MEMOIR
SEARS FOUNDATION FOR MARINE RESEARCH
Number I

Fishes of the Western North Atlantic

PART FIVE

Order Iniomi

AULOPIDAE, SYNODONTIDAE, BATHYSAURIDAE
BATHYPTEROIDAE, IPNOPIDAE, CHLOROPHTHALMIDAE
MYCTOPHIDAE AND NEOSCOPELIDAE (INTERIM ACCOUNTS)
SCOPELOSAURIDAE, PARALEPIDIDAE
OMOSUDIDAE, ALEPISAURIDAE
ANOTOPTERIDAE, EVERMANNELLIDAE, SCOPELARCHIDAE

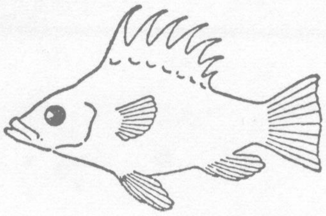
Order Lyomeri

EURYPHARYNGIDAE, SACCOPHARYNGIDAE

NEW HAVEN, 1966

SEARS FOUNDATION FOR MARINE RESEARCH, YALE UNIVERSITY

Fishes of the Western North Atlantic



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Introduction

THIS fifth part of FISHES OF THE WESTERN NORTH ATLANTIC includes accounts of two major groups of soft-rayed fishes of the area that extends from Hudson Bay to the Amazon, from the mid-Atlantic east of Bermuda to the estuaries of the coastal plain, and from the surface of the ocean to its bottom.

Most of the volume is devoted to the Order Iniomi (or Myctophiformes), a group well represented in the offshore waters of the world but little known to the nonspecialist, save for the lizardfishes and their allies which are common along tropical and temperate coasts. While the species included are largely those of the western North Atlantic, the accounts of the genera and families are world-wide in scope—a breadth of treatment appropriate for groups of oceanic animals with broad, if not cosmopolitan, marine distributions. Unfortunately, two families, one of immense importance in the economy of the high seas, are represented by interim accounts only. These two, the Neoscopelidae and Myctophidae, contain many poorly known forms. Revisionary work is in progress, but it was thought inadvisable to permit a further delay in publication of the completed sections. Full accounts of the myctophid fishes will appear in a later volume.

The second group considered in this volume is the Order Lyomeri (Saccopharyngiformes), a small group of deep-sea inhabitants so bizarre in form that they bear little resemblance to any other living creature—a tribute to nature's ingenuity in the deep-sea environment.

In order to reduce the repetition of the names of museums containing the specimens on which these studies were based while retaining the museum catalog numbers (the only connection between works such as these and the actual specimens studied), the editors have used throughout this volume the abbreviations that follow:

AM	—	Amsterdam Museum, Holland
AMNH	—	American Museum of Natural History
ANSP	—	Academy of Natural Sciences of Philadelphia
BLBG	—	Biological Laboratory, U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Brunswick, Georgia
BMNH	—	British Museum (Natural History), London
BNM	—	Bergens Museum, Norway

BOC	—	Bingham Oceanographic Collection, Yale University
BU	—	Boston University
CAS	—	California Academy of Sciences
CF	—	Carlsberg Foundation, Copenhagen
CFG	—	California Division of Fish and Game
CM	—	Carnegie Museum
CNHM	—	Chicago Natural History Museum
CU	—	Cornell University
FSM	—	Florida State Museum
IJ	—	Institute of Jamaica, B.W.I.
IRSNB	—	Institut Royal des Sciences Naturelles de Belgique, Belgium
LMNH	—	Leiden Museum of Natural History, Holland
MCZ	—	Museum of Comparative Zoology, Harvard University
MMF	—	Museu Municipal do Funchal, Madeira Islands
MHNBA	—	Museo de Historia Natural de Buenos Aires, Argentina
MNHN	—	Muséum National d'Histoire Naturelle, Paris
MOM	—	Musée Océanographique, Monaco
MRAC	—	Musée Royal d'Afrique Central, Tervuren
MRCB	—	Musée Royal du Congo Belge
MSNF	—	Museo di Storia Naturale, Firenze
NHR	—	Naturhistoriska Riksmuseum, Stockholm
NYZS	—	New York Zoological Society
POFI	—	Pacific Oceanic Fishery Investigation, U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Honolulu, Hawaii
ROMZ	—	Royal Ontario Museum of Zoology, Canada
SIO	—	Scripps Institution of Oceanography
SU	—	Natural History Museum, Stanford University
TU	—	Tulane University
UCLA	—	University of California at Los Angeles
UF	—	University of Florida
UI	—	University of Indiana
UL	—	University of Louisville
UMIM	—	University of Miami Ichthyological Museum
UMML	—	University of Miami Marine Laboratory
UMMZ	—	University of Michigan Museum of Zoology
USNM	—	United States National Museum
UT	—	University of Texas
UW	—	University of Washington
VOM	—	Vanderbilt Oceanographic (Marine) Museum
WHOI	—	Woods Hole Oceanographic Institution
ZMA	—	Zoological Museum, Amsterdam
ZMC	—	Zoological Museum, Copenhagen.

