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A REVISION OF THE FISHES OF THE SUBFAMILY
ARGENTININAE

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A REVISION OF THE FISHES OF THE SUBFAMILY ARGENTININAE

DANIEL M. COHEN¹

SYNOPSIS: A systematic revision of the Argentininae divides the subfamily into two genera, *Argentina* with seven species and subspecies and *Glossanodon* with five species. Comments are given on habits and distribution, and brief discussions of the swimbladder and the spiral valve are included. The following new taxa are presented: *Prosoarchus*, new subgenus; *Glossanodon (Glossanodon) polli*, new species; *Glossanodon (Prosoarchus) pygmaeus*, new species; *Argentina elongata australiae*, new subspecies.

INTRODUCTION

The subfamily Argentininae as herein understood consists of argentinid fishes formerly referable to the genus *Argentina*. This subfamily is worldwide in distribution, and its members, as adults at least, are restricted to the edges and slopes of the continental shelf, in contradistinction to the other fishes of the suborder Argentinoidei which are bathypelagic. The Argentininae thus form a closely related group ecologically as well as morphologically.

This paper contains comments on various aspects of argentinoid morphology pertinent to the classification of the Argentininae, keys to the taxa, generic diagnoses, species descriptions, and synonymies, and the information available on the habits and distribution of the species included.

The following new taxa are proposed in this paper:

- Prosoarchus* — new subgenus
- Glossanodon (Prosoarchus) pygmaeus* — new species
- Glossanodon (Glossanodon) polli* — new species
- Argentina elongata australiae* — new subspecies.

Methods and Terminology

All counts and measurements were made on the left side of the specimen whenever possible. Measurements were taken with a pair of 140-millimeter needlepoint dividers, measured on a Keuffel and Esser 300-millimeter rule, and recorded to the nearest tenth of a millimeter.

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Measurements over 200 mm. on the larger specimens of *Argentina silus* were taken with a pair of sharp-pointed 600-mm. dividers, measured on a meter stick, and recorded to the nearest tenth of a millimeter. The latter measurements are probably not as accurate as the former. All calculations were made on a Monroe calculator. Unless otherwise noted the data for measurements are given as the arithmetic mean followed by the range in parentheses. The data from counts are given as the modal number followed by the range in parentheses.

In the measurements listed below the most anterior point is taken as the tip of the upper jaw. Standard length is measured to the crease at the hypural fan when the tail is bent. Preanal length is taken to a vertical through the anterior end of the anal fin base. Pre-ventral length is taken to a vertical through the anterior end of the ventral fin base. Predorsal length is taken to a vertical through the anterior tip of the dorsal fin base. Prepectoral length is taken to a vertical through the anterior end of the pectoral fin base. Head length is taken to a vertical through the posterior tip of the opercle. Maxillary length is taken to a vertical through the posterior tip of the maxillary. Snout is taken to a vertical through the anterior margin of the eye.

Eye is the horizontal diameter of the cornea (not to be confused with the orbital diameter; in *Argentina* and *Glossanodon* the anterior circumorbitals extend far forward, and the area between the anterior edge of the eye and the posterior edge of the circumorbitals is filled with the hyaline tissue of the adipose eyelid). Head depth is taken at the greatest depth of the head, immediately anterior to the nape. Depth of caudal peduncle is taken at the point of least depth. Depth at dorsal fin is taken at the anterior end of the dorsal fin base; when the dorsal fin base is slightly elevated above the dorsum, the measurement is taken anterior to the rise. Interorbital is the shortest distance across the top of the skull between the lateral edges of the bony orbit. Maxillary width is taken at the greatest width of the maxillary, close to the posterior end.

Vertebral counts do not include the urostyle. In dorsal and anal fin ray counts the double ray at the end of each fin (the last ray is closely appressed to its anterior neighbor) is counted as two. Other terms used are self-explanatory or defined when used.

The osteological terminology follows that of Chapman (1942).

The following abbreviations are used throughout the text in referring to fish collections:

- | | |
|-----|--|
| BM | Universitet I Bergen, Zoologisk Museum |
| CKM | Collection of Dr. Kiyomatsu Matsubara |

CNHM	Chicago Natural History Museum
DMW	Dominion Museum, Wellington, New Zealand
MCZ	Museum of Comparative Zoology, Harvard College
NFRS	Newfoundland Fisheries Research Station
RCB	Musée Royal du Congo Belge
ROMZ	Royal Ontario Museum of Zoology
SIO	Scripps Institution of Oceanography
SU	Natural History Museum, Stanford University
TU	University of Tokyo
UCLA	University of California at Los Angeles
UF	University of Florida Collections
UM	University of Miami
USNM	United States National Museum

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The following individuals were most generous in lending or in giving me specimens: Tokiharu Abe, Tokyo University; Giles W. Mead, Stewart Springer, and Robert Wilson of the U.S. Fish and Wildlife Service; Hans Brattstrom and Johan Willgohs of the Universitet I Bergen; John C. Briggs of the University of Florida; Carlos Bas and F. García del Cid of the University of Barcelona; Pierre Desbrosses of the Institut Scientifique et Technique des Pêches Maritimes in Paris; J. A. F. Garrick of Victoria University College, Wellington, New Zealand; Carl L. Hubbs and Boyd Walker of the University of California; Jozica Karlovac of the Institut za Oceanografiju u Splitu in Yugoslavia; Kiyomatsu Matsubara of Kyoto University; John Moreland of the Dominion Museum, New Zealand; Ian Munro and Dudley Kurth of C.S.I.R.O. Division of Fisheries, Australia; Max Poll of the Musée Royal du Congo Belge at Tervuren, Belgium; Alfredo Ramalho, Estação de Biologia Marítima, Lisbon; C. Richard Robins of the University of Miami; William C. Schroeder and (Mrs.) Myvanwy M. Dick of the Museum of Comparative Zoology at Harvard; W. B. Scott of the Royal Ontario Museum of Zoology; Leonard P. Schultz of the U.S. National Museum; H. J. Squires of the Fisheries Research Board of Canada; Å. Vedel Tåning of the Marinbiologisk Laboratorium in Denmark; Enrico Tortonese of the Genoa Museum; and Loren P. Woods and (Mrs.) Marion Grey of the Chicago Natural History Museum.

Each of the following has sent me unpublished information on fishes of this group: Elbert H. Ahlstrom of the U.S. Fish and Wildlife Service, Hans Tambs-Lyche of the Universitet I Bergen, Carl L. Hubbs, H. J. Squires, and Robert Wilson.

James Böhlke of the Academy of Natural Sciences of Philadelphia; Anne C. Cohen of Gainesville, Florida; Arni Fridriksson of the Conseil

International pour L'Exploration de la Mer; Lisa Lanz of Palo Alto, California; and Norman J. Wilimovsky of the U.S. Fish and Wildlife Service have helped in various ways. Warren Freihofer of Stanford University generously made some histological preparations. I am particularly indebted to George S. Myers and Margaret H. Storey of Stanford for their help during this study, most of which was carried on at Stanford.

Figures 3, 4, 5, and 9 were prepared by Margaret G. Bradbury. Figure 7 is reproduced through the courtesy of the Dominion Museum, Wellington, New Zealand.

THE SPIRAL VALVE PROBLEM

Kendall and Crawford (1922) and Chapman (1942) state that *Argentina sphyraena* and *A. silus* possess an apparently functional spiral valve. Chapman uses the presence of this structure as a character in defining the suborder Opisthoproctoidei (= Argentinoidae). I have investigated the so-called "spiral valve" in as many species as possible. The following description is based on specimens of *Argentina sphyraena*, of which I had abundant material for dissection. On other species I made briefer observations. As these showed considerable variation between species, the findings are included in the systematic section under the species descriptions.

For slightly less than half its length the intestine is a thin-walled, almost transparent tube. The inner wall is slightly elevated into a large number of zigzag fleshy ridges (the *zickzack Grundnetze* of Jacobshagen, 1937) giving the inner surface a labyrinthine appearance. These ridges are closer together and more abundant along the dorsal third of the gut and cause the wall to appear considerably thicker in this area.

A second area of the intestine, slightly shorter than the first, is characterized by the presence of rings of tissue (*Ringfalten*) which project out into the gut. The first four or five of these rings are truly spiral in nature, while the remainder are simple circles. The structures are easily visible through the walls of the empty gut. In no instance was the center of the gut observed to be occluded, so that although the inner surface of the gut is greatly increased, the distance that food must travel is not increased. It seems highly probable, however, that these rings of tissue hanging into the cavity of the gut slow the passage of the food considerably. A specimen from Portugal 165 mm. in standard length has 15 rings, the first five of which are each connected with the next by a septum running along the roof of the gut.

A similar connection is present between rings 10 and 11. The posterior ring is the most strongly developed. It blocks off a greater section of gut than do any of the more anterior ones. In pushing material along the gut with a probe to clear it, the absence of spiral motion is notable, as is the valvelike action of the posterior fold in slowing the passage of the gut contents. The rings are about 1.5 mm. apart, and the intervening areas are filled with the labyrinthine ridges mentioned above. In some instances the ridges run out onto the rings.

In smaller specimens the rings are considerably less developed, and the intestine is relatively longer compared to the body length than in larger fishes. For example, in a fish with standard length of 165 mm. the length of the intestine from the junction of the posterior-most pyloric caecum to the anus was 40 percent of the standard length; in a specimen 128 mm. in standard length the intestine was 47.5 percent of the standard length; in an example 115 mm. in standard length the intestine was 49.6 percent of the standard length. Although more data should be collected to test the hypothesis, it may well be that in *A. sphyraena* the increase in internal surface area in the intestine caused by strong development of *Ringfalten* is an adaptation to counter the relative decrease in linear dimension caused by allometric growth.

