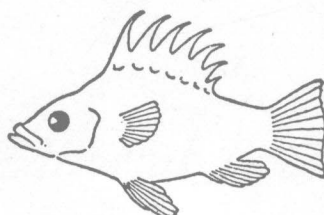


MEMOIR
SEARS FOUNDATION FOR MARINE RESEARCH

Number I

Fishes of the Western North Atlantic



PART TWO

Sawfishes, Guitarfishes, Skates and Rays

HENRY B. BIGELOW *and* WILLIAM C. SCHROEDER

Museum of Comparative Zoology

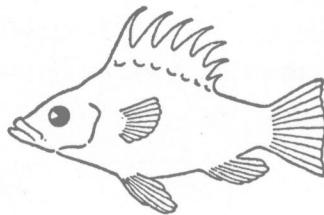
Chimaeroids

HENRY B. BIGELOW *and* WILLIAM C. SCHROEDER

NEW HAVEN 1953

SEARS FOUNDATION FOR MARINE RESEARCH, YALE UNIVERSITY

Fishes of the Western North Atlantic



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PRINTED IN DENMARK FOR
SEARS FOUNDATION FOR MARINE RESEARCH
BINGHAM OCEANOGRAPHIC LABORATORY
YALE UNIVERSITY

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Introduction

WITH THE PUBLICATION of the second part of FISHES OF THE WESTERN NORTH ATLANTIC it seems desirable to restate briefly the purposes and aims of this series, particularly for those who may not be familiar with Part One. In ichthyology, as in other sciences, much of the early work was devoted to purely descriptive accounts which appeared in numerous publications here and abroad, and although new species are still described occasionally, a stage of relative stability has been achieved in our knowledge of the species which occur in the western North Atlantic. At this time, therefore, it seems particularly important to bring together and synthesize the vast amount of information which has been amassed in the past and thus make it available to both public and marine biologists. It is intended that each article in this series shall be a critical review and revision rather than a mere compilation of previously published works, and, as pointed out in the Preface to Part One, that it be "written on the premise that it should be useful to those in many walks of life—to those casually or vitally interested in the general phenomena of life in our waters, to the sportsman whose interests are closely associated with pleasure and relaxation, to the fisherman whose livelihood depends upon knowledge of where fishes are gathered together, as well as to the amateur ichthyologist and the professional scientist."

Part One, published in 1948, dealt with the Lancelets, Cyclostomes and Sharks of the western North Atlantic. The present publication, treating of Sawfishes, Guitarfishes, Skates, Rays and Chimaeroids, brings to completion a further effort in the over-all purpose of this series. In general the format and treatment of these groups are the same as in Part One. In conformance with general policy, these studies also are written for the layman as well as the specialist and are critical reviews rather than perfunctory compilations. The text, together with meticulously accurate illustrations, should leave no place for confusion in the reader's mind. As in Part One, under each species will be found not only a detailed description and the distinctive characters which set it apart from its nearest relatives, but notations on color, size, general habits, abundance, range, relation to man, and occurrence. The geographical range of the fishes described remains essentially the same—the western half of the North Atlantic, including the adjoining gulfs and seas, from Hudson Bay southward to the Amazon River. Numerous species found in other parts of the globe are often referred to, and occasional species from adjoining seas are described.

Again we wish to acknowledge our gratitude to the Sears Foundation for Marine Research, which has financed the publication. We are also grateful to the Woods Hole Oceanographic Institution and the Museum of Comparative Zoology, which have contributed in large measure to these publications through salaries to the authors and through special grants for the preparation of illustrations and for travel to examine specimens. We are likewise indebted to those institutions which have generously supported the work of the editors, particularly the Bingham Oceanographic Laboratory, the American Museum of Natural History and the New York Zoological Society.

The Editorial Board again expresses its particular appreciation and thanks to Yngve H. Olsen, who has edited the manuscripts and seen them through press with untiring patience and enormous skill and to Henry Sears for his continued interest and support.