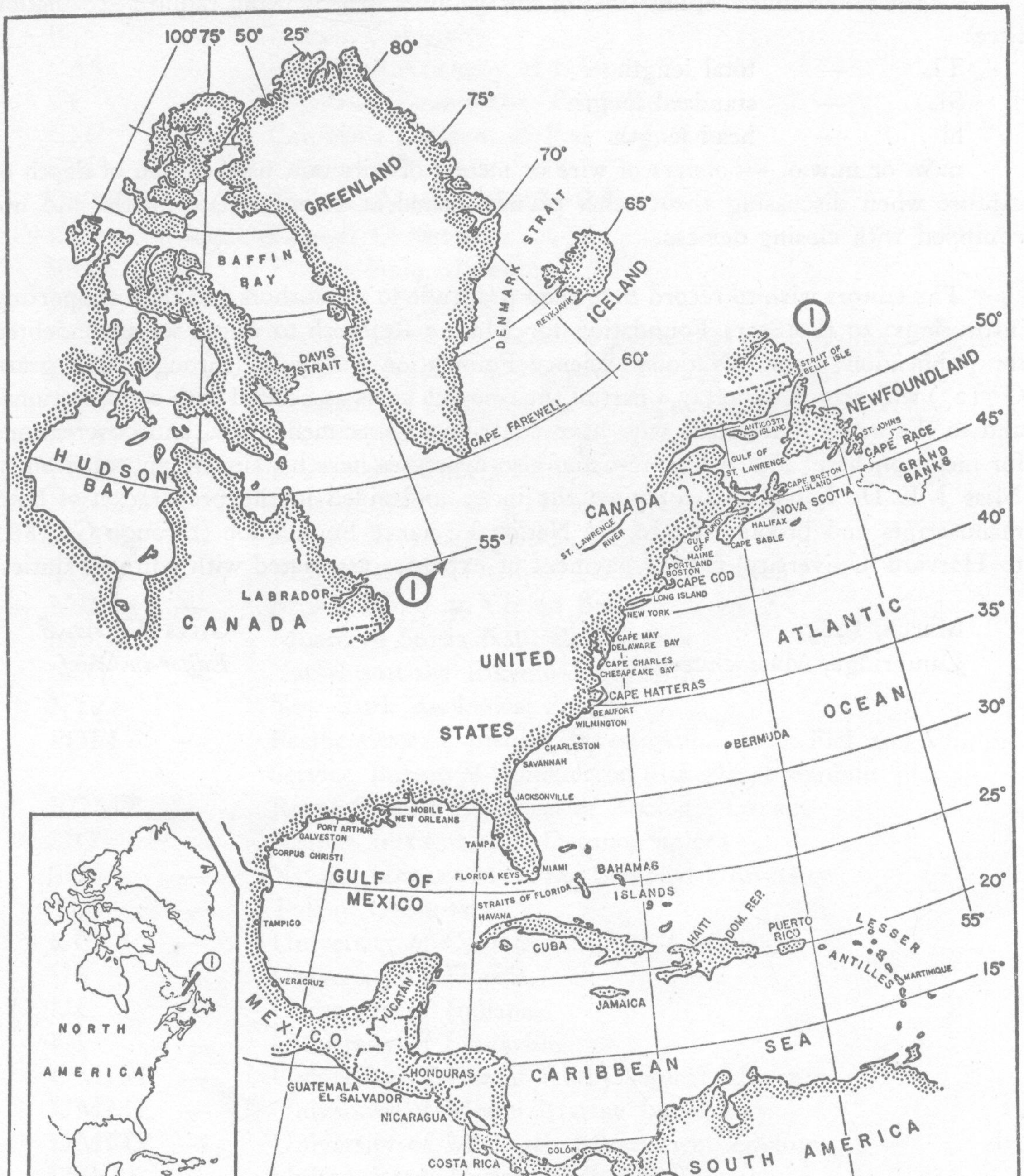
Of the other abbreviations used in this volume, the following require explanation here:

TL — total length
SL — standard length
hl — head length
m.w. or m.w.o. — meters of wire or meters of wire out, used in lieu of depth of capture when discussing the catches of nets fished at indeterminate depths and not equipped with closing devices.

