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INDIAN COUNCIL OF AGRICULTURAL RESEARCH

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

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**FAO/DANIDA/ICAR National Training Course on  
Fish Stock Assessment**

Held during

**7 November 1983 - 9 December 1983**

at



**CENTRAL MARINE FISHERIES RESEARCH INSTITUTE**

**COCHIN - 682 018**

## FISH HARVEST MELA AT CALICUT

A fish harvest mela to demonstrate to the fish farmers the technical feasibility of converting the derelict sandy shores to productive fish ponds by providing polythene lining in excavated pond areas and culture of economical fishes like milkfish and marine prawns was conducted at the Research Centre of Central Marine Fisheries Research Institute, Calicut on 31st December, 1983.

The fish harvest which started by 11 A. M. was over in the evening by about 3 P. M. A total of 278 kg. of *Chanos chanos* (Poomeen) was harvested from 3 ponds having a total area of 0.18 ha. The maximum

length and weight of the fish was observed to be at 375 mm. and 380 gm. respectively. The fishes were sold to the public at the rate of Rs. 10/- per kg. on the spot.

A public meeting held in this connection at the Marine fish farm was presided over by Dr. P. V. Ramachandran Nair, Scientist of CMFRI. Mr. A Sankaran, Mayor of Calicut Corporation as the Chief Guest pointed out the importance of fish as a protein rich food and appreciated the efforts of the CMFR Institute in various methods of culture of fishes.



Fishing in progress



Mayor Mr. Sankaran watching the catch taken



Harvested fish

## PREFACE

Assessment of fish stocks assumes all the more importance on global level when the limitation on the available land mass to feed the increasing population is felt. In addition, fish is protein rich and relatively cheap when compared to other cereals. Fish stocks being a renewable resource should therefore be scientifically exploited on sound management approach. The factors affecting fish stocks other than human intervention such as fishing, oil and mineral exploration and pollution have also to be taken into account while studying their conditions.

For this purpose mathematical models are available and to estimate the parameters involved statistical techniques have been developed. In studying fish stocks in temperate waters these models and techniques have been extensively used. In case of tropical regions ageing of fish has always posed problems and this has stood in the way of proper assessment of stocks.

In order to make a break through, length frequency analysis has been developed and this approach is used in studying tropical stocks. Though this approach has its own limitations, as any other models for that matter, it serves at least as a first approximation in assessing the impact of fishing on the stocks.

With this view FAO in collaboration with Danish International Development Agency, Denmark has started training courses on fish stock assessment wherein workers dealing with this aspect in their research or teaching programmes have been taken as participants. These participants have been exposed to extensive material dealing with the models and methods of arriving at estimates of parameters using programmable pocket calculators. Such calculators are provided to each one of the participants so as to have first hand knowledge of arriving at estimates independently by each one of them. Another important aspect of these training courses is the case study approach in which published

material is considered for detailed study to bring out the merits and the demerits of the approach in these case studies and to point out the methods of improving the same. By this approach an insight in depth in analysing data on fish stocks is obtained by the participants.

Five weeks FAO/DANIDA/ICAR National Training Course on Fish Stock Assessment is one such training course organised by FAO, DANIDA and ICAR for the benefit of Indian Scientists dealing with fish stock assessment either in their research programmes or teaching courses or in both. For this purpose workers from various Agricultural Universities and Research Organisations have been selected as participants. In the faculty in addition to FAO/DANIDA experts there were three Indian course instructors.

This National Training Course organised at CMFRI commenced on 7, Nov. 1983 and concluded on 9, Dec. 1983. There were altogether 25 participants. I am sure that this Training Course will have a great impact on the participants so as to generate new thinking in studying tropical fish stocks and result in improved as well as new models for the proper assessment of the fish stocks. In the following pages are given the proceedings of the training course. This course, though had a serious bearing throughout, was not without lighter moments some of which are also recorded for the benefit of the readers.

I take this opportunity to thank FAO, DANIDA and ICAR for extending all the help for the successful completion of the course and the various organisations for readily sponsoring their candidates as participants. I also thank the faculty members and the participants for their sincere and devoted co-operation but for which this course would not have been a grand success. I would like to place on record my sincere thanks to the other sister organisations in Cochin for extending their help during the training course.

E. G. SILAS  
Course Director

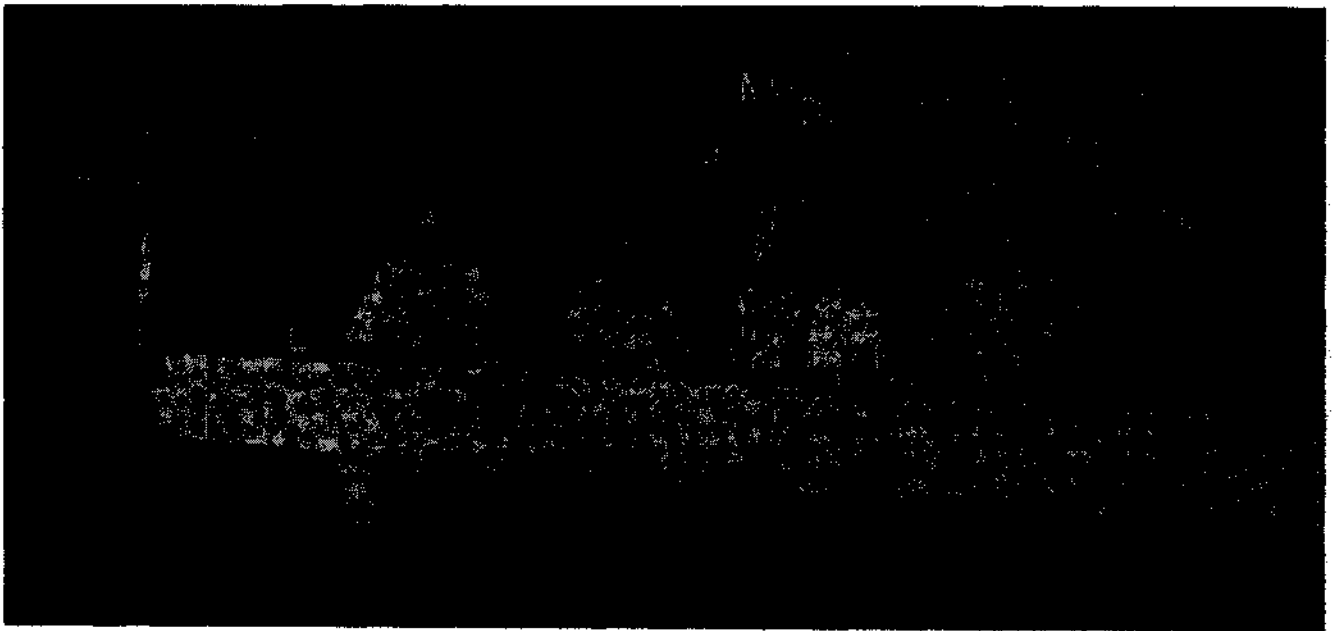
## I. Inauguration

The inaugural function was presided over by Dr. K. Gopalan, Vice-Chancellor, University of Cochin, Cochin, which was held on 7-11-83, the venue being International Hotel, Ernakulam.

In his welcome address Dr. E.G. Silas, Director, CMFRI and the Course Director of the National Training Course reviewed the present status of the exploited marine fisheries in India mentioning both capture and culture aspects and the role played by CMFRI in the development of marine fisheries research in India. Tracing the history of the fishery science he indicated that from a descriptive science in the last century it has now grown to a multi-disciplinary one involving basic sciences such as biology and mathematics, environmental sciences such as oceanography and meteorology and applied sciences such as fish processing, ship building, fishery economics and management. In this era of remote sensing, he continued, the importance of data collection from different angles - biological, environmental and management - and the coverage of EEZ has been felt and CMFRI has established National Marine

Living Resources Data Centre to meet the requirements. The system developed by CMFRI in the estimation of marine fish landings in India and the voluminous data collected by CMFRI from its very inception on marine fisheries was also outlined by him. Indicating the increase in the area of exploitation by the declaration of EEZ in 1976, Dr. Silas mentioned that the total marine fish landings in India did not show further increase from 1.4 million tonnes per year, thus belying the expectation of larger landings from the enlarged available area for exploitation. Hence attention has been now drawn, he said, towards diversification of fishing, intensifying coastal aquaculture activities, creating infrastructure facilities and development and improvement of internal and external markets for the marine products. This, according to him, calls for data on the availability of stocks, their levels and the area of their distribution and methods of processing and analysis of the same as quickly as possible so as to make the results available to the industry as and when they are required.

