History of the Monographic Series Fishes of the Western North Atlantic

Authors: Collette, Bruce B., and Bemis, Katherine E.

Source: Ichthyology & Herpetology, 112(3) : 519-529

Published By: The American Society of Ichthyologists and Herpetologists

URL: https://doi.org/10.1643/t2023102

Ichthyology & Herpetology 112, No. 3, 2024, 519–529

HISTORICAL PERSPECTIVES

History of the Monographic Series *Fishes of the Western North Atlantic*

Bruce B. Collette[1] and Katherine E. Bemis[1,2]

The monographic series *Fishes of the Western North Atlantic* (FWNA) is widely used as a reference for fishes of the region. The original goal of FWNA was to develop comprehensive species accounts to address the identification, nomenclature, biology, and distribution of all the fishes in the region; however, only ten Parts were completed, from the lancelets, cyclostomes, and sharks in 1948 to the needlefishes, halfbeaks, sauries, and flyingfishes in 2019. Production of FWNA engaged broad participation from the ichthyological community with 48 authors from 28 institutions, including museums, universities, federal and state agencies, and marine laboratories. With publication of Part Ten, the series concluded, and all Parts were reissued. Here we present a history and evolution of the series over the 85 years since the series was proposed in 1937 and assess its impact on ichthyology, the ichthyologists who participated in FWNA, and the institutions that supported them.

FISHES of the Western North Atlantic (FWNA) is a widely used reference for fishes of the region. Species accounts in FWNA were designed to be comprehensive and cover taxonomy, identification, biology, and distribution, with illustrations of each species. These species accounts summarized published information and author's original data (Hubbs, 1955: 263). Part One, lancelets, cyclostomes, and sharks was published in 1948; Part Two, sawfishes, skates, and rays in 1953; Part Three, soft-rayed bony fishes including sturgeons to salmons in 1963; Part Four, argentines to telescope fishes in 1964; Part Five, Iniomi and Lyomeri in 1966; Part Six, halosaurs to grenadiers in 1973; Part Seven, lanternfishes in 1977; Part Eight, pipefishes and seahorses in 1982; Part Nine, eels in two volumes, in 1989. Part Ten on needlefishes, halfbeaks, sauries, and flyingfishes, of which we, Bruce B. Collette and Katherine E. Bemis, are among the four authors, was published in 2019, concluding the series. Publication of this last Part encouraged us to examine the history of FWNA, which we present here based on published reviews of individual Parts and our experiences with the series.

Audience and purpose of the series.—In the Introduction of Part One, John Tee-Van provided the impetus for the new series. He wrote that Jordan and Evermann's *The Fishes of North and Middle America* (1896–1900), which had been the only comprehensive guide to fishes of the western North Atlantic, had become outdated given the vast amount of new information available. Tee-Van (1948: xii) outlined the purpose of FWNA to "bring together and synthesize this scattered ichthyological information and to make it available to both the public and to marine biologists." The vision for FWNA at the start was that it would be used by lay people, ichthyologists, and marine biologists alike (Tee-Van, 1948: xiv), although the series became more technical over the course of its history.

Sears Foundation and funding for FWNA.—The Sears Foundation for Marine Research, which provided funding for FWNA, was established in 1937 by Albert E. Parr, Director of Yale's Bingham Oceanographic Laboratory, through a gift from Henry Sears to promote research and publication in marine sciences. Sears was interested in the ocean, sailing, and fishes, and by working with Parr, he learned to preserve fishes for the Bingham Oceanographic Lab in 1934–1935 (specimens now held at Yale Peabody Museum; Veronis, 2009). Around the same time, a wealthy uncle of Sears passed away and left him a sizable inheritance. Sears established, under guidance from Parr, a foundation at Yale to fund publication of the *Journal of Marine Research* and the monographic series *Fishes of the Western North Atlantic*. Parr became the Director of the Sears Foundation and first editor of FWNA (Table 1). The early volumes (e.g., Parts 1–4) were primarily supported by Henry Sears and the Sears Foundation. Later, funding for both the research and publication of the volumes was supplemented by grants from the National Science Foundation and support from the National Marine Fisheries Service.

Sears went on to serve in WWII, including as captain of the U.S.S. *Wesson*, a destroyer escort in the Pacific (Veronis, 2009). After the war, he formed Henry Sears & Co., a venture capital company in New York. He continued sailboat racing and was an active member in the New York Yacht Club and the America's Cup. He retired in 1972 and managed a 5,000-acre farm in Maryland. Sears continued to donate funds for FWNA when asked and was active in other philanthropies (Veronis, 2009).

Authors and Editorial Board.—The 20th century ichthyological community was deeply involved in the preparation of FWNA. Forty-eight authors from 28 institutions (Table 1), including museums, universities, federal and state agencies, and marine laboratories, contributed to the ten Parts. In general, families or orders of fishes were assigned to authors

[1]Division of Fishes, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560; Email: (BBC) collettb@si.edu; and (KEB) bemisk@si.edu.
[2]National Systematics Laboratory, Office of Science and Technology, NOAA Fisheries, Washington, DC 20560; ORCID: 0000-0002-7471-9283; Email: katherine.bemis@noaa.gov.
 DOI: 10.1643/t2023102 Published online: 31 October 2024

Table 1. Summary of contributors to each Part.