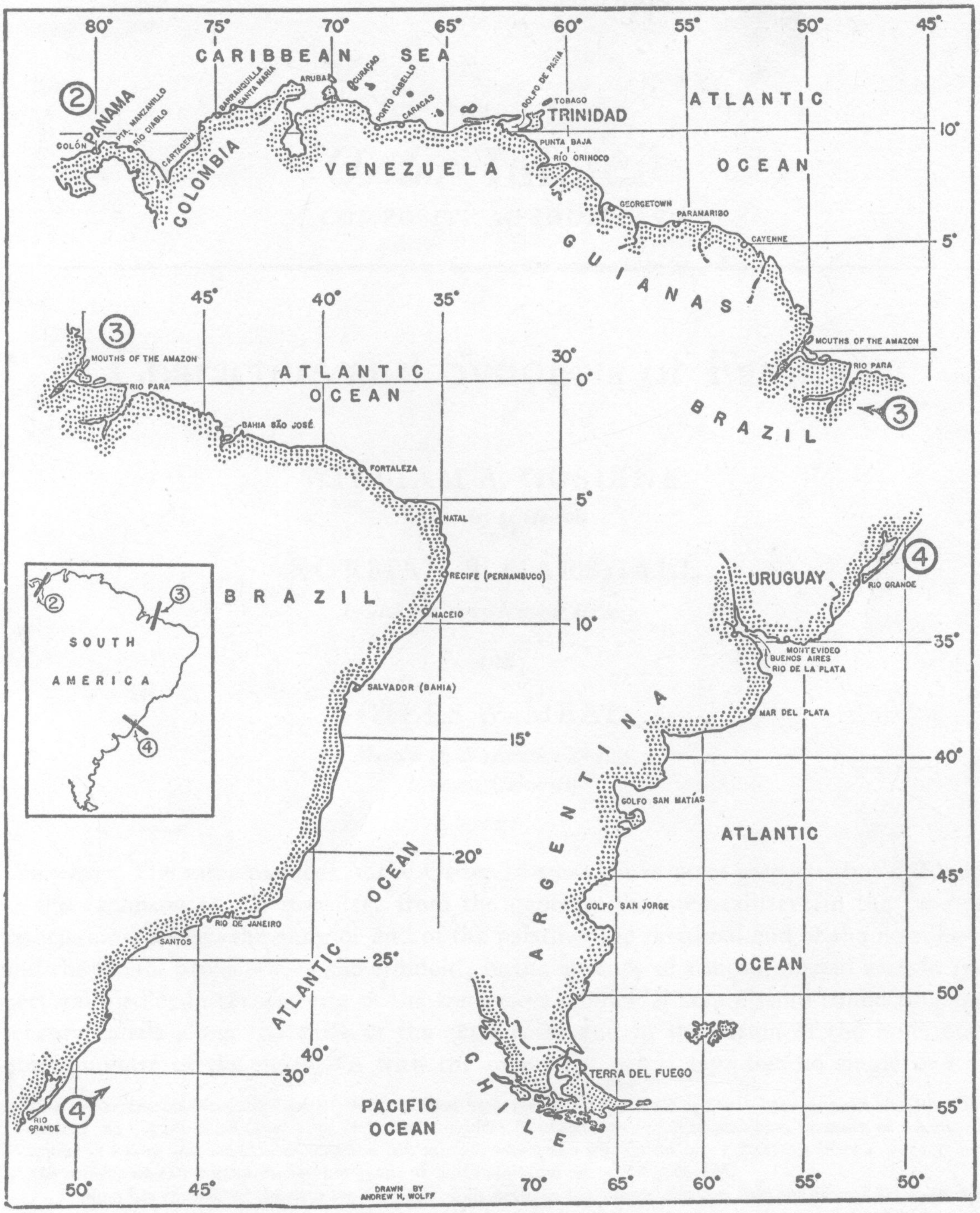
The editors wish to record here their gratitude to the authors and their supporting institutions; to the Sears Foundation for Marine Research to whom we are indebted for publication; to the National Science Foundation for funds (through NSF grant G 7123) with which to defray a part of the research costs associated with some sections; and to the many individuals who have contributed specimens, data, and observations for inclusion here. The Editor-in-Chief also expresses here his sincere appreciation to Miss J. E. De Falla, who compiled the index and aided in the preparation of both manuscripts and proofs; and to the National Science Foundation (through G 15887 to Harvard University) for the payment of expenses associated with editorial duties.