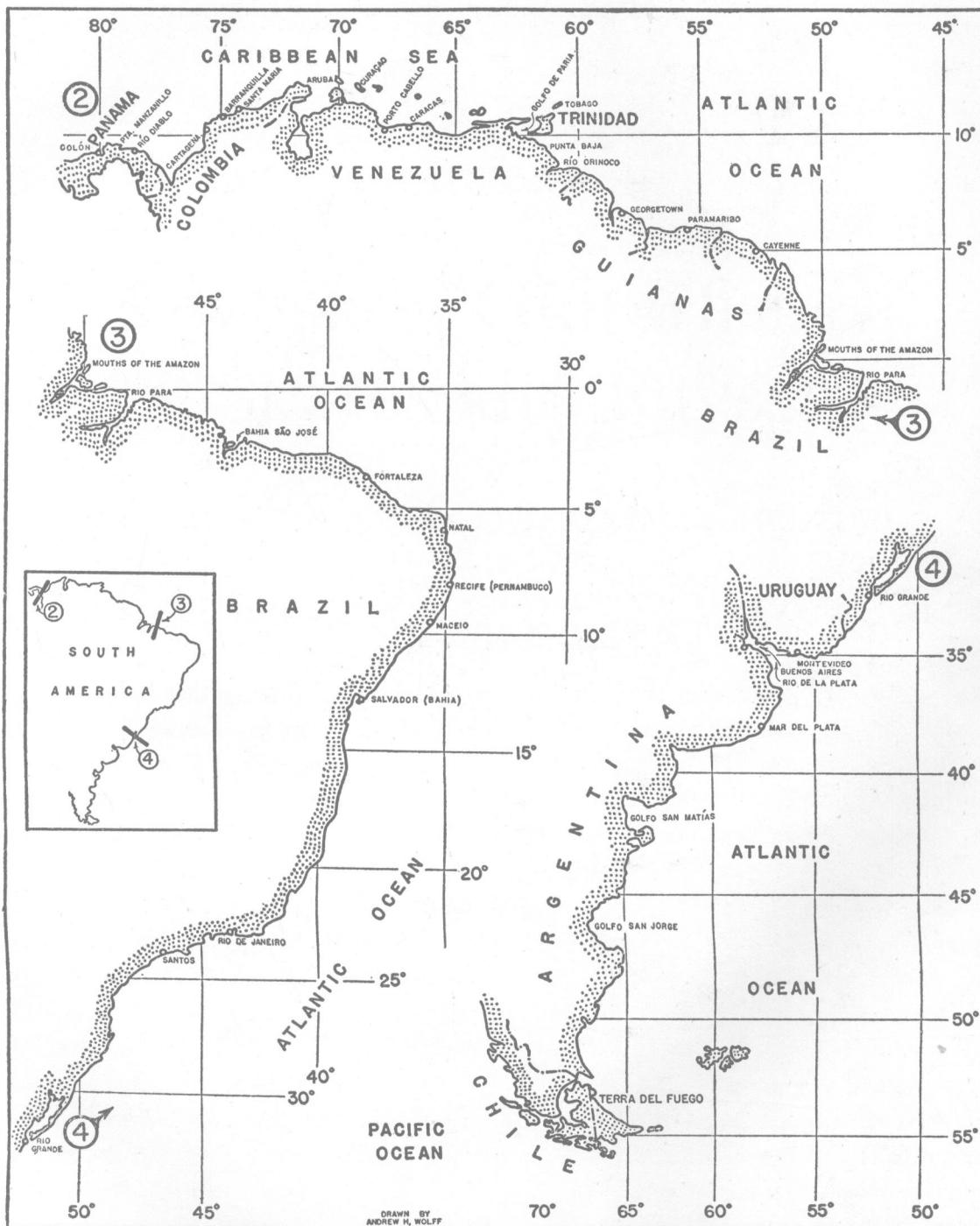
Finally, we note with profound regret the death of the late Dr. Samuel F. Hildebrand, who served the field of ichthyology so well and long and who gave so generously of his time and experience as a member of our Editorial Board.

