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Ichthyoplankton

Report of the CICAR Ichthyoplankton Workshop

CICAR Cooperative Investigation of the Caribbean and Adjacent Regions
IOC-Unesco

Unesco 1975

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Mexico City, 17-26 July 1974

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No.	Title	Publishing Body	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia /Report of the IDOE Workshop on/; Bangkok, Thailand, 24-29 September 1973. UNDP (CCOP), 158 p.	Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok 2, Thailand	English
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974. (Unesco Technical Paper in Marine Science, No. 20)	Division of Marine Sciences, Unesco, Place de Fontenoy 75700 Paris, France	English Spanish
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	IOC, Unesco, Place de Fontenoy 75700 Paris, France	English French Spanish
4	Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador, 4-12 December 1974.	FAO 00100-Rome, Italy	English Spanish
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish

PREFACE

This series, the Unesco Technical Papers in Marine Science, is produced by the Unesco Division of Marine Sciences as a means of informing the scientific community of recent developments in oceanographic research and marine science affairs.

Many of the texts published within the series result from research activities of the Scientific Committee on Oceanic Research (SCOR) and are submitted to Unesco for printing following final approval by SCOR of the relevant working group report.

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1. INTRODUCTION

E. Fagetti

1.1 Historical Background

The Ichthyoplankton Workshop represents one of the scientific events scheduled for 1974 in support of the activities of the Co-operative Investigations of the Caribbean and Adjacent Regions (CICAR), coordinated by the IOC.

During the 6th meeting of the International Coordination Group of CICAR (Cartagena, Colombia, 16-20 July 1973), it was proposed to conduct a workshop on fish eggs and larval taxonomy, to be held in the Mexico Oceanic Sorting Centre (CPOM) and organized by the Mexican Coordinator for CICAR, Dr. A. Ayala-Castañares; the Director of the CPOM, Mr. César Flores Coto., and the Curator of the international collection, Dr. Martha Vannucci. The Intergovernmental Oceanographic Commission at the 8th session of its Assembly (Paris, November 1973) approved the recommendation of the International Coordination Group. The Division of Marine Sciences of UNESCO and the IOC agreed to sponsor the workshop by providing travel expenses for the participants from developing countries as well as for some of the invited speakers, and for local arrangements. Dr. W.J. Richards, from the National Marine Fisheries Service of Miami, acted as convener of the meeting and collaborated with the local scientists in the coordination of the scientific activities to be developed during the workshop.

The CPOM, which represents a part of the Mexican contribution to CICAR and is intended as a regional service unit, was selected as the host institution because of its excellent laboratory facilities as well as its sorted collections of fish eggs and larvae from the CICAR area. The CPOM was responsible for all local arrangements, including laboratory space and equipment, and the meeting room.

The national coordinators for CICAR were contacted to nominate candidates to attend the meeting. The Government of the USA provided the necessary funds for the attendance of four of their participants and the Government of the USSR provided travel funds for three Soviet scientists.

1.2 Objectives of the Workshop

The purpose of the meeting was to review current advancements in the field of the studies of eggs, larvae and juveniles of fish from the tropical waters of the Atlantic Ocean, with special emphasis on the CICAR area. The workshop was meant to be mainly educational by determining our collective knowledge about the ichthyoplankton from the tropical waters of the Atlantic and the problems which occur there. Invited speakers were contacted to present lectures and demonstrations on the various phases of ichthyoplankton research. Emphasis was given to practical work in the laboratory, discussion of identification problems and methodology of handling ichthyoplankton data. Presentation of individual research papers was restricted. Emphasis was given to open discussion among the participants to determine problems and outline solutions to the problems that were raised.

1.3 Participants

The high number of scientists attending the workshop is an indication of the interest of developed as well as of developing countries in ichthyoplankton research work, largely because of the application of these studies to fisheries resource management.

The meeting was attended by 32 participants from the following countries: Brazil (1), Colombia (1), Cuba (2), France (1), Jamaica (3), Mexico (10), Panama (1), UK (1), USA (8), USSR (3) and Venezuela (1). In addition, twelve graduate students attended the workshop as observers (Annex 1).

1.4 Programme

The meeting was opened in the auditorium of the Institute of Biomedical Studies of the National University of Mexico (UNAM), where the participants were received by the Mexican National Coordinator for CICAR, the Director of the CPOM, representatives of the Mexican National Research Council for Science and Technology (CONACyT) and of the Sub-Secretary of Fisheries, as well as by the UNESCO representative and the Convener.

The Director of the CPOM, Mr. César Flores, welcomed the participants on behalf of the host institution. The convener, Dr. Richards, after welcoming the participants, briefly outlined the purpose of the meeting. He also introduced Dr. E.H. Ahlstrom, who was recently honoured with the highest U.S. Department of Commerce award for his scientific achievements in the field of fishery research. Dr. Elda Fagetti spoke on behalf of UNESCO and the IOC, thanking the organizers for the local arrangements and pointing out the importance of fish eggs and larval studies in relation to fishery sciences. The Mexican Coordinator for CICAR, Dr. A. Ayala-Castañares, described the historical background of the workshop within the framework of the scientific activities of CICAR, as well as the Mexican contribution to this co-operative research programme.

The efforts of IOC, UNESCO and the Governments of Mexico, U.S.A. and USSR in sponsoring the workshop were highly appreciated, as well as the generous hospitality of the CPOM and the kind collaboration of its staff. Working sessions were held in the meeting room and laboratories of the CPOM, whose facilities proved to be quite adequate for this sort of meeting.

The programme included theoretical sessions led by a specialist who lectured on the particular subject and directed the ensuing discussions. Contributed papers related to each of the subjects treated were also presented during the corresponding session (see Abstracts in Annex 2). The programme covered a wide range of ichthyoplankton research ranging from methodology of sampling and handling fish eggs and larvae to the application of ichthyoplankton studies to fishery management. However, most of the sessions dealt with taxonomy problems, mainly of important commercial groups. During the taxonomy sessions, much time was spent in practical work in the laboratory to analyze the identified specimens brought *ad hoc* by the specialists.

In view of the great interest raised by the workshop among the local scientific community, the Director of the "Centro de Ciencias del Mar y Limnología" requested two of the invited participants to present the following lectures to the Centre staff: "Quantitative sampling of zooplankton at sea and handling of the samples in the laboratory" by R. Marak and "Application of ichthyoplankton studies to fishery management" by A. Saville.

2. TIMETABLE

July 1974	Morning	Afternoon
Wednesday 17	Session I Opening of the Meeting: welcoming addresses by C. Flores, W.J.Richards, E. Fagetti and A. Ayala. Discussion of the Agenda	Session II Ichthyoplankton Sampling Chairman: E.D. Houde Rapporteur: E.P. Wilkens
Thursday 18	Session III Mechanics of Handling Ichthyoplankton Chairman: R. Marak Rapporteur: B. Marcy	Session III (continued) Power plant entrainment Chairman and rapporteur: B. Marcy Session IV Ancillary information Chairman and rapporteur: W.J. Richards
Friday 19	Session V Taxonomy Introductory Session: "A Discussion of the Problems. What is Known and What is Not Known". Chairman: E.H. Ahlstrom Rapporteur: W.J.Richards	
Saturday 20	Examination Under the Microscope of Unidentified Material.	
Monday 22	Session VI Clupeid and Engraulid Taxonomy Chairman: E.D.Houde Rapporteur: Y. Matsuura Practical work in the laboratory, with identified species brought by the participants.	Session VII Myctophid, Gonostomatid, and Sternoptychid Taxonomy Chairman: E.H. Ahlstrom Rapporteur: P. Wilkens
Tuesday 23	Session VIII Leptocephali Taxonomy Chairman: D. Smith Rapporteur: T. Potthoff Practical work in the laboratory with identified specimens.	Session IX Carangid Taxonomy Chairman and rapporteur: A. Aboussouan

July 1974	Morning	Afternoon
Wednesday 24	Session X Scombrid, Xiphiid and Istiophorid Taxonomy Chairman: T. Potthoff Rapporteur: W.J. Richards	Session XI General Taxonomy Session Chairman and rapporteur: W.J. Richards
	Practical work in the laboratory with identified specimens.	
Thursday 25	Session XII Taxonomy Summary Session Co-operative Projects Chairman: E.H. Ahlstrom Rapporteur: W.J. Richards	Session XIII Application of Ichthyoplankton Studies to Fisheries Research Chairman: A. Saville Rapporteur: E.D. Houde
Friday 26	Session XIII (continued)	Session XIV Summary Session Revision of Session Draft Reports & Recommendations Summary remarks by: W.J. Richards Closing remarks by: C. Flores Coto

3. SESSION REPORTS

3.1 Ichthyoplankton Sampling

Chairman: E.D. Houde

Rapporteur: E.P.H. Wilkens

The objectives of an ichthyoplankton sampling survey are to determine accurately and precisely distribution and abundance over both space and time. Sampling gears and techniques should be carefully considered in designing an ichthyoplankton survey. Standardization of methods by various CICAR nations will allow easier interpretation of survey results and will lead to better appraisal of fishery resources in the area. If sampling programmes for ichthyoplankton are effective, they are powerful tools to help determine: 1. spawning areas and seasons, 2. biomass of adult spawners, 3. annual fluctuations in adult biomass, 4. migrations of adults, 5. growth and mortality of the larval stages, 6. the relation of oceanographic conditions to distribution and abundance of both adults and larvae, 7. the trophic relations among fish larvae and zooplankton.

The following gear and techniques are recommended for ichthyoplankton surveys in the CICAR area:

1. Sampling frequency - year-round sampling will be necessary in the CICAR area because some spawning can be expected by most species during every month of the year.

2. Stations - fixed stations be established in an areal pattern which is practical for oceanic ichthyoplankton surveys and from which it is possible to determine gradients of abundance in two directions.

3. Samplers - a bridleless net. Eliminating the bridle preceding the mouth may reduce avoidance. Bridleless nets are being used by Cuba (Trapezo) and U.S.A. (Bongo).

4. Mesh size - .505 mm net mesh. This mesh will retain fish eggs and larvae, and will filter a large volume of water without clogging. The .505 mm mesh is becoming a standard mesh for ichthyoplankton work in many parts of the world.

5. Volume filtered - it is suggested that at least 100 m^3 be filtered to give a reasonable probability of sampling both common and uncommon ichthyoplankton.

6. Depth of tow - this will depend on sampling location. In shallow areas, a tow to within 5 m of the bottom is recommended, while in deep water a tow to within 200 m may appear adequate.

7. Type of tow - oblique tows are best to estimate numbers of eggs and larvae, when estimates of abundance in the entire water column are desired.

8. Wire release and retrieval rates - standard rates of wire release and retrieval during net tows are recommended where possible. A release rate of 50 m per min. and retrieval rate of 20 m per min. have been used successfully for many years in the CalCoFi surveys.

9. Towing speed - 2 knots (100 cm/sec.) is suggested. Towing speed greater than this will damage specimens, while slower speeds may cause increased avoidance of the samples.

10. Flowmeter - a flowmeter to estimate volume of water filtered by the sampler should always be used in ichthyoplankton surveys.

11. Time-Depth Recorder (TDR) - a record of the depth and pattern of each tow should be obtained by attaching a TDR to the sampler at each station.

Many sources of error exist in estimating distribution and abundance of ichthyoplankton. These errors should be kept to a minimum whenever possible. Some sources are:

1. Time: it is assumed that the abundance of ichthyoplankton estimated on a given cruise represents some longer period of time.

2. Area: it is assumed that the catch at a station represents some longer period of time.

3. Observed catch: the estimate of abundance from the observed catch at a station is assumed to reflect accurately the true abundance of ichthyoplankton.

4. Volume filtered: the column of water encountered by the net opening is assumed to be completely filtered by the net.

5. Depth of tow: the depth distribution of eggs and larvae is assumed to be encompassed by each net tow and the depth of tow is assumed to have been accurately determined.

When possible, errors due to these sources of variation should be evaluated by techniques that are referred to in FAO Tech. Pap. 122.