In this context Dr. Silas stressed the importance of such training courses to present before the Scientists the models appropriate for stock assessment. Mentioning



Inauguration

the genesis of this training course, the part played by Mr. Venema and Dr. Christensen and the initial problems encountered, he appreciated the steps taken by FAO and DANIDA in arranging such training courses. Since the four case studies chosen for this training course are concerned with tropicals the participants, he hoped, would be exposed to a number of approaches in dealing with tropical stocks and thus this training course would bring out an evolutionary change in the study of fish stocks in India.

While concluding Dr. Silas expressed his great pleasure in welcoming Dr. K. Gopalan, the Vice-Chancellor of University of Cochin, Mr. S.C. Venema and Dr. J.M. Christensen, the Co-Directors of the Course, Dr. Erik Utsin and other course Instructors, the participants and the distinguished guests including the Press. In his introductory remarks Mr. S.C. Venema, Fisheries Resources Officer, FAO and a Co-Director of this course detailed the genesis of this course and the part played by the FAO. Dr. J. Moller Christensen, Director, Danish Institute for Fisheries and Marine Research, Denmark and a Co-Director of this Course narrated the steps taken by his Institute for the inputs of this Course and wished that more and more exchange of ideas and research results between his Institute and CMFRI would be forthcoming in the future for the betterment of marine fisheries research in Denmark and India.

In his inaugural address, Dr. K. Gopalan, Vice-Chancellor, University of Cochin, expressed his happiness at organising this National Training Course at Cochin and choosing CMFRI as the venue for this purpose. Though he is not a fishery scientist, he mentioned, he is convinced that Indian seas have a high potential of fishery resources. India by declaring the Exclusive Economic Zone in 1976 has extended its national jurisdiction upto 200 nautical miles thus adding a very large area to its economic limits in the sea. This large area, he continued, needs to be intensively explored for the living and the non-living resources. Though fishery potential is estimated at 4.0 million tonnes in Indian waters it has taken three decades to reach a level of 1.4 million tonnes annually in the total marine fish landings in India. In this respect, he commented, the fishing industry is not only very slow to develop but also very reluctant to go in for deep-sea-fishing. The major accent of fishing industry is shrimp-oriented and it has not been easy to wean it away from this "Shrimp-mania". Diversification of fishing over species may help to overcome this. The chartering of foreign vessels by Indian Companies to exploit the EEZ may affect the resources in the inshore waters. Hence the urgency for stock assessment and

the appropriateness of this kind of training courses, he added.

While mentioning about the complexity of problems in tropic regions, Dr. Gopalan further said that the marine fisheries in India have peculiar characteristics with over 150 species of fish and shell fish entering the



Dr. K. Gopalan, Vice-Chancellor, University of Cochin delivering inaugural address

commercial fisheries. The gears operating are varied in nature exploiting different columns of water from surface to bottom. In this context, he pointed out, it is commendable that CMFRI has extensive data on marine fishery resources methodically collected since its inception in 1947 by evolving and later on improving a system of stratified multistage random sampling for this purpose. One can really be proud of this fact that the importance of scientific data collection based on sound statistical principles was realised by India long before any other country in this region. Having sound data base computer facilities are required for quick data processing and analysis. In this context, Dr. Gopalan mentioned, whatever help is required from his University he would like to extend the same to CMFRI. He further added that CMFRI has been recognised by the University of Cochin as the Centre for Advanced Studies in Mariculture for conducting Post Graduate and Ph.D. courses. While concluding he expressed his hope that this training course would help the participants in assessing fish stocks available in EEZ and to make short term forecasts on fish stocks indicating maximum

sustainable yields to the fishing industry and fishery administrators. Wishing success to all concerned he declared the FAO/DANIDA/ICAR National Training Course on Fish Stock Assessment inaugurated.

Shri T. Jacob, Head, Fisheries Economics and Extension Division, CMFRI, Cochin, proposed vote of thanks.

## II. Introduction to the Course

The aim of the course is to teach the participants appropriate techniques for assessing fish stocks and fisheries in tropical seas as a basis for management. For this purpose participants are expected to have practical experience in stock assessment and to have a basic knowledge of the standard mathematical methods of fish population dynamics as they are taught at the Central Marine Fisheries Research Institute, Cochin and the Central Institute of Fisheries Education, Bombay. The course commenced with an introduction to mathematics, statistics, calculator programming and some basic concepts. The next four weeks of the course were



Course Director Dr. E. G. Silas, Director, CMFRI and Co-Director Mr. S. C. Venema discussing the programme

devoted to four case studies each of a duration of about a week in which one or more important papers or research reports were critically read, calculations checked and alternative methods suggested, tried and discussed. The convenor of each case study saw to it that each method used in the papers read and each alternative method suggested was briefly high-lighted in a short lecture to make sure that everybody present was familiar with the methods and the ideas behind them.

The first day of each case study was used mainly for review of the basic techniques, general introduction to

the subject, discussion on data bases and application to management problems. The last day of each case study was devoted to discussions of the application to Indian research and management. Exercises related to the case studies took place in groups each having an Indian and or an FAO/DANIDA instructor.

During the week days Monday through Friday, work programme started at 08.30 hrs. and concluded at 17.00 hrs. with a lunch break between 12.00 and 14.00 hrs. On each Saturday only morning session was held. In the evenings faculty meetings were held to take stock of what has been presented to the participants on that day and to decide the presentation for the next day. These faculty meetings were found to be very much helpful in that the programme to be presented for the next day was discussed in detail among the faculty members and the mode of presentation was decided so that the participants would feel at home when the methods would be explained. These decisions were based on the experience gained by the staff during their discussions with the participants while working out the exercises during the earlier sessions.

The following lectures on general topics were also arranged during this course.

- i. "The tropical, the Temperate and the Arctic Seas as media of fish production".

By Dr. Erik Ursin on 23-11-'83.

- ii. "Some recent advances in the study of tropical fish recruitment".

By Dr. Daniel Pauly on 1-12-'83.

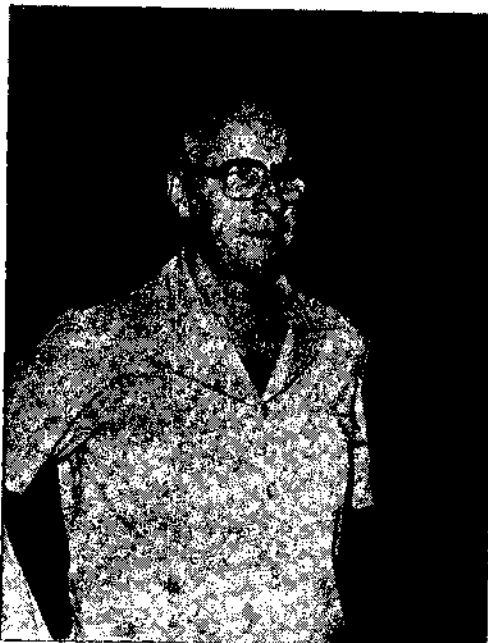
Four trips for the benefit of the participants have been arranged as follows:

- i. On board the vessel trip on 23-11-'83,
- ii. Boat trip to back-waters of Cochin on 27-11-'83,
- iii. Visit to Cochin Fisheries Harbour on 3-12-'83  
and
- iv Visit to the places of interest-off Cochin on 4-12-'83.

