

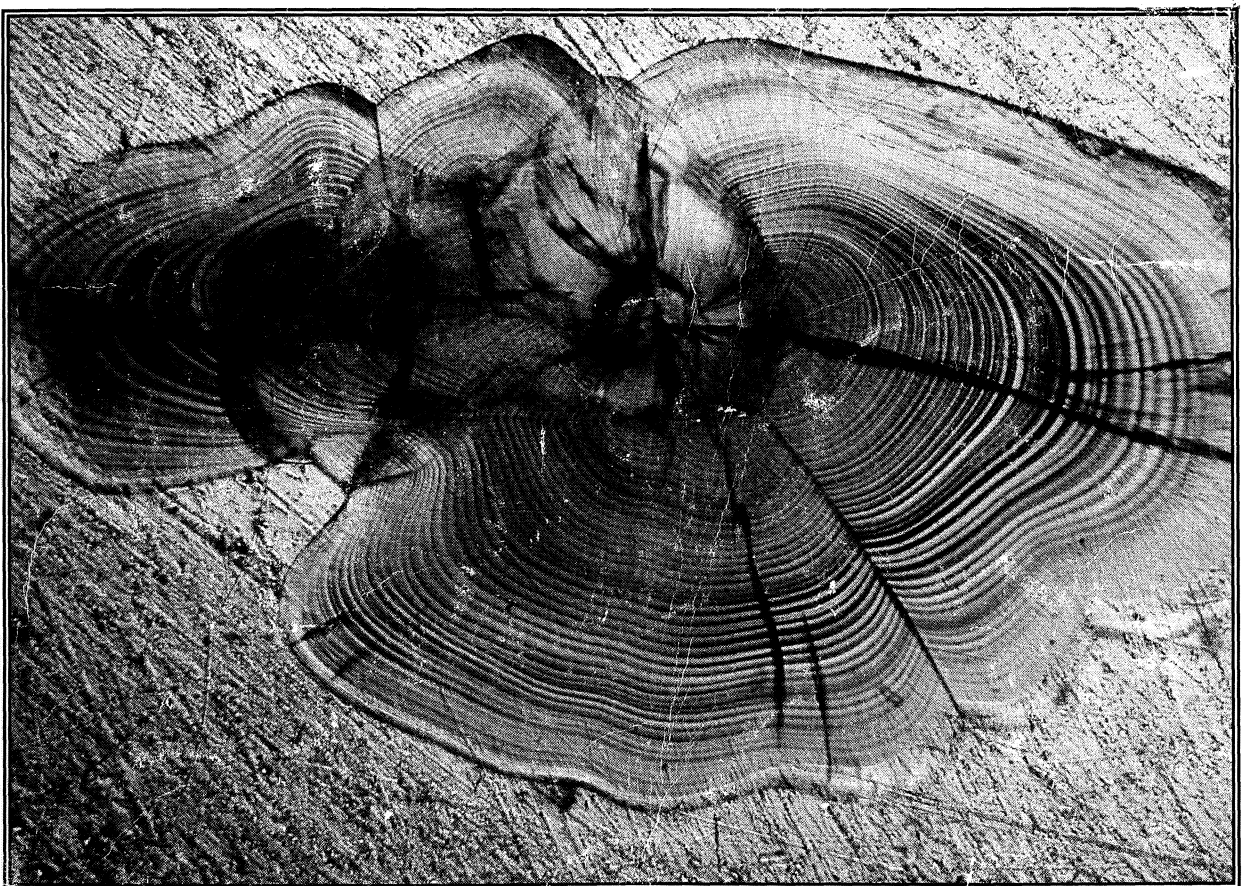


Canadian Special Publication of Fisheries and Aquatic Sciences 117

Otolith Microstructure Examination and Analysis

Edited by

David K. Stevenson • Steven E. Campana



Fisheries
and Oceans

Fisheries
and Oceans

Canada

Canadian Special Publication of Fisheries and Aquatic Sciences 117

IAIN SUTHERS
BIOLOGICAL SCIENCE
UNIVERSITY OF NEW SOUTH WALE
SYDNEY 2052 AUSTRALIA
61-2-385-2065 FAX 662-2913

Otolith Microstructure Examination and Analysis

Edited by

David K. Stevenson

*Department of Marine Resources
Marine Resources Laboratory
McKown Point,
West Boothbay Harbor, Maine 04575, USA*