JOHN TEE-VAN,
New York Zoological Society.

February 1, 1953



North America



South America

Table of Contents

INTRODUCTION	xi
MAPS	xiv
SAWFISHES, GUITARFISHES, SKATES and RAYS, By HENRY B. BIGELOW and WILLIAM C. SCHROEDER	I
ACKNOWLEDGMENTS	I
GENERAL DISCUSSION	2
Subclass Elasmobranchii	4
Order Batoidei	4
Suborder Pristoidea	15
Family Pristidae	18
Genus <i>Pristis</i>	18
<i>Pristis pectinatus</i>	23
<i>Pristis perotteti</i>	34
Suborder Rhinobatoidea	43
Family Rhynchobatidae	44
Family Rhinobatidae	46
Genus <i>Rhinobatos</i>	50
<i>Rhinobatos horkelii</i>	56
<i>Rhinobatos lentiginosus</i>	60
<i>Rhinobatos percellens</i>	68
Genus <i>Rhinobatos</i> Addendum	73
<i>Rhinobatos spinosus</i>	73
Genus <i>Zapteryx</i>	74
<i>Zapteryx brevirostris</i>	75
Suborder Torpedinoidea	80
Family Torpedinidae	87
Genus <i>Torpedo</i>	90
<i>Torpedo nobiliana</i>	96
Genus <i>Narcine</i>	107
<i>Narcine brasiliensis</i>	112
Genus <i>Diplobatis</i>	123
<i>Diplobatis pictus</i>	124
Genus <i>Benthobatis</i>	126
<i>Benthobatis marcida</i>	128
Suborder Rajoidea	132
Family Rajidae	133

Table of Contents

Genus <i>Raja</i>	138
<i>Raja ackleyi</i>	155
<i>Raja bathyphila</i>	159
<i>Raja eglanteria</i>	165
<i>Raja erinacea</i>	176
Addendum to <i>Raja erinacea</i> by D. MERRIMAN, Y. H. OLSEN, S. B. WHEATLAND, and L. H. CALHOUN	187
<i>Raja fyllae</i>	194
<i>Raja garmani</i>	200
<i>Raja hyperborea</i>	206
<i>Raja jenseni</i>	213
<i>Raja laevis</i>	217
<i>Raja lentiginosa</i>	228
<i>Raja lintea</i>	232
<i>Raja mollis</i>	237
<i>Raja ocellata</i>	240
<i>Raja olseni</i>	251
<i>Raja radiata</i>	255
<i>Raja senta</i>	264
<i>Raja spinicauda</i>	271
<i>Raja teevani</i>	276
<i>Raja texana</i>	279
Genus <i>Breviraja</i>	284
<i>Breviraja atripinna</i>	286
<i>Breviraja colesi</i>	289
<i>Breviraja cubensis</i>	293
<i>Breviraja plutonia</i>	297
<i>Breviraja sinus-mexicanus</i>	302
<i>Breviraja spinosa</i>	306
<i>Breviraja yucatanensis</i>	310
Genus <i>Cruriraja</i>	313
<i>Cruriraja atlantis</i>	315
<i>Cruriraja poeyi</i>	319
Genus <i>Dactylobatus</i>	323
<i>Dactylobatus armatus</i>	323
Family Anacanthobatidae	327
Genus <i>Springeria</i>	328
<i>Springeria folirostris</i>	328
Suborder Myliobatoidea	331
Family Dasyatidae	335
Genus <i>Dasyatis</i>	340