Posterior to the *Ringfalten* area and for a distance equal to less than half the length of the *Ringfalten* area, the intestine is thin-walled and transparent and carries a reduced number of labyrinthine ridges.

On the basis of histological investigations Jacobshagen interprets the *Ringfalten* as being homologous with the *Grundnetze*, and he distinguishes both structures from the *Spiralfalten* or true spiral valve, although he states that the *Ringfalten* can appear valvelike. The true spiral valve he restricts to the Chondrichthys, sturgeons, gars, and *Amia*, while he lists the *Ringfalten* as occurring in *Salmo*, *Coregonus*, *Thymallus*, *Clupea*, *Alosa* and perhaps others. *Chirocentrus*, which some ichthyologists have mentioned as possessing a spiral valve, differs in having its rings extend all the way to the anus; of the above genera it resembles *Coregonus* more than any others in having its rings in a spiral and very close together. Of the species in which I examined the gut (listed below), the rings of *A. sphyraena* are perhaps most similar to those of *Salmo gairdneri*, differing only in having a greater number of more strongly developed rings. I have found distinct *Ringfalten* in the intestines of the following species: *Salmo gairdneri* (143.5 mm. SL, SU 49265, San Mateo Co., California), *Thymallus arcticus signifer* (156 mm. SL, SU 48313, Lake Alexander Netting Station, Susitna Basin, Alaska), *Coregonus sardinella* (172 mm. SL, SU 49119, Barrow, Alaska) and *Chirocentrus dorab* (145.5 mm. SL, SU

30689, Singapore). The *Ringfalten* of *Coregonus* are very similar to those of *Coregonus maraena* as figured by Jacobshagen (1937, fig. 528), and the *Ringfalten* of *Chirocentrus* are identical with the figure of *C. dorab* given by Goodrich (1909, fig. 77). I have examined the following species of osmerid fishes and found the *Ringfalten* to be either lacking or barely discernable: *Spirinchus starksi* (118.5 mm. SL, fish market, Monterey, California) and *Mallotus villosus* (132.5 mm. SL, Barrow, Alaska).

If Jacobshagen's ideas are correct (and I might add that I consider certain aspects of his theories open to question) there is an unfortunate confusion in terminology. As noted above, he has restricted the use of the *Spiralfalten* to the structure present in Chondrichthys and certain archaic fishes. Yet several of the isospondylous fishes, which according to Jacobshagen's interpretation have only *Ringfalten*, have the *Ringen* partially, as in *Argentina sphyraena*, or wholly, as in *Chirocentrus dorab*, formed in a spiral. This has given rise to the term "vestigial spiral valve" in the British and American ichthyological literature. This term implies homologies with the *Spiralfalten* and should be used with great caution. A further complication is the situation which Kendall and Crawford (1922) report in *Argentina silus* in which a functional "spiral valve," presumably derived from the *Ringfalten* has developed, but which I have been unable to verify. (See section on *A. silus*.)

Further consideration of this problem is beyond the scope of the present work. The reader is referred to the works of Jacobshagen (1937) for additional references and a summary of his theories on the homologies of the intestinal structures. It seems safe to conclude that the presence of a "spiral valve" cannot be used in defining the subfamily Argentininae nor indeed any other argentinoid group.

THE SWIMBLADDER

The Argentininae differ from other Isospondyli except the Stomiatoidei (Jones and Marshall, 1953) in possessing a swimbladder that lacks a connection with the gut. These fishes agree, however, with the Salmonidae and Cyprinidae (Jones and Marshall, 1953) and *Spirinchus starksi*, an osmerid, in lacking a *rete*. I have made observations on as many species as possible and find general agreement among the species of *Argentina* and *Glossanodon*, although specimens of *Glossanodon* I dissected were usually in such a poor state of internal preservation that it was difficult to make out many details. The following

description is based on specimens of *A. sphyraena*. Variations are noted in the systematic section under each species.

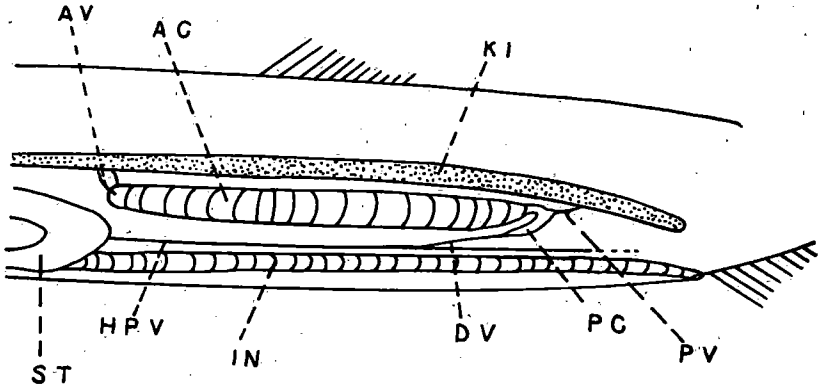


Figure 1.—Diagram of left side of body cavity of *Argentina sphyraena*. Mesenteries and peritoneal membranes are not shown. AC, anterior chamber of swimbladder; AV, anterior vein from swimbladder to kidney; DV, vein draining distal end of swimbladder; HPV, hepatic portal vein; IN, intestine; KI, kidney; PC, posterior chamber of swimbladder; PV, posterior vein from swimbladder to kidney; ST, stomach.

The swimbladder (see fig. 1) is a two-chambered structure lying dorsal to and separate from the gut cavity. The anterior chamber is an elongate, fusiform structure with its bluntly rounded anterior end situated above the posterior end of the stomach and its posterior end at about the level of a vertical from the posterior tip of the ventral fins. The thick-walled outer layer of the anterior chamber is heavily impregnated with a brilliant silvery pigment which has drawn comment from ichthyologists since the days of Willughby. The internal layer is a thin-walled, transparent membrane lying closely appressed to the inner walls of the outer layer.

The posterior chamber, which has heretofore gone unnoticed in this genus, is a small, thin-walled diverticulum which lacks silvery pigment. It originates at the posterior end of the anterior chamber and extends posteriorly for a distance equal to about one-fifteenth the length of the anterior chamber. At this point the posterior chamber curves sharply downwards and then runs anteriorly for at least twice the distance of its own posterior extension, from the anterior chamber. The forward extension becomes much smaller at its distal end and finally terminates as a narrow blind sac.

The wall of the distal end of the bladder (see fig. 2) continues anteriorly carrying a vein which drains the distal end of the posterior

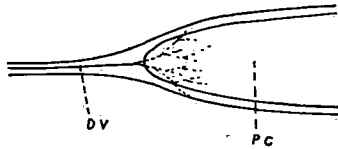


Figure 2.—Diagram of distal end of posterior chamber of swimbladder of *Argentina silus* showing the origin of the vein that drains this area.

chamber. Slightly distal to its origin the vein descends through the peritoneum and runs forward in the dorsal mesenteries parallel to the hepatic vein before joining that vein. A second vein runs from the most posterior part of the posterior chamber and, as far as I have been able to discern, enters the renal portal system. In five *A. sphyraena* I dissected, the vein entered the left kidney, while in one specimen it entered the right kidney. At the anterior end of the anterior chamber a pair of veins run from the sides of the bladder to the kidneys. Lack of material properly preserved for investigating the soft anatomy prevented reliable observations on the arterial supply to the swimbladder; however, many blood vessels, usually invested with considerable amounts of fat, course over the surface of the swimbladder and send branches into the interior.

An observation of some interest is that the striking silvery pigment which colors the swimbladder of *Argentina sphyraena*, *A. silus*, and *A. striata* is absent from the swimbladders of the other species of the genus. Furthermore, I have not found it in any of the species of *Glossanodon* whose swimbladders I was able to examine. As far as I have been able to discern, the reason for the lack of pigment in some species is not due to age, size, or time of year when the specimens were caught, or to the method of preservation. I have examined specimens of *Argentina elongata australiae* that are a bright silver along the sides of the body and the head, areas which would be leached out at once by a preservative, while the swimbladder had only a faint iridescent sheen over its surface and no thick deposition of pigment at all. Neither does the character seem to be geographical, for specimens of *Argentina sphyraena* from the Adriatic were found to be brightly pigmented with silver, while the swimbladder of an Adriatic specimen of *Glossanodon leioglossus* lacked silvery pigment entirely. The above reasons lead me to assume this character is genetically controlled, and I have used it taxonomically, although always in company with other characters.

SUBFAMILY ARGENTININAE GILL

Argentininae Gill, 1863 : 14 (in part). 1893b : 131 (name only).
 Argentinidae Gill, 1893a : 112 (in part). Goode and Bean, 1895 : 51. Regan,
 1913 : 289 (in part). Jordan, 1923 : 125. Berg, 1940 : 428. Chapman,
 1942 : 116.

Type genus *Argentina* Linnaeus, 1758.

These are argentinid fishes that may be distinguished from other fishes in the Argentinidae chiefly in having supratemporals lateral to and in contact with the parietals and fused to the pterotics, in having a mesocoracoid, and in having the pectorals inserted on the ventrolateral contours of the body.

The fishes of this subfamily vary in body shape from almost subcylindrical to rather strongly laterally compressed. Many of the species, perhaps all, have the body molded by the scales into an elongate, angular box. A cross-section shows a polygon of from 6 to 10 sides, depending on what part of the body the section was taken through and perhaps which species as well. From its greatest width immediately behind the head, the body tapers to the caudal fin.

The eyes are nontubular; adipose eyelids are present. The eyes are on the sides of the head, which slope inward ventrally and thereby afford the fish a ventral as well as a lateral field of vision.