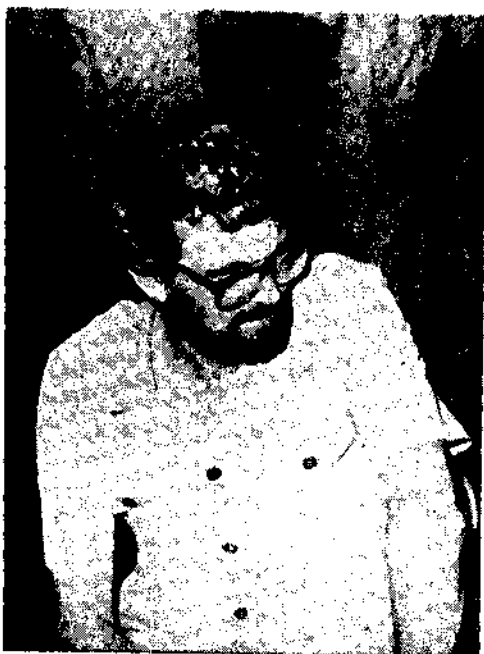
Each participant received a complete set of educational material comprising lecture notes, exercises, extracts of relevant chapters of different manuals,



publications and a scientific programmable calculator, Sharp EL 5100 S (List enclosed, Appendix-3).



Dr. J. M. Christensen Co-Director of the course



Mr. S. C. Venema, Co-Director of the course

Course Instructors :

- i Dr. Erik Ursin (First three weeks)
- ii Mr. Hans Lassen (Last four weeks)
- iii Mr. Per Sparre (Last four weeks)
- iv Dr. Daniel Pauly (Fourth week only)
- v Dr. K. Alagaraja
- vi Dr. M. Devaraj
- vii Shri K.K. Ghosh.



Course Director and Co-Director with the participants



Dr. J. M. Christensen discussing a point with the scientists

The staff of the Course are as under.

Course-Director : Dr. E. G. Silas

Co-Directors i. Dr. J. Moller Christensen (First week only).

ii Mr. S. C. Venema (First and last week)

There were two get-together dinners one on 11-11-83 and the other on 8-12-83 in which senior scientists of the CMFRI, Course Director, Co-Directors, faculty members and participants took part.

### III. Course Proceedings

Actual training course commenced in the afternoon of 7-11-'83. After self introduction by participants and faculty members Dr. E.G.Silas, the Course-Director expressing his happiness for having this National Training Course at CMFRI explained the facilities, particularly library facilities, available for the faculty members and the participants, at CMFRI. He advised the participants to make the best use of this training course. Dr. J.M. Christensen, then gave a brief talk on the "Role of the Fishery Biologist". While touching upon the historical growth of fishery science he mentioned how the stocks were studied initially and how mathematical models are now used with involvement of various disciplines in studying stocks. Thus he indicated the fishery science has become a multi-disciplinary one involving fishery biology, population dynamics, fishery economics and management. The major events in the fishing history he continued, are (1) tremendous increase in fishing effort and (2) the development of electronic equipments including computers. He also mentioned the principal tasks of a fishery biologist. They are according to him (1) to provide information on the interaction between the production of the fishery resources in the sea (and in fresh water) and the fishery which exploits these resources and (2) to advise administrators about how the fishery affect the resources and hence the yields which may be obtained from them in future. Mr. S. C. Venema briefly described the role of FAO in this training programme on fish stock assessment and the experience gained during the earlier training programme particularly in Kenya.

During the rest of the week refresher courses in Mathematics, Statistics and instruction in the use of programmable pocket calculator Sharp EL-5100 S were given to the participants.

Dr. Alagaraja while introducing the basic mathematics mentioned that Mathematics is a language of symbols. Explaining the same he introduced symbols for summations, product and inequalities. Variables, functions, dimensions, transformations, laws of indices, logarithms, differentiation and integration were the major topics touched up on during this course. Rates of mortality and the difference between ordinary rates and instantaneous rates have also been explained by him. He also distributed his lecture notes on these topics.

Mentioning briefly the importance of Statistics in the study of life sciences Dr. Alagaraja introduced Statistics as a study of variations. Different measures to study a population have also been explained by him under

the measures of central tendency and dispersion. Under central tendency mean (Arithmetic, Geometric and Harmonic), median and mode have been explained with suitable examples. Range, mean deviation and standard deviation as the square root of variance were explained by him under measures of dispersion. Lecture notes on these topics prepared by him have been distributed to the participants.

Shri K.K. Ghosh introduced the concept of regression and correlation with simple examples. He also explained the significance of 'a' and 'b', the parameters appearing in the linear regression  $y = a + bx$  with suitable graphs. The significance of 'r' the correlation coefficient was pointed by him and lecture notes on these aspects prepared by him have been made available to the participants.

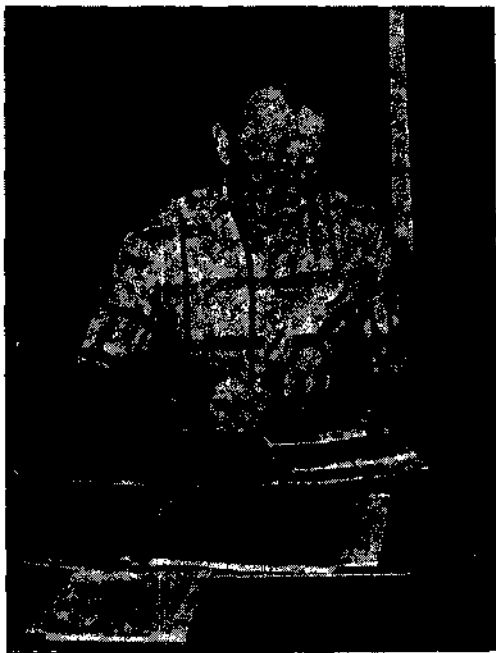
Dr. Erik Ursin introduced the Sharp EL 5100S programmable pocket calculator and explained how basic operations could be performed and simple programmes developed so as to estimate the measures of central tendency, dispersion, 'a', 'b' and 'r'. This introduction was so timed that as soon as a concept was explained and examples given calculation part was done by the help of the calculator. In this way both theory and the method of estimation have been presented side by side for the better understanding of the participants. This approach was very much appreciated by all the participants.

#### Case Study I: 'Population dynamics of threadfin bream'.

In the second week first case study was taken up by the convenor, Dr. Erik Ursin. The reference material was a paper by Daniel Pauly and P. Martosubroto appeared in 1980 in the Journal of Fishery Biology, 17: 263-73 the title of the paper being "The population dynamics of a threadfin bream, *Nemipterus marginatus* off Western Kalimantan, South China Sea". Introducing the case study Dr. Ursin mentioned the following.

When handling tropical demersal fisheries with a large number of important species it becomes increasingly clear that some groupings of these fishes are required. Yield assessment can then be carried out for each group of species with similar values of parameters of mortality, growth and food consumption. This requires initial studies of individual species even if these, as in the present case, contribute only one per cent to the total catch. The paper is remarkably suitable for a case study because it highlights many methods dealt with in Pauly's manual, FAO Fisheries Technical Paper No. 24 and takes the

reader through the processes of parameter estimation ending with an yield assessment. It shows how much can be achieved with very limited resources and invites the introduction of several of Pauly's computer programmes.



Dr. Erik Ursin preparing for the case study I

With this introduction Dr. Ursin explaining the case study approach mentioned the importance of critically reading the material to decide whether one should agree with the author(s) or not. He also explained the purposes of data collection in that he highlighted the importance of ageing fish, estimating mortalities and plotting yield curves. For age frequency studies he advocated parabola method which according to him is simple and straight forward when compared to Cassie's and Bhattacharya's methods. He also emphasised the need for alternative methods for estimation of parameters for mutual check.

