Proceedings of the Summer Institute in Recent Advances on the Study of Marine Fish Eggs and Larvae

14 JUNE to 3 JULY, 1989

ICAR

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

Dr. SALIM ALI ROAD

COCHIN - 682 031.

CMFRI/SI/1989/Th.VI (2)

SURVEY OF EGGS AND LARVAE IN SPACE AND TIME

By

K.C. George
Principal Scientist

(Central Marine Fisheries Research Institute, Cochin)

Icthyoplankton surveys are carried out mainly to:

1. Obtain basic knowledge on taxonomy, distribution and ecology of this component in the plankton.
2. To use the quantitative data obtained for exploring new fishery resources and to determine the relative abundance and distribution of economically important species.
3. To complement knowledge of fish population dynamics and to use the results to estimate spawning biomass by estimating abundance of eggs and young larvae.
4. Forecasting year class strength on the basis of the abundance of older larvae.

Icthyoplankton surveys are accepted as one of the useful methods to monitor the adult populations and estimate biomass.

The early life history stages of marine fishes are passive and are usually found in the upper mixed layers. Most eggs and almost all larvae are pelagic and it is easy to sample several species over a wide area with simple plankton nets. The index of larval abundance has been shown to provide fairly reliable estimates of biomass of their adults as in the case of pacific mackerel, sardine and anchovy.

However, there are problems associated with this like taxonomic, technical and statistical nature. Problems involved in taxonomy are mainly due to the limited number of specialists knowledgeable in the identification of fish eggs and larvae. Technical problems relate to adequate vessel time and staff for collection and processing of samples which may be very large in numbers. Sampling process involving quantification need to be of standard nature and statistical problems are inherent in the sampling process as well as interpretation of data.

Of the early quantitative works in the nature of surveys on the eggs and larvae of marine fishes, the programmes on the Pacific sardine (*Sardinops caerulea*) Initiated in the thirties deserve special mention (Scofield, 1934, Sette and Ahlstrom, 1941, Ahlstrom, 1948, 1952, 1954, 1959). Marak and Colton (1961), Marak *et. al*. (1962) and Ahlstrom (1971, 1972) reported on several eggs and larval surveys conducted annually, under the auspices of the U.S. Department of Fish and Wild life Service. Boonprakob (1962) published the results of fish eggs survey in the Gulf of Thailand. In Indian waters, Bal and Pradhan (1945, 1946, 1947) and Pânikkar and Nair (1945) reported on the results of investigations on egg and larval collections in Bombay and Madras waters.

During the International Indian Ocean Expedition IIOE-1960-'65) collections of Icthyoplankton from a wide area of the Indian ocean were made by participating ships with the Indian Ocean Standard Net and used for quantitative studies. These have resulted in the publication of some general accounts of fish eggs and larvae and their distribution in the Indian ocean, (Ahlstrom, 1968, Peter, 1969, 1974, 1977), Panikkar and Rao, 1973, Shomura, 1970) as well as Atlas on fish eggs and larvae distribution (Panikkar, 1973 ed).

The IIOE collections have been made on the whole from widely separated stations of the open ocean and shelf water coverage has been rather limited. However, Nellen (1973) made a detailed study on the kinds and abundance of the fish larvae from the cruise of R.V. Meteor in the Arabian Sea and Persian Gulf during 1964-65, when some sections covering the shelf waters of the SW coast of India were also worked.

Another recent contribution with a quantitative approach, from areas adjacent to Indian coasts is of Alikhan (1972), who studied the distribution and abundance of fish larvae in the Gulf of Aden and off the coast of west Pakistan based on material collected during 1964-'67 period, in 9 different cruises.

Silas (1974) described in detail the different larval stages of Indian mackerel and mapped their distribution and abundance off the SW coast of India and the Laccadives sea, based on material from cruises of R.V. Varuna in 1964.

Sampling system for Icthyoplankton surveys:

The field operations will have to be conducted from ships of appropriate size, with a hydrographic winch and meter block. An inclimometer to measure the wire angles is also required.

The 'Bongo 60', a twin ring (0.6 m dia) net towed at slow speed (2-3 knots) is recommended as a suitable gear for ichthyoplankton sampling. It is a bridle free net, the towing rope being connected to the yoke joining the two rings of the net. A hydrodynamic depressor (about 20 kg) is suspended beneath the frame.

