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Synopsis of the Special Session on Squids, September 1984

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Introduction

Squids of the families Loliginidae and Ommastrephidae comprised 68-74% of the annual catches of cephalopods in the world's oceans during 1975-81 (FAO, 1983). In the Northwest Atlantic, these families are represented by the long-finned squid *Loligo pealei* and the short-finned squid *Illex illecebrosus*, which historically have been important to the fisheries of the region. Exploitation of *Illex*, in particular, expanded rapidly during the 1970's, with a peak catch of nearly 180,000 (metric) tons in 1979.

In view of the rapid development of the trawl fishery for *Illex* on the continental shelves off eastern Canada and northeastern United States, the International Commission for the Northwest Atlantic Fisheries (ICNAF) and its successor the Northwest Atlantic Fisheries Organization (NAFO) recognized the need to develop a biological basis for management of the fishery. Intensive analysis of available field and laboratory information on *Illex* during scientific meetings from 1978 to 1982 led to the development of recommendations for the future direction of research and the coordination of research vessel surveys (ICNAF, 1978, 1979; NAFO 1980, 1981, 1982). It was generally accepted that, although progress could be anticipated from a broad range of biological studies, the greatest gains would be achieved through better understanding of the life cycle and the oceanographic processes which affect the early life-history stages. During 1979-83, much new information on these early stages became available from laboratory observations on spawning of *Illex* at the Aquatron Laboratory, Dalhousie University, Halifax, Nova Scotia, and from Canadian, Japanese and USSR research vessel surveys which were aimed at detecting larvae and juveniles in the Gulf Stream and associated water masses.

At its meeting in June 1983, the Scientific Council of NAFO determined that the time was appropriate for an in-depth review of the two commercially-important species of squid in the Northwest Atlantic (NAFO, 1983). Consequently, a special session was held at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, during 5-7 September 1984, with the theme "Biology and Ecology of the Squids *Illex illecebrosus* and *Loligo pealei* in the Northwest Atlantic", which focused on the following specific topics: (a) early life histories and their relation to oceanic processes, (b) size distribution and cohort components related to the life cycle, (c) sexual maturity and growth, (d) large-scale and microscale distributional characteristics in relation to environmental conditions, (e) age-validation techniques, (f) predator-prey relationships, (g) sampling methodology, and (h) biological implications to management.

More than 50 scientists from fisheries institutes and universities of 16 countries participated in the 3-day session. There were 26 contributions on cephalopods, most of which dealt with, in whole or in part, the biological and environmental aspects of the two Northwest Atlantic species. Three of the contributions were summaries for which complete manuscripts were not provided for documentation. In addition, a bibliography on the squid genus *Illex* was distributed. A brief summary of the scientific presentations and related discussion and some objectives for future research on squid, which evolved from the session, are given in the following sections.

General Considerations

Comparisions of early life histories of closely-related ommastrephids of the genus *Illex* and *Todarodes pacificus* and also the more distant myopsid (*Loligo pealei*) and sepiolid squids provided for broad-ranging discussion of maturation, mating, spawning and larval-juvenile characteristics of squids. However, the major focus was on elucidating the biology and ecology of *I. illecebrosus*. Biological and oceanographic information on distribution of *Illex* sp. larvae and juveniles between Florida and Cape Hatteras provided insights into the likely region of transport within the Gulf Stream system and the complex oceanographic processes which influence the rate of transport of larvae toward the northeast. Laboratory studies provided additional support for pelagic spawning and for retention of egg masses and *Illex* larvae in the mesopelagic zone. The likelihood of mesopelagic spawning in the Gulf Stream-Slope Water frontal zone and the documented capability of larvae to migrate vertically were

seen to extend the possible spawning area along the Gulf Stream system. Discussion of distributions of *Illex* larvae and juveniles led to a caution that, although the rhynchoteuthion Type C' larvae from areas north of Cape Hatteras have been attributed to *I. illecebrosus*, those from the region south of Cape Hatteras cannot yet be identified to the species level, because *I. oxigonius* and *I. coindetii* are also found in the area. The value of standardizing taxonomic efforts through the use of a single identification center was emphasized for large-scale programs such as those that were conducted under the aegis of NAFO in recent years. There was also discussion about the merits of plankton sampling gear with and without opening-closing devices and the place of each in relation to basic survey objectives.

