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# Journal of Northwest Atlantic Fishery Science

## Editorial Policy

The *Journal of Northwest Atlantic Fishery Science*, published by the Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO) with headquarters in the Bedford Institute of Oceanography, Dartmouth, Canada, is intended to be regional in scope, publishing original research papers and notes on Northwest Atlantic fisheries science with emphasis on the environmental, biological, ecological and fishery aspects of living marine resources and ecosystems. Papers of general applicability, methodological papers and review papers relevant to other areas may also be considered. Space for "Letters to the Editor" will also be provided, when necessary, to facilitate scientific discussion of published papers containing controversial aspects. Manuscripts approved for publication are accepted with the understanding that their content is unpublished and is not being submitted elsewhere for publication. All manuscripts should be submitted to the Editor, who, with the assistance of Associate Editors expert in the fields of biological oceanography, vertebrate fisheries biology, invertebrate fisheries biology and biomathematics, will ensure that the submitted papers, prior to publication, meet the high standards required for a primary scientific journal.

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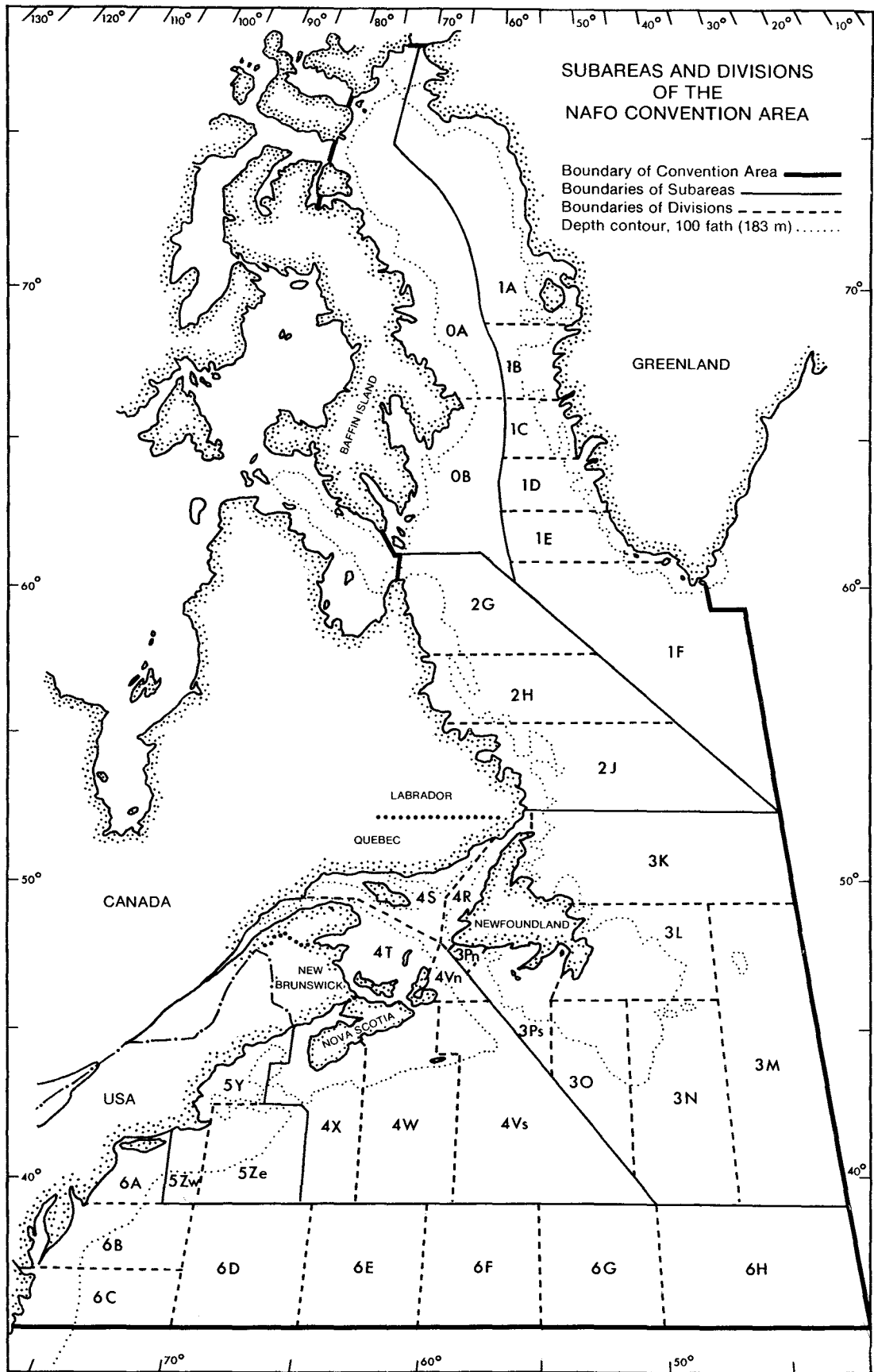
Volume 4