Participants received a copy of the paper with serial numbers inserted in the margin and referring to a set of notes. These were of three kinds namely (1) comments by Dr. Ursin on methods used and on alternative methods, (2) documentation consisting of copies of relevant pages of papers referred to by authors or papers describing alternative methods and (3) exercises based on data in the paper itself or in the documentation sheets. Participants performed the calculations made by the authors and discussed merits and disadvantages of alternative methods. Opportunity was taken to use the programmable pocket calculator. Additional data were intro-

duced from other publications and incorporated in the study.

During the discussions, participants questioned the way in which mortalities were estimated, moving averages taken and assumptions on isometric growth made by the authors in the case study material. Extensive exercises on decomposition of multimodal curves into unimodal components by using different methods, estimation of mortalities, growth parameters and yield per recruit and use of sharp EL 5100 S in programming the processes to arrive at these estimates easily and quickly helped the participants to understand the stock assessment problems in a very clear way. The importance of the following points has emerged out of this case study.

(1) Representation of the samples—whether the sample is adequate to reflect the characteristics of the stock under study; (2) The periodicity of the length modes—whether it is monthly, quarterly, annual or anything else; (3) assumption on the normality of the components of age distribution and (4) the veracity of the modes—whether the modes are real and age specific or otherwise.

During the session for the presentation of the Indian material Dr. Alagaraja was the Convenor. In this session Dr. Alagaraja, Dr. Sriramachandra Murty, Shri. K. S. Udupa and Dr. Devaraj presented their materials for discussion.

Dr. Alagaraja provided new approach to estimate  $l_{\infty}$  and  $K$  along with their standard errors. He brought home to the participants the point that modal progression should not follow either arithmetic or geometric progression when growth is assumed to follow that of von Bertalanffy. Estimating the instantaneous rate of total mortality, 'Z', on the basis of length frequency data alone was also explained by him. Use of data on tagging for estimation of 'K' and assessment of well exploited stocks using theory of relative response were also explained by him with suitable examples. Copies of notes containing these results were distributed to the participants.

Dr. Sriramachandra Murty presented results on *Nemipterus* spp. particularly on *Nemipterus japonicus* in Andhra waters. Explaining the *Nemipterus* fishery in Kakinada area on the basis of his experience, he mentioned the results obtained by Dr. B. Krishnamurthy. He also mentioned the methods adopted by various authors for estimating growth parameters. He emphasised the need for finding age through hard part studies and doubted whether the modes indicated in Pauly and Martosubroto paper were really annual.

Presenting his material Shri K. S. Udupa explained how to estimate  $l_{\infty}$  and  $K$  by using his method of dividing the modes into three equal groups. In case of missing data also he mentioned the method of estimation of  $l_{\infty}$  and  $K$ .

Dr. Devaraj, while presenting his material based on the data collected off Bombay coast, mentioned a graphical approach to trace the modes and assigning them age. His approach indicated the existence of two clear broods with six months apart. He was of the opinion that though this graphical approach is subjective this may indicate atleast the relative age of modes. Regarding the adjacent modes these modes may belong to males and females which exhibit differential growth. He suggested that such modes could be separated on the basis of sexes and graphs for males and females could be drawn. However, he pointed out that sexing in their earlier stages of growth would not be easy.

Winding up the discussions the convenor Dr. Alagaraja thanked Dr. Ursin for the interesting way he conducted the case study and Dr. Devaraj, Shri K. S. Udupa and Dr. Sriramachandra Murty for presenting Indian material.



Mr. Per Sparre with material for case study II

#### Case Study II. "Assessment of penaeid shrimp stocks"

During the third week second case study was taken up by Mr. Per Sparre, the Convenor. The topic was the assessment of penaeid shrimp stocks. The material for this case study was based on the paper entitled "Estimation of mortality rates and population size for shrimps in Kuwait waters"- Kuwait Bulletin of Marine Research 1981 by Jones and Van Zalinge.

In Kuwait, when processed, shrimp tails are usually graded into about ten size groups. Data on the quan-

ties processed on each size category are used to estimate length composition of shrimp landings. These data formed the input to the case study material considered here for "Jones" length cohort analysis which as output gave monthly estimates of mortality rates and stock sizes. This method was illustrated by the data from Kuwait shrimp fishery. The results from the cohort analysis were compared to those obtained from an alternative method namely the cumulative catch curve method. This case study dealt with the data on shrimp tails as mentioned earlier. Data on shrimp tails are not difficult to obtain. The conversion of data on shrimp tails to the length data is also straight forward. Hence the importance of this case study to obtain information from industrial data.

In his introductory remarks on the case study Mr. Sparre explained four different methods for assessing shrimp stocks viz (1) cumulative catch curve; (2) Beverton-Holt method of estimation of 'Z' using mean size and the size at first capture; (3) cohort analysis using age frequency data and (4) cohort analysis using length frequency data. He added that in the cumulative catch curve a constant 'Z' is assumed and so also in the Beverton-Holt approach. In the case of cohort analysis natural mortality alone is assumed to be constant. Hence 'F' the instantaneous rate of fishing mortality becomes age or length specific in this case. Virtual population analysis (VPA) developed by Pope has been extensively used for this purpose. Programmes using the Sharp EL 5100 S for cohort analysis and cumulative catch against length and age were given to the participants. Methods of arriving at the results step by step in each of these approaches have been illustrated in the work sheets supplied to them. Extensive exercises were given and by doing these exercises the participants became familiar with these methods.

During the discussions it was pointed out that the cumulative catch approach using relative age using von-Bertalanffy's growth equation was more time consuming than the one where lengths were used in the place of estimated relative age on the basis of lengths. The difference in the estimates of Z for males and females was explained by the phenomena that segregation of males and females takes place during breeding season when females move to deeper areas for spawning. While clarifying the doubts Mr. Sparre mentioned that in cohort analysis internal consistency in the estimates of 'F' should be ensured. For deciding the magnitude of 'M' the instantaneous rate of natural mortality, the range of M/K should be taken into consideration. The initial value of 'F' substituted in the cohort analysis should be such that the curve of 'F' against length groups is almost

asymptotic at larger lengths. Shri K.K. Ghosh, by bringing out the contrasts between the different methods, clarified the doubts of the participants.

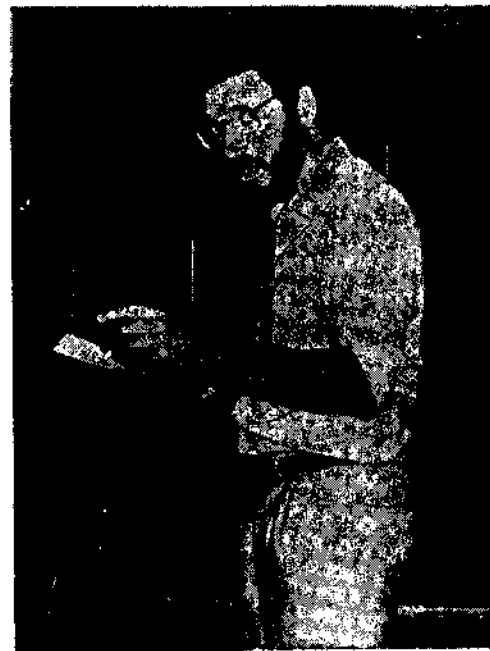
Dr. M. Devaraj was the Convenor when the Indian material was presented under this case study. Dr. S. Ramamurthy and Dr. Devaraj provided the material for discussions.

While enumerating constraints on shrimp stock assessment studies Dr. Ramamurthy highlighted the persistence of modes throughout the year, clearly indicating the breeding of shrimps over a wide range of time. He presented the estimates of growth parameters as arrived at by him and other workers for detailed discussions. He also pointed out the difficulty in arriving at these estimates as the shrimp fishery is a multi-species one operated upon by multi-gears. Standardisation of effort posed problems he added.