Table of Contents

ix

<i>Dasyatis americana</i>	345
<i>Dasyatis centroura</i>	352
<i>Dasyatis geijskesi</i>	363
<i>Dasyatis guttata</i>	365
<i>Dasyatis sabina</i>	370
<i>Dasyatis say</i>	378
Genus <i>Himantura</i>	389
<i>Himantura schmardae</i>	390
Family Gymnuridae	395
Genus <i>Gymnura</i>	396
<i>Gymnura altavela</i>	399
<i>Gymnura micrura</i>	408
Family Urolophidae	416
Genus <i>Urolophus</i>	418
<i>Urolophus jamaicensis</i>	420
Genus <i>Urotrygon</i>	427
<i>Urotrygon microphthalmum</i>	428
<i>Urotrygon venezuelae</i>	430
Family Myliobatidae	433
Genus <i>Myliobatis</i>	435
<i>Myliobatis freminvillii</i>	438
<i>Myliobatis goodei</i>	446
Genus <i>Aetobatus</i>	451
<i>Aetobatus narinari</i>	453
Family Rhinopteridae	465
Genus <i>Rhinoptera</i>	465
<i>Rhinoptera bonasus</i>	469
<i>Rhinoptera brasiliensis</i>	477
Family Mobulidae	480
Genus <i>Mobula</i>	486
<i>Mobula hypostoma</i>	488
<i>Mobula mobular</i>	495
Genus <i>Ceratobatis</i>	497
<i>Ceratobatis robertsii</i>	497
Genus <i>Manta</i>	500
<i>Manta birostris</i>	502

CHIMAEROIDS BY HENRY B. BIGELOW and WILLIAM C. SCHROEDER

GENERAL DISCUSSION	515
Subclass Holocephali	515
Order Chimaerae	515
Family Chimaeridae	516
	523

Table of Contents

Genus <i>Chimaera</i>	524
<i>Chimaera cubana</i>	527
Genus <i>Hydrolagus</i>	533
<i>Hydrolagus affinis</i>	539
<i>Hydrolagus alberti</i>	545
Family Rhinochimaeridae	548
Genus <i>Harriotta</i>	550
<i>Harriotta raleighana</i>	551
Family Callorhinchidae	558
Genus <i>Callorhinchus</i>	560
INDEX	563

CHAPTER ONE

Sawfishes, Guitarfishes, Skates and Rays¹

BY

HENRY B. BIGELOW *and* WILLIAM C. SCHROEDER

ACKNOWLEDGMENTS

Many persons have assisted us in the preparation of the following pages. Our thanks are due in particular to Leonard P. Schultz and to A. S. Romer for allowing us free access to the collections of the United States National Museum and of the Harvard Museum of Comparative Zoology, which have been the chief sources of our Study Material; to the authorities of the British Museum (Natural History), the American Museum of Natural History, the Academy of Natural Sciences of Philadelphia, the Boston Society of Natural History, the Chicago Museum of Natural History, the Charleston Museum, South Carolina, and the Museum of Zoology, University of Michigan, for the loan of much needed material; to the Woods Hole Oceanographic Institution for constant assistance; to Stewart Springer who has contributed a large amount of valuable information and many specimens of Skates, Rays and Chimaeras from Florida and the Gulf of Mexico; to Anton Fr. Bruun for the loan of rhinochimaeroid material collected by the ATLANTIDE Expedition from deep water off equatorial West Africa; to J. L. Baughman for Sawfishes, Guitarfishes, and other specimens from the Gulf of Mexico; to Gordon Gunter for Guitarfishes from Texas; to Michael Lerner and C. M. Breder for obtaining two specimens of Manta for us at Bimini, Bahamas, and to Ivor Cornman for arranging to have parts of them shipped to Cambridge; to William Royce and the scientific staff of the