Part	Date pub	Title	Editors	Editorial Board	Preface or foreword author	Introduction author	Authors
One	1948	Lancelets, Cyclostomes, Sharks	A. E. Parr, Editor Y. H. Olsen, Assistant Editor	J. Tee-Van, Editor-in-Chief C. M. Breder S. F. Hildebrand A. E. Parr W. C. Schroeder *J. R. Norman initially on Editorial board, but died in 1944	Unsigned (written by Tee-Van according to 1949 review by Hubbs)	J. Tee-Van	H. B. Bigelow I. Pérez Farfante W. C. Schroeder
Two	1953	Sawfishes, Guitarfishes, Skates, Rays	A. E. Parr, Editor Y. H. Olsen, Assistant Editor	J. Tee-Van, Editor-in-Chief C. M. Breder A. E. Parr W. C. Schroeder L. P. Schultz	No preface	J. Tee-Van	H. B. Bigelow W. C. Schroeder
Three	1963	Soft-rayed Bony Fishes, Acipenseroidei, Lepisostei, Elopoidea, Clupeoidea, Salmonoidea	Y. H. Olsen, Editor	H. B. Bigelow, Editor-in-Chief C. M. Breder D. M. Cohen G. W. Mead D. Merriman Y. H. Olsen W. C. Schroeder L. P. Schultz J. Tee-Van	Y. H. Olsen	H. B. Bigelow	H. B. Bigelow M. G. Bradbury J. R. Dymond S. R. Greeley S. F. Hildebrand G. W. Mead R. R. Miller L. R. Rivas W. C. Schroeder R. D. Suttkus V. D. Vladykov
Four	1964	Soft-rayed Bony Fishes, Argentinoidea, Stromiatoidea, Esocoidea, Bathylaconoidea, Giganturoidea	Y. H. Olsen, Editor	H. B. Bigelow, Editor-in-Chief C. M. Breder D. M. Cohen G. W. Mead D. Merriman Y. H. Olsen W. C. Schroeder L. P. Schultz J. Tee-Van	No preface	H. B. Bigelow	H. B. Bigelow D. M. Cohen M. M. Dick R. H. Gibbs, Jr. M. Grey J. E. Morrow, Jr. L. P. Schultz V. Walters
Five	1966	Orders Iniomi and Lyomeri	Y. H. Olsen, Editor J. W. Atz, Assistant Editor	G. W. Mead, Editor-in-Chief H. B. Bigelow C. M. Breder D. M. Cohen D. Merriman Y. H. Olsen W. C. Schroeder L. P. Schultz J. Tee-Van	No preface	G. W. Mead	W. Anderson F. H. Berry J. E. Böhlke R. L. Bolin J. W. Gehringer R. H. Gibbs, Jr. W. A. Gosline N. B. Marshall G. W. Mead R. R. Rofen N. J. Wilimovsky

Table 1. Continued.

Part	Date pub	Title	Editors	Editorial Board	Preface or foreword author	Introduction author	Authors
Six	1973	Notacanthiformes, Cyprinodontoidei, Beryciformes, Stephanoberyciformes, Gadiformes (in part)	D. M. Cohen, Editor	D. M. Cohen, Editor-in-Chief J. W. Atz F. H. Berry J. E. Böhlke R. H. Gibbs, Jr. E. A. Lachner G. W. Mead D. Merriman A. E. Parr* W. C. Schroeder* *Editors Emeriti	No preface	D. M. Cohen	D. M. Cohen A. W. Ebeling T. Iwamoto S. B. McDowell N. B. Marshall D. E. Rosen P. Sonoda W. H. Weed, III L. P. Woods
Seven	1977	Myctophiformes	None listed	R. H. Gibbs, Jr., Editor-in-Chief F. H. Berry J. E. Böhlke D. M. Cohen B. B. Collette W. N. Eschmeyer G. W. Mead D. Merriman T. W. Pietsch A. E. Parr* *Editor Emeritus	No preface	R. H. Gibbs, Jr.	B. G. Nafpaktitis R. H. Backus J. E. Craddock R. L. Haedrich B. H. Robison C. Karnella
Eight	1982	Syngnathoidei	None listed	J. E. Böhlke, Editor-in-Chief D. M. Cohen B. B. Collette W. N. Eschmeyer R. H. Gibbs, Jr. T. W. Pietsch W. J. Richards C. Lavett Smith K. S. Thomson A. E. Parr* *Editor Emeritus	No preface	J. E. Böhlke	C. E. Dawson R. P. Vari
Nine, Vol. 1	1989	Anguilliformes, Saccopharyngiformes	None listed	B. B. Collette, Chairman D. M. Cohen W. N. Eschmeyer R. H. Gibbs, Jr. W. D. Hartman T. W. Pietsch W. J. Richards K. S. Thomson A. E. Parr* *Editor Emeritus	No preface	E. B. Böhlke and B. B. Collette	E. Bertelsen E. B. Böhlke J. E. Böhlke J. E. McCosker J. G. Nielsen C. R. Robins C. H. Robins D. G. Smith K. A. Tighe

Table 1. Continued.

Part	Date pub	Title	Editors	Editorial Board	Preface or foreword author	Introduction author	Authors
Nine, Vol. 2	1989	Leptocephali	E. B. Böhlke	B. B. Collette, Chairman D. M. Cohen W. N. Eschmeyer R. H. Gibbs, Jr. W. D. Hartman T. W. Pietsch W. J. Richards K. S. Thomson A. E. Parr* *Editor Emeritus	No preface	D. G. Smith	W. H. Hulet M. M. Leiby C. R. Robins D. G. Smith (all authors from Vol. 1 listed in front of Vol. 2) Illustrator M. H. Fuges credited on title page
Ten	2019	Beloniformes	None listed (R. Volpe?)	B. B. Collette T. J. Near	T. J. Near	B. B. Collette	B. B. Collette K. E. Bemis N. V. Parin I. B. Shakhovskoy

by the Editorial Board. This Board was formed to oversee production, and 23 ichthyologists from 13 institutions served on the Board (Table 1). The Editorial Board operated informally and did not have regular meetings, yet agreed upon standards for both the text and illustrations to ensure uniform treatment across Parts. Many ichthyologists began as authors of Parts of FWNA and subsequently served on the Editorial Board. The importance of FWNA to the careers of authors and Editorial Board members is recorded in many of their obituaries, such as those for Samuel Hildebrand (Higgins, 1950; Hubbs, 1950), Marion Grey (Sonoda and Inger, 1964), Robert H. Gibbs, Jr. (Springer and Collette, 1989), Eugenia Böhlke (Smith, 2002), Giles Mead (Cohen and Collette, 2004), Isabel Pérez Farfante (Bauer, 2010), Richard Backus (E. H. Backus and Collette, 2013), and Daniel Cohen (Collette, 2019).

Citations to the Parts and the chapters within them are complicated because each Part had an Editor in Chief, an Editorial Board, and frequently several multi-authored accounts. Table 1 summarizes the contributors to each Part.

Printing and publishing.—When the series began, the books were large format, hardcover books, printed on 50% cotton rag paper. Assistant Editor Yngve H. Olsen designed the large, elegant page layout that included wide, white margins. The cost to purchase Part One (Bigelow and Schroeder, 1948) was $10.00 and 2,500 copies were printed. Parts 1–6 were published in Copenhagen, Denmark by Bianco Luno. Parts 7–9 were published in Lawrence, Kansas, USA by Allen Press. Part Ten was published by the Peabody Museum of Natural History, Yale University, distributed by Yale University Press, and is available only as softcover in a smaller format. With completion of Part Ten, Yale University Press reissued all Parts of the series in a format matching the softcover style of Part Ten.