Continuing the presentation of the Indian material Dr. Devaraj compared the estimates of growth parameters for *Metapenaeus dobsoni* as arrived at by different workers on the basis of data collected at Cochin, Calicut, and Mangalore. Comparing the estimates he explained the reasons for differences if any among them. During the discussions it was mentioned that identification of age groups was the problem in assessing shrimp stocks. Winding up the discussions, Dr. Devaraj thanked Mr. Sparre for the clarity of his presentation of the case study and Dr. Ramamurthy for his contribution in the session for the presentation of Indian material.

### Case Study III "Small-scale fisheries of San Miguel Bay"

Dr. Daniel Pauly, as the Convenor for this case study in the fourth week, presented the material "Small-scale fisheries of San Miguel Bay, Philippines", ICLARM, Technical reports Nos. 7 to 10. He started his case study in the form of questionnaire for formulation of management advice based on data from the multi-species, multi-gear and multi-problem fishery of San Miguel Bay. For this purpose, according to him, formulation of management advice must be based on a broad understanding of a fishery inclusive of the social and economic factors affecting the fishery. This applies particularly to such cases where conflicts between small-scale and large-scale fishermen augment the usual problems associated with the assessment of any tropical fishery. This case study was based on the results obtained in the course of the multi-disciplinary investigation of a major fishing ground in the Philippines, the San Miguel Bay. Information relating to the following aspects of the fishery was presented and discussed by the participants. The major aspects



Dr. Daniel Pauly driving home a point

were the bay ecosystem, estimation of catch and effort, stock assessment, fishery regulations and legal aspects, economics of production and marketing, incomes, assets and attitudes in fishermen families, their occupational and geographical mobility and alternative occupations, rich and poor fishermen the problem of equity vs economic-efficiency, estimating maximum economic yield (MEY) and MEY as a basis for fishery management.

The available information was then used by the participants to formulate realistic management schemes for the San Miguel Bay fishery. These management schemes considered all forms of interventions possible to various agencies, including but not restricted to direct interventions (quotas, control of effort, closed seasons etc.) as well as indirect ones (helping to set up production of marketing co-operatives, subsidies, cheap loans, infrastructure development etc.). Thus the major aim of this case study is to provide the participants with criteria with which to assess the usefulness of various methods and approaches used in stock assessment and to formulate meaningful fishery research programmes.

Since the approach in this case study was different from the earlier ones in that the present case study did not require much routine calculations but more thinking and formulations of research programmes including budget proposals, the participants felt a change for the good and were enthusiastic in advancing their ideas in different aspects of management planning. Each group was asked to develop a programme for a better management of a fishery and a representative of each group

was asked to come forward to present his group's ideas. After the presentation of ideas by all groups, discussions took place and the omissions and commissions in the project so developed and improvements required to meet all the challenges – social, political and economical – have been spelled out. Dr. Pauly maintained that in studying various aspects of fishery one should take note of question of sequence, relevance of factors, abiotic factors affecting fishermen and choice among priorities for detailed study.

In continuation of this case study, Mr. Hans Lassen gave a brief account on fishery economics covering biology, economy, sociology and laws of fishing. He also introduced the concept of 'opportunity cost'. In the place of maximum sustainable yield (MSY) which deals with biological aspects of fishery only, he mentioned, maximum economic yield (MEY) is to be taken into account since this concept covers both biological and economic aspects of a fishery. During the discussions it was pointed out that maximum catch, maximum income and maximum employment would not be compatible and hence a suitable course has to be considered to take care of socio-economic aspects while making policies in fishery development programmes. The importance of three tier planning namely structural, functional and practical was also brought out during the discussions. Winding up the case study Dr. Pauly brought out the significance of old data and advantages of comparative study using different models on data bases collected at different periods.

While the Indian material was presented by Shri. K.K.P. Panikkar, Shri. K. K. Ghosh was the Convenor. Dealing with the impact of purse-seining on indigenous fishing in Kerala coast Shri. Panikkar mentioned that though the catch levels of mackerel were not affected much, the reasons for lesser landings of mackerel by the indigenous units were the earlier arrivals of mackerel of purse-seines through trucks throughout the coast and the lower price of fish. Since the price per kg. of mackerel was low indigenous units stopped going for mackerel fishing during 1981. He also pointed out that indigenous fishermen sought alternative employment as road repairers, stone cutters etc. during this period. He then presented data on the compatibility of mechanised fishing with the indigenous fishing. The area of study for this purpose was Pudiappa-Puthiangadi near Calicut. In this area near about sixty mechanised boats were introduced by the Agricultural Refinance Development Corporation, through the fishermen Co-operative Societies involving many of the fishermen families and hence fishermen using indigenous units started operating mechanised boats also. These fishermen during off-season

used mechanised boats for towing indigenous units to deeper waters and started fishing. In this way, Shri. Panikkar pointed out, the availability of mechanised boats was fully utilised by the local fishermen along with their indigenous units for increasing their income from fishing. Analysis of data further indicated more economic activity in this region when compared to the nearby village Elathur. During the discussion it was pointed out that over capitalisation should not be encouraged and for this purpose stock assessment studies of the region should be taken up before enlarging the effort of fishing. Winding up the discussion Shri Ghosh thanked Dr. Pauly for his innovative approach in the case study and Shri Panikkar for having presented Indian material for discussion. He appreciated the work done in this line and wished that more and more such studies would be taken up in order to understand the fishery as a whole and the impact of the changes taking place in the fishery on the socio-economic conditions of the fishermen community.

#### **Case study IV: "Appraisal of data from research vessel survey"**

In the fifth and the final week appraisal of data from research vessel survey was taken up for the fourth case study. The material for this purpose was drawn from the survey report from Kenya. Mr. Hans Lassen was the Convenor for this case study. According to him, assessment of tropical fish stocks is often mainly based on results from research vessel surveys. These surveys



Planning for presentation of material for the case study IV-  
Mr. Hans Lassen

may be based both on trawling and on acoustical integration. Both methods create a large confusing pile of work sheets. The case study illustrates the process from work sheet to condensed tables in a report. The problem also exists for other sampling programmes and the principles illustrated in this case study apply equally well to that situation. The objective of surveying is an appraisal of the fish resources and an evaluation of the possible yield which may be expected from the surveyed stocks.

The exercises in this case study hence centred on estimation of stock abundance from a set of trawl hauls and acoustical transects. The statistical background, sampling design, estimators etc were presented without any formal mathematical derivation of formula. The data reduction required in these types of analysis was demonstrated by design of worksheets. The participants received relevant extracts of the reference listed above and related exercises.

To assess fish stocks, Mr. Lassen continued, information on the following items should be obtained: (1) gear-wise catch per unit effort; (2) area swept-out by each gear; (3) average biomass; (4) species-wise catch details and (5) efficiency of each gear. With the knowledge of these items one would be able to pool the estimates to obtain MSY and test the precision of estimates. To explain basic concept of sampling techniques to the participants he requested Dr. Alagaraja to give a talk on this topic. He also requested Shri. Ghosh to explain the participants the basic concepts of analysis of variance (ANOVA) as required in the case study.

Accordingly Dr. Alagaraja mentioned the importance of sampling, difference between sampling and census and the preference for sampling over census. While explaining the different sampling techniques he touched upon simple random sampling with and without replacement, systematic, cluster and stratified sampling and multi-stage sampling. He also briefly mentioned the methodology used by CMFRI for estimating marine fish landings in India through a stratified multistage random sampling scheme. Lecture notes prepared by him on these aspects were distributed to the participants.

Shri K.K. Ghosh explained the use of ANOVA and mentioned the important assumptions underlying the models. One-way and two-way classifications under ANOVA have been presented and the significance of each term was pointed out. The lecture notes containing these aspects have been distributed by Shri Ghosh to the participants.