Guide to the Early Stages of Marine Fishes Occurring  
in the Western North Atlantic Ocean, Cape Hatteras  
to the Southern Scotian Shelf

Michael P. Fahay

Northwest Atlantic Fisheries Organization  
Dartmouth, Canada  
July 1983





## Preface

This guide presents egg and larval descriptions of 290 species of fishes (contained within 92 families, 28 suborders and 13 orders) likely to be collected in plankton and neuston sampling operations in continental shelf and oceanic waters of the western North Atlantic. Coverage is designed to emphasize species occurring between Cape Hatteras (latitude 35° N) and the southern Scotian Shelf (about 43° N) and includes oceanic mesopelagic and bathypelagic forms. Coverage is also designed to provide (a) as wide a phylogenetic survey of larval characters as today's published record allows, and (b) direct comparisons of confusing species pairs. The latter two considerations result in the inclusion of a few estuarine species or species occurring south of Cape Hatteras.

Throughout the taxonomic section of the guide, illustrations are placed on the right-hand page and the corresponding descriptions are placed on the left. Consistency in the descriptions is largely dependent on descriptive information available in the published literature. Certain meristic and morphometric characteristics of adults are included to aid in the identification of larger larvae and juveniles. Special introductory pages, which summarize and compare characters for a number of species, are provided for the families Gonostomalidae (including Sternoptychidae), Myctophidae, Paralepididae, Carangidae, Sciaenidae, Scombridae and the (sub)orders Anguilliformes, Gadiformes, Ceratioidei, Stromateoidei and Pleuronectiformes.

Many published illustrations have been redrawn, primarily to correct inconsistencies and errors in the original descriptions, but also to provide uniformity throughout the guide. Introductory material includes explanation pages, a glossary of terms widely used in ichthyoplankton work, a table of larval characters for the 13 orders, and a table of meristic characters (including presence or absence of adipose fin), arranged according to range of myomeres or vertebrae, to assist in the identification of problem larvae.

May 1983

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# Guide to the Early Stages of Marine Fishes Occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf

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## Introduction

Ichthyoplankton research in recent years has advanced beyond the expedition era where early developmental stages of fishes were collected solely for taxonomic and descriptive purposes or to establish locations where spawning occurred. Ichthyoplankton surveys today provide the material necessary to study many aspects of fisheries research. The abundance and distribution of eggs are used to derive estimates of the sizes of spawning populations. Collections of fishes in their larval phase provide material for various studies (including age, length and growth, feeding and starvation, predation, mortality, transport by currents during development, and impacts of pollution), which lead to an understanding of the factors determining year-class success and brood strength. Because most fish species produce pelagic eggs or larvae, use of plankton sampling gear provides information on a wide range of species and leads to a better understanding of the entire fish community, including underutilized species. Furthermore, characters of eggs and larvae, when examined and compared above the specific level, provide insight into the related problems of systematics and phylogeny (e.g. see Moser and Ahlstrom 1970, 1974; Johnson 1974; Okiyama 1974; Okiyama and Ueyanagi 1978; Kendall 1979; Richardson 1981).