Mr. Marak presented a short film on performance of the Bongo net sampler. The filtration efficiency of the sampler was very good, as shown by dye plume tests, at speeds up to 7 knots. Stability of the four-net Bongo array was good at speeds to 5 knots when the V-fin depressor was used. At low speeds (3 knots) a 50 kg weight was sufficient to maintain stability of the gear, as well as attaining desired depths with a minimum of towing wire released.

Mr. Matsuura gave results of day-night variation in the plankton net catches of several taxa of larvae from two sampling stations off the coast of Brazil. The ratio of night to day catches in vertical and horizontal tows confirmed that night tows helped to overcome avoidance by larvae of most taxa. Larvae of *Sardinella brasiliensis* were especially abundant in night tows compared to day tows, the ratio of night to day catches ranging from approximately 35 to 650 times. These ratios exceeded any that have been previously reported in the literature. Mr. Matsuura stressed the importance of assessing avoidance by fish larvae when conducting ichthyoplankton surveys.

Mr. Peter Wilkens discussed results of his research on kinds and diversity of larval fishes from the Eastern Gulf of Mexico. He pointed out that the 20 cm diameter Bongo nets catch many fewer taxa of larvae in a standard length tow than do the 60 cm diameter nets. This probably is due to the low volume of water strained by the smaller diameter net and the resulting low likelihood of sampling uncommon or rare taxa. Common taxa were represented equally well in the 20 and 60 cm diameter nets. Mr. Wilkens recommended using the 60 cm diameter Bongo net in the CICAR area, and he suggested that tows be at speeds of 2 knots or less to minimize damage to larvae that frequently makes identificiation impossible.

Mr. Bart Marcy described a new ichthyoplankton sampler that he has used effectively in lakes, rivers and marine environments. It consists of paired 1/2 m plankton nets mounted in a frame. The gear can be attached to a sled to allow towing near the bottom, or it can be towed without the sled at mid-depths and near surface.

The sampler costs about $200 U.S. and is particularly effective in sampling large larvae and small juveniles when towed near bottom.

Dr. Mar Juarez described a bridleless, 1 m diameter plankton sampler that is called the 'trapecio' net. The net is mounted in a rectangular frame that swivels on the ring of the plankton net. This net has been used by Cuba as a successful ichthyoplankton sampler in the CICAR area. It should be compared to the Bongo net in the future.

The value and uses of neuston nets were discussed by workshop participants. Neuston nets usually are not as effective as obliquely-towed plankton nets in ichthyoplankton surveys. However, both Drs. Ahlstrom and Richards pointed out exceptions to the usual rule; some fish larvae, like those of saury, istiophorids and certain scombrids, can best be studied to determine distribution and relative abundance from neuston net tows. Because the neuston net fishes only the surface layer, catches are subject to variation arising from time of day, sea state, cloud cover and other meteorological or hydrographic conditions.

3.2 Mechanics of Handling Ichthyoplankton

Chairman: R. Marak

Rapporteur: B. Marcy

The proper handling of plankton samples after collection is a very important part of any ichthyoplankton programme as mishandling can introduce serious errors in the data. The necessity for standardization, where possible, of handling techniques was stressed.

The references "Collecting and Processing Data on Fish Eggs and Larvae in the California Current Region" - David Kramer, Mary Kalin, Elizabeth Steves, James Thrailkill and James Zweifel, NOAA TR NMFS ICRC - 370, 1972; "Fish Egg and Larval Surveys" - G. Hempel, editor, FAO Fish. Tech. Paper No. 122, 1973 (Preliminary draft); and "Marine Resources Monitoring Assessment and Prediction" (MARMAP) Programme, Survey I Manual (Ichthyoplankton NCAA-NMFS, 1973, were used in developing this section and as a basis for discussion. Copies will be made available to the participants.

The following topics along with their problem areas were discussed:

a. Cleaning the net - thorough and gentle flushing to avoid contamination of subsequent samples.

b. Preservation of samples - 2% formaldehyde solution (buffered with marble chips) recommended, preservative solution should occupy 75% of jar; 4% formaldehyde recommended in tropical waters. Preservation should be immediate.

c. Standard labelling - label should contain necessary data to ensure no confusion of sample, and written with permanent ink.

d. Storage of samples aboard the ship - should be in stable, cool area when possible.

e. Measurement of displacement volume - can be used for rough measure of biomass.

f. Percentage of sample to be sorted - recommended that total sample be sorted for fish larvae. Aliquoting should be held to a minimum except where trophic level studies are involved. Folsom splitter, if used, should be calibrated.

g. Sorting for fish eggs and larvae - technicians can be trained to sort and even identify some common groups. However, identifications should be checked by a taxonomist.

h. Automated density gradient sorting - a film and demonstration was presented on the potential of this method; reprints on this work were made available (see Annex 4).

i. Quality control - recommended that individual systems be set up to ensure at least 97% efficiency.

j. Necessity of keeping sample intact so that no components are lost.

k. Thoroughness of identification - dependant on objectives of programme.

l. Quantification of catch - numbers should be standardized to numbers under a unit area of sea surface (1-10-100 m^3).

m. Recording - recommended that standard logs be used.

n. Other constituents of sample (zooplankton) - should study relationship between ichthyo and zooplankton (predator-prey).

o. Establishment of reference collection - necessary for comparative identification studies.

p. Archiving of samples - storage should be orderly for quick reference; preferably away from light and checked periodically for loss of liquid.

Copies of standard log sheets (see Annex 7) used by the MARMAP (Marine Resources, Monitoring, Assessing and Prediction) programme of the National Marine Fisheries Service, NOAA, USA, will be sent to each participant for comment toward development of standard logs to be used in the CICAR area. Comments should be sent to the CPOM for evaluation.

Copies of the references cited in paragraph two of Session III as well as those on development of density gradient methods of sorting plankton will also be sent.

Mr. B.C. Marcy discussed a method to facilitate sorting. A dye (Rose Bengal) has been used to cut sorting time by 50% and increase efficiency of sorting by 18% (80 to 98%). The dye is a vital protein stain and can be obtained for about U.S. $4.00 a bottle. A bottle may last for two to three years. A few granules can be added to develop a colour hue desirable to the sorter. It stains the eggs and larvae a light rose colour and makes it easy to pick out all the specimens from the detritus. The dyeing is reversible if transferred to clean formalin; it will leach out about 50% in 5 days and be completely clear again in about six months. The dye helps also in identification and in counting myomeres.

The dye can be added to the total formalin mixture for field use, having the advantage of identifying it from other formalin solutions. It can be added at the lab to the total sample or to the ichthyoplankton sample. The dye takes 4-6 hours to work. However, it works best if left overnight. It is extremely useful for sorting samples with high concentrations of debris, detritus, jellyfish, etc. Mr. Marcy provided stained samples for examination.

3.3 Power Plant Entrainment

Chairman and Rapporteur: B.C. Marcy

A new dimension of ichthyoplankton studies is now developing which is concerned with the effects of the passage of fish eggs and larvae through power plants. This taking of free-floating organisms from the surrounding waters is defined as <u>entrainment</u>. Entrainment refers to those organisms which pass through (non-screenable) the 1 cm mesh of the travelling screens in the intake of a power plant and impingement refers to those organisms which are too large to pass through the screens and are impinged or trapped on the screens.

With the need for electrical power doubling every ten years in some countries and considering that power plants require tremendous volumes of water (3,600–6,800 m^3/min.) to cool their condensers, the entrainment of ichthyoplankton has become an urgent concern of environmentalists. Some 140 nuclear power plants are operating or are under construction in the U.S.A. today. Sources for large volumes of water in lakes and rivers are already running short. Offshore marine nuclear facilities are now past the planning stages and one will operate soon off the coast of New Jersey, U.S.A.

In the past (late 1960 and early 1970), entrainment studies concentrated on phytoplankton and zooplankton because the organisms were easily obtained and much information was available. It was not until 1971 that anyone began studying the effects of entrainment on ichthyoplankton. Studies on ichthyoplankton entrainment are extremely important as regeneration times for fishes are two to four years as opposed to five months for zooplankton (copepods).

An organism, like a fish larvae, if vulnerable or within the influence of the water passing into the intake, will pass through 1) – the travelling screens where it may be susceptible to biocide injection (chlorination – used to eliminate fouling organisms in the condenser tubes); 2) – through large intake impeller pumps; 3) – into condenser tubes (280,000 of 2.5 cm diameter each) where heat exchange takes place and the larvae or egg is exposed to a sudden temperature shock of between 8^{o} and 15^{o}C above ambient temperature; 4) – and the passages into a discharge system where it is exposed to prolonged increased temperatures until it reaches the original water source.

A nuclear power plant then is a predator, where entrained organisms are susceptible to various stresses leading to mortalities caused by mechanical abrasion, pressure changes, biocide addition (chlorination and other chemicals), and heat shock and high thermal exposures. A review of the available literature, scarce as it may be, shows that entrained phytoplankton may either increase or decrease in productivity depending on the characteristics of the plant. The mortality of zooplankton appears to range between 20 and 83%. Ichthyoplankton is the most susceptible group, where mortalities have ranged from 60 to 100%.

Results of studies to date have, in general, shown that mechanical damage is the highest contributor to the overall mortality of entrained ichthyoplankton (50–100%). Thus, it may be advisable to increase the temperature rise across condensers and lower the intake volume, i.e. the number of eggs and larvae withdrawn from the surrounding waters. A minimum volume concept is recommended for plants utilizing large volumes of water since mortality of meroplankton is directly related to pumping volumes. This method for exclusion of organisms is the only currently available practical approach to minimize adverse impact in the aquatic environment. Future power plants can minimize impact by siting in non-productive areas or employing closed cooling systems (e.g. cooling towers) to reduce the water volume required.

We must rapidly develop new sampling techniques to evaluate accurately the effects of entrainment. For example, different flow rates at intake and discharge make sampling and good statistics difficult, distributions change radically from intake to discharge and organisms are more susceptible to predation on the discharge side. We must determine the percentage of living versus dead in the plankton prior to entering the plant and determine the absolute concentrations of organisms in a defined area in the vicinity of the plant to assess the annual loss of members and biomass to the intake. High concentrations of sampling on a 24-hour basis are required to gather such information. One must evaluate, for example, day and night tidal differences in terms of vulnerability of entrainment. In estuaries, due to tidal fluctuation, organisms may be susceptible to entrainment many times before passing downstream past the plant.

We have spent many years now refining classic techniques and increasing our confidence in identification. We now are faced with decisions on total ecological effects and impacts where present 'state-of-the-art' knowledge does not allow us confidence. For example, of the millions of larval fish killed by entrainment at water intakes each year, how many would have survived to become adults? Since entrainment mortality is an additive above natural mortality, what is the effect of losses on the ultimate population of adults and the total ecological picture? These are the questions engineers and politicians are asking us today. We need to know the natural variation in ichthyoplankton populations in order to assess the impact of entrainment losses. We need to know the natural survival rates between life stages, the carrying capacity of the system, and the total dynamics of a fishery to assess a power plant or the cumulative effects of several power plants on a body of water.

We must begin modelling (fecundity - natural survival - entrainment mortality - ultimate adult population - production) to assess these immediate and long-range problems and shorten the distance between classic quantitative re-evaluation and the present circumstance of making broad ecological 'guess-estimate' decisions before it is too late.

3.4 Ancillary Information

Chairman and Rapporteur: W.J. Richards

This discussion session emphasized the need to collect as much data as possible in order to understand the reasons of ichthyoplankton abundance. These data include physical oceanographic data, chemical oceanographic data, meteorological data, and additional biological data. Minimal data should include temperature (preferably throughout the water column sampled), salinity, weather and sea conditions, and plankton volume determination from the .333 mm mesh bongo sample for an estimate of biomass.

Many other biological, chemical and physical observations should be made. Particular emphasis should be given to currents and their effects on the distribution of ichthyoplankton. It was emphasized that ichthyoplankton specialists should collaborate with scientists from other marine disciplines so that a more complete understanding of ichthyoplankton and its relation to the environment may be achieved.