The lachrymal is not in contact with the eye, but is set forward a distance approximately equal to the width of the pupil. The space between the anterior edge of the eye and the posterior edge of the lachrymal is occupied by hyaline tissue which projects posteriorly as the adipose eyelid.

A crescent of white tissue of unknown function lies above the dorsal or posterodorsal segment of the iris. Some workers feel that this structure may be luminescent. I have examined the tissue under ultraviolet radiation with negative results.

The palatines, head of vomer, ceratobranchials of 5th gill arch and suprabranchials of 4th gill arch all bear teeth. Lingual and dentary teeth may be present or absent.

The snout is longer than half the diameter of the eye. The nares are placed at the level of the upper third of the eye and are usually slightly closer to the eye than to the snout. A small flap is present on the posterior nostril.

The branchiostegals are 4 to 6, and the gill membranes are separate. The ventral arm of the preopercle and the interopercle extend forward to the level of the anterior edge of the eye.

The lateral line originates slightly below the dorsal angle of the opercle and runs straight back to the base of the caudal fin.

The scales are large; one taken from between the lateral line and the ventral fin origin is larger than the pupil of the eye. A scalesheath covers the proximal portion of the folded ventral fins. The dorsal fin origin is closer to the ventral fin origin than to the pectoral fin origin. The distance from the origin of the ventrals to the origin of the anal

is equal to or greater than the distance from the origin of the ventrals to the origin of the pectorals. A dorsal adipose fin occurs over the anal fin base.

In many of the species the larvae and postlarvae have a row of dark, transverse bands on the sides. In subadults and in adults of some species these are reduced to dusky blotches along the dorsal half of the body, while in adults of other species the bands are entirely absent. Adults and adolescents have a broad silvery stripe along the side and a considerable amount of silvery pigmentation on the opercles and other parts of the head. Ontogenetic changes in color pattern may perhaps be correlated with changes in habitat for, so far as known, the young are pelagic while adults live close to the bottom, generally on the continental shelf or slopes.

Distribution is worldwide along the margins of continents, though no species have been recorded as yet from the west coasts of South America, from the southern coasts of Asia, or from Antarctica.

Records of seven fossil species referred to *Argentina* appear in the literature, all described from otoliths. Sites at which fossils have been discovered are the lower Tertiary of southern England (Frost, 1933), early Tertiary of southern Rumania, middle Oligocene of Germany, Miocene of Czechoslovakia, Miocene of Austria and Pliocene of Italy (Weiler, 1950). Although the general shape of the otoliths suggests that *Argentina*-like fishes were present at the times and places mentioned above, considerable care should be exercised in differentiating species and genera of this group on the basis of otoliths alone. In examining series of otoliths from *Argentina sphyraena* I noted variations of a magnitude equal to some of those used in describing fossil species as new.

Glossanodon may be an older group than *Argentina*, as the former has a more complex maxillary and premaxillary and the general tendency in the argentinoids is towards a reduction of these elements. Furthermore, *Glossanodon* has evolved to the point where two distinct subgeneric types are recognizable, while the species of *Argentina* have not diverged subgenerically. In conflict with the primacy of *Glossanodon* is the fact that *Argentina* has reached the west coast of North America and the coasts of Australia and New Zealand, both areas from whence *Glossanodon* is unrecorded.

Key to the Genera of Argentininae.

- 1a. Vomerine and palatine teeth in a continuous band of closely spaced, posteriorly directed teeth; vomerine teeth located less than

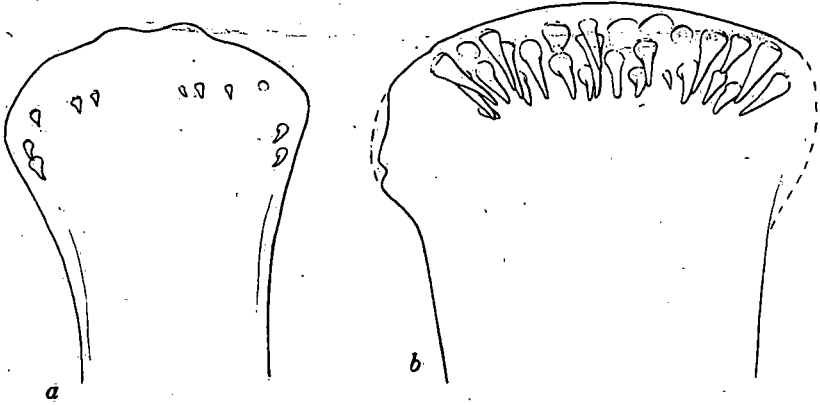


Figure 3.—(a) Head of vomer dissected from *Glossanodon semifasciatus*. (b) Head of vomer dissected from *Argentina elongata elongata*.

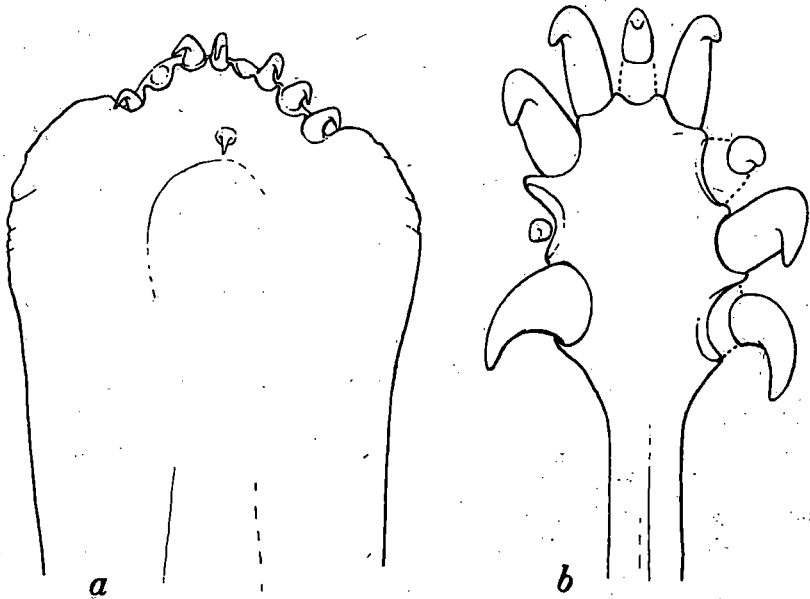


Figure 4.—(a) Tongue dissected from *Glossanodon semifasciatus*. (b) Tongue dissected from *Argentina sphyraena*.

the length of a tooth behind the anterior edge of the head of the vomer; tongue teeth located on the front and lateral edges of the tongue; medial ends of the maxillaries separated by at least one-half the width of the broad, underlying mesethmoid (figs. 3b, 4b, 5b) *Argentina* p. 104

- lb. Vomerine and palatine teeth not in continuous band of closely spaced, posteriorly directed teeth; vomerine teeth located three to eight tooth-lengths behind the anterior edge of the head of the vomer; tongue teeth when present located at the front of the tongue, not along the lateral edges; medial ends of the maxillaries touching in the midline or separated by less than one-fourth the width of the narrow, underlying mesethmoid (figs. 3a, 4a, 5a) *Glossanodon* p. 143

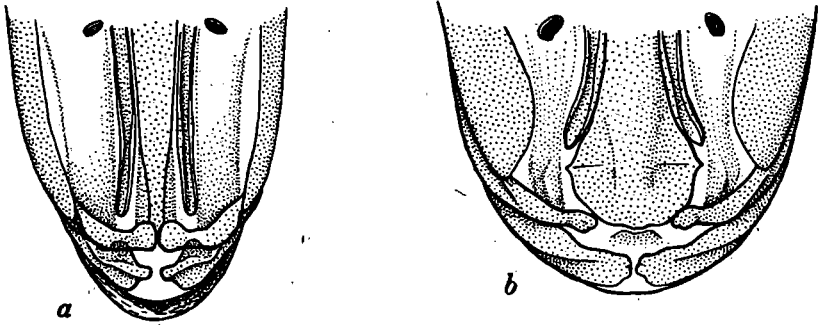


Figure 5.—(a) Dorsal view of alizarin preparation of snout of *Glossanodon semifasciatus*. (b) Dorsal view of alizarin preparation of snout of *Argentina striata*.

GENUS ARGENTINA LINNAEUS

Argentina Linnaeus, 1758 : 315 (type species *Argentina sphyraena* Linnaeus, 1758, by monotypy).

Silus Reinhardt, 1833 : 11 (type species *Salmo silus* Ascanius, 1775, by absolute tautonymy).

Goniosoma Costa, 1844, in Costa 1836-44 (type species *Argentina sphyraena* Linnaeus, 1758, by monotypy).

Acantholepis Krøyer, 1846 : 97 in Krøyer, 1846-49 (type species *Salmo silus* Ascanius, 1775, by monotypy).

DIAGNOSIS.—Argentinine fishes that have their maxillaries separated medially by a distance at least one half the width of the broad, underlying mesethmoid. The premaxillary is simple and does not articulate with the medial portion of each maxillary, which is not enlarged. Distal to its median end, each maxillary sends down a single prong (not

shown in figure) which articulates with the posterior face of each premaxillary. The premaxillaries do not send up prongs to articulate with the maxillaries.

The palatine and vomerine dentition is in the form of a rather regular, continuous arch of small, closely spaced, posteriorly directed teeth. The palatine and vomerine teeth are difficult to distinguish separately without dissection of a cleared and stained specimen. The vomerine teeth are located less than the length of a tooth behind the head of the vomer. The tongue teeth lie along the lateral edges of the bone as well as at the anterior margin.

