the others as immature and by determining the percentage of mature specimens in each length group. The length, in which 50% of

the specimens are mature, is taken as the length at first maturity. For determining the spawning period, all the specimens of and above length at first maturity were considered. The number of gravid and ripe adults together was expressed as percentage of total number of adults in every month and the proportion of such fish in every month taken to determine the spawning period and peak spawning period.

Growth: The length data were grouped into 5mm or 10mm class intervals depending upon the maximum length of the species and then the frequency distribution determined. The von Bertalanffy growth parameters were estimated using the estimated monthly length frequency distribution of catch and following the FiSAT package (Gayanilo *et al.*, 1988, 1994) assuming that the growth in length follows von Bertalanffy growth equation. The maximum known length of the species was taken into consideration while estimating the $L\infty$ of any species. This helped in obtaining reasonably acceptable estimates of $L\infty$ and K for each species. The length-weight relationship was estimated by the least squares method (Snedecor and Cochran 1967) following Le Cren (1951); for this purpose, the total length in mm and weight in grams were taken.

Estimation of stock size: The ornamental fishes are presently not exploited on a commercial scale. Hence the natural mortality rate (M) was taken as equal to total mortality rate (Z) (M=Z). The natural mortality rate was estimated using the empirical formula of Pauly (1980). The procedure followed for arriving at the required estimates is given below.

The yield per recruit (Y_w/R) and biomass per recruit (B/R) were estimated using the VB growth parameters and length-weight relationship and the estimated values of natural mortality rate, age at recruitment (t_r) and age at first capture (t_c). The length at first capture (L_c) is taken as equal to the length at recruitment (L_r). The smallest length in the catch during the survey period was taken as representing these values and it was converted to age ($t_r = t_c$) to incorporate in the yield equation. Since there is no exploitation of these species (F = 0), the yield per recruit and biomass per recruit against an F value of 0.01 in each species, were taken as the 'current' values to enable make further estimates. These estimates can be reasonably taken as the first approximation since the value of the current fishing mortality rate (F) considered is almost equivalent to zero. In each species, the estimated total catch (in number) at length, in all the years of study was converted into annual average catch in number at length. Using the length-weight relationship, the catch in number was converted into catch in weight and that was taken as the annual average yield (Y). The recruitment was estimated by the relation $R = Y_w / (Y_w/R)$, (see Sainsbury, 1984). Biomass was estimated as $B = (B/R) * R$. From the total number of fish in the estimated catch and their total weight, the average weight of one fish in the population was estimated. The standing stock size (number) was estimated by dividing the estimated value of biomass by the average weight of one fish in the population. MSY/R was taken from the yield per recruit analysis by Beverton-Holt (1957) method using the LFSA package (Sparre 1987). Using the estimates of the MSY/R and R, the MSY (weight) is calculated. Using the estimated MSY (weight) and the estimated average weight of one fish in the population, the maximum possible yield (number) was estimated. The value of the maximum possible yield thus estimated is taken to

Table: 3 Familywise and islandwise catch by traps together with the estimated catch rates

ISLAND	NUMBER OF DAYS OPERATED	NUMBER OF TRAPS SET	SOAK TIME (HOURS)\TRAP	ACANTHURIDAE	CANTHIGASTERIDAE	CHAETODONTIDAE	HOLOCENTRIDAE	LABRIDAE	MULLIDAE	OSTRACIONTIDAE	PLESIOPIDAE	POMACENTRIDAE	POMOCANTHIDAE	SCARIDAE	SCORPAENIDAE	SERRANIDAE	SYNANCEIDAE	TOTAL
				Number caught														
AMINI	1	3	24	0	1	0	0	0	0	0	1	0	0	1	0	1	0	4
AGATTI	23	74	40	8	1	23	7	5	4	2	0	2	2	6	1	29	1	91
BITRA	8	17	66	6	0	0	4	0	0	0	0	0	0	0	0	7	0	17
CHETLAT	18	34	48	0	5	5	15	0	1	0	0	2	0	2	0	3	1	34
KADMAT	21	31	40	11	1	0	23	0	0	0	0	1	1	0	0	1	0	38
KALPENI	13	33	49	0	0	12	9	6	1	0	0	11	0	1	0	20	0	60
KAVARATTI	22	35	71	4	0	5	8	1	1	0	0	1	0	4	0	4	0	28
KILTAN	15	25	62	7	0	2	4	0	0	0	0	0	1	1	0	7	0	22
TOTAL	121	252	50*	36	8	47	70	12	7	2	1	17	4	15	1	72	2	294
Number (average)/Trap/ 50 hrs				0.14	0.03	0.19	0.28	0.05	0.03	0.01	0.00	0.07	0.02	0.06	0.00	0.29	0.01	1.17
Estimated No/10 traps/72hrs				2.06	0.46	2.69	4.00	0.69	0.40	0.11	0.06	0.97	0.23	0.86	0.06	4.11	0.11	16.80
Percentage of each family				12.24	2.72	15.99	23.81	4.08	2.38	0.68	0.34	5.78	1.36	5.10	0.34	24.49	0.68	

*Average (weighted) soak time per trap

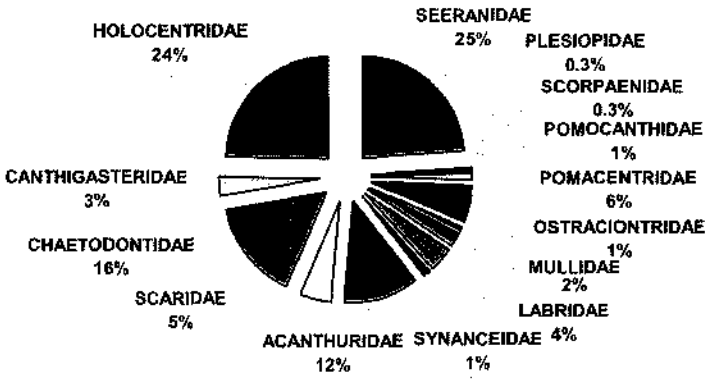

Figure 3 Composition of ornamental fish of different families caught in the traps in the Lakshadweep lagoons

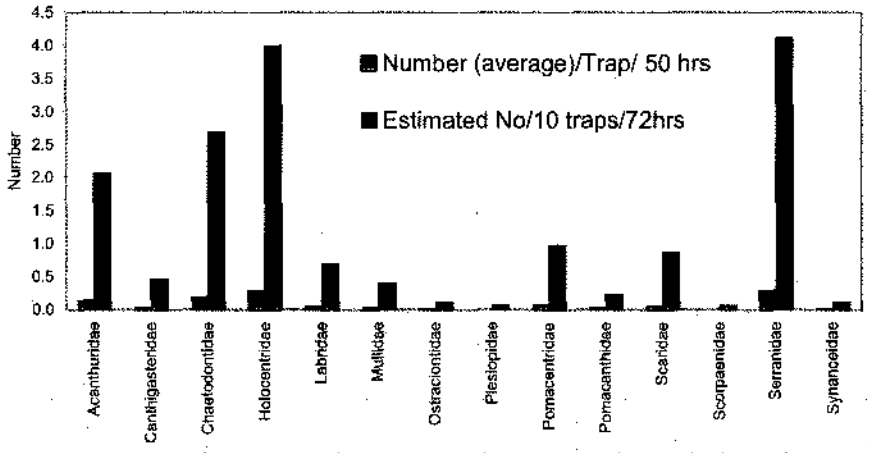

Figure 4 Estimated catch rates of ornamental fish by traps in the Lakshadweep lagoons

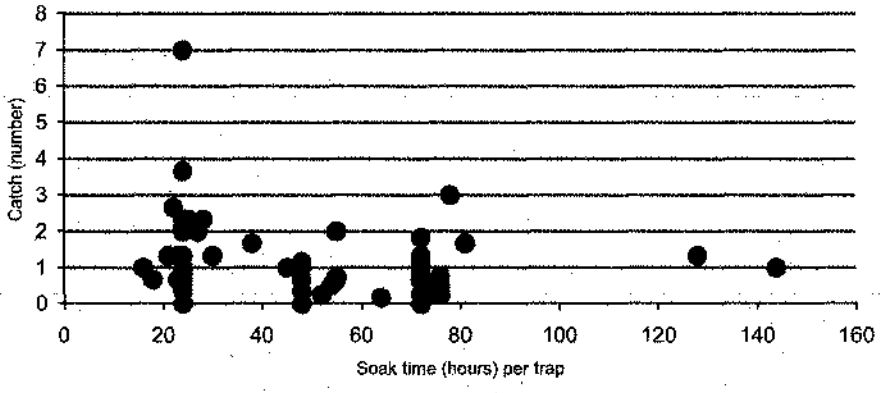

Figure 5. Ornamental fish catches by traps as a function of soak time

represent the maximum exploitable yield from all the nine islands, under the presently unexploited situation.

This analysis was carried out in respect of species for which adequate data could be obtained during the survey. Thus, the standing stock size and maximum possible yield were estimated for 40 species. Using such estimates of fishes of a family and the catch of other species in the same family, the standing stock and maximum possible yield estimates were derived for other species in the family.

FISHING BY TRAPS

Trap Fishing was done in the lagoon alongside the reef flat, in the middle of the lagoon, along the shoreline in the lagoon and near the jetties in different islands. The traps (Plate 2b) were kept in the lagoon continuously for a minimum period of 24 hours and a maximum period of 144 hours. The traps were covered by nylon mesh of 1cm size to prevent escape of small fishes. No bait was provided and the traps were covered by sea weeds/sea grasses, leaving only the openings. The species-wise catches obtained in different island lagoons for different soak-periods are shown in the Table 3. Surgeonfish, butterfly fish, squirrelfish, wrasses, goatfish, boxfish, angels, damsels, parrotfish, scropean fish, rock cod and puffer fish were collected in these traps.

In Agatti, fishing was conducted for 23 days using 3-6 traps each time for periods ranging from 23 to 76 hours per trap during January, March, August and November. A total of 91 specimens were caught during the entire operation (Table 3). Rock cods formed 31.4% of the catch followed by butterfly fish (25.3%), surgeonfish (8.8%), squirrel fish (7.7%), wrasses (5.5%), goatfish (4.4%), damsels (2.2%) and others.

In Bitra (Table 3), the operations were conducted for 8 days in January and April using 4-9 traps for periods ranging from 48 to 72 hrs per trap and a total of 17 fishes were caught represented by rock cods (41.2%), surgeons (35.3%) and squirrelfish (23.5%).

In Chetlat, trap fishing was conducted for 18 days using 3-6 traps each time for periods ranging from 18 to 81 hours per trap and 34 fishes represented by squirrel fish (44.1%), butterfly fish (14.7%), rock cods (8.0%), parrot fish (5.9%), goat fish (5.9%) and others were caught (Table 3).

In Kadmat, 38 fishes were caught in 21 days by operating 1-4 traps each time for a period ranging from 16 to 76 hours per trap. Squirrelfish formed (60.5%) followed by surgeons (28.9%), and others (Table 3).

In Kalpeni, trap fishing was conducted for 13 days during January, May and December using 3-6 traps each time for periods ranging from 24 to 75 hours per trap (Table 3). A total of 60 fishes were caught. Rock cods formed 33.3% of the catch, followed by butterfly fish (20%), damselfish (18.3%), squirrelfish (10%) and others.

In Kavaratti, a total of 28 fishes were caught in 22 days using 3-8 traps each time for periods ranging from 24 to 144 hours per trap. Squirrelfish (28.6%), was dominant followed by butterfly fish (17.8%), rock cods (14.3%) and others (Table 3).

In Kiltan (Table 3), fishing was conducted by traps for 15 days in different months using 3-6 traps each time for periods ranging from 25 to 76 hours. 22 fishes were caught of which surgeons formed 31.8% followed by rock cods (31.8%), squirrelfish (18.2%), butterflyfish (9.1%) and others.

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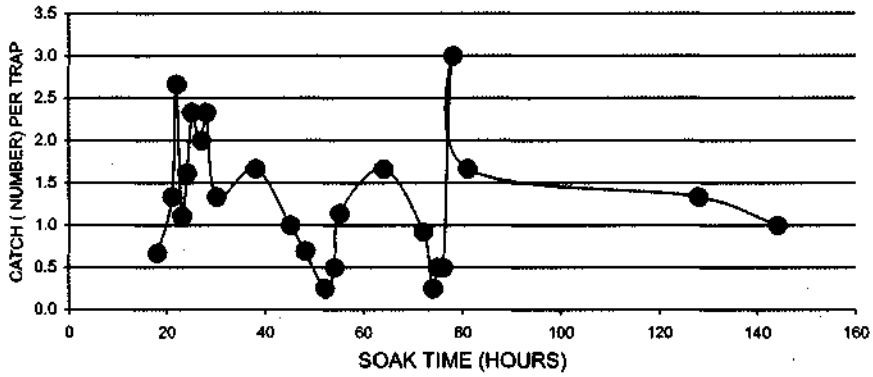

Figure 6. Ornamental fish catch in traps as a function of soak time (average catch for particular soak times taken)

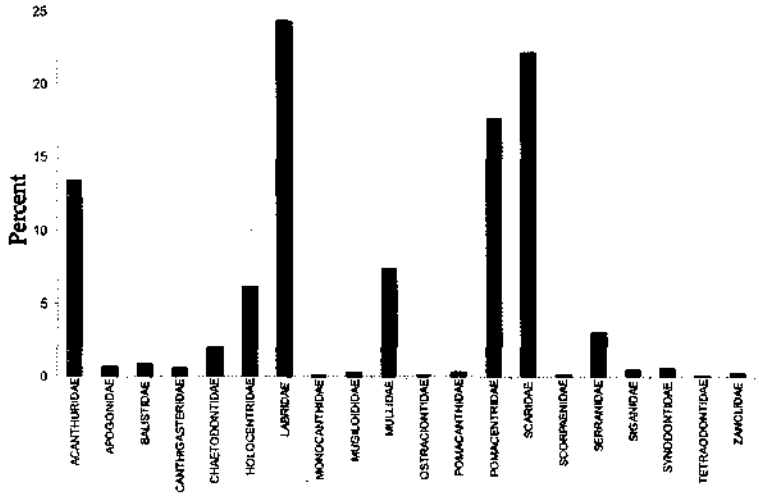

Figure 7 Proportion of number of fish of each family in the catches of fishes of twenty families of ornamental fish in nine islands of Lakshadweep

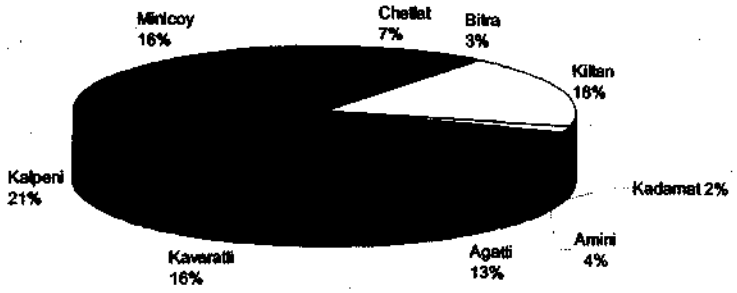

Figure 8 Relative abundance of Surgeon fishes (Acanthuridae) in different Lakshadweep islands

Table: 4 Details of the number of species known and collected in the present survey from Lakshadweep

S.No.	Family	Popular Name	Number of species	
			Known	Collected
1	Acanthuridae	Surgeon fish	20	17
2	Apogonidae	Cardinal fish	22	9
3	Balistidae	Trigger fish	10	6
4	Canthigasteridae	Puffer fish	4	2
5	Chaetodontidae	Butterfly fish	18	14
6	Holocentridae	Squirrel fish	11	11
7	Labridae	Wrasses	42	32
8	Monocanthidae	File fish	7	2
9	Mugiloididae	Sandsmelt	2	2
10	Mullidae	Goat fish	14	10
11	Pomacanthidae	Angels	2	2
12	Pomacentridae	Damsel fish	35	26
13	Ostraciontidae	Box fish	4	1
14	Scaridae	Parrot fish	15	12
15	Scorpaenidae	Scorpean fish	14	3
16	Serranidae	Rockcod	21	9
17	Siganidae	Rabbit fish	3	3
18	Synodontidae	Lizard fish	2	1
19	Tetradontidae	Puffer fish	5	2
20	Zanclidae	Moorish idol	1	1
	Total		**252**	**165**

The data of all the islands were pooled to examine the overall catches and catch rates. In all the islands together, the trap fishing was conducted for 121 days spending 12,600 trap hours with an average of 50 hours per trap (Table 3). A total of 294 fish were caught. Rock cods were dominant forming 24.5% of the catch followed by squirrel fish (23.8%), butterfly fish (16%), surgeons (12.2%), damsel fish (5.8%), parrotfish (5.1%), wrasses (4.0%) and others (Fig. 3, 4). The average catch per trap for 50 hours of soak time was 1.17 specimens only. At this rate, if 10 traps are used for 72 hours each, 17 specimens can be caught.

The data on actual soak time and catch obtained are plotted in Figure 5. While a relationship is not discernible, the data suggest that the catch declines if soak-time exceeds about 60 hours. The average catch for a given soak-time (actually operated) (Fig. 6) indicates, barring a few exceptions, that the catches were high for soak-periods 20- 40 hours and poor beyond that. This could be the result of Predation within the traps – rock cods and squirrelfish that are carnivores constitute about 50% of trap catch

and they could predate on other smaller fish entering the traps, escapement from the trap or, gear avoidance after about 40 hours of soak-time.

However, traps are the best gear in the sense that they do not cause destruction of corals if properly set. Moreover the catches of butterfly fish constitute about 16% and surgeons 12% in addition to squirrelfish (25%) and others (Fig. 3, 4) which are good aquarium fishes. Since majority of ornamental fishes are not represented in adequate quantities in the trap catches, trap fishing was not continued further.

FISHING BY GILLNETS

The gillnets of 20, 30, 40, 50mm mesh, operated in the lagoons yielded adequate quantities of a large number of species. Hence, these net webbings (monofilament, white) were procured in required numbers and got them mounted with floats and sinkers. The details of these nets are furnished in Table 2. These nets get damaged after one or two operations and loose their efficiency in yielding representative catches. Such nets were always discarded and new nets were used. The details presented henceforth in this publication are based on gillnet fishing only.

MAJOR ORNAMENTAL FISH RESOURCES OF LAKSHADWEEP

Over six hundred species of marine fishes are known from the Lakshadweep group of Islands (Jones and Kumaran, 1980). Of these over 300 species belonging to about 35 families are known for their attractive colours and shapes (Murty *et al.* 1989) and can be termed as ornamental fishes for aquarium keeping. Of these 35 families, 20 are represented well in the collections of the present survey (Table 4). These twenty families are known to be represented by 252 species in different islands of the Lakshadweep and the present collections consisted of 165 species. These fishes constitute the major ornamental fishes and have great demand in the ornamental fish trade.

The family Labridae (wrasses) is the most dominant among the ornamental fishes. These fishes are abundant in all the islands both in terms of number of species and in terms of population size. The labrids formed about 23% of the number of fishes of the twenty families collected (Fig. 7). The group which is second in abundance is the family Scaridae (parrotfishes) which constituted 22% of the fishes collected (Fig. 7). The family Pomacentridae (damsels, clownfish) is next in abundance; this group accounted for about 18% of the catches of the 20 families. The surgeonfish (family Acanthuridae), represented by 17 species in the catch formed 13% of the total number of fishes of the twenty families collected. This group is followed by the goatfish (Mullidae), which formed 7% of the total number of fishes collected. This is further followed by Holocentridae (squirrelfish) (6%), Serranidae (rock cods) (3%), Chaetodontidae (butterfly fish) (2%), Balistidae (triggerfish) (1%) and the rest by Apogonidae (cardinal fish), Ostraciontidae (box fish), Canthigasteridae (puffer fish), Siganidae (Rabbit fish), Mugiliodidae (sandsmelt), Synodontidae (lizard fish), Scorpaenidae (scorpeanfish), Tetradontidae (puffer fish), Pomacanthidae (Angel fish), Monocanthidae (File fish) and Zanclidae (moorish idol). The wrasses, damsels, parrotfish, surgeons, triggerfish, goatfish, squirrelfish, butterfly fish and rock cod represented by 180 species in the Lakshadweep, are most important from the point of view of ornamental fish.

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Plate 3 a & b. Convict surgeon-*Acanthurus triostegus*

In the Amini island (Fig. 2), which has a very small lagoon and an extensive shallow sea grass region in the eastern side, the collections consisted of 8 families of which the wrasses (Labridae) are most abundant forming over 70% of the catch in numbers followed by goatfish (Mullidae, 9%), damsels (Pomacentridae, 8%), surgeons (Acanthuridae, 5%), parrotfish (Scaridae, 5%) and squirrel fish (Holocentridae), butterfly fish (Chaetodontidae), rock cods (Serranidae) and lizard fish (Synodontidae) together accounted for the rest of 3%.

In Agatti (Fig. 2), a total of 16 families of ornamental fishes were collected of which wrasses formed 27% by numbers followed by parrotfish (26%), surgeons (13%), goat fish (10%), butterfly fish (5%), rock cods (5%), squirrel fish and damsels (3% each) and box fish, trigger fish, Pufferfish, rabbit fish, sand smelt, lizard fish, angels and moorish idol constituted 11% of the catch.

In Bitra Island (Fig. 2), a total of 15 groups of fishes were collected of which wrasses were most abundant forming 32% of the total catch. Parrot fish and damsels formed 22% each; goatfish 7%, rock cods 7%, butterfly fish 2% and trigger fish, rabbit fish, squirrel fish, sandsmelt, scorpeanfish, puffer fish, angel fish and moorish idol together formed 8% of the total catch in numbers.

In Chetlat Island (Fig. 2), parrotfish and damselfish are most abundant together forming about 60% of the fishes collected. The wrasses accounted for about 10% of the catch followed by surgeons (9%), squirrelfish (8%), goatfish (6%) and puffer fish, rabbit fish, butterfly fish, sand smelt, lizard fish and rock cods together accounted for 7% of the total catch.

Goatfish is the most dominant component in the catches in Kadmat (Fig. 2), accounting for about 33% of the total catch. Damsel fish formed 22% followed by squirrel fish (11%), parrot fish (10%), wrasses (9%), cardinal fish (8%) and rabbit fish, rock cods, lizard fish, butterfly fish and sand smelt together accounted for 7% of the total catch.

Damsel fishes are most dominant forming 30% of the catch by numbers in Kalpeni (Fig. 2) followed by surgeon fish (17%), wrasses (15%), squirrel fish (13%), parrot fish (12%), goatfish (5%), butterfly fish (3%) and cardinal fish, triggerfish, puffer fish, lizard fish and rock cods together accounted for 5% of the total catch by numbers.

In Kavaratti (Fig. 2), parrotfish is the most abundant, forming about 50% of the total catch followed by surgeons (16%), wrasses (11%), damsel fish (10%), squirrel fish (5%), goatfish (4%), rock cods (3%) and butterfly fish, trigger fish together 1%.

Surgeons are the most dominant component in Kiltan (Fig. 2) forming 24% of the total catch by numbers. Damsels formed 22 % of the catch followed by parrotfish (18%), wrasses (15%), squirrelfish (7%), goatfish (6%) and rock cods (3%). Cardinal fish, triggerfish, butterfly fish, lizardfish, scorpeanfish, angelfish and sand smelt together formed 5% of total catch.

In Minicoy (Fig. 2), damsel fish, wrasses, parrotfish and surgeons are distributed more or less in the same proportions together accounting for about 80% of the total catch by numbers. The remaining 20 % is constituted by rock cods, goat fish, squirrel fish, butterfly fish, trigger fish, lizard fish, angel fish and sand smelt.

In all the islands together, the wrasses are dominant constituting 23% of the catch taken, followed by parrotfish, damselfish,

Plate 4 a & b. Blue-banded surgeon-*Acanthurus lineatus*

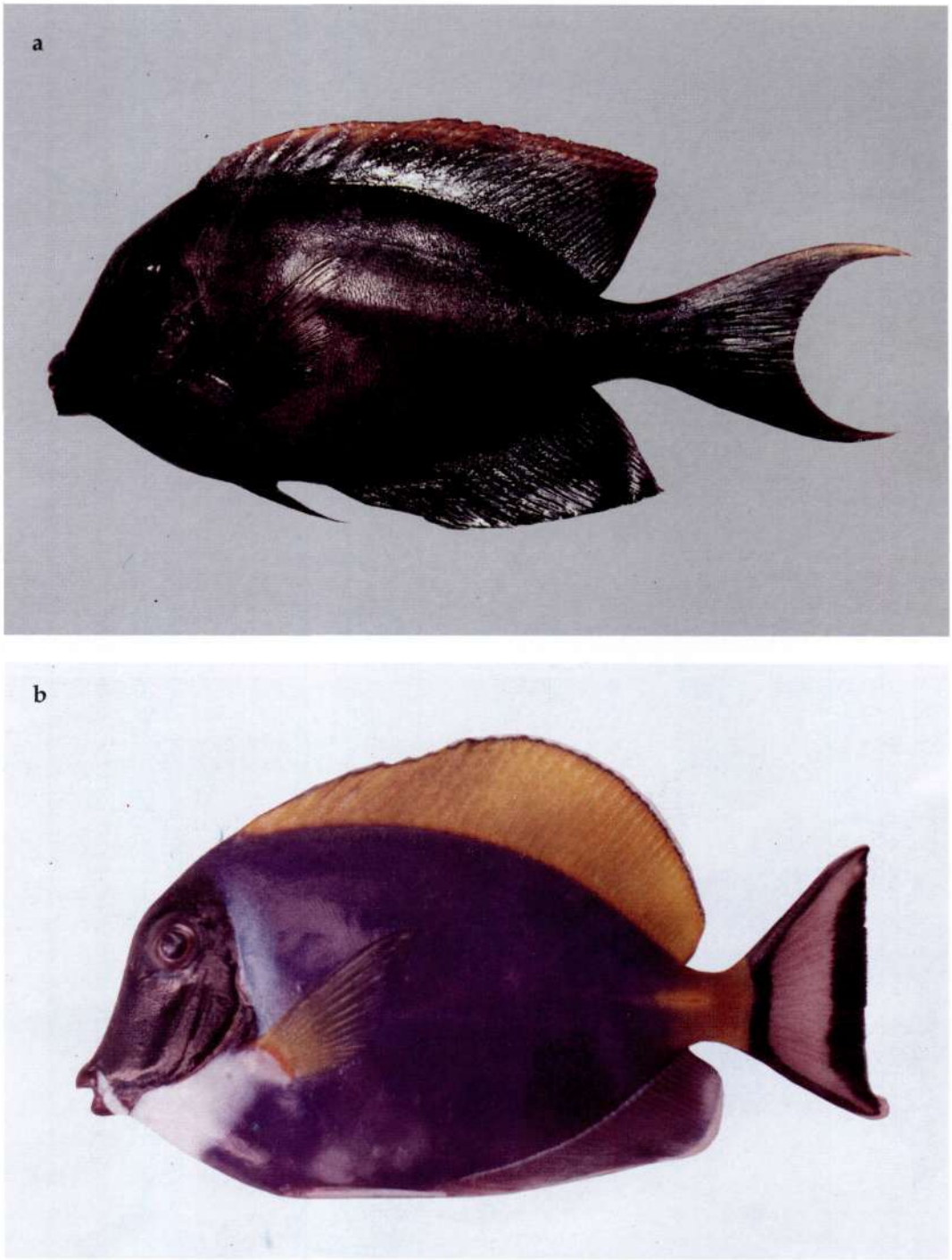


Plate 5 a. Elongate surgeon-*Acanthurus mata*
b. Powderblue surgeon fish-*A. leucosternon*

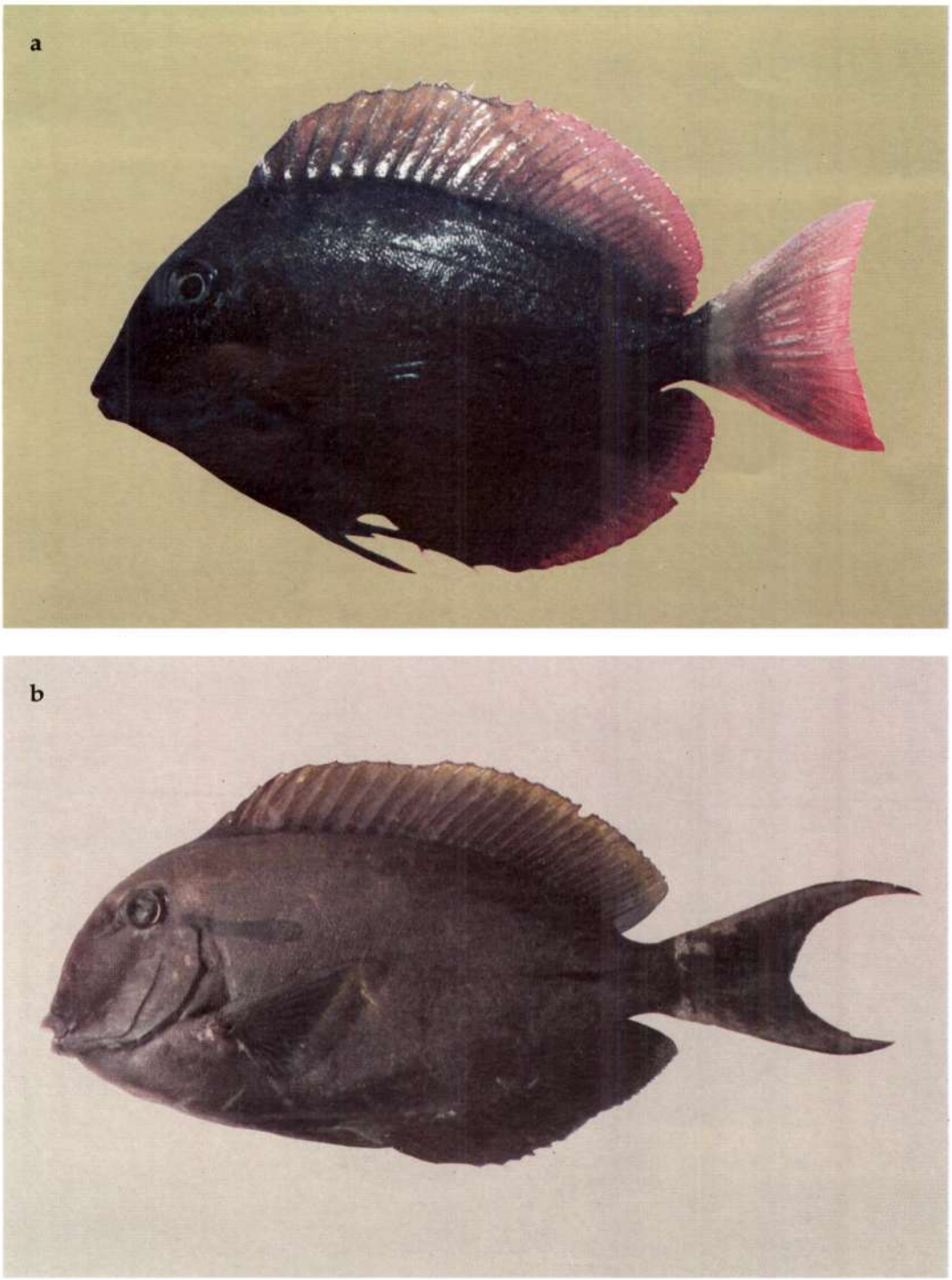


Plate 6 Epaulette surgeon-*Acanthurus nigricauda*, a. Juvenile, b. Adult

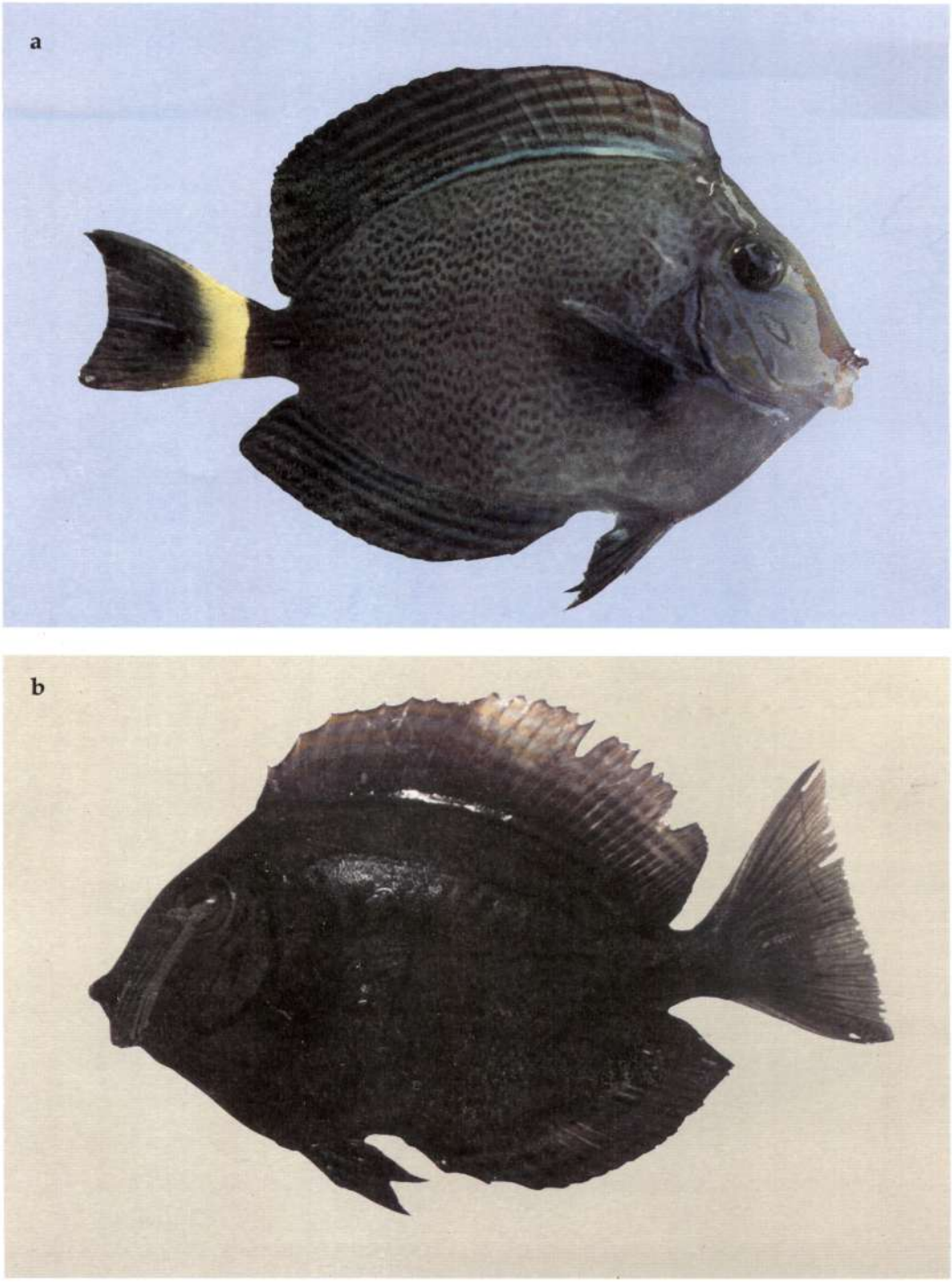


Plate 7 a. Tailring surgeon-*Acanthurus blochii;* b. *A. matoides*

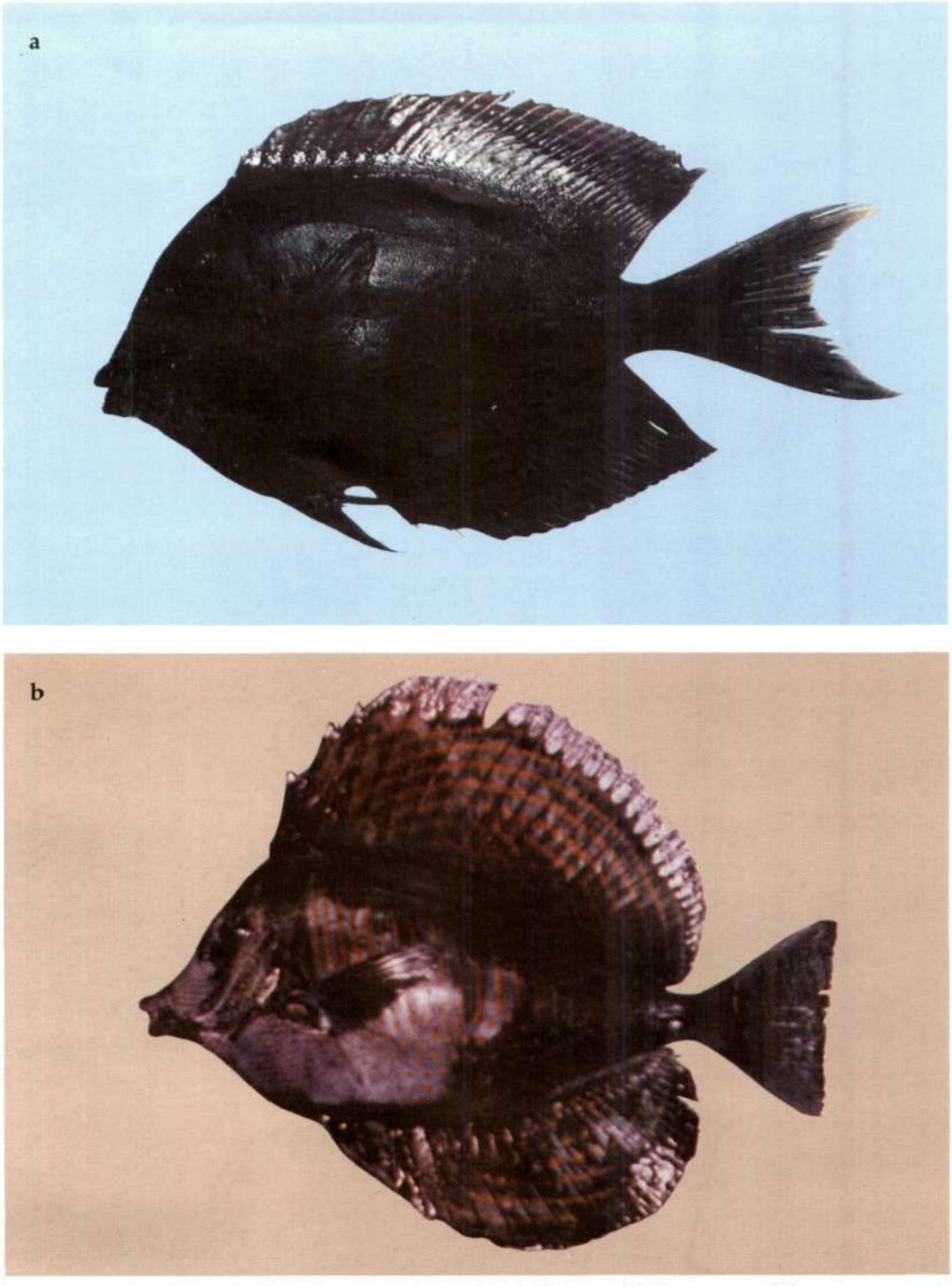


Plate 8 a. Bristletooth-*Ctenochaetus strigosus;* b. Sailfin tang-*Zebrasoma veliferum*

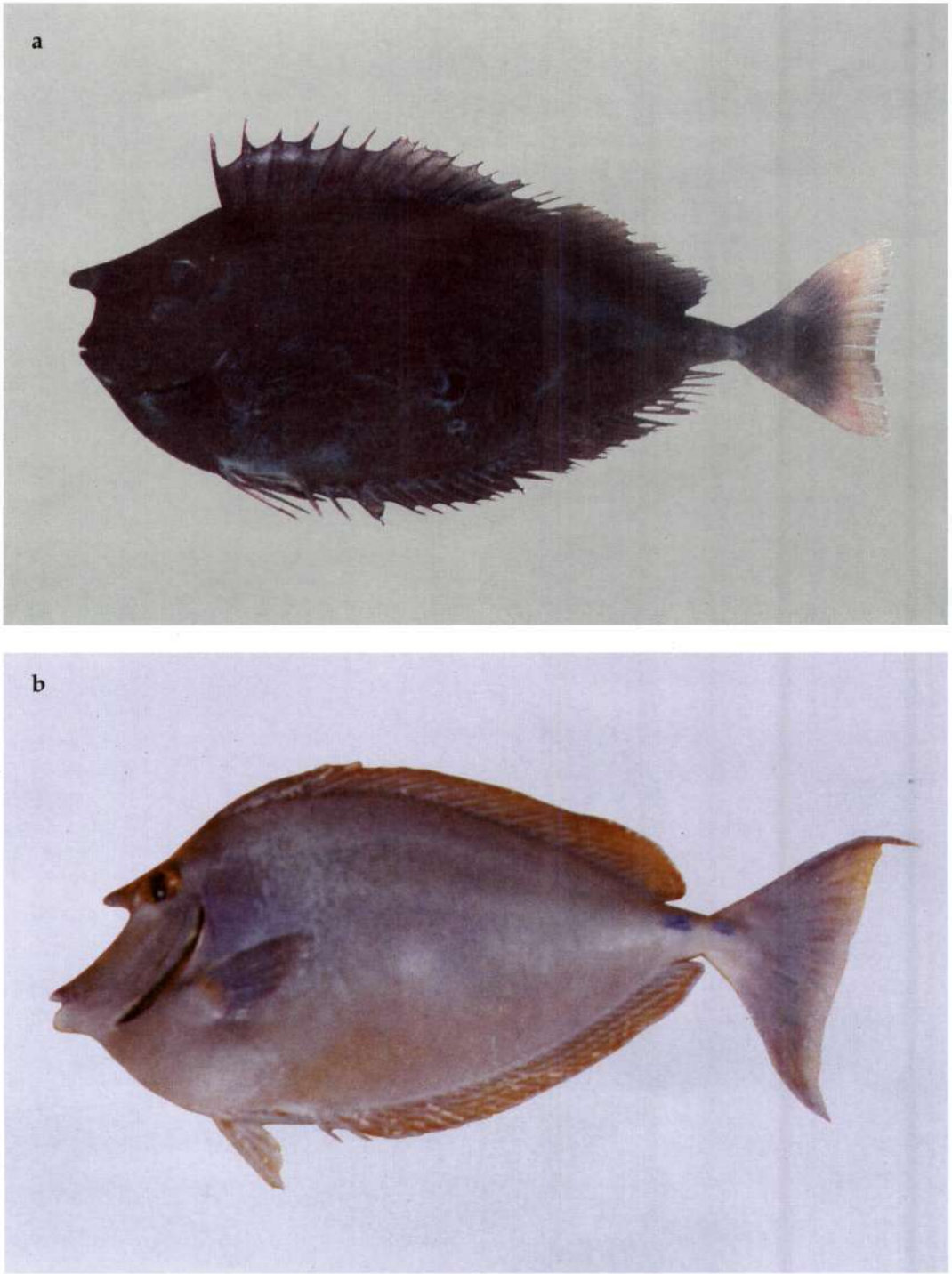


Plate 9 a. Spotted unicorn-*Naso brevirostris;* b. Bluespine unicorn-*Naso unicornis*

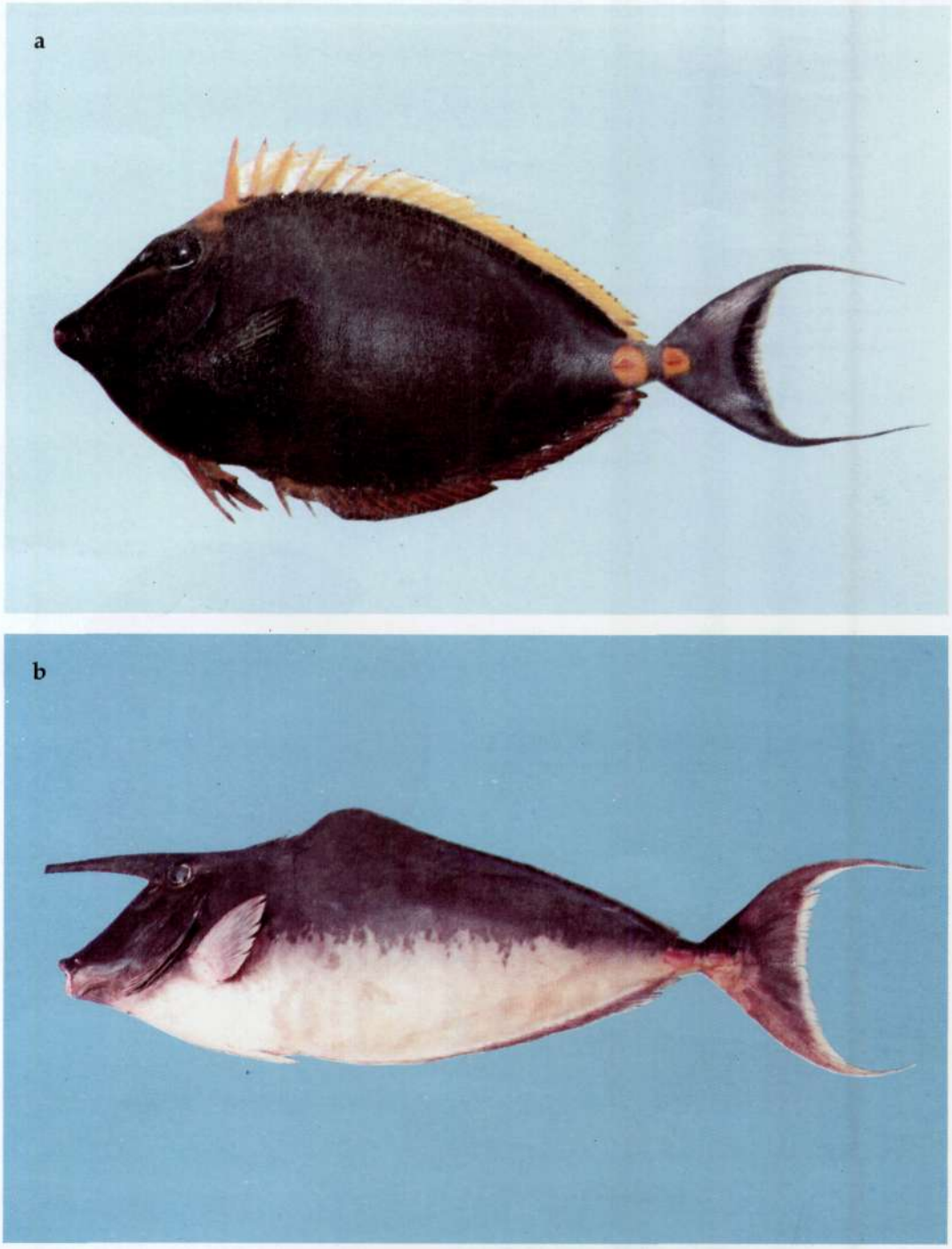


Plate 10 a. Orangespine unicorn-*Naso lituratus*
b. Humpback unicorn-*Naso brachycentron*

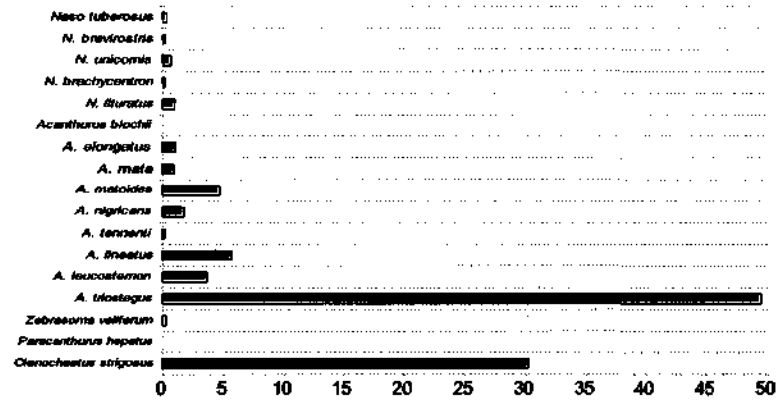


Figure 9 Relative abundance of different species of surgeon fish (Acanthuridae) in Lakshadweep

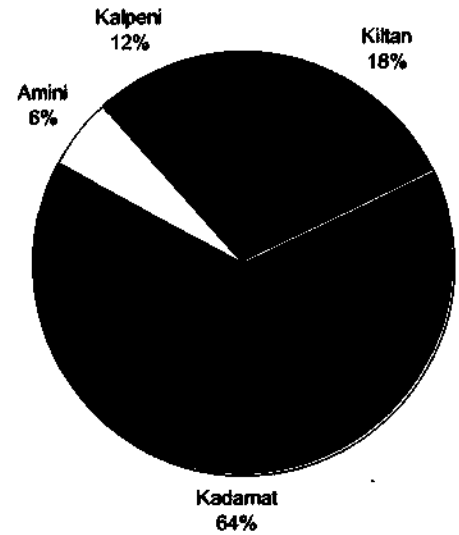


Figure 10. Relative abundance of Cardinal fish (Apogonidae) in different Lakshadweep Islands

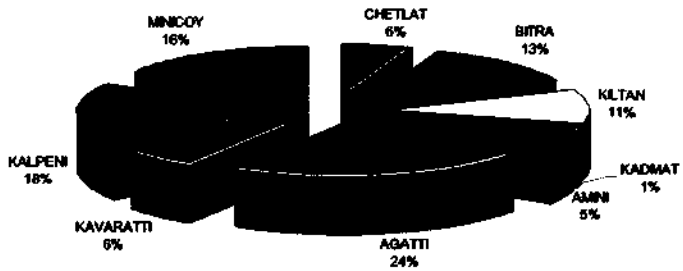


Figure 11 Relative abundance of Triggerfish (Balistidae) in the Lakshadweep islands

surgeonfish, goatfish, squirrel fish, rock cod, butterfly fish, triggerfish and others (Fig. 7)

DISTRIBUTION AND ABUNDANCE OF SPECIES

Acanthuridae (Surgeon fish) (Plates 3-10) : Kalpeni is the richest island in regard to the abundance of surgeon fish, accounting for 21% of the catch obtained from nine islands followed by Kiltan (18%), Kavaratti and Minicoy (16% each), Agatti (13%), Chetlat (7%), Amini (4%), Bitra (3%) and Kadmat (2%) (Fig. 8).