Continuing the case study Mr. Lassen explained the three methods of estimation of potential yield (P.Y.) In all these methods, an estimate of biomass (B) is required. The first method equates P. Y. with  $0.5 \times M \times B$ , where M is the instantaneous rate of natural mortality. In the second method M is replaced by Z the instantaneous rate of total mortality. In the last method  $P.Y. = 2.3 \times W \times B$ . This case study was also full of exercises and once again the participants started using pocket calculators vigorously. The use of transformation of data when some of the assumptions for ANOVA were not true was explained by him. Logarithmic transformation, he suggested, would be better for the data obtained from trawl surveys.

Dr. Devaraj was the Convenor when the Indian material was presented by S/Shri. K. Krishna Rao and M.E. John. Shri Rao explained the method of forming grids for surveys and mentioned two approaches of surveys viz. parallel grid and zig zag grid surveys. Copies of his paper containing the results of his findings have been distributed. Shri. John placed before the participants the results of a cruise in which he was the leader. In this cruise he mentioned that there were 85 trawl stations. The duration of the cruise was 22 days. Each haul covered two hours. The total catch was about 24 tonnes dominated by cat fish forming about 50%. On the basis of this survey depthwise species availability could be indicated, he mentioned. Since this survey was meant for fish trawling, the catches did not contain shrimps.

Winding up the discussions Dr. Devaraj thanked Mr. Lassen for his lucid way of presenting his case study and the extensive exercises. He also thanked S/Shri. Krishna Rao and John for presenting the Indian material and the participants for their involvement in the discussions.

During this week, a questionnaire prepared by Mr. S.C. Venema was distributed to the participants to assess their impressions on this training course. It revealed that those who have mathematical/statistical background have expressed that the course content is sufficient in this topic. Those who have no background however indicated that the duration may be extended from one to two weeks, increasing exercises both in mathematics and statistics. There was an overall agreement in expressing their appreciation to Dr. Erik Ursin's way of presentation of case study, and all the participants felt satisfied in the way the discussions were held throwing much light on the stock assessment. It was also expressed that the exercises in the second case study by Mr. Per Sparre were informative and exhaustive. The

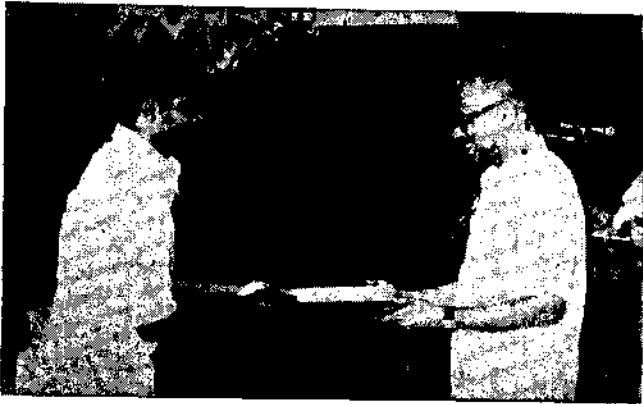




Shri K. S. Udupa giving his impressions



Shri T. Madhava Menon, Vice-Chancellor,  
Kerala Agricultural University,  
delivering the valedictory address



Distribution of certificate



Distribution of certificate



Distribution of certificate



A view of the audience



relevance of the third case study by Dr. Daniel Pauly was very much appreciated and also the case study on trawl surveys by Mr. Hans Lassen.

#### IV. Valedictory function

On 9-12-83 the final day of the course, valedictory function was held at 16.00 hrs at the Banquet Hall of International Hotel, Ernakulam. Shri. T. Madhava Menon, Vice-Chancellor of Kerala Agricultural University presided over the function. Dr. K. Alagaraja welcomed the gathering. Dr. E.G. Silas in his introductory remarks expressed his happiness for the successful completion of the training course and hoped that the benefit accrued from this course to the participants would be reflected in their research programmes on stock assessment and in the re-orientation of syllabus in their teaching programmes on this topic. He also mentioned that CMFRI would extend all required help to the participants in this regard. Mr. S.C. Venema expressed his thanks on behalf of FAO to one and all for the happy ending of the training course and appreciated the systematic way the daily programmes were conducted and the regularity and punctuality in the attendance of the participants. He also mentioned that he has gained a lot from this course by his participation in the discussions during the course. He wished that follow up action would be taken up by all concerned by keeping up contacts with one another.



Participants at work

Impressions on the course were given by Shri. K.K. Ghosh from the faculty side and by Dr. S. Ajmal Khan and Shri K.S.Udupa from the participants side. They all expressed their happiness for taking part in this course and thanked the Course Director for arranging this training course. They also thanked FAO, DANIDA and ICAR for the same. They mentioned that they would take up their work in stock assessment with new

ideas derived from this course and reorient their teaching course accordingly.

Shri T. Madhava Menon gave the valedictory address and distributed the certificates to the participants.

In his valedictory address Shri. Madhava Menon expressed his thanks to Dr. E.G. Silas, Director, CMFRI for inviting him to preside over this function and to distribute the certificates to the participants. In the course of his address he commended the role played by FAO and DANIDA for organising this type of training on global level. Tracing the history of fishing from the time immemorial to the present day he said that fishing has remained a family occupation in our country. The improvement in the marine fish landings from a humble 0.5 million tonnes in fifties to about 1.4 million tonnes at present, he opined, was mainly due to R & D programmes in this sector after independence and these programmes have lifted this artisanal occupation to a highly capital intensive industry earning at present a foreign exchange of about Rs. 350 crores.

While comparing fish stocks with other resources he mentioned that these stocks are beyond direct count and there are innumerable number of species spread over the seas in a heterogeneous way due to different environmental conditions such as depth, current, temperature, wind and latitude. Moreover the marine wealth is not inexhaustive as it was thought of, he said. To support this he cited the anchovian fishery of South America. In this context he stressed the need for a good data base and quick processing and analysing through computerised approach.

Shri Madhava Menon expressed his happiness for the selection of suitable case studies for this course. Indicating their relevance for our conditions he mentioned that methods developed elsewhere and quoted in these case studies should both be a challenge and a hopeful solution to our Scientists and Administrators. Appreciating the appropriateness of the choice of Central Marine Fisheries Research Institute, Cochin as the venue for this National Training Course he also mentioned the important role played by CMFRI from its very inception in the field of marine fisheries research, the system of data acquisition developed by it, the establishment of National Marine Living Resources Data Centre at this Institute and short and long-term multi-disciplinary research programmes on capture and culture fisheries undertaken by it.

Commending on the choice of expertise from FAO, DANIDA and ICAR Institutes and the selection of

## V. Special lectures

There were two special lectures arranged for the benefit of the participants and other Scientists working in CMFRI and other fishery organisations in and around Cochin. In this connection invitations have been sent to all Fisheries Research Institutes, State and Central



Dr. Erik Ursin delivering special lecture

Fisheries Organisations and the Universities. These lectures were well-attended by the staff of these institutions.

The first lecture on "The tropical, the temperate and the Arctic seas as media of fish production" was delivered by Dr. Erik Ursin on 23-11-83. In that he highlighted the differences of conditions of marine life in high and low latitudes. According to him the three major causes for the differences are (1) the more marked seasonal differences in high latitudes; (2) the differences in metabolic rates and rates of decay caused by temperature; and (3) the specialisation achieved in evolutionary old echo-systems. Explaining the range in temperatures prevailing in these regions he drew the attention of the audience to the relationship existing between phytoplankton and copepods and between copepods and predators. He also mentioned about the seasonal variation in primary production. He further observed that temperate seas with mean temperature about 10°C and an annual variation in temperature from 3°C to 16°C are similar in many ways to the Arctic seas. However, when in Arctic seas we have an annual primary production of 40 g C/m<sup>2</sup>/y, we often have 100-200g in temperate waters. By contrast the tropical shelves proper, with temperatures about 27°C all the year around usually show little seasonal variation in primary production. The great difference is between the open sea with low production rates of 40g c/m<sup>2</sup>/y as in the Arctic and the coastal waters with production levels of 200-400 g. The absence of time lags between biomass maxima of the different trophic levels is found in the tropic seas.