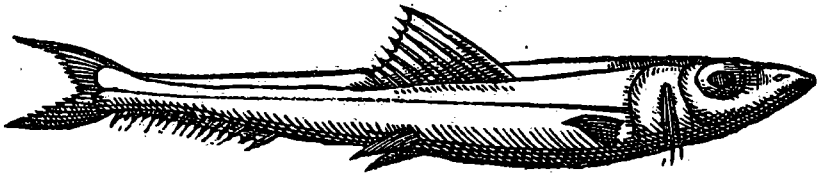


Figure 6.—*De Sphyraena parva sive Sphyraena, secunda specie*
(From Rondelet, 1554).

HISTORY.—What is probably the first record of *Argentina* was published in 1554 when Rondelet described and figured *De Sphyraena parva sive Sphyraena, secunda specie*, or the "hautin" from the Mediterranean. The flat dorsum and the shape of the head in the figure (see fig. 6, a reproduction of Rondelet's figure) combined with the general description leave little doubt as to the identity of Rondelet's specimen. Unfortunately, as Cuvier (1815) points out in a review of the early history of the genus, Rondelet's description is marred by several imperfections. First of all, an adipose fin is neither indicated in the figure nor mentioned in the brief description; second, the anal fin is too long; and third, the lines which represent the posterior edge of the preopercle have been continued below the ventral border of the head, and they appear to represent a structure hanging from the opercle. These several inaccuracies continued to plague authors for many years to come.

Whether or not Belon mentioned *Argentina* I have been unable to verify. Artedi's (1738) synonymy of the genus lists an "hautin" of Belon, but Cuvier states Belon did not mention it. Gesner (1558: 1061) follows Rondelet in his description of the fish and he also reproduced Rondelet's figure. Willughby (1686: 229) gives a more thorough description than does Rondelet. He heads his section on the fish as "Pisciculus Romae Argentina dictus," and he further states it is the *Sphyraena secunda specie* of Rondelet and Gesner. He gives fin counts

and mentions details of internal anatomy. He notes the absence of teeth in the jaws and their presence on the tongue, thus making it fairly certain that he examined a specimen of *Argentina sphyraena*. Willughby is also the first to comment on the use of the silvery pigment of *Argentina* as a coloring agent in the manufacture of artificial pearls. He also copied Rondelet's figure.

Cuvier states that Ray (1710) copied Willughby, abridging his description slightly. The next mention of *Argentina* is by Peter Artedi in 1738. In part 3, page 8, he gives a brief description of *Argentina*, which he recognizes as a separate genus in his order Malacopterygii. In part 5, page 17 he gives a synonymy of the form.

Linnaeus first lists *Argentina* in the fourth edition of the "Systema Naturae" (1744). Cuvier states that Linnaeus followed Artedi. Indeed, it seems doubtful that Linnaeus ever had the opportunity of examining a specimen of *Argentina*. As Günther (1899) points out, most of Linnaeus' fish specimens came from three major sources. The first of these was Scandinavia. Though *Argentina* is indeed found in Scandinavian waters, Linnaeus does not record the genus as occurring there. The second source was a collector who sent German freshwater fishes to Linnaeus. These collections could certainly not have included *Argentina*, a strictly marine form. The third of Linnaeus' major sources of fish was Alexander Garden, of Charleston, South Carolina. Although *Argentina* has been taken off South Carolina, this area could not have produced the *Argentina* referred to in the 1744 edition of "Systema Naturae," for Klauber (1948) informs us that Dr. Garden did not send collections to the great Swedish naturalist until the early 1760's.

Günther makes no mention of *Argentina* in his 1899 catalog of Linnean specimens in the collections of the Linnean Society in London. Lönnberg, however, in listing the Linnean types at Upsala mentions (1896: 25) that the type specimen of a species of *Argentina* has been lost. Lönnberg goes on to state that the original description of the species was given in the "Museum Adolpho-Fridericianum" (1746) by Linnaeus, was later published in "Amoenitates Academicæ" (1749) entitled "Museum Principis." After examining the description in "Museum Principis" there seems little doubt that Cuvier was correct in identifying this nominal species of *Argentina* as a pike.

Cuvier goes on to state that in the sixth edition of "Systema Naturae" (1748) Linnaeus incorporates in the genus *Argentina* the pike, with 10 branchiostegal rays, and *A. sphyraena* which, according to Linnaeus, has 6 branchiostegal rays.

Gronovius (1754, vol. 1: 6) lists an *Argentina*. Although he cites Artedi, it seems doubtful that the specimen Gronovius examined at

this time was congeneric with that of Artedi as Gronovius mentions the presence of teeth on the jaws, palate, and tongue, while Artedi finds them present on only the palate and tongue. In volume 2 of the same work (1756) Gronovius attributes to *Argentina* a species from Surinam, which Cuvier considers an anchovy.

The ninth edition of "Systema Naturae" (1756), Cuvier tells us, also contains two species of *Argentina*. One of these is *A. sphyraena*, which Linnaeus states possesses 6 branchiostegal rays, while the other is the pike of the sixth edition which Linnaeus lists as having 10 branchiostegal rays. As a generic character, however, Linnaeus gives 8 branchiostegal rays. He also states that presence of teeth in both jaws is a generic character, although they are absent in *A. sphyraena*.

Finally, in the tenth edition of "Systema Naturae" (1758), Linnaeus removes the pike and leaves *Argentina sphyraena* standing as the sole representative of the genus. He does this, however, without emending his definition of the genus, so that among the generic characteristics are teeth in the jaws and 8 branchiostegal rays. Neither of these features, of course, is characteristic of *A. sphyraena*. In his brief synonymy and description of the species Linnaeus cites Artedi, whose description was of the true *A. sphyraena*, and Gronovius, whose description is discussed above. Linnaeus also quotes Ray concerning the swimbladder and the use of the silvery pigments as coloring agents for artificial pearls.

Thus considerable confusion attended the pre-Linnaean identity of *Argentina* and continued in the works of certain post-Linnaean authors as well, largely because of the authority carried by the writings of Gronovius. Indeed, fishes belonging to groups such as *Elops*, *Albula*, and *Maurolucus* as well as anchovies and pikes continued to be ascribed to the genus for some time.

Key to the Species of *Argentina*

- 1a. Branchiostegals 6, scales with spines.
 - 2a. Lateral line scales 52 (50-54); gill rakers on lower arm of first arch 8 (7-10) *Argentina sphyraena* p. 108
 - 2b. Lateral line scales 67 (64-69); gill rakers on lower arm of first arch 13 (11-15) *Argentina silus* p. 117
- 1b. Branchiostegals 5, scales without spines.
 - 3a. Gill rakers on lower arm of first arch 17 (14-21); swimbladder impregnated with silvery pigment *Argentina sialis* p. 125
 - 3b. Gill rakers on lower arm of first arch 6 (5-10), swimbladder not impregnated with silvery pigment 4

- 4a. Pectoral rays 19 (18-20); approximately 45 teeth on vomer
 *Argentina striata* p. 129
- 4b. Pectoral rays 15 (13-17); approximately 25 teeth on vomer
 *Argentina elongata* p. 133

Argentina sphyraena Linnaeus

Argentina sphyraena Linnaeus, 1758 : 315, in part (original description, type locality: "Mari infero" cites Ardeidi who gives "Mare Inferum ad Romam etc." as locality, holotype: unknown). Brünnich, 1768 : 78 (description, Marseille). Gmelin, 1778 : 1394, in part (description). Walbaum, 1792 : 44, in part (description). Walbaum, 1793 : 17 (synonymy). Lacépède, 1803 : 366, in part (description, synonymy, distribution). Sonnini de Manoncourt, 1804 : 361 (description). Rafinesque-Schmaltz, 1810 : 35 (Sicily, common names). Cuvier, 1815 : 228, pl. 2 (description, relationships, nomenclature, poor figure). Cuvier, 1817 : 164 (description). Risso, 1826 : 462 (description, synonymy, Nice). Oken, 1836 : 331 (description, synonymy, Mediterranean). Swanson, 1839 : 287 (description). Bonaparte, 1846 : 25 (synonymy, Mediterranean). Günther, 1866 : 203 (description, synonymy, Mediterranean). Steindachner, 1868 : 732 (description, synonymy, Cadiz). Canestrini, 1870 : 129 (description, synonymy, common names, spawning time, Italy). Collett, 1875 : 171 (description, *A. hebreidica* synonymized with *A. sphyraena*, Christianafjord, Stavanger). Doderlein, 1878 : 56 (Sicily). Collett, 1879 : 92 (Norway). Giglioli, 1880 : 12 (in part, variation in tongue dentition, synonymized with *A. leioglossa*, Nice, Naples, Messina, Spalato). Day, 1881 : 78, pl. 4 (description, synonymy, nomenclature, distribution). Day, 1880-84 : 136, pl. 125 (description, synonymy, nomenclature, distribution). Moreau, 1881 : 554, fig. 208 (description, synonymy). Reguis, 1882 : 175 (description). Faber, 1883 : 224 (common names, Adriatic). Günther, 1887 : 218 (in part, synonymy, distribution). Günther, 1888 : 220 (northwest coast of Scotland, 32 and 37 fms.). Lilljeborg, 1891 : 692 (description, synonymy, distribution along Norwegian coasts). Carus, 1893 : 555 (description, distribution in Mediterranean, common names). Holt and Calderwood, 1895 : 361 (description, summary of Irish records, in skate stomach 375-500 fms. off Achill Head, Ireland). Smitt, 1895 : 917, fig. 230 (description, synonymy, distribution in Atlantic and Mediterranean, good figure). Goode and Bean, 1895 : 51 (in part, description, synonymy, distribution). Garman, 1899 : 403 (listed). Collett, 1903 : 163 (Norwegian records, food, parasites). Schmidt, 1906 : 10, pl. 1, figs. 14-23 (descriptions of larvae and postlarvae, comparisons with *A. silus*, distribution in Atlantic). Fage, 1907 : 75 (listed). Ehrenbaum, 1909 : 351, fig. 133 (eggs and larvae, after Schmidt, 1906). Fage, 1910 : 3, fig. 1 (larva, near Monaco, 20 meters). Holt and Byrne, 1910 : 3 (listed). Fowler, 1912 : 556 (Italy). Murray and Hjort, 1912 : 394, 447 (west of British Isles, 146 and 148 m.). Ninni, 1912 : 181 (common names, markets of Venice in winter). Meek, 1916 : 143, fig. 52 (spawning time, distribution map). Schmidt, 1918 : 6, fig. 1, chart 1 (young stages, comparison with *A. leioglossa*, distribution in Atlantic and Mediterranean). De Buen, 1919 : 216, 315 (Spanish references, distribution, common names, abundant at Cadiz). Johnsen, 1919 : 56 (Norwegian records, comparison with *A. silus*). Jenkins, 1925 : 248 (description, distribu-