A total of 20 species are known from the Lakshadweep islands of which 17 species are represented in the present collections (Table 4). Of these, *Acanthurus triostegus* is most abundant numerically forming 49% of the catch of the group. *Ctenochaetus strigosus* is the next abundant species forming 30.2% of the catch of the family, followed by *Acanthurus lineatus* (5.6%), *A. matoides* (4.7%), *A. leucosternon* (3.7%), *A. nigricauda* (1.7%) and others (Fig. 9).

Among the dominant species of surgeons, *A. triostegus* is abundant in all the islands but most abundant in Chetlat accounting for 81% of surgeon fish catch in the island followed by Kiltan (72%), Minicoy (70%), Agatti (57%), Amini (51%) and other islands. The peak periods of abundance of surgeons in all the islands are March and November.

Ctenochaetus strigosus is most abundant in Kalpeni accounting for 90% of catch of the group by numbers in the island followed by Bitra (52%), Kadmat (26%), Minicoy (23%) and other islands. *Acanthurus lineatus* is most abundant among the surgeons in Amini and Kavaratti islands accounting for about 18% of surgeonfish catch in these two islands. *A. leucosternon* is most dominant in the group in Amini and Kavaratti forming 15% and 14% of the surgeonfish catch respectively.

A. triostegus is abundant almost round the year but January and November are the peak months of abundance. *Ctenochaetus strigosus* is represented by about 10% or less of the catch of the species in all the months except March which accounted for about 60% of the annual catch of the species. In the case of *A. leucosternon*, peak period of abundance is October- November. In *A. lineatus* the peak periods are March and November.

Apogonidae (Cardinal fish): This family is represented by 22 species in the Lakshadweep. Most of the species are used as live-bait in the pole and line fishery for tunas. The present collections consisted of only nine species. The fishes are sluggish and are known for their mouth – incubating habit. Some species are brightly coloured. These fishes are collected from 4 islands only. Kadmat is the richest in these fishes accounting for 64% of the total catch taken followed by Kiltan (18%), Kalpeni (12%) and Amini (6%) (Fig.10). These fishes were collected only during four months during October – January and maximum catches were taken during December – January. Of the nine species collected, *Pristiapogon snyderi* is the most abundant species which formed 66% of the catch of the group followed by *Ostorhynchus savayensis* (17%), *O. moluccensis* (6%) and others. *O. savayensis* is abundant in December and *P. snyderi* in January and November.

Balistidae (Triggerfish) (Plates 11-13) : This family is represented by 10 species in the Lakshadweep of which only 6 species are represented in the present collections (Table 4). Agatti Island is the richest in the abundance of these fishes; in this island, triggerfish accounted for 24% of the total

surgeonfish, goatfish, squirrel fish, rock cod, butterfly fish, triggerfish and others (Fig. 7)

DISTRIBUTION AND ABUNDANCE OF SPECIES

Acanthuridae (Surgeon fish) (Plates 3-10) : Kalpeni is the richest island in regard to the abundance of surgeon fish, accounting for 21% of the catch obtained from nine islands followed by Kiltan (18%), Kavaratti and Minicoy (16% each), Agatti (13%), Chetlat (7%), Amini (4%), Bitra (3%) and Kadmat (2%) (Fig. 8).

A total of 20 species are known from the Lakshadweep islands of which 17 species are represented in the present collections (Table 4). Of these, *Acanthurus triostegus* is most abundant numerically forming 49% of the catch of the group. *Ctenochaetus strigosus* is the next abundant species forming 30.2% of the catch of the family, followed by *Acanthurus lineatus* (5.6%), *A. matoides* (4.7%), *A. leucosternon* (3.7%), *A. nigricauda* (1.7%) and others (Fig. 9).

Among the dominant species of surgeons, *A. triostegus* is abundant in all the islands but most abundant in Chetlat accounting for 81% of surgeon fish catch in the island followed by Kiltan (72%), Minicoy (70%), Agatti (57%), Amini (51%) and other islands. The peak periods of abundance of surgeons in all the islands are March and November.

Ctenochaetus strigosus is most abundant in Kalpeni accounting for 90% of catch of the group by numbers in the island followed by Bitra (52%), Kadmat (26%), Minicoy (23%) and other islands. *Acanthurus lineatus* is most abundant among the surgeons in Amini and Kavaratti islands accounting for about 18% of surgeonfish catch in these two islands. *A. leucosternon* is most dominant in the group in Amini and Kavaratti forming 15% and 14% of the surgeonfish catch respectively.

A. triostegus is abundant almost round the year but January and November are the peak months of abundance. *Ctenochaetus strigosus* is represented by about 10% or less of the catch of the species in all the months except March which accounted for about 60% of the annual catch of the species. In the case of *A. leucosternon*, peak period of abundance is October- November. In *A. lineatus* the peak periods are March and November.

Apogonidae (Cardinal fish): This family is represented by 22 species in the Lakshadweep. Most of the species are used as live-bait in the pole and line fishery for tunas. The present collections consisted of only nine species. The fishes are sluggish and are known for their mouth – incubating habit. Some species are brightly coloured. These fishes are collected from 4 islands only. Kadmat is the richest in these fishes accounting for 64% of the total catch taken followed by Kiltan (18%), Kalpeni (12%) and Amini (6%) (Fig.10). These fishes were collected only during four months during October – January and maximum catches were taken during December – January. Of the nine species collected, *Pristiapogon snyderi* is the most abundant species which formed 66% of the catch of the group followed by *Ostorhynchus savayensis* (17%), *O. moluccensis* (6%) and others. *O. savayensis* is abundant in December and *P. snyderi* in January and November.

Balistidae (Triggerfish) (Plates 11-13) : This family is represented by 10 species in the Lakshadweep of which only 6 species are represented in the present collections (Table 4). Agatti Island is the richest in the abundance of these fishes; in this island, triggerfish accounted for 24% of the total

Plate 11 a & b. Blackbar triggerfish-*Rhinecanthus aculeatus*
c. Orangestriped triggerfish-*Balistapus undulatus*

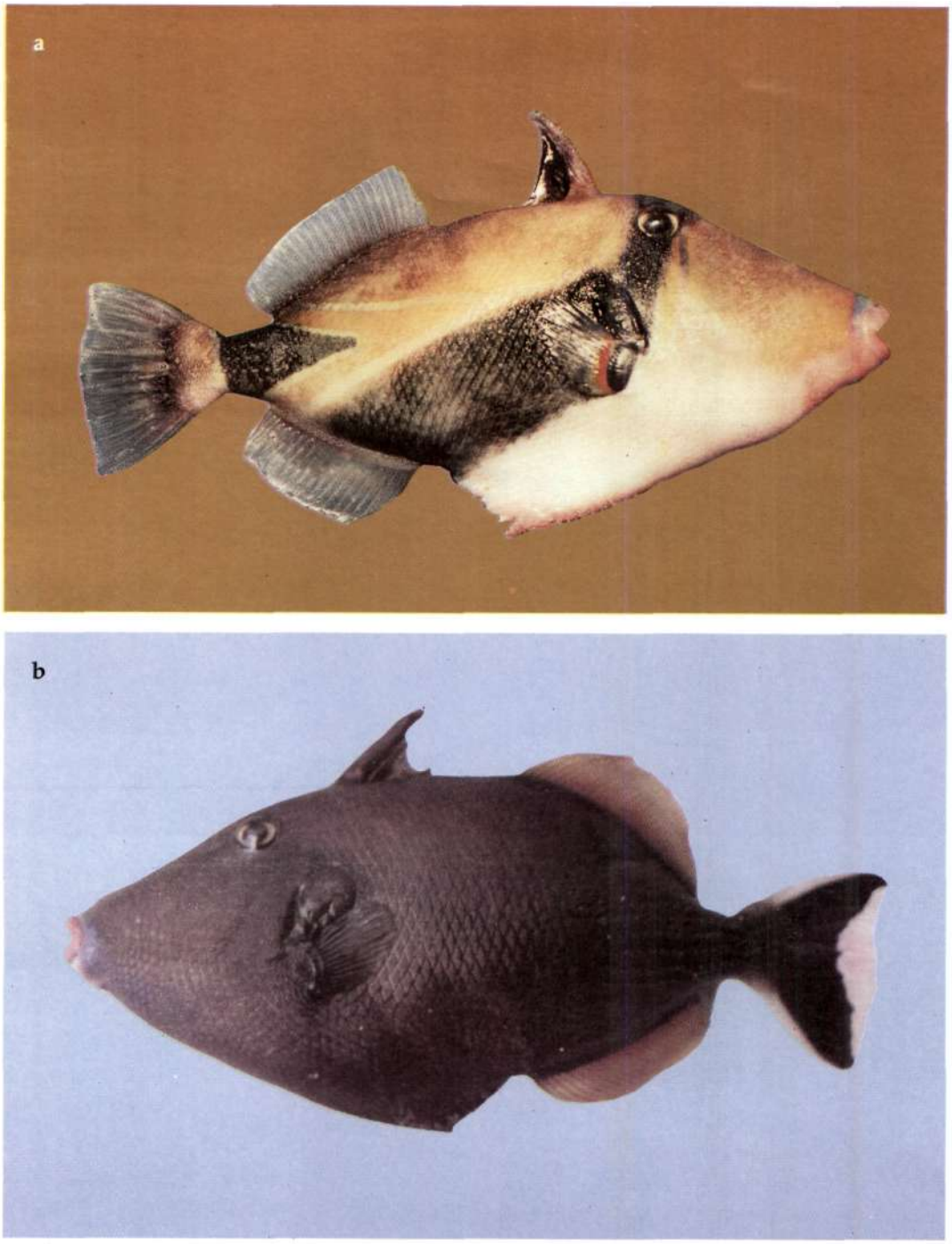


Plate 12 a. Patchy triggerfish-*Rhinecanthus rectangulus*
b. Halfmoon triggerfish-*Sufflamen chrysoptera*

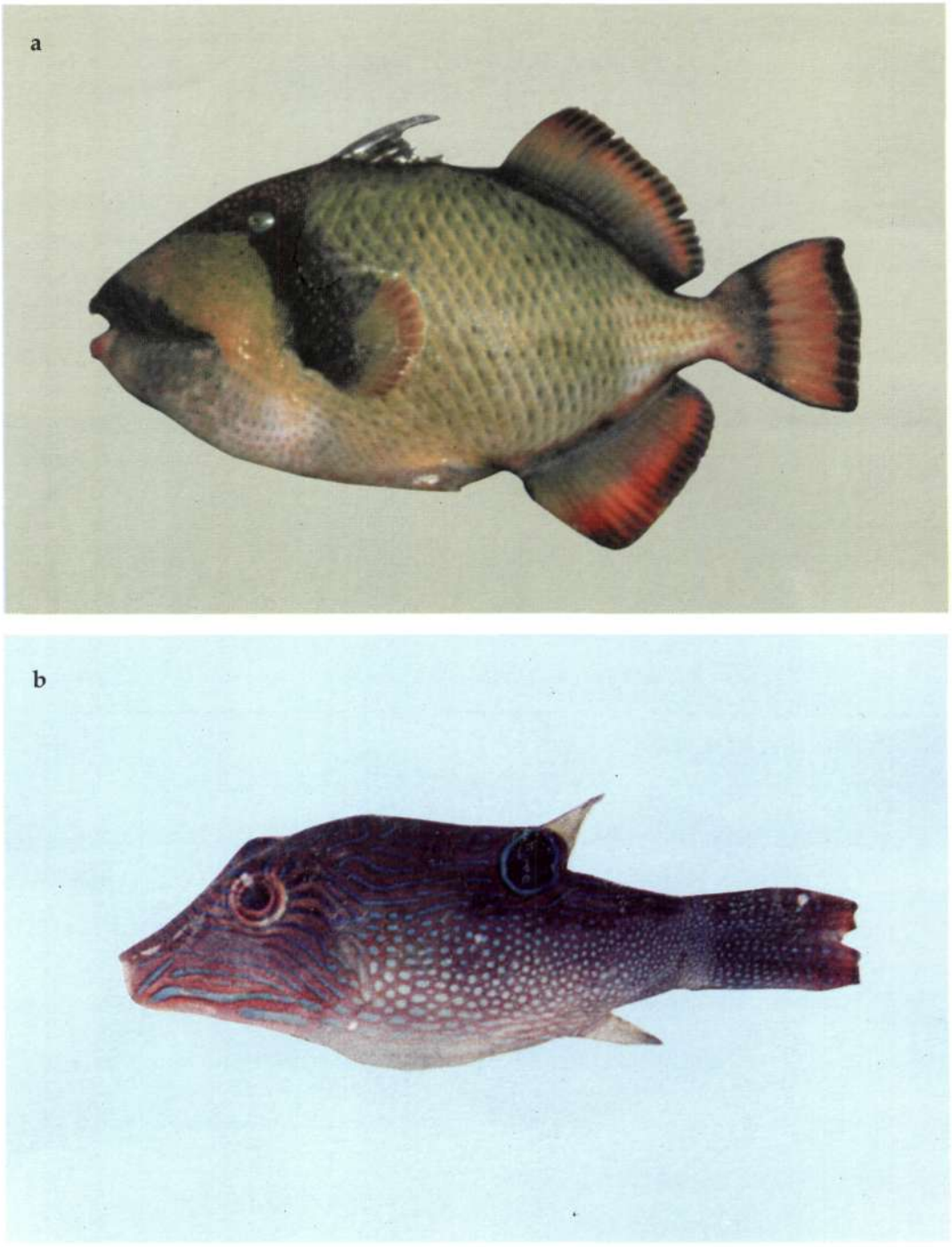


Plate 13 a. Dotty triggerfish-*Balistoides viridescens*
b. False-eye tobby-*Canthigaster margaritatus*

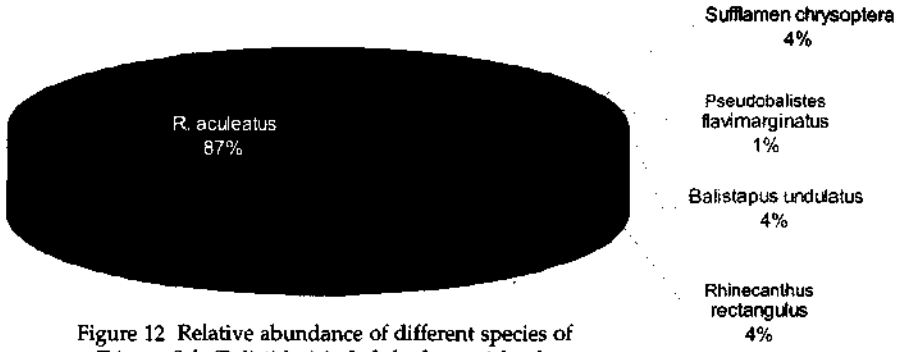


Figure 12 Relative abundance of different species of Trigger fish (Balistidae) in Lakshadweep islands

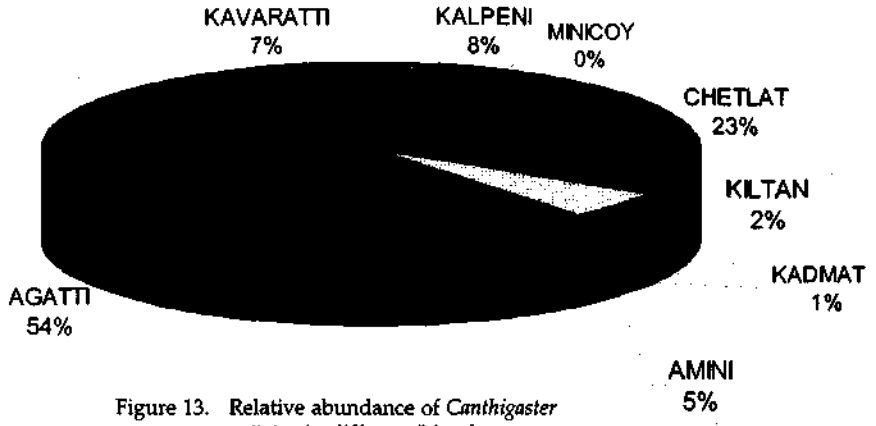


Figure 13. Relative abundance of *Canthigaster margaritatus* in different Islands

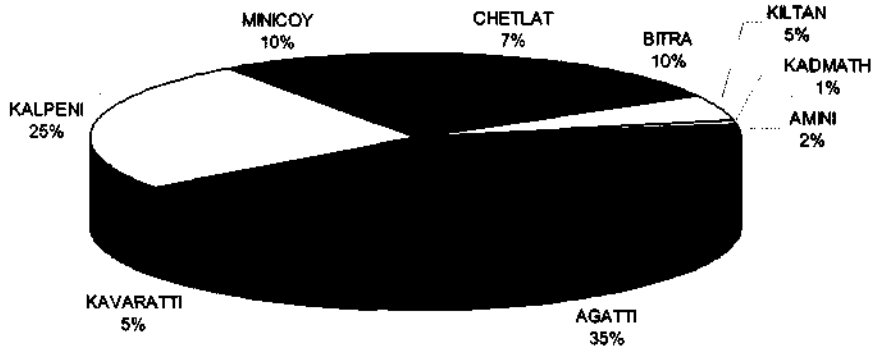


Figure 14 Relative abundance of Butterflyfish (Chaetodontidae) in different islands

catch of these fishes taken in all the 9 islands. Kalpeni accounted for 18% of trigger fish catch in all the islands followed by Minicoy (16%), Bitra (13%), Kiltan (11%), Kavaratti and Chetlat (6% each), Amini (5%) and Kadmat (1%) (Fig. 11).

Of the six species represented in the catches obtained during the survey, *Rhinecanthus aculeatus* is most dominant accounting for 86.8% of the trigger fish catch followed by *R. rectangulus* (4.3%), *Sufflamen chrysoptera* (4.0%), *Balistapus undulatus* (3.5%) and *Pseudobalistes flavimarginatus* and *Balistoides viridescens* the rest (1.4%) (Fig.12). *Rhinecanthus aculeatus* is most abundant in all the islands accounting for 71 to 100 % of triggerfish catch in each of them.

R. rectangulus was caught from Chetlat, Kiltan, Amini and Minicoy. In Amini this species formed 28.6% of triggerfish catch in the island followed by Kiltan (14.0%) and others.

Triggerfish is available during all the months but January–May and November–December are the peak periods and so is the case with *R. aculeatus*.

Canthigasteridae (Pufferfish): These fishes are sluggish but form a good material for aquarium. This family is represented by four species in the Lakshadweep but the present collection is represented by two species (Table 4). These fishes are abundant in all the islands and very large schools were observed in May – June period. It is possible to easily collect hundreds of these fish during the period. Agatti Island is the richest in regard to abundance of these fishes (Fig. 13b) followed by Chetlat, Kalpeni, Kavaratti, Amini, Kiltan and Kadmat. The month of May is the peak period of abundance of these fishes in all the islands. *Canthigaster margaritatus* (Plates 13b) is the most dominant species in the Lakshadweep.

Chaetodontidae (Butterfly fish) (Plates 14-19) : This is the most important group of ornamental fishes in the Lakshadweep in terms of demand for aquarium keeping. Lakshadweep is the richest single region in the country's EEZ with regard to number of species in the family. A total of 18 species are known from the region, of which 14 species are represented in the present collections (Table 4).

Among the nine islands surveyed, Agatti is the richest in regard to abundance of butterfly fish, accounting for 35% of the total catch (by number) taken in all the islands. Kalpeni is next in importance accounting for 25% of the catch of the family followed by Bitra and Minicoy (10% each), Chetlat (7%), Kiltan and Kavaratti (5% each) Amini (2%) and Kadmat (1%) (Fig.14).

Among the different species, *Chaetodon auriga* is the most abundant species constituting 32.9% of the catch of butterfly fish followed by *C. trifasciatus* (17.2%) *Heniochus acuminatus* (14.6%), *Megaprotodon strigangulus* (9.8%), *C. xanthocephalus* (6.0%) and others (Fig. 15).

Though this family is one of the richest in terms of number of species, the numerical abundance of the species is limited, as reflected in the smaller number in the catches. These fishes are relatively more abundant in different lagoons during May with a smaller peak in December – January. *Chaetodon auriga* is the most abundant in March, May and October, *C. trifasciatus* in March, May and December, *Heniochus acuminatus* in May and *Megaprotodon strigangulus* in May and December.

Chaetodon auriga is most abundant in Kadmat accounting for about 75% of the catch of butterfly fish in all the islands followed by Kiltan (65%), Bitra (40%), and

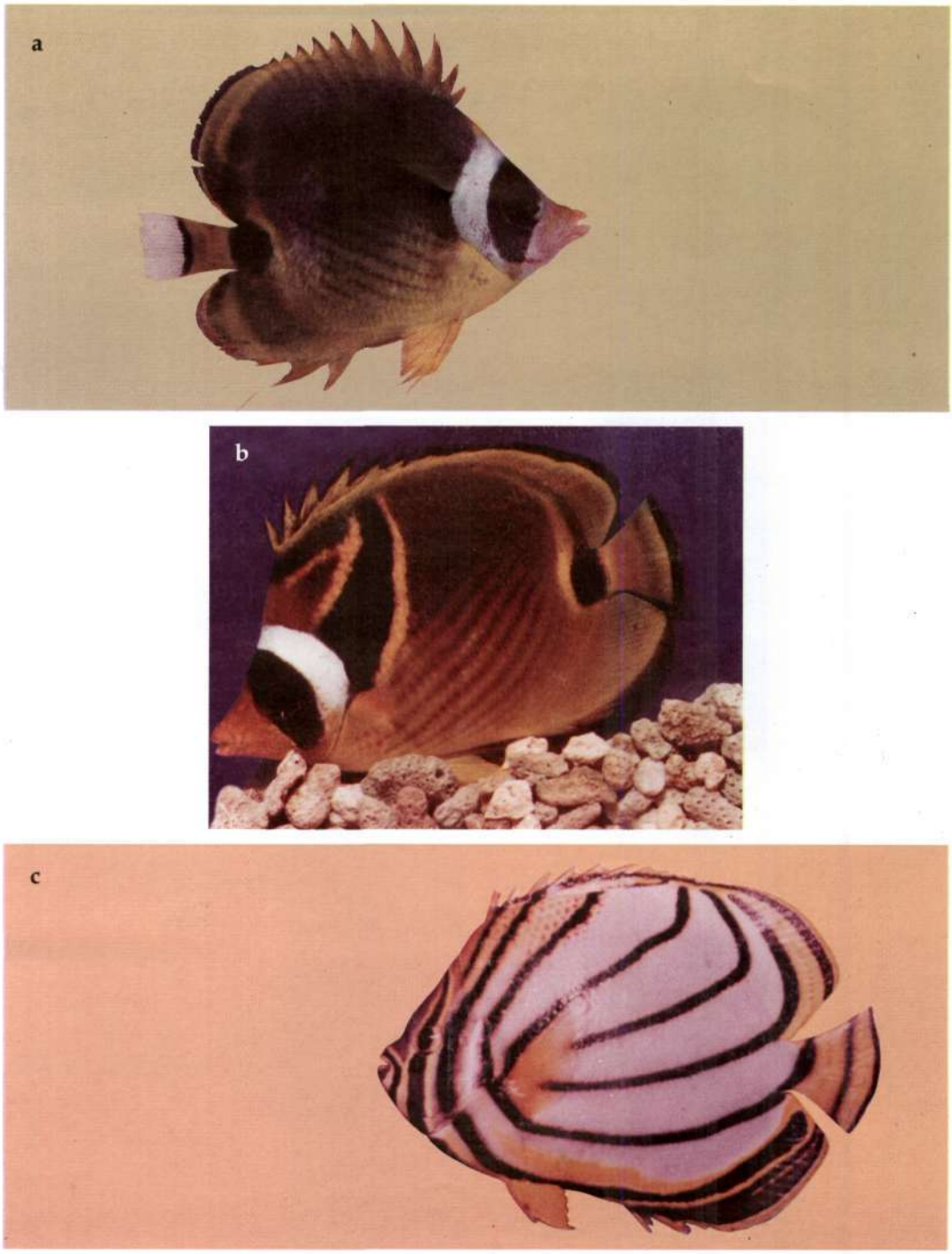


Plate 14 a & b. Halfmoon butterfly fish-*Chaetodon lunula*
c. Maypole butterfly fish-*Chaetodon meyeri*

Plate 15 a & b. Whitespotted butterfly fish-*Chaetodon kleini*
c.Thredfin butterflyfish-*Chaetodon auriga*

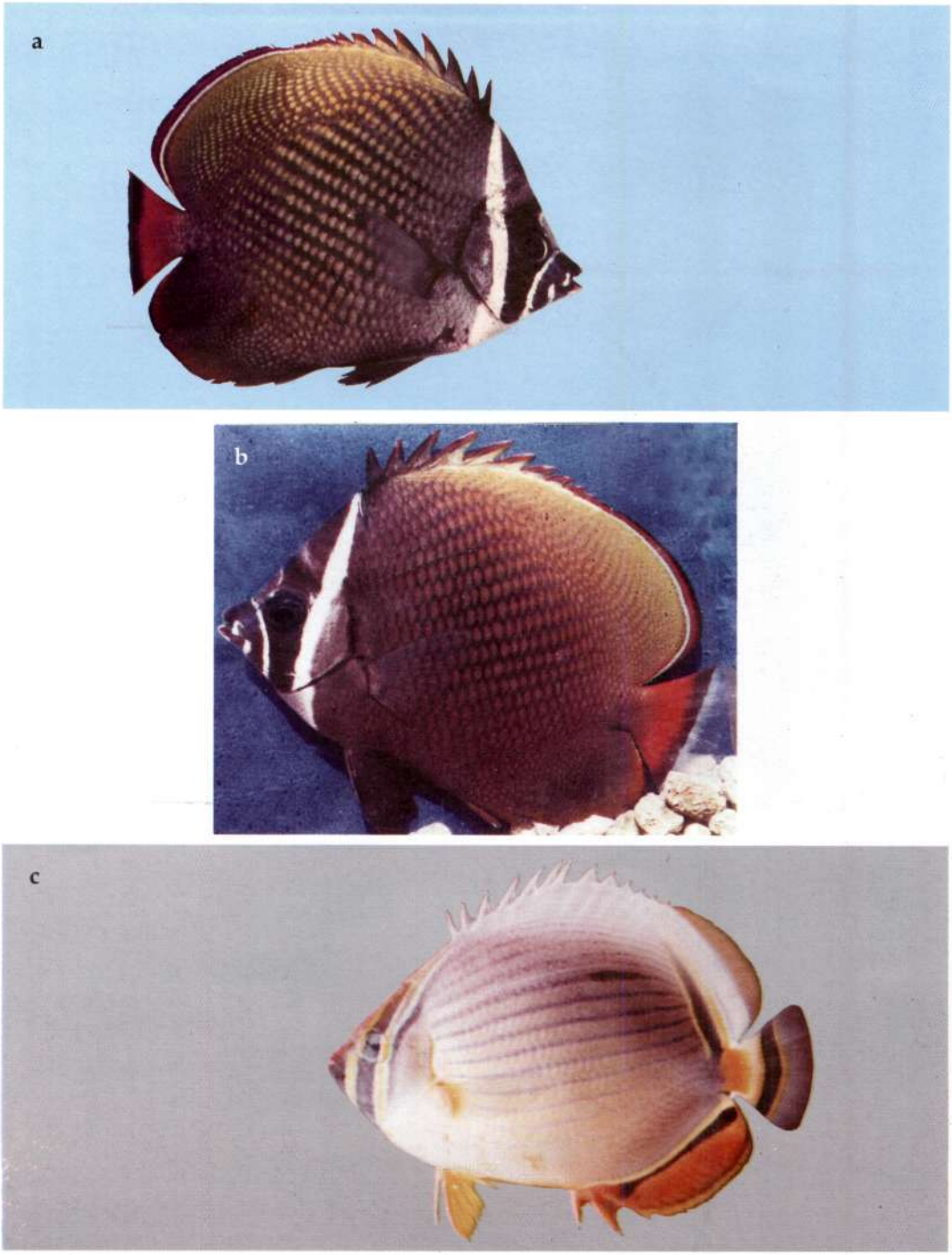


Plate 16 a & b. Collar butterflyfish-*Chaetodon collaris*
c. Purple butterfly fish-*Chaetodon trifasciatus*

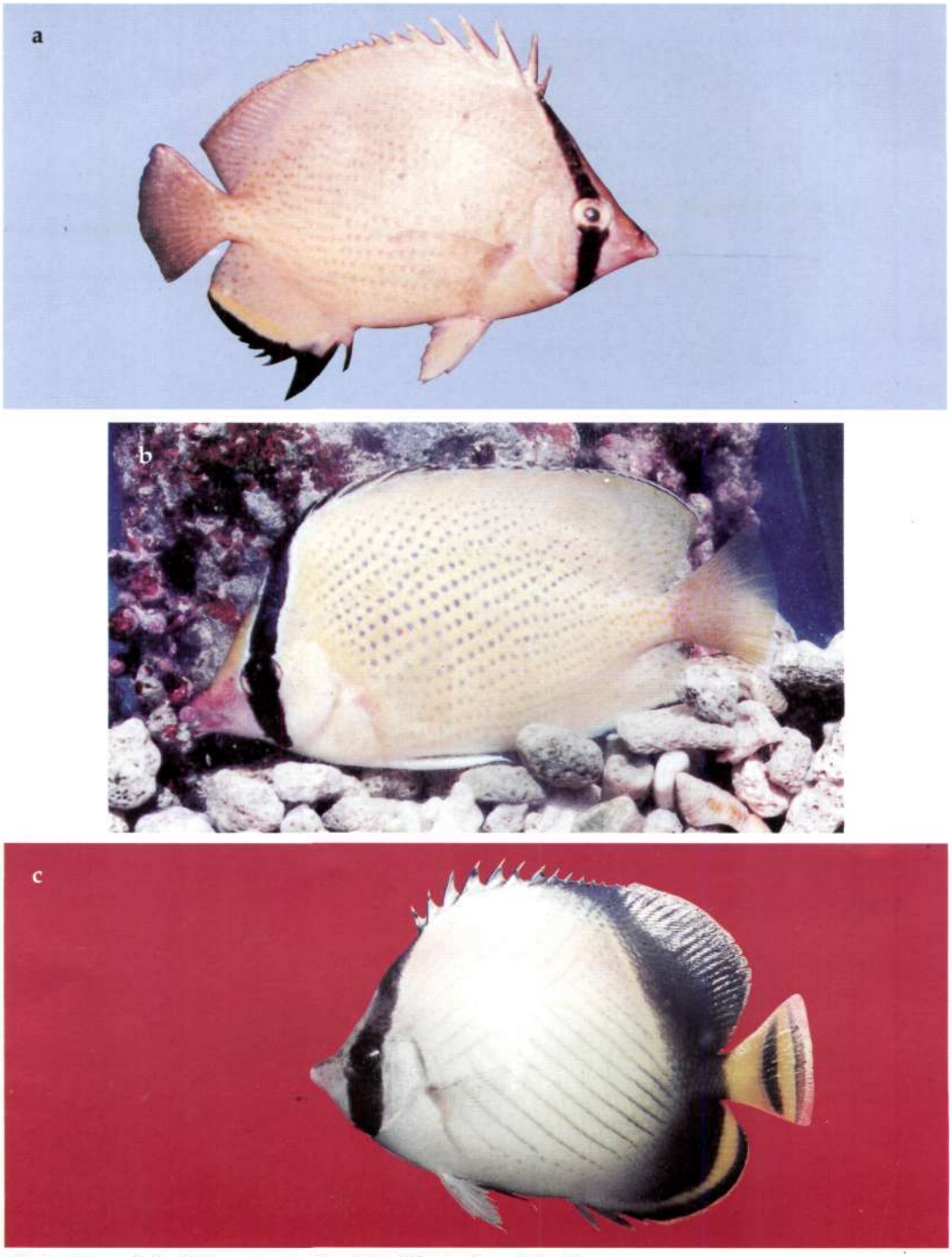


Plate 17 a & b. Citron butterfly fish-*Chaetodon citrinellus*
c. Vagabond butterfly fish-*Chaetodon vagabundus*

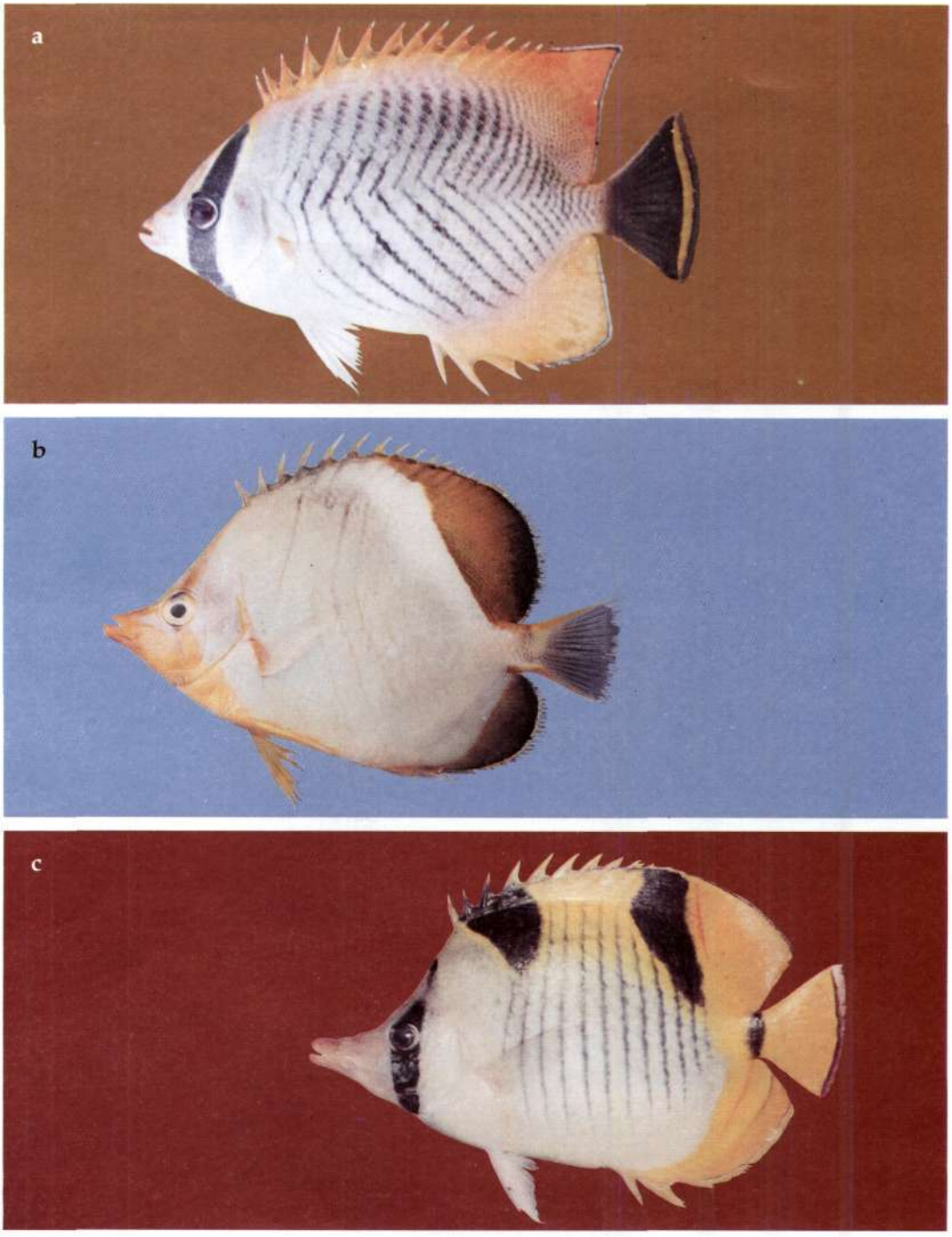


Plate 18 a. Striate butterfly fish-*Megaprotodon strigangulus*
b. Yellow-head butterfly fish- *Chaetodon xanthocephalus*
c. Saddled butterfly fish-*Chaetodon falcula*

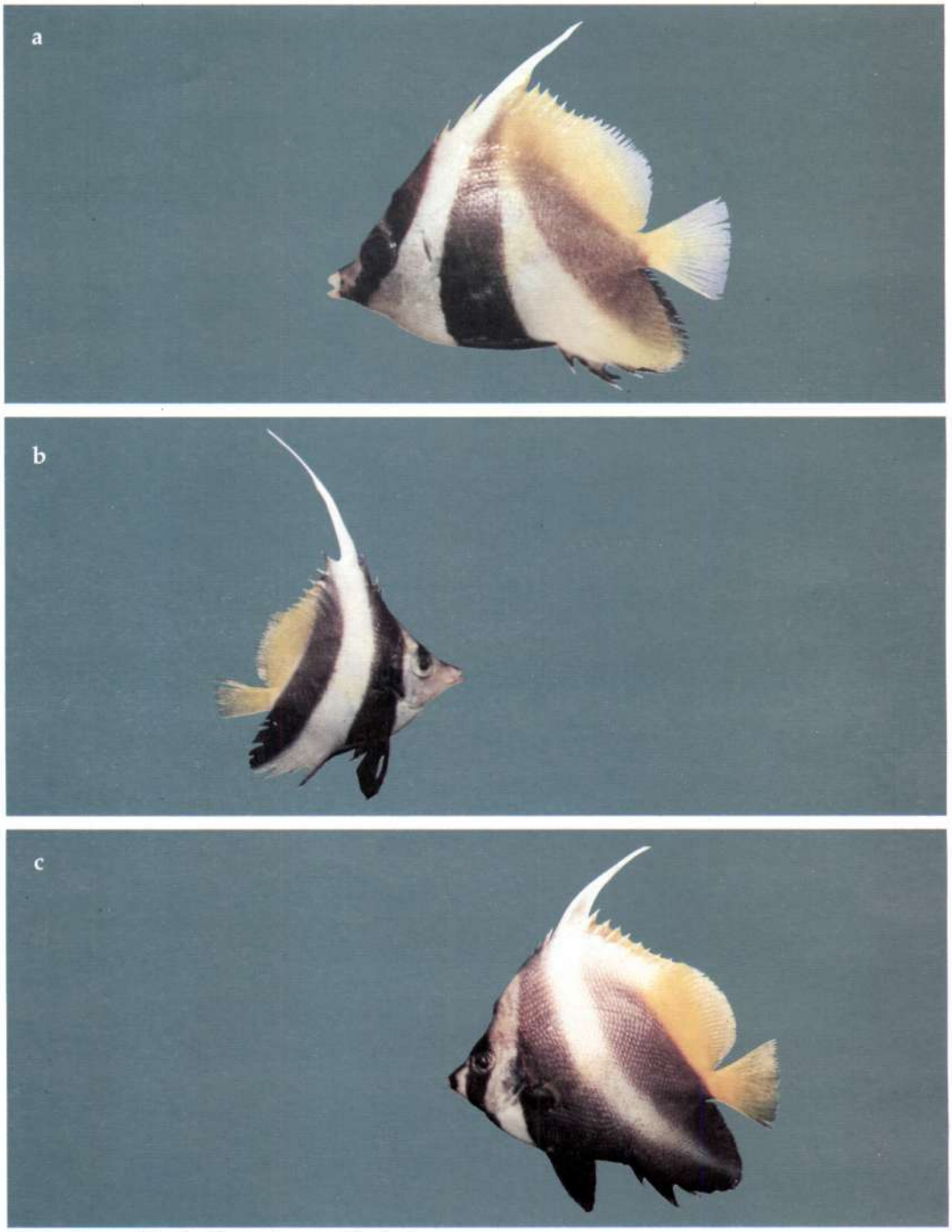


Plate 19 a. Masked coachman-*Heniochus monoceros*
b. Schooling coachman-*Heniochus acuminatus*
c. Philippine pennant fish- *Heniochus singularis*

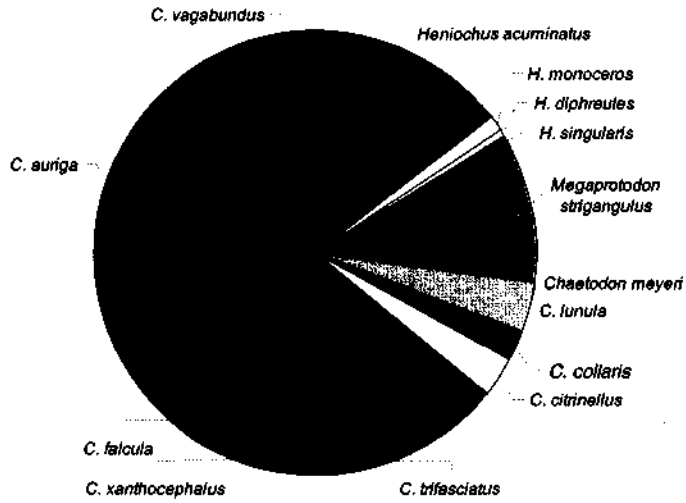


Figure 15. Relative abundance of Butterflyfish species in Lakshadweep islands

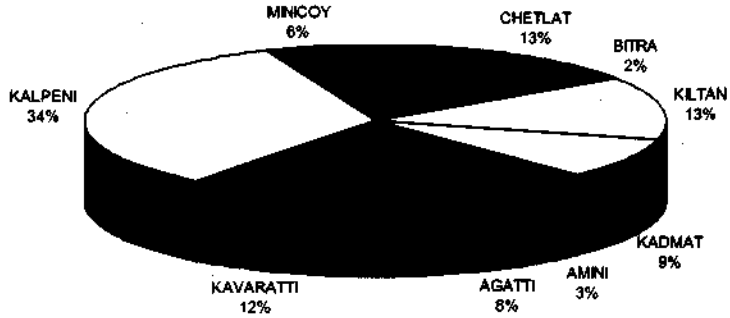


Figure 16. Relative abundance of Squirrel fish (Holocentridae) in Lakshadweep islands

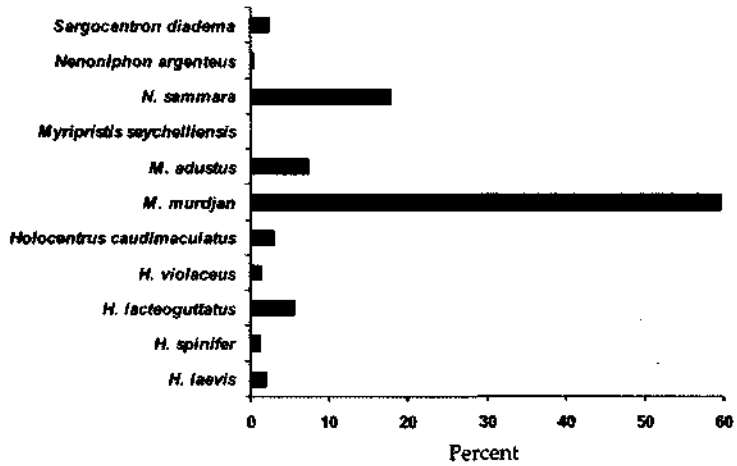


Figure 17. Relative abundance of squirrel fish species in Lakshadweep islands

others. Chetlat Island is richest in the abundance of *C. trifasciatus* accounting for about 60% of the butterfly fish catch in the island followed by Amini (53%) and others. *Heniochus acuminatus,* which ranks third in abundance, was caught in only Agatti and Kadmat. Agatti contributed about 42% of the catch of the family from the islands and over 99% of the catch from Kalpeni consisted of *Megaprotodon strigangulus;* this species formed 12% of the catch in Kavaratti and 16% in Chetlat. This species was not caught in the present survey from Amini, Bitra, Kadmat and Minicoy. 65% of the catch of *M. strigangulus* is taken from Kalpeni followed by 15.8% in Agatti, 11.1% in Chetlat and others.

Holocentridae (Squirrelfish) (Plates 20-22) : This family is represented by bright red-colored fish which are carnivorous and nocturnal, living in crevices and underneath corals and rocks during daytime and coming out during nighttime. Maximum catches of these fishes are obtained during night fishing operations.

This family is represented by 11 species in the Lakshadweep islands (Table 4) and in the catches of the present survey. Kalpeni island is the richest in regard to the abundance of these fishes accounting for 34% of the catch of the group in all the islands surveyed, followed by Chetlat (13%), Kiltan (13%), Kavaratti (12%), Kadmat (9%), Agatti (8%), Minicoy (6%), Amini (3%) and Bitra (2%) (Fig.16).

Of the eleven species, *Myripristis murdjan* is the most abundant species in the catches of different islands accounting for about 60% of catch of squirrelfish by numbers. *Neoniphon sammara* is the second most abundant species, accounting for 18% of the catch followed by *M. adustus* (7%), *Holocentrus lacteoguttatus* (6%) and others (Fig. 17)

Squirrelfish is available in all the months but its maximum abundance is in May, which accounts for over 50% of the catch in the year. In the case of *M. murdjan,* peak catches are taken in May and in the case of *N. sammara* there are two peaks, one in May (major) and the other (minor) in December.

Labridae (Wrasses) (Plates 23-34) : This family is most abundant in the Lakshadweep both numerically and in terms of number of species. A total of 42 species are known from the region; of these, 32 species are represented in the present collections (Table 4). Amini island is the richest in these fishes accounting for 34% of the total catch of wrasses, followed by Agatti (16%), Minicoy and Bitra (11% each) Kalpeni (9%), Kavaratti and Kiltan (6% each), Chetlat (5%) and Kadmat (2%) (Fig.18). A maximum of 23 species was collected from Agatti, 20 from Minicoy, 19 from Kiltan and Bitra, 17 from Kalpeni and Kavaratti, 15 from Kadmat and 14 from Amini and Chetlat.