3.5 Taxonomy Introductory Session

Chairman: E.H. Ahlstrom

Rapporteur: W.J. Richards

Dr. Ahlstrom presented a lecture on the basic principles for the identification of fish eggs, larvae and juveniles. He pointed out that two methods were commonly used to arrive at the proper identification of ichthyoplankton: 1) work from juveniles to larvae to eggs and 2) rear from known parents to identifiable stages in the laboratory. Both methods require a complete series of specimens and the second method provides material in the best condition.

He gave definitions for the various stages of ichthyoplankton - eggs which includes the embryonic stage; yolk-sac larvae which is the transition from the hatched embryo to the larval stage; the larvae which includes that stage prior to the acquiring of juvenile characters; the transition stage when juvenile characters are acquired; the juvenile stage defined as the stage which has all the fin elements present; and the specialized prejuvenile stage which is applied to only a few groups of fishes.

Dr. Ahlstrom then discussed and gave examples of the four major characters which need to be understood to achieve reliable identification. These characters are:

1. Morphometrics: measurements of body parts over a size range of specimens from nearly hatched larvae to (and through) transformation size specimens to the early juvenile stage.

   Evaluation of changes in body proportion during the larval period, such as in body depth, head size, gut length, fin positions, etc. including size at end of yolk-sac stage and size at transformation.

2. Meristics: countable structures such as number of myomeres or vertebrae, number of fin rays in all fins, number of branchiostegal rays, gill rakers, etc. and the size range over which fins and other structures attain their complement of elements.

3. Pigmentation: documentation of melanistic pigment patterns and their change during early life history stages from that developed on embryos, rearrangement (if any) during the yolk-sac stage, and sequence of pigment change during the larval stage through to juvenile stage.

   Inasmuch as melanophores are somewhat variable on larvae of the same size, may be expanded or contracted at time of preservation and can be destroyed by exposure to light or through improper preservation, pigmentation must be used with some caution.

4. Specialized larval characters: structures unique to the larval stage such as spines on opercular bones and/or on the head; narrowed eyes often with tear-drops of underlying choroid tissue; stalked eyes; elongated anterior dorsal and/or ventral rays or spines; extended snout; trailing gut.

Dr. Ahlstrom stressed that one must know basic information about the adults of a region before ichthyoplankton identification can be made. He pointed out that literature from other areas is quite useful since many juveniles are found in common between areas.

Dr. Dekhnik presented an overview of the families of larvae commonly found in the CICAR area including information on distribution and abundance. An abstract of her paper is in Section 5.4.

Dr. Ahlstrom then led a discussion on what families of fishes occur in the CICAR area and what groups would be studied in some detail in the taxonomic session.

The following groups would be emphasized: Clupeidae, Engraulidae, Myctophidae, Sternoptychidae, Gonostomatidae, Leptocephali-types, Scombridae, Xiphiidae, Istiophoridae and Carangidae. One session would be devoted to a general examination of most of the remaining families. A list of the families is appended in Section 5.3.

A special session was held on the morning of 20 July for the examination of unidentified material brought by participants of the meeting.

3.6 Clupeid and Engraulid Taxonomy

Chairman: E.D. Houde

Rapporteur: Y. Matsuura

Clupeid and engraulid fishes constitute a large fishery resource in the CICAR area. Questions still exist regarding the systematics of all life stages, including adults. Consequently, taxonomy of these fishes needs to be pursued, not only for the egg and larval stages, but for the larger individuals that make up the exploitable stocks. Five genera of clupeids occur in the CICAR area that are of potential commercial importance and which are marine throughout all of their life stages. These are *Etrumeus*, *Brevoortia*, *Opisthonema*, *Sardinella* and *Harengula*. Two genera *Alosa* and *Dorosoma*, may be found in marine environments as juveniles and adults, but spawning by these fishes occurs in fresh water.

The genus *Jenkinsia* may be abundant in some parts of the CICAR region but no published accounts of eggs or young larvae exist. Dr. Mar Juarez reported that she has found eggs of these fishes in the sand on Cuban beaches, which indicates that these are not pelagic eggs. Several species of engraulids occur in the CICAR area but no accounts of eggs and larvae are available except for some limited information on *Anchoa mitchilli*.

Clupeid Spawning Seasons and Areas

The information presented here is based on knowledge accumulated to date. As more is learned about CICAR area clupeids, some of this information may have to be corrected or modified.

Etrumeus teres: probably found throughout the CICAR area in waters of moderate depth, 30-200 m. Spawning in the Gulf of Mexico occurs from November through May when surface temperatures are less than 25°C.

Brevoortia smithi: found in the eastern Gulf of Mexico, in shallow shelf and estuarine areas; also found on the Florida east coast. Spawning occurs from November through March.

Brevoortia gunteri: found in the western Gulf of Mexico. Nothing known of its spawning habits but probably will be similar to *B. smithi*.

Brevoortia patronus: found along the north central and northeastern shelf of the Gulf of Mexico. Spawns from November through March, usually within 40 km of the coast.

Opisthonema oglinum: found in shallow waters throughout the CICAR region. Spawning in the Gulf of Mexico occurs from April through August at water temperatures above 25°C.

Opisthonema captivai: reported from coastal waters off Colombia; nothing known about its spawning habits.

Sardinella anchovia: probably found on the continental shelves throughout the CICAR region. Spawns throughout the year in the Gulf of Mexico but most spawning occurs from September to April at temperatures of 20-26°C. Similar spawning habits reported for this species off Venezuela.

Sardinella brasiliensis: the distribution of the species in the CICAR area is known, but spawning by this species in the CICAR area is not well known. In south Brazil, this species predominates and supports and important commercial fishery. Spawning in south Brazilian waters is during spring and summer (from September to April) with water temperatures ranging between 19° and 25°C (average 22.4°C). Spawning occurs in shelf waters and seems to be related to upwelling.

Harengula jaguana: found in shallow waters throughout the CICAR region. Spawns from February through July on the Florida east coast and in the eastern Gulf of Mexico, when surface temperatures exceed 22°C.

Harengula spp: other species of Harengula occur in the CICAR area, but nothing is known at present of their spawning habits.

Jenkinsia spp: no documented information about spawning by this species is available. Possibly three species occur in the CICAR area.

Distinguishing Clupeid from Engraulid Larvae

Both clupeids and engraulids are elongate, rod-shaped larvae with long guts. The gut length of clupeid larvae, excepting the sub family Pristigasterinae, is greater than 80% NL* while that of engraulids is less than 75% NL. Engraulid larvae have slightly greater body depth than clupeids and they are less laterally compressed than clupeids, median fin development begins at less than 6 mm NL in engraulids but does not begin until 7 mm NL in the clupeids. Engraulid larvae have pigment on the ventral midline posterior to the anus at sizes less than 6 mm NL, but no clupeids develop pigment there until much larger sizes. Engraulids have fewer melanophores in the foregut series at any given size than do clupeid larvae of the same size.

Clupeid and engraulid larvae are easy to separate by experienced ichthyoplankton workers. No other families of larval fishes are likely to be confused with the clupeids or engraulids, except perhaps certain gonostomatids (e.g. Vinciguerria spp.).

Identifying Clupeid Genera

The eggs and larvae of clupeid genera that have potential commercial importance in the CICAR area can be distinguished in most cases, except for Jenkinsia which is undescribed. Many of the characters used to identify clupeids are discussed in detail in the selected references that are listed below. In this report we list the characters that are most useful for identifying clupeids.

Meristics are the most useful characters to distinguish genera. Total myomere of vertebral counts are necessary. When the dorsal fin has begun to develop, the number of myomeres located between its posterior ray and the end of the gut is an indispensable aid to the identification of clupeid genera in the CICAR area. For larvae longer than 17 mm SL the ray counts of the dorsal and anal fin are useful; the anal fin ray counts are particularly helpful. Morphometrics usually are not as reliable as meristics to distinguish the genera, except during the transforming stages, when measurements such as predorsal, prepelvic, and preanus lengths may characterize certain genera.

Pigmentation, particularly that associated with the caudal area in larvae less than about 8 mm NL, can be distinctive and will distinguish some genera if used with the myomere counts. Pigmentation of more advanced larvae is less helpful in identifying clupeids because of the similarity among genera and because of variation in serial melanophore counts among individual larvae.

Clearing and staining specimens is a valuable aid to identification of clupeids and should be used frequently on some larger specimens. Staining of smaller specimens, before ossification is complete, often will make it easier to count myomeres and developing fin rays. This is particularly useful when large numbers of clupeids occur in collections because counts can be made faster after the larvae are stained.

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* NL = notochord length; SL = standard length; TL = total length.

Problems in the Taxonomy of Clupeid and Engraulid Eggs and Larvae

Much of the clupeid eggs and larvae material can be identified at present but some important problems remain to be solved. It is necessary to find techniques to distinguish larvae of Sardinella from those of Opisthonema. Presently most larvae can be separated but some specimens cannot be assigned to one genus or the other with certainty. Several species of Harengula occur in the CICAR area. Only Harengula jaguana eggs and larvae have been described. The other species need to be studied. Three species of Jenkinsia probably occur in the CICAR region but little is known about the eggs or young larvae of this genus. In fact, even the adult taxonomy of this species complex is uncertain. Three species of Brevoortia occur in the Gulf of Mexico. While adult systematics are well understood and the larvae can easily be identified to genus, there are no documented techniques to distinguish the three species in the egg and larval stages. Nothing is known about spawning habits, eggs, or larvae of Brevoortia gunteri.

A particularly important problem in the CICAR region is the confusion regarding the systematics of Sardinella spp. Two species apparently occur throughout much of the region, S. anchovia and S. brasiliensis, but neither adult systematics nor that of eggs and larvae is well understood. Because of the commercial importance of this genus a thorough systematic study of the genus should be made in the CICAR area.

Practically nothing is known about systematics of larval engraulids in the CICAR region. Any contributions to the study of development of engraulids will be valuable, but comparative studies among species are particularly needed.

More detailed knowledge of spawning places and seasons, and their relation to oceanographic conditions will be useful to clupeid and engraulid systematics. Lacking definite characters to identify eggs and larvae, some species of clupeids may be identified based on their occurrence seasonally or in relation to hydrographic factors.

A particularly good technique to obtain eggs and larval series for clupeids and engraulids is by laboratory rearing. Methods are now available which make this technique feasible throughout the CICAR region.

3.7 Myctophid, Gonostomatid and Sternoptychid Taxonomy

Chairman: E.H. Ahlstrom

Rapporteur: P. Wilkens

Although adults of myctophids, gonostomatids, and sternoptychids are of no importance in the commercial or sport fisheries of the CICAR area, the larvae of these families will sometimes be a dominant component of the ichthyoplankton. Since it may be necessary to separate large numbers of myctophids, gonostomatids and sternoptychids from other larvae of interest, it is important that characters that distinguish these families be understood. In addition, several taxa in the above three families can be confused with larvae of commercial importance. For example, the myctophid genera Lampanyctus is often misidentified as a scombrid, and the gonostomatids Cyclothone and Vinciguerria are sometimes confused with engraulids and clupeids.

Of the 31 genera of myctophids known, larval information is available for 20 myctophid genera that can be expected in CICAR ichthyoplankton samples:
(? = questionable occurrence)

Subfamily Myctophinae	Subfamily Lampanyctinae
? Protomyctophum	Notolychnus
? Electrona	Diaphus
Benthosema	Lobianchia

Diogenichthys

Hygophum

Symbolophorus

Myctophum

Gonichthys

Centrobranchus

Loweina

Lampadema

Taaningichthys

Lampanyctus

Notoscopelus

Ceratoscopelus

Lepidophanes

Bolinchthys

...riety of characters can be used to distinguish myctophid larvae. Of ...able value are larval characteristics. The early formation of certain ...hores (especially the second branchiostegal photophore) and the sequence of ...ion can be used to distinguish some genera. Other larval characteristics that ...ul include pigment, characteristics of the eye (shape, presence of stalks), ... the pectoral fins, the presence of large body envelopes, presence of ...cular spines, and development of the snout. Morphometric characters that are ... include body shape and length of gut, while useful meristic characters include ...al, branchiostegal, dorsal, anal and ventral fin ray counts.