Species coverage.—The geographic range and species to be covered by FWNA was described in Part One as follows (1948: xiv):

> "The geographical range of *Fishes of the Western North Atlantic* embraces the western half of the North Atlantic, including the adjoining gulfs and seas, from Hudson Bay southward to the Amazon River. But this range is not strictly adhered to in all instances; a number of species living close to the outer borders of the region covered by this publication are included, particularly when their inclusion assists in a more adequate understanding of the group under consideration. Brackish water species are included, and naturally those which are cosmopolitan. As far as oceanic forms are concerned, pelagic species are treated in full, while the strictly deep-sea (bathypelagic) fishes are referred to only in keys and by references to the more recent reports describing these animals. Two factors dictate this decision: 1) The relative paucity and incompleteness of our knowledge of these animals, and 2) the fact that they rarely, if ever, come within the provenance of the nonspecialist in fishes, since special vessels and gear are required to effect their capture."

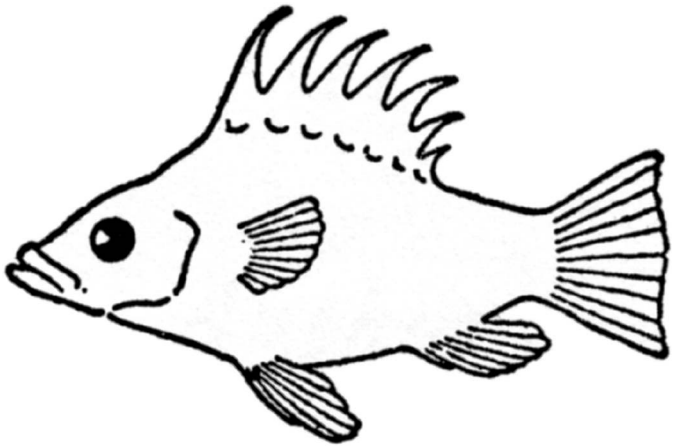

Fig. 1. Logo of *Fishes of the Western North Atlantic.* First appearing in Part One, this logo is used throughout the series.

The species coverage was later changed in Part Four and deep-sea fishes were included. This in turn also expanded the geographic range of species covered because many deep-sea species have large ranges that expand beyond the limits initially set by FWNA.

Description of new species.—The Editorial Board initially ruled that new species should not be described in FWNA because species descriptions should be made widely available in journals. This rule was broken in Part Six, which included descriptions of two new species of berycoid fishes by Loren Woods, and two new genera, nine new species, and two new subspecies of grenadiers by N. B. "Freddy" Marshall and Tomio Iwamoto. However, no one followed this lead, and no new species were described in subsequent Parts.

Illustrations.—A simple but charming fish logo first appears in Part One and is used throughout the series (Fig. 1). It is embossed in gold on the spines of the first editions of Parts One to Part Nine, on the title page of each Part, and above the list of authors. We were unable to find the history of who illustrated the logo or what the design represents, but the original metal block is at Yale Peabody Museum (E. A. Lazo-Wasem, pers. comm., 2020).

Illustration standards were one of the most important guiding principles laid out by the Editorial Board of FWNA that united all Parts. The illustrations in FWNA are all black and white line art and such an illustration is included for nearly every species covered in the series (e.g., Fig. 2); a series of photographs (of seahorses) is only included in Part Eight. Frequently, book reviews cited the illustrations as a highlight (e.g., Ebeling, 1966: 897, 898; Marshall, 1990: 1202; Parenti, 2021: 662). Most of the illustrations are left lateral views (e.g., cyclostomes, sharks, and bony fishes) or dorsal views (e.g., skates and rays), but sometimes other details of bones and scales are included in a species account. Illustrations in FWNA were made by laboratory personnel, graduate students, such as those by Rudy Miller in the section on lepisosteids authored by R. D. Suttkus (1963: figs. 12, 13, 18; Robison, 2020: 695), and even the husband of Isa Pérez Farfante, Gerado Canet, contributed illustrations (Pérez Farfante and Bigelow, 1948: figs. 1–3). For most species accounts, one or two illustrators worked with the account authors; for example, National Systematics Laboratory illustrator Mildred Carrington worked closely with Collette to illustrate halfbeaks and needlefishes. Most of the flyingfish illustrations were drawn by Harold E. Hamman working under contract to Robert H. Gibbs, Jr. while he was at Boston University. Some illustrations were drawn by the account authors; for example, Tomio Iwamoto and N. B. Marshall drew some species of Macrouridae, Jack W. Gehringer illustrated all the Synodontidae, and Margaret Bradbury illustrated bones of fishes and some species of Beryciformes (Fig. 3). Despite the illustrations being among the most noted aspects of the series, in early Parts (e.g., Parts 1–4), illustrators were not acknowledged for their work. This gradually shifted to all illustrators being recognized by name for their contributions.

Maps.—In Parts 1–6, only range statements are provided and there are no species distribution maps. Part Seven introduced the first maps, and the maps were such an important aspect that "Atlantic Mesopelagic Zoogeography" was put on the spine of the book at the same heading level of Neoscopelidae and Myctophidae. The maps in Part Seven, an undertaking by a large team of myctophid biologists, were the first of their kind to synthesize how the distribution of marine mesopelagic fishes is influenced by physical environments (Krefft, 1979). Species distribution maps, primarily point maps based on examined specimens, were included in subsequent Parts 7–10.

References.—For Parts 1–6, literature cited was only provided as an abbreviated reference in the "Synonyms and References" section or as Footnotes, where titles were omitted (Robins, 1974: 574). In the Introduction of Part One, Tee-Van wrote that complete references were left out to make the series more accessible to lay people but promised that the final volume would contain a complete bibliography. Beginning with Part Seven, a literature cited section with references written out was provided at the end of each authored account (Krefft, 1979: 374).

OVERVIEWS AND REVIEWS OF FWNA

Below we provide a brief history of each Part and the authors to highlight unique aspects and emerging themes across the series, drawing from our experience and published book reviews. Titles, editors, and authors are summarized in Table 1.

Part One, 1948.—The series started with Part One, on the lancelets, cyclostomes, and sharks, edited by Bigelow and Schroeder (Table 1). Henry Bigelow was a professor and curator of oceanography at the Museum of Comparative Zoology, Harvard, and the first director of the Woods Hole Oceanographic Institution (WHOI; Redfield, 1976). Together with William "Bill" C. Schroeder, the Business Manager of WHOI from 1932–1952 (Dedication, Part Six), the pair championed the ambitious cooperative series. By the time Bigelow and Schroeder undertook FWNA, they had already co-authored 14 papers and went on to publish other important works, including *Fishes of the Gulf of Maine*. Isa Pérez Farfante, first a master's student at Radcliffe College and later Ph.D. student at Harvard University where she became one of the first women to earn a doctoral degree from Harvard (Bauer, 2010), co-authored the lancelet chapter with Bigelow while she was an Associate Curator at the Museum of Comparative Zoology. In 1948, Bigelow was awarded the Daniel Giraud Elliot Medal by the National Academy of Sciences for his work on FWNA.