Of the 23 species collected in Agatti, only 6 are abundant accounting for 84% of the wrasses caught in this island. *Halichoeres hortulanus* is the most dominant species forming 34% of the catch, followed by *Stethojulis albovittata* (27.3%), *H. scapularis* (10.9%), *H. marginatus* (7.3%), *Thalassoma hardwicki* (2.5%), *T. janseni* (2.6%) and others.

In Amini, of the fourteen species collected, three constitute over 90% of the catch in the island. *S. albovittata* is the most dominant species forming 74% of the catch followed by *H. scapularis* (12.7%), *H. kawarin* (4.7%) and others.

In Bitra a total of 19 species were collected and six species are most abundant together accounting for over 80% of the catch of wrasses from the island. The species

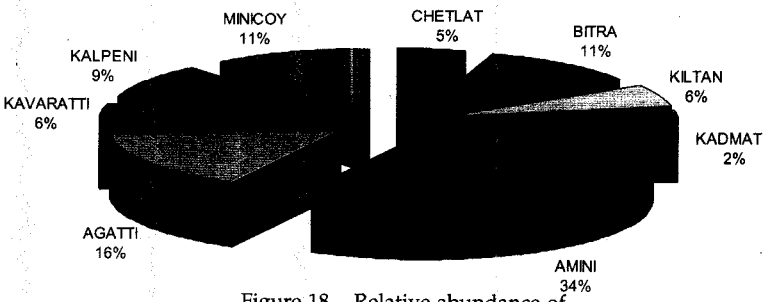


Figure 18. Relative abundance of Wrasses (Labridae) in different Lakshadweep islands

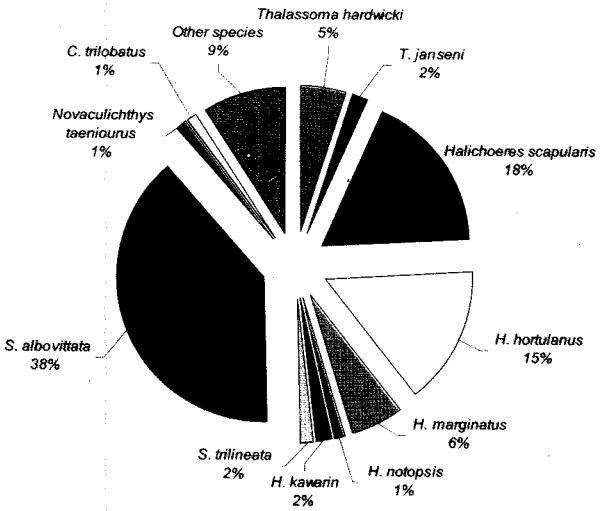


Figure 19. Relative abundance of major species of Wrasses (Labridae) in the Lakshadweep

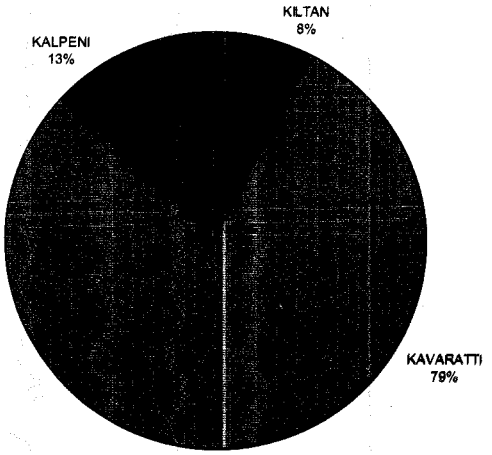


Figure 20. Relative abundance of Monocanthidae in different Lakshadweep islands

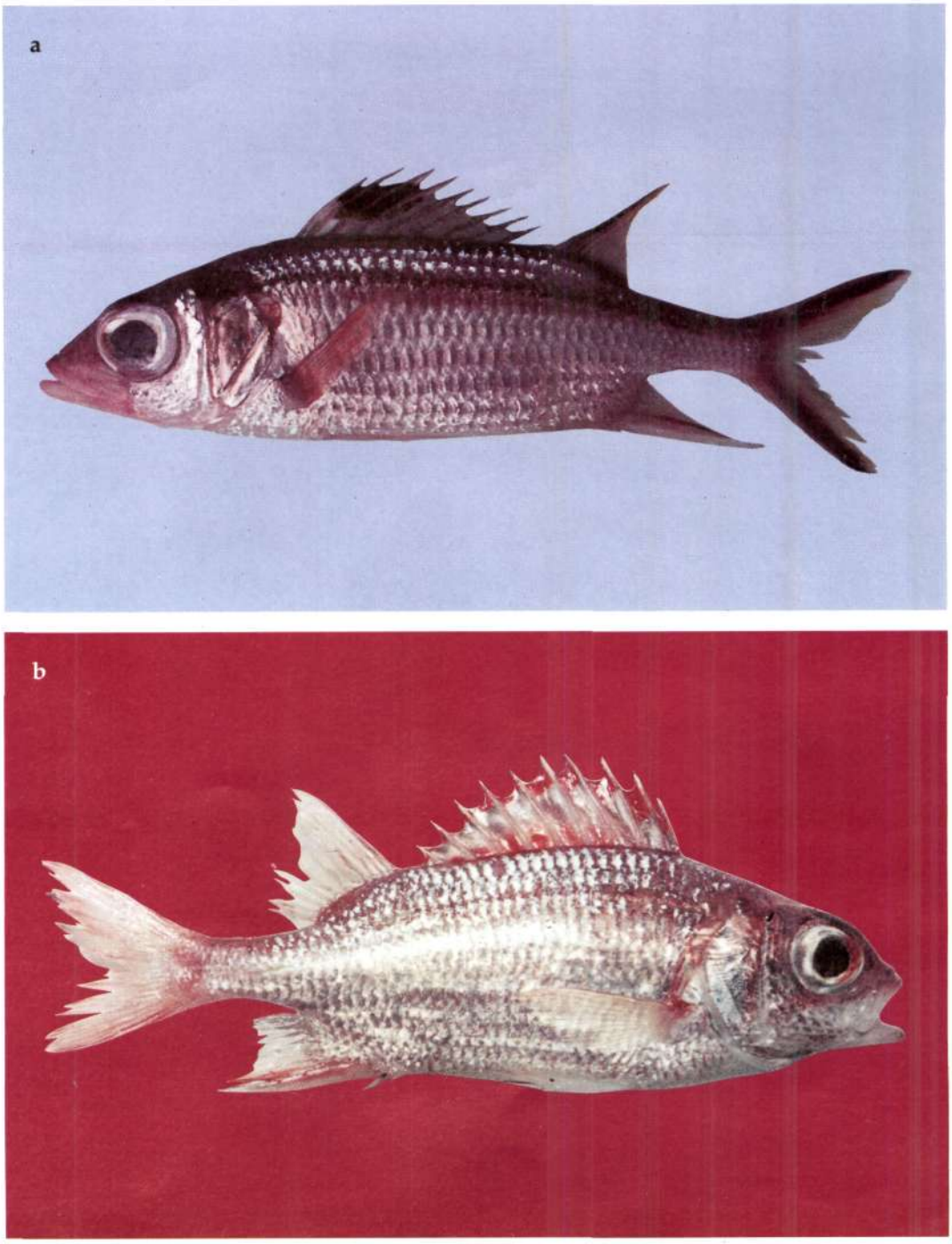


Plate 20 a. Spot fin squirrelfish-*Neoniphon sammara*
b. Crown squirrelfish-*Sargocentron diadema*

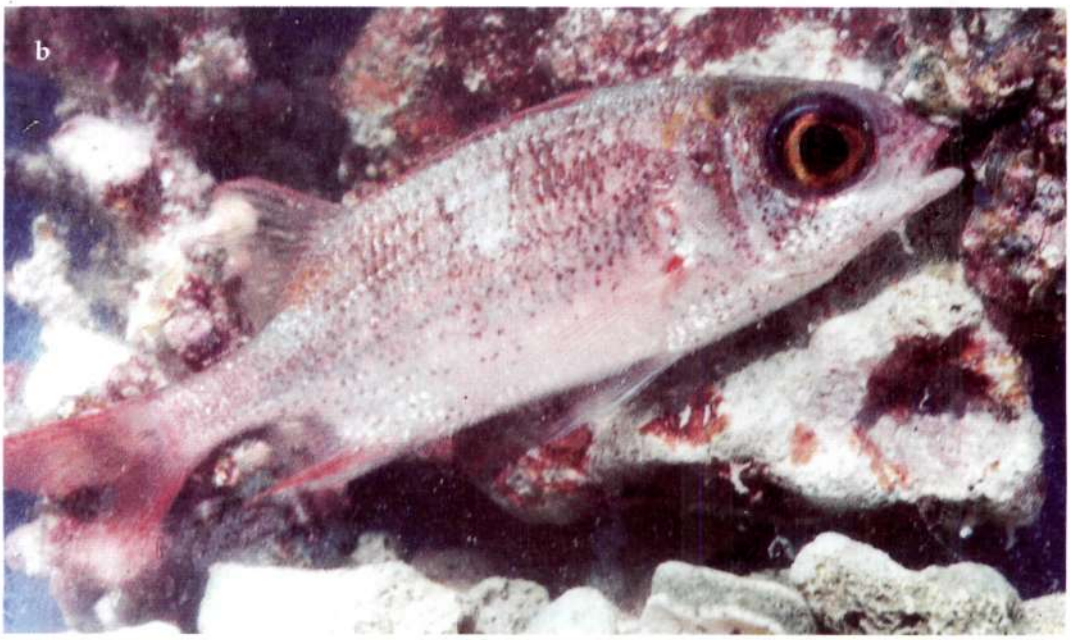


Plate 21 a & b. Silver squirrelfish-*Neoniphon argenteus*

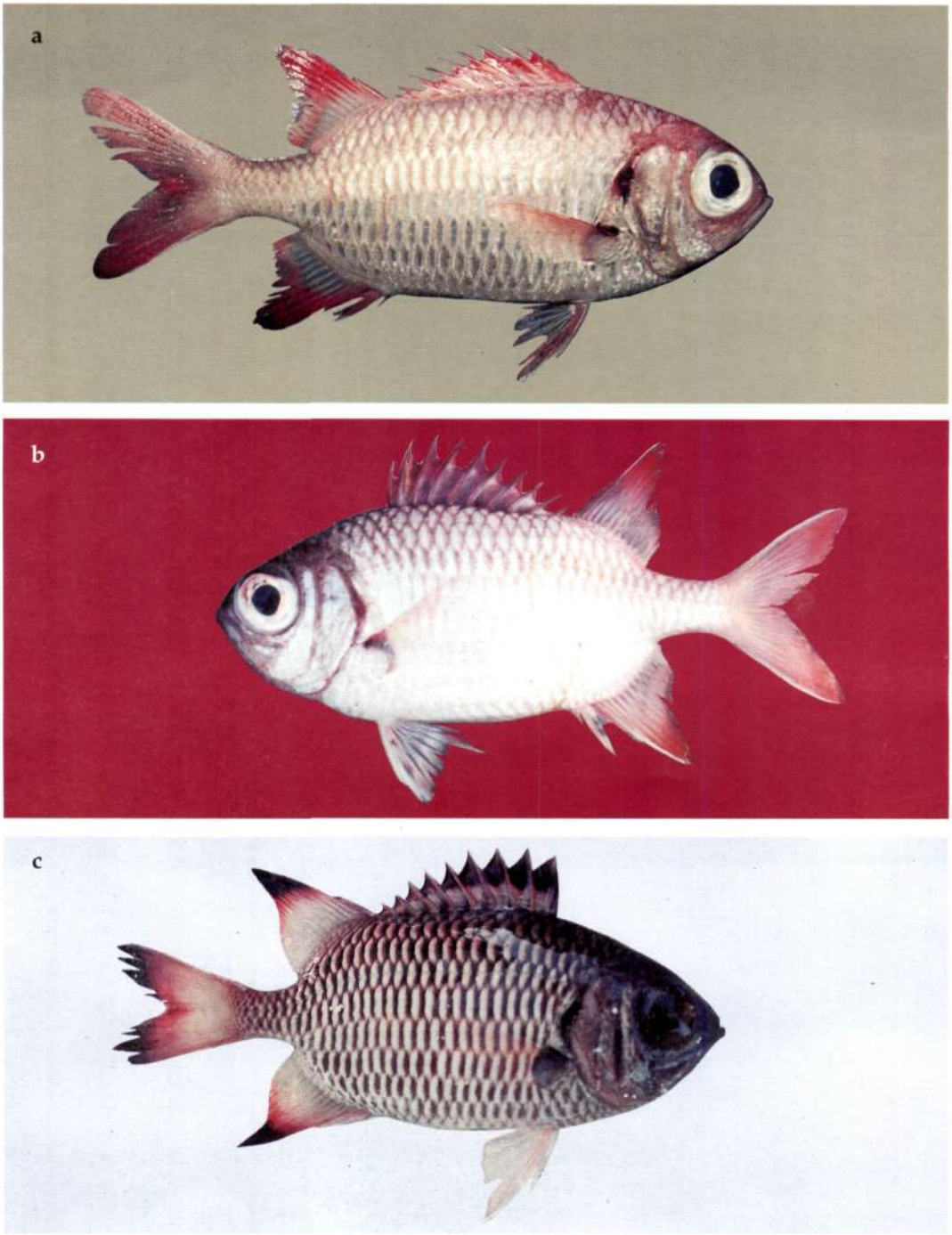


Plate 22 a. Blotch eye soldier- *Myripristis murdjan*
b. Seychelles soldier-*Myripristis seychelliensis*
c. Shadowfin soldier-*Myripristis adustus*

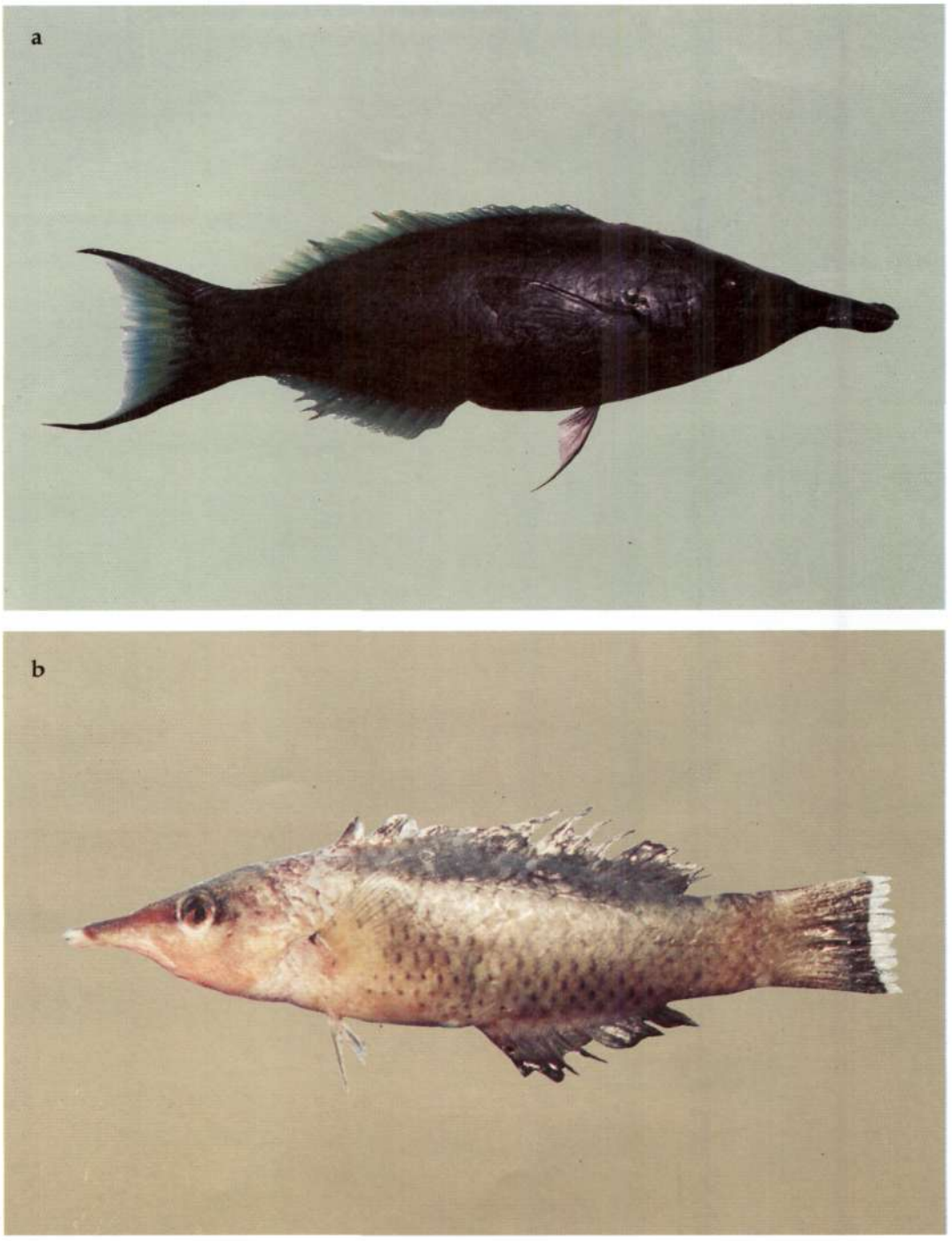


Plate 23 a. Blue birdfish-*Gomphosus caeruleus*
b. Birdfish-*Gomphosus varius*

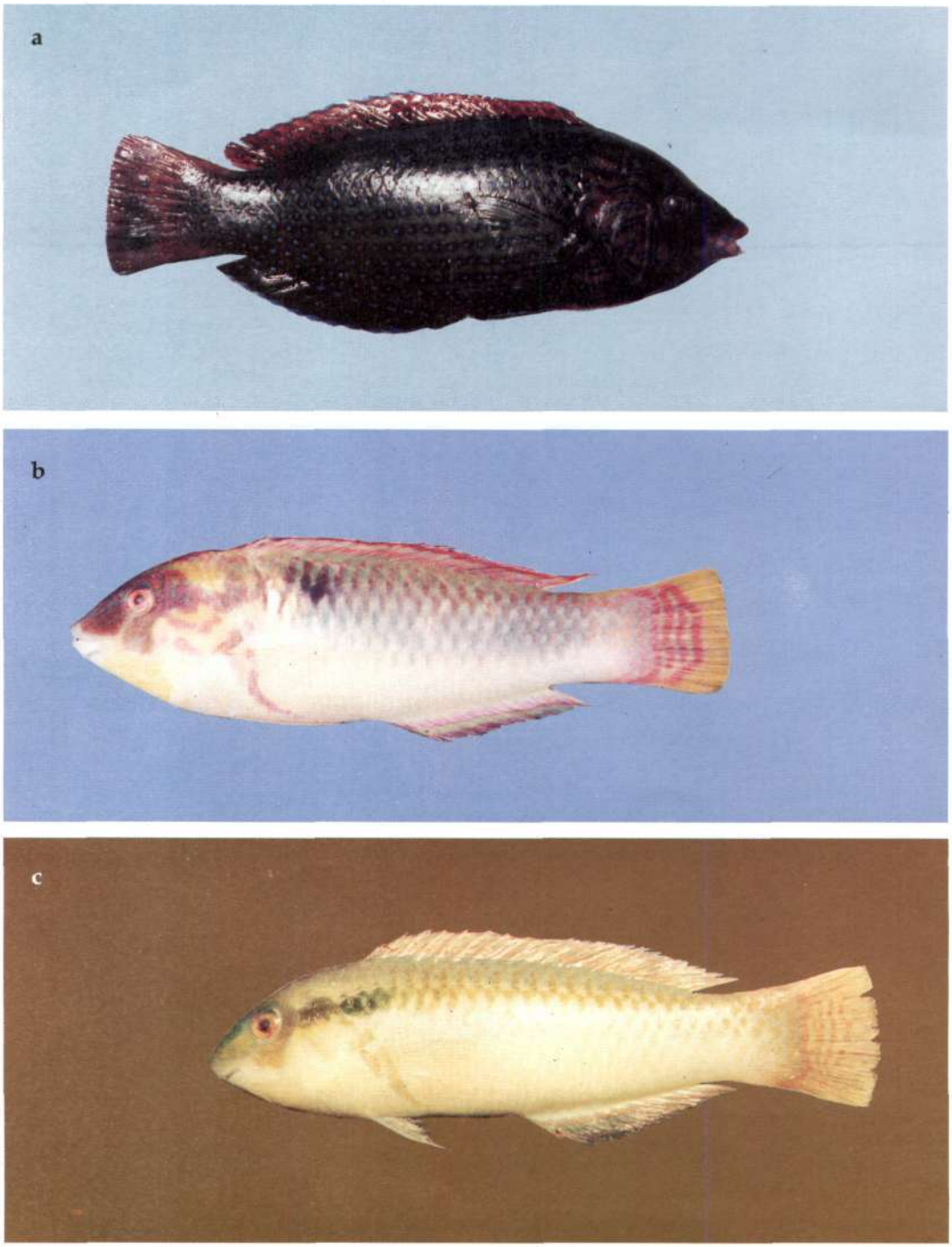


Plate 24 a. Blue spotted Tamarin-*Anampses caeruleopunctatus*
b & c. Zigzag sandwrasse-*Halichoeres scapularis*

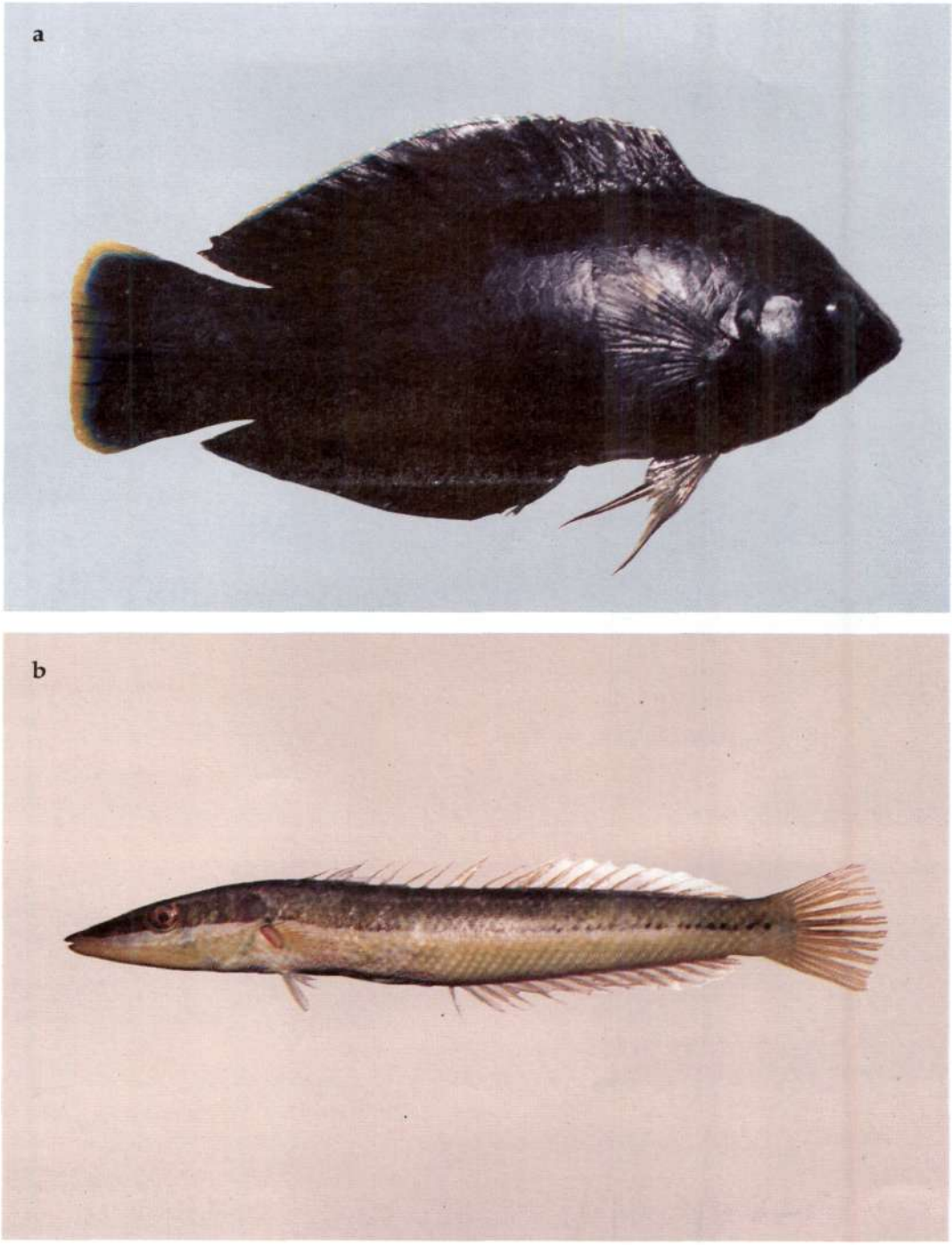


Plate 25 a. Dusky wrasse-*Halichoeres marginatus*
b. Cigar wrasse-*Cheilio inermis*

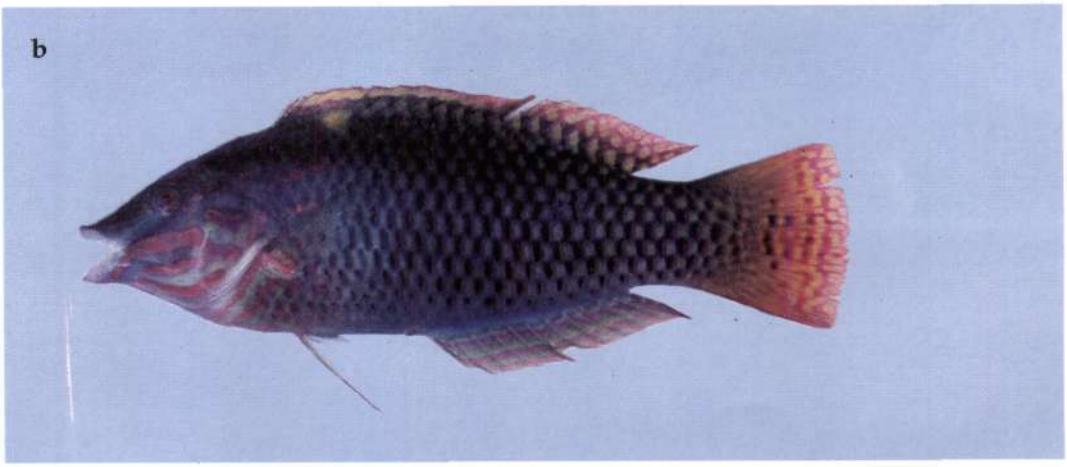


Plate 26 Checkerboard wrasse- *Halichoeres hortulanus*: a. in the aquarium, b. Male, c. Female

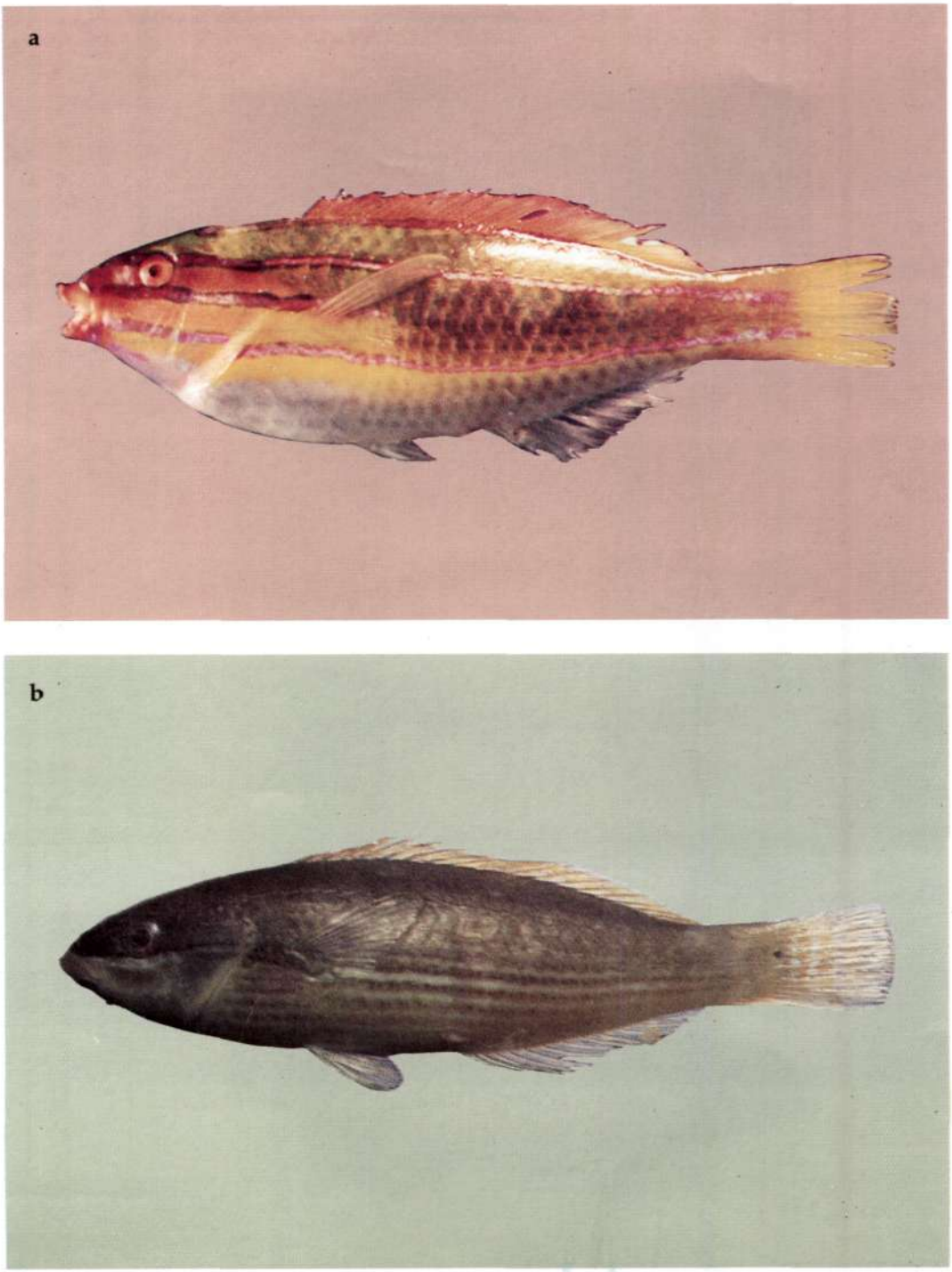
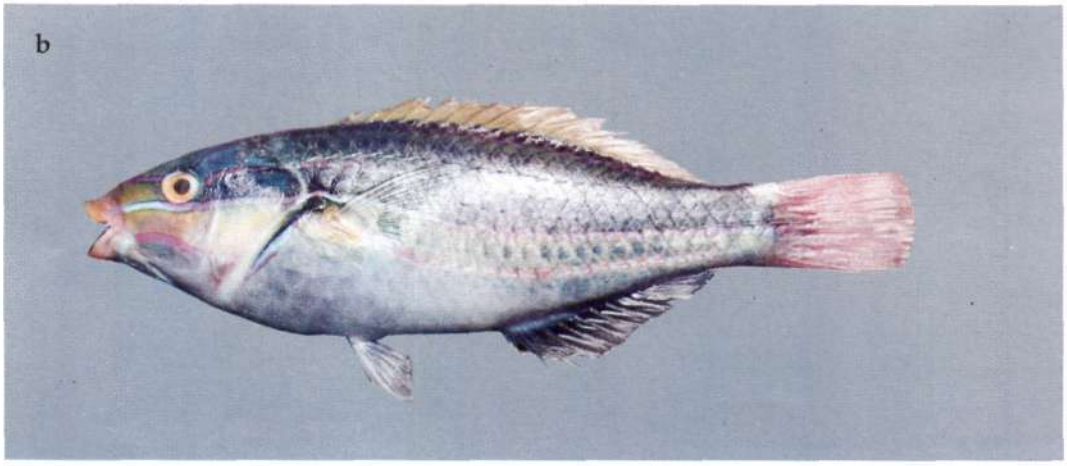


Plate 27 Three ribbon wrasse-*Stethojulis strigiventer*: a. Male, b. Female



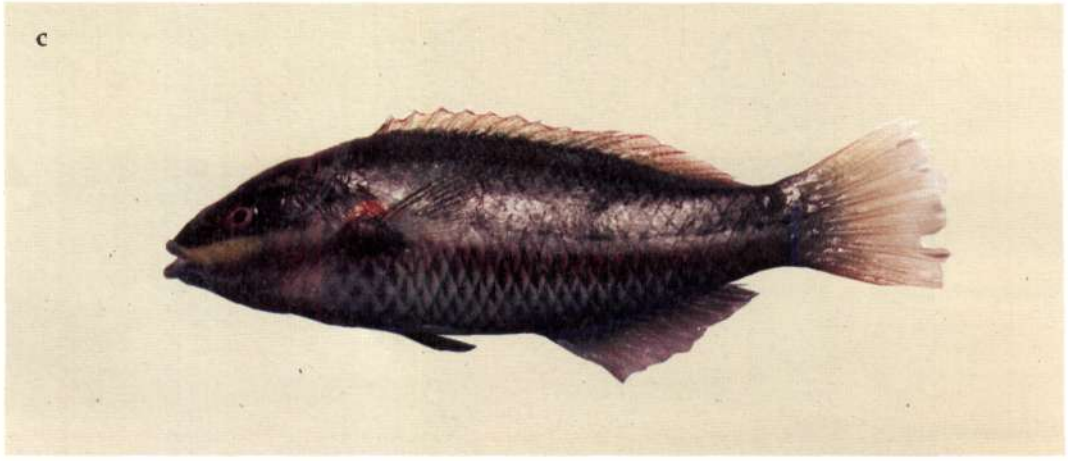


Plate 28 Blue lined wrasse- *Stethojulis albovittata*: a & b. Male, c. Female

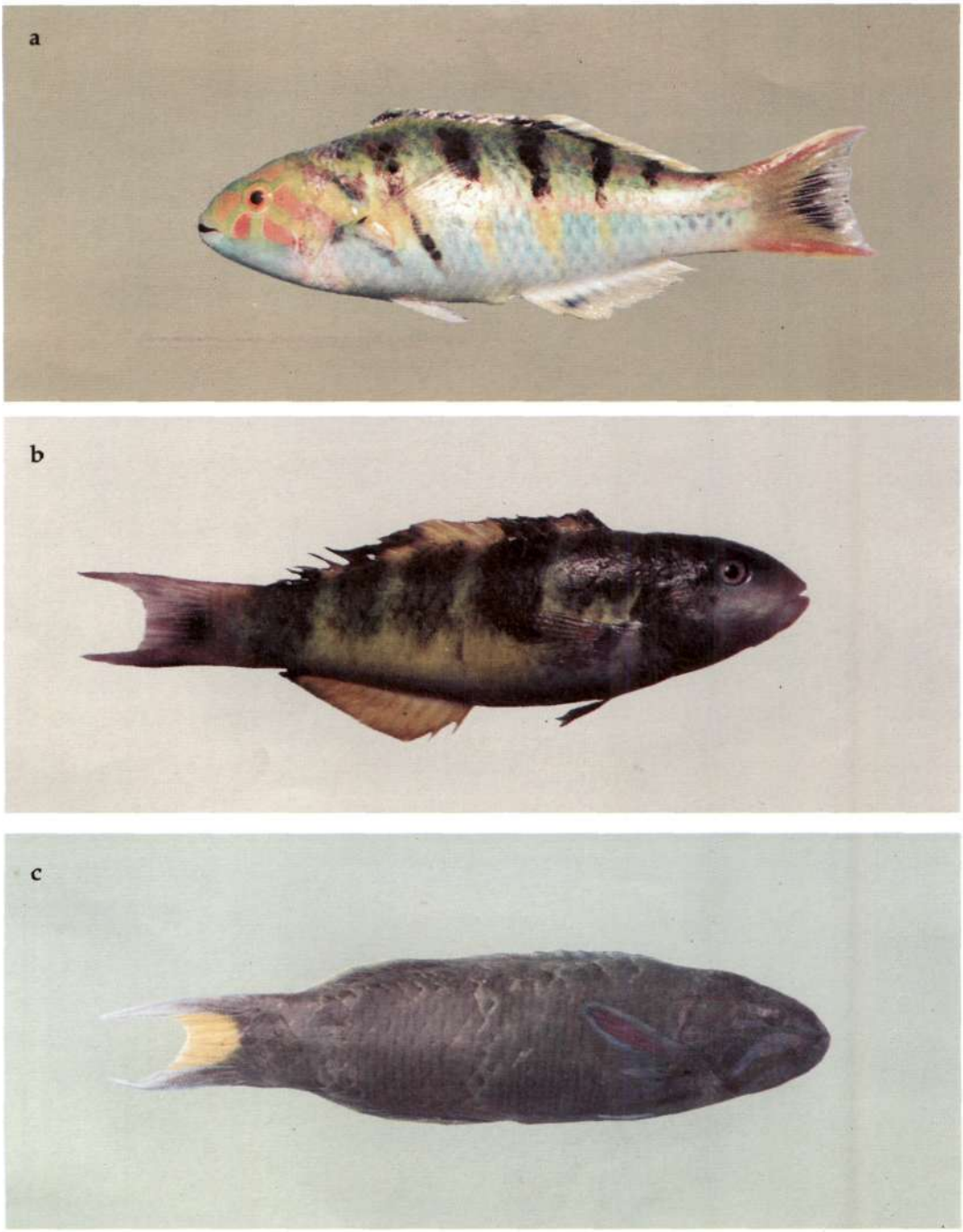


Plate 29 a. Six bar wrasse-*Thalassoma hardwicki*
b. Jansen wrasse-*Thalassoma janseni*
c. Crescent wrasse-*Thalassoma lunare*

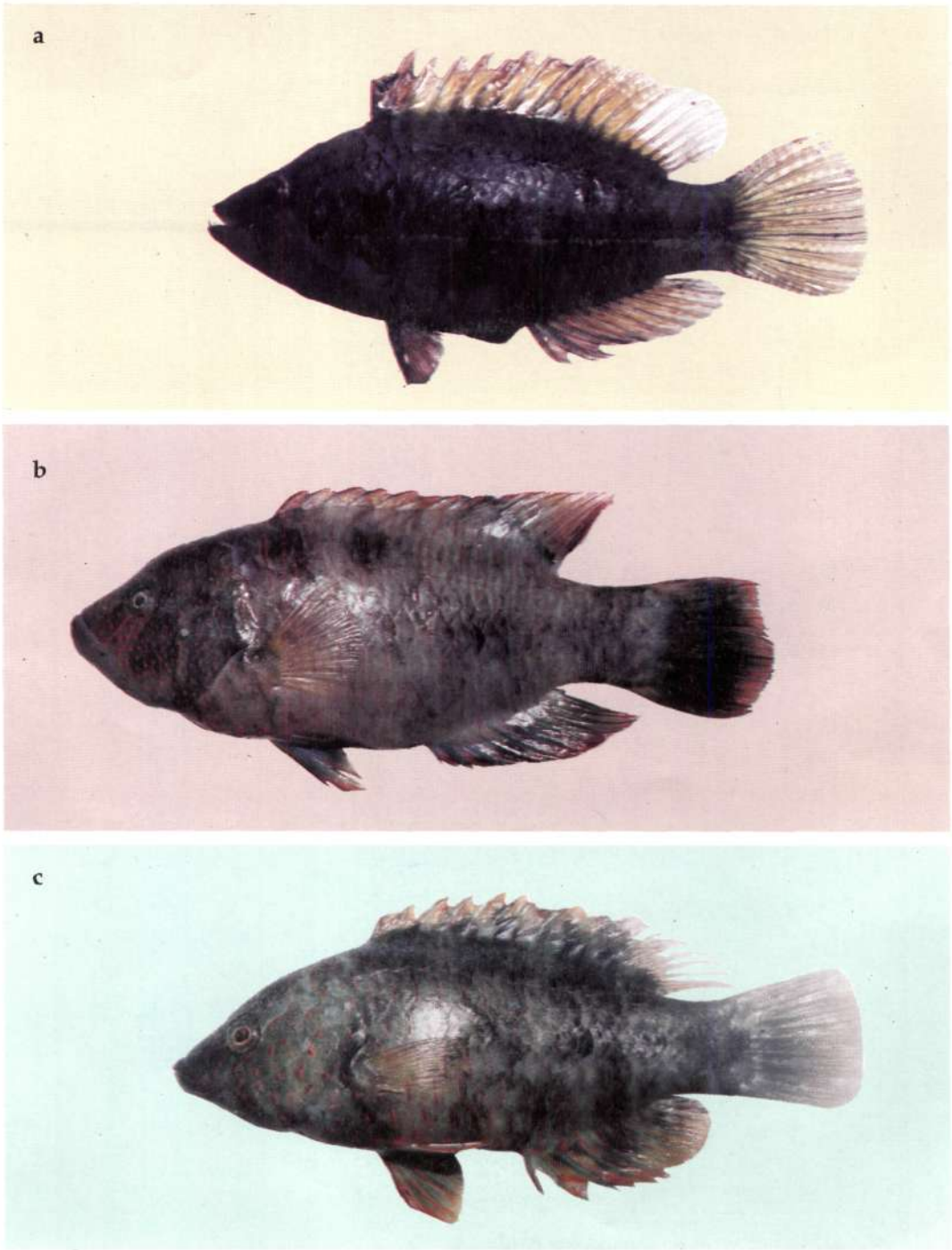


Plate 30 a. Snooty wrasse-*Cheilinus oxycephalus*
b & c. Triple tail wrasse-*Cheilinus trilobatus*

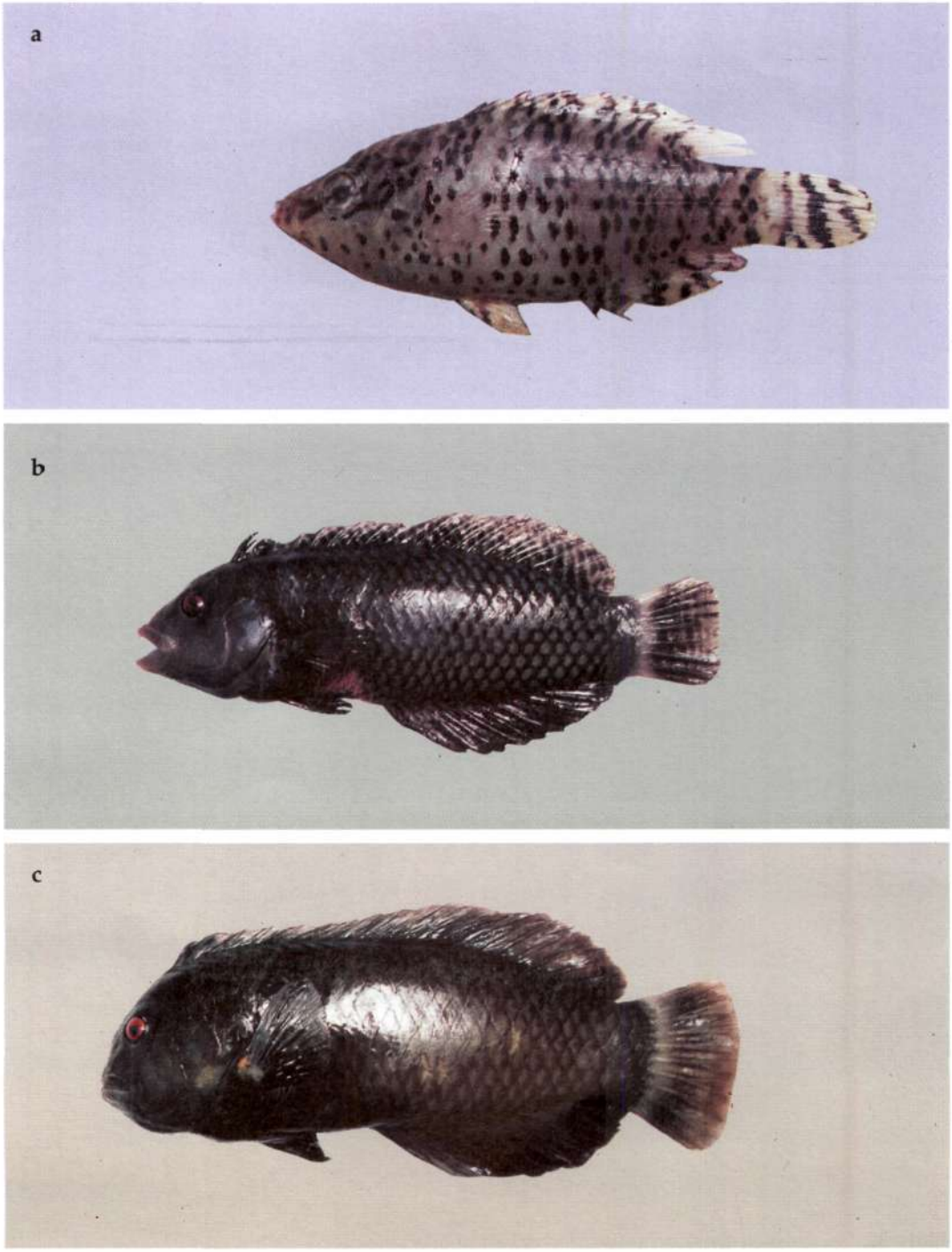


Plate 31 a. Humphead wrasse- *Cheilinus undulatus*
b & c. Rock mover wrasse- *Novaculichthys taeniourus*

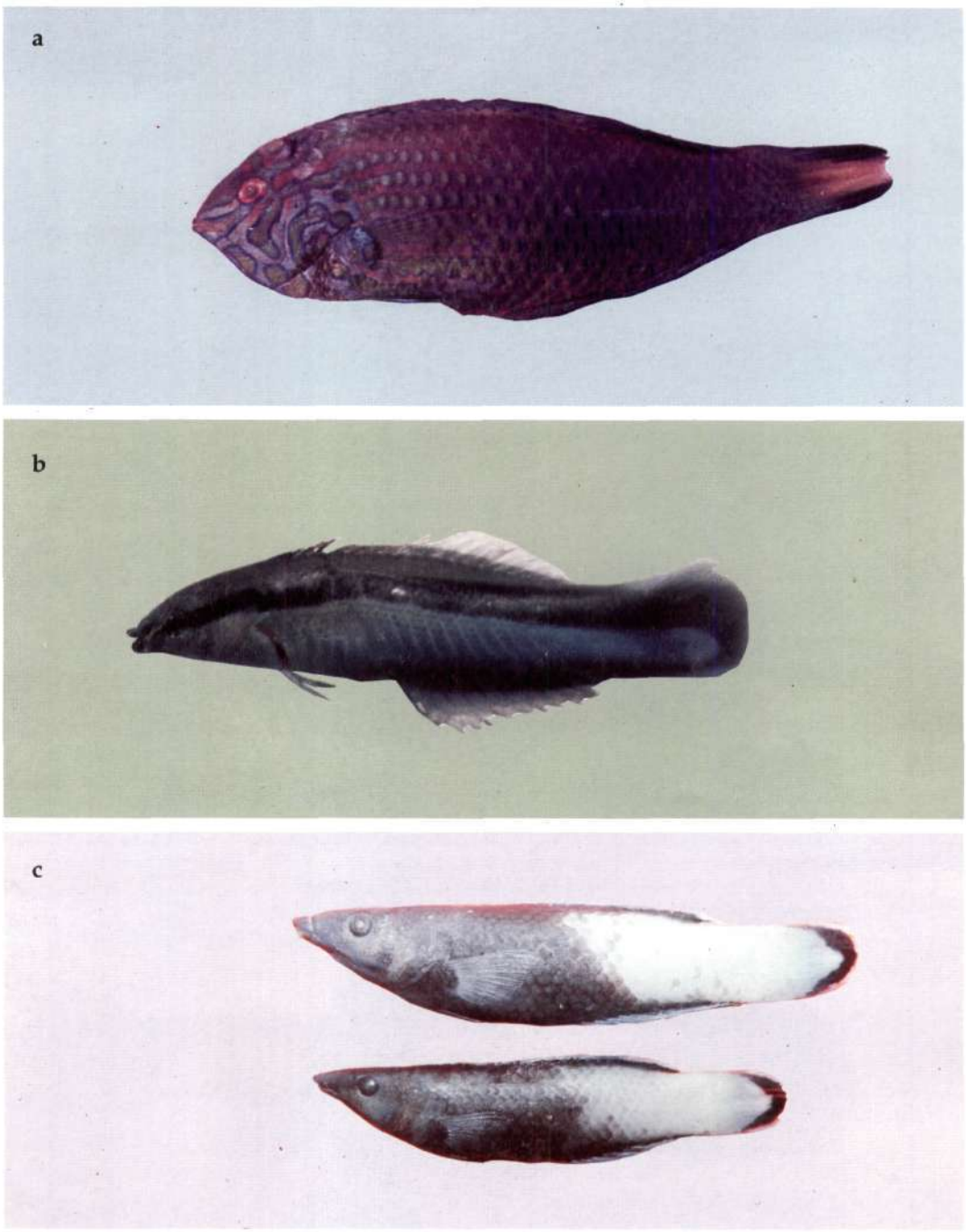


Plate 32 a. Guinea-fowl wrasse- *Macropharyngodon meleagris*
b. Blue streak cleaner wrasses-*Labroides dimidiatus*
c. Bicoloured cleaner wrasse- *Labroides bicolor*

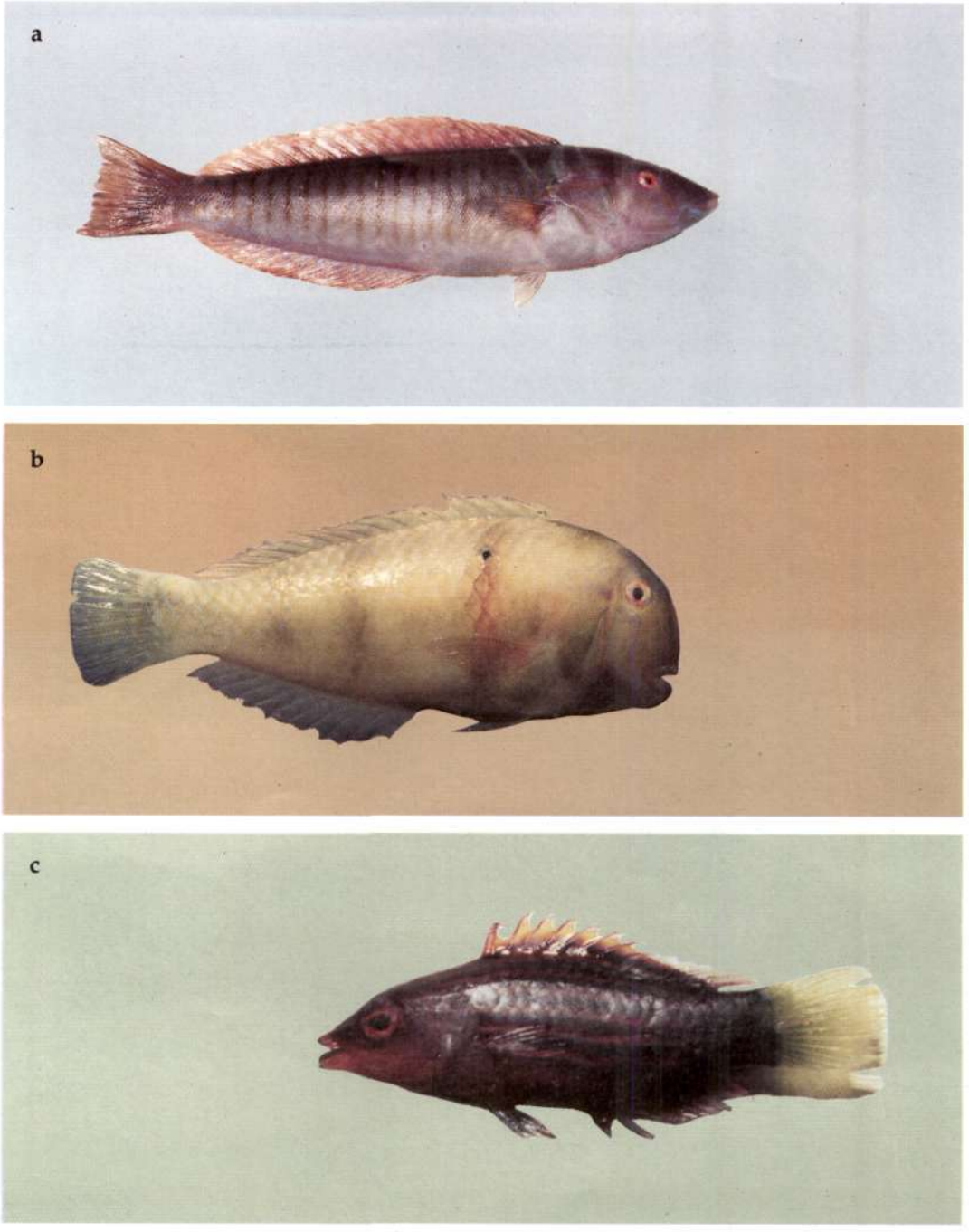


Plate 33 a. Ringed wrasse- *Hologymnosus semidiscus*
b. Peacock wrasse-*Xyrichtys pavo*
c. Six stripe wrasse-*Pseudocheilinus hexataenia*

a

b

Plate 34 a. Queen coris-*Coris formosa*
b. Gaimard Coris- *Coris gaimardi*

in the order of abundance are *Halichoeres scapularis* (28.3%), *H. hortulanus* (26.5%), *S. albovittata* (8.1%), *S. trilineata* (5.5%), and *H. marginatus* (5.2%).