...rvae of Sternoptychidea (including Gonostomatidae) are usually more slender- ... than myctophid larvae. The combined family Sternoptychidae - Gonostomatidae ... genera. These fishes also have patterns of photophores that form during the ...ormation stage. The genera may be divided into the following four clusters. ... group the light organs occur singly, and most light organs are formed at the ...time (Vinciguerria and Cyclothone). In another group, the light organs occur ... but are formed gradually (Gonostoma, Margrethia, Bonapartia). In the ...ining two groups the light organs occur in clusters with common bases. In one ... remaining groups the light organs form gradually (Maurolicus) while in the ...roup the light organs form gradually and there is a marked change in body shape ...en larvae and juveniles (Sternoptyx, Argyropelecus, and Polypnus).

...uring the laboratory demonstration 12 kinds of myctophid larvae and 7 kinds ...ernoptychid-gonostomatid larvae were made available for study under the micro-... A list of selected references was distributed (Annex 5).

...8 Leptocephali Taxonomy

Chairman: D.G. Smith

Rapporteur: T. Potthoff

...r. Smith opened the session with a discussion of the general morphology of ...ocephalus larvae. Leptocephali larvae are deeply compressed, have well-developed ... teeth and well-developed eye and nasal organs. The myomeres are superficial ...n). The interior of the larvae is filled with a noncellular mucoid substance. ...hen discussed some distinctive features of Leptocephali larvae:

. Unusual large size, commonly 50-100 mm TL, largest known larva 1800 mm TL.

. Brief transition stage due to abrupt metamorphosis.

. Nutrition: larvae do not eat solid food but may utilize dissolved organic substances or bacteria.

d. Why teeth then? The function of teeth is unknown although it may be that they are used as storage for calcium for bone formation during metamorphosis.

Dr. Smith then discussed the differences between the larvae of the three orders:

a. Elopiformes: large forked caudal fin, except in very small larvae. Total myomeres always less than one hundred. They all have a ventral fin, and their dorsal and anal fins have short bases, which are not confluent with the caudal fin.

b. Anguilliformes: small rounded caudal fin. Total myomeres almost always more than one hundred. The ventral fins are absent. Dorsal and anal fins have long bases and are confluent with caudal.

c. Notacanthiformes: caudal fin absent, instead they have a long single filament. Numerous myomeres present, several hundred. They have a very small ventral fin. Dorsal fin short on anterior part of body. Anal fin present.

Dr. Smith continued by summarizing important characteristics used in the identification of all Leptocephalus larvae. He then covered the taxonomy of the various groups of Leptocephalus larvae found in the CICAR area.

The following groups were discussed and characterized: Elopidae, Albulidae, Saccopharyngoidei, Moringuidae, Nettastomidae, Dysommidae, Cyemidae, Ophichthidae, Anguillidae, Muraenidae, Synaphobranchidae, Serrivomeridae, Nessorhamphidae, Derichthyidae, Nemichthyidae, Xenocongridae, Congridae and Notacanthiformes.

It was mentioned during Dr. Smith's discussion that the eggs and early larvae of Harengula jaguana were erroneously attributed to Megalops atlanticus by C.M. Breder, 1944, Zoologica, N.Y. 29 (19):217-252; A.J. Mansueti and J.D. Hardy, 1967, Development of fishes of the Chesapeake Bay region, Solomons, Md., U. of Maryland (USA), 202 p; J.E. Mercados and A. Ciardolli, 1972, Bull.Mar.Sci. 22(1):153-184.

3.9 Carangid Taxonomy

Chairman and rapporteur: A. Aboussouan

The author has mainly worked with Carangidae larvae from the Mediterranean and the western coast of Africa, from Gibralter to southern Senegal. Even if he is not very involved with the CICAR area it seems to him that the Carangidae show throughout the world several common features due to pan-tropical distribution of several species as well as to the fact that there are species which are common to both coasts of the tropical Atlantic Ocean.

Among the species observed, some are common to both coasts of the Atlantic: Trachurus trachurus, T. trecae, T. picturatus (?), Trachynotus goreensis, T.ovatus, Caranx rhonchus, C. senegallus, C. crysis, C. hippos, Chloroscombrus chrysurus, Vomer setapinnis, Scyris alexandrina, Selene vomer, Blepharis crinitus, Selar crumenophtalmus. Data on the distribution of some of the above species in relation to the hydrological seasons off Senegal have been given. The hydroclimate of these regions can be defined as follows: a cold season, lasting from January to April (surface temperature 16°-18°C); a warm season, from July to September (surface temperature 26°-28°C) with low salinity values (from 36.7‰ to 33.0‰) and two transitional seasons which are of considerable importance for the ichthyofauna.

During the first transitional season, lasting from April to July, the surface temperature increases from 18° to 28°C with a stasis at about 22°C in May; the second transitional season from October to December shows a decreasing surface temperature from 28° to 18°C, with also a stasis at about 22°C in November. The trade winds from N-NE in this region promote water mass movements of the upwelling type, whose origin as well as ending greatly influence the hydroclimate. T. trachurus distributes south of 17°20'N only during the maximum intensity of the NE trade winds. The larvae of this species are found sporadically as far south as Dakar during January to March: T. trecae larvae are quite abundant from November-December to March, April and May; C. rhonchus during the transitional seasons, May-June and November-December; Chloroscombrus chrysurus, which can withstand great variations in salinity - from 36.7‰ to 33.0‰ during the end of the warm season - is abundant during the warm season; Decapterus punctatus is found sporadically in June and October. The remaining species are much less abundant and related in general to high temperature.

While in the world ocean the Carangids occupied the sixth position of fish catch with more than 2.10^6 tons in 1973, off the western coast of Africa their catches have increased 10 times. Such a situation should urge us to study the reproductive potential of the species, as affected by such an important fishing effort. Ichthyoplankton programmes fit therefore quite well in this regard.

Concerning the taxonomy of the early stages of Carangids, the following can be concluded:

a. The author does not discuss egg identification but suggests that all, or almost all, the Carangids lay pelagic eggs with a diameter between 0.7 and 1.20 mm and an oil globule between 0.16 and 0.22 mm, an homogeneous yolk and without any particular structure. The anterior position of the oil drop in the yolk sac larvae is a good character to be taken into account.

b. Based on his own experience on Carangid larvae and on data from the literature, the author reviews the main criteria which allow their identification, specifying that a good knowledge of the taxonomic characters of the adults is needed for such a purpose.

Following the order of the characters proposed by Dr. Ahlstrom for larval identification, the author analyses each of them:

a. General morphology of the larvae:- There is a progressive evolution of the general morphology with two different types - elongate larvae and deep bodied larvae. This is quite a distinctive character which separates the Carangids larvae into two main categories.

b. Meristic characters:- The vertebral formula, which is in general quite stable, presents 24 total vertebrae (10 + 14) with some exceptions: Decapterus punctatus (10 + 15), Caranx crysos (10 + 15), S. alexandrina (10 + 16), Oligoplites saurus (10 + 16), Naucrates ductor, Seriola dorsalis, S. dumerili (10 + 15).

   The position and shape of the first hemal spine allows the separation of Naucrates, Seriola, Decapterus, Caranx, Chloroscombrus of 6 mm, or thereabouts, in certain cases.

c. Numeric characters:- These correspond to radial formula and gill raker counts. Before full development of the fin rays, the position of the basal thickness of second dorsal fin in relation to the anal fin can help taxonomic differentiation of the youngest stages. This character is very useful in larvae from 4 mm length to distinguish Naucrates, Seriola and Trachynotus from Trachurus and Caranx. The relative length of the bases of the second dorsal fin in relation to that of the anal fin helps establish a distinction between several genera, particularly Trachurus from Caranx. The precocious apparition of the rays in the first dorsal and second dorsal, as well as in the ventral fin, separates easily *Scyris* and *Blepharis* from *Vomer* and *Selene*.

The following range of fluctuation of gill raker counts on the ventral margin of adults was given for several genera with indication of the species which represent exception:

Trachynotus 8 to 15 (usually 11-13, except *T. ovatus* with 28-31); *Uraspis* 14; *Oligoplites* 13 to 15; *Alectis* 14-16; *Seriola* 11-13 (16-18 in *S. rivoliana*); *Naucrates* 18-19; *Hemicaranx* 19-23; *Caranx*, *Vomer* 15 or more, but always less than 30 (with the exception of *C. ruber* 31-35 and *C. rhonchus* 37); *Elagatis* 25-30; *Chloroscombrus* 32-35; *Selar* 27-30; *Decapterus* more than 30 and up to 40.

d. Armature of the head:- The following characters were taken into account with indication for each species treated:

Preopercular armature - shape and number of spines, the biggest one being of particular interest when serrated or denticulated (genus *Elagatis*, *Oligoplites*);

Sub-orbital crest - single and short (*Trachurus*, *Decapterus*, *Caranx*); double and long (*Naucrates ductor*); long and serrated (*Trachynotus*)

Auricular and temporal spines - according to their size.

It was pointed out that the greatest number of characters should be taken into account simultaneously and that none was listed in hierarchical order.

Sagittal crest: Particular attention was given to this character which, even if mentioned by several authors, has never been studies in detail. Photographs of different types of sagittal crest were circulated. It seems that its presence or absence, its shape low or high, and the position of its denticulations are quite useful for distinguishing some genera as well as some species.

Finally, the author reviewed critically several biometric criteria, particularly the ratio height/length of the gut, height/length of the head. Certain relationships used by other specialists to distinguish between the genus *Trachurus* and *Caranx* seem to be less reliable than the analysis of anatomical characters, considering that the fixations of the larvae can produce modifications in the different body proportions.

Identified specimens of different species and size from both coasts of the Atlantic have been compared under the microscope. It was observed that the Carangid fauna of the CICAR area is in fact more diversified than that off West Africa and that there are still several uncertainties which we hope to solve in collaboration with specialists working in these areas.

A list of Carangid species whose larvae have been described (see Annex 4) and a preliminary selected bibliography (see Annex 5) were distributed to the participants.

3.10 Scombrid, Xiphiid and Istiophorid Taxonomy

Chairman: T. Potthoff

Rapporteur: W.J. Richards

Mr. Potthoff presented the most recent classification of the family Scombridae as proposed by B. Collette. He then explained the pigment patterns used in larval scombrid identification and the presence or absence and acquisition of pigment characters in tabular form for the various species of larval scombrids in the CICAR area. He also presented a list of meristics for the juvenile Scombrid species and noted that larvae of the genus Thunnus from 2.5 - 7.0 mm SL in the Western Atlantic cannot be identified from pigment characters with certainty, except for T. thynnus.

All larvae of Thunnus greater than 7.0 mm SL from the CICAR area can be identified from osteological characters except the T. albacares and T. obesus complex, although this complex is separable from the other species. He also noted that there is some difficulty in separating very small Auxis spp. from Euthunnus alletteratus. This can be resolved by observing pigment patterns over the midbrain. The taxonomic problems of adult Auxis are not resolved. Mr. Potthoff also noted that the larvae of Scomberomorus regalis are not described or well known. Larger larvae and juveniles of Scomberomorus regalis can be identified by meristic characters. The species of scombrids that are present in the CICAR area and whose larvae were discussed by Mr. Potthoff are:

Tribe Scombrini: Scomber japonicus

Tribe Scomberomorini: Scomberomorus cavalla
S. maculatus
S. regalis
Acanthocybium solandri

Tribe Sardini: Sarda sarda

Tribe Thunni: Thunnus alalunga
T. albacares
T. obesus
T. atlanticus
T. thynnus
Katsunonus pelamis
Euthynnus alletteratus
Auxis spp.

Dr. Richards discussed the problem of billfish identification. The larvae of Xiphias gladius present no problem, but the larvae of the Istiophoridae are extremely difficult. Dr. Richards would appreciate receiving all istiophorid larvae for identification purposes. The species occurring in the CICAR region are Istiophorus platypterus, Tetrapturus albidus, T. pfluegeri, and Makaira nigricans. Two other species may occur, T. georgei and M. indica; the latter is most doubtful.