1. Contribution No. 570 from the Woods Hole Oceanographic Institution.

U. S. Fish and Wildlife Service vessel ALBATROSS III for desirable specimens and data on Skates and Rays from the North Carolina Coast taken during midwinter; to Luis Howell-Rivero for Cuban Rays; to Captain R. Howard, A. U. S., for Torpedo and Sting Rays from the east coast of Florida; to Marie Poland Fish for Rays from Rhode Island; to Leslie W. Scattergood for information as to the season for *Raja ocellata* with egg cases off the coast of Maine; to Paul M. Hansen for specimens of *Raja radiata* from Greenland and for other information; to Captain C. W. Thomas, U. S. C. G., and Commander P. L. Stimpson, U. S. C. G., for obtaining specimens of *Raja hyperborea* for us in West Greenland; to Commander David C. Nutt and Richard H. Backus for records of *Raja radiata* from Labrador; to W. Templeman for a specimen of *Raja spinicauda* from northeastern Newfoundland, for specimens of *R. radiata* from the Grand Banks, and for other information; to V. D. Vladykov for specimens of *Raja erinacea* from the estuary of the St. Lawrence River; to Miss Ethelwyn Trewavas of the British Museum (Natural History) for supplying the description of the type specimen of the Devil Ray *Ceratobatis robertsii* and for arranging to have drawings of it prepared by Hubert Williams; to G. Palmer for drawings and measurements of *Diplobatis pictus*; to Dr. George White, J. Incardone, and W. E. Kruger for the x-ray photographs reproduced in Fig. 62, and to Dr. Leonard D. Nathan for his assistance in obtaining x-rays; to Señora Helena Paes de Oliveira for photographs of Brazilian Skates; to John Tee-Van for contributing bibliographic citations without which the work could hardly have been undertaken; to Ludlow Griscom and James L. Peters for assistance in nomenclatural problems; to H. W. Fowler for welcome information on various Skates and Rays; to Frank Huber for notes on a large Manta taken off New Jersey; to F. E. Firth, and Captains Donald Campbell and Frank Janssen for interesting records of offshore captures of *Torpedo nobiliana*; to Captains Henry W. Klimm, Jr. and Jared Vincent for furnishing information on the captures of various Skates on the offshore winter fishing grounds off southern New England; to J. C. Brew, Sir P. H. Buck and Captain E. H. Bryan for assembling information on the use of Sting Ray spines as weapons in various parts of the world, and to Mrs. Myvanwy Dick for much assistance in the preparation of the manuscript.

GENERAL DISCUSSION

Scope of Study. The following pages give descriptions, illustrations, life histories, geographic distribution, and references for all species of Sawfishes, Guitarfishes, Skates and Rays that are known in the western side of the North Atlantic. The characterizations of suborders, families, and genera, together with the corresponding Keys, cover the batoid fishes as a whole; this also applies to Species Keys in cases where present knowledge permits.

Descriptions. The descriptions are based on the Study Material listed under each species, except for *Urotrygon microphthalmum* and *Mobula mobular*, no specimens of which were available. The accounts of habits and distribution are based on published data, on information from correspondents whose assistance is acknowledged, and on our own observations.