In Chetlat, 14 species were collected of which *Halichoeres scapularis* is most dominant forming 38% of the catch of wrasses followed by *H. hortulanus* (18.7%), *S. albovittata* (12.5%), *Thalassoma hardwicki* (8.8%), *H. marginatus* (6%) and others.

In Kadmat, *H. hortulanus* is the most dominant species, forming 31.4% of the catch of wrasses in the island followed by *H. scapularis* (25.7%), *H. marginatus* (5.9%), *S. albovittata* (5.7%) *Novaculichthys taeniourus* (4.6%), *T. hardwicki* (4.2%) and others. The above six species account for 77.5% of the labrid catch in the island.

Of the 17 species caught in Kalpeni, *H. scapularis* is the most abundant species forming 38.6% of the total catch of wrasses, followed by *S. albovittata* (22.4%), *H. hortulanus* (12.7%), *T. hardwicki* (7.6%) and others.

In Kavaratti, a total of 19 species were collected of which *H. hortulanus* is most abundant (37.8%), followed by *S. albovittata* (17.5%), *H. scapularis* (16.1%), *H. marginatus* (9.0%) and *T. hardwicki* (5.5%). The five species account for 86% of the total catch of wrasses in the island.

In Kiltan, *Halichoeres hortulanus* is most abundant forming 36% of the wrass catch in the island followed by *S. albovittata* (23.4%), *H. scapularis* (18.8%) and *H. marginatus* (5.1%). These four species constitute 83% of the catch of 19 species in the island.

In Minicoy, of the 20 species caught, only five are most abundant together accounting for 88% of the total wrasses. They are *H. hortulanus* (25.5%), *H. scapularis* (21.5%), *H. marginatus* (18.1%), *T. hardwicki* (14.2%) and *S. albovittata* (8.9%).

In all the islands together, *S. albovittata* constituted 38% of the wrasses, followed by *H. scapularis* (18%), *H. hortulanus* (15%), *H. marginatus* (6%) and the remaining 28 species (23%) (Fig. 19). The wrasses are abundant numerically in October followed by May, January, November and other months. *H. hortulanus* is abundant in May, March and November, *H. marginatus* in May, October and November, *H. scapularis* in December, January and May, and *S. albovittata* in October and May and *T. hardwicki* in January, May and October.

Monocanthidae (Filefish) (Plate 35) : This family, represented by 7 species in the Lakshadweep, is a group of less common fishes in the lagoons. Two species are collected from the lagoons of only three islands: Kalpeni, Kavaratti and Kiltan (Fig. 20). Of the two species collected, *Oxymonocanthus longirostris* is the common and is one of the most beautiful ornamental fish. Kavaratti yielded maximum, in the catches (79%) taken from different islands followed by Kalpeni and Kiltan. These fishes are common in the lagoons in November and December.

Mugiloididae (Sandsmelt) (Plate 36) : This family is represented by two species in the Lakshadweep and these two species are represented in the present survey also (Table 4). They are common in all the islands. Maximum catches are taken in Minicoy and Agatti (21% each) followed by Chetlat (16%), Bitra (10%), Kalpeni, Kavaratti and Kiltan (8% each), and Kadmat and Amini (4% each) (Fig. 21). Peak abundance was observed during March-April, November and January.

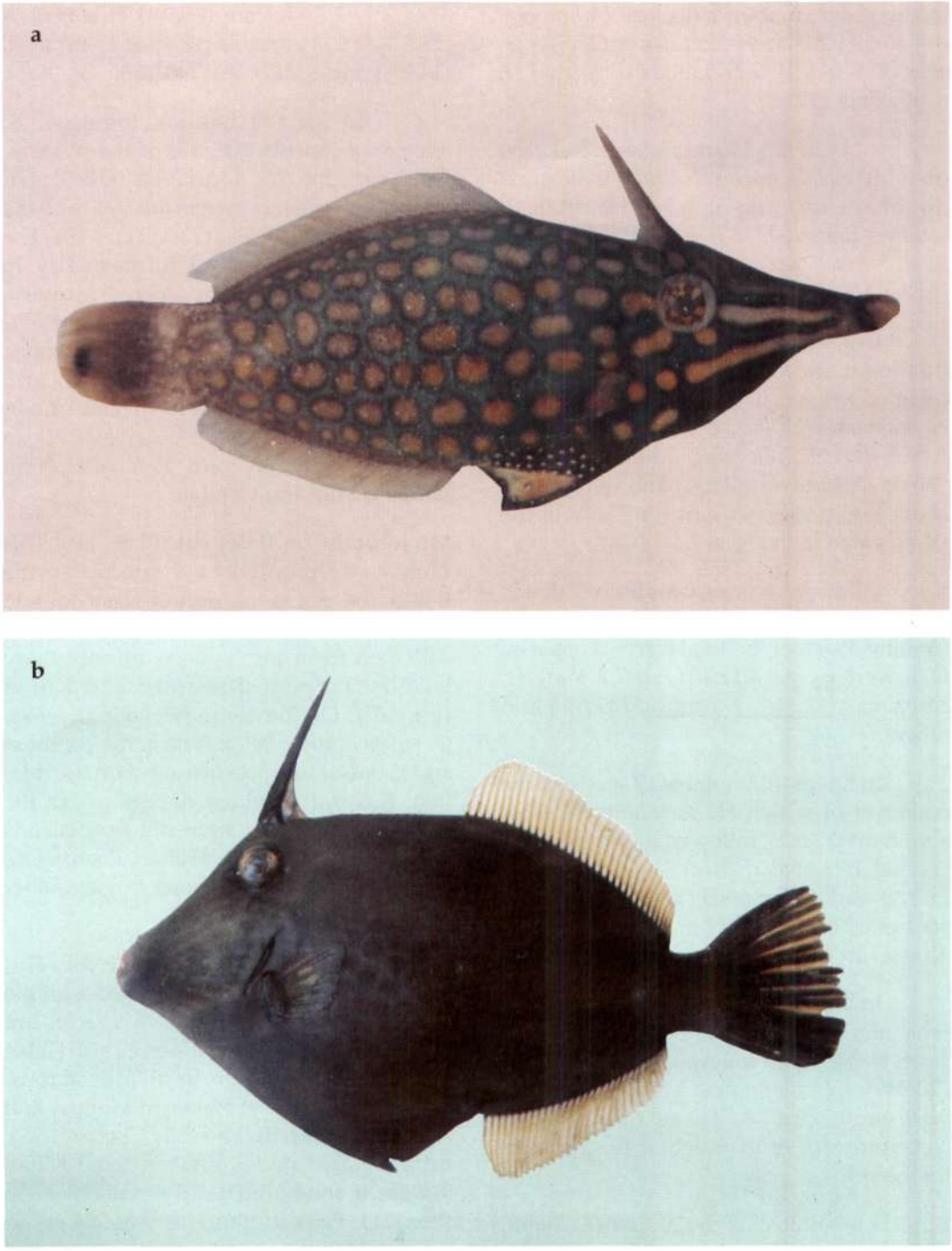


Plate 35 a. Harlequinn filefish-*Oxymonocanthus longirostris*
b. Filefish-*Amanses sandwichiensis*

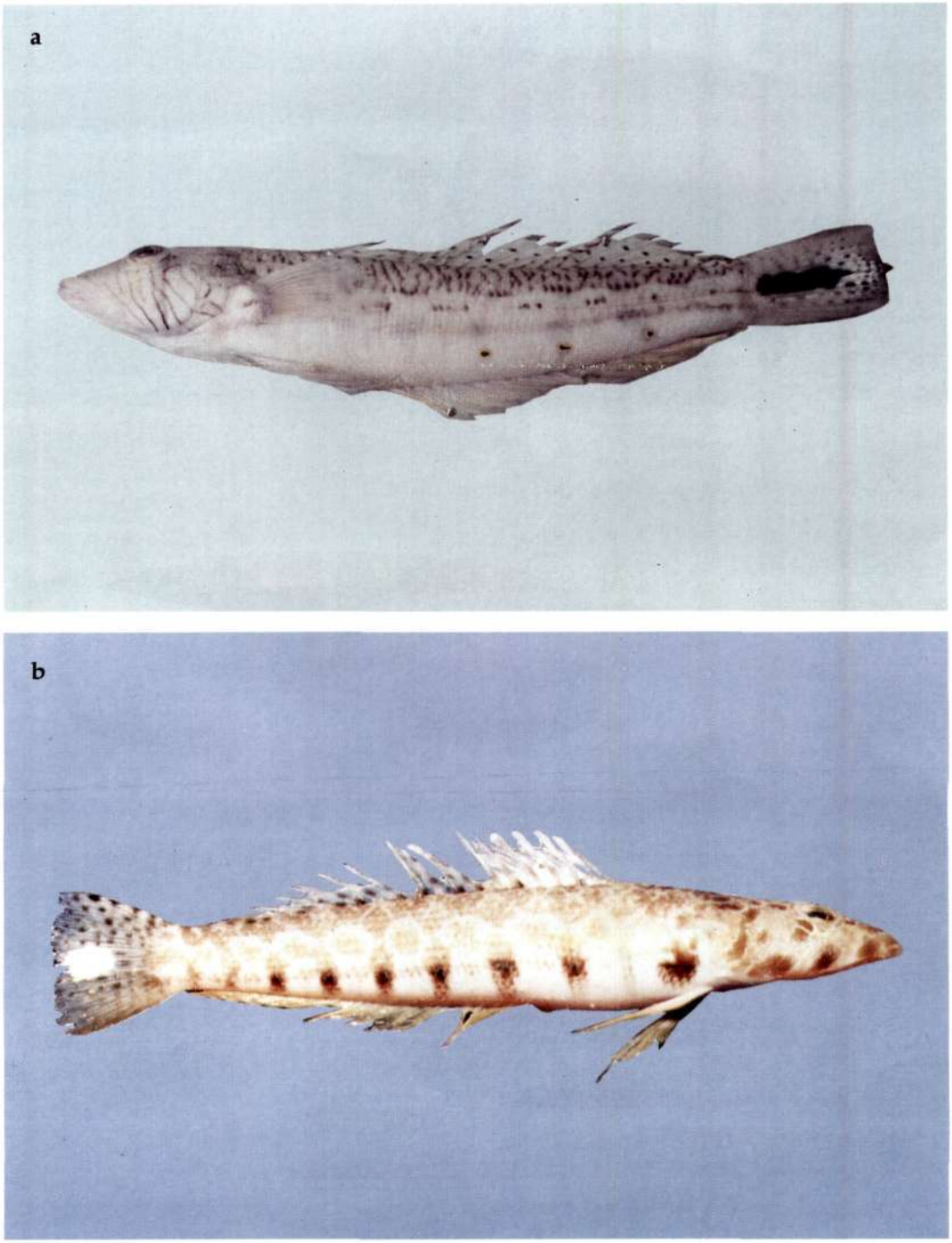


Plate 36 a. Black tail Sandsmelt-*Parapercis hexophthalma*
b. White bar weever-*Parapercis quadrispinosa*

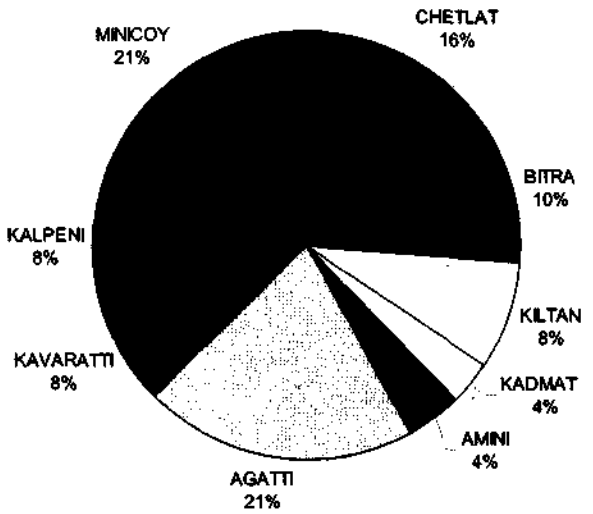


Figure 21. Relative abundance of Sandsmelts in different islands

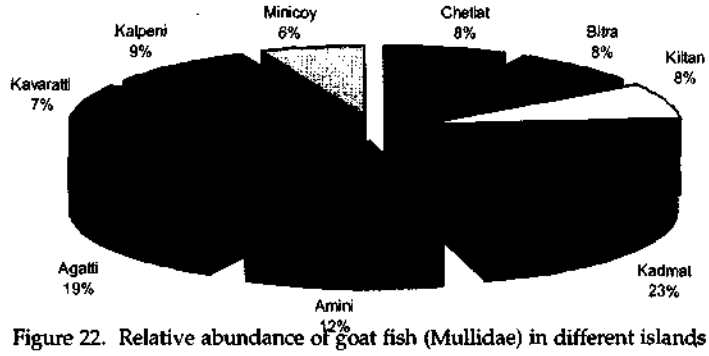


Figure 22. Relative abundance of goat fish (Mullidae) in different islands

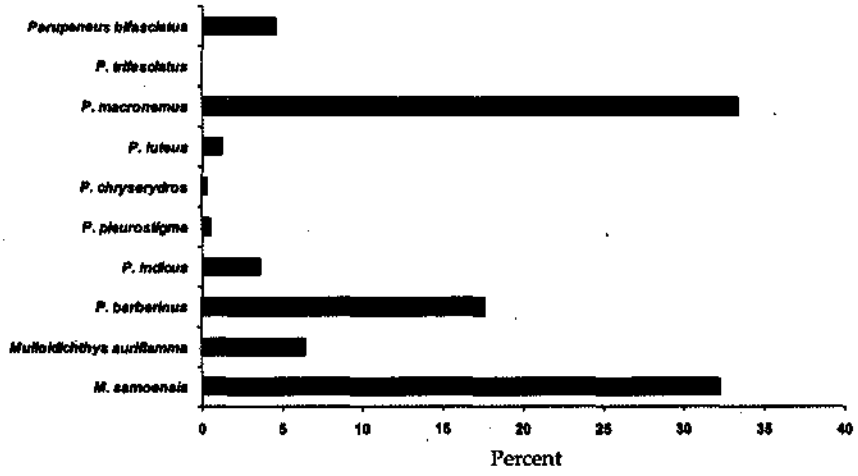


Figure. 23. Relative abundance of different species of goat fish (Mullidae) in the Lakshadweep islands

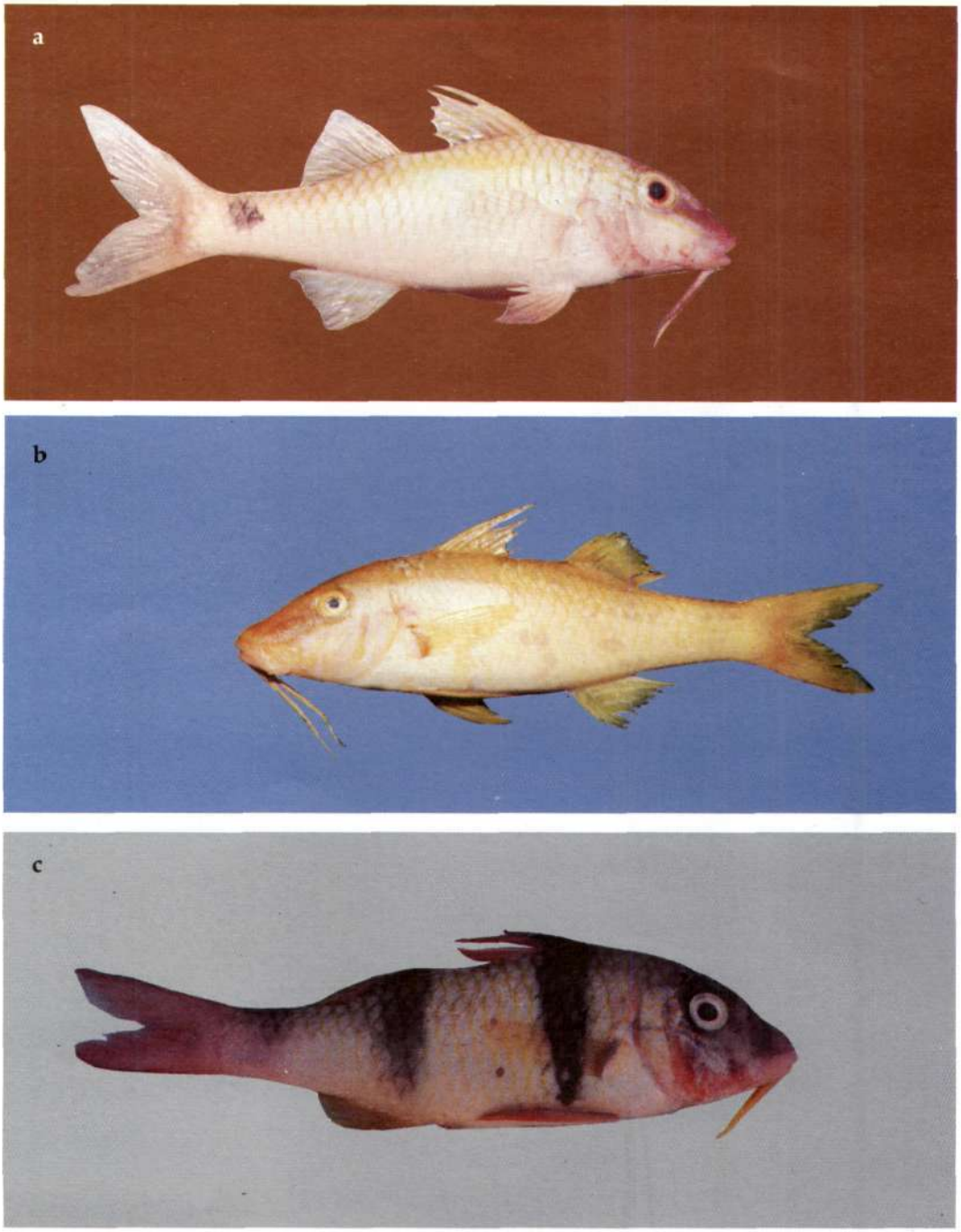


Plate 37 a. Indian goatfish-*Parupeneus indicus*
b. Yellow goatfish-*Parupeneus luteus*
c. Two saddle goatfish-*Parupeneus bifasciatus*

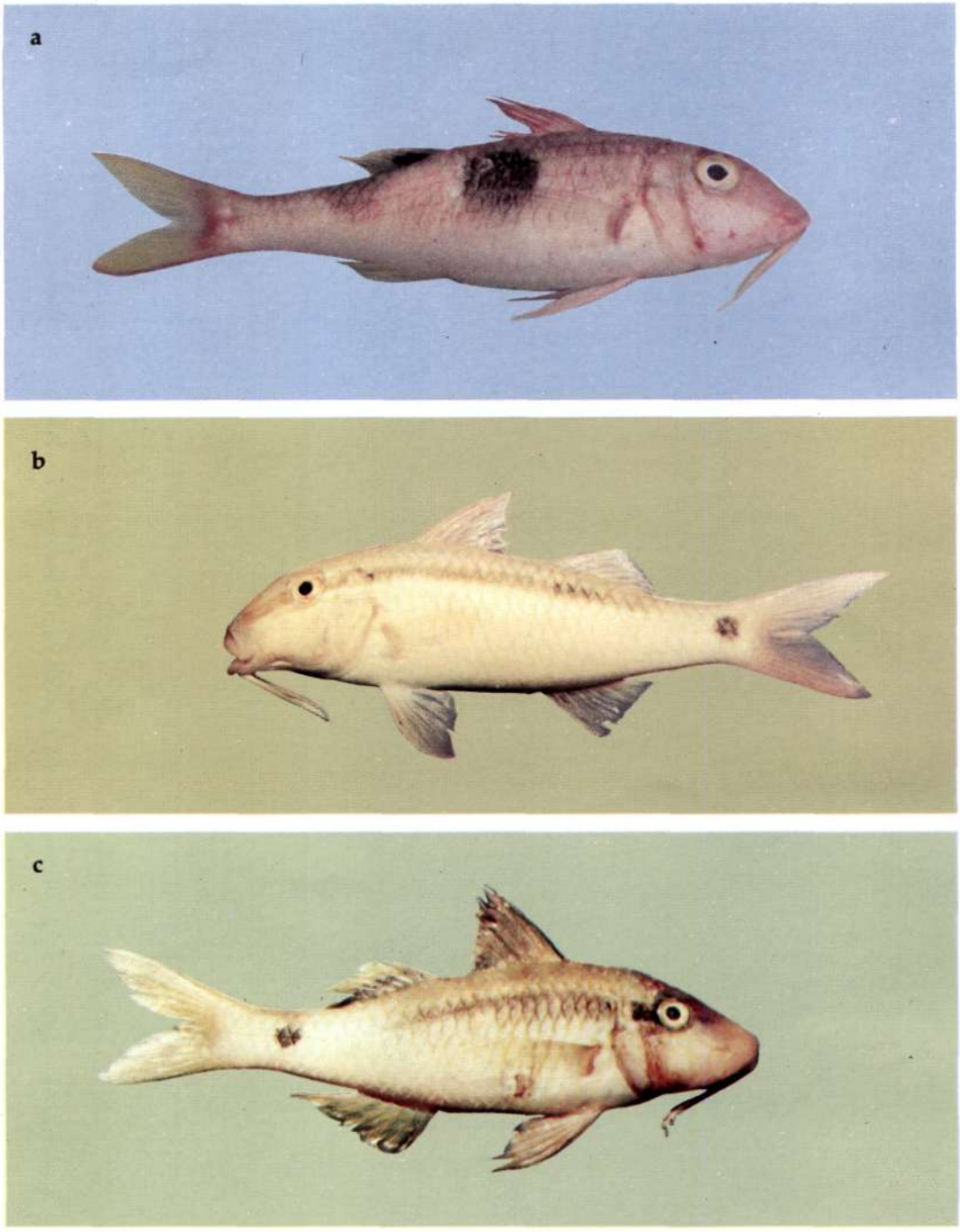


Plate 38 a. Black spot goatfish- *Parupeneus pleurostigma*
b. Dash-dot goatfish-*Parupeneus barberinus*
c. Band-dot goatfish-*Parupeneus macronema*

Mullidae (Goatfish) (Plates 37-39) : The goatfishes are abundant in all the islands but most abundant in Kadmat, which accounted for 23% of goatfish taken from different islands. Agatti is second important lagoon for these fishes, accounting for 19% of the catch followed by Amini (12%), Kalpeni (9%), Chetlat, Bitra and Kiltan (8% each), Kavaratti (7%) and Minicoy (6%) (Fig. 22). This family is represented by 14 species in the Lakshadweep and 10 species were collected in the present survey. Of them, *Parupeneus macronemus* is most dominant accounting for 33% of the goatfish catch taken in all the nine islands, followed by *Mulloidichthys samoensis* (33%), *Parupeneus barberinus* (18%), *M. auriflamma* (6%), *P. bifasciatus* (5%), *P. indicus* (4%) and others (Fig. 23).

Parupeneus macronemus is abundant in all the islands but most abundant in Bitra accounting for 61% of goatfish catch in this island. This species accounted for 48% of goatfish catch in Kalpeni 45%, in Amini and in other islands its contribution is 10 – 36%.

Mulloidichthys samoensis is most abundant in Kadmat forming 64% of goatfish catch in the island. In Chetlat, this species accounted for 55% of goatfish catch, in Minicoy 48%, and Kiltan 36%; in other islands its contribution was in the range of 3 – 28%. *Parupeneus barberinus* is abundant in all the islands but its contribution ranged from 5 to 15%.

Goatfish are abundant in all the months but maximum abundance was in May, October and March. *Mulloidichthys samoensis* was available in all the months but peak months are October, March, and December. Similarly, *P. barberinus* was abundant round the year but peak catches are taken during May. *P. macronemus* is also abundant in all the months with peak during May and October.

Ostraciontidae (Boxfish): (Plate 47a) This family is represented by four species in the Lakshadweep, of which only one species is represented in the collections of the present survey from only Agatti and Chetlat (Table 4). Maximum number was collected from Agatti (Fig. 24). These fishes occurred in the catches during January, May and November with maximum in May. *Ostracion cubicus* was the only species collected.

Pomacanthidae (Angelfish) (Plate 40) : This family is represented by two species in the islands and the two species were fished in the present survey. These fishes are among the preferred groups for aquarium keeping. Bitra Island accounted for maximum of 36% of the Angel fish caught in all the nine islands followed by Minicoy (18%), Kiltan (16%), Amini (9%), Agatti (7%), and the rest in Chetlat, Kadmat, Kavaratti and Kalpeni.

Of the two species, *Centropyge multispinis* is most abundant forming 90% of the angels caught and *Pomacanthodes imperator* formed the rest (10%). *C. multispinis* was taken from all the islands except Amini; it was the only species of angels in all the islands except Amini and Agatti. *P. imperator* was caught in Amini and Agatti; it was the only angel species in Amini and accounted for 9% of angel fish catch in Agatti (Fig. 25). These fishes were available almost round the year, but peak period of abundance is April.

Pomacentridae (Damselfish) (Plates 41-46): This family is represented by 35 species in the Lakshadweep of which 26 species were collected in the present survey. This family is most abundant in the lagoons in terms of number of species as well as numerical abundance occupying second position next to wrasses. The damselfish live in the crevices and interstices of corals in large numbers and exhibit territorial behavior.

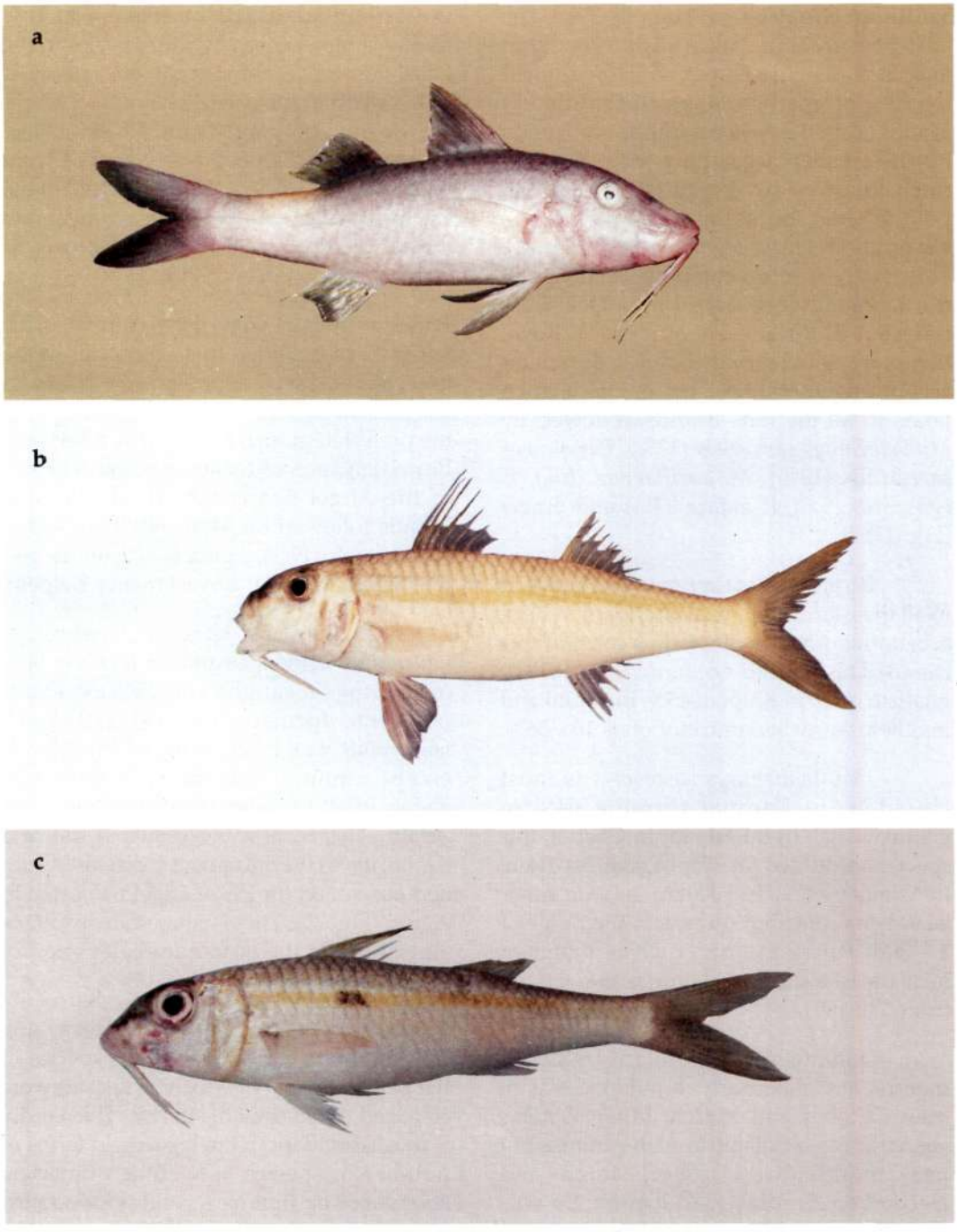


Plate 39 a. Gold saddle goatfish- *Parupeneus chryserydros*
b. Flame goatfish-*Mulloidichthys auriflamma*
c. Yellow stripe goatfish-*Mulloidichthys samoensis*

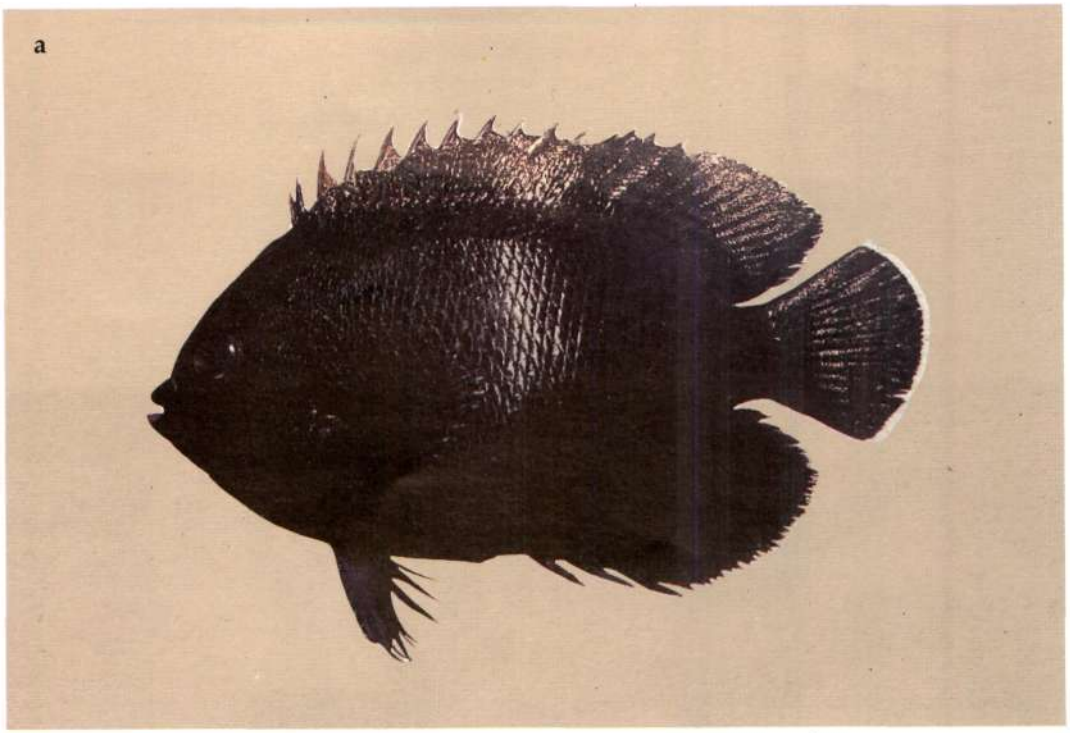


Plate 40 a & b. Dusky cherub-*Centropyge multispinis*

Plate 41 Zebra humbug-*Dascyllus aruanus*

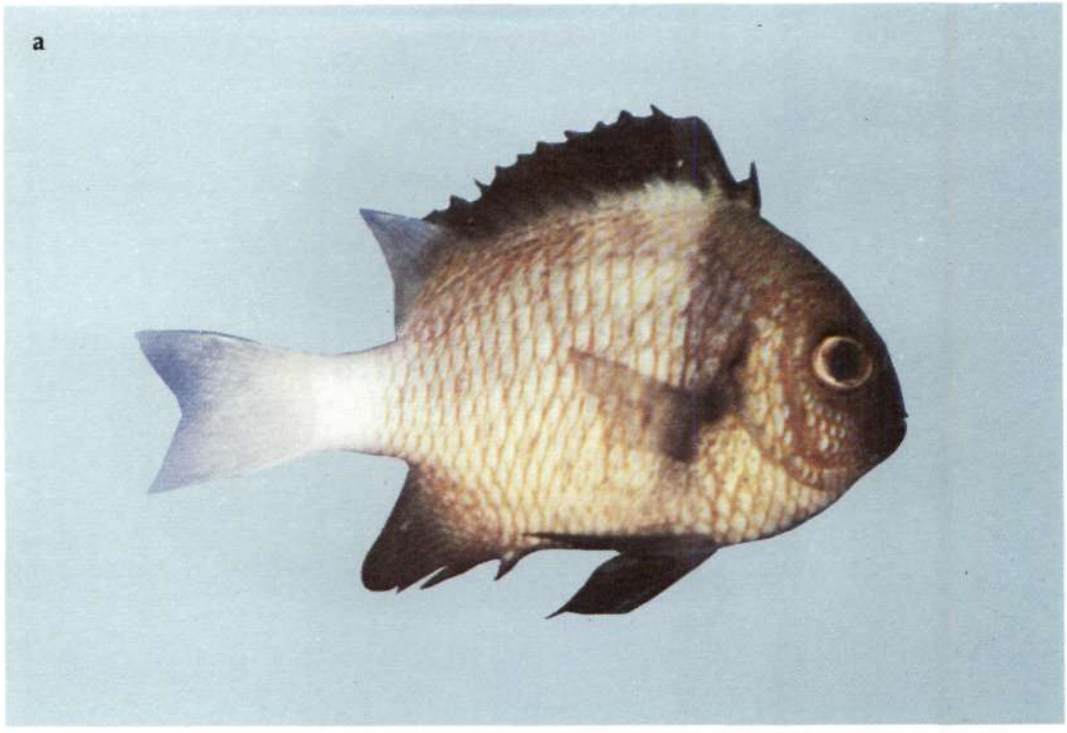


Plate 42 a & b. Twobar humbug-*Dascyllus reticulatus*

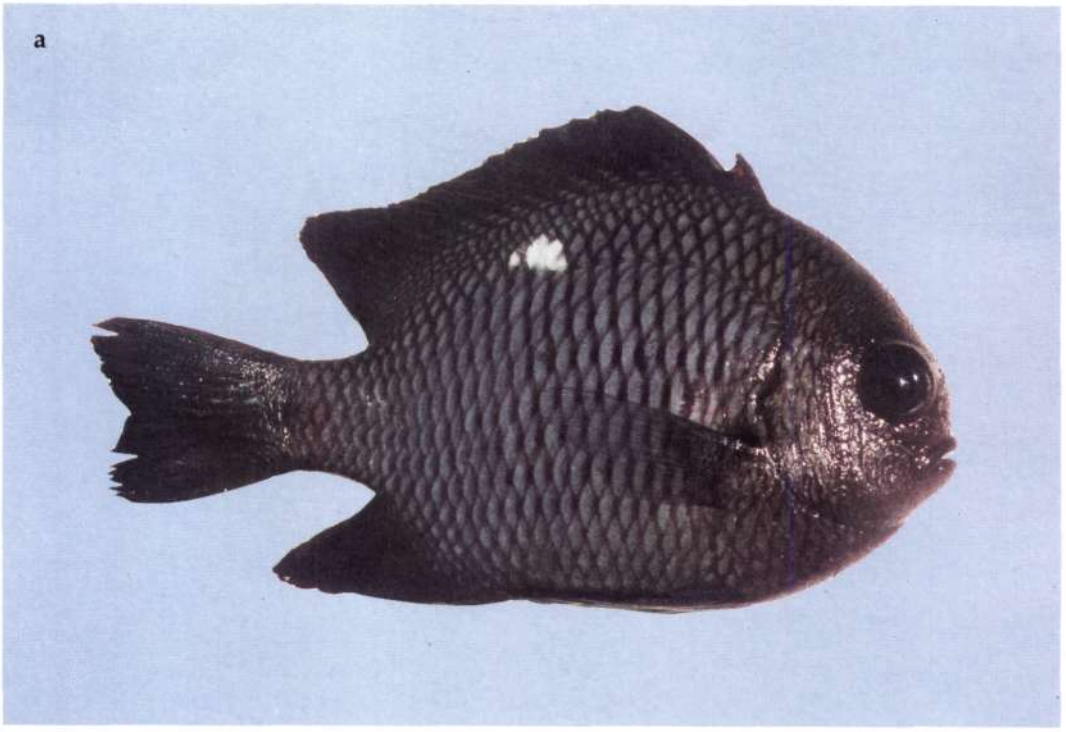


Plate 43 a & b. Domino-*Dascyllus trimaculatus*

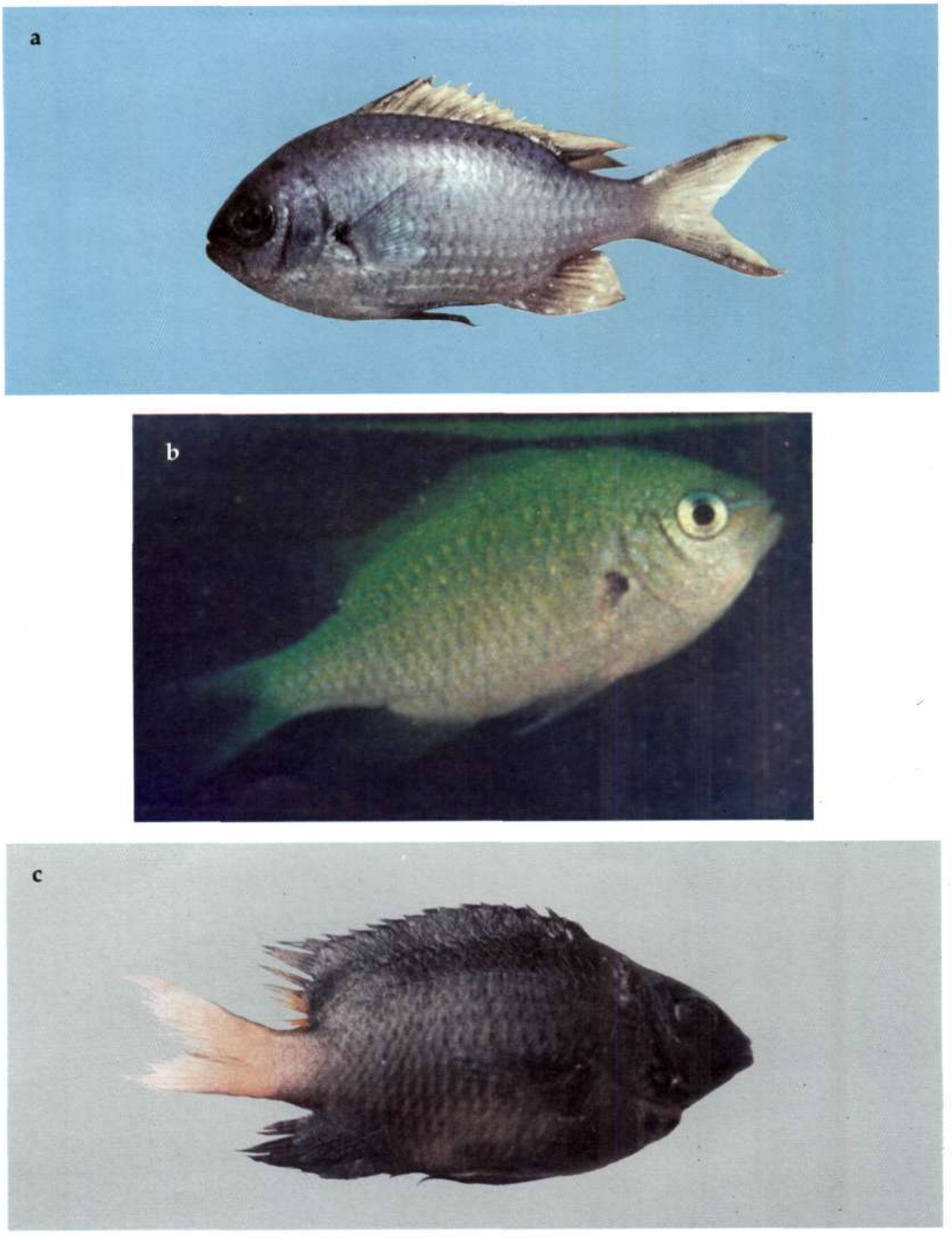


Plate 44 a & b. Blue puller-*Chromis caeruleus*
c. Jewel damsel-*Pomacentrus lacrymatus*

