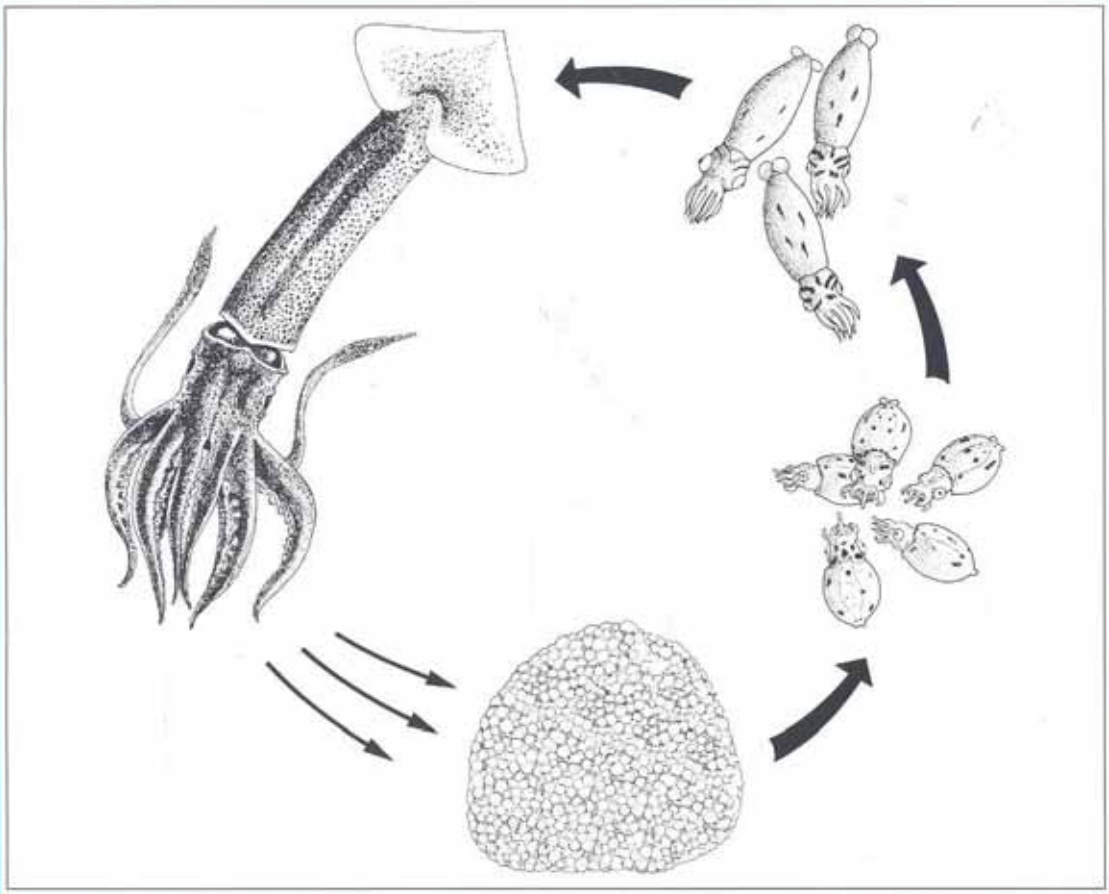
ISSN 0429-9345

FAO
FISHERIES
TECHNICAL
PAPER

376

# Squid recruitment dynamics

## The genus *Illex* as a model, the commercial *Illex* species and influences on variability



Food
and
Agriculture
Organization
of
the
United
Nations

# Squid recruitment dynamics

## The genus *Illex* as a model, the commercial *Illex* species and influences on variability

FAO
FISHERIES
TECHNICAL
PAPER

376

Edited by
**P.G. Rodhouse**
British Antarctic Survey
Natural Environment Research Council
Cambridge, United Kingdom