Dr. Juarez presented an excellent technical paper on the distribution of scombrid larvae in the Gulf of Mexico.

Specimens were examined by the participants.

3.11 General Taxonomy Session

Chairman and rapporteur: W.J. Richards

This general session reviewed several families of fishes which could not be covered in detail, emphasizing those areas where mistakes commonly occur. One such is the confusion of the monotypic family Dactylopteridae represented by D. volitans with the Istiophorids: D. volitans lacks a bill but has a sagittal crest and melanophores above and below the notochord tip, both features lacking in istiophorids. Another is confusion between the families Coryphaenidea, Rachycentridae and Echeneidae which represent heavily-pigmented and slender larvae. Coryphaenids and Echeneids (genus Remora) have forked caudals, Rachycentron and the Echeneid Echeneis have lanceolate caudal fins.

The serranids were briefly discussed and it was noted that they could be separated to subfamily level. The family Lutjanidae most resembles the subfamily Epinephelinae in being deep-bodied with long first dorsal spines but differs from this form by being laterally compressed and having spines which are not so accentuated.

Specimens representing these groups were then examined.

3.12 Taxonomy Summary Session and Co-operative Projects

Chairman: E.H. Ahlstrom

Rapporteur: W.J. Richards

Dr. Ahlstrom considered projects that were essential to the development of our understanding of the ichthyoplankton of the CICAR area. These are:

Project 1. It is essential that compilations be made of adult meristics of all fishes grouped by families in the CICAR area that are likely to occur in ichthyoplankton collections.

Project 2. Handbooks should be prepared for the identification of eggs, larvae and juveniles particularly for the important groups such as clupeids, leptocephali, scombrids, carangids, and flatfishes. An outline of the proposed handbook is given in Annex 6.

Project 3. It is recommended that the CPOM receive all reprints on ichthyoplankton and serve as a base for the archiving of all pertinent literature. The world literature on ichthyoplankton should be gathered together, particularly illustrations. Dr. Ahlstrom has such a collection and invites individuals to come to La Jolla to make copies.

Project 4. An identified reference collection of eggs, larvae and juveniles should be established at the CPOM. These specimens should be confirmed by experts. Dr. Smith offered to identify all leptocephali and Dr. Richards offered to identify all scombrids and istiophorids.

Project 5. Information must be exchanged so that everyone is aware of what the other is doing, particularly to prevent duplication of effort.

Project 6. Experts on different groups should be requested to provide meristic data. A list of experts was discussed.

With regard to Project 1, it was agreed that the information obtained through the literature or through original observations be sent to the Director of the CPOM for compilation. The following participants offered to provide such information on meristics of adults already available to them as follows: Dr. Ahlstrom - Myctophids; Dr. Smith - Eels; Dr. Juarez - Mugilids and Exocoetidae. Suggestions of names and addresses of specialists in different fish families, to be contacted to obtain information in this regard, have been given.

In relation to Project 2, the following participants have expressed their intention to prepare a handbook for identification purposes: Dr. Houde is preparing a handbook on Clupeidae, for identification of eggs and larvae to genus and/or species level, to be published in the NMFS (National Marine Fisheries Service) Circular series; Dr. Smith is finalizing a guide for identification of Leptocephali, only to family level, to be published also in the NMFS Circular series; Mrs. Mantolio will prepare, in consultation with Dr. Aboussouan and, if possible, in collaboration with Mrs. Polanco, a handbook for identification of the Carangids larvae of the CICAR area. The outline proposed for the preparation of the handbook is given in Annex 6.

Regarding Project 4, a reference collection of identified fish larvae at family, genus and/or species level is being established by the CPOM. The reference collection includes at present about 23 families, 44 genera and 39 species found in the CICAR area and identified mainly during the workshop by Drs. Ahlstrom, Richards, Houde, Matsuura and Smith. The CPOM will soon prepare a list of the identified material available, to be distributed to the ichthyoplanktologists working in this region.

3.13 Application of Ichthyoplankton Studies to Fishery Management

Chairman: A. Saville

Rapporteur: E. Houde

There are three major purposes for ichthyoplankton surveys as applied to fishery resources management. These are:

1. to identify spawning areas and spawning seasons;
2. to measure either relative or absolute abundance of stock;
3. to determine species' interactions during the larval stage that may subsequently affect stock size.

Spawning areas and seasons can be determined by examining the state of ripeness of adult fishes caught at various times and places throughout the year.

Ichthyoplankton surveys provide a direct measure of the spawning areas and seasons, because the actual spawned eggs and larvae are collected. When little data on adult stocks exist, such as in the CICAR area, the egg and larvae collections will probably best delineate areas and times of spawning.

The most valuable application of ichthyoplankton surveys is to measure absolute stock size and relative changes in stock from year to year. Surveys to obtain good estimates of adult abundance must be carefully planned with the sampling survey encompassing the entire spawning area and season. A grid of evenly-spaced stations is the best way to survey an area initially. Subsequently, stations should be concentrated in areas of intense spawning, once these areas are delineated, because this will help to get more precise estimates. In the initial survey, cruises should be scheduled evenly throughout the year if nothing is known about the spawning seasons. When these periods are known, cruises should be concentrated during periods of intense spawning, because this also will provide more precise estimates of total eggs spawned, and subsequently adult biomass.

Relative changes in stock size probably can be evaluated in the CICAR area with as few as three or four cruises a year. Relative changes in egg abundance from such surveys may reflect large changes in stock size that might have occurred. These kinds of data can be valuable to help manage heavily exploited fisheries.

Absolute measures of stock size are possible from ichthyoplankton surveys. To obtain such estimates we must know the total number of eggs spawned annually, the mean fecundity of the stock and the sex ratio of the stock. If we know fecundity as related to weight of the stock we can get a biomass estimate directly from the relationship:

$$W = \frac{P}{KF}$$

where W = biomass of the stock, P = annual egg production, F = fecundity per unit weight, and K = the proportion of females in the stock.

It may be difficult to get accurate fecundity estimates in the CICAR area because of the lack of seasonality in spawning by some species. Each species will have to be studied carefully to obtain good estimates of mean annual egg production by females or mean fecundity per unit weight of stock.

The number of larvae at a given stage, rather than eggs, can be used to estimate adult stock abundance, but such estimates are always minimal unless the mortality between the egg and that larval stage is known.

The number of eggs or larvae at a given stage produced below 1 m^2 of sea surface per day at a particular station can be estimated from the formula: $\frac{ND}{VT} = C_i$

where N = the number in the catch, D = the depth of the tow in metres, V = the volume filtered in cubic metres, T = the time in days to develop to the egg or larval stage being used.

A cruise total for eggs or larvae of given stages can be obtained by three techniques: 1) if each station represents an equal area, the estimate of the mean number of eggs per station can be multiplied by the total area surveyed in the cruise according to the formula: $C_j = \frac{A \sum ND/VT}{n}$

where A = total area in square metres represented by the cruise and n = total number of stations sampled; 2) if areas represented by stations vary, the technique of summing the estimated abundance at each station multiplied by its area in square metres will give a cruise estimate; 3) alternatively, the cruise estimate could be obtained by drawing isometric lines of egg or larval abundance and then summing the abundances between the contours. In practice, both of the latter techniques seem to give similar estimates of abundance.

To obtain annual estimates of egg or larval abundance the cruise estimates must be integrated over time. Three techniques have been used. The Sette and Ahlstrom (1948) technique assumes that each cruise estimate represents the dates of the cruise plus half the number of days since the previous cruise and half the number of days to a subsequent cruise. Each cruise estimate is multiplied by the number of days that the cruise represents and the sum of these gives an annual estimate of abundance.

A second technique (Simpson, 1959) plots the individual cruise estimates on the ordinate and the mid-data of the cruises on the abscissa. Lines are drawn to connect the individual cruise estimates and the area under the resulting polygon is an estimate of annual abundance.

The third technique is that of Saville (1956) where a mathematical function such as a normal curve is assumed to describe the annual spawning cycle. The individual cruise estimates are used as data in fitting the function and the annual estimates then obtained. The Saville technique is particularly useful where only a few cruises are possible during the spawning season, but where some knowledge of the spawning cycle and its peak intensity are known.

Workshop participants were given the opportunity to solve a problem by obtaining biomass estimates from egg catch data. The example that was used obtained daily estimates of spawning at a station, the total estimate of spawning in the area represented by the station, the estimate of abundance for the cruise, and finally the annual estimate of abundance.

The three major sources of error associated with estimating annual spawning from ichthyoplankton surveys were discussed.

These errors arise from integrating catches over time, from integrating catches over area, and from sampling variation at a station. It is expensive to evaluate the first two error sources, but past experience has shown that annual estimates of eggs or larvae abundance can be estimated within 0.5 to 2 times the true abundance at the 0.95 confidence level, if the survey has been well designed and carried out. Ichthyoplankton survey techniques have been shown to compare favourably with other methods of stock assessment and may be the best technique for unexploited or little exploited stocks.

The third application of ichthyoplankton surveys, the study of species interactions during the larval stage, was discussed with much input by workshop participants. Little is known at present about species interaction during the larval stage but it was hypothesized by Saville that competition for food during the larval period might be a major factor affecting survival and subsequent year class strength. The stock-recruitment relationships of Beverton and Holt and Ricker indicate that survival of larvae may be density dependent at high stock densities because recruitment does not increase at high stock levels. Density dependent factors could operate at either the intra- or inter-species level during the larval stage.

Saville suggested that intensive fishing on a stock could reduce its reproductive capacity to the point that competition from larvae would be at such a low level that survival of other species would be improved.

Examples of possible cases from the North Sea were also presented.

It was felt that studies of food habits of larvae that may be in competition and of their mortality rates should be carried out in the future.

Dr. Dekhnik discussed the results of her research on larvae of Black Sea *Engraulis encrasicholus* and *Trachurus symmetricus*. In the Black Sea, food supply is not the limiting factor for larval survival but predation varies annually, and this factor affects subsequent year class strength.

Mrs. Gutierrez presented a paper on ichthyoplankton studies in the Gulf of California carried out by Mexico. Her data showed four major spawning areas of *Sardinops caerulea*, and that most spawning occurred along the eastern coast of the Gulf. Eggs and larvae of four pelagic species also were studied.

Dr. Pinus presented her paper on the influence of ichthyoplankton on population dynamics of fishes. She has studied the survival of larvae and year class strength of Azov Sea *Clupeonella delicutula* in relation to biotic and abiotic factors. Year class strength is positively related to the number of days of optimal temperatures ($15^{\circ} - 18^{\circ}C$) during May. At optimal temperatures larval survival is high because predation is lower than at suboptimal temperatures. Predation is a more important factor governing year class strength than is the food supply.

Lively discussions were generated among participants with regard to possible mechanisms affecting larval survival, and the need for more research in this area of study was emphasized.

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4. SUMMARY REMARKS AND RECOMMENDATIONS

E. Fagetti

Several planktonic surveys have been conducted in the Gulf of Mexico and Caribbean Sea in recent years by different countries as a part of the biological programme of the Co-operative Investigations of the Caribbean and Adjacent Regions (CICAR). One of the objectives of collecting plankton in the standard biological stations of the CICAR area was to study the ichthyoplankton fauna of the region, its composition, distribution and abundance both in time and space, with a view to providing information for the stock assessment and management of the fishery resources of the region.

Ichthyoplankton research encompasses problems of taxonomy, physiology, ecology, biology and behaviour of the fishes in their critical phases of development, as well as other aspects of applied fishery sciences. It is generally recognized that the biggest gaps in the knowledge of fishery resources are found in the first developmental stages of fish, but it is also recognized that the task of filling these gaps is a rather difficult one, due to the complexity of the problems involved, which run from the methodology of quantitative sampling of plankton at sea, to the sorting and the identification of the samples.

The ichthyoplankton survey programme in the CICAR area is aimed at attaining the following research objectives:

- to obtain the necessary basic knowledge on taxonomy, distribution and ecology of this important component of the planktonic community;
- to use the quantitative data obtained during ichthyoplankton surveys to explore new fishery resources and to determine the relative abundance and distribution of the economically important species;
- to complement our knowledge of fish population dynamics and, whenever possible, to use the results on fish egg and larval studies to estimate the spawning biomass and to forecast fecruitment.