March, 1965
Cambridge, Massachusetts

Giles W. Mead
Editor-in-Chief



North America



South America

Table of Contents

Order Iniomi[1]

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Characters and Synopsis of Families

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Characters. The same as those in the Order Isospondyli in most respects, but differing in the exclusion of the maxillary from the gape by the premaxillary; in the type of association between the anterior end of the palatine, the proximal end of the maxillary, and the lateral projection of the ethmoid; in the absence of a mesocoracoid arch in the pectoral girdle; in the absence of the transverse ethmoidal commissure connecting the sensory canals along the sides of the skull roof; and in the fusion of the innermost pterygiophore of the pelvic fin with the innermost pelvic ray; but no single one of

1. The Order Iniomi (Scopeliformes of Berg) as used here excludes several groups that have occasionally been included: the Giganturidae (Part 4, p. 570); Cetomimidae; Rondeletiidae and Barbourisiidae, accounts of which will appear in a later volume; Ateleopidae and Miripinnati, which also will appear later; *Bathylaco* (Part 4, p. 562); and *Macristium*, an extralimital monotypic genus of uncertain affinities (see Regan, *22*).

Gosline has considered the osteological distinctions between the Iniomi and the Isospondyli and has suggested the myctophoid groups. His work was made possible by a Guggenheim Fellowship and was accomplished in the United States National Museum. He is indebted to Leonard P. Schultz and the staff of the Division of Fishes for space and equipment in that institution, to Giles W. Mead and Daniel M. Cohen of the U. S. Fish and Wildlife Service for background information, specimens, and literature, and to N. B. Marshall for his many valuable comments and suggestions. Marshall has written the alepisaurid introduction. Mead has provided the portions regarding the Iniomi as a whole.

these features is diagnostic; each is subject to qualification.[2] Under these circumstances, it seems advisable to include here a discussion of these characters and the relationships of the Iniomi.

Discussion.[3] To many ichthyologists, the fishes considered here as representatives of the Order Iniomi are sufficiently similar to those of the preceding Order, Isospondyli, to be included within that group.[4] Certainly many of the features characteristic of the isospondylous fishes (Part 3, pp. 89–106) are duplicated in iniomous species. Among these are the nature of the fins and fin rays, including the degree of branching, the lack of true spines, the frequent presence of an adipose fin, the high number of branched caudal rays (typically 17), and the frequent posterior (abdominal) position of the ventral (pelvic) fins. Similar, too, are the various patterns of scale coverings, the nature of the individual scales, and the development of photophores in certain groups of both Orders.

Other features are more nearly diagnostic for the iniomous fishes. Thus the invariable absence of a mesocoracoid arch in the pectoral girdle and the closed swim bladder (when present) are duplicated in only a few isospondylous forms.[5]

The ethmoid-palatine-maxillary series of articulations also belong in the same category. In most iniomous fishes, as Regan noted (*23*), the anterior end of the palatine (Fig. 1) forms "a process directed upwards and outwards which overlaps the proximal end of the maxillary and is supported by a lateral projection of the ethmoid." The portion of the maxillary over which this palatine process projects is not only far forward but consists of a flat area or depression, with at most a very slightly raised articular socket, on the upper maxillary surface. In the isospondylous fishes there is considerable variation in the nature of the palatine-maxillary articulation (*cf.* Fig. 1 A, B). Most frequently, perhaps, the palatine has a sort of elbow that overlaps a nodule on the dorsomedial surface of the maxillary, as in Fig. 1 B; this nodule is lateral to, and well separated from, the anterior maxillary head.