**E.G. Dawe**
Science Branch
Department of Fisheries and Oceans
St John's, Newfoundland, Canada

**R.K. O'Dor**
Department of Biology
Dalhousie University
Halifax, Nova Scotia, Canada


Food
and
Agriculture
Organization
of
the
United
Nations

M-43
ISBN 92-5-104159-8

## PREPARATION OF THIS DOCUMENT

This document has been prepared as part of the Regular Programme activities of the' Marine Resources Service, Fishery Resources Division of FAO. The original proposal to produce this volume resulted from a joint initiative of the Cephalopod International Advisory Council (CIAC) and the Guiding Group of Experts of the International Recruitment Programme (IREP) of the IOC-FAO Programme on Ocean Science in Relation to Living Resources (OSLR), through which the IOC-FAO OSLR Programme was encouraged to look further into the recruitment processes in squid species. As a result of this initiative, the Guiding Group of Experts of IREP and OSLR recommended FAO to sponsor the preparation and publication of a volume on squid recruitment dynamics. The preparation of this volume was organized and coordinated by A. Bakun and J. Csirke, from the Marine Resources Service of FAO, who at that time were respectively Chairman and Technical Secretary of the IOC-FAO OSLR Programme, and by P.G. Rodhouse, E.G. Dawe and R.K. O'Dor, editors of this volume, who, together, with the authors of individual chapters have contributed to this major effort aimed at improving fisheries management and responsible fishing of this important species group, through a better understanding of their stock structure and recruitment dynamics.

Particular thanks are due to the editors and authors of individual chapters for their contribution and patience. Rapid changes in the knowledge base for the field made it inevitable that all chapters could not be completed on the same schedule. Thanks are also due to the many authors that reviewed other chapters and to the following external reviewers: Andrew Clarke, British Antarctic Survey, Cambridge, U.K.; Ken Drinkwater, Department of Fisheries and Oceans, Dartmouth, Canada; Inigo Everson, British Antarctic Survey, Cambridge, UK; Michael J. Fogerty, National Marine Fisheries Service, Woods Hole, USA; Jonathan B. Joy, Memorial University of Newfoundland, St. John's, Canada; Mario Rasero, Instituto de Investigaciones Marinas, Vigo, Spain; Martina Roeleveld, South African Museum, Capetown, South Africa; Robert Scheibling, Dalhousie University, Halifax, Canada; Carolyn Symon, British Antarctic Survey, Cambridge, U.K.; Ron Trites, Department of Fisheries and Oceans, Dartmouth, Canada; Janet Voight, Field Natural History Museum, Chicago; and Robert D. Ward, CSIRO Division of Fisheries, Hobart, Tasmania. The technical editor was Janet R. O'Dor, Canadian Institute of Fisheries Technology, Technical University of Nova Scotia. June D. Hall, Halifax, assisted with the copy-editing and Emanuela d'Antoni, Rome, assisted with the illustration of the front cover. Thanks are also due to the various institutions mentioned above for their support and material contributions in the different phases of the preparation of this volume.

### *Dedication*

At the request of the editors, this volume is dedicated to Ron Trites of the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, whose early contributions to the studies of paralarval distribution of *Illex illecebrosus* helped to shape many of the ideas this document contains. Through a long fight he continued to play an important role at the interface between biology and ocean physics.

**Distribution**

FAO Fisheries Department
FAO Regional Fishery Officers
Department of Fisheries
Regional and International Fisheries Organizations
Authors

Rodhouse, P.G.; Dawe, E.G.; O'Dor, R.K. (eds.)
Squid recruitment dynamics. The genus *Illex* as a model. The commercial *Illex* species. Influences on variability.
*FAO Fisheries Technical Paper*. No. 376. Rome, FAO. 1998. 273p.

## ABSTRACT

Squid are among the fastest-growing short-lived commercial species and, as opposed to most finfish resources worldwide, their contribution to the total world fish production has been increasing at a high rate in the two last decades. Also, since squids tend to have higher global market values than many fish, they have the potential to produce both larger and more valuable catches, given the same level of primary productivity. As annuals, ommastrephid squid, like those in the genus *Illex* used as an example in this volume, grow rapidly with high production to biomass ratios, but have no reserves of genetic diversity once a year class is overfished. Thus, detailed understanding of stock structure and highly variable recruitment dynamics is required to ensure conservation of the resource base and achieve sustainability of directed fisheries. Increment analysis for age and growth, and stomach content analysis, indicate flexible seasonality and feeding strategies allowing a wide range of habitats. *I. coindetii* occupies the Mediterranean, Caribbean and eastern Atlantic margin from 55°N to 20°S but never sustains major fisheries. In the western boundary currents of the Atlantic, *I. illecebrosus* collapsed after intense, widely distributed fishing in the north, while, in the south, *I. argentinus* has survived much longer as the world's largest squid fishery, possibly stabilized by a complex of stocks, with widely dispersed breeding in space and time. Selective gears in feeding areas may be self-limiting, so long as migration ensures adequate escapement and the squid are not pursued into breeding areas. Recruitment appears to be limited by food production and by instabilities in the interactions between adult migrations and ocean physics, which strongly influence early growth and survival. After chapters reviewing the principal commercial species of *Illex*, both techniques and results of studies on these influencing factors are reported in separate chapters by experts in their fields.