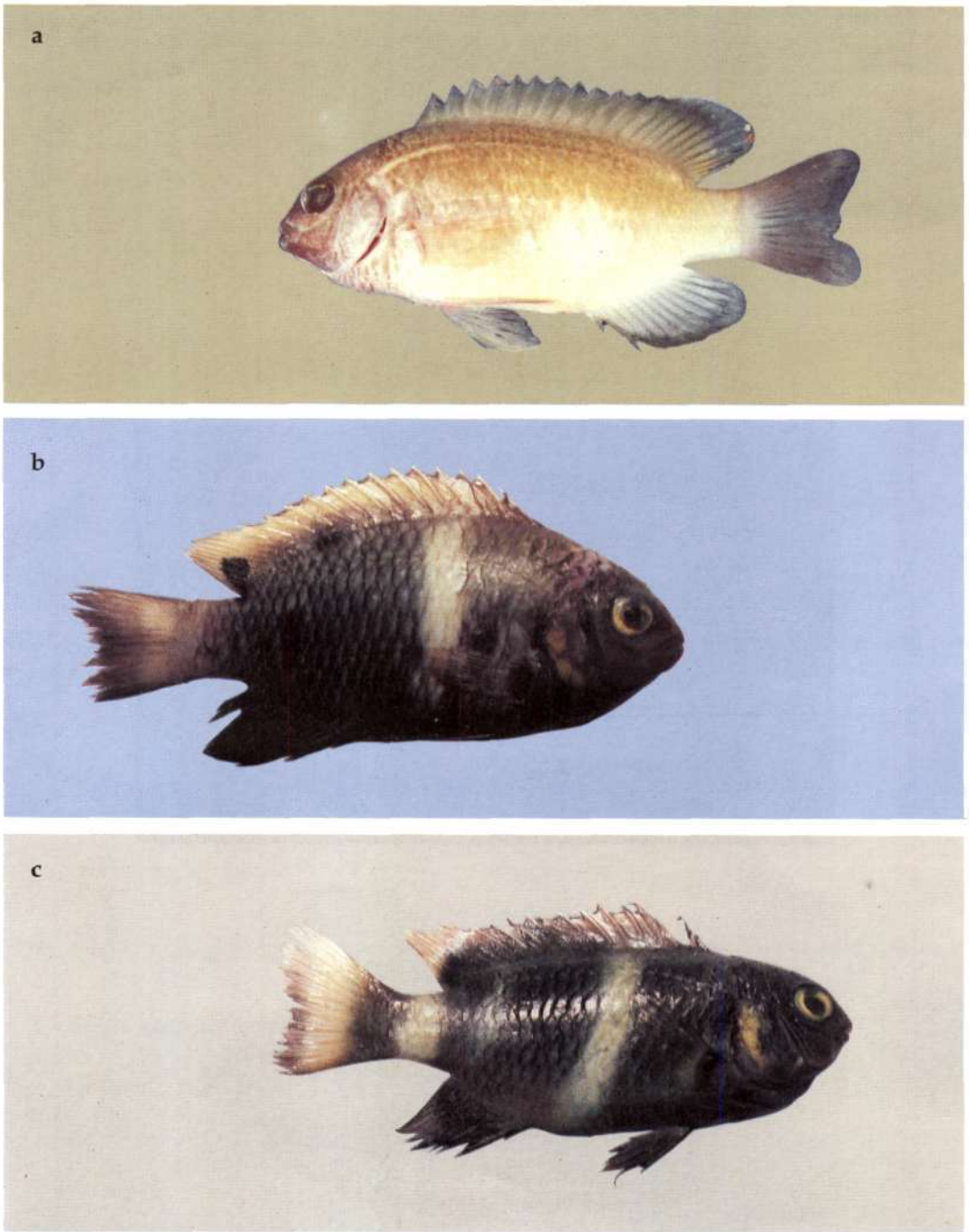


Plate 45 a. Damselfish-*Abudefduf glaucus*
b. Two-spot damsel-*Abudefduf zonatus*
c. *Abudefduf xanthozona*

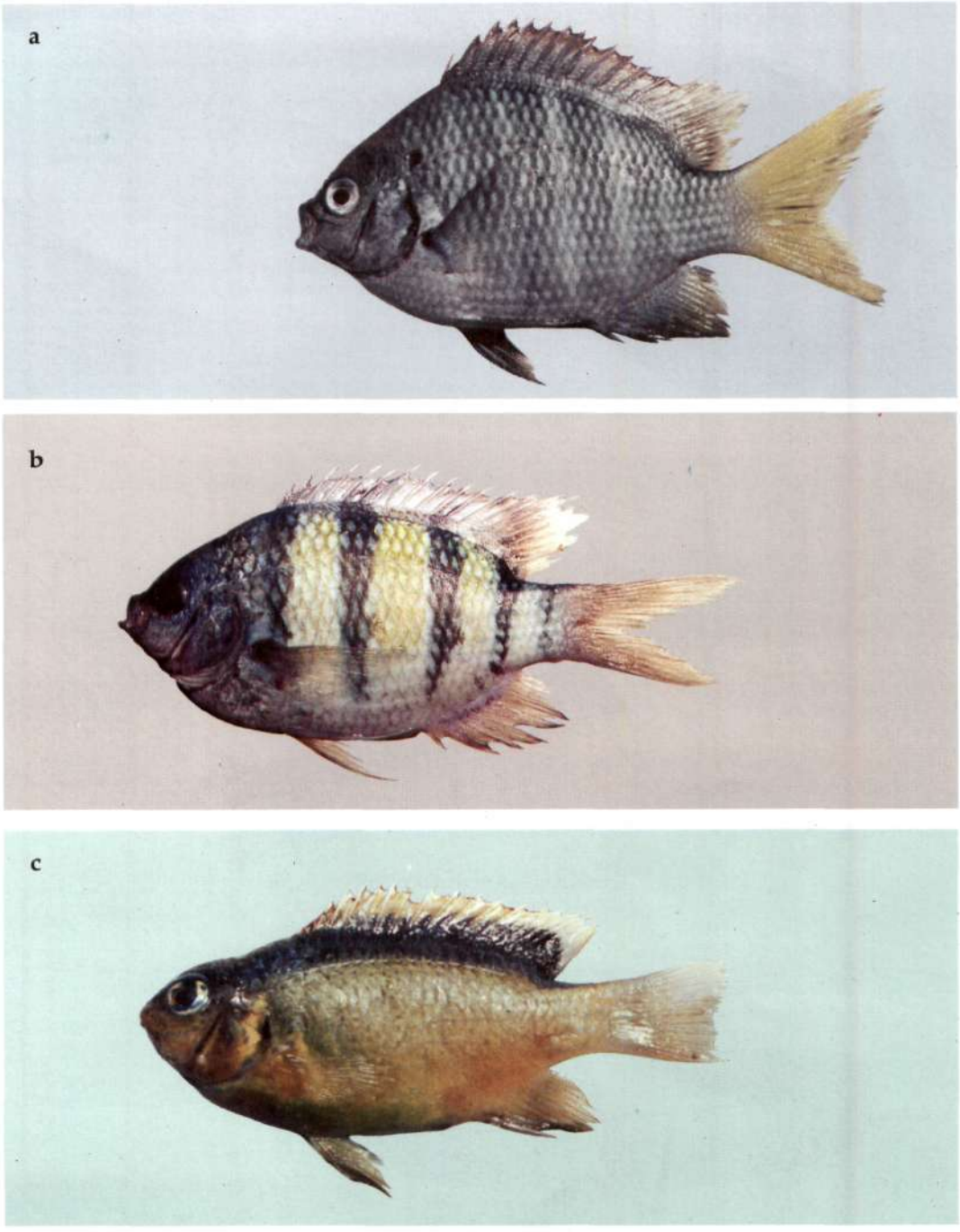


Plate 46 a. Dusky damsel-*Abudefduf notatus*
b. South seas sergeant major-*Abudefduf vaigiensis*
c. Onespot damsel-*Chrysiptera unimaculata*

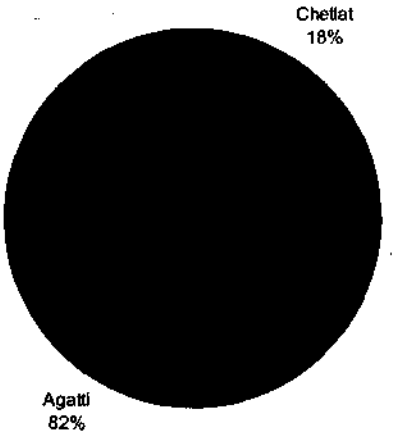


Figure 24. Relative abundance of *Ostracion cubicus* in Lakshadweep islands

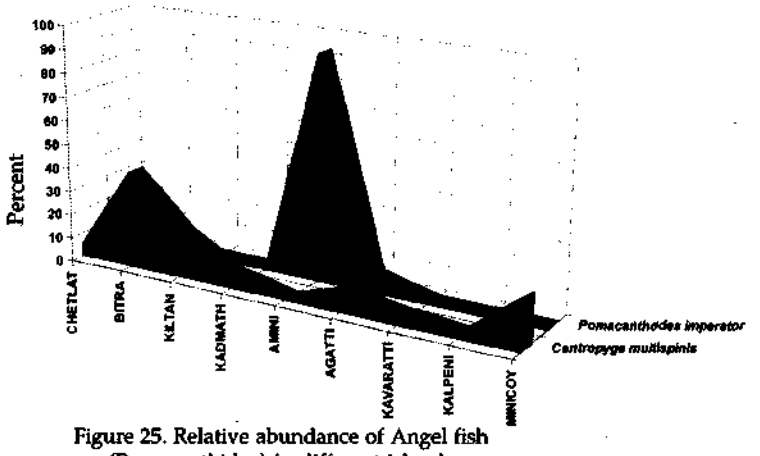


Figure 25. Relative abundance of Angel fish (Pomacanthidae) in different islands

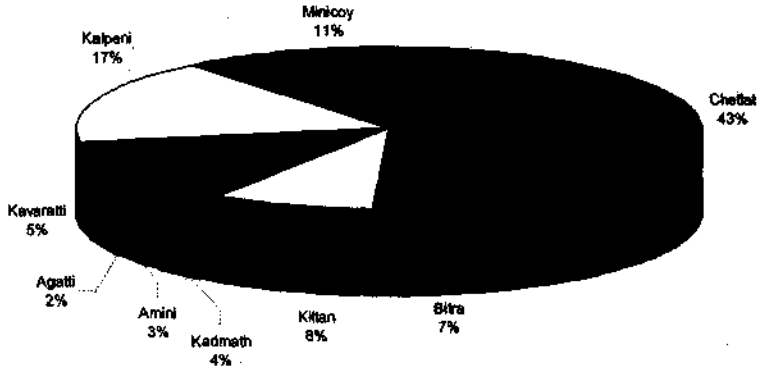


Figure 26. Releative abundance of Damsel fish (Pomacentridae) in different Lakshadweep islands

Generally there is species-wise grouping in different corals.

Among the nine islands covered in the present survey, Chetlat is the richest in regard to abundance of damselfish accounting for 43% of these fishes caught in the nine islands (Fig. 26). The next island of importance is Kalpeni which accounted for 17% of damselfish caught, followed by Minicoy (11%), Kiltan (8%), Bitra (7%), Kavaratti (5%), Kadmat (4%), Amini (3%) and Agatti (2%) (Fig. 26).

Of the 26 species collected in the present survey, *Chromis caeruleus* and *Dascyllus aruanus* are the most abundant together accounting for 68% of the damselfish caught in all the islands. These two species inhabit close by and sometimes together in the same coral. *Abudefduf vaigiensis* is next in abundance accounting for 8.3% of the damselfish caught followed by *A. biocellatus* (4.8%), *A. lacrymatus* (2.5%), *A. glaucus* (2.4%), *A. zonatus* (2.3%), *Chromis chrysurus* (2.2%) and other 18 species (9.5%) (Fig. 27).

In the Amini island, 6 species occurred in the catches and *Chromis caeruleus* was the most dominant species accounting for 45% of pomacentrid catch in the island, followed by *Abudefduf biocellatus* (27%), *A. zonatus* (13%), *A. vaigiensis* (10%), *Dascyllus aruanus* (3%) and *D. reticulatus* (2%).

In the Agatti Island, 14 species occurred in the catches of which *Abudefduf vaigiensis* was the most dominant species accounting for 64% of the damselfish catch in the island. Among the remaining 13 species, *Dascyllus reticulatus, D. aruanus, D. trimaculatus, Pomacentrus albifasciatus, Abudefduf lacrymatus* and *A. glaucus* together accounted for over 30% of the damselfish catch.

In Bitra, a total of 11 species occurred in the catches, of which *Dascyllus aruanus* was the most abundant species accounting for 53% of the pomacentrid catch (numbers) in this island. *Abudefduf vaigiensis* was the next dominant species, which formed 9.4% of the damselfish catch followed by *Dascyllus trimaculatus* (8.4%), *Abudefduf lacrymatus* (7.9%), *Chromis caeruleus* (7.5%), *A. glaucus* (3.5%), *A. nigrepes* (3.2%) and the other four species (6.1%).

In Chetlat also, eleven species contributed to the catches, but *Chromis caeruleus* was the most dominant species forming 69% of the damselfish catch in the island followed by *Abudefduf biocellatus* (10.6%), *A. glaucus* (6.4%), *A. zonatus* (3.9%) and the other 7 species (10%)

The damselfishes are represented by 18 species in the Kadmat Island. *Dascyllus aruanus* was the most abundant species accounting for 36% of the damselfish catch in the island followed by *Chromis caeruleus* (23%), *C. chrysurus* (17%), *Abudefduf glaucus* (4%), *Pomacentrus littoralis* (4%), *P. albicaudatus* (3%), *A. biocellatus* (3%) and the other 11 species (10%).

In Kalpeni, 16 species of damsel fishes occurred in the catches, of which *Dascyllus aruanus* formed 48% of the catch of the group followed by *Chromis caeruleus* (34%), *Abudefduf zonatus* (3%), *D. reticulatus* (3%), *D. trimaculatus* (3%) and the other 11 species (9%)

In Kavaratti, 16 species contributed to the catches. *Abudefduf vaigiensis* was the most dominant species accounting for 48% of the damselfish catch followed by *Chromis caeruleus* (33%), *Abudefduf lacrymatus* (6%), *Pomacentrus melanopterus* (5%) and the remaining 12 species (8%).

In Kiltan, a total of 13 species

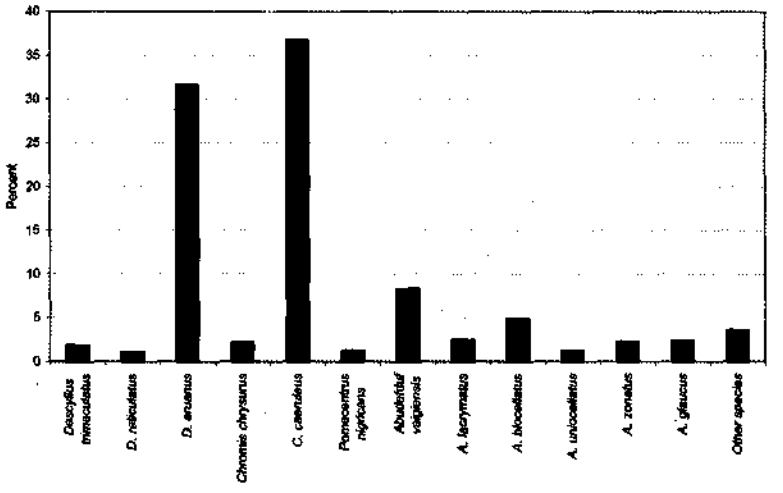


Figure 27 Relative abundance of major species of Pomacentridae in the Lakshadweep

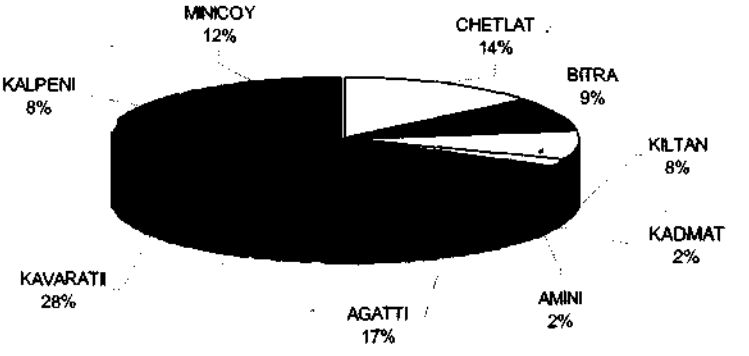


Figure 28. Relative abundance of parrot fish (Scaridae) in Lakshadweep islands

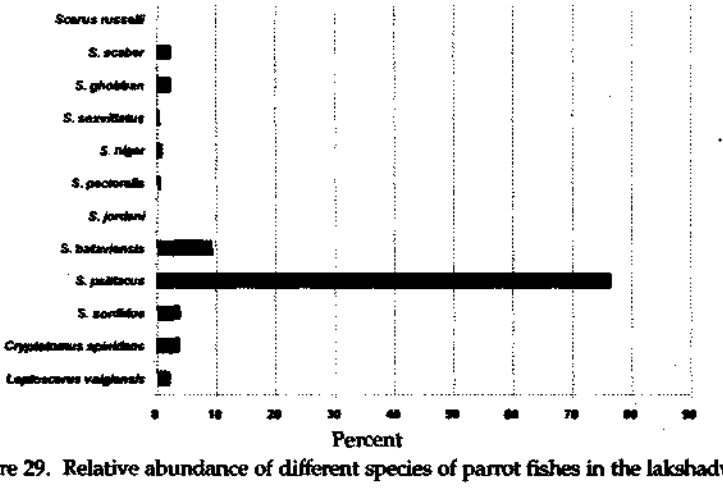


Figure 29. Relative abundance of different species of parrot fishes in the lakshadweep islands

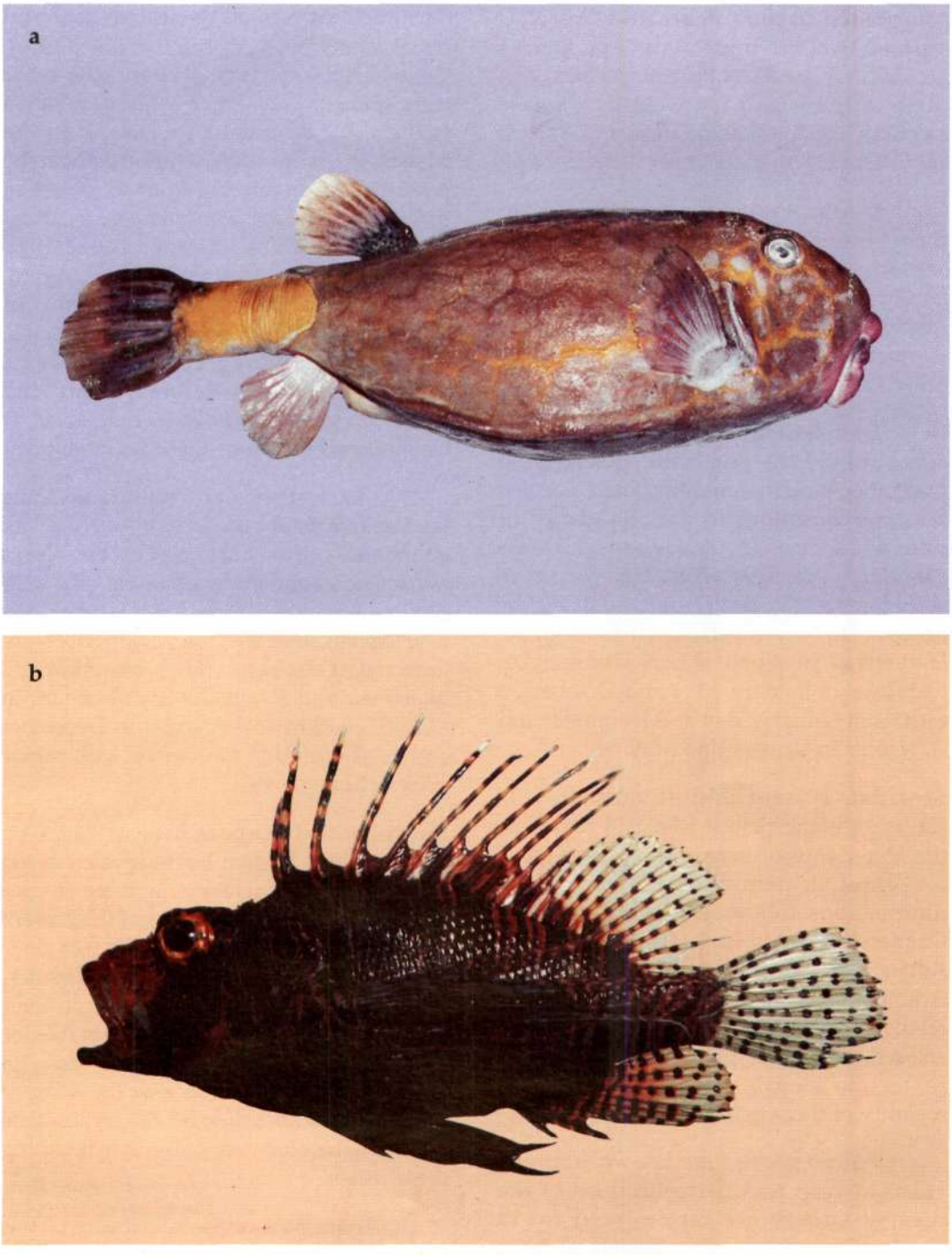


Plate 47 a. Box fish-*Ostracion cubicus*
b. Zebra lion fish-*Dendrochirus zebra*

contributed to the catches and *Dascyllus aruanus* was the most abundant species accounting for 62% of the pomacentrid fish catch in the island followed by *Chromis caeruleus* (20%), *Abudefduf vaigiensis* (8%), *A. xanthozona* (3%) and the other 9 species (7%).

In Minicoy, 18 species were caught in the present survey of which *Chromis caeruleus* formed 50% of the catch of the family, followed by *Dascyllus aruanus* (22%), *Abudefduf biocellatus* (6%), *A. lacrymatus* (6%), *A. vaigiensis* (4%), *A. glaucus* (3%) and the other 12 species (9%).

Damselfish occur in the lagoons almost round the year with peaks during December, January and May. There are also seasonal variations in the abundance of different species in the lagoons. *Chromis caeruleus* and *Dascyllus aruanus* were abundant in May and December, *Abudefduf vaigiensis* in November, March and May, *A. lacrymatus* in April and November, *A. biocellatus* in January, May and October, *A. zonatus* in January, May and December and *A. glaucus* in January and May.

Scaridae (Parrotfish) (Plates 48-51): Kavaratti is the richest island in regard to the abundance of parrotfishes, accounting for 28% of the parrotfish catch from all the nine islands followed by Agatti (17%), Chetlat (14%), Minicoy (12%), Bitra (9%), Kiltan (8%), Kalpeni (8%), Kadmat (2%) and Amini (2%) (Fig. 28). The parrotfishes attain relatively larger lengths and are variously colored, the colour pattern being different in certain length groups and sexes in majority of the species.

Fifteen species are known from the Lakshadweep and the collections of the present survey are represented by 12 species. Of these species collected from the nine islands, *Scarus psittacus* is the most dominant species accounting for 76% of the parrotfish catch in all the islands followed by *S. bataviensis* (9%), *S. sordidus* (4%), *Cryptotomus spinidens* (4%) and the other eight species (7%) (Fig. 29). *Scarus psittacus* is the most dominant species in all the islands, the proportion of this species in the parrotfish catch ranging from 45 to 99% in different islands. This species is most dominant in Bitra followed by Chetlat, Kavaratti, Kiltan, Minicoy, Kalpeni, Agatti, Kadmat and Amini in the order of abundance. Among the other species, *Cryptotomus spinidens* is abundant in Amini, *Scarus bataviensis* in Kadmat, Agatti and Amini, *S. ghobban* in Kalpeni, *S. scaber* in Chetlat, *and Leptoscarus vaigiensis* in Minicoy.

Parrotfishes are abundant in the lagoons round the year with peak abundance during May and October. *Scarus psittacus* is abundant in all the months with peaks during May and October. In *Cryptotomus spinidens*, the peak periods are January, October and November. *S. bataviensis* and *S. sordidus* are abundant in May, S. *ghobban* and *S. scaber* in December and *L. vaigiensis* in December with minor peak in May.

Scorpaenidae (Scorpean fishes) (Plate 47b): This family is known by 14 species in the Lakshadweep, of which only three species are represented in the catches of the present survey. These fishes are known for their bright and most beautiful colours; besides, these fishes are slow and sluggish in their movements making them most suitable for aquarium. The fin spines are provided with poison glands and ducts and the sting of these fishes is known to be dangerous. One has to be, therefore, very careful in handling these fishes.

About 34% of the specimens of this family were collected from Kiltan, 25% from Bitra, 13% from Agatti, 11% from Kavaratti, 6% from Minicoy and 5% from Kadmat.

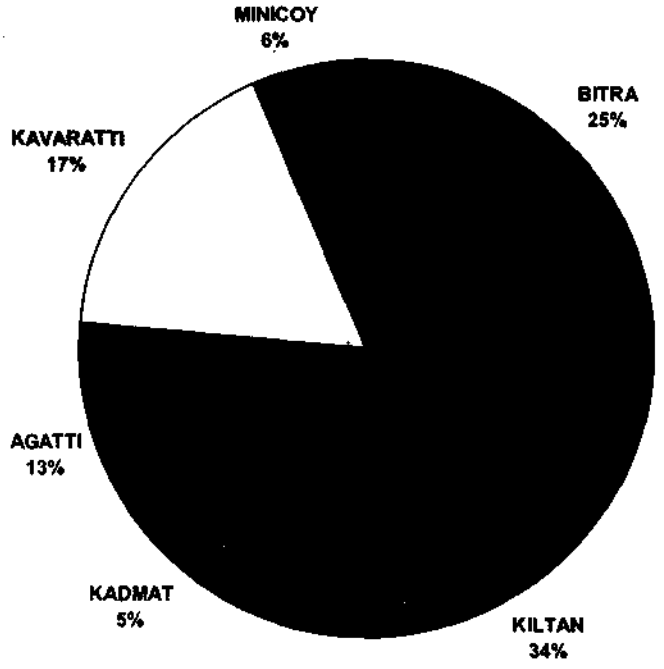


Figure 30. Relative abundance of Lion fish (Scorpaenidae) in Lakshadweep islands

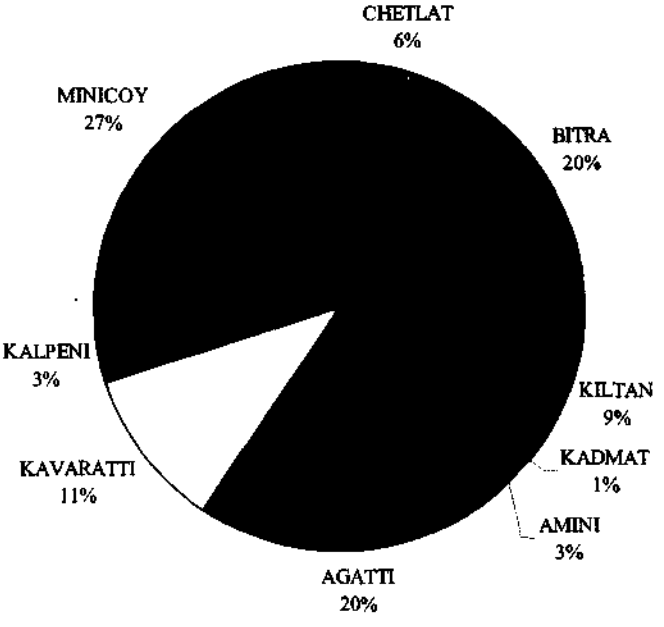


Figure 31. Relative abundance of Rock cods (Serranidae) in Lakshadweep islands

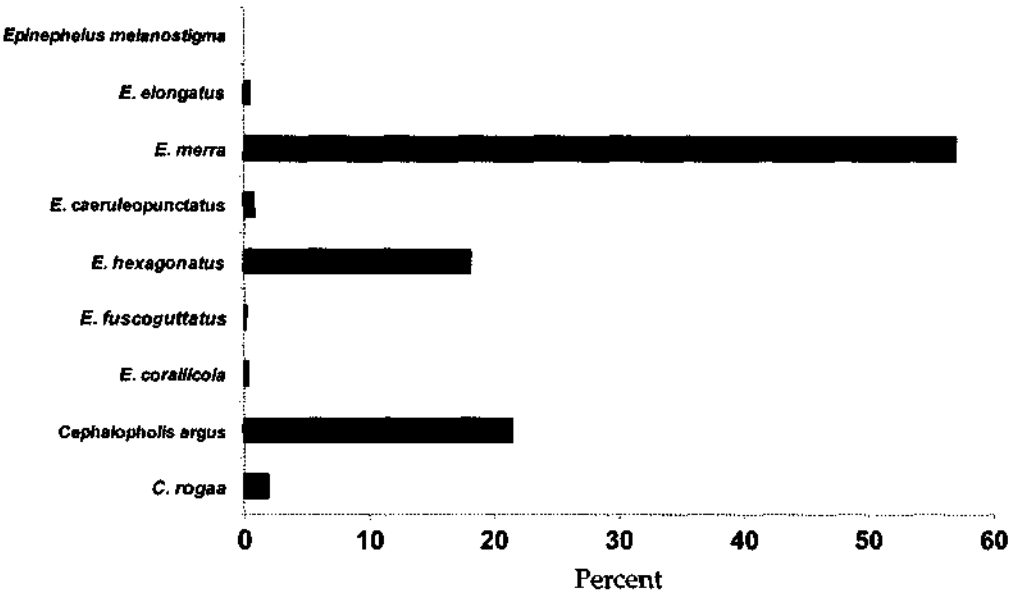


Figure 32. Relative abundance of Rock cod species in Lakshadweep islands

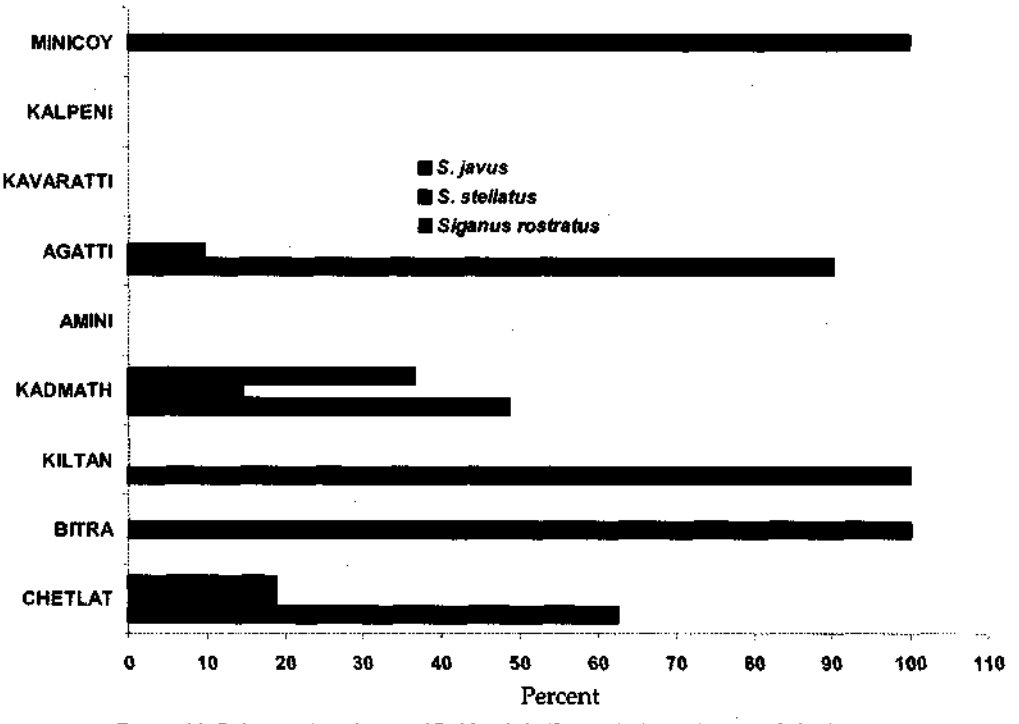


Figure 33. Relative abundance of Rabbit fish (Siganidae) species in Lakshadweep

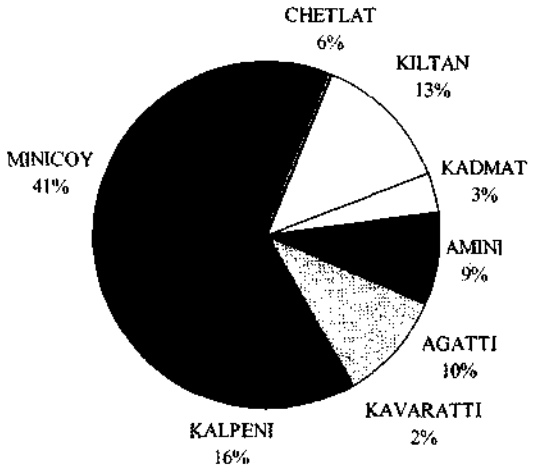


Figure 34. Relative abundance of variegate Lizard fish *(Synodus variegatus)* in the Lakshadweep islands

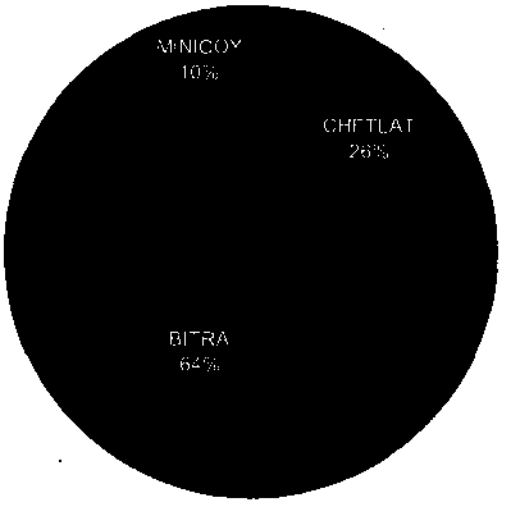


Figure 35. Relative abundance of Pufferfish (Tetradontidae) in the Lakshadweep islands

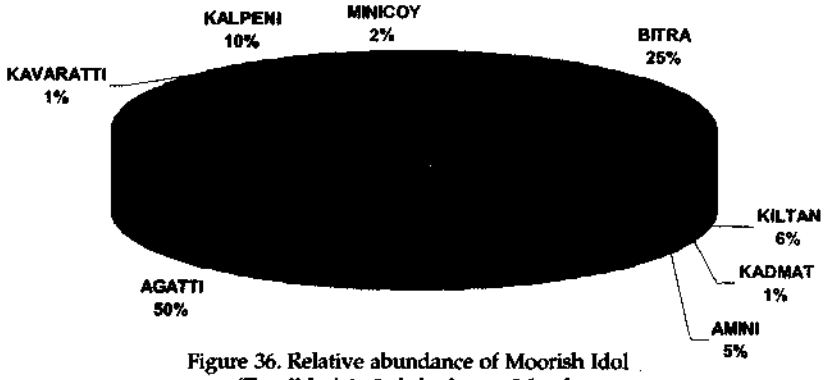


Figure 36. Relative abundance of Moorish Idol (Zanclidae) in Lakshadweep Islands

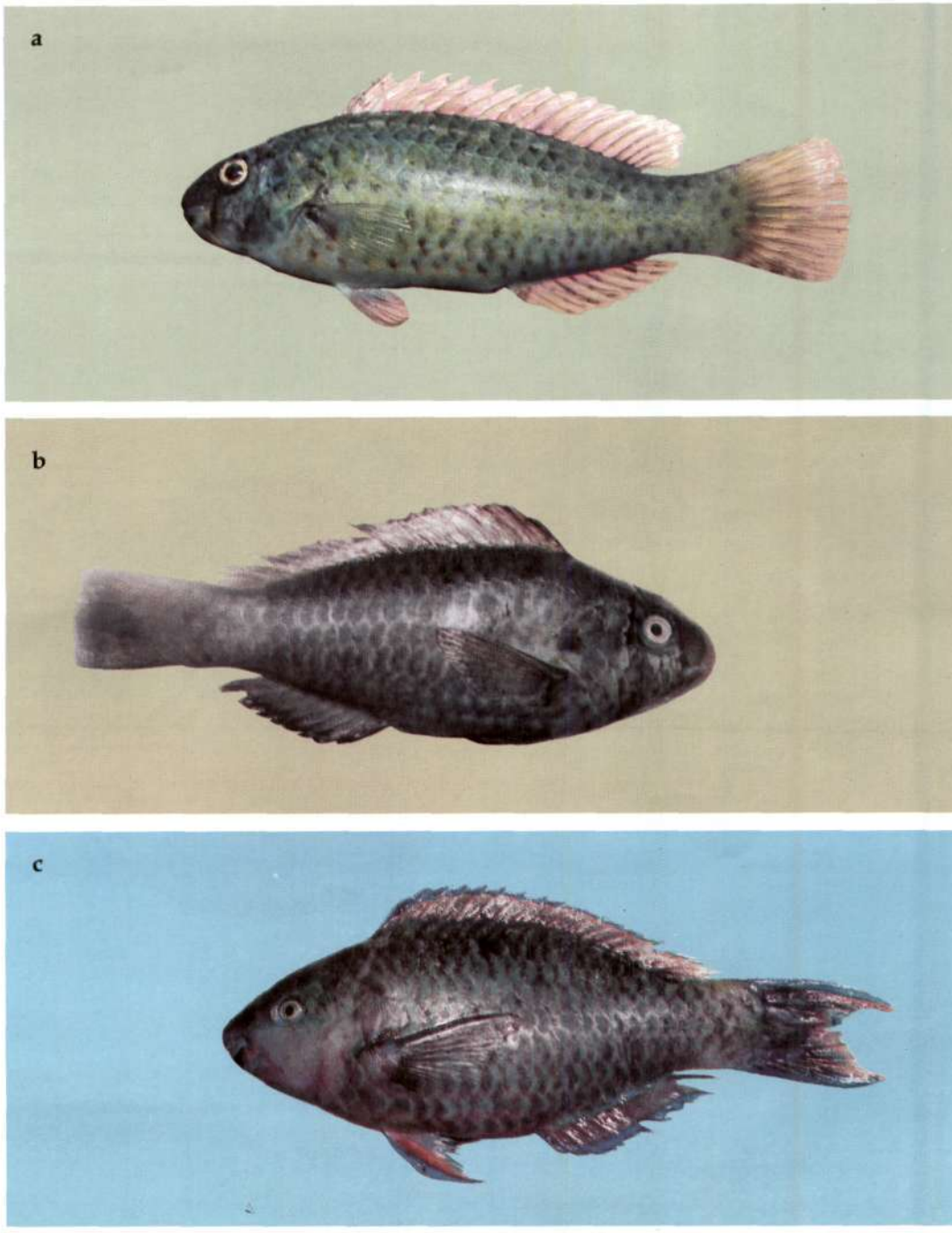


Plate 48 a. Marbled parrotfish-*Leptoscarus vaigiensis*
b. Bullet-head parrot fish-*Scarus sordidus*
c. Blue barred parrotfish-*Scarus bataviensis*

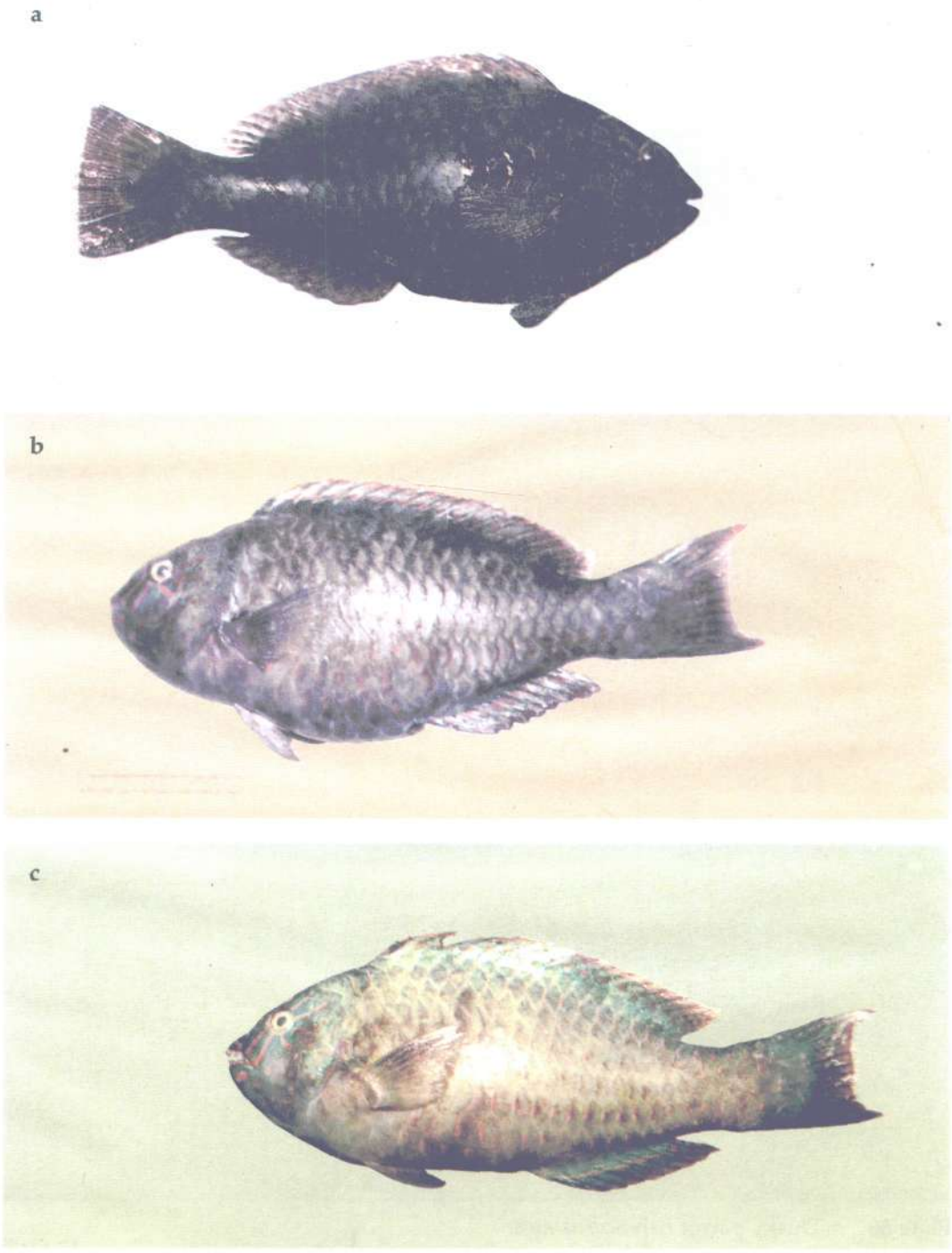


Plate 49 a, b & c. Spinytooth parrot fish-*Cryptotomus spinidens*

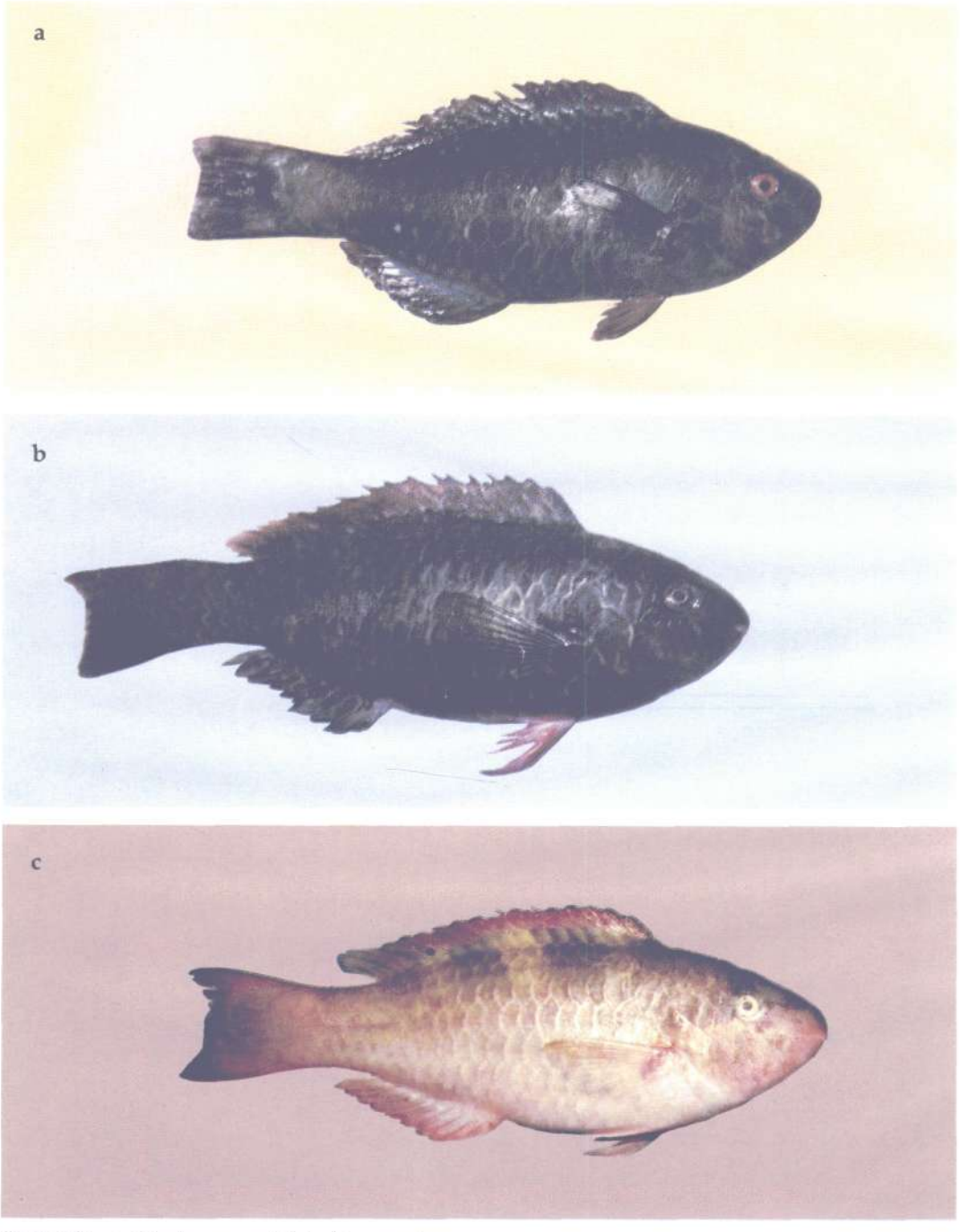


Plate 50 a. Dusky parrot fish-*Scarus niger*
b. Palenose parrotfish-*Scarus psittacus*
c. Five-saddle parrotfish-*Scarus scaber*

Plate 51 a. Blue barred parrot fish-*Scarus ghobban*
b. Eclipse parrotfish-*Scarus russelli*

Table 5. Estimated values of von Bertalanffy growth parameters and natural mortality rates of species of major ornamental fish families in the Lakshadweep lagoons

S. No	SPECIES	L_{max} (mm)	$L\infty$ (mm)	K (Per year)	M
	ACANTHURIDAE				
1	*Ctenochaetus strigosus*	215	233	0.90	1.82
2	*Acanthurus lineatus*	275	287	2.56	3.40
3	*Acanthurus triostegus*	179	200	1.00	2.03
4	*Acanthurus nigricauda*	244	243	0.60	1.38
5	*Acanthurus leucosternon*	195	210	1.30	2.38
	BALISTIDAE				
6	*Rhinecanthus aculeatus*	267	283	0.40	1.01
	LABRIDAE				
7	*Halichoeres hortulanus*	289	286	0.72	1.48
8	*Halichoeres scapularis*	219	225	0.62	1.44
9	*Halichoeres marginatus*	179	200	0.72	1.64
10	*Cheilinus trilobatus*	239	255	1.00	1.90
11	*Novaculichthys taeniourus*	268	275	1.40	2.33
12	*Thalassoma hardwicki*	189	188	1.00	2.07
13	*Stethojulis albovittata*	129	135	1.20	2.55
14	*Stethojulis trilineata*	139	150	1.10	2.34
	CHAETODONTIDAE				
15	*Chaetodon auriga*	149	174	1.50	2.75
16	*Chaetodon trifasciatus*	188	190	1.90	3.13
17	*Megaprotodon strigangulus*	125	145	0.53	1.47
	POMACENTRIDAE				
18	*Abudefduf biocellatus*	125	133	0.74	1.87
19	*Abudefduf glaucus*	100	115	0.80	2.05
20	*Abudefduf vaigiensis*	189	200	0.85	1.83
21	*Abudefduf zonatus*	109	120	0.91	2.20
22	*Chromis chrysurus*	95	100	0.80	2.13
23	*Chromis caeruleus*	114	115	2.30	4.09
24	*Dascyllus reticulatus*	85	100	0.52	1.74
25	*Dascyllus aruanus*	99	110	2.90	4.81
	SCARIDAE				
26	*Scarus bataviensis*	295	300	0.69	1.42
27	*Scarus psittacus*	239	245	1.80	2.82
28	*Scarus ghobban*	259	274	0.56	1.26
29	*Scarus scaber*	239	260	0.83	1.67
30	*Scarus sordidus*	295	310	1.10	1.91
31	*Cryptotomus spinidens*	289	297	0.95	1.76

Continued.....