Although some general patterns of both areal and bathymetric distribution are evident for *I. illecebrosus* during their residency as juveniles and maturing adults on the continental shelves, the relationship of these distributions to temperature, Shelf Water-Slope Water frontal zone and other abiotic factors is unclear. Near-bottom temperatures appear to be important, but it is likely that temperatures in other parts of the water column and other abiotic factors, as well as biotic features, also influence these patterns. It was thought that detailed analysis of available data sets could provide further insights into "preferred" regimes and, hence, into the distributional characteristics of the species. In the southern part of the distributional range of *I. illecebrosus* (Cape Hatteras to Florida), the absence of significant fishing activity and squid-directed research surveys leaves a major gap in data acquisition for what seems to be the most important spawning area. Stomach sampling of large pelagic fish, such as swordfish and sailfish, was suggested as a possible source of information on the biology and distribution of *Illex* sp. in this southern area.

The application of a seasonalized von Bertalanffy growth equation with objectively-fitted length-frequency data was proposed for modelling squid growth. Other methodological approaches were suggested for estimation of mortalities from length-converted catch curves and recruitment based on annual catch and yield-per-recruit. The basic premise is that much can be learned from the systematic application of "fish models" to squid data, with the likelihood that the deviations from the models will in themselves be instructive. It was recognized that a proposed abundance model might be applicable to *I. illecebrosus*. However, it is necessary to determine in more detail the abiotic factors which affect population dynamics and to seek the quantitative parameters of the model.

Discussion of squid food and feeding studies left little doubt that these are still in a very formative stage. Defects in methodology were pointed out, and it was emphasized that future studies should attempt to identify and quantify these sources of error. Currently-used gravimetric methods are very unsatisfactory, as are the subjective visual indexes which are sometimes used. Because squid stomach contents are often largely particulate matter in liquid, it was suggested that filtering or drying the contents might be a useful approach. Future studies would benefit substantially from research on rates of gut evacuation and from marrying studies of feeding and energetics. The impact of cannibalism remains very unclear and requires careful study if its importance is to be determined. The greatest progress will likely result from combined field and laboratory studies.

The maturity indexes that are currently used for males are clearly inadequate, particularly the criteria for full maturity. A more useful basis for measuring maturity may be the number of spermatophores in Needham's sac, but this criterion requires further evaluation, because the premature release of sperm and spermatophores has been observed under conditions of stress. The present maturity stages for females appear to be appropriate for field and laboratory studies, because they cover all ontogenetic, spawning and spent stages. The life cycle of *I. illecebrosus* was examined in terms of reproductive ecological stages, and scales of maturity stages were described on this basis for males and females. The scale for females was based in part on assumed analogies to the later maturity and ecological stages of *Illex argentinus*. It was felt that the reproductive ecological scale could serve as the basis for comparative ecological studies at the specific and interspecific levels.

Chemical marking of statoliths was shown to provide excellent agreement between the number of growth increments and the elapsed time in days after marking. The feeding regime evidently did not affect ring deposition, and it was hypothesized that deposition may be controlled either by photoperiod or by some intrinsic mechanism. The apparent relationship between statolith length and age (number of rings) in *I. illecebrosus* may, after verification, allow the use of statolith length as a more rapid method of ageing. Further work is needed to develop an effective means of relating statolith age data to more readily measurable field data (i.e. mantle length).

A few papers dealt with the biology of *Loligo pealei*. These studies related primarily to aspects of feeding and general ecology. Of special interest was a yield analysis for *L. pealei* off the northeastern United States. Relative to the information on *I. illecebrosus*, there was little new biological data for *L. pealei*. The ecological relationship between the two species represents an important problem area which requires further investigation.

Objectives for Future Work

The contents and discussion of papers that were presented at the Special Session allowed the formulation of two major objectives for future investigations of *I. illecebrosus*. The principle objective is to determine the major regularities in abundance fluctuations on the basis of comprehensive studies of variability in abiotic conditions (mostly water dynamics) and in the life history of the species. The second objective, closely connected with the first, is to study the role of *I. illecebrosus* in the trophic structure of the marine environment throughout its life cycle, with regard to the diversity and specific features of the feeding areas. These obejctives can be tackled only by conducting simultaneous work throughout the range of the species in the western North Atlantic under a coordinated research program. This implies the need for establishing more uniform methods of collecting and processing field material. Additionally, the need to ensure close interrelationship between field and laboratory studies, such as those that have been conducted in the Aquatron Laboratory of Dalhousie University, should be emphasized.

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