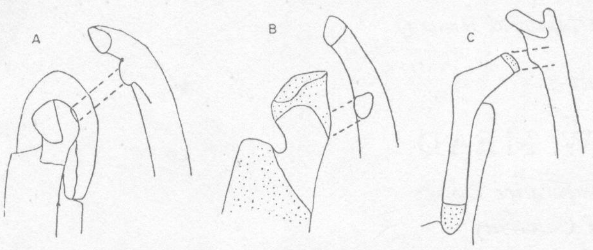

FIGURE 1. Right palatine-maxillary articulation in A, *Tarpon*, B, *Yarrella*, and C, *Chlorophthalmus*, from above. The maxillary has been pulled away from the palatines, the pair of dashed lines indicating the articulating areas of the two bones concerned. Stippling indicates cartilage.

Unfortunately, this differentiation does not always hold for all the members of either the Iniomi or the Isospondyli. Among the latter, some of the southern hemisphere representatives, *e.g. Galaxias* and *Aplochiton*, have a palatine-maxillary articu-

2. Bigelow (Part 3, p. 92) has noted the withdrawal of the maxillary bone from the border of the gape in several typical clupeoid and elopoid isospondyls: *Chaetoessus*, *Albula*, and *Pterothrissus*.
3. For further information on the anatomy and major classification of the iniomous fishes, the reader is referred to Regan (*23*), Parr (*19*; *20*), and Marshall (*14*).
4. For example, Schultz and Stern (*24*) and Bertin and Arambourg (*2*).
5. Among isospondylous fishes the mesocoracoid arch is lacking only in the haplomous fishes and certain salmonoid and stomiatoid forms; the swim bladder is closed only in the stomiatoids and certain deep-sea salmonoids (*11*).

lation much like that just described for the Iniomi. There are also iniomous fishes without such a palatine structure. Thus, among the alepisauroid anioms, *Evermannella* has the palatine-maxillary articulation typical for the Order; *Alepisaurus*, *Omosudis*, and *Sudis* have it in modified form; but *Lestidium* appears to have no articulation whatever between the anterolateral palatine projection and the maxillary. Also, among certain myctophoid inioms, such as *Harpadon* and *Bathysaurus*, the maxillary has either dropped out or has become fused to the premaxillary so that the palatine head appears to articulate directly with the premaxillary.

The chief character usually used to separate the Iniomi from the Isospondyli is the difference in premaxillary construction. Chapman (*4*) has summarized the problems involved in this mode of separation as follows:

> . . . the Isospondyli and Iniomi as recognized by Regan and Jordan (and generally by present day ichthyologists) have only one distinguishing characteristic which all members of each order share, and that is that in the Iniomi all members have the maxillary excluded from the gape by the premaxillary, and all isospondylous fishes have the maxillary participating in the gape. The fact that the Aplochitonidae (an isospondylous family) have the maxillary excluded from the gape, for all practical purposes, by the premaxillary does not necessarily mean close relationship with the Iniomid fishes, but it does indicate that the separation of the two orders on the basis of this single character presents difficulties.

As the general similarity between the myctophid-like inioms and the gonostomatid isospondyls (Suborder Stomiatoidea) has led many to regard the two groups as more closely related than ordinal separation would indicate, Marshall's (*15*: *54*) recent comparison of the swim bladders of the two groups is instructive (Table I).

Table I. Stomiatid and Myctophid Swim Bladders

	Myctophidae	Stomiatidae
Swimbladder type	Euphysoclist (with oval)	Paraphysoclist
Number of retia	Three	One
Type of rete	Unipolar	Bipolar
Position of rete	Anterior	Posterior

In view of the generally unsatisfactory nature of the iniomous-isospondylous separation discussed in the previous paragraphs, two hitherto unused means of distinguishing many of the Iniomi from the Isospondyli seem worth some mention here.