Table 5. (continued) Estimated values of von Bertalanffy growth parameters and natural mortality rates of species of major ornamental fish families in the Lakshadweep lagoons

S. No	SPECIES	L_{max}* (mm)	$L\infty$ (mm)	K (Per year)	M
	HOLOCENTRIDAE				
32	*Neoniphon sammara*	209	260	0.52	1.23
33	*Myripristis murdjan*	215	262	0.68	1.46
	MULLIDAE				
34	*Mulloidichthys auriflamma*	265	270	1.20	2.10
35	*Mulloidichthys samoensis*	265	262	0.90	1.76
36	*Parupeneus barberinus*	345	352	1.20	1.95
37	*Parupeneus macronemus*	285	295	1.50	2.37
	SYNODONTIDAE				
38	*Synodus variegatus*	230	290	0.43	1.05
	SERRANIDAE				
39	*Epinephelus merra*	285	290	0.65	1.38
40	*Epinephelus hexagonatus*	275	295	0.91	1.71

* Maximum length recorded in the collections

(Fig. 30). They were not available from Amini, Chetlat and Kalpeni. The scorpean fishes were collected during five months with maximum during January. The catches of these fishes in the gillnet were rather very poor owing to their distribution in sheltered regions in the lagoons and their sluggish movements. Of the three species collected, *Pterois volitans* is most dominant in all the islands from where it was caught.

Serranidae (Rock cods, Groupers) (Plate 52) : This family is represented by 21 species in the Lakshadweep. Only 9 species were collected in the present survey. These fishes are available at the bottom under corals and rocks in the lagoons. They are very sluggish and prefer shelter during daytime and move out during nights. Though a fair number of species attain large sizes and are good table fish, some species attain relatively smaller maximum lengths. With their beautiful colour patterns and sluggish behavior these fishes are good for aquarium purposes also and therefore included in the present work. The serranids are abundant in all the islands (Fig. 31).

Of the nine species collected in the present survey, *Epinephelus merra*, is the most dominant species accounting for 57% of the catches of serranids followed by *Cephalopholis argus* (21%), *E. hexagonatus* (18%), *C. roga* (2%) and the others (2%) (Fig. 32). *E. merra* is abundant in all the islands, *C. argus* in Agatti, Amini, Bitra, Chetlat, Kalpeni, Kiltan and Minicoy. *E. hexagonatus* is abundant in Bitra, Kavaratti and Minicoy.

The serranids are abundant round the year, but peak abundance was observed in April, November and January. *E. merra* is also abundant during these months but *C. argus* is abundant in May and *E. hexagonatus* in April and November.

Table: 6. Length range (mm), weight range (g) and the estimated values of slope (b) and elevation (a) in the length-weight relationship of different species

S.No.	Species	N	Length range	Weight range	*a*	*b*	R^2
	ACANTHURIDAE						
1	*Ctenochaetus strigosus*	208	54-214	1-194	2.505070E-06	3.3799418	0.95
2	*Acanthurus triostegus*	1005	35-192	1-125	1.767240E-05	3.0819678	0.95
3	*Acanthurus leucosternon*	73	107-187	27-180	3.438910E-05	2.9207279	0.95
4	*Acanthurus lineatus*	54	82-274	3-302	1.088450E-05	3.0643596	0.96
5	*Acanthurus nigricauda*	16	95-231	15-184	5.442050E-05	2.7593037	0.99
	BALISTIDAE						
6	*Rhinecanthus aculeatus*	87	39-267	6-310	5.74675E-04	2.4135178	0.74
	CHAETODONTIDAE						
7	*Chaetodon auriga*	36	23-165	1-95	1.19420E-04	2.6410852	0.95
8	*Chaetodon trifasciatus*	28	52-115	3-48	8.58262E-07	3.7411262	0.98
	SCARIDAE						
9	*Leptoscarus vaigiensis*	84	75-222	9-183	2.12187E-05	2.9442457	0.97
10	*Cryptotomus spinidens*	55	85-242	5-315	4.82656E-06	3.2733812	0.98
11	*Scarus sordidus*	111	90-220	9-257	4.52434E-06	3.2956102	0.97
12	*Scarus bataviensis*	212	95-270	14-319	9.93264E-06	3.1273717	0.98
13	*Scarus ghobban*	40	102-275	11-331	2.80459E-05	2.9195755	0.88
14	*Scarus scaber*	58	98-211	16-186	3.85798E-05	2.8566879	0.88
15	*Scarus psittacus*	2149	43-226	2-229	3.22431E-05	2.9028429	0.90
	HOLOCENTRIDAE						
16	*Neioniphon sammara*	124	45-211	1-170	2.04261E-06	3.3796202	0.98
17	*Holocentrus lacteoguttatus*	56	75-200	6-129	9.50867E-06	3.0893137	0.96
18	*Myripristis murdjan*	368	42-205	2-200	1.78100E-05	3.0341487	0.99

...contd.

Table: 6. (Contd.) Length range(mm), weight range(g) and the estimated values of slope (b) and elevation (a) in the Length-weight relationship of different species

19	*Thalassoma hardwicki*	149	78-165	4-67	3.96469E-06	3.2566632	0.94
20	*Halichoeres scapularis*	506	70-183	4-85	2.17685E-06	3.3815102	0.92
21	*Halichoeres hortulanus*	843	85-243	7-212	1.03356E-05	3.0645836	0.93
22	*Halichoeres marginatus*	206	75-170	6-78	2.02972E-06	3.4143414	0.93
23	*Stethojulis trilineata*	60	45-133	2-39	4.13380E-06	3.2277682	0.97
24	*Stethojulis albovittata*	698	48-118	2-25	1.17400E-04	2.5223570	0.73
	MULLIDAE						
25	*Mulloidichthys samoensis*	316	99-303	10-272	7.71499E-06	3.0602362	0.92
26	*Parupeneus barberinus*	111	96-336	5-450	4.00537E-06	3.1948381	0.97
27	*Parupeneus macronemus*	371	81-220	5-115	2.75431E-06	3.2976428	0.94
28	*Parupeneus bifasciatus*	26	109-226	13-155	1.26493E-06	3.4514692	0.99
	POMACENTRIDAE						
29	*Dascyllus aruanus*	770	13-100	1-24	4.48000E-04	2.3329436	0.87
30	*Chromis caeruleus*	1079	30-98	1-16	4.01657E-05	2.7845753	0.89
31	*Abudefduf vaigiensis*	103	78-179	7-86	5.35316E-06	3.2668053	0.87
	SERRANIDAE						
32	*Cephalopholis argus*	69	81-298	5-442	3.60943E-06	3.2737667	0.98
33	*Epinephelus hexagonatus*	49	100-266	9-310	2.07568E-05	2.9300048	0.87
34	*Epinephelus merra*	310	75-210	5-150	1.90392E-06	3.4136198	0.96
	SYNODONTIDAE						
35	*Synodus variegatus*	52	108-205	10-81	9.73053E-07	3.4309175	0.95

Table 7. Length range and common length range in the catches and, the estimated values of length at first maturity (mm) in major ornamental fish species

S. No.	Species (mm)	Length range (mm)	Common length range	Length at first maturity
1	*Ctenochaetus strigosus*	50 - 220	120 - 180	145
2	*Acanthurus leucosternon*	90 - 200	100 - 140	138
3	*Acanthurus nigricauda*	60 - 210	110 - 150	
4	*Acanthurus triostegus*	20 - 180	80 - 130	75
5	*Acanthurus lineatus*	70 - 280	130 - 200	
6	*Rhinecanthus aculeatus*	40 - 230	120 - 180	140
7	*Myripristis murdjan*	10 -220	60 - 180	175
8	*Neoniphon sammara*	50 - 260	80 - 180	150
9	*Megaprotodon strigangulus*	40 - 130	60 - 90	
10	*Chaetodon trifasciatus*	40 - 190	70 - 130	
11	*Chaetodon auriga*	40 - 150	50 - 140	130
12	*Halichoeres scapularis*	60 - 220	75 -145	
13	*Halichoeres hortulanus*	20 - 290	110 - 200	128
14	*Halichoeres marginatus*	60 - 170	110 - 140	70
15	*Stethojulis trilineata*	80 - 140	90 -130	90
16	*Stethojulis albovittata*	40 - 130	60 - 110	
17	*Thalassoma hardwicki*	60 - 190	110 - 160	85
18	*Novaculichthys taeniourus*	100 - 270	120 - 240	
19	*Cheilinus trilobatus*	80 - 240	100 - 120	
20	*Parupeneus macronemus*	70 -290	90 - 180	123
21	*Parupeneus barberinus*	80 - 350	100 - 200	
22	*Mulloidichthys samoensis*	110 - 270	150 - 240	175
23	*Mulloidichthys auriflamma*	120 - 280	150 - 190	
24	*Dascyllus reticulatus*	40 - 90	70 - 85	
25	*Dascyllus aruanus*	15 - 100	35 - 90	50
26	*Abudefduf zonatus*	40 -150	65 - 100	
27	*Abudefduf vaigiensis*	40 - 190	100 -150	120
28	*Abudefduf glaucus*	50 - 100	80 - 90	
29	*Abudefduf biocellatus*	40 - 125	70 - 90	
30	*Chromis caeruleus*	20 - 115	30 - 100	58
31	*Chromis chrysurus*	30 -100	70 - 90	
32	*Scarus psittacus*	50 - 240	110 - 190	105
33	*Scarus bataviensis*	90 - 300	170 - 230	148
34	*Scarus scaber*	70 -220	130 - 200	
35	*Scarus ghobban*	60 - 280	80 - 180	
36	*Scarus sordidus*	80 - 240	100 - 140	150
37	*Cryptotomus spinidens*	90 - 290	110 - 190	105
38	*Epinephelus hexagonatus*	90 - 280	150 - 210	190
39	*Epinephelus merra*	40 -290	110 -190	110
40	*Synodus variegatus*	105 - 220	110 -160	140

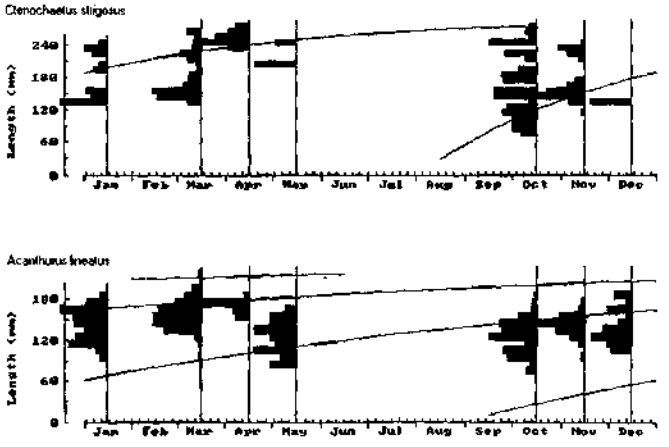


Figure: 37. Monthly length frequency distribution and growth curves fitted using ELEFAN in*Ctenochaetus strigosus* ($L\infty$ = 233 mm, K= 0.9 per year, SS 2, SL 90 mm, Rn 287) and *Acanthurus lineatus* ($L\infty$ = 287 mm, K = 2.56 per year, SS3, SL 240mm, Rn 230)

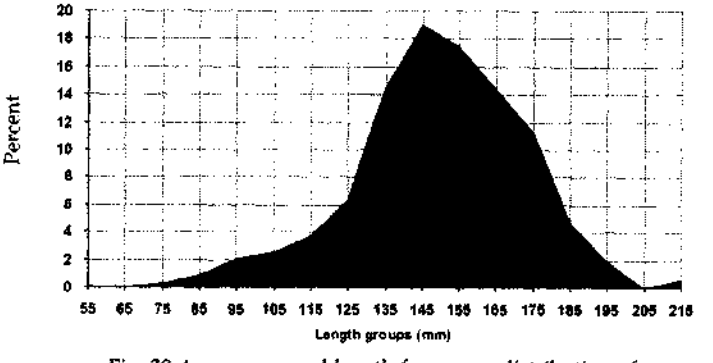


Fig. 38 Average annual length frequency distribution of *Ctenochaetus strigosus* as obtained in the present survey

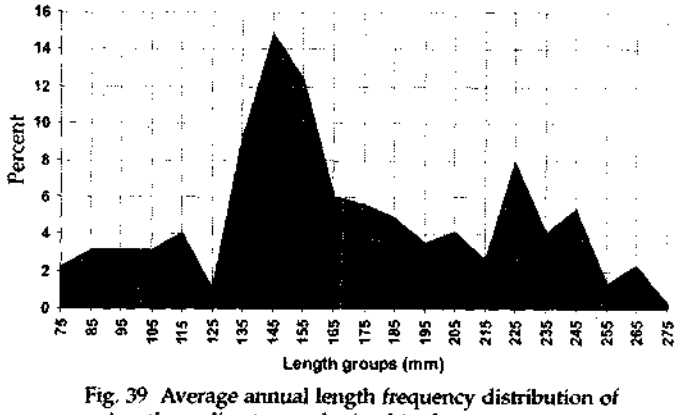


Fig. 39 Average annual length frequency distribution of *Acanthurus lineatus* as obtained in the present survey

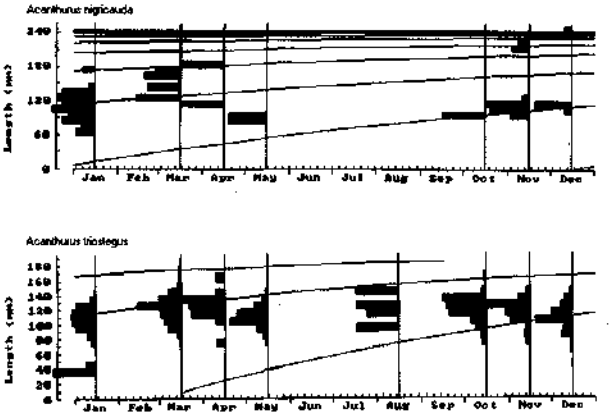


Figure: 40. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Acanthurus nigricauda* ($L\infty$ = 243 mm, K= 0.6 per year, SS6, SL 107.5, Rn 343) and *Acanthurus triostegus* ($L\infty$ = 200 mm, K = 1.0 per year, SS 3, SL 135 mm, Rn 208)

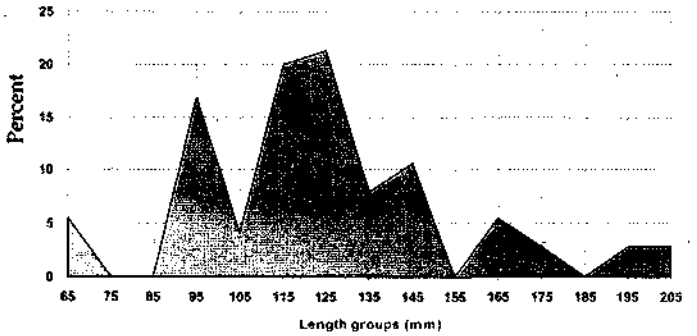


Figure.41 Average annual length frequency distribution of *Acanthurus nigricauda* as obtained in the present survey

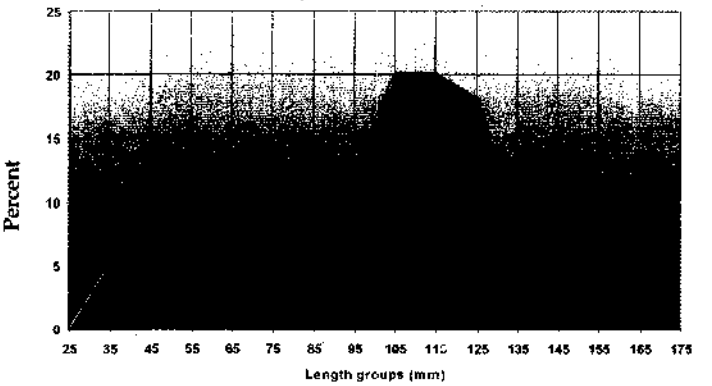


Figure. 42 Average annual length frequency distribution of *Acanthurus triostegus* as obtained in the present survey

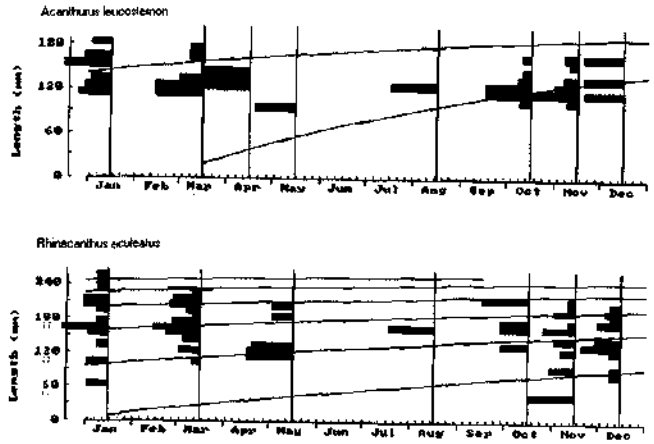


Figure: 43. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Acanthurus leucosternon* ($L\infty$ = 210 mm, K= 1.3 per year, SS 6, SL 120 mm, Rn 223) and *Rhinecanthus aculeatus* ($L\infty$ = 283 mm, K = 0.4 per year, SS 1, SL 160 mm, Rn 213)

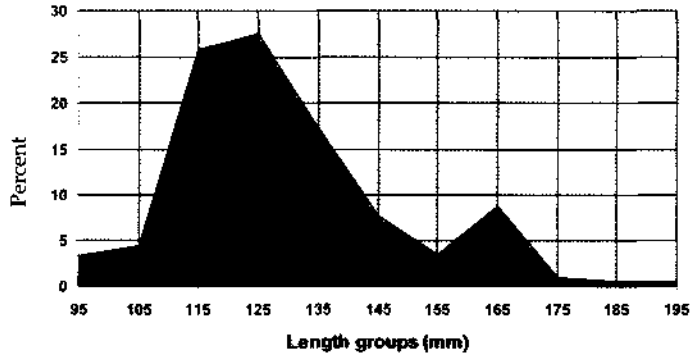


Figure. 44 Average annual length frequency distribution of *Acanthurus leucosternon* as obtained in the present survey

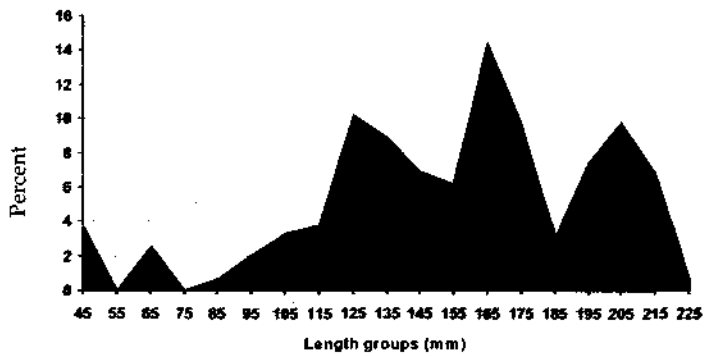


Figure. 45 Average annual length frequency distribution of *Rhinecanthus aculeatus* as obtained in the present survey

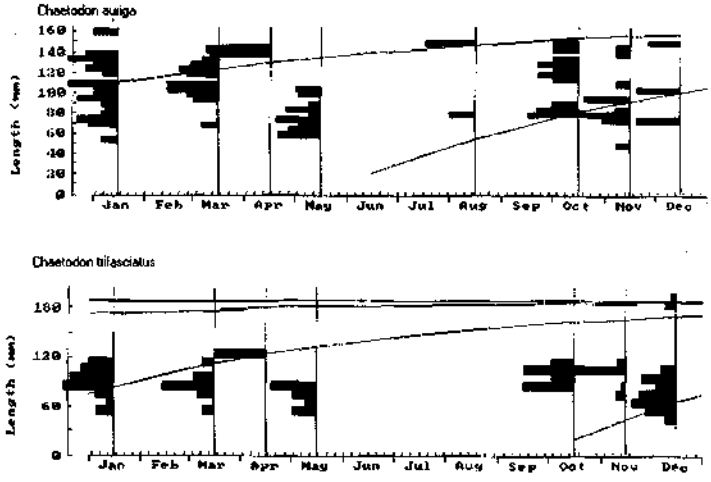


Figure 46. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Chaetodon auriga* ($L\infty$ = 174 mm, K= 1.5 per year, SS 2, SL 124 mm, Rn 187) and *Chaetodon trifasciatus* ($L\infty$ = 190 mm, K = 1.9 per year, SS 7, SL 65 mm, Rn 227)

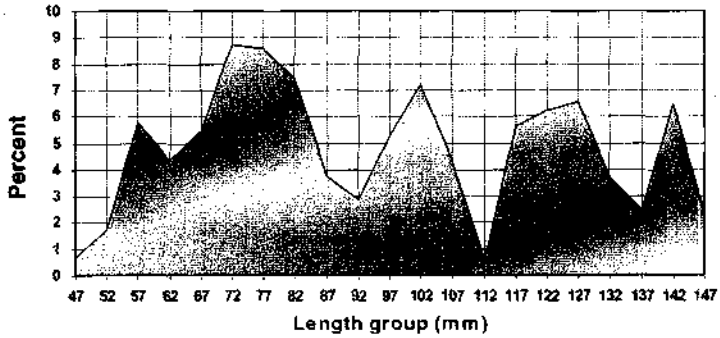


Figure 47 Average annual length frequency distribution of *Chaetodon auriga* as obtained in the present survey

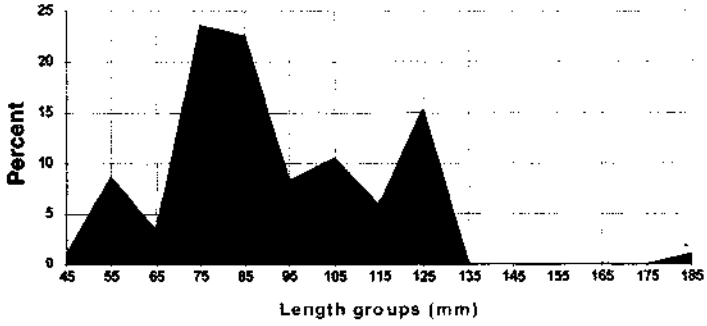


Figure 48 Average annual length frequency distribution of *Chaetodon trifaciatus* as obtained in the present survey

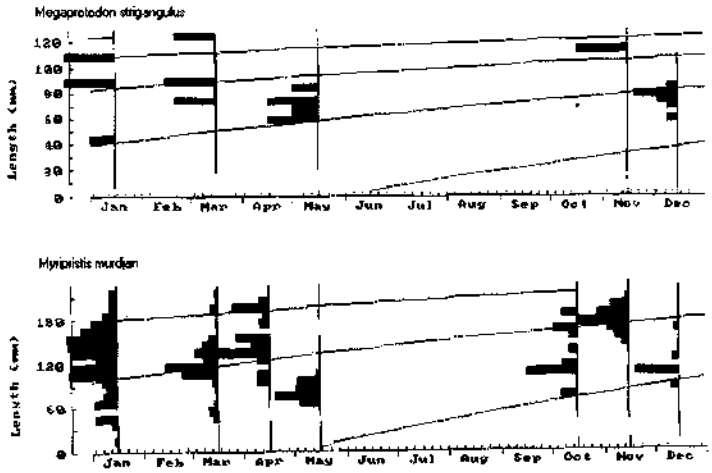


Figure 49 Monthly length frequency distribution and growth curves fitted using ELEFAN in *Megaprotodon strigangulus* ($L\infty$ = 145 mm, K= 0.53 per year, SS 1, SL 41.5 mm, Rn 306) and *Myripristis murdjan* ($L\infty$ = 262 mm, K = 0.68 per year, SS 1, SL 100 mm, Rn 213)

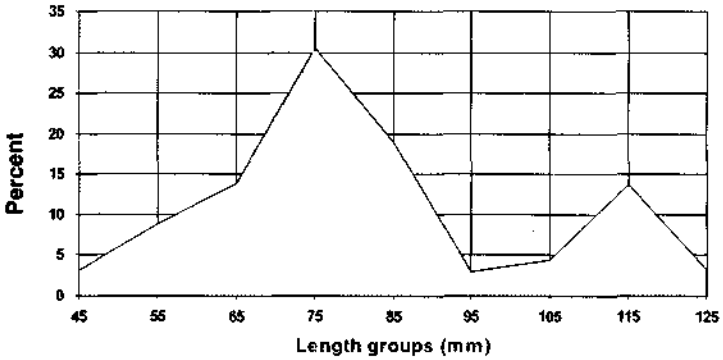


Figure 50 Average annual length frequency distribution of *Megaprotodon strigangulus* as obtained in the present survey

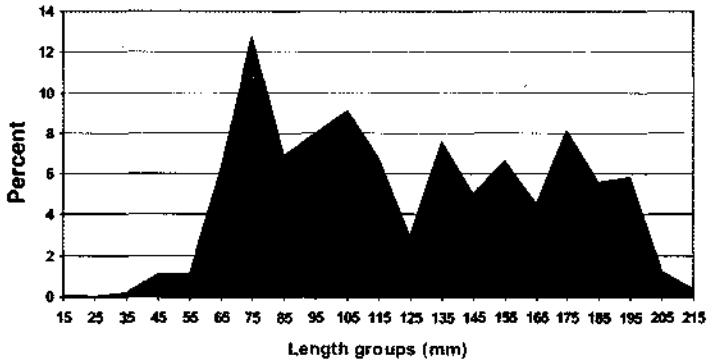


Figure 51 Average annual length frequency distribution of *Myripristis murdjan* as obtained in the presevt survey

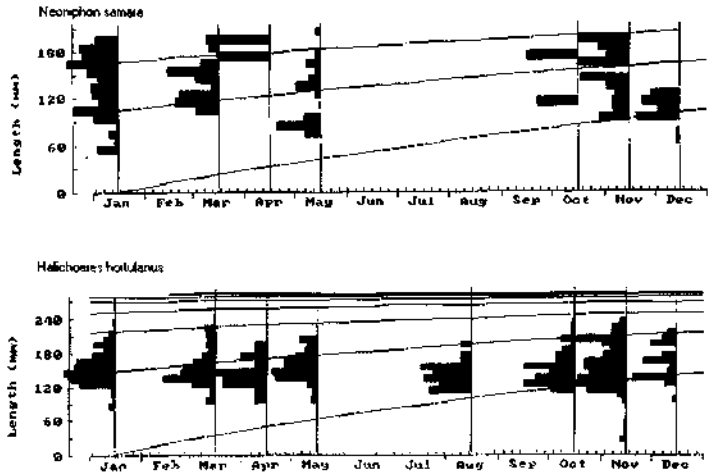


Figure 52. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Neoniphon sammara* (L_∞ = 260 mm, K= 0.52 per year, SS 4, SL 130, Rn 242) and *Halichoeres hortulanus* L_∞ = 286 mm, K = 0.72 per year, SS 3, SL 170, Rn 172)

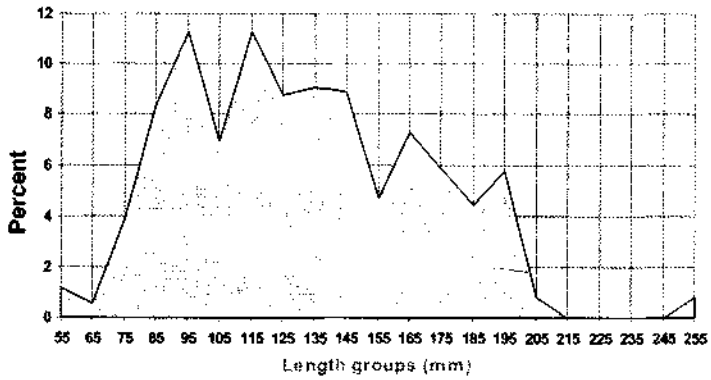


Figure 53 Average annual length frequency distribution of *Neoniphon sammara* as obtained in the present survey

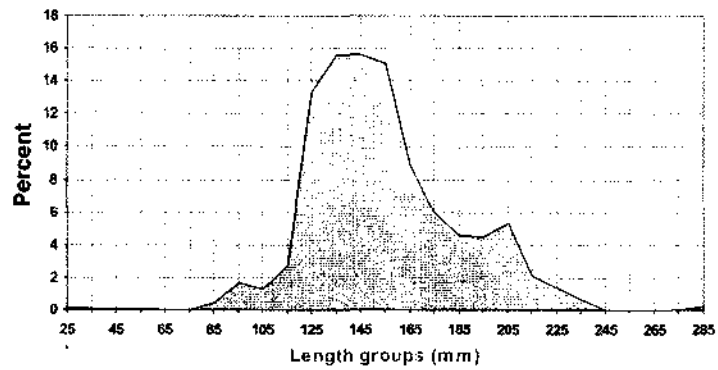


Figure 54 Average annual length frequency distribution of *Halichoeres hortulanus* as obtained in the present survey

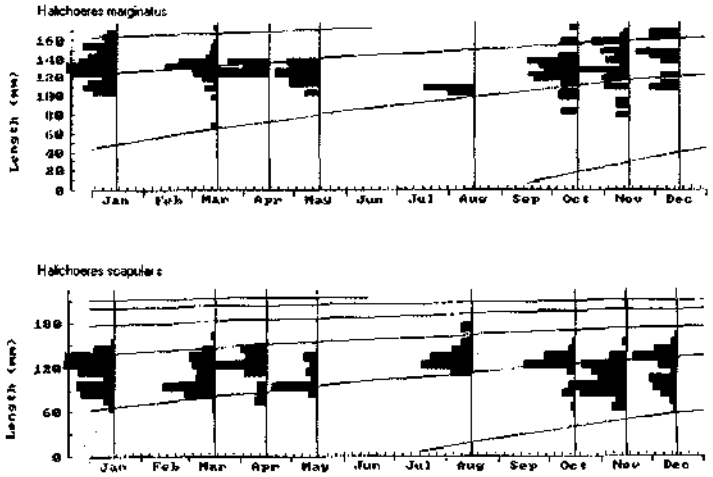


Figure 55. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Halichoeres marginatus* ($L\infty$ = 200 mm, K= 0.72 per year, SS 2, SL 134 mm, Rn 205) and *Halichoeres scapularis* ($L\infty$ = 225 mm, K = 0.62 per year, SS 4, SL 95 mm, Rn 245)

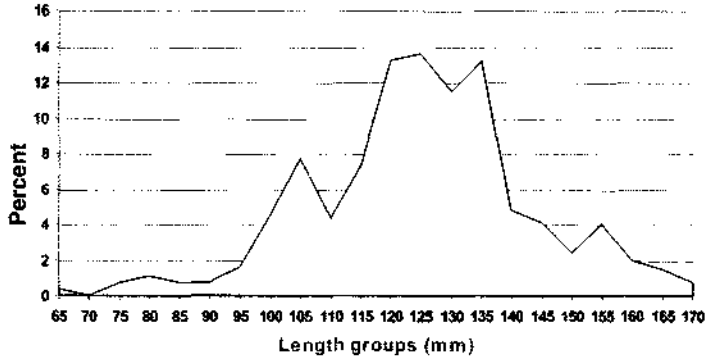


Figure 56 Average annual length frequency distribution of *Halichoeres marginatus* as obtained in the present survey

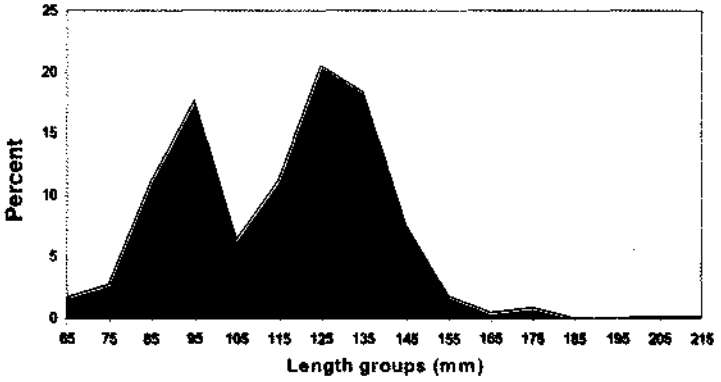


Figure 57 Average annual length frequency distribution of *Halichoeres scapularis* as obtained in the present survey

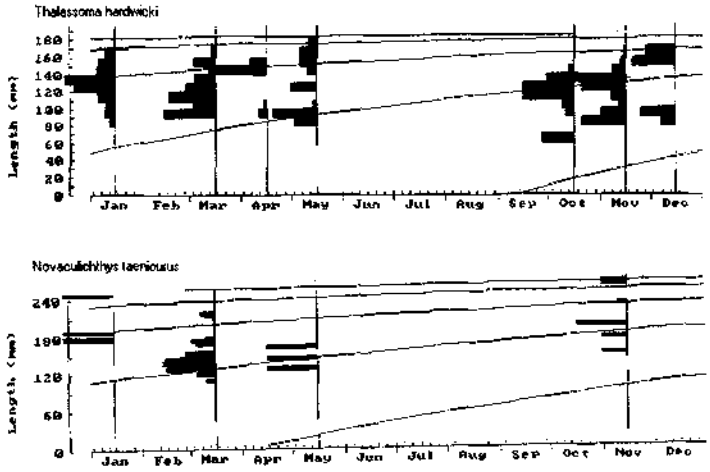


Figure 58. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Thalassoma hardwicki* (L∞ = 188 mm, K= 1.0 per year, SS 5, SL 125 mm, Rn 238) and *Novaculichthys taeniourus* (L∞ = 275 mm, K = 0.67 per year, SS 2, SL 129 mm, Rn 204)

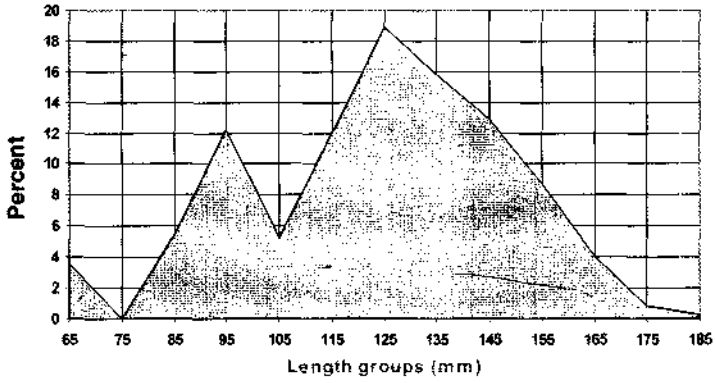


Figure 59 Average annual length frequency distribution of *Thalassoma hardwicki* as obtained in the present survey

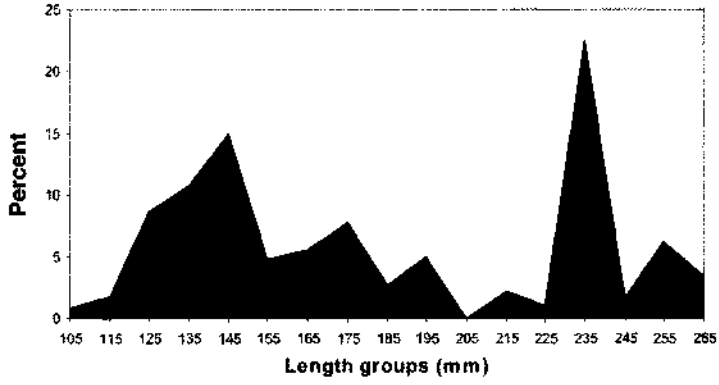


Figure 60 Average annual length frequency distribution of *Novaculichthys taeniourus* as obtained in the present survey

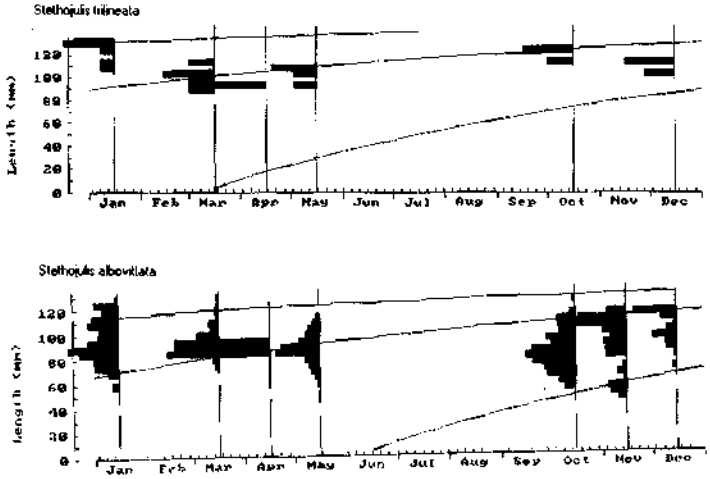


Figure 61. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Stethojulis trilineata* ($L\infty$ = 150 mm, K= 1.1 per year, SS 2, SL 101.5 mm, Rn 470) and *Stethojulis albovittata* $L\infty$ = 135 mm, K = 1.2 per year, SS 2, SL 81.5 mm, Rn 215)

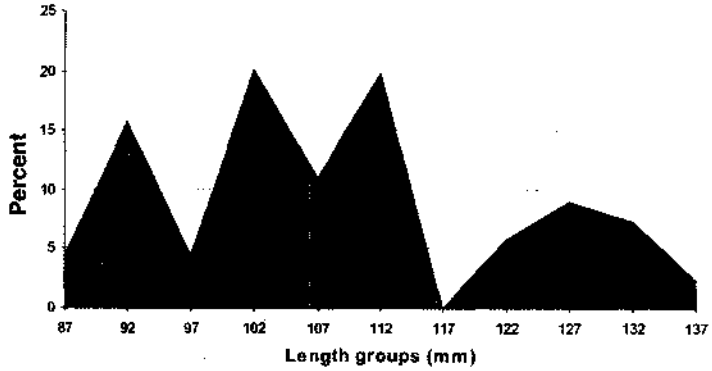


Figure 62 Average annual length frequency distribution of *Stethojulis trilineatas* as obtained in the present survey

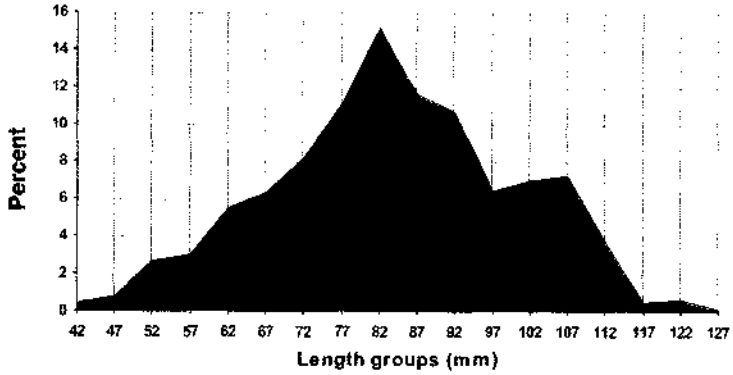


Figure 63 Average annual length frequency distribution of *Stethojulis albovittata* as obtained in the present survey

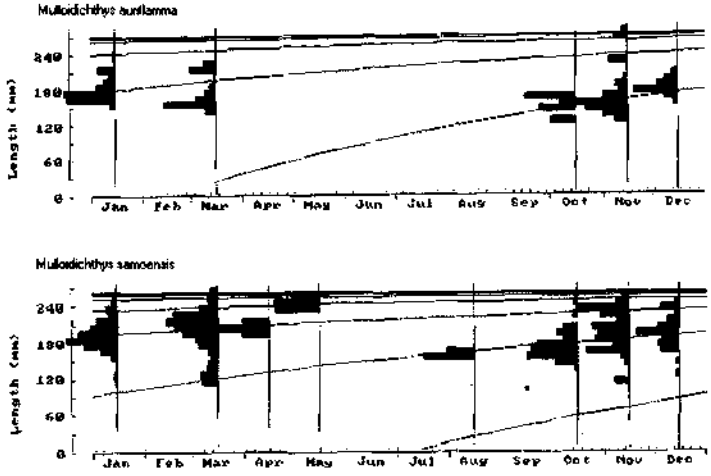


Figure 64. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Mulloidichthys auriflamma* (L_∞ = 270 mm, K= 1.2 per year, SS 5, SL 170 mm, Rn 329) and *Mulloidichthys samoensis* (L_∞ = 262 mm, K = 0.9 per year, SS 8, SL 190 mm, Rn 214)

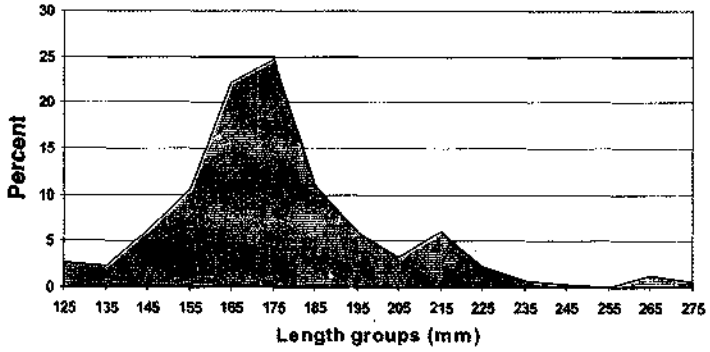


Figure 65 Average annual length frequency distribution of *Mulloidichthys auriflamma* as obtained in the present survey

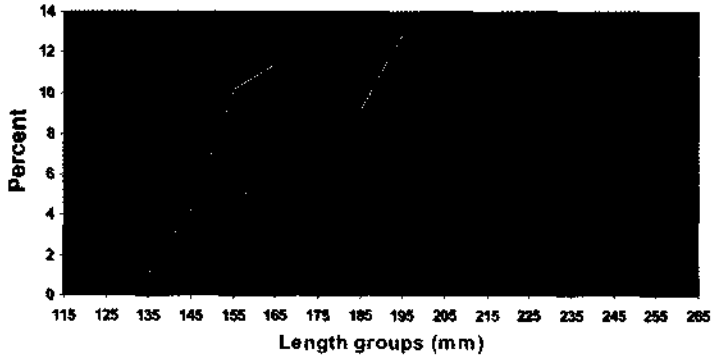


Figure 66 Average annual length frequency distribution of *Mulloidichthys samoensis* as obtained in the present survey

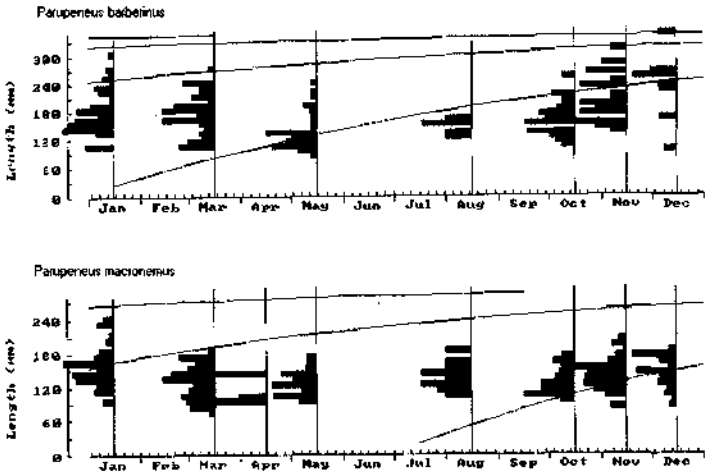


Figure 67. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Parupeneus barberinus* ($L\infty$ = 352 mm, K= 1.2 per year, SS 3, SL 130 mm, Rn 170) and *Parupeneus macronemus* ($L\infty$ = 295 mm, K = 1.5 per year, SS 1, SL 164.5, Rn 172)

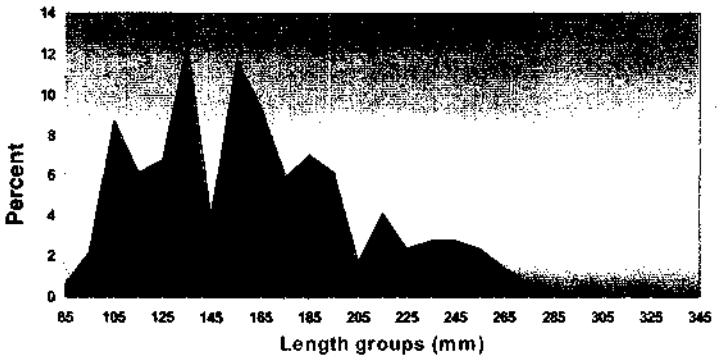


Figure 68 Average annual length frequency distribution of *Parupeneus barberinus* as obtained in the present survey

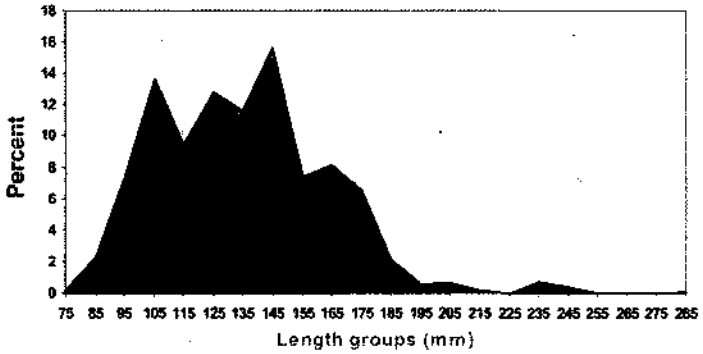


Figure 69 Average annual length frequency distribution of *Parupeneus macronemus* as obtained in the present survey

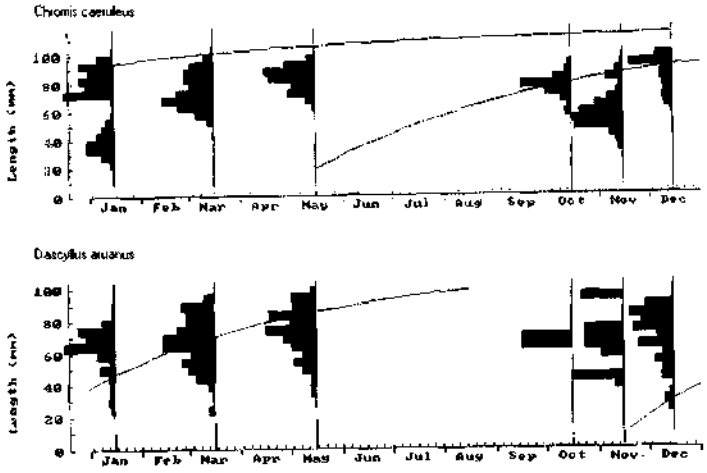


Figure 70. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Chromis caeruleus* ($L\infty$ = 115 mm, K= 2.3 per year, SS 6, SL 90 mm, Rn 250) and *Dascyllus aruanus* ($L\infty$ = 110 mm, K = 2.9 per year, SS 6, SL 29 mm, Rn 181)

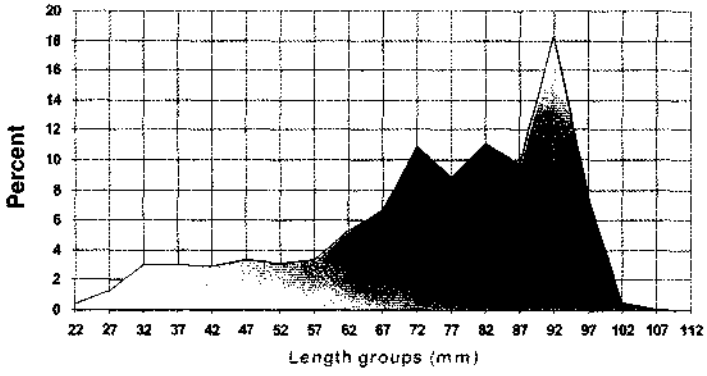


Figure 71 Average annual length frequency distribution of *Chromis caeruleus* as obtained in the present survey