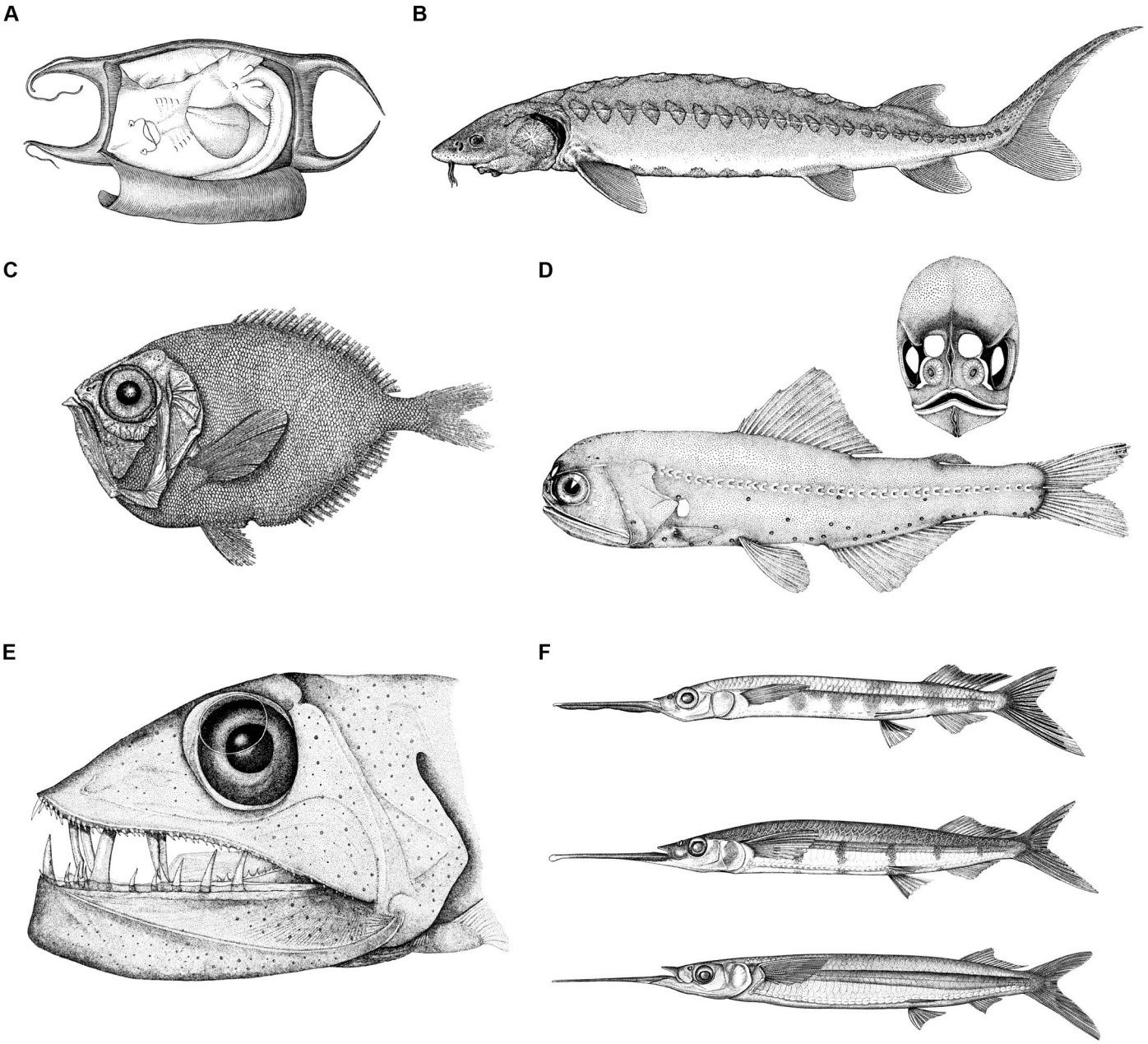

Fig. 2. *Fishes of the Western North Atlantic* set line art standards for illustration of full body and key characters of fishes. (A) Dissected *Raja ocellata* egg case, Part Two (fig. 54: 247), illustrator unknown. (B) Lateral view of *Acipenser brevirostrum*, Part Three (fig. 8: 37), illustrator unknown. (C) Lateral view of *Diretmus pauciradiatus*, Part Six (fig. 15: 297), illustration by Mary Ann Holloway. (D) *Diaphus lucidus*, Part Six (fig. 80: 138), illustrator unknown. (E) Head of adult *Omosudis lowei*, Part Five (fig. 166: 469), illustration by William F. Stone, Jr. (F) Ontogenetic series of *Hemiramphus balao*, Part Ten (fig. 4.5, 100), illustrations by Mildred Carrington.

Carl Hubbs (1949: 155) reviewed Part One concluding that "The first volume of *Fishes of the Western North Atlantic* sets a very high standard—perhaps so high a standard as to render difficult the completion of subsequent volumes by authors less well equipped than Henry Bigelow and associates in courage, energy, time, meticulousness, thoroughness, experience, library facilities and willingness to sacrifice much else for this one grand task …" Hubbs continued (p. 157), "In several ways this volume has been successfully adapted, in line with the policy set for the series, for the use and interest of sportsmen and general naturalists as well as ichthyologists. Features that lead to this desirable end … include the excellent summaries of natural history information … the simplified keys, the complete coverage of the species in the clear-cut illustrations." Hubbs also commented on the design and layout of the volume. He noted that the printed matter only covered 46% of the page, so a smaller page would have been adequate. However, because they kept the cost low, he appreciated the elegance of the large format.