The first step towards achieving these objectives is the correct identification of the ichthyoplankton material. This is a notoriously difficult task, particularly in tropical areas, where the number of fish species is quite large. The main purpose of the workshop was therefore to help overcome these difficulties with identification both through direct comparisons of material collected and identified in this region and through discussions among the specialists of the pertinent taxonomic problems faced by each of them.

The selection of the CPOM as the guest institution proved to be most suitable for this sort of meeting, not only because of its very adequate laboratory space and facilities, but also because of the availability of its sorted collections of fish eggs and larvae from the CICAR area, part of which had already been identified to the family level. In addition, the participants became personally acquainted with the services provided by the Centre. The Director of the CPOM explained to the participants that the main purpose of the Centre, which was established in June 1972, is to provide scientists throughout the world with sorted material from the CICAR area for further taxonomic and ecological studies. Furthermore, he stated that the distributed material, part of which will be returned identified to the Centre to serve as a base for comparison , greatly increases the value of the CPOM to the scientific community.

Additional contributions to the CPOM reference collection of identified fish larvae were made by the specialists attending the workshop. Many had brought identified eggs and larvae from their own laboratories which they donated to the Centre and all assisted in naming some of the previously unidentified specimens already in the collection. It was agreed among the participants that in the future they would forward to the CPOM the identified specimens of eggs and larvae of fishes inhabiting their geographical area of research, in order to collaborate in completing its reference collection. The existence of good reference collections in the CPOM will greatly assist future research workers to overcome the difficulties in taxonomical work. It was emphasized that a similar need for good reference collections exists for the other planktonic taxa sorted in the Centre. Therefore, it was recommended to the participants that they inform their colleagues working on other plankton groups of the needs and the services of the CPOM.

It was the consensus of the participants that the time spent both in theoretical discussions and in practical work of examining the specimens under the microscope was very stimulating and useful and that this meeting represented a start toward the understanding of the ichthyoplankton of the CICAR area. It is therefore hoped that future investigations in this field will move forward more rapidly as a consequence of not only the information exchanged but also of the personal contacts established during this workshop among the specialists from the different countries.

It was recommended that international organizations should co-operate in organizing a second ichthyoplankton workshop for the same geographical area, to be held within a few years, in order to assess the progress made in this research field.

The following is a summary of the main topics covered during the meeting sessions and pertinent recommendations.

1. Sampling, its problems and applications. It was agreed that the most important consideration is that sampling always be conducted according to a standard procedure in order that valid comparisons can be made among all data collected by various researchers in a particular region. Comparability of quantitative data between different fishery areas is the essential prerequesite for co-operative survey programmes. The 60 cm diameter Bongo net with .505 mm mesh, was recommended as the standard gear for ichthyoplankton surveys in the CICAR area. Mr. R. Marak, acting chief of the MARMAP field group in Narragansett, Rhode Island, has kindly offered to provide a set of standard Bongo nets to those specialists from the CICAR countries who do not have this gear. The availability of the Bongo net to all of the participating CICAR countries, will allow intercalibration with other sampling gear now being used in the area. Such intercalibration is necessary in order to facilitate the standardization and comparison of the data already obtained by different groups working in the area.

Detailed descriptions of the recommended sampling procedure were provided during the theoretical session.

2. Handling of ichthyoplankton samples. The main point stressed in this discussion was the necessity of exercising extreme care during the collection and processing of the samples in order to minimize damage to the specimens. Identification of early life stages of fishes is often quite difficult; therefore it is most important that the material be in the very best possible condition. Four per cent buffered formaldehyde solution was recognized as the most adequate fixative for fish eggs and larvae from tropical areas. Detailed instructions for each of the handling procedures to be adopted for ichthyoplankton collections are given in the report of the related session.

3. Ancillary data. It was stressed that the understanding of ichthyoplankton distribution and abundance implies a sound knowledge of the environmental conditions at the time and place of sampling. The types of environmental information that should be collected were analyzed and discussed.

4. Taxonomy. Approximately 180 fish families are represented in the CICAR area. From results of the taxonomy sessions it has been shown that, at present, it is possible to identify the larvae of most of these families, but that eggs are known for very few. Below the family level the available information is most incomplete. The most necessary prerequisite for accurate larval identification is knowledge of meristic data for adults. It was requested that the participants collect all available information on the meristic characters of the species occurring in their geographical area of research, and distribute it to one another. It was also agreed that the CPOM gather and distribute the information available in the literature on meristic data of adult species from the CICAR area.

Lists of selected references, mainly on identification of fish eggs and larvae grouped by family, were prepared by some of the participants and distributed during the workshop, as background documents to the meeting. In view of the very useful bibliographic information contained in many of these references, it was recommended that the CPOM compile a single bibliography from this material, and reproduce it, for distribution among interested scientists of the area. Copies of the bibliography may be requested from the CPOM or the Unesco Division of Marine Sciences.

Considering the difficulties inherent to fish eggs and larvae taxonomy it was recommended that specialists in different fish families prepare identification handbooks for those families whose larval species have already been described in sufficient detail. It was agreed that those who intend to prepare such a handbook should notify workshop participants in order to avoid duplication of effort. Drs. E. Houde and D. Smith stated that they are preparing identification handbooks for Clupeid larvae at species level and Leptocephali at family level, respectively. It was also recommended that the Director of the CPOM coordinate this matter.

The necessity for co-operation in identification problems was emphasized and it was agreed to exchange material for identification or confirmation of identification.

5. Stock assessment and management based in ichthyoplankton. One of the ultimate goals of ichthyoplankton research is to provide information that can be used for fishery management. Data collected on fish eggs and larvae can be used to obtain more accurate estimates of such factors as spawning success and size of spawning stock than can be obtained by more expensive methods. These data, when compared to catch statistics of particular fisheries, can be used to indicate when the level of overexploitation is being approached. It is already known how to achieve these estimates for many species. It was therefore concluded that ichthyoplankton collection, sorting, identification and the subsequent analysis of data must continue in the CICAR area. It is well known that in order to obtain estimates of spawning biomass from fish egg and larval data it is necessary to know the fecundity of the species; however, it was recognized during the discussions that fecundity studies are needed for most of the commercially important species of the CICAR area.

Although at the present time the fishery resources of the CICAR area are for the most part underexploited, it is anticipated that exploitation will increase rapidly in the future. It was recognized that, with the present state of knowledge of the ichthyoplankton of the area, in the next few years specialists should be able to provide a sound data base for the estimate of stock sizes of most of the economically important species of the CICAR area.

Annex 1

LIST OF PARTICIPANTS

Steering Committee Members:

Dr. AGUSTIN AYALA-CASTANARES, Mexican National Coordinator for CICAR

Mr. CESAR FLORES COTO, Director, Mexican Oceanic Sorting Centre

Dr. MARTHA VANNUCCI, International Curator, UNESCO

Dr. ELDA FAGETTI, International Curator, UNESCO

Convener:

Dr. WILLIAM RICHARDS, National Marine Fisheries Centre, Miami

Names and addresses of participants:

Dr. Alain ABOUSSOUAN,
Station Marine Endoume,
rue Batterie des Lions,
13007 Marseille,
FRANCE.

Dr. Elbert H. AHLSTROM,
National Marine Fisheries Service,
Southwest Fisheries Centre,
P.O. Box 271,
La Jolla, California 92037,
U.S.A.

Mr. Karl AIKEN,
Ministry of Agriculture,
Fisheries Division,
Marcus Garvey Drive,
Kingston 13,
JAMAICA

Miss Virginia ALVARADO MARTINEZ,
Secretaría de Marina
Hermosillo 16 - 6° piso
México 7, D.F.,
MEXICO

Dr. Daniil BOGDANOV,
All-Union Research Institute of
Marine Fishery and Oceanography,
VNIRO - V. Krasnoselskaya, 17-1,
Moscow,
U.S.S.R.

Dr. Tatiana V. DEKHNIK,
Academy of Sciences of Ukrainian SSR,
Institute of Biology of South Seas,
Nakhimov Street 2,
Sebastopol,
U.S.S.R.

Miss Maritza ESCUDERO
Centro de Preclasificación
Oceánica de México - CPOM
Apartado Postal 70-305,
México 20, D.F.
MEXICO

Dr. Elda FAGETTI
Centro de Preclasificación
Oceánica de México - CPOM
Apartado Postal 70-305
México 20, D.F.,
MEXICO

Mr. César FLORES COTO
Director,
Centro de Préclasificación Océanica
de México - CPOM
Apartado Postal 70-305,
México 20, D.F.,
MEXICO

Ms. Sonia GUTIERREZ de CEBALLOS
Departamento de Biología Marina
Universidad de Panamá
Estafeta Universitaria
Panamá,
PANAMA.

Ms. Consuelo GUTIERREZ H.
Instituto Nacional de Pesca
Chiapas 121, 2º piso
México, D.F.,
MEXICO

Dr. Edward HOUDE
Rosenstiel School of Marine and
Atmospheric Sciences
University of Miami
4600 Rickenbacker Causeway
Miami, Florida 33149
U.S.A.

Dr. Mar JUAREZ FERNANDEZ
Centro de Investigaciones Pesqueras
1ra. y 26 Miramar, Marianao 13,
Habana,
CUBA

Mr. Héctor R. LOPEZ
Instituto de Zoología Tropical
Facultad de Ciencias
Universidad Central de Venezuela
Caracas
VENEZUELA

Ms. Maida MANTOLIO
Centro de Investigaciones Pesqueras
1ra. y 26 Miramar, Marianao 13,
Habana,
CUBA

Mr. R. Robert MARAK
Research and Development
MARMAP Field Office NOAA
R.R. 7-A, Box 522-A,
South Ferry Road,
Narragansett, Rhode Island 02882
U.S.A.

Mr. Barton MARCY, Jr.,
1910 Cochrand Road,
Pittsburgh, Penn. 15220,
U.S.A.

Mr. Yasunobu MATSUURA
Instituto Oceanográfico da
Universidade de Sao Paulo
Caixa Postal 9075
Sao Paulo
BRAZIL

Ms. Rosamaría OLVERA
Instituto Nacional de Pesca
Chiapas 121, 2º piso
México, D.F.
MEXICO

Mr. J. Manuel ORTIZ
Instituto Nacional de Pesca
Chiapas 121, 2º piso
México, D.F.,
MEXICO

Mr. Alberto PEREZ FRANCO
Centro de Preclasificación
Oceánica de México - CPOM
Apartado Postal 70-305
México 20, D.F.,
MEXICO

Dr. G.N. PINUS
All-Union Research Institute of
Marine Fishery and Oceanography
VNIRO - V. Krasnoselskaya 17-1
Moscow, B - 140
U.S.S.R.

Mr. Thomas POTTHOFF
National Marine Fisheries Service
South East Fisheries Centre
75 Virginia Beach Drive
Miami, Florida 33149,
U.S.A.

Mr. Peter REESON
Fisheries Ecology Research Project
c/o Zoology Department
University of the West Indies
Mona - Kingston 7,
JAMAICA

Ms. Bertha RENTERIA de MONSALVE
Centro de Ciencias Marinas
INDERENA
Apartado Aéreo 2459
Cartagena
COLOMBIA

Dr. William J. RICHARDS
National Marine Fisheries Service
South East Fisheries Centre
75 Virginia Beach Drive
Miami, Florida 33149
U.S.A.

Mr. Javier ROBLES FLORES
Secretaría de Marina
Hermosillo 16 - 6º piso
México 7, D.F.
MEXICO

Dr. Alan SAVILLE
Department of Agriculture and Fisheries
Marine Laboratory
P.O. Box 101,
Torry, Aberdeen
U.K.

Dr. David G. SMITH
Marine Biomedical Institute
200 University Blvd.
Galveston, Texas 77550
U.S.A.