Among pre-isospondyls (holosteans) and the most primitive teleosts (*e.g. Elops*) there are two cross-commissures connecting the sensory canals running along the sides of the skull roof. One of these, the ethmoidal commissure (Nybelin, *18*), extends across the snout; the other, the supratemporal commissure, traverses the back of the skull roof. In modern iniomous fishes there is no ethmoidal commissure, but instead there is often a cross-connection between the supraorbital canals just behind the orbits. No evidence of such a cross-connection has been found in isospondylous fishes (*25*). In *Aulopus* this transverse canal is enclosed in the frontals for all but the median third of its length (Fig. 2 A). The amount of bone coverage in this genus seems to be independent of size, judging from an examination of specimens 3 to 15 inches long. In a

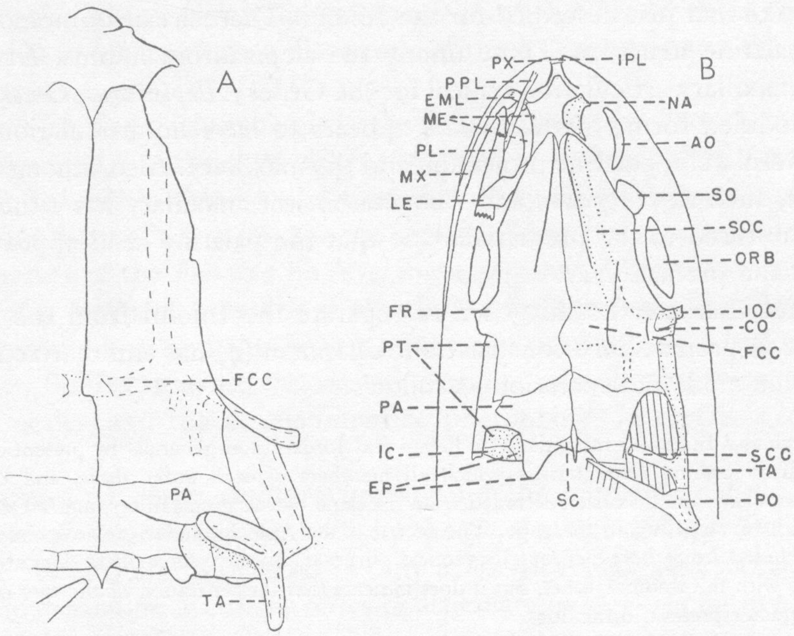

FIGURE 2. Top of skull of A, *Aulopus* and B, *Solivomer*. In B the sensory canals and certain superficial bones and muscles are shown on the right, the deeper bones and certain ligaments on the left. Sensory canals outlined with dashes have a bony roof; those outlined with dots lack a bony roof. Hatching represents musculature; stippled area, the floor of the post-temporal fossa. AO, antorbital; CO, posteriormost circumorbital; EML, ethmoid-maxillary ligament; EP, epiotic; FCC, frontal sensory canal commissure; FR, frontal; IC, intercalar; IOC, infraorbital sensory canal; IPL, interpremaxillary ligament; LE, lateral ethmoid; ME, mesethmoid; MX, maxillary; NA, nasal; ORB, orbit; PA, parietal; PL, palatine; PO, post-temporal; PPL, palatine-premaxillary ligament; PT, pterotic; PX, premaxillary; SC, supraoccipital; SCC, supratemporal sensory canal; SO, supra-orbital; SOC, supraorbital sensory canal; and TA, tabular.

skull of *Synodus* this commissure is completely embedded in, and enclosed by, the frontals; in *Saurida* it is covered to about the same extent as in *Aulopus*; but in *Harpadon* it seems to be represented by a large, flesh-covered median depression. In *Parasudis* and *Bathysauropsis* only about a fifth of this cross-channel is covered by bone, and in *Chlorophthalmus* even less. In *Neoscopelus* and *Solivomer* (Fig. 2 B) only the lateral portions of this commissure have a bony roof, and in *Lampanyctus* there is merely a narrow, arched bony bridge over the point of exit of this commissure from the supraorbital canal on each side. In *Sudis* there is the same sort of opening from the inside of each supra-orbital canal as in *Lampanyctus*, but it is obvious that the cross-commissure is incomplete because the skull between these two openings is tightly covered by a thin skin.

The final difference lies in the pelvic osteology. Under the base of the several innermost rays in most of the isospondylous fishes examined, there is a bony or cartilaginous nodule (pterygiophore) with which these pelvic rays movably articulate (Fig. 3 A, B); in a few this nodule is lacking, and the unmodified rays seem to articulate directly with the pelvic girdle. By contrast, in the great majority of iniomous fishes examined (*Aulopus*, *Saurida*, *Chlorophthalmus*, *Solivomer*, *Lampanyctus*, and *Lestidium*), this pterygiophore has become fused with the base of the bottom half of the innermost pelvic