The towing frame is fitted with two cylindrical conical nets made of monofilament synthetic netting. One net (0.505 mm mesh) can be used as a principal ichthyoplankton sampling net and the other (0.333 mm) may be used for plankton biomass studies or fish egg and larvae escapement and extrusion studies. The use of soft cod ends is recommended as a matter of handling ease and also spillage back into the net is also likely to be less than with hard plankton bucket. The cod ends are made of the same type of material and mesh size as the net cones. A calibrated flow meter is fixed to the mouth of each cone if the cones are of different mesh sizes or only to one cone if they are of same mesh size.

Plankton tow:

The ship is stopped and the depth at station is recorded. The initial flow meter reading and winch meter reading are to be checked and zeroed. The net is lowered to surface of water and the ship set underway.

The nets are allowed to stream off at surface briefly and lowered without entangling. Enough wire length is released to reach the net to the desired depths. eg. to lower the net to a depth of 210 m with wire angle of 45°, requires that 300 m of wire be let out (wire angle is the deviation from the vertical).

Length of wire out x cosine 45° = net depth
300 m x 0.707 = 210 m

A depth of tow graph can be prepared to have instant check on the wire to be paid out for the desired depth. While the ship is underway, the wire is paid out and after reaching the desired depth, retrieved at the same speed. This is called a continuous oblique tow. After taking up the net on board and washing down, the flow meter final reading is recorded.

To be more accurate regarding the time of tow a stop watch can be used to record the sinking time (the time to reach the desired depth) and retrieval time.

Anomalies in flow meter reading can happen due to varying ship speed, clogging of the net etc. While a typical exercise in ichthyoplankton collection for quantitative studies has been detailed above, a survey to cover spawning of any species in a wide area and time requires efforts of several boats.

Efforts on these lines were made during the several surveys conducted by Ahlstrom (1941-1972) in the eastern Pacific for pilchard, and the sardine. In the Japanese waters during the post-war years (1949) co-operative Iwashi resources surveys incorporated eggs and larval surveys in the programme. (Nakai and Hattori, 1949-51). As the spawning grounds of the species were concentrated in the coastal areas, extension of the survey to offshore areas was not necessary as in the case of oil sardine, mackerel and other small pelagics in Indian waters.

Cost of egg and larval surveys:

The cost in terms of vessel time and human effort required for egg and larval surveys is considerable. However any other type of vessel survey like acoustic and fishing for objectives like fish stock size estimate would require vessel time cost, but the survey results can be made available more quickly than in the case of egg and larval surveys, where processing material and data will take relatively more time.

Processing of material and data:

The plankton sample is washed out to bottles of appropriate capacity and labels put with details on Date/ Station No./Ship/Cruise No./Time/Gear/Position/Depth of tow etc. Two labels one inside and one over the bottle are to be used. The sample is normally preserved in formaline of 4-5% strength taking care to add enough laboratory grade formaline required for the volume of the full sample bottle. The preserving liquid may be about 3 times the actual plankton material volume. To get the required strength of 5% solution of formaline in a half litre jar 50 ml of concentrated commercial formalin can be added. 10 ml of sodium borate solution in sea water is added for each litre of preserved sample to counteract acidity.

In tropical conditions airconditioned, temperature controlled storage of material is advised.

For standard ichthyoplankton survey physical oceanographic data at the stations are useful supplementary information. This includes, temperature salinity and dissolved O_2 of the column sampled.

Laboratory procedures:

Volume estimate

Net volume estimate by displacement method for each sample.

(a) Total volume including all material

(b) Volume excluding large items, whose individual volume exceeds 5 ml.

Sorting:

It is recommended that total samples be sorted for fish eggs and larvae whenever possible and fractioning may be limited to exceptionally large samples. The 'Folsom splitter' is a standard apparatus for dividing plankton samples into aliquot portions.

Sorting is done usually under a dissecting microscope (x 10 times).

Identification:

Preliminary identification to family level may be possible during sorting by skilled technicians, while final identification needs careful scrutiny by experts. However if a survey is for a particular species only such material need be isolated and studied.

Storing identified material:

It is usual tostore identified eggs and larvae in vials and closed with cotton plug and finally stored in a mother bottle containing appropriate strength preservative.

Study of survey data and interpretation:

The basic data for estimation of abundance of eggs and larvae are obtained from systematic sampling at regular time intervals at a number of stations distributed rather evenly through space. Integration of data from different cruises in relation to space and time is needed.

Two assumptions underlie this method of treatment: (1) The distribution of egg concentrations through space and through time are continuous (2) the egg concentration gradients between points in space and time are linear.