Within the area covered by this guide, the Marine Resources, Monitoring, Assessment and Prediction (MARMAP) Program of the U. S. National Marine Fisheries Service has undertaken surveys of ichthyoplankton and related parameters on an intensive basis since 1971. The area, which is completely sampled six to eight times each year, covers 260,000 km<sup>2</sup> of continental shelf waters from Cape Hatteras, North Carolina, to the Scotian Shelf. The ichthyoplankton data accruing from these surveys provide valuable scientific information leading to an understanding of population levels of fishery resources which vary seasonally and annually.

In order to utilize ichthyoplankton for fisheries-related research, it is obviously essential that eggs and larvae be correctly identified. Correct identification, in turn, depends on systematic analyses of characters which can only be undertaken after examining those characters in all related larvae of a group, whether at the level of genus, family or order, thus gaining an appreciation for the value of certain characters. Although this dependence on correct identification appears to be an obvious requirement, several gaps exist in knowledge of early life-history stages of western North Atlantic fishes, including some commercially-important species. In the western North Atlantic, more detailed and exacting descriptions are needed for commercially-important species of the families Clupeidae, Gadidae, Scorpaenidae and Pleuronectidae, as well as ecologically-important groups, including Ammodytidae, Ophidiidae, Triglidae and Anguilliformes.

Scientists studying the ichthyoplankton of the western North Atlantic must, in some cases, rely on descriptions of eastern Atlantic material. Such reliance may be dangerous when one acknowledges the vagaries of geographic variation in early fish development. Users of this guide should, where possible, be aware of the sources of material for descriptions of larval development and should also be aware that larval characters may vary between regions. For example, the characters described herein for *Scomber* pertain to specimens collected in the western North Atlantic off the northeastern United States and may not apply to *Scomber* larvae collected elsewhere. Where appropriate in this guide, instances are indicated where larval descriptions were derived from specimens collected in the eastern Atlantic, Pacific or other oceans.

Species selected for inclusion in this guide are those for which published larval descriptions are available. Some are augmented by previously unpublished observations of the author or a reviewer, but it is not the purpose of this guide to formally publish original detailed

descriptions of larval development. A more complete listing of sources of information concerning the early life histories of fishes is available in the multi-authored six-volume series entitled "Development of Fishes of the Mid-Atlantic Bight: An Atlas of Egg, Larval and Juvenile Stages", published in 1978 by the Biological Services Program of the U. S. Fish and Wildlife Service.

In the course of preparing this guide, the author has drawn freely from notes generated by several students during an excellent series of courses in ichthyoplankton taxonomy taught by the late Dr E. H. Ahlstrom and Dr H. G. Moser at the National Marine Fisheries Service Laboratory in LaJolla, California, from 1971 to 1977. One of the recurring themes in those courses was that proper identification and description of larval fishes depend on ontogenetic series rather than on character states of the individual specimen. Thus the changes in a larval structure (sequence of formation of parts, loss or acquisition of transitory features) with development becomes as much a character as the simple presence or absence of a structure.

Depending on the adequacy and completeness of published descriptions of larval development, four broad subjects were considered in preparing the accounts for this guide: (1) Osteological characters include the time and sequence of development of bony parts as well as meristic characters present at certain stages of development (which may differ from meristic characters in adults). Also considered here was the presence or absence of transitory hard parts, such as body or head spines or larval spinous scales. (2) Morphometric characters include measurements of relative body proportions in the larval stages and how these change during ontogenetic development. The size at which notochord flexion and transformation to the juvenile stage occurs is often a very important feature and is included when known. (3) Descriptions of pigmentation characters include distinctive patterns of melanophore distribution and how these may change during development. (4) Miscellaneous characters include geographic range of the adults and/or larvae, spawning times and places, vertical distribution of eggs and larvae (if appropriate), and behavioral traits associated with certain stages (i.e. egg deposition on specific substrates, habits of pelagic juvenile stages, etc.). Users of this guide should understand that the contents represent current knowledge on the development of western North Atlantic fishes. It is hoped that the gaps which are evident in the text will stimulate further, more detailed research.