## FOREWORD

Global productivity of squid fisheries is limited by variable recruitment, which can lead to poor economic return on investment despite the high overall productivity of squids. Better understanding of the factors controlling the annual recruitment of squids and other cephalopods should lead to improved management strategies and, potentially, to methods for enhancing squid production through recruitment stabilization. The IOC/FAO's International Recruitment Program (IREP) has encouraged the development of this approach since its 1981 meeting in Halifax, Nova Scotia. Although squid were recognized by IREP as an important target group, techniques for studying them were lacking at the time. Plans for a global survey of potential target species were proposed at the Northwest Atlantic Fisheries Organization Squid Symposium in Halifax (Rowell *et al.* 1985), and presented to the Cephalopod International Advisory Council (CIAC) "Larval" Squid Workshop in Banyuls-sur-Mer, France (Mangold and Boletzky 1985, Sweeney *et al.* 1992). Ideas developed at this meeting were conveyed to the IREP Guiding Group of Experts in 1987, who recommended FAO sponsorship of this volume on squid recruitment. The authors gathered to outline the volume at the ICES Shellfish Life Histories Symposium (Aiken *et al.* 1995). Rapid advancement of the concepts and new approaches outlined herein were reported at the CIAC Cephalopod Fishery Biology Workshop in Tokyo (Okutani *et al.* 1993), and many of the chapters were presented at the British Antarctic Survey/CIAC Southern Ocean Cephalopods Symposium in Cambridge (Rodhouse *et al.* 1994). We believe this volume demonstrates that advances over the intervening decade now provide the necessary basis for developing a comprehensive understanding of recruitment processes for cephalopods, and that they, in fact, are a prime target for advancing our knowledge of marine recruitment processes in general.

The concept of this volume was first to focus on a genus with closely related commercial squid species that are widely distributed in the eastern and western bound by currents of both hemispheres and then to develop generalizations. Although less intensely studied than *Todarodes pacificus* in Japan, the various *Illex* fisheries throughout the Atlantic provided a good range of data for a variety of physical regimes, once they were all assembled. The volume begins with an exploration of some of the differences between fishery and systematic perspectives of the genus, followed by an examination of distributions and current systematics. It then assembles extensive data sets on *Illex* from various commercial or potentially commercial stocks. Details of physical and biological environments are outlined, techniques for monitoring squid populations discussed, and then the interplay of physics, life-history, ecology, evolution and fisheries examined in a series of integrative chapters. The principles suggested in these later chapters should be applicable to and testable in a wide variety of commercial squid species.

The authorship of the volume also clearly illustrates the need for international cooperation in understanding and conserving stocks of widely distributed and highly migratory species; the editors thank the authors of the descriptive chapters and all external reviewers for their cooperation and diligence. Although they did not participate directly in the volume, the editors would also like to acknowledge Dr Hirosi Hatanaka and his colleagues at the Japan National Research Institute of Far Seas Fisheries in Shimizu for their pioneering research on the *Illex* fisheries and for sharing their data and ideas, particularly during the 1990 CIAC meetings.

## REFERENCES

AIKEN, D.E., WADDY, S.L. & CONAN, G.Y. (eds) 1995. *Shellfish life histories and shellfishery models.* ICES Mar. Sci. Symp. 199: 467 pp.

MANGOLD, K. & BOLETZKY, S.V. (eds) 1985. Biology and distribution of early juvenile cephalopods. *Vie Milieu,* 35: 137-302.

OKUTANI, T., O'DOR, R.K. & KUBODERA, T. (eds) 1993. *Recent advances in cephalopod fisheries biology*, 752 pp. Tokyo, Tokai University Press.

RODHOUSE, P.G., PIAKOWSKI, U. & Lu, C.C. (eds.) 1994. Southern Ocean cephalopods, *Antarctic Sci.*, 6: 135-283.

SWEENEY, M., ROPER, C.F.E., MANGOLD, K.M., CLARKE, M.R. & BOLETZKY, S.V. (eds.) 1992. "Larval" and Juvenile Cephalopods: A manual for Their Identification. *Smithsonian Contributions to Zoology* 513: 105-119.

ROWELL, T.W., NIGMATULLIN, CH.M. & HODDER, Y.M. (Eds.) 1985. Special Session on Squids, September, 1984. *NAFO Sci. Coun. Studies* 9: 1-175.

## TABLE OF CONTENTS

### Introduction: The genus *Illex* as a model



### The commercial *Illex* species

**Influences on variability**