Part Two, 1953.—Part Two was also prepared by Bigelow and Schroeder and reviewed by Carl Hubbs (1955) and Leonard Schultz (1955). Hubbs extolled the excellent figures and the carefully prepared identification keys and concluded that

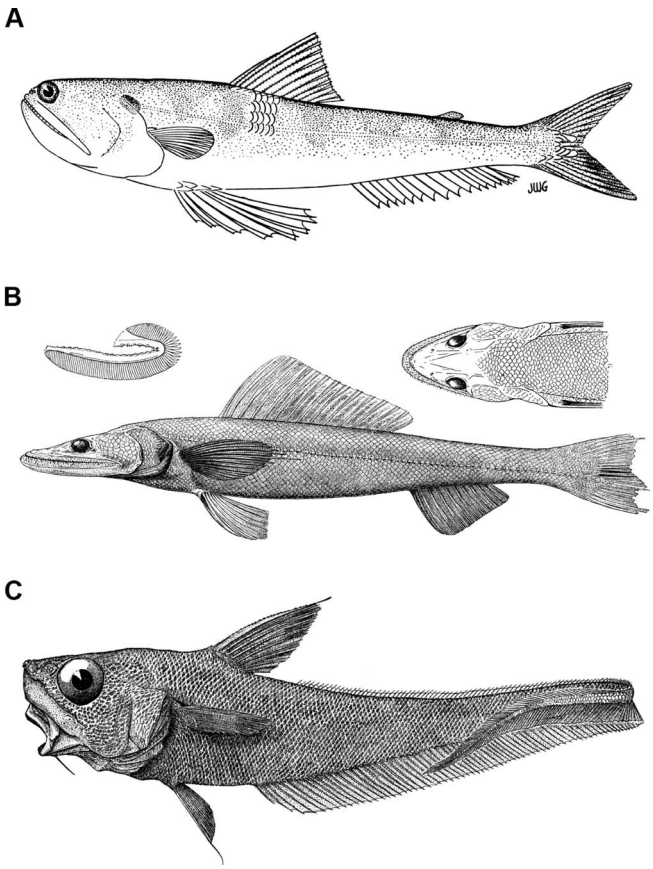

Fig. 3. Illustrations in *Fishes of the Western North Atlantic* prepared by authors. (A) *Trachinocephalus myops*, Part Five (fig. 14: 39), illustration by Jack Gehringer. (B) Lateral view, gill arch, and dorsal view of head of *Bathysaurus agassizi*, Part Five (fig 36: 106), illustration by Margaret G. Bradbury. (C) Lateral view of *Nezumia longebarbatus*, Part Six (fig. 39: 627), illustration by Tomio Iwamoto.

"A mighty firm foundation has been provided for further contributions" (Hubbs, 1955: 263). Schultz (1955: 81) noted, "The editorial board may need to alter the present plans sufficiently to expedite the completion of this important undertaking in a reasonable amount of time." Schultz's early insight was realized, as long periods between publication Parts were common. Both Hubbs (1955) and Schultz (1955) note that although the publication date printed in the book is 1953, it was not mailed from Denmark until 1 December 1954.

Part Three, 1963.—Samuel Hildebrand was assigned the sections on clupeoids for Part Three of FWNA because of his work on anchovies (Hildebrand, 1943), and his experience with east coast fishes (Hubbs, 1950). Hildebrand put aside his own projects on fishes of Panama and from 1944 until his death in 1949 he worked on chapters for FWNA (Higgins, 1950; Hubbs, 1950). Hildebrand's death was a loss to both the authorship of Part Three and the Editorial Board of FWNA (see Introduction to Part Two by Tee-Van, 1953) and created a lag between completion of manuscripts and their publication. Hubbs (1949, 1950) foresaw this problem and noted in his reviews of FWNA that he hoped it would not cause delay. Unfortunately, it did, and it was not until 1963 that Part Three was published. Luis Rivas and Robert Rush Miller updated accounts of two genera of Clupeidae, but other clupeoids did not include updated literature published from 1948–1963. To rectify this, Fred Berry (1964) reviewed Hildebrand's clupeoid account in FWNA and incorporated references that had been published after Hildebrand had completed his account.

Part Four, 1964.—Part Four is dedicated to the memory of Marion Grey by her friends and colleagues. Grey studied biology in college but did not immediately pursue a career because she raised a family. In 1942, she inquired about volunteering at the Chicago Natural History Museum. She was welcomed by Karl P. Schmidt, Chief Curator of Zoology, who asked her to keep the Division of Fishes running while Loren P. Woods was away in the Navy during World War II. Grey died just short of 53 years old, but in her short 22-year career she published 15 papers, including the Gonostomatidae in Part 4, and accumulated an enormous index to the literature of abyssal fishes (Sonoda and Inger, 1964).

Part Four has two back-to-back reviews in a 1965 issue of *Copeia*, the first by Bertelsen (1965) followed by a review by Ahlstrom (1965a, 1965b). Both reviewers noted a persistent problem of the series—manuscripts being finished long before their publication in FWNA. Bertelsen (1965) suggested that it would have been helpful to the reader if the date of manuscript completion were included in each account. For example, Leonard Schultz's account of the marine hatchetfishes, the Sternoptychidae, dated to the late 1950s; his 1961 (Schultz, 1961) revision of Sternoptychidae was only referenced as a footnote.

Part Five, 1966.—Although 11 authors contributed to Part Five (Table 1), more than half of the volume was authored by Robert R. Rofen, then at the Aquatic Research Institute, Port of Stockton, California. Rofen wrote the chapter on Paralepididae and four related aulopiform families. (Note: Rofen's first revisionary studies of the Paralepididae in 1953 were as Robert R. Harry). Later, he was an ichthyologist at the George Vanderbilt Foundation at Stanford University. Part Five was funded by both the Sears Foundation and NSF grants.

Albert Ebeling (1966) provided an extensive review of Part Five, noting the importance of the work addressing groups known only from few specimens. Reviews by Ebeling (1966), Koo (1966), and Miller (1967) all concluded that FWNA was an invaluable contribution to taxonomy and biology.

Part Six, 1973.—Part Six covers halosaurs to grenadiers and was prepared by nine authors (Table 1). This Part begins with a photograph and dedication to W. C. Schroeder in recognition of his service to the series. Part Six was reviewed by C. G. Gruchy (1974), C. R. Robins (1974), and T. Abe et al. (1974). All wrote about changes to the series including not needing to be done in phylogenetic order and the possibility of including descriptions of new species, with the hope that this would lead to more rapid completion and publication of future Parts. The reviews also noted that Donn Rosen had provided only a brief account of the killifishes (suborder Cyprinodontoidei), largely a list and a key, because killifishes are primarily freshwater and estuarine species. The work was described as "well edited and the cost is the same as for parts 3–5 [$27.50/Part], a good bargain in the present era of inflated costs" (Robins, 1974: 576).