tion, eggs). De Buen, 1926 : 49 (synonymy, Spanish references, Spanish distribution). Smith, 1928 : 88 (Irish Sea, Pt. Erin). Kyle and Ehrenbaum, 1929, XII. F 46, fig. 27 (description, distribution, common names). Scheuring, 1929 : 658, fig. 33 (distribution, after Meek). Schnakenbeck, 1931, fig. (description, distribution, common names). Sanzo, 1933 : 26, figs. 24-31, pl. 2 (development, comparison with development of *A. leioglossa*). Brunelli and Bini, 1934 : 743 (Montecristo, Italy). De Buen, 1935 : 47 (synonymy, Spanish distribution). Valiani, 1940 : 125 (comparison of stomach contents and size of specimens from Nice and the Tirreanean Sea). Chapman, 1942, figs. 1-8 (osteology, relationships of family). Lozano Rey, 1947 : 127, fig. 25 (description, distribution, common names). Soljan, 1948 : 185, figs. (description, Adriatic). Karlovac, 1949 : 9 (postlarvae in Adriatic). Tortonese and Trotti, 1949 : 34 (Mediterranean distribution, common names, Italian references). Bruun and Pfaff, 1950 : 28 (Skagerrak, Norwegian and Swedish coasts). Went, 1951 : 197 (Ireland, coast of county Dublin). Palombi and Santarelli, 1953 : 12, fig. (description, common names). Andriashiev, 1954 : 120 (description). Tambs-Lyche, 1954 : 8 (fjords in vicinity of Bergen, 195-200 m.). Kotthaus and Kreft, 1957 : 171 (west and southeast coasts of Iceland).

Salmo sphyraena Bloch and Schneider, 1801 : 414 (description).

Argentina silus junior Risberg, 1835 : 7 (original description, type locality: Christiana, holotype: unknown).

Osmerus hebreidicus Yarrell, 1838 : 108 (original description, type locality: Bay of Rothsay, Isle of Bute, Hebrides, holotype: unknown). Bonaparte, 1846 : 24 (Britain). Yarrell, 1860 : 16, fig. (reprint of original description). Couch, 1865 : 297, pl. 233 (description, nomenclature, Orkneys, plate after Bloch and Schneider, copied from Ascanius' figure of *Salmo silus*).

Goniosoma argentinum Costa, 1844 in Costa 1836-44, pl. 36 (*nomen novum pro Argentina sphyraena* Linnaeus, description, synonymy, distribution, nomenclature, common names, Naples).

Argentina cuvieri Valenciennes, 1848 : 413 (*nomen novum pro Argentina sphyraena* Linnaeus, description, Malta, Malaga, Balearic Islands). Bertin, 1940 : 307 (lists paratypes in Paris Museum).

Argentina yarrelli Valenciennes, 1848 : 418 (*nomen novum pro Osmerus hebreidicus* Yarrell, description, distribution, nomenclature). Bertin, 1940 : 307 (lists paratypes in Paris Museum).

Argentina hebreidica Nilsson, 1855 : 474 (description, synonymy, Scandinavia, comparison with *A. sphyraena*). Yarrell, 1859 : 300, fig. (description, nomenclature). Günther, 1866 : 203 (description, synonymy, coasts of Norway and Scotland). Brito Capello, 1881 : 35 (synonymy, Lisbon). Garus, 1893 : 555 (description, distribution).

Diagnosis.—*A. sphyraena* differs from all other species of *Argentina* except *A. silus* in having 6 branchiostegal rays (other species have 5) and in having spines on the scales. It can be distinguished from *A. silus* by a lower lateral line scale count (50 to 54 in *A. sphyraena*, 64 to 69 in *A. silus*), fewer gill rakers on the lower arm of the first arch

(7 to 10 in *A. sphyraena*, 11 to 15 in *A. silus*), lower vertebral count (49 to 52 in *A. sphyraena*, 65 to 69 in *A. silus*), and a lower pectoral count (12 to 15 in *A. sphyraena*, 15 to 18 in *A. silus*). *A. sphyraena* can also be differentiated from *A. elongata* and *A. striata* by the silvery pigment impregnating its swimbladder.

COUNTS AND MEASUREMENTS.—Based on 73 specimens. D. 11 (10-12); A. 13 (11-15); pectoral 14 (12-15); ventral 11 (10-12); gill rakers on first arch 4 (3-5) + 1 (0-1) + 8 (7-10); lateral line scale rows 52 (50-54); standard length 70.9-210.5 mm. (the largest specimens recorded in the literature are examples up to 32.0 cm. noted by Kotthaus and Kreff, 1957); preanal 82.3 (78.0-84.8); preventral 51.6 (49.0-52.1); predorsal 44.9 (41.2-47.1); prepectoral 28.9 (25.4-32.8); head length 28.3 (24.0-31.2); snout 9.1 (7.4-10.6); eye 8.8 (7.2-10.3); maxillary length 6.5 (5.3-7.9); maxillary width 1.9 (1.4-2.4); depth at dorsal fin 13.3 (9.7-14.2); width behind head 10.6 (9.2-12.2); head depth 13.2 (11.3-14.4); interorbital 7.4 (6.5-8.5); depth of caudal peduncle 5.7 (4.5-6.5); vertebral count of one North Sea specimen 52, a specimen from Portugal 49 and two from the Mediterranean 49 and 50; pyloric caeca 9 for a specimen from Portugal, 7-12 in four examples from the Mediterranean (Smitt, 1895 summarizes the observations of several authors, the counts ranging from 5 to 20); branchiostegals 6 (Chapman, 1942 records 7; however, I have found only 6, even in cleared and stained specimens).

DESCRIPTION.—Body elongate, laterally compressed, with the greatest depth in some specimens immediately behind the head, in others at the dorsal origin, tapering to the caudal peduncle. A lateral view shows the upper profile of the head descending in a gentle curve which is broken by the dorsal margin of the eye. The ventral profile rises more gently from the posterior edge of the preopercle to the union of the articular and the quadrate from whence it rises more rapidly. Chapman (1942) has described the interorbital space as "depressed to form a broad, V-shaped trough." In specimens I have examined the frontals between the supraocular canals constitute a broad flat area. The canals themselves are slightly raised above the flat surface in larger examples, while in smaller specimens the canals are almost flush with the surface. Lateral to the canals the frontals arch upwards to accommodate the top of the eye. The dorsal edge of the maxillary lies tucked under the lachrymal in smaller specimens and extends to the jugal in larger ones. The posterior edge of the maxillary lies closer to the eye than to the snout. The epidermis covering the ventral edge of the posterior portion of the maxillary bears minute papillae which extend in a narrow band onto the upper lip where they meet a similar band from the other side. Both the upper and lower jaws are

rounded, and the upper jaw projects slightly. A small knob is present below and slightly behind the curved symphysis of the lower jaw.

The palatines and the head of the vomer bear a band from 2 to 4 teeth wide composed of small, closely spaced, posteriorly directed teeth. There are about 50 teeth on each palatine and about 35 on the vomer. The tongue is armed with 5 to 8 strong, recurved teeth. Tongue teeth were present in all the specimens I examined. (Giglioli (1880) examined a series of specimens which he said varied considerably in the dentition of the tongue. His comments lead me to believe he examined a collection of *Argentina sphyraena* mixed with *Glossanodon leioglossus*, a species in which the tongue teeth are small and easily overlooked.) Sensory papillae were not observed on the tongue. The ceratobranchial of the 5th gill arch bears 11 small, conical teeth. Two oval-shaped patches of short, conical teeth, about 14 teeth on the anterior patch and 16 on the posterior patch, are present at the anterior end of the 4th suprabranchial. The gill rakers are medium-sized, widely spaced, triangular in shape and compressed. The 4th raker forward from the angle on the lower arm is equal in length to about one-sixth of the interorbital distance. The rakers on the upper arm are fewer in number and slightly smaller than those on the lower arm.

The pectoral fins usually originate in line with a vertical from the posterior tip of the opercles, although the origin may be slightly ahead of or slightly behind this line. The posterior end of the pectoral fin base forms an angle of 20 to 35 degrees with a plane parallel to the venter. The distance between the bases of the innermost rays of each pectoral fin is approximately equal to the least depth of the caudal peduncle. The longest dorsal ray is equal to the depth of the body at the dorsal fin origin, and the longest anal ray is less than the least depth of the caudal peduncle. The tip of the pectoral fin extends to a point midway between the anterior base of the pectoral and the anterior base of the ventral. The ventral fin is equal in length to the pectoral fin.