Mr. Leon TISSOT P.
Instituto Tecnológico de Monterrey
Guaymas, Sonora,
MEXICO

Mr. Peter WILKENS
NUS Corporation
18731 Martinique Drive
Houston
Texas 77058
U.S.A.

Mr. John WYATT
Fisheries Ecology Research Project
c/o Zoology Department
University of the West Indies
Mona - Kingston 7,
JAMAICA

Names and addresses of observers:

Mr. Maximo ALONZO RUIZ
Centro de Preclasificación Oceánica de México - CPOM
Apartado Postal 70-305
México 20, D.F.
MEXICO

Mr. José ALVAREZ C.
Centro de Preclasificación Oceánica de México - CPOM
Apartado Postal 70 - 305
México 20, D.F.
MEXICO

Ms. Hilda AVENDANO S.
Fideicomiso para el Desarrollo de la Fauna Acuática
Tonalá 112 - 5º piso
México 7, D.F.,
MEXICO

Miss Anayansi CANUDAS G.
Centro de Preclasificación Oceánica de México - CPOM
Apartado Postal 70-305
México 20, D.F.,
MEXICO

Mr. Sergio CORTEZ G.
Centro de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de México
Apartado Postal 70-305
México 20, D.F.
MEXICO

Ms. Patricia CRESPO M.
Secretaría de Marina
Dirección General de Oceanografía
Centro Nal. de Datos Oceanográficos
Medellin 10
México, D.F.
MEXICO

Mr. Alejandro GARCIA C.
Escuela Nacional de Ciencias Biológicas
Instituto Politécnico Nacional
Plan de Ayala y Carpio
México 14, D.F.
MEXICO

Mr. Samuel GOMEZ AGUIRRE
Instituto de Biología
Universidad Nacional Autónoma de México
Apartado Postal 70-233
México 20, D.F.
MEXICO

Mr. Ricardo W. LOPEZ
Centro de Preclasificación Oceánica de México - CPOM
Apartado Postal 70-305
México 20, D.F.
MEXICO

Dr. Richard NUGENT
Centro de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de México
Apartado Postal 70-305
México 20, D.F.
MEXICO

Ms. Edith POLANCO
Consejo Nacional de Ciencia y Tecnología
Av. Insurgentes Sur 1814, 5°. piso
México 20, D.F.
MEXICO

Mr. Laurentino SANCHEZ I.
Centro de Preclasificación Oceánica de México - CPOM
Apartado Postal 70-305
México 20, D.F.
MEXICO

Present address of:

Dr. Martha VANNUCCI
Unesco **Regional Office** of Science and Technology for South and Central Asia
Unesco House,
40B Lodhi Estate,
New Delhi 3,
INDIA

Permanent address of:

Dr. Elda FAGETTI
Fisheries Resources and Environment Division
FAO
00100-Rome
ITALY

Annex 2

ABSTRACTS OF PAPERS CONTRIBUTED

I. Ichthyoplankton Sampling

A STUDY OF THE UNDERSAMPLING PROBLEM OF FISH LARVAE OBSERVED AT TWO FIXED STATIONS IN SOUTH BRAZIL

Yasunobu Matsuura

The undersampling of fish larvae collected during daytime is discussed using data obtained at two fixed stations occupied off the south Brazilian coast in 1969 and 1971.

The predominant species on the stations was the larvae of *Sardinella brasiliensis*. The larvae of *Harengula* spp., Scombridae, Bregmacerotidae and Ophidiidae were also collected, but these were not as abundant.

When compared with the other larvae, the undersampling of sardine larvae during daytime was extremely high. Because the sampling was done both vertically and horizontally at one fixed station and marked undersampling was observed at both fixed stations, it was concluded that the undersampling was caused by avoidance. It was necessary to take this problem into careful consideration for computation of larval abundance.

The size frequency composition of sardine larvae is discussed.

Note: The report will be published in "Boletin do Instituto Oceanográfico da Universidade do Sao Paulo".

II. Taxonomy and distribution

SPECIES COMPOSITION AND QUANTITATIVE DEVELOPMENT OF ICHTHYOPLANKTON IN THE CARIBBEAN SEA

T.V. Dekhnik and V.I. Sinyukova

1. According to the international CICAR programme, a complex investigation was carried out by the R/V "Akademik Vernadsky" in November-December 1970 and in October-December 1972 in order to obtain data on primary production and quantitative distribution of zoo- and ichthyoplankton.

2. During the two periods of investigation, ichthyoplankton was collected vertically with a Bogorov-Rass conical net (N 23 gauze, 0.5 m^2 mouth area) from depths of 50-0, 100-50, 200-100 (or 300-100)m at 90 stations (at five stations ichthyoplankton was collected from the depth of 500m. and at three stations from 1000m

3. In all the areas surveyed (excluding Kariak Deep) the predominant organisms were the larvae of the family Myctophidae (up to 40-60 per m^2). The larvae of commercial fish such as Clupeidae, Carangidae, Thunnidae, Pleuronectidae and Percidae were present almost everywhere (mainly in the upper 50 m layer) but in relatively lower numbers (up to 10-12 per m^2). In the Kariak Deep the highest proportion was made up by larvae of *Bregmaceros macclelandii* (up to 80% of the total number of larvae in the plankton from this area).

4. The abundance of ichthyoplankton was found to vary considerably over the area surveyed. The total number of eggs was not higher than 150 per m^2, with usually as few as several eggs collected in the area sampled. Most of the eggs were provisionally identified as Myctophidae. Fish larvae were found everywhere, with the highest concentrations (averaging 110 per m^2) recorded in the Caribbean Sea. The abundance of larvae showed a tendency towards increasing from the northern to the southern portions of the meridional sections, in agreement with increasing content of nutrients (particularly phosphates), primary production and zooplankton standing crop. In all the straits and passages surveyed, the numbers of fish larvae were on the average 2.5 times lower than in the Caribbean Sea.

5. Fish larvae were mainly found in the upper 200 m layer. The hauls from 50-0, 100-50 and 200-100 m layers showed a consistent decrease in the abundance of fish larvae with depth.

Note: The report will be published in Russian in "Investigations of the Caribbean Sea". Special Series, 1975, Naukova Dumka, Kiev.

DISTRIBUTION OF LARVAL STAGES OF SOME SPECIES OF THE FAMILY SCOMBRIDAE IN THE GULF OF MEXICO

Mar Juarez

Results on the distribution of scombrid larvae are presented from ichthyoplankton surveys in the Gulf of Mexico. Sampling was carried out in three periods during 1973: April-May, August-September and October-November. In the April-May survey, larvae of *Auxis thazard*, *Euthynnus alletteratus*, *Katsuwonus pelamis* and *Thunnus thynnus* were taken. In the August-September survey, larvae of *Thunnus atlanticus*, *Auxis thazard*, *Scomberomorus cavalla*, *Euthynnus alletteratus* and *Katsuwonus pelamis* were taken. In the October-November survey, larvae of *Katsuwonus pelamis*, *Thunnus atlanticus*, *Scomberomorus cavalla*, *Auxis thazard* and *Euthynnus alletteratus* were taken. Numbers of larvae indicate that in April-May period *Auxis thazard* is the most abundant (46.6%) followed by *Thunnus thynnus* (24.6%), *Euthynnus alletteratus* (21.3%) and *Katsuwonus pelamis* (7.3%). In the August-September period *Thunnus atlanticus* larvae accounted for 56.6% of the scombrid catch followed by *Auxis thazard* (33.7%), *Euthynnus alletteratus* (4.2%), *Katsuwonus pelamis* (3.8%) and *Scomberomorus cavalla* (1.7%). In the October-November period, percentages of catch were for *Katsuwonus pelamis* (41.8%), *Thunnus atlanticus* (29.2%), *Auxis thazard* (19.7%), *Scomberomorus cavalla* (6.2%) and *Euthynnus alletteratus* (3.0%).

Note: The report will be published in Spanish in the Bulletin of the "Centro de Investigaciones Pesqueras de Cuba".

III. Application of Ichthyoplankton Studies to Fisheries Research

ICHTHYOPLANKTONIC INVESTIGATION IN THE GULF OF CALIFORNIA DURING APRIL 1971

Consuelo Gutiérrez H.

Based on the results of the analysis of ichthyoplankton samples obtained at 50 stations in the central part of the Gulf of California, data are given on the distribution and abundance of *Sardina caerulea* eggs in the explored area during April 1971.

On the basis of these quantitative data, an attempt is made to assess the size of the spawning stock during the month of April.

Note: Published in Spanish in the "Informe Técnico, Serie Informativa", INP/SIC* : i 17, 14 pp, 4 figs.

THE IN LUENCE OF ICHTHYOPLANKTON IN FISH POPULATION DYNAMICS

G.N. Pinus

The high mortality of pelagic eggs in the sea and the dependence of larval survival and growth on the feeding conditions make it particularly important to study the role of ichthyoplankton in the formation of a fish year class strength.

A procedure, consisting of defining the significance of a specific environmental factor when other factors are at an optimum, was applied by the author to study the effect of various environmental factors on the eggs of Clupeonella delicatula N. in the Azov and Caspian Seas and showed the decisive role of the temperature regime in the dynamics of the abundance of this fish. The year class strength of this species occurring in the southern USSR seas was found to depend on the number of days with temperatures optimal for the development of eggs.

Though the study of the ichthyoplankton of tropical and subtropical waters, in particular of the Caribbean Sea and the Gulf of Mexico, involves certain difficulties, the knowledge of factors influencing the survival of eggs and larvae of fishes inhabiting these waters is important for establishing relationships with population dynamics.

* Instituto Nacional de Pesca/Secretaría de Industria y Comercio, México, D.F.

Annex 3

LIST OF THE FAMILIES OF MARINE TELEOSTS WHOSE LARVAL STAGES OCCUR IN THE CICAR AREA

Elopidae
** Megalopidae
** Albulidae
Anguillidae
  plus 22 additional eel families
Saccopharyngidae
  plus 2 related families
Halosauridae
  plus 2 related families
** Clupeidae
** Engraulidae
** Chirocentridae
Argentinidae
Bathylagidae
Opisthoproctidae
* Sternoptychidae
  (includes Gonostomatidae)
Astronesthidae
Melanostomiatidae
Malacosteidae
Chauliodontidae
Stomiatidae
Idiacanthidae
= Alepocephalidae
= Bathylaconidae
Giganturidae
Aulopidae
* Synodontidae
Bathysauridae
Bathypteroidae
Ipnopidae
Chlorophthalmidae
* Myctophidae
Scopelosauridae
* Paralepididae
Omosudidae
Alepisauridae
Anotopteridae
Evermannellidae
Scopelarchidae
= Cetomimidae
  plus 2 related families
= Ateleopidae
Mirapinnidae
Eutaeniophoridae
** Exocoetidae

Belonidae
Scomberesocidae
Atherinidae
Batrachoididae
Gobiesocidae
Lophiidae
Antennariidae
= Chaunacidae
Ogcocephalidae
Ceratiidae
  plus 9 related families
Moridae
* Bregmacerotidae
Gadidae
Merlucciidae
Macrouridae
* Ophidiidae
  (includes the Brotulidae)
Carapidae
Polymixiidae
= Berycidae
= Diretmidae
Trachichthyidae
= Anomalopidae
Holocentridae
= Anoplogasteridae
Gibberichthyidae
  (includes Kasidoridae)
= Stephanoberycidae
Melamphaidae
Zeidae
Grammicolepidae
= Caproidae
= Lampridae
Veliferidae
Lophotidae
  plus 2 related families
Stylephoridae
Aulostomidae
Fistulariidae
Macrorhamphosidae
Syngnathidae
* Scorpaenidae
Triglidae
Peristediidae
* Dactylopteridae
** Mugilidae
** Sphyraenidae
Polynemidae

** Serranidae
= Grammidae
= Grammistidae
Centropomidae
Priacanthidae
Apogonidae
Branchiostegidae
= Cirrhitidae
Rachycentridae
Pomatomidae
Echeneidae
** Carangidae
Coryphaenidae
Bramidae
= Emmelichthyidae
** Lutjanidae
Lobotidae
Gerridae
** Pomadasyidae
** Sparidae
** Sciaenidae
Mullidae
Pempheridae
(includes the Bathyclupeidae)
Kyphosidae
Ephippidae
Chaetodontidae
Pomacentridae
* Labridae
* Scaridae
Opisthognathidae
Caalionymidae
Uranoscopidae
Blenniidae
= Chaenopsidae
Clinidae
* Gobiidae
Acanthuridae
Centrolophidae
Nomeidae
Stromateidae
Tetragonuridae
* Gempylidae
Trichiuridae
** Scombridae
** Xiphiidae
Luvaridae
** Istiophoridae
Champsodontidae
Chiasmodontidae
= Percophidae
Scophthalmidae
* Bothidae
Pleuronectidae
* Soleidae
Cynoglossidae
* Balistidae
=* Ostraciotidae
* Tetraodontidae
* Diodontidae
Molidae
Microdesmidae

Note :

* indicates larvae abundant of non commercial importance;
** indicates commercial or recreational importance;
= indicates larvae not yet described

Annex 4

LIST OF TECHNICAL DOCUMENTS DISTRIBUTED TO PARTICIPANTS

I.- Ichthyoplankton sampling and handling of samples on shore

- Fish Eggs and Larval Surveys (Contribution to a Manual). FAO Fish.Tech. Pap., 122 (1973)
- Collecting and Processing Data on Fish Eggs and Larvae in the California Current Region, by D. Kramer et.al.,NOAA Tech.Rep.NMFC Circ., 370 (1972)
- Density - gradient centrifugation as an aid to sorting planktonic organisms. I. Gradient materials, by Bowen,R.A. et.al.,Mar.Biol.,14 (3): 242-47 (1972)
- Analysis of plankton populations by sedimentation in density gradients, by Price,C.A.,Interim Report on MARMAP Research organized by the Rutgers University Particle Separation Centre.