Part Seven, 1977.—Part Seven includes the Myctophidae. This family was first covered in an interim two-page account by Rolf L. Bolin in Part Five. Part Seven is dedicated to Bolin who "set the standards in lanternfish taxonomy" (Dedication and Introduction of FWNA Part Seven: xii–xiii) and had planned to write the accounts before his death. Many of the taxa covered in the full account of myctophids by Nafpaktitis et al. (1977) were recently described or reviewed by Bolin (e.g., *Diogenichthys* Bolin 1939, *Hygophum* Bolin 1939, and *Taaningichthys* Bolin 1959). Basil Nafpaktitis was the logical person to lead the myctophid account having already described several Atlantic species of lanternfishes (Pietsch, 2016). The maps in Part Seven, an undertaking by the large team of myctophid biologists led by Richard Backus (E. H. Backus and Collette, 2013), were the first of their kind to synthesize how the distribution of marine mesopelagic fishes is influenced by their physical environments and were lauded by Krefft (1979). Krefft (1979: 372) also wrote that progress in producing FWNA was unduly slow, but he attributed this to "a satisfactory innovation of editorial concept."

Part Eight, 1982.—Part Eight covers the Syngnathiformes, pipefishes and seahorses. Charles Dawson (Overstreet and Poss, 1993) wanted to publish his work on western Atlantic pipefishes in FWNA but refused to study the other part of the family, the seahorses. The Editorial Board wanted the whole family included in FWNA so, fortunately, Richard Vari (Sidlauskas et al., 2017) accepted the task of revising the western Atlantic seahorses, enabling completion of Part Eight. This Part was the only one to contain a series of photographs and was briefly reviewed by Grant Gilmore (1983), who noted that the coverage of the three species of seahorses (*Hippocampus* spp.) were not as detailed as the pipefish accounts.

Part Nine, 1989.—Part Nine covers the eels and is divided into two volumes: Volume One covers the adults and Volume Two the leptocephali larvae. Part Nine is dedicated to James E. Böhlke (1930–1982) who contributed greatly to the series with his research, obtaining funding from NSF, and providing support and encouragement to all authors of the work. James E. Böhlke was Curator of Fishes at the Academy of Natural Sciences in Philadelphia (now part of Drexel University) who focused on eels and fishes of the Bahamas. After his death, his wife Eugenia Böhlke took over the eel work, prepared chapters in both volumes of Part Nine, and coordinated completion of the volumes (Smith, 2002).

Volume 1 of Part Nine, adult eels, was reviewed by Wheeler (1990), noting that it covered all species of eels known from the western North Atlantic. Although calling the volume "a magnificent production," Wheeler (1990: 831) pointed out that after four decades since the first Part was published "the series has crept onwards to Part Nine, the eels. In systematic terms, it could be said that it had not yet got as far as 'real fishes.'"

The importance of eel larvae, leptocephali, and their many differences from adult eels led to the separation of Part Nine into one volume for the adults, and a second volume for leptocephali larvae. Strang (1990) considered the leptocephali volume to be the most comprehensive piece of literature on the subject. "Apart from the Ophichthidae and Serrivomeridae, all other leptocephali are in the hands of David G. Smith whose dedicated studies have resulted in eels now being 'on the map,'" according to Marshall (1990).

Part Ten, 2019.—Part Ten was originally planned to cover the Atherinomorpha, killifishes, silversides, halfbeaks, needlefishes, and flyingfishes. Killifishes were partially covered in Part Six by Donn Rosen, but the plan was to include a comprehensive account with the atherinomorphs. Fred Berry began research on the needlefishes and halfbeaks, but this project was transferred to Collette when Berry moved from his fisheries post in Brunswick, Georgia to La Jolla, California (Collette and Anderson, 2002). Part Ten suffered from two delays. Robert H. Gibbs, Jr. studied flyingfishes during his time at Boston University, but when he moved to the Smithsonian Institution in 1963, his research focus shifted to stomiiforms (Springer and Collette, 1989). Nicolay Parin, Russian flyingfish expert, agreed to complete the flyingfish chapter but was only able to complete a few generic accounts before his premature death in 2012 (Collette, 2013). In 2014, Collette enlisted Bemis to work on the project, and together we enlisted Russian flyingfish expert, Ilia Shakhovskoy, to complete the accounts of the flyingfishes. The authors who were initially interested in providing an account of the silversides and a more extensive account of the marine killifishes were not able to complete them, so Part Ten only includes the beloniform fishes. Part Ten is dedicated to the memories of three beloved ichthyological colleagues, Fred Berry, Bob Gibbs, and Nik Parin, who began research on beloniforms and helped us understand these fascinating fishes.

Lynne Parenti (2021) noted that Part Ten containing accounts of the 38 species of Beloniformes "is a fine addition to, and the final number of the series." Parenti concludes (p. 662) that "the illustrations are priceless and the maps illuminating."

DISCUSSION

Impact of FWNA.—After we completed our historical summary, we were convinced that FWNA had a significant impact on ichthyology. But how should we measure "impact"? One common way of assessing impact of publications is to use a citation index; however, it is difficult to use this to measure the impact of FWNA for several reasons. First, it is a reference work, so while it may be consulted for keys or general information about a species or family, such use might not result in a citation. Second, although it has been a serial publication, it is not a journal nor is it a book and thus FWNA has been inconsistently cited (e.g., sometimes it is cited as published by the Sears Foundation, sometimes by Yale University Press). We consulted with Jane Quigley (Head, National Museum of Natural History Library), who, after five hours of using Web of Science and Zotero, found 642 distinct articles citing Part 1 since its publication in 1948. This methodology would be time consuming to assess later Parts that had many authors (Table 1), so we did not attempt it.

Another important aspect of FWNA is the effect it has had on the research careers of the authors. As one example, the formal evidence of Collette's involvement in FWNA began with the description of a new species of halfbeak from Bermuda (Collette, 1962). Research on beloniform fishes for FWNA extended worldwide and became a major part of his 63-year career in ichthyology (approximately 25% of Collette's publications are on beloniforms, which he began studying because of FWNA). Bemis's involvement began in the summer of 2014 as the project for her summer undergraduate internship in the NOAA Ernest F. Hollings program, which continued on into her time as a Ph.D. student at Virginia Institute of

Marine Science. Working on FWNA introduced her to writing taxonomic accounts and prepared her for attaining a permanent position and career in ichthyology.

Similarly, preparation of FWNA accounts led several ichthyologists to direct much of their research to their FWNA groups of fishes: clupeoids for Samuel Hildebrand, aulopiforms for Robert Rofen, gadiforms for Daniel Cohen, lanternfishes for Basil Nafpaktitis, stomiiforms for Robert H. Gibbs, Jr., pipefishes for Charles Dawson, adult eels for James and Eugenia Böhlke, and leptocephalus eels for David G. Smith. Research for FWNA also directly affected research at institutions, particularly Museum of Comparative Zoology (Parts One and Two), National Museum of Natural History (Parts Three, Eight, Nine, and Ten), Field Museum of Natural History (Part Four), California Academy of Sciences (Part Six), Academy of Natural Sciences, Philadelphia (Part Nine), National Oceanic and Atmospheric Administration (Parts Six and Ten), and the Woods Hole Oceanographic Institution (Parts One, Two, and Seven).