The scales bear minute spines which are barely discernible by running a finger forward over the body of the fish. The weakness of these spines is in marked contrast to the well-developed scale spines of *A. silus*. The scales of both species have been illustrated by Smitt (1895: 913, 917). The scales seem to play an important part in maintaining the shape of the body. They act as a true exoskeleton by forming an elongate, 10-sided box. The shape is evident only in the few specimens I have examined with nearly complete squamation. In specimens without scales the sharply defined angles slump away and leave the cross section oval.

The peritoneum is silvery on its outer surface, while the inner surface is heavily flecked with dark pigment, appearing almost solid black in some places, as is the dorsal section of the stomach. The ventral section is more lightly colored; the duodenum is lightly flecked and the remainder of the gut has only an occasional sprinkling of melanophores. The posterior curve of the stomach is about midway between the level of the pectoral insertion and the level of the ventral insertion. The outer surface of the curve bears only a small protuberance. The longest pyloric caeca extend back to the curve of the stomach in larger specimens, not as far in smaller ones. The gut runs in a straight line from the distal end of the stomach to the anus. Specimens from Portugal contain considerable amounts of fat investing the mesenteries, surrounding the pyloric caeca and pancreatic tissue, and adhering to the face of the swimbladder. Examples from Barcelona are thinner and practically free of fat. Many of the Spanish fish are heavily parasitized by roundworms.

The swimbladder is heavily impregnated with silvery pigment. The anterior end of the bladder lies above the posterior curve of the stomach and the posterior end is at about the level of a vertical from the posterior tips of the ventrals.

The color varies in the alcohol specimens I have examined. This variation seems to be due to locality, length of time since the specimen was collected, and type of initial preservation. A recently collected example from Lofoten, Norway, has a uniform light brown ground color ventrally with the dorsal half of this area lightly flecked with dark brown spots. An iridescent sheen is present in the skin of the entire light brown area. A narrow, silvery band runs along the lateral line; above this band is a dark brown horizontal band extending dorsally to the dorsolateral angle of the body. The entire dorsum of the fish is a light brown color similar to the area below the lateral line. The caudal is heavily flecked with dark brown, especially at the upper and lower corners of the caudal peduncle, while the lateral half of the pectoral fins and the entire dorsal and the ventral fins are flecked to a lesser degree, and the anal and medial half of the pectoral are uncolored. The opercle is transparent except for a sprinkling of large chromatophores. It also is faintly iridescent. The cheeks are brown; the top of the head is transparent posteriorly and translucent farther forward. The muzzle from the nostrils forward is dusky. A specimen from Oslo, Norway, collected at an earlier date and probably initially preserved in alcohol, has the uniform orange brown body traversed by a broad silvery band about as wide as the distance between the inner bases of the pectoral fin and extending from the poste-

rior edge of the opercle to the base of the caudal fin. It has the lateral line as its dorsal border and the next ventral body angle as its ventral border. The fins are all unmarked. The opercle and preopercle are a bright silver, while the rest of the head is a faded white. These two descriptions represent the extremes in coloration. Various intermediate patterns are present in the collection. Schmidt (1906) and Fage (1910) show figures of larval *A. sphyraena* in which a row of 7 to 9 dusky blotches are present along the ventral half of the side.

DISTRIBUTION.—*Argentina sphyraena* occurs from the Lofoten Islands of Norway south along the Scandinavian coast to the tip of Denmark in the Skagerrak; in the northern part of the North Sea, south along the western edge of the British Isles through the Bay of Biscay and down the Atlantic coast of the Iberian Peninsula to Gibraltar. It is taken occasionally in the Irish Sea, and Kotthaus and Krefft (1957) have recorded it off Iceland. In the Mediterranean the species has been taken along the European coast as far east as the Adriatic and is also found off the Balearic Isles and Sicily.

Poll's (1953) record of *A. sphyraena* from the west coast of equatorial Africa is referred to *Glossanodon polli* and discussed elsewhere in this paper. Gilchrist and von Bonde (1924: 33) record *A. sphyraena* from the Indian Ocean off the coast of Natal and Delagoa Bay. Unfortunately, they give neither a description nor a figure of their material, but merely list synonymy and the station number. Keppel H. Barnard of the South African Museum writes me that many of the specimens collected by the South African Fisheries Survey, *Argentina* among them, have been lost, and that he knows of no others having been collected. J. L. B. Smith of Rhodes University writes me that the record of Gilchrist and von Bonde mentioned above is the only one known and that the identification was never verified. He also states that his description of *Argentina* in his book on South African fishes (1953) was taken from Smitt (1895), as was the figure (which is actually of *A. silus*, not *A. sphyraena*). Therefore I have refrained from recognizing the Indian Ocean record of *A. sphyraena*. If an argentinid is discovered in this zoologically surprising area it will probably be a *Glossanodon*.

GEOGRAPHICAL VARIATION.—When certain of the counts and measurements summarized above are broken down into three geographical groups, differences in the ranges and average values independent of the size of the fishes become apparent. The geographical areas are the Mediterranean, the Atlantic off Portugal, and the North Atlantic and Norwegian Sea from Great Britain to the north. The collections

TABLE 1
COMPARISONS OF COUNTS AND MEASUREMENTS OF THREE GROUPS OF
Argentina sphyraena.

Group I the North Atlantic and Norwegian Sea from Great Britain to the north, Group II the Atlantic off Portugal, Group III the Mediterranean. All lengths are expressed as percentages of standard length.

Head length	I	II	III	Prepectoral length	I	II	III
24.0-9	1			25.0-9	2		
25.0-9	6			26.0-9	1		
26.0-9	10			27.0-9	10		
27.0-9	6		2	28.0-9	6	7	9
28.0-9	6	6	5	29.0-9	7	9	3
29.0-9	4	10	4	30.0-9	3	3	4
30.0-9	1	3	8	31.0-9			4
31.0-9			1	32.0-9			1
Average	27.5	29.2	29.4	Average	28.2	29.2	29.6
Preanal length	I	II	III	Predorsal length	I	II	III
78.0-9	2			41.0-9	2		
79.0-9	3			42.0-9	3		
80.0-9	5	2		43.0-9	11	2	
81.0-9	16	3	3	44.0-9	7	3	5
82.0-9	16	5	5	45.0-9	2	9	5
83.0-9		5	3	46.0-9		5	7
84.0-9		3	8	47.0-9			3
85.0-9		1		Average	44.1	45.4	45.9
Average	81.4	82.8	83.2	Snout length	I	II	III
Eye diameter	I	II	III	7.0-9	4		
7.0-9	6			8.0-9	22	2	3
8.0-9	21	12	5	9.0-9	7	14	14
9.0-9	5	6	13	10.0-9		3	3
10.0-9			2	Average	8.7	9.6	9.4
Average	8.8	8.8	9.3	Anal fin ray counts	I	II	III
Maxillary length	I	II	III	11			1
5.0-9	14			12		4	8
6.0-9	14	15	11	13	10	13	10
7.0-9	3	3	9	14	21	2	
Average	6.1	6.7	7.0	15	1		

from the most northerly of the three areas show; on the average, a higher anal count, shorter preanal distance, shorter predorsal distance, lesser head length, smaller eye, shorter prepectoral, shorter snout, and shorter maxillary. The Portuguese specimens are intermediate, while those from the Mediterranean show the opposite extremes for the characters listed above. The data are summarized in table 1. Schmidt (1918) investigated geographical variation in the vertebral number of *A. sphyraena*, and records a higher average number of vertebrae for fishes taken north of Scotland than for those taken north of Spain. The variation of *A. sphyraena* is perhaps another example of the widely known tendency of certain fish species to respond morphologically to environmental influences, particularly temperature as influenced by latitude.

HABITS.—*A. sphyraena* has occasionally been taken on a hook and line close to the surface, but it is most frequently captured in trawls on or close to the bottom. Tambs-Lyche (1954) states that in the Bergen area the species is generally taken at depths between 90 meters and 200 meters and that it is a member of the mud-bottom community. Holt and Calderwood (1895) identified *A. sphyraena* in the stomach of *Raja oxyrhynchus* captured somewhere between 375 and 500 fathoms. In general *A. sphyraena* seems to prefer the coastal shelf, although it avoids extreme shoal waters and for this reason perhaps has not been taken in the shallow southern part of the North Sea or in the English Channel. Although *A. sphyraena* may wander down the continental slope on occasion, it is certainly not a characteristic member of the deep sea fauna as many authors since before the days of Linnaeus have labeled it.

Schmidt (1906, 1918) describes the eggs and larvae as being pelagic in depths to 184 meters. He places the spawning of the Mediterranean population in the winter, the more northern populations later in the year:

The boxlike armor of scales which encases *A. sphyraena* would seem to preclude the possibility of rapid movement, yet the fish has adipose eyelids and scale sheaths for the ventral fins, both characteristics of relatively fast-moving fishes. Valiani (1940) examined the stomach contents of several hundred *A. sphyraena* in the Mediterranean, and his studies give some clue as to the habits of the species. The greater part of the food consisted of bottom-dwelling mollusks and crustaceans. However, the presence of *Clupea pilchardus* and *Pyrosoma elegans*, the latter a pelagic tunicate, indicates that a certain amount of time is spent off the bottom and that if necessary the fish can swim with the speed necessary to capture *Clupea*.

NOMENCLATURE.—*A. sphyraena* in the Mediterranean was described under two names other than *A. sphyraena*. The first of these, *Goniosoma argentinum*, was proposed in 1844 by Costa because of a misunderstanding of the mouth-part terminology used by Cuvier (1815) in defining the genus of Linnaeus. One is led to believe that a surfeit of chauvinism also played a part in the proposal of the new name if we are to judge from Costa's comment, "l'illustre zoologa francese ne avesse diradate le tenebre," in reference to Cuvier's treatment of *Argentina*. Valenciennes (1848) also decided that the species needed a new name, and, prompted by motives exactly the opposite of those which moved Costa, came forth with the name *Argentina cuvieri*, in honor of his late master.