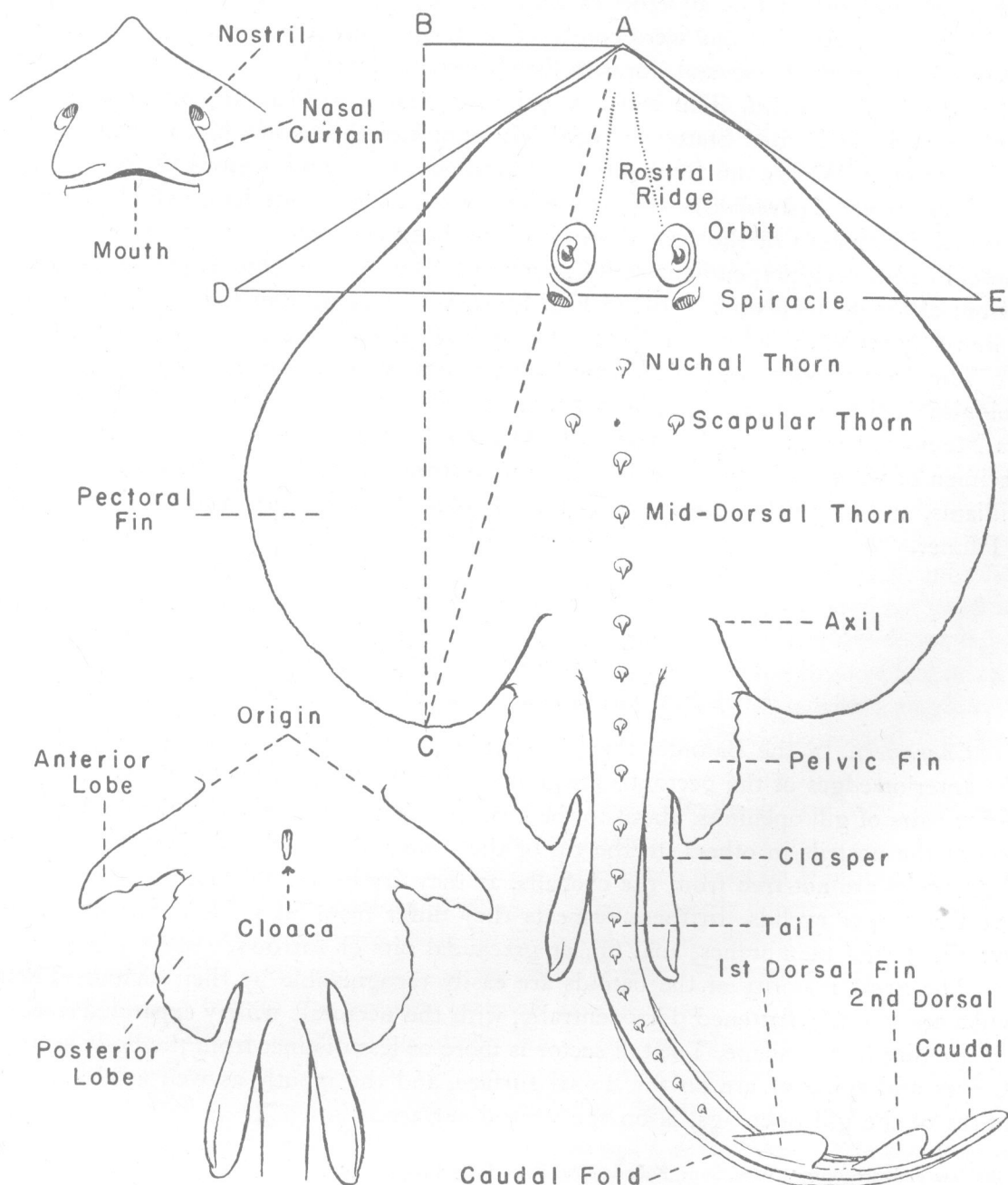


FIGURE 1. Outlines of a typical Skate to illustrate terminology and methods of measurement.

Keys. The Keys are offered solely for purposes of identification. Therefore, we have selected for their construction such characters as are not only alternative but which are easily seen or measured.

Arrangement. The larger groups, down to genera, are arranged in the sequence that seems to us to represent most nearly their probable relationships. The species within each genus are presented in alphabetical sequence as in our previous publication, *Sharks*.²

References. All citations were consulted in the original, except as noted, through the co-operation of the several libraries listed previously.³

Sources of Material. The collections in the Harvard Museum of Comparative Zoology and the United States National Museum have been the chief sources of our Study Material. We are much indebted also to the museums and persons listed (page 1).

Proportional Dimensions and Illustrations. The measurements from which the proportional dimensions of the several species have been calculated were taken on a horizontal line between perpendiculars at given points; for example, the length of the snout in front of the orbits is on line BC in Fig. 1, *not* AC; the length of the disc is measured on line BC, *not* AC; the anterior angle to the level of the spiracles is the angle DAE.