Why is Part 10 the last volume in the series?—Reviews of FWNA cited throughout this paper show that the series was widely respected, beautifully prepared, and the species accounts comprehensive in nature. Despite this praise, starting from publication of the first Parts, reviewers, editors, and authors recognized that it would be challenging to keep up. Indeed, as noted above, Wheeler (1990: 831) wrote that the series never reached "the real fishes." We identified six interrelated problems that challenged completion of FWNA and eventually led to the series ending, which we discuss below in hopes that lessons learned from this series might help preparation of future faunal works:

1. A large, diffuse, editorial board meant that no one was assigned the charge of advancing the progress and ultimate completion of a given Part;
2. FWNA was planned to be conducted in phylogenetic order, at least initially;
3. FWNA relied on taxonomic specialists to prepare each account;
4. The comprehensive nature of the accounts required a significant time investment;
5. The size of the region covered was large and diffuse;
6. Funding was available only for the publication of the series, not to support scientists preparing accounts.

Although editorial policies were updated in an attempt to expediate the time it took to complete each Part, ultimately this effort was not successful, and long times between publication of one Part to the next plagued FWNA throughout its history. The series was organized to cover taxa in phylogenetic order, and this created problems when no specialist was able to complete accounts at the appropriate time. This likely caused delay; however, it was not directly responsible for all the delay because the Editorial Board opted to progress out of phylogenetic order, if necessary, after Part Six. Phylogenetic order also contributed to significant delays in producing other faunal works, such as the three volumes of *Freshwater Fishes of North America* (Warren and Burr, 2014, 2020, of which only two have been published) and the multi-volume *Coastal Fishes of the Western Indian Ocean* (Heemstra et al., 2022). Publication of most manuscripts in these two series were also delayed; for example, beloniform sections were ten years out of date when published. For large projects to be successful, a leader needs to oversee progress, organize contributors, and ensure publication is timely.

A useful comparison is with the third edition of *Bigelow and Schroeder's Fishes of the Gulf of Maine* (Collette and Klein-MacPhee, 2002). *Fishes of the Gulf of Maine* summarizes biology of each species in a similar format to that of FWNA. For Collette, there were two previous editions of the book, so it was easier to produce a revised edition than creating a new work. For the third edition, Collette had institutional funding to support a co-editor, Grace Klein-MacPhee, and together they sought ichthyologists to prepare species accounts. When no specialists were available, they wrote the accounts themselves, which allowed relatively rapid completion of the book. *Fishes of the Gulf of Maine* was also successful because there was a clearly defined and limited geographical region for the series: the Gulf of Maine. In contrast, the geographic region of FWNA covered an enormous area: the western half of the North Atlantic, including the adjoining gulfs and seas, from Hudson Bay southward to the Amazon River; coverage also expanded over time to include deep-sea fishes, which had initially been excluded (Parts 1–3).

Although funding was available for publication of the series, authors of sections were not supported for the work required to produce an account. Often this work took many years to complete and extended beyond the time of typical grants; without funding available from FWNA, there was also no incentive to complete the work in a timely manner. For example, Collette's research on halfbeaks and needlefishes began in 1961 and continued until publication of Part 10 in 2019. One recent success story of a faunal compilation is *The Fishes of New Zealand* (Roberts et al., 2015), which had financial support and leadership from the Museum of New Zealand Te Papa Tongarewa to bring specialists to New Zealand to study specimens and complete summaries of various groups.

Today, completing comprehensive species accounts in the spirit of the FWNA style involves dealing with many more references than were available when Bigelow and Schroeder first undertook the task, though, frequently these references are more readily accessible (e.g., through web searches). This availability is exciting because knowledge of the fishes in our region has greatly expanded, but this also provides new challenges for how this knowledge should be summarized.

Conclusions.—We discuss these problems in hopes that lessons learned from this series might help preparation of future faunal works. Over the years, the content and format of the FWNA series changed, including adding complete references, maps, and moving away from a strict phylogenetic order. The audience also shifted: FWNA was originally designed to be accessible for lay people; however, over time the species accounts became more specialized, being of greater use only to scientists. Despite this, "FWNA provides a model how to summarize basic data for any taxon" (Parenti, 2021).

ACKNOWLEDGMENTS

We thank David G. Smith and Thomas A. Munroe for reviewing early drafts of our manuscript and providing suggestions that improved it. We thank Rosemary Volpe and Eric Lazo-Wasem for providing information about the Sears Foundation and Yale University Peabody Museum and Jane Quigley, National Museum of Natural History, Smithsonian

Institution, for her enthusiasm and assistance with our project. Finally, we thank the members of the ASIH History Committee, Aaron Bauer, Inci Bowman, Eric Hilton, Mark Sabaj, and Gregory Watkins-Colwell for their prompt and useful comments on the penultimate draft of our manuscript.

LITERATURE CITED

Abe, T., T. Ueno, and S. Okamura. 1974. Review of Fishes of the Western North Atlantic, Part 6. Japanese Journal of Ichthyology 21:43–45.

Ahlstrom, E. H. 1965a. Review: Fishes of the Western North Atlantic, Part Four. $27.50. Copeia 1965:528–530.

Ahlstrom, E. H. 1965b. Review: Fishes of the Western North Atlantic. Sears Foundation for Marine Research Memoir No. 1, Pt. 4. The Quarterly Review of Biology 40:209–210.

Backus, E. H., and B. B. Collette. 2013. Obituary: Richard Haven Backus (1922–2012). Copeia 2013:173–176.

Bauer, T. R. 2010. Obituary: Isabel Pérez Farfante de Canet 24 June 1916–20 August 2009. Journal of Crustacean Biology 30:345–349.

Berry, F. H. 1964. Review and emendation of family Clupeidae by Samuel F. Hildebrand. Fishes of the Western North Atlantic, Part 3. $27.50. Copeia 1964:720–730.

Bertelsen, E. 1965. Review: Fishes of the Western North Atlantic, Part Four. Oder Isospondyli, in part. $27.50. Copeia 1965:525–528.

Cohen, D. M., and B. B. Collette. 2004. Obituary: Giles W. Mead, Jr. 1928–2003. Copeia 2004:725–728.