Meanwhile, farther to the north, Risberg had recorded the species from Norway in 1835 (in a paper sometimes attributed to Nilsson) and demonstrated his opinion of its affinities by calling it *Argentina silus junior*. Yarrell rediscovered the species in the Hebrides in 1838, and called it *Osmerus hebreidicus*. Valenciennes placed Yarrell's species in the genus *Argentina* and in so doing decided to honor its discoverer by renaming the species *Argentina yarrelli*. In 1855 Nilsson identified *A. silus junior* with *Argentina hebreidica* and also placed *A. yarrelli* in the synonymy of *A. hebreidica*. In the same work he compared *A. hebreidica* with *A. sphyraena* and maintained the species were distinct.

The first author to lump the two forms was Collett in 1875. He was followed by Day (1881) who pointed out that many of the characters used to separate the two populations are extremely variable and to a certain extent dependent on size. Almost all authors since Collett and Day have agreed with their treatment of the species.

In the above synonymy I have treated *Goniosoma argentinum*, *Argentina cuvieri* and *Argentina yarrelli* as *nomina nova* rather than new species because in no case was the author describing a form which he considered new to science, but instead was substituting a new name for one which he considered untenable. I mention this somewhat obscure point because Bertin (1940) has listed the paratypes of the latter two, thereby implying he considers them to have been new species. A *nomen novum* based on a previous author's work is based on that author's material.

SPECIMENS EXAMINED.—

Norway: Nordaland county, Lofoten, BM 5202 (5); Hordaland county, Herdla, BM 4202 (2) and 4203 (2); Bergen, BM 2248 (1); Rogaland county, Mastrafjord, BM 3024 (3); Rogaland county, Gannsfjord, BM 3073 (7); Rogaland county, Baasfjord, BM 3053 (6); Oslo, BM 2254 (5).

Denmark: Near Hirshals, "Michael Sars" st. 383, BM 2417 (2).

Scotland: Morayshire, Lossiemouth, CNHM 35433-37 (5); 49° 32' N/ 10° 49' W, BM 3233 (1); 49° 27' N/ 8° 36' W, BM 3353 (2).

Portugal: 38° 21' N/ 9° 10' W, SU 49267 (20).

Spain: Barcelona, SU 49269 (15).

France: Herault, Sete, SU 48872 (7).

Italy: Gulf of Genoa, SU 49268 (1); Palermo, SU 1627 (1).

Yugoslavia: 43° 18.4' N/ 16° 23.5' E, SU 48873 (12).

Argentina silus (Ascanius)

Salmo silus Ascanius, 1775 : 3, pl. 24 (original description, type locality: Bergen, Norway, holotype: unknown, poor figure). Müller, 1776 : 49 (Scandinavian and Icelandic references, common names). Bloch and Schneider, 1801 : 414, pl. 81 (description, pl. after Ascanius).

Coregonus silus Cuvier, 1817 : 163 (listed, subsequent editions of this work use the same name). Nilsson, 1832 : 19 (description, synonymy, Norway). Bonaparte, 1846 : 24 (synonymy, Norway).

Silus ascanii Reinhardt, 1833 : 11 (*nomen novum pro Salmo silus* Ascanius).

Argentina silus Risberg, 1835 : 3 (description, synonymy, Bergen, Söndmör, Christiana, common names). Valenciennes, 1848 : 421 (description, discussion of synonymy, Bergen, common names). Nilsson, 1855 : 469 (description, synonymy, west coast of Norway, food, habits). Günther, 1866 : 202 (description, synonymy, northwest coast of Norway). Collett, 1875 : 173 (distribution along Norwegian coast, early history of common names). Collett, 1879 : 93 (description, distribution along Norwegian coast). Winther, 1879 : 45 (synonymy, Blaavands Huk, Denmark). Edward, 1881 : 334 (description, Moray Firth, Banffshire, color, food). Günther, 1887 : 217 (listed, distribution). Lilljeborg, 1891 : 679 (description, synonymy, Scandinavian distribution, osteology, habits). Smitt, 1895 : 913, fig. 229 (description, synonymy, distribution, habits). Goode and Bean, 1895 : 52, fig. 61 (description, synonymy, Sable Island Bank, 200 fms., Belfast, Maine, Biddeford Pool, Maine, poor figure). Jordan and Evermann, 1896 : 526, fig. 232 (description, distribution, figure from Goode and Bean, 1895). Holt, 1897 : 341 (50° 20' N/ 8° 25' W, 74 fms., food). Garman, 1899 : 403 (listed). Boulenger, 1900 : 160 (sold in market at Boston, Lincolnshire, England, caught off coast of Norway). Ehrenbaum, 1901 : 133 (synonymy, distribution). Collett, 1903 : 165 (Norwegian records from Christianafjord to Finnmarken, depths to 900 m., length to 475 mm.). Holt and Byrne, 1906 : 5, 22 (west coast of Ireland; south of Porcupine Bank, Irish Sea, 105 and 164 fms.). Schmidt, 1906 : 1, pls. 1-2 (eggs, larval and postlarval development, comparisons with early stages of *A. sphyraena*, distribution and depths of eggs and young in eastern north Atlantic). Kendall, 1908 : 49 (listed). Ehrenbaum, 1909 : 347, fig. 132 (eggs and larvae, after Schmidt, 1906). Holt and Byrne, 1910 : 3 (listed). Kendall, 1914 : 39 (Maine records). Meek, 1916 : 143 (distribution, spawning). Schmidt, 1918 : 10, chart 1 (records of eggs, larvae and postlarvae in eastern north Atlantic). Johnsen, 1919 : 56, 85 (Norwegian records, age, spawning time of Norwegian specimens). Dons, 1921 : 37 (records from northern Norway). Kendall and Crawford, 1922 : 8, figs. 1-2 (osteology, soft anatomy, North American records, relation-

ships). Grenholm, 1923 : 28 (fin muscles). Bigelow and Welsh, 1925 : 147, fig. 59 (description, distribution, Gulf of Maine records, habits, fig. from Goode and Bean, 1895, and Schmidt, 1906). Jenkins, 1925 : 248 (description, eggs, distribution). Kyle and Ehrenbaum, 1929 : XII. F 46, fig. 26 (description, common names, fig. after Smitt). Scheuring, 1929 : 658, fig. 33 (distribution, after Meek, 1916). Jordan, Evermann and Clark, 1930 : 68 (synonymy, distribution). Firth, 1931 : 10 (eastern N. Atlantic records). Schnakenbeck, 1931; fig. (description, distribution, common names, fig. from Smitt). Vladikov and McKenzie, 1935 : 59, fig. 37 (listed, fig. from Goode and Bean, 1895). Bigelow and Schroeder, 1936 : 328 (off Georges Bank and Cape Cod in deep water). Iversen, 1936 : 99 (65° 36' N/ 31° 15' W, only Greenland record). McKenzie and Homans, 1937 : 277 (43° 05' N/ 62° 35' W off Nova Scotia, 54 fms.). Fridriksson, 1937 : 72, fig. (distribution and depth off Iceland, life history data). McKenzie, 1939 : 15 (W to SW of Emerald Bank, Nova Scotia). Maslov, 1944 : 168 (Barents Sea east of N. Cape, Norway, spawning at Lofoten). Lozano Rey, 1947 : 129, figs. 27-8 (description, distribution, incorrectly recorded from Bay of Biscay, figs. from Smitt, 1895 and Schmidt, 1906). Breder, 1948 : 75, fig. (American distribution, spawning, eggs). Saemundsson, 1949 : 94 (distribution, Icelandic records and references). Bruun and Pfaff, 1950 : 28 (Skagerrak). Bigelow and Schroeder, 1953 : 139, fig. 59 (description, eggs and larvae, distribution, records from the Gulf of Maine). Andriashv, 1954 : 119, fig. 56 (description, synonymy, Arctic records). Anon. 1955 : 35 (1000-pound catch at edge of continental shelf, New England). Schroeder, 1955 : 362 (S of Nova Scotia, over 200 fms.). Kotthaus and Kreff 1957 : 171 (Iceland-Greenland Ridge, SW, W, and NW coasts of Iceland, Anton Dohrn Bank; 190-500 m.).

Acantholepis silus Krøyer, 1846-49 : 97, fig. (description, synonymy, nomenclature, common names, distribution). Krøyer, 1847, pl. 17.

Argentina syrtensium Goode and Bean, 1879 : 261 (original description, type locality: "from the stomach of a hake (*Phycis tenuis* ?)" in 200 fms. on Sable Island Bank off Nova Scotia coast, holotype: USNM 21624). Jordan and Gilbert, 1883 : 295 (description after Goode and Bean). Jordan, 1887 : 830 (listed).

DIAGNOSIS.—An *Argentina* with spiny scales, 6 branchiostegals, and the swimbladder impregnated with silvery pigment. *A. silus* differs from all other species of *Argentina* in its high lateral line scale count (64 to 69 in *A. silus* as against 48 to 56 in all other species), a higher average anal ray count (15 [13 to 17] as against 11 to 15 in all other species of *Argentina*), and a higher vertebral count (65 to 67 in *A. silus* as against 49 to 54 in all other species).