The great majority of the drawings in this book were prepared by the well known zoological artist, E. N. Fischer, who executed most of the illustrations for Part I of this Memoir series and for Garman's *Plagiostoma* (1913). *Ceratobatis robertsii*, the type specimen of which is in the British Museum (Natural History), was drawn by Hubert Williams, and original drawings of *Diplabatis pictus* were loaned to us by courtesy of G. Palmer.

Subclass ELASMOBRANCHII

Order BATOIDEI

Sawfishes, Guitarfishes, Skates and Rays⁴

Characters. In the Batoidei the gill openings are wholly on the ventral surface. The anterior edges of the pectorals are united with the sides of the head forward past all five pairs of gill openings, about to the level of the mouth in some (Pristidae), to the level of the nostrils in others, to the tip of the snout in still others. The upper edges of the orbits are not free from the eyeballs, as they are in Sharks; that is, they do not have free upper eyelids. In these respects they differ from all modern Sharks. None have nictitating membranes, anal fin, or precaudal pits or furrows.

The great majority of the batoids are easily recognizable by their shapes. Their trunks are strongly flattened dorsoventrally, with the pectorals widely expanded so that they are disc-like in shape. The tail sector is more or less distinct from the body sector, the eyes and spiracles are on the dorsal surface, and the mouth, as well as the entire lengths of the gill openings, is on the ventral surface.

2. Bigelow and Schroeder, Mem. Sears Found. Mar. Res., I (1) Chap. 3, 1948.

3. Mem. Sears Found. Mar. Res., I (1), 1948: 60.

4. For characters of the order Selachii, see Mem. Sears Found. Mar. Res., I (1), 1948: 62-64.

However, one group, the Sawfishes (Pristoidea), are shark-like in general appearance, though they are grouped among the batoids because of the relationship of the pectorals to the gills and because of the absence of upper eyelids, as well as on skeletal grounds. And most of the Guitarfishes (families Rhynchobatidae and Rhinobatidae) are intermediate in form, between shark-like and batoid-like.

Some batoids have no dorsal fin, whereas others have one or two, in which case the first dorsal (when there are two) varies in position from over the pelvics to far back on the tail. Some have a distinct caudal fin, which others lack. In all fins of some species the radial cartilages are supplemented distally (as in Sharks) by much more numerous fine horny rays (ceratotrichia) in double series, their inner ends embracing the outer ends of the cartilaginous radials; in others the unpaired fins have these horny rays whereas the pectoral and pelvic fins, in which the cartilaginous radials run out nearly or quite to the margin, do not; in still others neither the unpaired nor paired fins have horny rays. The spiracles are larger than those of most Sharks and are situated on top of the head in all cases; the rudimentary spiracular gill filaments are better developed than in Sharks, as is also the so-called spiracular valve, a stiff concentric fold of connective tissue on the anterior margin of the spiracle which is supported by a strong cartilage fixed at each end. The eyes are well developed in most, though degenerate in a few. All have five pairs of gill openings.

The skins of some are naked while those of others are variously armed with thorns, tubercles or prickles; the tails of some bear large saw-edged spines. The teeth vary from thorn-like to rounded or platelike (none have the blade-like dentition so characteristic of many Sharks), placed either in bands, in transverse rows, or in pavement or mosaic arrangement. The nostrils are connected with the mouth in some cases but are entirely separate from it in others. In one family, the Sawfishes, the snout is produced as a long flat blade supported by the rostral cartilages in the form of five or more calcified tubes (described on p. 16) and is armed along either edge with a single series of strong tooth-like structures, much as in the Saw Sharks (Pristiophoroidea). The heart valves are in two to seven rows.⁵

Some members of the order have electric organs more or less well developed, but none have luminescent organs so far as is known.

The vertebral column is completely segmented throughout its length in all species, with the centra fully differentiated and the axial canal so greatly constricted in its passage through them that the notochord is wholly or almost wholly obliterated there. Secondary calcifications of the vertebral centra in the form of radiating lamellae are described as growing inward toward the primary calcified double cone.