Steven E. Campana

*Department of Fisheries and Oceans
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia, Canada B2Y 4A2*

DEPARTMENT OF FISHERIES AND OCEANS
Ottawa 1992

© Department of Supply and Services 1992

Available in Canada through Associated Bookstores
and other booksellers or by mail from
Canada Communication Group - Publishing
Supply and Services Canada
Ottawa, Canada K1A 0S9

Cat. No. Fs 41-31/117E
ISBN 0-660-14747-5
ISSN 0706-6481
DFO/4776

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of Canada Communication Group - Publishing, Ottawa, Canada K1A 0S9.



Correct citation for this publication:

Stevenson, D. K., and S. E. Campana [ed.]. 1992. Otolith microstructure examination and analysis. Can. Spec. Publ. Fish. Aquat. Sci. 117: 126 p.

Contents

Abstract/Résumé.....	iv
Preface	v–vi
Acknowledgements	vi
CHAPTER 1. Development and Application of the Otolith Increment Technique. <i>By Cynthia M. Jones</i>	1–11
CHAPTER 2. Collection and Preservation of Material for Otolith Analysis. <i>By John L. Butler</i>	13–17
CHAPTER 3. Otolith Removal and Preparation for Microstructural Examination. <i>By David H. Secor, John Mark Dean, and Elisabeth H. Laban</i>	19–57
CHAPTER 4. Measurement and Interpretation of the Microstructure of Fish Otoliths. <i>By Steven E. Campana</i>	59–71
CHAPTER 5. Analysis of Otolith Microstructure Data. <i>By Steven E. Campana and Cynthia M. Jones</i>	73–100
CHAPTER 6. Validation of Otolith Increment Deposition Rate. <i>By A. J. Geffen</i>	101–113
CHAPTER 7. Sources of Error in Otolith Microstructure Examination. <i>By John D. Neilson</i>	115–126

Abstract

STEVENSON, D. K., AND S.E. CAMPANA [ED.]. 1992. Otolith microstructure examination and analysis. Can. Spec. Publ. Fish. Aquat. Sci. 117: 126 p.

The field of otolith microstructure research has experienced phenomenal growth since the early 1970's and now forms the basis for hundreds of studies of early life history, age, growth, recruitment, migration, mortality, and stock structure. While the field continues to grow and evolve, there is no question that otolith microstructure examination is now an important and accepted technology in fisheries biology.

This book represents the first effort to compile and summarize the many techniques and procedures associated with studies of otolith microstructure. The complete sequence of events, from sample collection to data analysis, is covered comprehensively, so as to be applicable to most species and situations. The various chapters include both published and unpublished procedures, making the book valuable to beginning and experienced investigators alike.

Résumé

STEVENSON, D. K., AND S.E. CAMPANA [ED.]. 1992. Otolith microstructure examination and analysis. Can. Spec. Publ. Fish. Aquat. Sci. 117: 126 p.

L'étude de la microstructure des otolithes a fait d'immenses progrès depuis le début des années 1970 et est maintenant appliquée à des centaines de travaux de recherche portant sur le développement, l'âge, la croissance, le recrutement, la migration, la mortalité ou la structure des stocks. Ce domaine de la recherche continue de s'élargir et d'évoluer, mais il est maintenant acquis que l'examen de la microstructure des otolithes est devenu une technique importante et reconnue en biologie des pêches.

Ce livre est la première tentative visant à compiler et résumer le grand nombre de techniques et procédures appliquées à l'étude de la microstructure des otolithes. Le déroulement complet d'une étude, du prélèvement des échantillons à l'analyse des données, y est présenté de façon détaillée afin qu'il soit possible de l'appliquer à la plupart des espèces ou des situations. Les divers chapitres traitent de procédures connues ou inédites, ce qui rend le livre utile à tous les chercheurs, qu'ils soient débutants ou expérimentés.

Preface

This publication represents the first effort to compile and summarize the many techniques and procedures associated with studies of otolith microstructure. Reviews to date have focused on the theoretical basis for the formation of periodic features in the otolith. While a handful of earlier studies have provided technical protocols for particular species or procedures, none have attempted to describe the complete sequence of events, from sample collection to data analysis, in a form sufficiently comprehensive to be applicable to most species and situations. The primary objectives of this book are to provide detailed descriptions of otolith microstructure techniques and procedures and to recommend preferred approaches to all stages of otolith microstructure research.