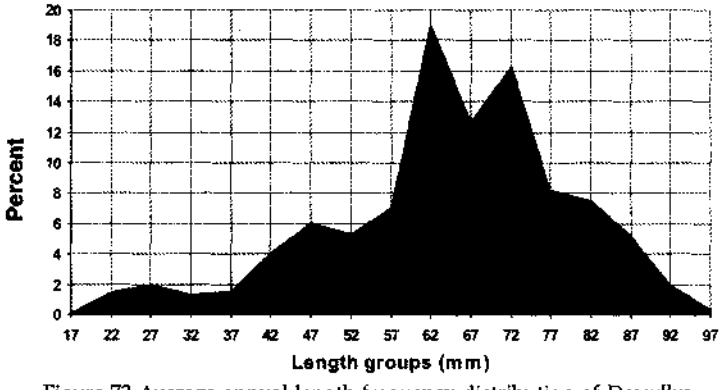


Figure 72 Average annual length frequency distribution of *Dascyllus aruanus* as obtained in the present survey

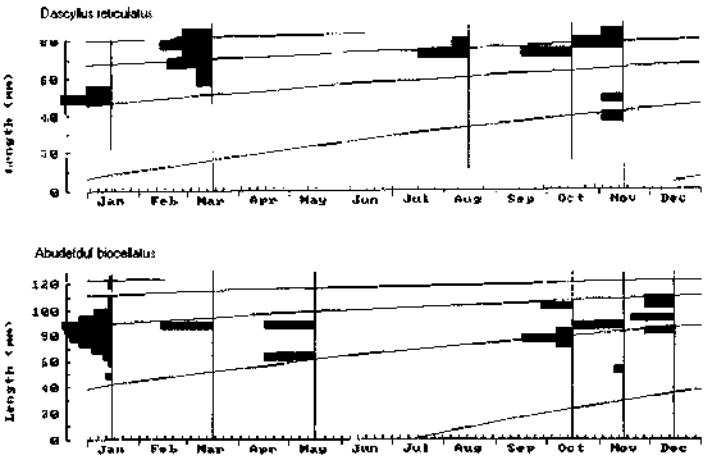


Figure 73. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Dascyllus reticulatus* ($L\infty$ = 96 mm, K= 0.58 per year, SS 5, SL 79 mm, Rn 332) and *Abudefduf biocellatus* ($L\infty$ = 133 mm, K = 0.74 per year, SS 3, SL 61.5 mm, Rn 236)

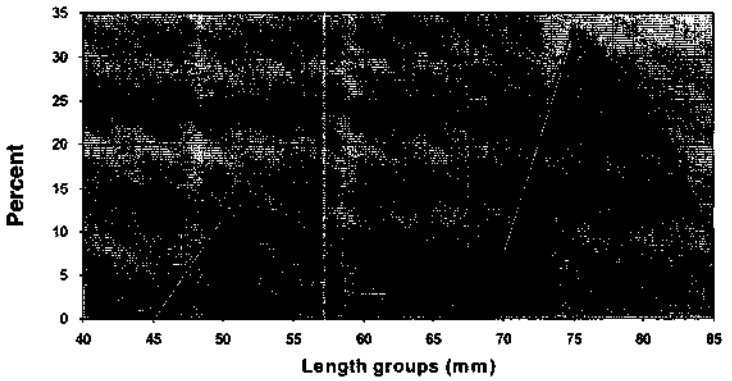


Figure 74 Average annual length frequency distribution of *Dascyllus reticulatus* as obtained in the present survey

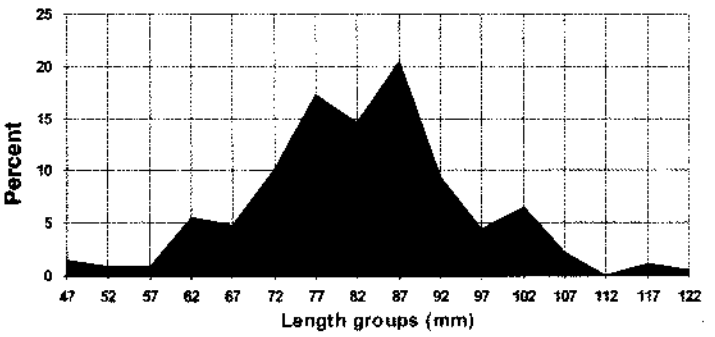


Figure 75 Average annual length frequency distribution of *Abudefduf biocellatus* as obtained in the present survey

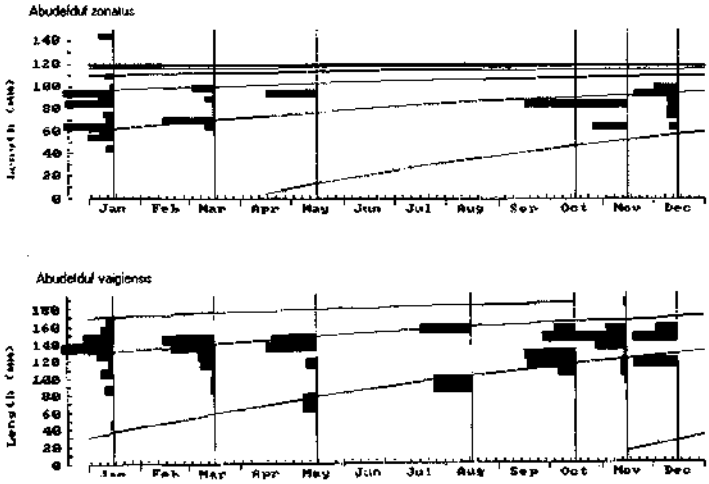


Figure 76. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Abudefduf zonatus* (Loc = 120 mm, K= 0.91 per year, SS 1, SL 61.5 mm, Rn 296) and *Abudefduf vaigiensis* (Loc = 260 mm, K = 0.83 per year, SS 1, SL 130 mm, Rn 264)

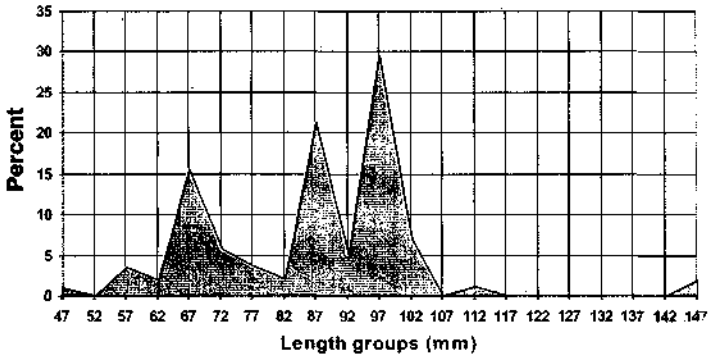


Figure 77 Average annual length frequency distribution of *Abudefduf zonatus* as obtained in the present survey

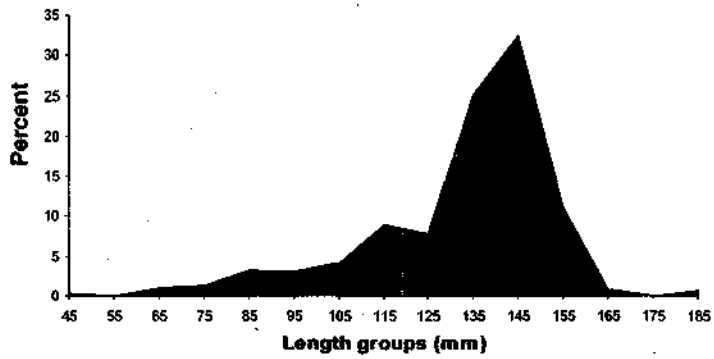


Figure 78 Average annual length frequency distribution of *Abudefduf vaigiensis* as obtained in the present survey

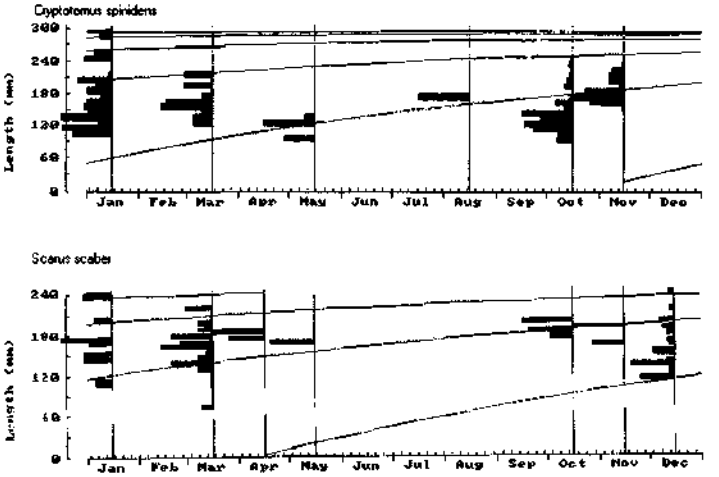


Figure 79. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Cryptotomus spinidens* (L∞ = 297 mm, K= 0.95 per year, SS 5, SL 219 mm, Rn 130) and *Scarus scaber* (L∞ = 260 mm, K = 0.83 per year, SS 2, SL 139 mm, Rn 196)

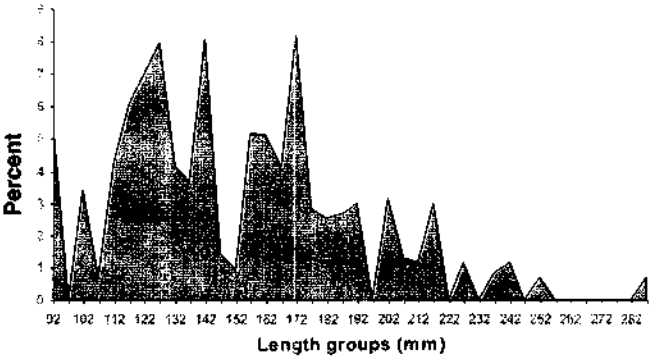


Figure 80 Average annual length frequency distribution of *Cryptotomus spinidens* as obtained in the present survey

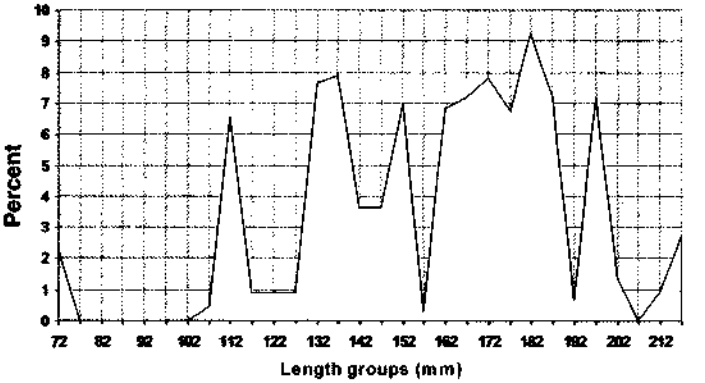


Figure 81 Average annual length frequency distribution of Scarus scaber as obtained in the present survey

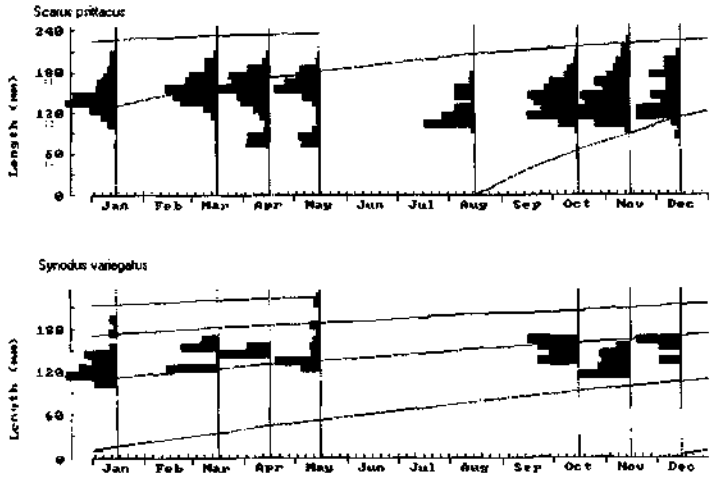


Figure 82. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Scarus psittacus* (L_∞ = 245 mm, K= 1.8 per year, SS 1, SL 130 mm, Rn 191) and *Synodus variegatus* (L_∞ = 290 mm, K = 0.43 per year, SS 4, SL 135 mm, Rn 280)

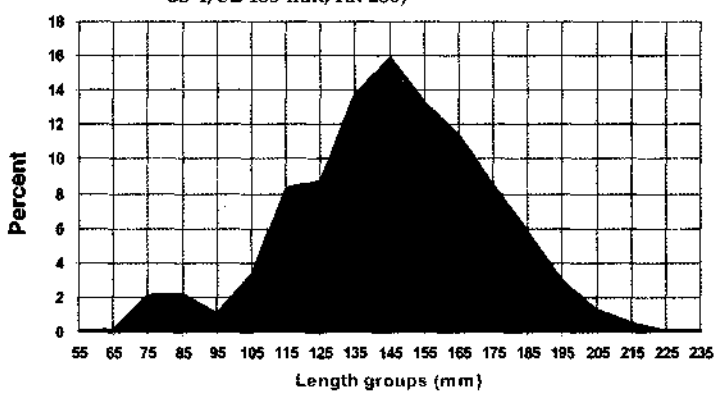


Figure 83 Average annual length frequency distribution of *Scarus psittacus* as obtained in the present survey

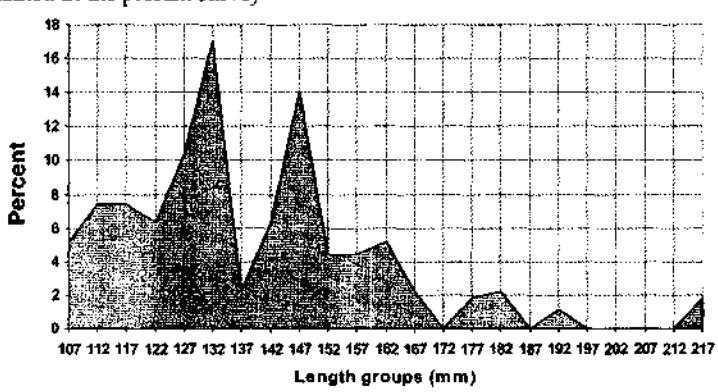


Figure 84 Average annual Length Frequency Distribution of *Synodus variegatus* as obtained in the present survey

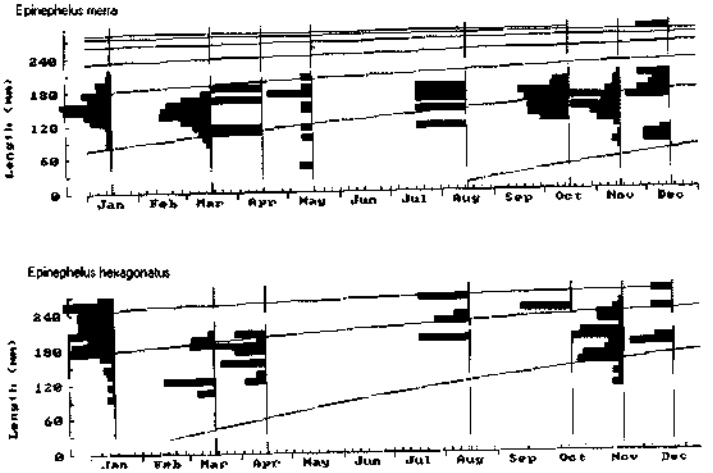


Figure 85. Monthly length frequency distribution and growth curves fitted using ELEFAN in *Epinephelus merra* (L∞ = 290 mm, K= 0.65 per year, SS 3, Sl 110 mm, Rn 178) and *Epinephelus hexagonatus* (L∞ = 295 mm, K = 0.91 per year, SS 4, SL 225 mm,

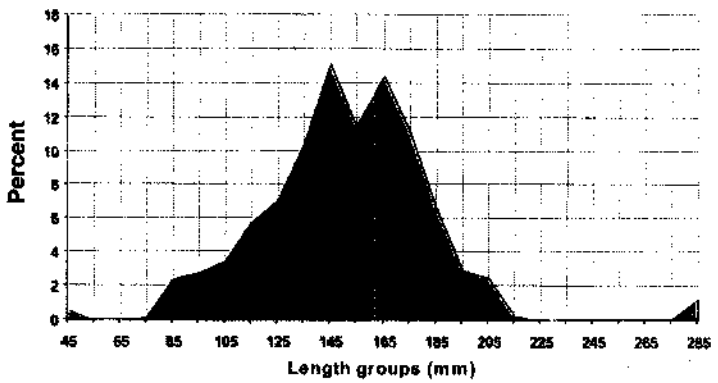


Figure 86 Average annual Length Frequency Distribution of *Epinephelus merra* as obtained in the present survey

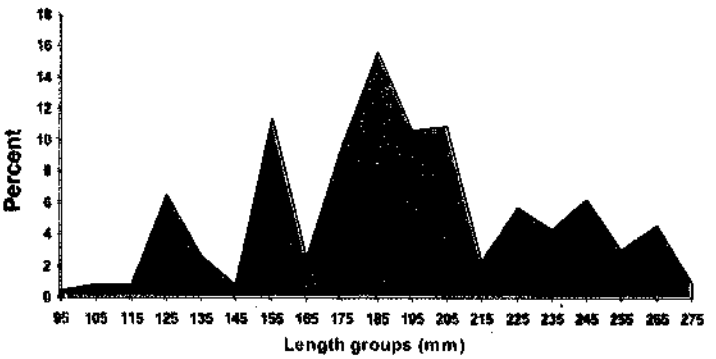


Figure 87 Average annual Length Frequency Distribution of *Epinephelus hexagonatus* as obtained in the present survey

Species	J	F	M	A	M	J	J	A	S	O	N	D
Acanthurus bleekeri												
A. lineatus												
Ctenochaetus striatus												
Scarus boholensis		N				N	N					
Scarus scaber		O				O	O					
Leptoscarus vaigiensis												
Scarus sordidus		D				D	D					
Scarus psittacus		A				A	A					
Cryptoyomus spinidens		T				T	T					
Chromis caerulea		A				A	A					
Dascyllus aruanus												
Abudefduf vaigiensis												
Cephalopholis argus												
Epinephelus hexagonatus												
E. merra												
Mulloidichthys samoensis												
Parupeneus bifasciatus												
P. macronemus												
Echinacanthus arcuatus												
Synodus variegatus												
Thalassoma hardwicki												
Halichoeres hortulanus												
H. marginatus												
H. scapularis												
Stethojulis interrupta												
Chaetodon auriga												
Holocentrus lacteoguttatus												
Neoniphon sammara												
Myripristis murdjan												

Spawning period Peak Spawning period

Figure 88 Spawning periods and peak spawning periods in different species

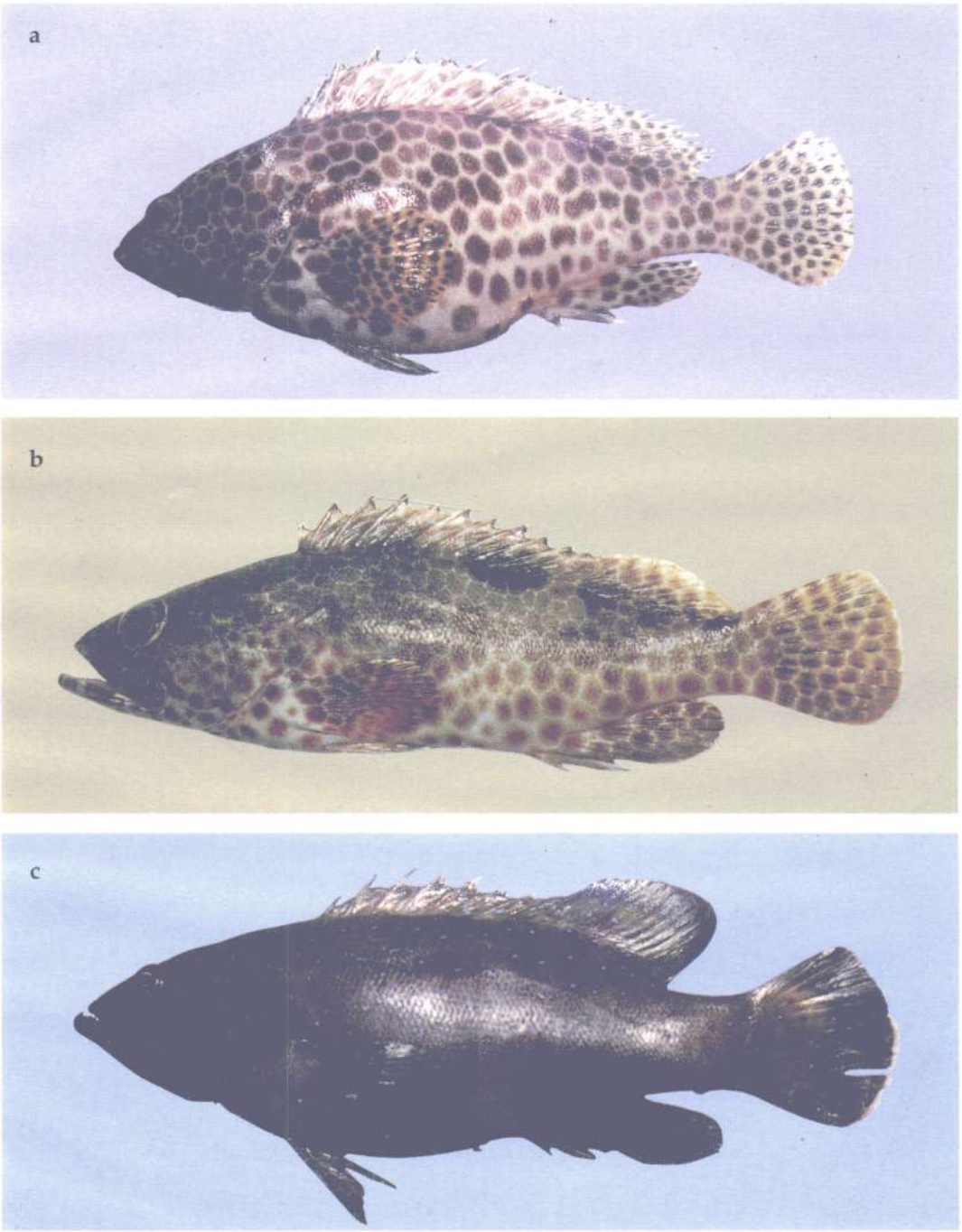


Plate 52 a. Honey comb rock cod-*Epinephelus merra*
b. White speckled rock cod-*Epinephelus hexagonatus*
c. Peacock rock cod-*Cephalopholis argus*

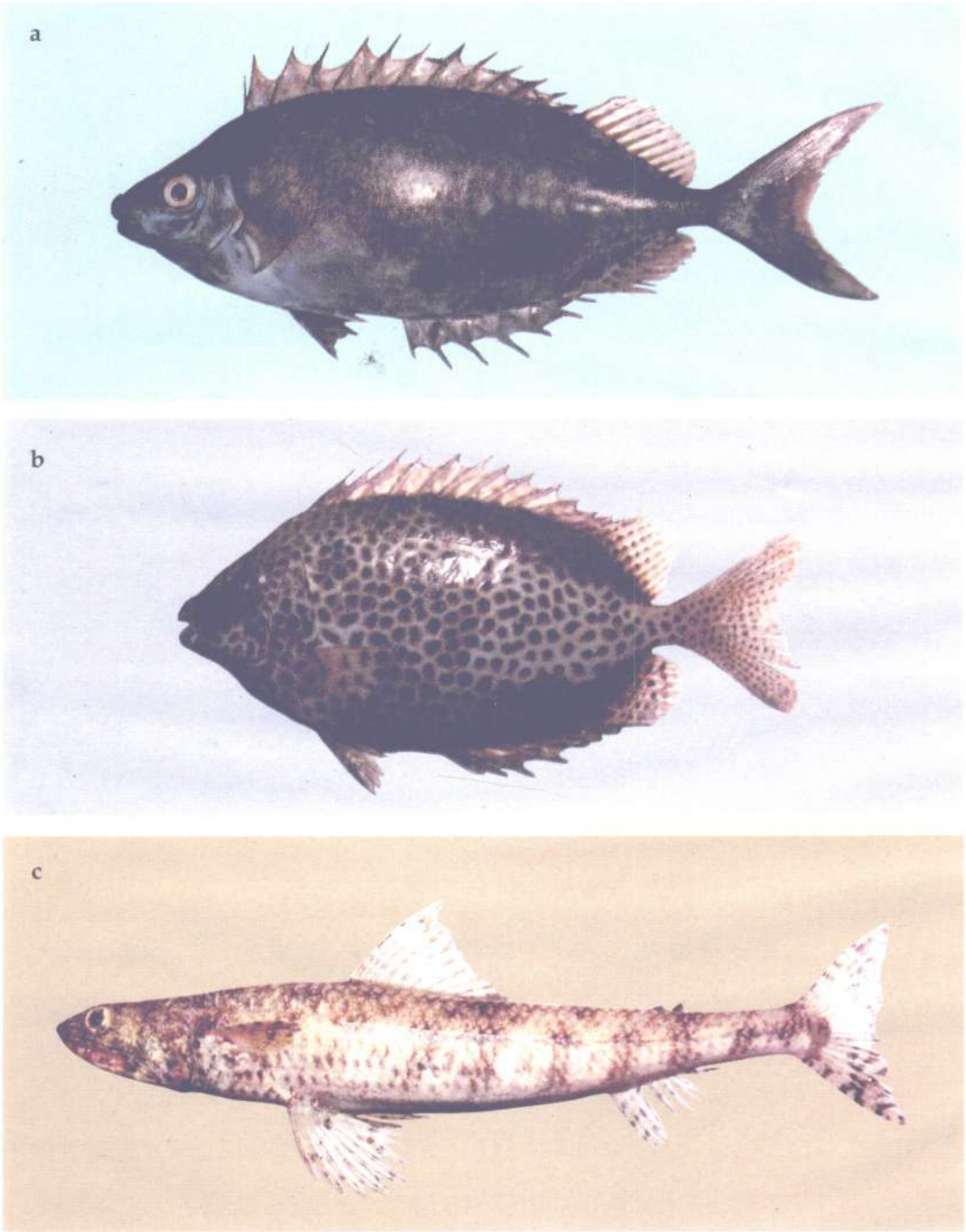


Plate 53 a. Grey spinyfoot-*Siganus rostratus*
b. Star spotted rabbit fish-*Siganus stellatus*
c. Vaiegated lizard fish-*Synodus variegatus*

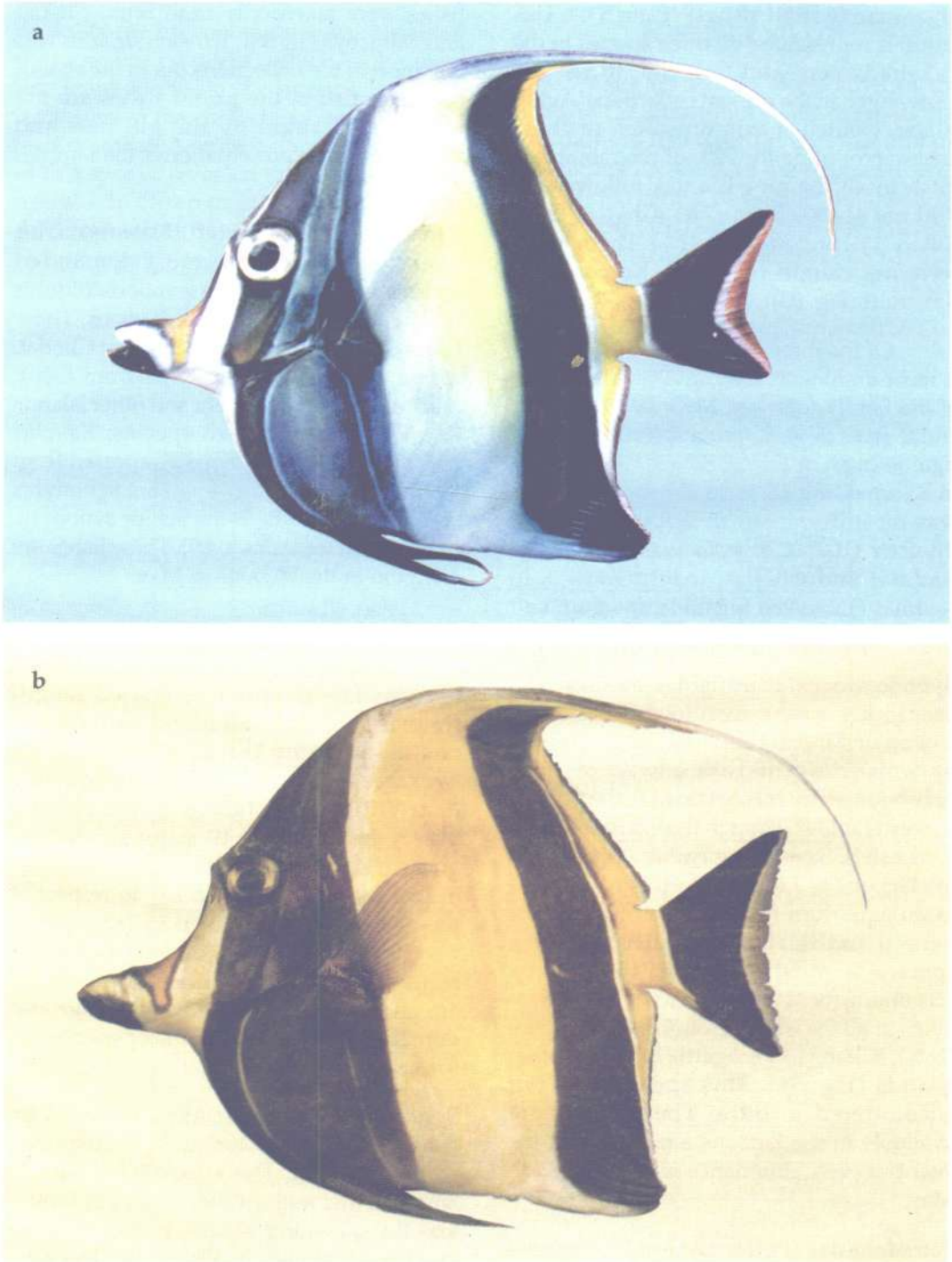


Plate 54 a & b. Moorish idol-*Zanclus canescens*

Siganidae (Rabbit fishes) (Plate 53) : This group is represented by three species in the Lakshadweep and all the three are represented in the present collections. Agatti Island yielded maximum catch of these fishes accounting for 72% of the rabbit fish catch in all the nine islands, followed by Kadmat (14%), Bitra (7%), Chetlat (5%), Kiltan (1%) and Minicoy (1%). These fishes were not caught in Amini, Kalpeni and Kavaratti (Fig. 33).

Of the three species, *Siganus rostratus* is most dominant forming 77% of the catch of the family followed by *S. stellatus* (17%) and *S. javus* (6%). *S. rostratus* formed 90% of siganid catch in Agatti, 63% in Chetlat, 49% in Kadmat and 100% in Kiltan. *S. stellatus* was most dominant in Bitra (100%) and Minicoy (100%). *S. javus* was taken from Kadmat and Chetlat; it formed 37% in Kadmat (Table 28). Siganids are abundant in the lagoons in May (Fig. 33).

Synodontidae (Lizardfish) (Plate 53c) : The lizardfishes are common food fishes in the seas around India. This family is represented by two species in the Lakshadweep of which only one species was obtained in the present survey (Table 4). Though the lizardfishes are food fishes, *Synodus variegatus*, occurring in the lagoons of Lakshadweep is considered as an aquarium fish because of its colour pattern and relatively smaller size. This species is most abundant in Minicoy accounting for 41% of the catch of the species taken in all the islands, followed by Kalpeni (16%), Kiltan (13%), Agatti (10%) and other islands (Fig. 34). This species was not encountered in Bitra. These fishes are available in the lagoons almost round the year but peak abundance was observed in May.

Tetradontidae (Puffer fishes): Five species are known from Lakshadweep of which two species were collected in the survey. These fishes were taken only from Bitra, Chetlat and Minicoy (Fig. 35). *Tetradon stellatus* was common in the collections. As in the case of scorpean fishes, the puffer fishes are not effectively caught by the gill nets and therefore their representation in the samples is rather poor.

Zanclidae (Moorish Idol) (Plate 54) : This family represents the most demanded marine aquarium fish. The moorish idol is not an abundant fish in the lagoons. These fishes did not occur in the catches at Chetlat. Maximum numbers were taken from Agatti followed by Bitra, Kalpeni and other islands (Fig. 36). Though two species, *Zanclus cornutus* and *Z. canescens* are reported from the Lakshadweep, these two are synonyms and the latter name is the senior synonym. (Smith and Heemstra, 1989). These fishes are common in the lagoons in May.

BIOLOGY

Growth: The monthly estimated length frequency distribution and the growth curves fitted by the ELEFAN and the average annual length frequency distribution as obtained in the present survey in respect of 40 major species are given in Figures 37-87. The estimated values of $L\infty$ K and the observed L_{max} in respect of these 40 species are shown in Table 5. The results of estimation of length-weight relationship in 35 major ornamental species are given in Table 6. The length range and dominant length range of major species are furnished in Table 7.

Spawning: All the specimens obtained by fishing with gillnets during the entire period were examined. The estimated values of length at first maturity are shown in Table 7 and the spawning periods in respect of 29 species are shown in Figure 88. The data suggest that that almost all the species have

protracted spawning period with one or two peaks. In the present study it was observed that *Chromis caeruleus*, which is the most dominant species in the lagoons, lays eggs in clusters in the corals inhabited and often feed on them. A large number of stomachs of this species revealed the presence of egg masses in different stages of embryonic development. This is confirmed by comparing ripe eggs in the ovaries.

STOCK SIZE AND MAXIMUM POSSIBLE YIELD

The estimated stock sizes of the fishes of the 20 families (Table 8) reveal that the damsel fish are the most dominant accounting for 43.7% of the estimated stock (137 lakhs) of the 20 families followed by parrot fish (15.3%), surgeon fish (13.3%), wrasses (11.0%), squirrel fish (2.5%), goat

Table 8. Estimated stock size (number) and maximum possible yield (number) of ornamental fishes belonging to 20 families in the Lakshadweep

S.No.	Group	Stock size	Maximum yield
1	Surgeonfish	18,17,418	7,82,195
2	Triggerfish	1,34,171	27,771
3	Butterfly fish	1,47,955	1,01,802
4	Wrasses	15,10,673	5,36,990
5	Squirrelfish	3,37,636	89,369
6	Goatfish	2,30,943	1,21,866
7	Damselfish	59,92,984	54,22,447
8	Parrotfish	21,01,167	12,65,071
9	Rock cod	83,573	27,082
10	Lizardfish	13,469	4,266
11	Cardinal fish	85,637	58,006
12	Filefish	13,841	9,376
13	Sandsmelt	13,841	9,376
14	Boxfish	13,841	9,376
15	Angels	27,682	18,752
16	Scorpeanfish	14,449	9,787
17	Rabbit fish	52,147	35,322
18	Puffer fish*	74,974	50,783
19	Moorish idol	29,261	19,820
	Total	1, 36,95,663	85,99,456

*The families Tetradontidae and Canthigasteridae pooled, as both of them come under pufferfish

Table 9. Estimates of stock size (number) and maximum possible yield (number) of different species

S.No.	Species	Stock size	Maximum yield
	Surgeonfish		
1	*Ctenochaetus strigosus* (Bennett, 1828)	90325	37446
2	*Acanthurus triostegus* (Linnaeus, 1766)	1410470	569240
3	*Acanthurus leucosternon* (Bennett, 1828)	22609	19377
4	*Acanthurus lineatus* (Linnaeus, 1758)	65584	63448
5	*Acanthurus nigricauda* (Duncker and Mohr, 1926)	58282	19455
6	*Paracanthurus hepatus* (Linnaeus, 1766)	959	413
7	*Zebrasoma veliferum* (Bloch, 1795)	4091	1761
8	*Acanthurus tennenti* Gunther, 1861	3515	1513
9	*Acanthurus matoides* Valenciennes, 1835	85393	36752
10	*Acanthurus mata* Valenciennes, 1835	16682	7180
11	*Acanthurus elongatus* (Lacepede, 1802)	18536	7978
12	*Acanthurus blochii* Valenciennes, 1835	1151	495
13	*Naso litturatus* Schneider, 1801	17258	7427
14	*Naso branchycentron* (Valenciennes, 1835)	2685	1155
15	*Naso unicornis* (Forskal, 1775)	11441	4924
16	*Naso brevirostris* (Valenciennes, 1835)	2109	908
17	*Naso tuberosus* Lacepede, 1802	6328	2723
	Total	1817418	782195
	Triggerfish		
18	*Rhinecanthus aculeatus* (Linnaeus, 1758)	116412	24096
19	*Rhinecanthus rectangulus* (Bloch and Schneider, 1801)	5726	1185
20	*Sufflamen chrysoptera* (Bloch and Schneider, 1801)	5436	1125
21	*Balistoides viridescens* (Bloch and Schneider, 1801)	580	120
22	*Pseudobalistes flavimarginatus* (Ruppell, 1829)	1305	270
23	*Balistapus undulatus* (Mungo Park, 1797)	4712	975
	Total	134171	27771
	Butterflyfish		
24	*Heniochus acuminatus* (Linnaeus, 1758)	21629	14882
25	*Heniochus monoceros* (Cuvier, 1831)	1689	1162
26	*Heniochus diphreutes* Jordan, 1903	1078	742
27	*Heniochus singularis* Smith and Radcliffe, 1911	1078	742
28	*Megaprotodon strigangulus* (Gmelin, 1788)	14515	9987
29	*Chaetodon meyeri* (Bloch and Schneider, 1801)	252	173
30	*Chaetodon lunula* (Lacepede, 1803)	5246	3609
31	*Chaetodon collaris* Bloch, 1787	3377	2324
32	*Chaetodon citrinellus* Cuvier, 1831	4060	2793
33	*Chaetodon trifasciatus* Quoy and Gaimard, 1825	25509	17552
34	*Chaetodon xanthocephalus* Bennett, 1832	8910	6131
35	*Chaetodon falcula* Bloch, 1793	6683	4598
36	*Chaetodon auriga* Forskal, 1775	48719	33522
37	*Chaetodon vagabundus* Linnaeus 1758	5210	3585
	Total	147955	101802

Table 9. (Contd.) Estimates of stock size (number) and maximum possible yield (number) of different species

S.No.	Species	Stock size	Maximum yield
	WRASSES		
38	*Anampses caeruleopunctatus* Ruppell, 1829	8536	3034
39	*Anampses diadematus* Ruppell, 1835	807	287
40	*Cheilio inermis* (Forskal, 1775)	11051	3928
41	*Gomphosus caeruleus* Lacepede, 1802	13162	4678
42	*Gomphosus varius* Lacepede 1802	15831	5627
43	*Thalassoma hardwicki* (Bennett, 1828)	25831	15645
44	*Thalassoma janseni (Bleeker, 1856)*	25268	8982
45	*Thalassoma lunare* (Linnaeus, 1758)	7854	2792
46	*Thalassoma umbrostigma* (Ruppell, 1835)	1862	662
47	*Thalassoma purpurea* (Forskal, 1775)	745	265
48	*Thalassoma quinquevittata* (Lay and Bennett, 1839)	124	44
49	*Labroides dimidiatus* (Valenciennes, 1839)	5712	2030
50	*Macropharyngodon meleagris* (Valenciennes, 1839)	5432	1931
51	*Halichoeres scapularis* (Bennett, 1831)	102383	38864
52	*Halichoeres hortulanus* (Lacepede, 1801)	956687	265186
53	*Halichoeres marginatus* Ruppell, 1835	37065	17249
54	*H. notopsis* (Valenciennes, 1839)	17259	6135
55	*Halichoeres kawarin* (Bleeker, 1852)	27565	9798
56	*Hemigymnus melapterus* (Bloch, 1791)	2639	938
57	*Halichoeres argus* (Bloch and Schneider, 1801)	3787	1346
58	*Stethojulis strigiventer* (Bennett, 1832)	7667	2725
59	*Stethojulis trilineata* (Bloch and Schneider, 1802)	11681	7290
60	*Stethojulis albovittata* (Bonnaterre, 1788)	145648	98230
61	*Hologymnosus semidiscus* (Lacepede, 1802)	1490	530
62	*Coris formosa* (Bennett, 1834)	1211	430
63	*Coris gaimardi* Smith, 1957	1428	508
64	*Coris frerei* (Gunther, 1856)	1862	662
65	*Novaculichthys taeniourus* (Lacepede, 1801)	9679	6807
66	*Epibulus insidiator* (Pallas, 1770)	1894	673
67	*Pseudocheilinus hexataenia* (Bleeker, 1857)	559	199
68	*Cheilinus undulatus* Ruppell, 1835	11454	4072
69	*Cheilinus trilobatus* Lacepede, 1801	46500	25443
	Total	1510673	536990
	Squirrelfish		
70	*Neoniphon sammara* (Forskal, 1775)	146267	39223
71	*Neoniphon argenteus* (Valenciennes, 1831)	1251	331
72	*Holocentrus laevis* Gunther, 1859	6490	1718
73	Sargocentron spiniferum (Forskal, 1775)	3623	959
74	*Sargocentron diadema* (Lacepede, 1801)	7455	1973
75	*Sargocentron lacteoguttatus* (Cuvier, 1829)	18559	4912
76	*Sargocentron violaceus* (Bleeker, 1853)	4666	1235

Table 9. (Contd.) Estimates of stock size (number) and maximum possible yield (number) of different species

S.No.	Species	Stock size	Maximum yield
77	*Holocentrus caudimaculatus* Ruppell, 1828	10035	2656
78	*Myripristis murdjan* (Forskal, 1775)	114579	29821
79	*Myripristis adustus* (Bleeker, 1853)	24242	6417
80	*Myripristis seychelliensis* Cuvier, 1829	469	124
	Total	337636	89369
	Goatfish		
81	*Mulloidichthys samoensis* (Gunther, 1874)	87164	41293
82	*Mulloidichthys auriflamma* (Forskal, 1775)	14319	10577
83	*Parupeneus barberinus* (Lacepede, 1802)	39294	18187
84	*Parupeneus indicus* (Shaw, 1803)	8329	4395
85	*Parupeneus pleurostigma* (Bennett, 1831)	1337	705
86	*Parupeneus chryserydros* (Lacepede, 1802)	749	395
87	*Parupeneus luteus* (Valenciennes, 1831)	2806	1480
88	*Parupeneus macronemus* (Lacepede, 1802)	66310	39222
89	*Parupeneus trifasciatus* (Lacepede, 1804)	59	31
90	*Parupeneus bifasciatus* (Lacepede, 1801)	10576	5581
	Total	230943	121866
	Damselfish		
91	*Amphiprion nigripes* Regan, 1908	21145	19132
92	*Dascyllus trimaculatus* (Ruppell, 1828)	112824	102083
93	*Dascyllus reticulatus* (Richardson, 1846)	9175	5460
94	*Dascyllus aruanus* (Linnaeus, 1758)	223329	222369
95	*Chromis chrysurus* (Bliss, 1883)	270039	164985
96	*Chromis caeruleus* (Cuveir, 1830)	4720647	4381134
97	*Pomacentrus lividus* (Bloch and Schneider, 1801)	4485	4058
98	*Pomacentrus nigricans* (Lacepede, 1803)	73632	66622
99	*Pomacentrus albifasciatus* (Schlegel and Muller, 1839)	19436	17586
100	*Pomacentrus littoralis* (Cuvier, 1830)	33479	30292
101	*Pomacentrus albicaudatus* (Baschieri-Salvadori, 1955)	26270	23770
102	*Pomacentrus pavo* (Bloch, 1787)	12014	10870
103	*Pomacentrus melanopterus* Bleeker, 1852	43651	39495
104	*Abudefduf bengalensis* (Bloch, 1787)	4085	3696
105	*Abudefduf vaigiensis* (Quoy and Gaimard; 1825)	50515	21135
106	*Abudefduf sexfasciatus* (Lacepede, 1802)	481	435
107	*Abudefduf sordidus* (Forskal, 1775)	3844	3478
108	*Abudefduf notatus* (Day, 1869)	2883	2609
109	*Abudefduf cingulam* (Klunzinger, 1871)	4806	4348
110	*Abudefduf lacrymatus* (Quoy and Gaimard, 1824)	148973	134790
111	*Abudefduf dickii* (Lienard, 1839)	11053	10001
112	*Abudefduf biocellatus* (Quoy and Gaimard, 1825)	37342	20528
113	*Abudefduf uniocellatus* (Quoy and Gaimard)	74380	67299
114	*Abudefduf xanthozona* (Bleeker, 1853	30756	27828
115	*Abudefduf zonatus* (Cuvier, 1830)	12755	5597
116	*Abudefduf glaucus* (Cuvier, 1830)	40985	32847
	Total	5992984	5422447

Table 9. (Contd.) Estimates of stock size (number) and maximum possible yield (number) of different species

S.No.	Species	Stock size	Maximum yield
	Parrotfish		
117	*Leptoscarus vaigiensis* (Quoy and Gaimard, 1824)	38188	22992
118	*Cryptotomus spinidens* (Quoy and Gaimard, 1824)	35141	16765
119	*Scarus sordidus* Forskal, 1775	69526	33793
120	*Scarus psittacus* Forskal, 1775	1558866	1033366
121	*Scarus bataviensis* (Bleeker, 1857)	243702	95733
122	*Scarus jordani* (Jenkins, 1899)	1073	646
123	*Scarus pectoralis* (Valenciennes, 1839)	6663	4011
124	*Scarus niger* Forskal, 177512923	7781	
125	*Scarus sexvittatus* (Ruppell, 1835)	7065	4254
126	*Scarus ghobban* Forskal, 1775	72677	21760
127	*Scarus scaber* Valenciennes, 1840	53197	22678
128	*Scarus russelli* Valenciennes, 1840	2146	1292
	Total	2101167	1265071
	Rockcod		
129	*Cephalopholis roga* (Forskal, 1775)	1559	505
130	*Cephalopholis argus* Bloch and Schneider, 1801	17837	5780
131	*Epinephelus corallicola* (Valenciennes, 1878)	273	88
132	*Epinephelus fuscoguttatus* (Forskal, 1775)	117	38
133	*Epinephelus hexagonatus* (Bloch and Schneider)	16245	7469
134	*Epinephelus caeruleopunctatus* (Bloch, 1790)	611	198
135	*Epinephelus merra* Bloch, 1793	46567	12886
136	*Epinephelus elongatus* Schultz, 1953	312	101
137	*Epinephelus melanostigma* Schultz, 1953	52	17
	Total	83573	27082
	Lizardfish		
138	*Synodus variegatus* (Lacepede, 1803)	13469	4266
	Total	13469	4266
	Cardinalfish		
139	*Archamia fucata* (Cantor, 1850)	1214	822
140	*Pristiapogon fraenatus* (Valenciennes, 1832)	1396	946
141	*Pristiapogon snyderi* (Jordan and Everman, 1902)	56215	38077
142	*Ostorhynchus savayensis* (Gunther, 1871)	14691	9951
143	*Ostorhynchus endekataenia* (Bleeker, 1852)	486	329
144	*Ostorhynchus novemfasciatus* (Cuvier, 1828)	668	452
145	*Ostorhynchus moluccensis* (Valenciennes, 1832)	4735	3207
146	*Pseudamia gelatinosa* Smith, 1954	971	658
147	*Paramia quinquelineata* (Cuvier, 1829)	5261	3564
	Total	85637	58006
	Pufferfish		
148	*Canthigaster amboinensis* (Bleeker, 1865)	1093	740
149	*Canthigaster margaritatus* (Ruppell, 1828)	68235	46219
	Total	69328	46959

Table 9. (Contd.) Estimates of stock size (number) and maximum possible yield (number) of different species