The Batoidei in which the anatomy has been studied, including the Sawfishes, differ from all modern Sharks in the attachment of the pectorals to the sides of the head, in the lack of a free upper eyelid, in the better developed spiracles, in the ventral

5. See Garman (Mem. Harv. Mus. comp. Zool., 36, 1913: pl. 56, figs. 7-10, pl. 57, figs. 1-6) for illustrations from original dissections of the heart valves of various batoids; see White (Bull. Amer. Mus. nat. Hist., 74, 1937: 87, 91) for a general discussion of their significance in classification and for tabulations of their numbers in various Sharks and batoids.

positions of the gill openings, and in a number of skeletal characters, of which the following may be selected as the most obvious:

The upper jaw cartilage is attached only loosely to the cranium, at most, by a ligament of considerable length.

The cranium is firmly connected with the vertebral column by a definite articulation between its posterior face and the anterior vertebra by means of two condyles which are lacking in Sharks.

The first few vertebrae, differing in number in different families, are united together as a continuous rigid tube.⁶

The ceratohyal cartilage is attached only to the lower end of the hyomandibular and thus plays no direct part in the support of the lower jaw, which is suspended from the hyomandibular alone.

The shoulder girdle is directly and firmly attached to the vertebral column, either above the latter by a special scapular element (or elements) or to its sides.

The propterygial cartilage of the pectoral bears at least as many radials as the metapterygial cartilage and many more than the mesopterygial, which is much smaller than either the propterygial or the metapterygial.

The union of the two halves of the upper jaw at the symphysis is much more intimate in many batoids than in Sharks, but not in all.⁷ On the other hand, the connections between the anterior parts of the upper jaw cartilages and the cranium, being by ligament only, are less intimate among the batoids than they are in many Sharks, though the two groups intergrade in this respect.⁸

It has long been known that the attachment of the pectorals to the sides of the head in batoids is a secondary development, for the early embryos of even the most highly specialized of them are slender-bodied like those of Sharks, with the rudiments of the pectoral fins at first wholly posterior to the gill openings. As development proceeds, the pectorals expand rearward as well as forward past the gill openings in a form that has been variously described as blade-like or horn-like. The anterior horns of the pectorals then fuse with the sides of the head above the five posterior gill openings that are destined to persist as such but below the persistent portion of the first embryonic gill openings that are destined to form the spiracle of the adult. The sequence of events of this transformation of the pectorals has been observed among Skates (Rajidae), among Torpedoes (Torpedinidae),⁹ and among Sting Rays.

6. For excellent illustrations of the anterior part of the vertebral column showing this fusion, see Garman (Mem. Harv. Mus. comp. Zool., 36, 1913: pl. 55, figs. 3-10).

7. This is true of the Rajidae but not of the genus *Gymnura* (Dasyatidae), in which the two halves of each jaw cartilage are clearly separated.

8. For further information on this point, see Bigelow and Schroeder (Mem. Sears Found. Mar. Res., I (1), 1948: 65).

9. The sequence of stages leading to the fusion of the anterior parts of the pectorals with the sides of the head seems to have been observed first by Leuckart (Z. wiss. Zool., 2, 1850: 261, pl. 16, figs. 1, 2) in the Mediterranean *Torpedo marmorata* more than a century ago. For other illustrations of embryo torpedinids with the anterior parts of the pectorals still wholly or partially free, see de Sanctis (Atti Accad. Sci. fis. mat. Napoli, 5, 1873: pl. 1, fig. 9), Goodrich (in Lankester, Treat. Zool., 9, 1909: 754, fig. 117), Prashad (Rec. Indian Mus., 19, 1920: pl. 7, figs. 7, 8), and especially Waite (Rec. Canterbury [N. Z.] Mus., 1 [2], 1909: pl. 18, fig. 3); see also p. 101, Fig. 23. The process was described and pictured in some detail by Wyman (Mem. Amer. Acad. Arts Sci., [N. S.] 9, 1867: 35, 1 pl.) in his classic