Collette, B. B. 1962. *Hemiramphus bermudensis*, a new halfbeak from Bermuda, with a survey of endemism in Bermudian shorefishes. Bulletin of Marine Science of the Gulf and Caribbean 12:432–449.

Collette, B. B. 2013. Obituary: Nikolai Vasil'evich Parin (1932–2012). Copeia 2013:768–780.

Collette, B. B. 2019. Obituary: Daniel Morris Cohen (1930–2016). Copeia 107:160–168.

Collette, B. B., and W. D. Anderson, Jr. 2002. Obituary: Frederick H. Berry, 1927–2001. Copeia 2002:558–567.

Collette, B. B., and G. Klein-MacPhee (Eds.). 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine. Third edition. Smithsonian Institution Press, Washington, DC.

Ebeling, A. W. 1966. Review: Fishes of the Western North Atlantic, Part Five. Orders Iniomi and Lyomeri. $27.50. Copeia 1966:895–898.

Gilmore, R. G. 1983. Review: Fishes of the Western North Atlantic, Part Eight. Family Syngnathidae. Copeia 1983:848–849.

Gruchy, C. G. 1974. Fishes of the Western North Atlantic. The Canadian Field Naturalist 88:525–526.

Heemstra, P. C., E. Heemstra, D. A. Ebert, W. Holleman, and J. E. Randall (Eds.). 2022. Coastal Fishes of the Western Indian Ocean, 5 vols. South African Institute for Aquatic Biodiversity.

Higgins, E. 1950. Obituary: Samuel Frederick Hildebrand as a government scientist. Copeia 1950:8–11.

Hildebrand, S. F. 1943. A review of the American anchovies (Engraulidae). Bulletin of the Bingham Oceanographic Collection of Yale University 8:1–165.

Hubbs, C. L. 1949. Review: Fishes of the Western North Atlantic, Part One. $10.00. Copeia 1949:155–157.

Hubbs, C. L. 1950. Samuel F. Hildebrand, ichthyologist and herpetologist. Copeia 1950:12–14.

Hubbs, C. L. 1955. Review: Fishes of the Western North Atlantic. Part Two. Sawfishes, guitarfishes, skates and rays [and] chimaeroids. $15.00. Copeia 1955:263.

Jordan, D. S., and B. W. Evermann. 1896–1900. The fishes of North and Middle America. Bulletin of the U.S. National Museum 47:1–3313.

Koo, T. S. 1966. Review: Fishes of the Western North Atlantic. Memoir I, Part 5 by William W. Anderson. Chesapeake Science 7:177.

Krefft, G. 1979. Review: Fishes of the Western North Atlantic. Part Seven. Family Neoscopelidae, Family Myctophidae; Atlantic Mesopelagic Zoogeography. $27.50. Copeia 1979:372–374.

Marshall, N. B. 1990. Review: Fishes of the Western North Atlantic. Part Nine: Anguilliformes, Saccopharyngiformes, and Leptocephali. 2 Vols. $145.00. Copeia 1990:1201–1202.

Miller, R. R. 1967. Review: Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research, Number 1, Part Five. Order Iniomi and Order Lyomeri. The Quarterly Review of Biology 42:443–444.

Overstreet, R. M., and S. G. Poss. 1993. Obituary: Charles Eric "Chuck" Dawson 1922–1993. Copeia 1993:921–924.

Parenti, L. R. 2021. Review: Fishes of the Western North Atlantic. Order Beloniformes: Needlefishes, Sauries, Halfbeaks, and Flyingfishes: Belonidae, Scomberesocidae, Hemiramphidae, Exocoetidae. Part Ten. Ichthyology & Herpetology 109:661–663.

Pietsch, T. W. 2016. Obituary: Basil George Nafpaktitis (1929–2015). Copeia 104:293–296.

Redfield, A. C. 1976. Henry Bryant Bigelow, 1879–1967. National Academy of Sciences Biographical Memoirs 48:50–80.

Roberts, C. D., A. L. Stewart, and C. D Struthers (Eds.). 2015. The Fishes of New Zealand, 4 vols. Te Papa Press, Wellington, New Zealand.

Robins, C. R. 1974. Review: Fishes of the Western North Atlantic. Part Six. Order Heteromi (Notacanthiformes), Suborder Cyprinodontoidei, Order Berycomorphi (Beryciformes), Order Xenoberyces Stephanobercyiformes), Order Anacanthini (Gadiformes) in part, Macrouridae. $27.50. Copeia 1974:574–576.

Robison, H. W. 2020. Obituary: Rudolph J. Miller (1934–2017): Oklahoma ichthyologist, teacher and mentor, and naturalist painter. Copeia 108:629–697.

Schultz, L. P. 1955. Review: Fishes of the Western North Atlantic. Sawfishes, Guitarfishes, Skates, Rays, and Chimaeroids by Henry B. Bigelow, William C. Schroeder. Science 122:80–81.

Schultz, L. P. 1961. Revision of the marine Silver Hatchetfishes (family Sternoptychidae). Proceedings of the United States National Museum 112:587–649.

Sidlauskas, B. L., C. Ferraris, V. A. Funk, L. Parenti, M. de Pinna, and G. McGregor Reid. 2017. In Memoriam: Richard Peter Vari (August 24, 1949–January 15, 2016). Copeia 105:147–160.

Smith, D. G. 2002. Obituary: Eugenia Brandt Böhlke. Copeia 2002:1175–1182.

Sonoda, P. M., and R. F. Inger. 1964. Obituary: Marion Grey. Copeia 1964:598.

Springer, V. G., and B. B. Collette. 1989. Obituary: Robert H. Gibbs, Jr. 1929–1988. Copeia 1989:245–251.

Strang, P. 1990. Review: Fishes of the Western North Atlantic. Part 9, vol. 2. Journal of Fish Biology 37:831–832.

Suttkus, R. D. 1963. Order Lepisostei, p. 61–88. *In*: Fishes of the Western North Atlantic, Part Three. Olsen Y. H. (ed.). Sears Foundation for Marine Research, Yale University, New Haven, Connecticut.

Veronis, G. 2009. Introductory note from George Veronis, editor of the Journal of Marine Research and author of the following biographical sketch of Henry Sears, who founded the Sears Foundation of Marine Research, which publishes the Journal of Marine Research. Journal of Marine Research 67:113–117.

Warren, M. L., Jr., and B. M. Burr (Eds.). 2014, 2020. Freshwater Fishes of North America. Vols. 1 and 2. Johns Hopkins University Press, Baltimore, Maryland.

Wheeler, A. 1990. Review: Fishes of the Western North Atlantic. Part 9, vol. 1. Journal of Fish Biology 37:831.