Regarding metabolism, Dr. Ursin explained, that it is also related to temperature and indicated how the growth parameters  $r_{\infty}$  and  $K$  are dependent on metabolism. The tropical fishes generally appear to have, according to him, a routine metabolism two or three times higher than fishes of cold temperate waters. Geologically, he continued, the Pacific is supposed to be the oldest sea with the highest number of species. In contrast the cold temperate and the Arctic seas are extremely young regions on which so many stock assessment studies have been made. In these regions there has been little time for evolutionary adaptation and most species may be called ubiquists as compared to the varied and highly specialised fauna of the tropical Pacific and the Indian Ocean. The ability of an echo-system to withstand the effects of major fishery seems related to its specialisation; the more specialised, the more vulnerable. The North Sea is an example of a particularly robust system. In spite of a massive reduction of the stocks of herring and mackerel as an effect of introducing new technology the total fish biomass remained almost

the same. While concluding Dr. Ursin mentioned two important differences of tropical and temperate fish stocks viz. (1) The maximum of the yield curve (if any) is reached at higher effort levels in tropics. The kind of overfishing experienced at effort levels higher than 'Fmax' giving maximum yield is not likely to be discerned in a multi-species tropical fishery; and (2) temperate seas are characterised by relatively high virgin biomass because of the lower natural mortality rates which permit more age groups to contribute to the biomass.

The second lecture was given by Dr. Daniel Pauly on 1-12-83. The topic was "Some recent advances in the study of tropical fish recruitment". Recalling the failures of anchovy fishery in Peruvian waters and herring fishery in the North Sea he surmised that this failure could be due to lack of abundance in the recruitment to the exploited stocks. Hence, the relevance of study on recruitment in his opinion, assumes greater importance in assessing the exploited fish stocks. Reviewing the earlier work on this aspect he mentioned that different



Dr. Daniel Pauly delivering special lecture

types of relationships have been indicated between recruitment and stock size by different workers. Cushing tried to match spawning and Zooplankton production. Recruitment curves developed by Ricker and later by Beverton-Holt related recruitment with parent stock. Continuing Dr. Pauly said that there are many other factors that determine the recruitment to the stock. Environmental factors affecting (1) parent stock at the time of spawning; (2) eggs after spawning; (3) larvae before recruitment to the fishery; and (4) availability of food for recruits should be taken into account for establishing the failure or success of the fishery. This in turn helps one to evaluate maximum sustainable yield (MSY). The earlier models of Ricker and others are simplified versions of the conditions

obtaining in nature. These simple models do not take into consideration the environmental factors since equilibrium conditions are assumed for these models. Hence the need to integrate all these items in a model if it is to be realistic, he asserted.

Some of the most important factors that effect recruitment are upwelling, turbulence, monsoons, water and wind currents. Dr. Pauly illustrated the relationship between the effect of turbulence on the availability of food and the mortality of the larvae. He also indicated that turbulence is proportional to the cube of wind force. Effect of monsoons on spawning success is well established, he pointed out. The importance of microlayers for better recruitment is felt now-a-days. Apart from these environmental factors predators play a vital role on recruitment. In the light of this, Dr. Pauly suggested for a multifactor model involving environmental factors, predators, etc. in the place of existing simple models. The model he presented was

$$\log R/S = a + S + \sum_{i=1}^n b_i x_i$$

Where R and S indicate recruitment and Stock size respectively and  $x_i$  indicate factors such as predators, temperature and turbulence. He mentioned that data collected over thirty years on about twenty factors have been considered for analysis. He concluded saying that this multimodel approach would certainly lead to better understanding of recruitment pattern and reliable prediction on yield.

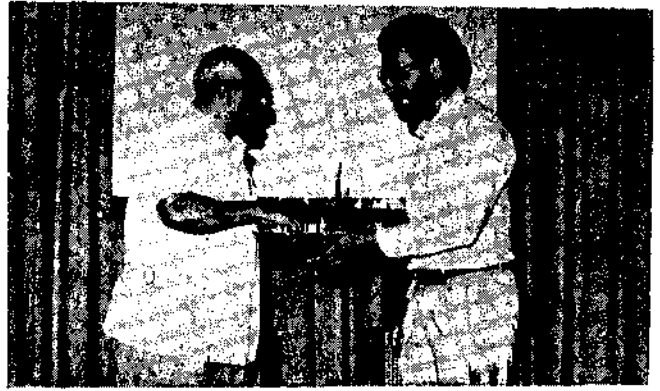
## VI. Outings

One vessel trip on 23-11-83 was arranged with the help of CIFNET for on board the vessel "Blue fin" for the benefit of the participants. Uses of acoustic equipments sonar and echo-sounders have been explained to them. Fish trawling was conducted off Cochin and the presence of Mr. Hans Lassen, the Convenor of the last case study on "Appraisal of data from research vessel survey" benefited one and all.

Another boat trip visiting Fort Cochin, Mattanchery and nearby islands on 27-11-83 was arranged. The operation of Chinese dip-nets and identification of species caught in these operations have been explained to the participants. St. Francis Church at Fort Cochin where Vasco-da-Gama was once buried, Dutch Palace and Jewish Synagogue at Mattanchery were the other places of interest visited by the participants.



Mr. S. C. Venema receiving memento from Dr. E. G. Silas



Dr. Daniel Pauly receiving memento from Dr. S. V. Bapat,  
Joint Director, CMFRI



Dr. Erik Ursin receiving memento from Dr. S. V. Bapat



Mr. Per Sparre receiving memento from Dr. E. G. Silas



Mr. Hans Lassen receiving memento from Dr. E. G. Silas



Dr. Erik Ursin with scientists at get-together



Get together talk by Dr. E. G. Silas

In order to see the gill net landings at Cochin Fisheries Harbour and assess the daily total landings, a trip was arranged on 3-12-83. Early morning at 06.30 hrs gill nets started arriving with their catches. The participants could get a very good idea about the pattern of landings. The procedure of collection of catch and other details including the species composition and collection of biological data done by CMFRI was explained to the participants.



Get together entertainment

On 4-12-83 the participants and faculty members went out of Cochin to see some of the important places of interest such as Kaladi and Edamalayar dam. This trip was so refreshing in that everyone could enjoy the scenic beauty of Kerala and breath fresh air in the hilly regions. The weather was also fine throughout the day as if prearranged as exclaimed by Mr. S. C. Venema, one of the Co-Directors of the Course.



Get together

## VII. Lighter Moments

### Chinese dip nets:

When the participants and the faculty members reached Fort Cochin they were shown the operation of Chinese dip nets. At that time an over enthusiastic person shot his colleague with the question: Do you know Chinese dip nets? Pat came the reply: Why? Everybody else does the same I suppose.

### Blindmen and the elephant:

While discussing about the various models for assessment of fish stocks a question was raised about the reliability of models. The answer was given with a simple story of blind men assessing an elephant by touching its different parts. One man touches its trunk, second its tail, third its leg, fourth its body, fifth its ear and so on. Each gives his description of the elephant. In fact each of their description of the elephant so far as its particular part is concerned is true. However, their descriptions differ so widely that for a person who has not seen an elephant these findings are very much confusing and as a result of this he does not believe these descriptions. Similarly no model that exists at present is capable of describing fully the conditions of an exploited stock. More and more information is required to understand the stocks better. In fact fishery independent factors do not have a role in the present day models.

### Herring is lost:

There was a discussion on depletion of stocks particularly of herrings of the North Sea. Many reasons were advanced by the participants and faculty members for this depletion. In this connection an anecdote on

an ICES (Internation Commission For The Exploration of Seas) meeting on herring depletion was mentioned. A Scientist was coming out of the ICES Conference and excitedly mentioned to his colleague "Herring is lost". "Herring is Lost". An onlooker, surprised at this remark went near the Scientist and patting on his shoulder remarked that her ring was intact and it was not lost. The surprised Scientist looked at the onlooker and then at the direction shown by him. There Mrs. Scientist with her earrings intact was slowly following him. This anecdote is meant to bring home the fact that even

the most affected stocks once left to themselves and ensured protection will not actually be lost and the renewable characteristic of this living resource will be reflected in the reappearance of the stocks.