The number of eggs/larvae taken from each haul is made comparable with the numbers from other samples by referring all collections to a common basis- the number of eggs under a standard unit area of the sea (say 10 square metres). The number of eggs taken under a standard area may represent an accumulation of eggs from spawning in one day or more as the case may be.

Reliable estimates of annual abundance of larvae are more difficult than for planktonic eggs because of net avoidance and variation in diurnal behaviour of larvae. However some of the difficulties have been overcome by the development of high speed nets and sampling day and night etc.

Methods of estimation of abundance of eggs and larvae:

1. Construction of lines of equal abundance (isometric lines) on charts of distributions and integrating the areas with the contour lines. (Buchanan - Wollaston, 1915, 1923, 1926).

2. Sette (1943) based his estimate of annual abundance of haddock eggs on the average catch of all the cruises.

The UNDP/FAO Pelagic fishery project, Cochin in its Ichthyoplankton survey adopted the first method and identified the areas of abundance of fish eggs and larvae.

However this work was not elaborated to estimate the stock size, but hither to little known information on the spawning time area and regionwise relative abundance of spawn products were gathered for the project area investigated. For calculation of standard indices of abundance, the number of eggs/larvae under one m^2 surface was computed. This was done by multiplying the original numbers for each station with sampling depth and dividing by the volume of water filtered. Volume of water filtered is computed from the calibrated flowmeter revolutions for each haul.

$$\frac{N \times D}{V}$$

These standardised numbers for each station are plotted for different periods or integrated for the year to get a synoptic picture of the relative densities of the spawn products. New forecasting the fisheries on the basis of indices of abundance of eggs/larvae involves a series of further estimates giving allowance for mortalities in the progressive development of the spawn products. It is easier to base this on the older larvae, thus eliminating the factor of mortality. So a relative index of abundance of late larvae could possibly be an index of the magnitude of recruitment into the fishery. However, it is a pretty time consuming exercise to arrive at this index before the start of a seasons fishery, especially,if the fishery immediately follows as in the case of the oil sardine or mackerel. Nowadays O - group surveys for young recruits are adopted in temperate waters to forecast fisheries. It would appear that these two methods can supplement each other; the larval abundance index enabling to get an idea of the forthcoming trend of fishery, earlier than the O - group abundance index which can be built up only later. In this connection, it is to be borne in mind that egg and larval surveys applicable to some of the temperate region fisheries are less appropriate in the case of tropical fisheries.

This is due to the reason that in temperate waters the spawning of fishes is relatively restricted in space and time and the hatching and larval development are slow, which enable a full assessment of the abundance of the spawn products. In case of most tropical species eggs hatch out within 24 - 48 hours and the larval development is also much faster. Still as a standard method either by itself or in combination with methods like O - group abundance studies and acoustic surveys, egg and larval surveys are considered to be useful in the forecast of fisheries.

References

Achari, G.P.K. and S.G. Vincent 1972. Studies on the occurrence of the larvae and juveniles of the oceanic skipjack (Katsuwonus pelamis) and oriental bonito (Sarda orientalis) from the inshore waters of the southwest coast of India. Symp. Pelagic Fisheries Resources of the seas around India. Cochin, 1972. Abst. No.27.

Ahlstrom, E.H. 1948. A record of pilchard eggs and larvae collected during surveys made in 1939 to 1941. Fish and Wildl. Serv. Spec. Sci. Rep. No. 54: 76 pp.

Ahlstrom, E.H. 1952. Pilchard eggs and larvae and other fish larvae, Pacific coast 1950. Ibid. No.80: 58 pp.

Ahlstrom, E.H. 1954. Distribution and abundance of egg and larval populations of the Pacific sardine. U.S. Fish Bull. 93. Vol.56: 83-140.

Ahlstrom, E.H. 1959 a. Distribution and abundance of eggs of the Pacific sardine, 1952-1956. Ibid. 60: 185-213.

Ahlstrom, E.H. 1959 b. Vertical distribution of pelagic fish eggs and larvae off California and Baja California, Ibid. 161. Vol.60: 107-143.

Ahlstrom, E.H. 1968. Appraisal of the IIOE larval fish collection at IOBC, Cochin, India - UNESCO Inform. Pap. 137: 1-10.

Anon, 1974. Plankton, fish eggs and larvae studies Progress Report No. 7, UNDP/FAO Pelagic Fishery Project, Cochin: 21 pp.