S.No.	Species	Stock size	Maximum yield
	Filefish		
150	*Oxymonocanthus longirostris* (Bloch and Schneider, 1801)	12020	8142
151	*Amanses sandwichiensis* (Quoy and Gaimard, 1824)	1821	1234
	Total	13841	9376
	Sandsmelt		
152	*Parapercis quadrispinosa* (Weber, 1913)	182	123
153	*Parapercis hexophthalma* (Cuvier, 1878)	35878	24302
	Total	36060	24425
	Boxfish		
154	*Ostracion cubicus* Day, 1878	13477	9129
	Total	13477	9129
	Angels		
155	*Centropyge multispinis* (Playfair, 1866)	36606	24795
156	*Pomacanthodes imperator* (Bloch, 1787)	3885	2632
	Total	40491	27427
	Scorpeanfish		
157	*Scorpaenodes guamensis* (Quoy and Gaimard, 1824)	425	288
158	*Pterois volitans* (Linnaeus, 1758)	13113	8882
159	*Dendrochirus zebra* (Quoy and Gaimard, 1824)	911	617
	Total	14449	9787
	Rabbitfish		
160	*Siganus rostratus* (Valenciennes, 1835)	39945	27057
161	*Siganus stellatus* (Forskal, 1775)	8924	6045
162	*Siganus javus* (Linnaeus, 1766)	3278	2220
	Total	52147	35322
	Pufferfish		
163	*Arothron meleagris* (Lacepede, 1799)	1457	987
164	*Arothron stellatus* (Bloch and Schneider, 1801)	4189	2837
	Total	5646	3824
	Moorish idol		
165	*Zanclus canescens* (Linnaeus, 1758)	29261	19820
	Total	29261	19820

Table 10 Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

S.No.	Species	Popular name	Local name	Catch quota (no.)
	Surgeonfish			
1	*Ctenochaetus strigosus* (Bennett, 1828)	Spotted bristletooth	*Rykathi, Pala*	18500
2	*Acanthurus triostegus* (Linnaeus, 1766)	Convict surgeon	*Rabolu, Nelalan, Kurichil*	285000
3	*Acanthurus leucosternon* Bennett, 1828	Powder-blue surgeon	*Voulang, Alakan*	8500
4	*Acanthurus lineatus* (Linnaeus, 1758)	Blue-banded surgeon	*Haravalu-rykathi, Varipad*	32000
5	*Acanthurus nigricauda* Duncker and Mohr, 1926	Epaulette surgeon	*Rykathi, Pala*	10000
6	*Paracanthurus hepatus* (Linnaeus, 1766)	Palette surgeon	*Voulang, Chankatayan*	200
7	*Zebrasoma veliferum* (Bloch, 1795)	Sailfin tang	*Gali-voulang, Churiyan*	900
8	*Acanthurus tennenti* Gunther, 1861	Lieutenant surgeon	*Rykathi, Pala, Neythala, Karuthakotti*	750
9	*Acanthurus matoides* Valenciennes, 1835		*Kalahandi, Rykathi, Pala*	18500
10	*Acanthurus mata* Valenciennes, 1835	Elongate surgeon	*Pala*	3600
11	*Acanthurus elongatus* (Lacepede, 1802)		*Kalahandi, Rykathi, Pala*	4000
12	*Acanthurus blochii* Valenciennes, 1835	Tailring surgeon		250
13	*Naso litturatus* Schneider, 1801	Orange-spine unicorn	*Andungeli, Ammas, Kankettiyar, Karukkan*	3700
14	*Naso branchycentron* (Valenciennes, 1835)	Humpback unicorn	*Komban-karukkan*	600
15	*Naso unicornis* (Forskal, 1775)	Bluespine unicorn	*Niggam-mas, Ammas, Karukkan*	2500
16	*Naso brevirostris* (Valenciennes, 1835)	Spotted unicorn	*Thumbi, Ammas, Karukkan, Mudiyan*	450
17	*Naso tuberosus* Lacepede, 1802	Humpnose unicorn	*Fullikkarukkan, Mudiyan*	1350
	Total			390800

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

	Triggerfish			
18	*Rhinecanthus aculeatus* (Linnaeus, 1758)	Blackbar triggerfish	*Furondu, Vellakkaratti*	12000
19	*Rhinecanthus rectangulus* (Bloch and Schneider, 1801)	Patchy triggerfish	*Furondu, Alikkaratti, Chikkannakaratti*	600
20	*Sufflamen chrysoptera* (Bloch and Schneider, 1801)	Halfmoon triggerfish	*Chundam-kartti*	550
21	*Balistoides viridescens* (Bloch and Schneider, 1801)	Dotty triggerfish	*Rondu, Palli*	60
22	*Pseudobalistes flavimarginatus* (Ruppell, 1829)	Yellow-face triggerfish	*Rondu, Palli*	150
23	*Balistapus undulatus* (Mungo Park, 1797)	Orangestriped triggerfish	*Rondu, Karatti, Valupallan-karatti*	500
	Total			**13860**
	Butterflyfish			
24	*Heniochus acuminatus* (Linnaeus, 1758)	Coachman	*Didanegi, Chinganchena*	7500
25	*Heniochus monoceros* Cuvier, 1831	Masked coachman	*Didanegi,*	600
26	*Heniochus diphreutes* Jordan, 1903	Schooling coachman		350
27	*Heniochus singularis* Smith and Radcliffe, 1911	Philippine pennant fish		350
28	*Megaprotodon strigangulus* (Gmelin, 1788)	Striate butterflyfish	*Handupholimas, Pakkikkadiya*	5000
29	*Chaetodon meyeri* (Bloch and Schneider, 1801)	Maypole butterflyfish	*Pakkikkadiya*	80
30	*Chaetodon lunula* (Lacepede, 1803)	Kalfmoon butterflyfish	*Handupholimas, Pakkikkadiya*	1800
31	*Chaetodon collaris* Bloch, 1787		*Pakkikkadiya*	1200
32	*Chaetodon citrinellus* Cuvier, 1831		*Handupholimas, Sikkikokkamas*	1400
33	*Chaetodon trifasciatus* Quoy and Gaimard, 1825	Purple butterflyfish	*Handupholimas*	8800
34	*Chaetodon xanthocephalus* Bennett, 1832	Yellowhead butterflyfish	*Handupholimas Rhyndukokka, Pakkikkadiya*	3000

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

35	*Chaetodon falcula* Bloch, 1793	Saddled butterflyfish	*Galikkokkamas, Handupholimas*	2300
36	*Chaetodon auriga* Forskal, 1775	Threadfin butterflyfish	*Handupholimas, Pakkikkadiya*	16000
	Chaetodon kleini	Whitespotted butterflyfish		Rare fish
37	*Chaetodon vagabundus* Linnaeus 1758	Vagabond butterflyfish	*Handupholimas*	1800
	Total			50180
	Wrasses			
38	*Anampses caeruleopunctatus* Ruppell, 1829	Blue spotted tamarin	*Dielahikkae, Vayittukadiyan*	1500
39	*Anampses diadematus* Ruppell, 1835		*Vayittukadiyan*	150
40	*Cheilio inermis* (Forskal, 1775)	Cigar wrasse	*Iholi, Kolas-nhola, Nuvachulam*	2000
41	*Gomphosus caeruleus* Lacepede, 1802	Blue Birdfish	*Hibbaruhikkae, Chulam, Erachichulam*	2300
42	*Gomphosus varius* Lacepede 1802	Birdfish	*Hibbaruhikkae, Chulam*	2800
43	*Thalassoma hardwicki* (Bennett, 1828)	Sixbar wrasse	*Galihikke, Nhola, Kuppichulam*	7800
44	*Thalassoma janseni* (Bleeker, 1856)	Jansen wrasse	*Galihikke, Nhola, Kuppichulam*	4500
45	*Thalassoma lunare* (Linnaeus, 1758)	Crescent-tail wrasse	*Nagudiguhikkae, Nhola, Chulam*	1400
46	*Thalassoma umbrostigma* (Ruppell, 1835)		*Hikkae, Nhola*	300
47	*Thalassoma purpurea* (Forskal, 1775)		*Nuhikkae, Pattunulan, Nhola*	130
48	*Thalassoma quinquevittata* (Lay and Bennett, 1839)		*Nuhikkae, Nhola*	20
49	*Labroides dimidiatus* (Valenciennes, 1839)	Bluestreak wrasse	*Haremkali*	1000
50	*Macropharyngodon meleagris* (Valenciennes, 1839)			950
51	*Halichoeres scapularis* (Bennett, 1831)	Zigzag sandwrasse	*Dong-hikkae, Vayittukadiyan*	19500
52	*Halichoeres hortulanus* (Lacepede, 1801)	Checkerboard wrasse	*Kunauhikkae, Nhola, Payathalayan*	133000
53	*Halichoeres notopsis* (Valenciennes, 1839)			3000

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

54	*Halichoeres marginatus* Ruppell, 1835	Dusky wrasse		11500
55	*Halichoeres kawarin* (Bleeker, 1852)		*Rybanduhikkae, Nhola*	5000
56	*Hemigymnus melapterus* (Bloch, 1791)		*Thokka,*	450
57	*Halichoeres argus* (Bloch and Schneider, 1801)		*Nhola*	650
58	*Stethojulis strigiventer* (Bennett, 1832)	Three-ribbon wrasse	*Hikkae, Nhola*	1300
59	*Stethojulis trilineata* (Bloch and Schneider, 1802)	Cutribbon wrasse	*Hikkae, Nhola*	3600
60	*Stethojulis albovittata* (Bonnaterre, 1788)	Bluelined wrasse	*Hikkae, Nhola*	49000
61	*Hologymnosus semidiscus* (Lacepede, 1802)	Ringed wrasse	*Dielahikkae, Vayittukadiyan*	250
62	*Coris formosa* (Bennett, 1834)	Queen coris	*Didanagihikkae*	200
63	*Coris gaimardi* Smith, 1957	African coris	*Didanagihikkae, Kodiyan-nhola*	250
64	*Coris frerei* (Gunther, 1856)	Queen coris	*Kodiyan-nhola*	300
65	*Novaculichthys taeniourus* (Lacepede, 1801)	Rockmover wrasse	*Balala, Pongan*	3400
66	*Epibulus insidiator* (Pallas, 1770)	Slingjaw		350
67	*Pseudocheilinus hexataenia* (Bleeker, 1857)	Sixstripe wrasse	*Rung-hikkae*	100
68	*Cheilinus undulatus* Ruppell, 1835	Humphead wrasse	*Thokka, Chavarichoran*	2000
	Xyrichtys pavo Valenciennes, 1839			Rare fish
69	*Cheilinus trilobatus* Lacepede, 1801	Tripletail wrasse	*Thokka, Chavarichoran*	9500
	Total			268200
	Squirrelfish			
70	*Neoniphon sammara* (Forskal, 1775)	Blackfin squirrelfish	*Hudubarihi, Kolkaduva*	19500
71	*Neoniphon argenteus* (Valenciennes, 1831)	Silver squirrelfish		150
72	*Holocentrus laevis* Gunther, 1859		*Digubarihi, Kolkaduva*	850
73	*Sargocentron spiniferum (Forskal, 1775)*			500
74	*Sargocentron diadema* (Lacepede, 1801)	Crown squirrelfish	*Rybarihi, Kaduva*	1000

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

75	*Sargocentron lacteoguttatus* (Cuvier, 1829)		*Barihi, Kaduva*	2500
76	*Sargocentron violaceus* (Bleeker, 1853)		*Kaduva*	600
77	*Holocentrus caudimaculatus* Ruppell, 1828		*Raverimas, Theekaduva*	1300
78	*Myripristis murdjan* (Forskal, 1775)	Blotcheye soldier	*Lobodubarihi*	15000
79	*Myripristis adustus* (Bleeker, 1853)	Shadowfin soldier	*Lofodubarihi, Perumkanni, Kannankaduva*	3200
80	*Myripristis seychelliensis* (Cuvier, 1829)			100
	Total			44700
	Goatfish			
81	*Mulloidichthys samoensis* (Gunther, 1874)	Samoa goatfish	*Thelakanthi, Manakkam*	20000
82	*Mulloidichthys auriflamma* (Forskal, 1775)	Yellow-stripe goatfish	*Rheenduthelakanthi Manhamankkam*	5000
83	*Parupeneus barberinus* (Lacepede, 1802)	Dash-dot goatfish	*Kaluoh, Manakkam*	9000
84	*Parupeneus indicus* (Shaw, 1803)	Indian goatfish	*Thelakanthi, Manakkam*	2000
85	*Parupeneus pleurostigma* (Bennett, 1831)	Blackspot goatfish	*Manakkam*	350
86	*Parupeneus chryserydros* (Lacepede, 1802)	Gold saddle goatfish	*Manjalmanakkam*	200
87	*Parupeneus luteus* (Valenciennes, 1831)		*Manjalmanakkam*	800
88	*Parupeneus macronemus* (Lacepede, 1802)	Band-dot goatfish	*Kaluoh, Manakkam*	19500
89	*Parupeneus trifasciatus* (Lacepede, 1804)		*Kalmanakkam*	30
90	*Parupeneus bifasciatus* (Lacepede, 1801)	Two-saddle goatfish	*Galikaluoh, Kalmanakkam*	2700
	Total			59580
	Damselfish			
91	*Amphiprion nigripes* Regan, 1908	Anemone fish	*Maugandumus, Pushpachala*	9500
92	*Dascyllus trimaculatus* (Ruppell, 1828)	Domino	*Kaluburang, Karipadatham, Barakkotti*	51000

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

93	*Dascyllus reticulatus* (Richardson, 1846)	Two-bar humbug	*Galiburang, Kallikotti*	2700
94	*Dascyllus aruanus* (Linnaeus, 1758)	Zebra humbug	*Galiburang, Kallikotti*	111000
95	*Chromis chrysurus* (Bliss, 1883)		*Nilamahi, Padatham*	82000
96	*Chromis caeruleus* (Cuveir, 1830)	Blue puller	*Nilamahi, Pachakkotti*	220000
97	*Pomacentrus lividus* (Bloch and Schneider, 1801)		*Kudikiruliya, Padatham*	2000
98	*Pomacentrus nigricans* (Lacepede, 1803)		*Ryburang, Padatham*	33000
99	*Pomacentrus albifasciatus* (Schlegel and Muller, 1839)		*Nagudonkiruliya, Padatham*	9000
100	*Pomacentrus littoralis* (Cuvier, 1830)		*Padatham*	15000
101	*Pomacentrus albicaudatus* (Baschieri-Salvadori, 1955)		*Burang, Padatham, Kotti*	12000
102	*Pomacentrus pavo* (Bloch, 1787)	Saphire damsel	*Thathali, Pachakkotti*	5400
103	*Pomacentrus melanopterus* Bleeker, 1852		*Padatham*	20000
104	*Abudefduf bengalensis* (Bloch, 1787)		*Burang,*	1800
105	*Abudefduf vaigiensis* (Quoy and Gaimard, 1825)	Sergeant major	*Galiburang, Variyanpadatham*	10500
106	*Abudefduf sexfasciatus* (Lacepede, 1802)	Stripetail damsel	*Galiburang, Variyanpadatham*	200
107	*Abudefduf sordidus* (Forskal, 1775)	Spot damsel	*Lafiburang, Padatham*	1700
108	*Abudefduf notatus* (Day, 1869)	Dusky damsel	*Rabolu, Galiburang, Kalli, Padatham*	1300
109	*Abudefduf cingulam* (Klunzinger, 1871)		*Burang, Padatham,*	2100
110	*Abudefduf lacrymatus* (Quoy and Gaimard, 1824)	Jewel damsel	*Ryburang, Padatham*	67000
111	*Abudefduf dickii* (Lienard, 1839)	Narrowbar damsel		5000
112	*Abudefduf biocellatus* (Quoy and Gaimard, 1825)		*Rammas, Neelapadatham*	10000
113	*Abudefduf uniocellatus* (Quoy and Gaimard)		*Kiruliyammas, Padatham, Kotti*	33500
114	*Abudefduf xanthozona* (Bleeker, 1853		*Kiruliyammas, Padatham,*	14000
115	*Abudefduf zonatus* (Cuvier, 1830)	Two-spot damselfish	*Kiruliyammas, Padatham*	2700
116	*Abudefduf glaucus* (Cuvier, 1830)		*Kiruliyammas, Padatham*	16500
	Total			738900

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

	Parrotfish			
117	*Leptoscarus vaigiensis* (Quoy and Gaimard, 1824)	Marbled parrotfish	*Hima-lande*	11500
118	*Cryptotomus spinidens* (Quoy and Gaimard, 1824)	Spinytooth parrotfish	*Fehilande, Veesam*	8400
119	*Scarus sordidus* Forskal, 1775	Bullethead parrotfish	*Chandi*	16800
120	*Scarus psittacus* Forskal, 1775	Palenose parrotfish	*Alilandae, Veesam*	516000
121	*Scarus bataviensis* (Bleeker, 1857)	Blue-barred parrotfish	*Fehi-lande, Veesam*	48000
122	*Scarus jordani* (Jenkins, 1899)		*Chandi*	300
123	*Scarus pectoralis* (Valenciennes, 1839)		*Chandi*	2000
124	*Scarus niger* Forskal, 1775	Dusky parrotfish	*Karutha-chandi*	3800
125	*Scarus sexvittatus* (Ruppell, 1835)		*Fehi-lande, Veesam*	2100
126	*Scarus ghobban* Forskal, 1775	Bluebarred parrotfish	*Landae, Chandi*	11000
127	*Scarus scaber* Valenciennes, 1840	Fivesaddle parrotfish	*Galilandae, Veesam*	11300
128	*Scarus russelli* Valenciennes, 1840	Eclipse parrotfish		600
	Total			631800
	Rockcod			
129	*Cephalopholis roga* (Forskal, 1775)		*Kalugini, Karuthachemmali*	250
130	*Cephalopholis argus* Bloch and Schneider, 1801	Peacock rockcod	*Bulufana, Neelachammam*	3000
131	*Epinephelus corallicola* (Valenciennes, 1878)		*Gaudarufana, Poochachammam*	50
132	*Epinephelus fuscoguttatus* (Forskal, 1775)	Blotchy rockcod	*Fana, Chammam*	20
133	*Epinephelus hexagonatus* (Bloch and Schneider)	Whitespecked rockcod	*Sikkisikkifana, Pullichammam*	3700
134	*Epinephelus caeruleopunctatus* (Bloch, 1790)	White-spotted rockcod	*Fana, Chammam*	100
135	*Epinephelus merra* Bloch, 1793	Honeycomb rockcod	*Sikkisikkifana, Fullichammam*	6400
136	*Epinephelus elongatus* Schultz, 1953		*Gaudarufana, Poochachammam*	50
137	*Epinephelus melanostigma* Schultz, 1953	One-blotch rockcod	*Sikkisikkifana, Fullichammam*	0
	Total			13570

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

	Lizardfish			
138	*Synodus variegatus* (Lacepede, 1803)	Variegate lizardfish	*Sudung, Valakka*	2100
	Total			**2100**
	Cardinalfish			
139	*Archamia fucata* (Cantor, 1850)	Redbarred cardinal	*Rybodi, Chonnapoothan*	400
140	*Pristiapogon fraenatus* (Valenciennes, 1832)		*Murakibodi, Poothan*	450
141	*Pristiapogon snyderi* (Jordan and Everman, 1902)		*Bodubodi, Kottapoothan*	19000
142	*Ostorhynchus savayensis* (Gunther, 1871)		*Kalubodi, Kodupoothan, Kottapoothan*	5000
143	*Ostorhynchus endekataenia* (Bleeker, 1852)		*Rung-bodi*	150
144	*Ostorhynchus novemfasciatus* (Cuvier, 1828)		*Rung-bodi*	200
145	*Ostorhynchus moluccensis* (Valenciennes, 1832)		*Donbodi, Poothan*	1600
146	*Pseudamia gelatinosa* Smith, 1954	Jelly cardinal		300
147	*Paramia quinquelineata* (Cuvier, 1829)		*Rung-bodi, Poothanchala*	1800
	Total			**28900**
	Pufferfish			
148	*Canthigaster amboinensis* (Bleeker, 1865)	Spotted tobby	*Thundigu-koli,*	350
149	*Canthigaster margaritatus* (Ruppell, 1826)	False-eye toby	*Thundigu-koli, Chundu*	23000
	Total			**23350**
	Filefish			
150	*Oxymonocanthus longirostris* (Bloch and Schneider, (1810)	Harlequin filefish	*Thundigu-kalihi, Chundan katti*	4000
151	*Amanses sandwichiensis* (Quoy and Gaimard, 1824)			600
	Total			**4600**

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

	Sandsmelt			
152	*Parapercis quadrispinosa* (Weber, 1913)		*Sudung, Valakka*	50
153	*Parapercis hexophthalma* (Cuvier, 1878)		*Sudung, Valakka*	12000
	Total			12050
	Boxfish			
154	*Ostracion cubicus* Day, 1878	Boxy	*Gonu, Thombu*	4500
	Total			4500
	Angels			
155	*Centropyge multispinis* (Playfair, 1866)	Dusky cherub	*Kalu, Karipadatham*	12400
156	*Pomacanthodes imperator* (Bloch, 1787)		*Handupholimas, Harabalukokkamas*	1300
	Total			13700
	Scorpeanfish			
157	*Scorpaenodes guamensis* (Quoy and Gaimard, 1824)	Guam scorpeanfish	*Gauviha-mas, Peychan*	150
158	*Pterois volitans* (Linnaeus, 1758)		*Fang-hamas, Phanhu-kuthi, Chavarali*	4400
159	*Dendrochirus zebra* (Quoy and Gaimard, 1824)	Zebra lionfish		300
	Total			4850
	Rabbitfish			
160	*Siganus rostratus* (Valenciennes, 1835)	Grey spinefoot	*Bori, Kalloran*	13500
161	*Siganus stellatus* (Forskal, 1775)	Star-spotted rabbitfish	*Vori, Oran, Kalloran*	3000
162	*Siganus javus* (Linnaeus, 1766)		*Vori*	1100
	Total			17600

Table 10 (Continued) Catch quota to be fixed in the beginning of commercial exploitation of ornamental fishes from the Lakshadweep Islands

	Pufferfish			
163	*Arothron meleagris* (Lacepede, 1799)	Guineafowl blassop	*Kalu-koli, Karutha-chundu*	500
164	*Arothron stellatus* (Bloch and Schneider, 1801)	Star blassop	*Sikki-koli, Puli-chundu, Veerkunnon, Oothunnon*	1400
		Total		1900
	Moorish idol			
165	*Zanclus canescens* (Linnaeus, 1758)	Moorish idol	*Didamegi, Kodiyan*	9000
		Total		9000
			Grand Total	23,34,140

fish (1.7%), butterfly fish (1.1%), trigger fish (1.0%) and the remaining twelve families (10.4%). The species wise estimates are shown Table 9. The estimated maximum possible yield of the 165 species is about 86,00,000 fishes. The Maximum possible yield estimates reveal that the damselfish with the estimated maximum annual yield of 54,00,000 fishes constitute 63% of the total estimated yield of the 20 families. With the estimated annual maximum yield of 12,65,000 fishes, the parrot fishes form 14.7% of the 20 families. The Surgeon fish account for 9.1% of the 20 families, with the estimated maximum annual yield of 7, 80,000 fishes. The wrasses with the estimated maximum yield of 5, 37, 000 fishes per year, account for6.2% of the twenty families. The goatfishes form 1.4% 0f the twenty families with the estimated maximum annual yield of 1, 22,000 fishes. The butterfly fishes with the estimated maximum yield of 1, 02,000 fishes, form 1.2% of twenty families of ornamental fishes. The squirrel fishes with the estimated maximum yield of 89000 fishes form 1.0% of the twenty families.

Among the damsel fishes (Table, 9), *Chromis caeruleus* constitutes the bulk of the potential with the projected annual yield of 43, 81,000 fishes forming 80.8% of the total yield of the group. This species is totally an inhabitant of corals, often in association with *Dascyllus aruanus*. This later species with the estimated maximum annual yield potential of 2, 22,000 fish, forms 4% of the total yield of the damselfishes. With the estimated maximum annual yield of 1, 65,000 fishes, *Chromis chrysurus* forms 3% of the total yield potential of the group. *Abudefduf lacrymatus* forms 2.5% of the total yield of the damsel fishes with the estimated annual yield potential of 1, 35, 000 fishes. *Dascyllus trimaculatus* forms 1.9% of the damselfish yield with the estimated annual yield

potential of 1, 02,000 fishes. With the estimated annual yield potential of 67,000 fishes, *Abudefduf uniocellatus* forms 1.2% of the total yield of damselfishes. The remaining twenty species of damsel fishes considered in the present survey account for a maximum annual yield of 50,43,000 fishes forming about 9.3% of the total estimated maximum yield of the group.

In the Parrotfishes, *Scarus psittacus* constitutes a maximum annual yield potential of 10,33,000 fishes forming 81.7 % of the total yield of the group. With the yield potential of 95,700 fishes, *Scarus bataviensis* forms 7.6% of total of the 12 species of the family. *Scarus sordidus* has the potential to yield an annual catch of 34,000 fishes accounting for 2.7% of the total estimated yield of parrotfishes. *Leptoscarus vaigiensis*, with the yield potential of 23,000 fishes forms 1.8% of the total yield of 12 species of the family. With the estimated maximum yield potential of 22,700 fishes, *Scarus scaber* forms 1.8% of the total yield of parrotfishes. *Scarus ghobban*, with the annual yield potential of 22,000 fishes, accounts for 1.7% of the total yield of parrotfishes. The remaining six species together account for 2.7% of the yield parrotfishes, with the yield potential of 34,700 fishes per year (Table, 9).

Of the seventeen species of the surgeon fishes obtained in the survey, *Acanthurus triostegus* has the potential to yield 5, 69,000 fishes accounting for 73% of the yield of the family. *Acanthurus lineatus* with the annual yield potential of 63,000 fishes forms 8.1% of the total yield of surgeon fishes. *Ctenochaetus strigosus* and *Acanthurus matoides*, each forming 4.8% of the total yield of the family, have the potential to yield 37,000 fish each annually. The remaining 13 species contribute 75,300 fishes to the yield of these fishes accounting for 9.6% of the yield of surgeonfish (Table, 9).

The wrasses represented by 32 species in the present survey, have the potential to yield maximum catch of 5,37,000 fishes (Table 9). *Halichoeres hortulanus* has the potential to yield 2, 65,000 fishes a year, accounting for 49.4% of the yield of wrasses. *Stethojulis albovittata* would yield 98,000 fishes a year accounting for 18.3% of the total yield of the wrasses. *Halichoeres scapularis* yields 39,000 fishes forming 7.2% of the wrasse yield. *Cheilinus trilobatus* yields about 25,000 fishes per year accounting for 4.7% of the yield of these fishes. *Halichoeres marginatus* has the potential to yield 17,000 fishes annually contributing 3.2% to the yield of wrasses. *Thalassoma hardwicki* yields about 16,000 fishes forming 2.9% of the yield of wrasses. The remaining 11 species yield about 76,000 fishes annually forming 14.2% of the yield of all the 17 species.

The goatfishes, represented by ten species in this survey have the potential to yield a maximum of 1,21,000 fishes annually. Of these, *Mulloidichthys samoensis*, with the potential yield of 41,000 fishes account for 33.9% of the total yield of goatfish. *Parupeneus macronemus*, with the maximum possible yield of 39,000 fishes, accounts for32.2% of the goatfish yield. *Parupeneus barberinus*, with the potential to yield 18,000 fishes annually, accounts for 15% of the goatfish yield. *Mulloidichthys auriflamma* forms 8.7% of the goatfish yield potential. The remaining six species with the potential yield of 12,600 specimens account for 10.3% of the ten species of goatfishes collected in the present survey.

The squirrel fishes offer a potential yield of 89,000 fishes per year. Among them, *Neoniphon sammara* yields about 39,000 fishes per year accounting for 43.9% of the 11 species. *Myripristis murdjan* yields about 30,000 fishes annually, accounting for 33.4%

of the yield of squirrelfish. The remaining 9 species, with the annual yield potential of 20, 000 fish, account for 22.7% of the squirrelfish yield.

The butterfly fish, a group that is in very great demand in aquarium fish trade, offers a potential to yield about 100,000 fish per year. Of the 14 species collected in the survey, *Chaetodon auriga* has the largest yield potential of 33,000 fish accounting for 32.9% of the yield of these fishes. *Chaetodon trifasciatus* with the maximum possible yield of 17,500 fishes per year accounts for 17.2% of the butterfly fish yield. *Heniochus acuminatus* with the yield of 15000 fish per year accounts for 14.6% of the yield of the 14 species. *Megaprotodon strigangulus* has the potential to yield 10,000 fishes per year and contributes about 9.8% to the butterfly fish yield. The remaining 10 species can yield 26,000 fishes accounting for 25.4% of the yield of 14 species considered here (Table 9).

The most sought after fish in the aquarium trade is the moorish idol (*Zanclus canescens*) which offers an annual yield potential (Table 9) of about 20,000 fishes.

The triggerfish also is very important in the aquarium fish trade. These fishes represented by six species in the present work, offer a potential to yield 28,000 fishes per year. Among them, *Rhinecanthus aculeatus* has the largest potential of 24,000 fishes accounting for 86% of the triggerfish yield per year.

The other fishes considered in the present work are Angelfish, represented by two species (*Centropyge multispinis* and *Pomacanthodes imperator)* have an annual yield potential of 27,000 fishes. Filefish (*Oxymonocanthus longirostris* and *Amanses sandwichiensis*), offer a maximum possible yield of 9,000 fish per year. Rabbit fish (*Siganus javus, S. rostratus, S. stellatus*) offer the yield potential of 35,000 fish. Rock cods (*Epinephelus merra, E. hexagonatus* and others) have the yield potential of 27,000 fish per year. Lizardfish (*Synodus variegatus*) has the scope for the maximum possible yield of 4000 fish per year. Cardinal fish offers the annual yield potential of 58,000 fish. Pufferfish (mainly *Canthigaster margaritatus*) has the annual yield potential of 50,000 fish. Sandsmelt (*Parapercis hexophthalma* and *P. qudrispinosa*) have an annual yield potential of 43,000 fish (Table 9).

DISCUSSION AND RECOMMENDATIONS

The present survey was carried out with the main objective of estimating the stock size of major ornamental fishes in the lagoons of the Lakshadweep islands to enable formulating strategies for commercial scale exploitation of these fishes, which have a lucrative export market. The lack of any fishery for these fishes in the region necessitated designing a sampling strategy to understand the population structure and their characteristics. In the coral environments, one way of estimating population size is through census by diving. In view of the shallowness of the lagoons, the multiplicity of the species, the lack of expert divers who could effectively conduct the census of each species and the very serious limitations of this method in enumerating each species underwater, it was felt necessary to conduct actual fishing on a regular basis towards achieving this objective. This however, needs to ensure that the catch so obtained is representative of each species in the region with reference to all the attributes of the population. Though traps yielded some catches in respect of certain species, there is the problem of long soak periods. Besides, the number of species

of the yield of squirrelfish. The remaining 9 species, with the annual yield potential of 20, 000 fish, account for 22.7% of the squirrelfish yield.

The butterfly fish, a group that is in very great demand in aquarium fish trade, offers a potential to yield about 100,000 fish per year. Of the 14 species collected in the survey, *Chaetodon auriga* has the largest yield potential of 33,000 fish accounting for 32.9% of the yield of these fishes. *Chaetodon trifasciatus* with the maximum possible yield of 17,500 fishes per year accounts for 17.2% of the butterfly fish yield. *Heniochus acuminatus* with the yield of 15000 fish per year accounts for 14.6% of the yield of the 14 species. *Megaprotodon strigangulus* has the potential to yield 10,000 fishes per year and contributes about 9.8% to the butterfly fish yield. The remaining 10 species can yield 26,000 fishes accounting for 25.4% of the yield of 14 species considered here (Table 9).

The most sought after fish in the aquarium trade is the moorish idol (*Zanclus canescens*) which offers an annual yield potential (Table 9) of about 20,000 fishes.

The triggerfish also is very important in the aquarium fish trade. These fishes represented by six species in the present work, offer a potential to yield 28,000 fishes per year. Among them, *Rhinecanthus aculeatus* has the largest potential of 24,000 fishes accounting for 86% of the triggerfish yield per year.

The other fishes considered in the present work are Angelfish, represented by two species (*Centropyge multispinis* and *Pomacanthodes imperator)* have an annual yield potential of 27,000 fishes. Filefish (*Oxymonocanthus longirostris* and *Amanses sandwichiensis*), offer a maximum possible yield of 9,000 fish per year. Rabbit fish (*Siganus javus, S. rostratus, S. stellatus*) offer the yield potential of 35,000 fish. Rock cods (*Epinephelus merra, E. hexagonatus* and others) have the yield potential of 27,000 fish per year. Lizardfish (*Synodus variegatus*) has the scope for the maximum possible yield of 4000 fish per year. Cardinal fish offers the annual yield potential of 58,000 fish. Pufferfish (mainly *Canthigaster margaritatus*) has the annual yield potential of 50,000 fish. Sandsmelt (*Parapercis hexophthalma* and *P. qudrispinosa*) have an annual yield potential of 43,000 fish (Table 9).

DISCUSSION AND RECOMMENDATIONS

The present survey was carried out with the main objective of estimating the stock size of major ornamental fishes in the lagoons of the Lakshadweep islands to enable formulating strategies for commercial scale exploitation of these fishes, which have a lucrative export market. The lack of any fishery for these fishes in the region necessitated designing a sampling strategy to understand the population structure and their characteristics. In the coral environments, one way of estimating population size is through census by diving. In view of the shallowness of the lagoons, the multiplicity of the species, the lack of expert divers who could effectively conduct the census of each species and the very serious limitations of this method in enumerating each species underwater, it was felt necessary to conduct actual fishing on a regular basis towards achieving this objective. This however, needs to ensure that the catch so obtained is representative of each species in the region with reference to all the attributes of the population. Though traps yielded some catches in respect of certain species, there is the problem of long soak periods. Besides, the number of species

as well as specimens caught of each of them is very less. This, however, does not preclude the introduction of traps for commercial fishing for ornamental fishes because in addition to being the best gear for collection of live fishes, it was also found that certain important fishes like butterfly fishes are caught in fair numbers in the traps. More over, this is the least destructive gear in the coral environment. Hence traps need to be encouraged for commercial exploitation of ornamental fishes.

The coral environment does not permit any dynamic gears because it results in damage to the gear as well as to the corals. Hence, it was felt desirable to use gillnets with white monofilament. As the gillnet is a selective gear, gillnets of four different mesh sizes of 20, 30, 40, 50 mm, side by side in the same region simultaneously, were used. By experience, it was found that these four nets would yield representatives of the species of ornamental fishes inhabiting the region. It was also found that the maximum size of any species considered in this survey does not require mesh size greater than that was used in the present work. The lack of fishing for these fishes and the consequent absence of data was a serious constraint. To achieve the required data, the results of fishing in each island were suitably weighted to obtain comparable data from different islands and to be able to obtain monthly-pooled estimates. This was done assuming that the species available in different islands constitute a single unit stock. It is only thus, was it possible to obtain monthly estimated catches, species composition and length composition. The methods of estimating the growth parameters, mortality rates, stock size and maximum possible yield are according to the established theoretical models and methodologies. Estimates of growth and mortality parameters could be made and stock size estimated in respect of forty species only. The stock estimates of the remaining species were made considering the species assemblages in the catches obtained, i.e. the proportion of each species in the total number of species of each group, assuming the species assemblages as obtained in the present survey are realistic and remain constant. It must be admitted that some of these assumptions cannot be reasoned on available evidence and it is not proposed to offer any explanation for this. One would agree, however, that these assumptions, at least, are not unreasonable while one is attempting to assess the virgin stocks in a 'data not available' situation. These limitations suggest that the estimates of stock size and maximum possible yield have to be taken as indicative to develop a strategy for initiating commercial exploitation.

The lagoons of the Lakshadweep islands offer vast scope for developing a sustainable fishery for ornamental fishes. The present study revealed that about 8.6 million fishes belonging to 165 species of 20 families could be fished every year. The design of the present survey took into account all major groups of ornamental fishes. However there are several other species like eels, which live in crevices and cannot be taken by set nets; their stock estimates could not be made. While such species are only a few and have little demand in the aquarium fish trade, the species other than those included in this report should be fished carefully restricting their catches to the barest minimum.

The ornamental fishes have a very lucrative export market. The lagoons are very shallow and easily accessible. The exploitation on a commercial scale is likely to result not only in quick overexploitation of the ornamental fish species but also in the

destruction of the coral population and the environment. The lagoon environment is very rich in biodiversity with a large number of animals (sponges, coelenterates-corals, sea anemones, molluscs, echinoderms, fishes and several others) inhabiting the region with certain interdependence and biological interactions. Any indiscriminate exploitation can disturb the balance in the associations of different organisms leading to loss of biodiversity and environmental degradation. Fishing for ornamental fishes, therefore should essentially be carried out by nondestructive methods. Trap fishing is effective for certain species while being nondestructive. Fishing for required species through diving and hand-net fishing is also nondestructive. Besides, this method also ensures collection of only the required species in required numbers. Hence these two methods need to be considered seriously while formulating strategies for commercial exploitation.

The aquarium fish market has very high demand for certain varieties of fish like moorish idol, butterflyfish, triggerfish, surgeonfish and such others. Hence the fishery can quickly and selectively exploit such species on large scale for temporary but high profits. Such an action could lead to imbalance in the environment besides leading to overexploitation of those species. In the Lakshadweep lagoons, the fishes in great demand, as mentioned above, are relatively less in number (Table 8, 9) than several other species. To prevent possible overexploitation and environmental degradation, the stock sizes are estimated for each of the 165 species and it needs to be ensured that the exploitation in a year does not exceed the maximum possible yield of these species. Besides, recognizing the danger of a blanket clearance, even to exploit up to the maximum possible yield level, for exploitation of these fishes for reasons mentioned above, species wise quotas are estimated for the initial phase of exploitation for the first about five years. Table 10 shows the maximum number of fishes of each species that could be fished per year. This needs to be enforced strictly. The development of ornamental fish fishery in the Lakshadweep should necessarily consider taking certain important actions before actual exploitation is initiated on a commercial scale:

- A viable and sustainable strategy should be formulated after due consultations with the Scientists, Administrators, Development organizations, the Industry and the export trade
- Database development should be an integral part of the programme,
- The fisheries department of the akshadweep should be vested with effective monitoring and regulatory authority and the exploitation and export/transport needs to be cleared by this department.
- Every island should develop a holding facility onshore. This should consist of cement tanks of 10-tonne capacity with running seawater facility.
- The transport of fishes from the islands to the mainland/abroad should be carried out from one island, preferably Kavaratti as most trips of the ships touch this island. As an alternative, this could be done from mainland also. The purpose of this restriction is to effectively monitor the export/transport
- All the fish caught live as well as dead should be brought to the shore and the authority should record the number of fish caught under each

species and the length and weight of each specimen caught

- There should be restriction on the number of firms entering the exploitation and export trade and there should be a scheme of licensing. As an alternative a Corporation should be established by the Government of the U.T. of Lakshadweep.
- Annual quotas for each species should be fixed and informed to the concerned firms
- If the quotas are exceeded by any firm, the license should be cancelled forthwith and a penalty imposed for violating the orders. Within the total quota fixed for a species, the different firms should be offered separate quotas, all of them together not exceeding total catch quota of the species.
- A small portion of the export value should be passed on to the ICAR for continuing research on these fishes and to advise the Government on the required measures to be adopted for sustaining the fishery and protecting the environment..
- The fishing in the lagoons should be banned during June-September every year
- Some island lagoons such as that of Bangaram should be left unexploited entirely to serve as Marine Protected Areas..
- A suitable mechanism should be developed to review the exploitation, monitoring and the trade to ensure sustainability of the fishery.
- Some species like *Chromis caeruleus* and *Dascyllus aruanus* are inhabitants of the interstices of the corals. Their collection often involves disturbing the coral and occasionally breaking them. *C. caeruleus* is a very delicate species and cannot survive the stress of collection. Though the standing stock of this species is the highest, it is recommended that collection of this species should be avoided totally. Onshore development of broodstock, breeding and culture of this species in two, three islands should receive priority consideration. Similarly, culture of other ornamental fish species also should be considered on a priority in the islands.

REFERENCES

ANON.1986. *Report on the Training Mission on ornamental fish export to the Netherlands*. Marine Products Export Development Authority, Cochin, 24 pp.

ANON. 1993. *Union Territory of Lakshadweep-Basic Statistics 1991-1992*. Planning Department, Secretariat, Kavaratti, 156pp.

APPUKUTTAN, K.K., A. CHELLAM, K. RAMDOSS, A.C.C. VICTOR and M.M. MEIYAPPAN. 1989. Molluscan Resources. *In*: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 77-96

BEVERTON, R. J. H. and S. J. HOLT. 1957. *On the Dynamics of the Exploited Fish Populations*. Fishery Investigation Series Ministry of Agriculture Fisheries and Food 19: 533pp.

BURGES,W. E. 1978. *Butterfly fishes of the world-a monograph of the family Chaetodontidae*. 832 pp. T.F.H.Publications, Inc. Ltd.

EDWARDS, A. J. and A. D. SHEPHERD. 1992. Environmental Implications of Aquarium-fish collection in the Maldives, with proposals for regulation. *Environmental Conservation*, **19**: 61-72.

GAYANILO Jr., F.C., M. SORIANO and D. PAULY. 1988. A Draft Guide to *COMPLEAT ELEFAN. ICLARM Software Project* **2**: 65 pp and diskettes

GAYANILO JR., F.C., P. SPARRE AND D. PAULY. 1994. The FAO-ICLARM Stock Assessment Tools (FiSAT) user's guide. FAO Computerized Information Series (Fisheries) No. 8. Rome, FAO, 124 pp., 3 diskettes

JAMES, D. B. 1989. Echinoderms of Lakshadweep and their Zoogeography. *In*: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 97-144.

JAMES, P.S.B.R., C.S.GOPINATHA PILLAI, P.P. PILLAI, P. LIVINGSTON AND MADAN MOHAN. 1986. Marine fisheries research in Lakshadweep-A Historical Resume. *Mar. Fish. Inform. Serv. T & E. Ser.*, **68**: 7-9.

JAMES, P. S. B. R., C.S.G.PILLAI, P.A. THOMAS, D.B. JAMES and SAID KOYA. 1989. Environmental Damage and Consequences. *In*: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 212-226.

JONES, S. 1986. Lakshadweep-General features and some considerations. *Mar. Fish. Inform. Serv. T & E. Ser.*, **68**: 1-6.

JONES, S. and M.KUMARAN.1980. *Fishes of the Laccadive Archipelago*. The Nature Conservation and Aquatic Sciences Service, Santhinivas, Nanthancode, Trivandrum, India,756 pp.

KALIAPERUMAL, N., P. KALADHARAN AND S. KALIMUTHU. 1989. Seaweed and Seagrass Resources. *In*: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull.Cent. Mar. Fish. Res. Inst.*, 43: 162-175.

LE CREN, E. D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis) J. Anim. Ecol.*, **20**: 201-219.

MADANMOHAN, C.S.G.PILLAI and K.K.KUNHIKOYA. 1987. Biology of the blue-puller *Chromis caeruleus* (Cuvier) from Minicoy Atoll. *Indian J. Fish.*, **33**: 457-470

MADANMOHAN and C.S.G. PILLAI. 1988. A contribution to the biology of the convict surgeonfish *Acanthurus triostegus triostegus* (Linnaeus) from Minicoy Atoll-Lakshadweep. *J. mar. biol. Ass. India*, **30**: 182-191.

MUNRO, J. L. (ed.). 1983. Caribbean Coral Reef Fisheries Resources. *ICLARM Stud. Rev.*, **(7)**: 276 pp.

MURTY, V. S. 1996. Marine ornamental fishes of India. *Proceedings of the Seminar on "Fisheries-A Multibillion Dollar Industry"* pp 23-34. Aquaculture Foundation of India, Madras, August 1995.

MURTY, V. S. 2001. Ornamental Fish Resources of Lakshadweep. *In*: Proceedings of Workshop on Scientific Database on Lakshadweep Islands. *Geol. Surv. Ind. Spl. Pub*, 56: 103-111

MURTY, V. S., M. KUMARAN and R.S. LALMOHAN. 1989. Resources of ornamental fishes. ***In***: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 46-64.

PAULY, D. 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J. Cons. CIEM* 39(2): 175-192.

PILLAI, C.S.GOPINATHA, MADANMOHANM AND K.K.KUNHIKOYA. 1983. On an unusual massive recruitment of the reef fish *Ctenochaetus strigosus* (Bennet) (Perciformes, Acanthuridae) to the Minicoy Atoll and its significance. *Indian J. Fish.*, **30**: 261-268.

PILLAI, C.S.GOPINATHA, MADANMOHAN AND K.K.KUNHIKOYA. 1987. A critique on the relationship of surface area of live-coral with total number of fishes as well as the biomass of fish in a coexisting system of *Chromis caeruleus* and *Dascyllus aruanus* (Pomacentridae) at Minicoy Atoll. *J. mar. biol. Ass. India*, **27**: 1-8.

PILLAI, C.S.GOPINATHA, MADANMOHANM AND K.K.KUNHIKOYA. 1987. Ecology and biology of the white-tailed humbug, *Dascyllus aruanus* (Pomacentridae, Pisces) from Minicoy Atoll. *J. mar. biol. Ass. India*, **27**: 113-123

PILLAI, C. S. GOPINATHA and S. JASMINE. 1989 The Coral Fauna of Lakshadweep. ***In***: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 179-195.

PILLAI, C. S. GOPINATHA and MADANMOHAN. 1990. Ecology and Biology of *Abudefduf glaucus* (Cuvier) (Pomacentridae, Pisces) from Minicoy Atoll, Lakshadweep. *Indian J. Fish.*, **37**: 15-23.

PILLAI, C.S.GOPINATHA, G. GOPAKUMAR AND MADANMOHAN. 1992. Ichthyofauna of the intertidal reef flats of Minicoy Atoll, Lakshadweep: An analysis of its structure, relative abundance and food. *J. mar. biol. Ass. India*, **34**: 74-83.

SAINSBURY, K. J. 1984. Optimal mesh size for tropical multispecies trawl fisheries. *J. Cons. Int. Explor. Mer.*, **41**: 129-139.

SMITH, M. M. and P.C. HEEMSTRA. (ed.). 1986. *Smith's Sea Fishes*. Springer-Verlag 1047 pp.

SNEDECOR, G. W. AND W. G. COCHRAN. 1967. *Statistical Methods*. Oxford and IBH Publishing Co., New Delhi, Sixth Edition, 593 pp.

SPARRE, P. 1987. Computer programs for fish stock assessment. Length-based fish stock assessment for Apple II computers. *FAO Fish. Tech. Pap.*, (101) Suppl., 2: 218 pp.

THOMAS, P. A. 1989. Sponge Fauna of Lakshadweep. *In*: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 150-162.

TOMEY, W. A. 1985. Survey in the Union Territory of Lakshadweep, the Bombay and Madras area;Promotion of export trade of Indian ornamental fishes from marine as well as freshwater origin and ornamental plants. Report to the CBI the Netherlands and the Marine Products Export Development Authority, Cochin.

TOMEY, W. A. 1986. Promotion of export trade of Indian ornamental fishes from marine as well as freshwater origin and aquatic plants for the aquarium industry; the pilot project; Conclusions and recommendations. Report on the project results to CBI/ MPEDA.

VICTOR, A.C. C., A. CHELLAM and K. RAMADOSS. 1989. Underwater observations in the lagoons. *In*: Marine Living Resources of the Union Territory of Lakshadweep-An Indicative Survey with suggestions for Development. *Bull. Cent. Mar. Fish. Res. Inst.*, 43: 227-242.

VIJAYANAND, P. E. and T. J. VARGHESE. 1990. Notes on marine ornamental fishes from Lakshadweep. *Seafood Export J.*, **22**: 13-18.