#### **Carp, Shark and Ray:**

The result of this training course is that hereafter there may be no carping on that there are sharks in solving some of the problems on tropical fish stocks as there is a ray of hope in solving the same.



Faculty members and participants

Sitting (L to R) K. Alagaraja, P. Sparre, H. Lassen, Erik Ursin, E. G. Silas, Daniel Pauly, K. K. Ghosh, M. Devaraj.  
 Standing 1st row (L to R) K. Krishna Rao, K. Narayana Kurup, M. Srinath, R. Thiagarajan, V. Sriramachandra Murty, R. A. Gupta, T. M. Yohannan, D. K. Chowdhury, S. Ramamurthy, K. V. Narayana Rao, M. E. John, C. Mukundan, K. Gopalakrishnan, K. Y. Mohammed Salih.  
 Standing 2nd row (L to R) R. K. Tyagi, K. K. P. Panikkar, R. S. Biradar, P. Natarajan, P. M. Mitra, M. M. Meiyappan, C. Suseelan, T. M. Sankaran, P. Parameswaran Pillai, S. Ajmal Khan and K. S. Udupa.

## VIII. APPENDIX

### **Faculty members**

**DR. E. G. SILAS,**  
 Director,  
 Central Marine Fisheries Research Institute,  
 Cochin - 18  
 Course Director

**MR. S. C. VENEMA,**  
 Fishery Resources Officer,  
 FAO, Rome  
 Course Co-Director

**DR. J. MOLLER CHRISTENSEN,**  
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**MR. H. LASSEN,**  
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MR. P. SPARRE,  
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DR. D. PAULY,  
International Centre for Living-  
Aquatic Resources Management,  
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DR. M. DEVARAJ,  
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#### Appendix II

##### Participants

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2. SHRI. R.S.BIRADAR,  
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3. SHRI. D.K. CHOWDHURY,  
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4. Shri R. A. GUPTA,  
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5. SHRI. K. GOPALAKRISHNAN,  
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6. SHRI. M.E. JOHN,  
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7. SHRI. K. KRISHNA RAO,  
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8. SHRI. M.M. MEIYAPPAN,  
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12. SHRI. K. NARAYANA KURUP,  
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15. SHRI. K. K. P. PANIKKAR,  
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16. DR. P. PARAMESWARAN PILLAI,  
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17. DR. S. RAMAMURTHY,  
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18. SHRI. T.M. SANKARAN,  
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19. SHRI. M SRINATH,  
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20. DR. V. SRIRAMACHANDRA MURTHY,  
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21. SHRI. C. SUSEELAN,  
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22. SHRI R. THIAGARAJAN,  
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23. SHRI R.K. TYAGI,  
Central Inland Fisheries Research Institute,  
Allahabad-211 002.
24. SHRI. K. S. UDUPA,  
Fisheries College, Mangalore-575 002.
25. SHRI T.M. YOHANNAN,  
Central Marine Fisheries Research Institute,  
Calicut-673 005.
7. FAO/DANIDA/GCP/INT/DEN.  
The Roles of the Fishery Biologist-lecture by J.  
Moller Christensen.
8. FAO/DANIDA/INT/392/DEN.  
Case Study 4 by Hans Lassen.
9. FAO/DANIDA/GCP/INT/392/DEN.  
The Tropical, the Temperate and the Arctic seas  
as media for fish production-Lecture by Erik Ursin.
10. FAO/DANIDA/GCP/INT/392/DEN.  
Case Study I by Daniel Pauly and P. Martosubroto.
11. Case Study II; Offshore Trawling Survey  
Work report No.8, UNDP & Govt of Kenya.
12. FAO/DANIDA/GCP/INT/392/DEN.  
Case Study III by P. Sparre.
13. FIDP/FAB/80/015.  
Assessment of the Shrimp Stocks of the West coast  
of the Gulf between Iran and the Arabian Peninsula,
14. FAO/TF/INT/180(C) (CAN) Suppl  
Selected lectures from the CIDA/FAO/CECAF.  
Seminar on Fishery Resources Evaluation.

### Appendix III

*Course material* supplied to the participants of  
FAO/DANIDA/ICAR National Training Course at  
CMFRI, Cochin.

1. FAO Fisheries Technical Paper No. 203.  
Life cycles, dynamics, Exploitation and Manage-  
ment of coastal penaeid Shrimp Stocks.
2. CECAF/ECAF Series 81/22:  
Eastern Central Atlantic Fisheries.
3. FAO/DANIDA/GCP/INT/392/DEN  
Fisheries Economics-Lecture by Hans Lassen.
4. FAO/DANIDA/GCP/INT/392/DEN.  
Models as Stock assessment tools-lecture by Erik  
Ursin.
5. FAO/DANIDA/GCP/INT/392/DEN.  
Case Study III San Miguel Bay by Daniel Pauly.
6. FAO/DANIDA/GCP/INT/392/DEN.  
"Do's and Don'ts" in tropical assessment-lecture  
by Daniel Pauly.
15. Manual of sampling and Statistical methods for  
fisheries Biology - Part I - Sampling methods (FAO)
16. Mesh regulation in the demersal fisheries of the  
South China Sea area by R. Jones.
17. FAO Fisheries Circular No. 701  
Models for fish stock assessment
18. FAO Fisheries Circular No. 734.  
The use of length composition data in fish stock  
assessment.
19. FAO Fisheries technical paper No. 234.  
Some simple methods for the assessment of tropical  
fish stocks.
20. ICFC/DEV/71/2.  
Survey of resources in the Indian Ocean and Indo-  
nesian area.
21. FAO Fisheries Technical paper No. 171.  
Survey methods of appraising fishery resources.
22. Language of symbols-lecture notes on basic mathe-  
matics--K. Alagaraja.

23. Study of variations-Lecture notes on basic statistics (measures of central tendency and dispersion)—K. Alagaraja.
24. Elements of Statistical regression and correlation—lecture notes by K. K. Ghosh.
25. A note on distinguishing features of ordinary cohort analysis and Length Cohort analysis-Lecture notes by K.K. Ghosh.
26. Technique of analysis of variance in relevance to trawl surveys-Lecture notes by K.K. Ghosh.
27. Sampling-Lecture notes by K. Alagaraja.
28. Small-scale fisheries of San Miguel Bay, Philippines: Biology and stock Assessment. Edited by Daniel Pauly and Antonio N. Mines. - ICLARM Technical Report-7.
29. Fish Stock Assessment: A manual of basic methods: J.A. Gulland. FAO/Wiley Series on Food and Agriculture. Vol.1.
30. Analysis of marine fish landings in India - A new approach. CMFRI Special Publication Number-10.
31. Pocket Calculator.
32. A set of parabolas (8 Nos.).

#### Appendix IV

The following committees functioned for the successful conduct of the FAO/DANIDA/ICAR National Training Course held at CMFRI Cochin during 7 November to 9 December 1983.

##### 1. Transport and Accommodation Committee

*Convenor:* Shri. S.K. Dharmaraja

*Members:* S/Shri. V.K. Pillai, R. Sathiadas, M. Srinath and V. Jacob.

##### 2. Secretarial Committee

*Convenor:* Shri. T. Jacob

*Members:* S/Shri K.N. Kurup, K. Balan and Smt. Krishna Srinath.

##### 3. Conference/Lecture hall amenities Committee

*Convenor:* Shri. G. Venkataraman

*Members:* S/Shri. G. Balakrishnan, U.K. Sathyavan, C. Suseelan, Joseph Andrews and Haja Najeemudeen.

##### 4. Finance Committee

*Convenor:* Dr. K. Alagaraja

*Members:* Dr. P.P. Pillai, S/Shri K.K.P. Panikkar and M. M. Meiyappan