Anon, 1976. Plankton fish eggs and larvae studies Ibid 17: 27 pp.

Boonprakob, U. 1962. Preliminary results of fish eggs survey in the Gulf of Thailand. Proc. IPFC. 10 (2): 10-18.

English, T.S. 1963. A theoretical model for estimating the abundance of planktonic fish eggs - contri. No.305 Symp. on the Measurement of abundance of fish stocks (ed) J.A. Gulland. Rapports et Process Verbaux Des Reunions (155): 174-182.

George, K.C. 1989. Results of Ichthyoplankton surveys along the south west coast of India with special reference to pelagic fish resources (In press) J. Mar. Biol. Ass. 31.

Marak, R.R. and J.B. Colton 1961. Distribution of fish eggs and larvae, Temperature and salinity in the Georges Bank-Gulf of Maine area, 1953 Spl. Sci. Rep. No. 398: 61 p.

Marak, R.R. Colton J.B. and Foster 1962 a. Distribution of fish eggs and larvae, temperature and salinity in the Georges Bank - Gulf of Maine area, 1953. Ibid. No. 411: 66 p.

Marak, R.R., J.B. Colton, D.F. Foster and David Miller 1962 b. Distribution cf fish eggs and larvae, temperature and salinity in the Georges Bank Gulf of Maine area, 1956. Ibid No. 412: 95 p.

Nellen, W. 1973. Kinds and abundance of fish larvae in the Arabian sea and the Persian Gulf. Ecological studies Analysis and synthesis 3 (ed) B. Zeitzschel. 415-544.

Padoa, E. 1956. Eggs, larvae and juvenile stages of the Scombriformes (in part) of the Gulf of Naples (In Italian - translation No.12 of the tropical Atlantic Biological Laboratory Bur. Comml. Fish Miamic 49 pp. 1967).

Panikkar, N.K. and Rao, T.S.S. 1973. Zooplankton investigations in the Indian waters and the role of Indian ocean biological centre IOBC Hand book V: 111-162.

Peter, K.J. 1974. Seasonal variation in the ichthyoplankton in the Arabian sea in relation to monsoon in the Early history of fish ed. J.H.S. Blaxter, springer-Verlag, Berlin.

Peter K.J., 1977. Distribution of tuna larvae in the Arabian sea Proc. Symp. on warmwater zooplankton spl. publ. NIO Goa: 36-40.

Premalatha, P. 1977. A study of the development and distribution of the larvae of leatherskin Chorinemus sanctipetri (Cuv. & Val) (carangidae-Pisces) along the south-west coast of India Proc. Symp. on warmwater zooplankton Spl. publ. NIO Goa: 450-459.

Raju, N.S. and P.N. Ganapathi 1969. Distribution of fish eggs and larvae in the Bay of Bengal Bull. Nat. Inst. Sci. India 38, Part II: 797-804.

Saville, A. ed. 1971. Symposium on the biology of early stages and recruitment mechanisms of herring Rapports et. Process. Verbaux des Reunions Vol. 160. Conseil. Inter. Pour. 1' explo. de la Mer. Denmark: 205 pp.

Scofield, E.C. 1934. Early life history of California sardine with special reference to distribution of eggs and larvae, Calif. Div. Fish. Game. Fish Bull. 41:48 p.

Silas, E.G. and K.C. George 1971. On the larval and post larval development and distribution of the mesopelagic fish Vinciguerria nimbaria (Jordan and Williams) family gonostomatidae off the west coast of India and the Laccadives sea J. Mar. Biol. Ass. India 11 (1 & 2): 218-250.

Sette, O.E. and E.H. Ahlstrom 1941. Estimations of abundance of the Pacific Pilchard (Sardinops caerulea) off Southern California during 1940 and 1941 J. Mar. Res. 7: 511-542.

Smith, P.E. & S. Richardson 1977. Standard techniques for pelagic fish egg and larval surveys. FAO Fish. Tech. Pap. (175): 100 pp.

Sreekumari, A. 1977. Development and distribution of the larvae of the whitebait Stolephorus zollingeri Bleeker (Engraulidae) Pisces) along the south-west coast of India Proc. Symp. on warm water zooplankton. spl. publ. NIO, Goa: 440-449.

Venkataramanujam K. and K. Ramamurthi 1974. Seasonal variation in fish eggs and larvae of Porto Novo coastal waters. Indian J. Fish 21: 254-262.