II.- Larval Taxonomy

- Terminology of Early Stages of Fishes, by Hubbs, Copeia 1943 (1):260
- Notes on Clupeidae Eggs and Larvae of Commercial Important or Potentially Important Marine Spawning Genera in CICAR Region, prepared by E.Houde (Unpublished).
  (It presents : a.- measurements and other diagnostic characteristics of the planktonic eggs of 7 species belonging to the genera *Brevortia*, *Opistonema*, *Sardinella*, *Harengula*, *Etrumeus*;
  b.- Myomere counts, description and drawings of the pigment pattern of 5 larval species belonging to the above genera.)
- A Guide to the Laptocephali of the Western North Atlantic, prepared by D.G.Smith (Unpublished).
  (14 pag. and 29 Figs.- The Guide includes: a.- identification keys to the Orders of Leptocephali, to Elopiform Leptocephali at species level and to Anguilliform Leptocephali mainly at family level; b.- description and drawings of several larval species and, c.- 3 selected references for each family treated.)
- List of Carangidae Species Whose Larval and/or Juveniles Stages Are Described, prepared by A. Aboussouan (Unpublished)
  (It includes 44 species with indication of bibliographic references dealing with pertinent description of the larvae and/or juveniles).
- Identification Characteristics of Scombrid Larvae of Western North Atlantic Ocean, prepared by W.J.Richards (Unpublished).
  (Miomeres counts are given in order to place the larvae in generic groups; other distinguishing characters are presented for each group which allow the separation into genera and species).

- The Family Scombridae, prepared by T.Potthoff (Unpublished)
  (7 pag. and 48 fig.It presents: a.-the taxonomy of the Atlantic species of the family; b.- a list of the described species at larval stage with some of the more pertinent references; c.- Table giving distribution pattern of larval pigment for 10 Scombrid larvae from 3 to about 8mm.SL.; d.- 1 Table on adult meristics (Vertebrae gill rakers and dorsalspines) of 13 species; e.- original drawings of the larvae Scomber japonicus and/or juveniles of 9 scombrid species).

- Distribution and Relative Abundance of Larval Tunas Collected in the Tropical Atlantic During Equalant I and II, by W.J.Richards, in Proc. Symposium on Oceanography and Fisheries Resources of the Tropical Atlantic. Review Paper and Contribution, UNESCO,pp.289-315 (1968)

- Identification Sheet of Larvae and Juveniles of Thunnus atlanticus, prepared by M. Juarez.
  (It presents 6 drawings of the different larval stages of the species, a brief diagnosis of the larvae and data on their geographical distribution in Caribbean waters, seasonal distribution and selected references).

III.- Power Plant Entrainment

- Vulnerability and Survival of Young Connecticut River Fish Entrained at a Nuclear Power Plant, by Barton C. Marcy Jr., J.Fish.Res.Board Can. 30 : 1195-1203

Annex 5

LIST OF SELECTED BIBLIOGRAPHIC REFERENCES DISTRIBUTED TO THE PARTICIPANTS

I.- Ichthyoplankton Sampling

- Some Useful References on Sampling Eggs and Larvae of Marine Fishes, compiled by E.Houde (27 refs.)

II.- Identification and Distribution of Fish Larvae

- Bibliography on Studies of Eggs and Larvae of Fishes from the Gulf of Mexico, compiled by E.Houde (43 refs).
- Selected References for the Identification of the Early Life Stages of Clupeids of the CICAR area
- Selected References for the Identification of Flatfish Larvae,compiled by W.J.Richards (23 refs.)
- Selected References on Larval Studies of Families Gonostomatidae,Sternoptychidae,Astronesthidae, Melanostiomatidae, Malacosteidae,Chauliodontidae,Stomiatidae and Idiacanthidae, compiled by W.J.Richards (15 refs.)
- Selected References to the Eggs and Larvae of Gadoid Fishes, compiled by W.J.Richards (14 refs.)
- Selected References on Myctophid Larvae, compiled by W.J.Richards (40 refs.)
- Istiophoridae and Xiphiidae, compiled by W.J. Richards (81 refs.)
- Preliminary Selected Bibliography on Carangidae Larvae, compiled by A. Aboussouan (86 refs.)

III.- Power Plant Entrainment

- Selected References, compiled by Barton C. Marcy (11 refs.)

Note : The bibliographic material prepared for the Workshop, will be compiled and reproduced by the CPOM, in a technical paper to be distributed among interested scientists. Requests should be addressed to the Director of the CPOM.

Annex 6

SUGGESTED OUTLINE FOR THE PREPARATION OF HANDBOOKS IN FISH EGGS AND LARVAE IDENTIFICATION

Handbooks for the identification of eggs and larvae of different fish families should contain the following information:

1.- Adult species list
2.- Notes on distribution and spawning time, with indication of temperature and salinity ranges.
3.- Adult meristics, from literature sources
4.- Illustrations of eggs, yolk-sac larvae, larvae and juveniles
5.- Distinguishing features, emphasizing critical features, and comparison with similar or other confusing species
6.- Bibliographies with quotations on adult and young stages

Credit for the original author drawings should be given for reproduced illustrations.

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ZOOPLANKTON SAMPLE LOG
(ZSL)

CRUISE	VESSEL	STATION NO.	HAUL NO.	DATE (DAY, MONTH, YEAR - GMT)
BEGINNING LATITUDE	BEGINNING LONGITUDE	FINAL LATITUDE	FINAL LONGITUDE	OPTIONAL-1
SHIP'S SPEED KNOTS	SHIP'S HEADING ° MAG. ° TRUE	DEPTH INSTRUMENT	DEPTH INSTR. SERIAL NO.	OPTIONAL-2
LOG FINISH	LOG START	LOG DIFFERENCE	ESTIMATED SHIP'S TRAVEL METERS	OPTIONAL-3
TIME GOING OUT MIN. SEC.	TIME AT DEPTH MIN. SEC.	TIME COMING IN MIN. SEC.	ELAPSED TIME IN WATER SEC.	ESTIMATED NET TRAVEL METERS
ALIQUOT	ALIQUOT VOLUME ML.	TOTAL SAMPLE VOLUME ML.	DETERMINED BY	DATE

TYPE OF TOW: (CIRCLE ONE) SINGLE-OBLIQUE, DOUBLE-OBLIQUE, SINGLE-STEPPED-OBLIQUE, DOUBLE-STEPPED-OBLIQUE, HORIZONTAL-OBLIQUE, STANDARD-VERTICAL, STANDARD-HORIZONTAL, OTHER:, STANDARD-SURFACE, STANDARD-NEUSTON

BKG/TDR TRACE: (CIRCLE ONE) NORMAL, SLIGHTLY-ABNORMAL, VERY-ABNORMAL, MALFUNCTION, NOT-USED

WIRE ANGLES RECORDED DURING RETRIEVAL EACH 30 SECONDS / 10 M CABLE / OTHER

TIME AT MAX. DEPTH																
MAX. CABLE OUT																

30 SEC. INT.		30	29	28	27	26	25	24	23	22	21	20	19	18	17
WIRE OUT (M)		300	290	280	270	260	250	240	230	220	210	200	190	180	170
WIRE ANGLE															

30 SEC. INT.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
WIRE OUT (M)	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10
WIRE ANGLE																

GEAR	MESH SIZE (MM)	MOUTH DIAM. (M)	MOUTH HEIGHT (M)	MOUTH WIDTH (M)	FLOW METER'S POSITION	FLOW METER NUMBER	METER START	METER END	DEEPEST DEPTH (M)	NO. BOTTLES FILLED	SERIAL NUMBERS
					INSIDE OUTSIDE						
					INSIDE OUTSIDE						
					INSIDE OUTSIDE						
					INSIDE OUTSIDE						

REMARKS, DAMAGE, OR LOSS

RECORDED BY	CHECKED BY	DATE	ADDT'L INFO. ADDED BY	PAGE OF

MARMAP FORM 73-7 (1/73)

UNESCO TECHNICAL PAPERS IN MARINE SCIENCE

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No.		Year	SCOR WG
1	First report of the joint panel on oceanographic tables and standards held at Copenhagen, 5-6 October 1964. Sponsored by Unesco, ICES, SCOR, IAPO	1965	WG 10
2	Report of the first meeting of the joint group of experts on photosynthetic radiant energy held at Moscow, 5-9 October 1964. Sponsored by Unesco, SCOR, IAPO	1965	WG 15
3	Report on the intercalibration measurements in Copenhagen, 9-13 June 1965. Organized by ICES	1966	–
4	Second report of the joint panel on oceanographic tables and standards held in Rome, 8-9 October 1965. Sponsored by SCOR, Unesco, ICES, IAPO	1966	WG 10
5	Report of the second meeting of the joint group of experts on photosynthetic radiant energy held at Kauizawa, 15-19 August 1966. Sponsored by Unesco, SCOR, IAPO	1966	WG 15
6	Report of a meeting of the joint group of experts on radiocarbon estimation of primary production held at Copenhagen, 24-26 October 1966. Sponsored by Unesco, SCOR, ICES	1967	WG 20
7	Report of the second meeting of the Committee for the Check-List of the Fishes of the North Eastern Atlantic and of the Mediterranean, London, 20-22 April 1967	1968	–
	Procès-verbal de la 2e réunion du Comité pour le catalogue des poissons du Nord-est atlantique et de la Méditerranée, Londres, 20-22 avril 1967		
8	Third report of the joint panel on oceanographic tables and standards, Berne, 4-5 October 1967. Sponsored by Unesco, ICES, SCOR, IAPO	1968	WG 10
10	Guide to the Indian Ocean Biological Centre (IOBC), Cochin (India), by the Unesco Curator 1967-1969 (Dr. J. Tranter)	1969	–
11	An intercomparison of some current meters, report on an experiment at WHOI Mooring Site "D", 16-24 July 1967 by the working group on Continuous Current Velocity Measurements. Sponsored by SCOR, IAPSO and Unesco	1969	WG 21
12	Check-List of the fishes of the North-Eastern Atlantic and of the Mediterranean (report of the third meeting of the Committee, Hamburg, 8-11 April 1969)	1969	–
14	Fifth report of the joint panel on oceanographic tables and standards, Kiel, 10-12 December 1969. Sponsored by Unesco, ICES, SCOR, IAPSO	1970	WG 10