The genesis of this publication dates back to February 1988 when the Maine Department of Marine Resources convened an otolith microstructure workshop in Boothbay Harbor, Maine. Cynthia Jones was one of the participants in that workshop. Given the rapid proliferation of otolith microstructure studies that was evident even then, she felt that it was time to provide some advice to new investigators that would assist them in selecting appropriate techniques and applying them correctly. The rest of the group agreed this was a good idea and plans were made to collaborate in writing a paper to meet this objective. David Stevenson, the organizer of the workshop, agreed to coordinate the preparation of the paper.

As time passed the original idea evolved into a more ambitious one, i.e., to compile a manual with chapters containing detailed explanations of how to collect samples, how to remove and prepare otoliths from larval and juvenile fish, what techniques to use in examining them, what are the preferred methods for data analysis, how to validate daily ring deposition, and what sources of error to expect and how to correct for them. At the same time, two of the original group of authors dropped out of the project and three new ones were recruited. First drafts were written and distributed among authors for review. As revisions were made ready for editing, it became clear that a second editor was needed to further review the technical content of each chapter. Steve Campana, who was already heavily involved as an author and in coordinating the review process, agreed to act as the technical editor.

Each contribution to this publication has been reviewed according to the same high standards expected of the better scientific journals. Since the

authors involved in the preparation of this book were among the most knowledgeable in the field, each chapter was reviewed by the other authors in the group. The editors insured that all manuscripts received at least two thorough reviews and that the review process was both critical and objective. In the case of Steve Campana's contributions, David Stevenson was responsible for the editorial process.

In its final incarnation, this publication is not, strictly speaking, a manual. Each of the seven chapters in this volume stands on its own as a discrete contribution, but the logical progression and cross-referencing of chapters has produced, in our judgement, a detailed and complete source of technical information that is of value to beginning and experienced investigators alike. Beginning investigators who are designing new research that requires use of the otolith increment technique would be well advised to read all the chapters in the order in which they are presented. The more experienced investigator may want to use this book to review specific topics or use the bibliographies at the end of each chapter to obtain more specific information on topics of interest. Even though much of the material presented will be familiar to the experienced investigator, new information and procedures which have not been published elsewhere are presented in several of the chapters in this publication. This is particularly true of the chapter on data analysis. Note that we have not included a chapter on elemental analysis techniques in recognition of the rapid advances now being made in this discipline.

The first chapter in this monograph, by Cynthia Jones, summarizes the development of the otolith increment technique and presents an overview of current and future applications of the technique in fisheries science. It also outlines some important issues that should be considered in planning and executing otolith microstructure studies. This chapter serves as a valuable introduction to the subject matter covered by the rest of the chapters in this monograph. The second chapter, by John Butler, describes some of the troublesome aspects of sampling and the collection and preservation of larval and juvenile fish. In the next chapter, David Secor, John Dean and Elisabeth Laban give detailed information on various techniques used to remove otoliths of different types and sizes from larval and juvenile fish and how to prepare them for microscopic examination, either with a light microscope or scanning electron microscope. The fourth chapter, by Steve Campana, provides valuable guide-

lines for light microscopic examination and interpretation of otoliths, including a discussion of image analysis techniques. The fifth chapter, by Steve Campana and Cynthia Jones, presents an overview of statistical and data analysis techniques most appropriate to otolith microstructure data, particularly those recommended for estimating growth rates, mortality rates, and hatch date distributions. In the next chapter, Audrey Geffen reviews the various methods which are used to validate daily otolith increment deposition. Finally, in the last chapter, John Neilson provides

some insight into the various sources of error that are inherent in otolith microstructure studies and suggests some ways to avoid them.

The field of otolith microstructure research has experienced phenomenal growth since the early 1970's and now forms the basis for hundreds of studies of early life history, age, growth, recruitment, migration, mortality, and stock structure. While the field continues to grow and evolve, there is no question that otolith microstructure examination is now an important and accepted technology in fisheries biology.

Acknowledgements

The editors would like to thank Lila Achor, Glenn Nutting, and Clarisse Simard of the Maine Department of Marine Resources for their help in preparing the manuscripts in this book for publication.