### **Acknowledgements**

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## Methods

This guide was planned and designed to be most useful to the biologist-technician faced with the task of identifying large numbers of eggs and larvae representing a wide range of taxa. Toward that end, pertinent literature has been evaluated, oversights and errors have been corrected, and, where necessary, previous descriptions have been tempered with more recent (some unpublished) observations. The emphasis has been placed on the most diagnostic, easily-observable characters, but details of ossification sequence and changes in morphometry with growth are included, in order to facilitate comparisons between related taxa. Users who are unfamiliar with the larval morphology of major groups should consult the tables on pages 20–23 and 401–406 and the various introductory pages before attempting to identify specimens to the species level. With a few exceptions, illustrations are placed on the right-hand page and the corresponding text on the facing, left-hand page. Names of orders, suborders or families are located in the appropriate upper corner of each page to provide a "thumb index". The phylogenetic sequence of this guide follows Nelson (1976).

**Coverage.** This guide contains descriptions of eggs and larvae of fishes likely to be collected in plankton and neuston sampling operations in continental shelf and adjacent oceanic waters from the southern Scotian Shelf and Gulf of Maine southward to Cape Hatteras (latitude 35°N) (NAFO Divisions 4X, 5Y–Z, 6A–D). The coverage is designed to provide (a) as wide a phylogenetic survey of larval characters as today's published records allow, and (b) direct comparisons of confusing species pairs or groups. These considerations result in the inclusion of a few primarily estuarine species or species generally occurring south of Cape Hatteras.

**Introductory pages.** Additional pages of information, which summarize and compare characters for a number of species, are provided for the orders Anguilliformes, Gadiformes and Pleuronectiformes, for the suborders Ceratioidei and Stromateoidei, and for the families Gonostomatidae (including Sternoptychidae), Myctophidae, Paralepididae, Carangidae, Sciaenidae and Scombridae. These pages precede the pertinent taxonomic section.

**Nomenclature.** The scientific name of each species is centered in bold italics at the top of each text page or midway down the page when more than one species is treated. Nomenclature follows Robins *et al.* (1980) for continental shelf species and the most recent revision for oceanic species. Exceptions are noted in the text. The grammatical form of family names follows recent general usage (see Steyskal 1980, and discussion by Robins *et al.* 1980).

**Sequence of description.** When morphological information was considered adequate and complete, the following sequence was used: details of spawning (season and area); characters of egg and embryo; morphometry (including at least preanus length, head length and body depth) for preflexion, flexion and postflexion stages; size ranges in which flexion and transformation (metamorphosis) occurs, presence of and size at formation of transitory spines or other larval structures; sequence of ossification of fin rays, vertebrae and teeth, if such data were available; pigmentation characters, including changes in pigment pattern with development; comments on geographic range, if pertinent; and figure credits and references consulted for text information.

**Meristic characters.** The myomere count (range) in larvae and the vertebral count (range) and pertinent fin-ray counts in adults are positioned in the upper right hand corner of the text page pertinent to the species. Whenever possible, the counts listed therein pertain to the western North Atlantic region encompassed by this guide.

**Measurements.** Linear measurements are designated NL (notochord length), SL (standard length) or TL (total length), depending on the usage of the cited author. If the author's method of measurement was unclear or indeterminable, the listed measurement is not followed by a qualifier. In a few cases (preflexion larvae), the author's original "SL" was converted to "NL" (see explanatory figures, page 12); "Preanus length" in this guide refers to a straight-line measurement from the tip of the snout to a vertical through the anus, and "preanal length" refers to a straight-line measurement from the tip of the snout to a vertical through the origin of the first anal spine or ray. In some cases, the terminology of the cited author was changed to adhere to these rules.

**Figure citations.** Sources of illustrations are cited after "Fig." at the bottom of each text page. If illustrations have been redrawn, the cited source is followed by "(redrawn)". A few previously unpublished illustrations are included, and the sources of this material are given on page 11. Figure citations should also be regarded as sources of information on the text page.

**References.** Citations listed after "Ref." at the bottom of the text page pertain to sources from which information other than illustrative material was obtained.

**Illustrations.** These generally appear on the page facing the text page. Published illustrations were examined closely for adherence to descriptions accompanying them. When redrawing was deemed necessary, extraneous pen-strokes were deleted and an attempt was made to adopt a uniform style. Fin rays have not been included in illustrations unless it was clear that they were fully ossified. In a few cases, myomeres were redrawn to bring illustrations into agreement with descriptions.