COUNTS AND MEASUREMENTS.—Based on 59 specimens. D. 12 (11-13); A. 15 (11-17); pectoral 17 (15-18); ventral 12 (12-13); gill rakers on first arch 6 (5-7) + 1 + 13 (11-15); lateral line scale rows 66 (64-69); standard length 77.4-321.9 mm. (Smitt, 1895, quotes Nilsson as saying that this species may reach 2 Swedish feet (59 cm.); preanal 82.4 (79.8-85.4); preventral 52.5 (50.0-55.4); predorsal 43.1 (40.7-45.4); prepectoral

27.3 (24.6-30.1); head length 27.5 (25.4-29.6); snout 7.9 (7.0-8.8); eye 9.0 (6.0-11.1); maxillary length 6.2 (5.2-7.4); maxillary width 1.8 (1.5-2.2); depth at dorsal fin 16.1 (11.3-22.0); width behind head 11.9 (9.3-14.7); head depth 14.3 (12.7-15.5); interorbital 7.5 (6.5-8.3); depth caudal peduncle 6.5 (6.0-7.6); vertebral count of two western Atlantic specimens 67, of an eastern Atlantic specimen 65; pyloric caeca of three western Atlantic specimens 21, 22 and 28, two from the eastern Atlantic 15 and 27; branchiostegals 6.

DESCRIPTION.—Body deepest at dorsal origin, slender to robust, laterally compressed. Gravid females with bellies much distended. Greatest depth at or slightly ahead of the dorsal insertion. The dorsal profile curves gently to the snout from the point of greatest depth and extends posteriorly to the caudal peduncle in a straight line. The dorsal profile of the head is interrupted by the dorsal margin of the eye which juts up prominently in larger specimens, less so in smaller ones. The ventral profile of the head runs forward almost in a straight line with only a slight angle at the union of the articular and the quadrate. The general shape of the head reminds me, as it did Smitt, of a rather blunt, four-sided wedge. The interorbital is a broad flat-bottomed space between the supraocular canals, which are raised above the surface of the median portion of the interorbital space. Lateral to these canals the frontals arch upwards to accommodate the dorsal edge of the very large eyes. The posterior adipose eyelid is continuously connected with a layer of clear hyaline tissue over the preopercle. The dorsal edge of the maxillary fits under the lachrymal and extends to the jugal as well. The posterior edge of the maxillary is closer to the eye than to the tip of the snout. The epidermis covering the ventral edge of the maxillary bears a considerable number of small papillae, which in many larger specimens are visible to the naked eye. These papillae, much reduced in size, extend in a narrow band onto the epidermis covering the premaxillary where they meet a similar band from the other side. The jaws are subequal with the upper jaw rounded and the lower jaw rather bluntly pointed and bearing a distinct knob at the symphysis.

The palatines and the vomer bear a band of teeth from 1 to .3 teeth wide. There are about 25 teeth on each palatine and about 18 teeth on the head of the vomer. The tongue is armed with 8 to 10 strong recurved teeth. Thickly distributed along the margins of the tongue and interspersed between the teeth are considerable numbers of minute papillae, which are relatively broad based and send up from 1 to 5 short, twiglike branches. These papillae are similar to those previously noted on the premaxillary and maxillary. Similar struc-

tures are also found in large numbers on ridges in the floor and roof of the pharynx. In the only two larvae of this species I have examined (total lengths 25 mm. and 35 mm.) the dentaries bear a single row of minute cardiform teeth. The next smallest specimen available (71 mm. total length) lacked teeth on the lower jaw, as did all larger specimens. The ceratobranchial of the 5th gill arch bears 5 small teeth. At the anterior end of the 4th suprabranchial are two small patches of teeth with about 10 teeth in the posterior patch and 3 in the anterior. The gill rakers are medium sized, widely spaced, roughly triangular in shape, and compressed. The 4th raker forward from the angle on the lower arm of the 1st arch is equal to or slightly shorter than one-fourth the interorbital width. The rakers on the upper arm are fewer in number and slightly smaller than those on the lower arm of the arch.

The pectoral fin originates close to a vertical from the posterior edge of the opercle. The posterior end of the pectoral base forms an angle of 30 to 35 degrees with a plane parallel to the venter. The distance between the innermost rays of each pectoral fin is less than the least depth of the caudal peduncle. A ventral adipose fin, about as high and twice as long as the dorsal adipose is present in front of the anus of a specimen 54.6 mm. in standard length, while a specimen 63.0 mm. in standard length was observed to have a small adipose flap in front of the anus. No ventral adipose fin was observed in any other specimen of *A. silus* examined. The longest dorsal ray is approximately equal to the depth of the body at the origin of the dorsal fin. I have seen no specimens with unbroken anal rays. The tip of the pectoral fin extends to a point about midway between the anterior of the pectoral fin base and the anterior of the ventral fin base. The ventral fin is slightly shorter than the pectoral fin.

A distinctive feature of the scales is the presence of small, but strong spines on their posterior exposed portions. These spines may be easily discerned by running a finger forward over the side of a specimen. The spines grow from the posterior edge of the scale as well as on the surface, thus giving the scales a distinctly ctenoid appearance. Smitt (1895) figured these scales. As in other species of *Argentina*, the scales mold the body shape, at least in smaller specimens, while specimens which lack scales are oval in cross section. The angles of the body in the few specimens available with complete squamation are less sharply defined than those of *A. sphyraena*.

The outer surface of the peritoneum is coated with a silvery pigment, while the ventral and lateral surfaces of the inner face of the peritoneum are so densely punctate they appear dark brown or

blackish. The dorsal surface bears fewer chromatophores and the silvery swimbladder is visible dorsally through the peritoneal membranes. The stomach is almost unmarked, with only an occasional chromatophore. The pyloric caeca and the remainder of the gut are lightly peppered with chromatophores. The stomach runs posteriorly to a point slightly anterior to the insertion of the ventral fins. The outer surface of the posterior curve of the stomach bears an extension which Kendall and Crawford (1922) have illustrated and compared to a short caecum. The intestine is twisted into a single loop at a point slightly behind a vertical from the posterior tip of the stomach. Distal to the loop the intestine runs straight back to the anus. I have dissected the intestines of 6 specimens of *A. silus*, 4 from the western Atlantic and 2 from the eastern Atlantic, and in none of these did I observe a "functional spiral valve" as figured and described by Kendall and Crawford (1922). In general, the intestine and *Ringfalten* are in good agreement with those of *A. sphyraena*. I counted 23 *Ringen* in the intestine of a specimen of *A. silus*, 300 mm. in standard length.

The swimbladder is similar to that described for *A. sphyraena* with the exception that it is more elongate and its anterior end lies slightly behind the anterior end of the body cavity.

The coloration of alcohol specimens is light on the ventral half of the body, while the dorsal half is more heavily pigmented. Many of the specimens are a rich orange brown on the dorsal half and also along the belly. Closer examination shows this color is due to countless small oil droplets in the skin beneath the scales. These fish are quite greasy to handle, and slight pressure on the side or belly of such a fish causes a film of oil to exude. Some Norwegian specimens, collected at an earlier date than those described above and probably initially preserved in alcohol, have a broad silvery band running the length of the body with the dorsal edge slightly above the lateral line and the ventral edge about two-thirds of the distance between the lateral line and the venter. The caudal fin is rather heavily pigmented at its base, less so at the extremities of the rays. The dorsal and anal fin are lightly pigmented and the pectoral and ventral fins have pigment on their lateral rays only, while the median portion of each fin is uncolored. The opercle is bright silver. The cheeks are about the same color as the ventral half of the fish. The top of the head is transparent posteriorly and translucent farther forwards. The muzzle is generally dusky, and the entire underside of the head is lightly sprinkled with chromatophores. Adolescent specimens have 10 to 12 faint dusky blotches along the dorsal half of each side of the body.

DISTRIBUTION.—*Argentina silus* has a disjunct distribution with populations on each side of the North Atlantic. The southern limit of this species on the American side seems to be the edge of Georges Bank east of Cape Cod. The species is also found in the Gulf of Maine (see Bigelow and Schroeder, 1936, for records) up the southeast coast of Nova Scotia, in the Gulf of St. Lawrence, and according to Squires (1954, *in litt.*) it is taken "fairly frequently on the S. W. edge of the Grand Banks and on St. Pierre Bank in depths generally over 100 fathoms." Mr. Squires has given me several records from the Grand Banks, of which $54^{\circ} 38' N / 53^{\circ} 38' W$ is the most northerly.

The European population is more widely distributed with its southernmost occurrence southeast of Ireland at about $49^{\circ} N$ (Schmidt, 1918). From this point it ranges along the west coast of the British Isles, also entering the Irish Sea. Murray and Hjort (1912) record *A. silus* from south of the Canary Islands, but I examined several of their specimens and found them, as Schmidt (1918) suggested, referable to *Argentina leioglossa* (= *Glossanodon leioglossus*). *A. silus* occurs northwest to the Faeroes and is also known from off Iceland. The species is absent from the English Channel and the shallow southern part of the North Sea; however, it has been taken at Blaavands Huk on the west coast of Denmark, and eggs and larvae are known from the deep part of the Skagerrak. The species has been recorded many times from the west coast of Norway as far north as West Finmarken. More recently Andriashev (1954) has summarized Russian records of this fish at the northern tip of Norway, at Bear Island, and near the southwest coast of Spitzbergen. It should be emphasized, however, that Murray and Hjort (1912) characterize *A. silus* as a member of the boreal fauna rather than the cold water arctic fauna. In view of the species' known distribution, the single record from the east coast of Greenland (Iversen, 1936), an area whose fauna Murray and Hjort label as arctic, should probably be considered as a stray rather than any indication of a permanent population.

GEOGRAPHICAL VARIATION.—The samples of *A. silus* I have examined from each side of the Atlantic have been remarkably constant for the characters investigated. I noted only three proportional differences, and these overlap to a considerable extent. Differences are listed below as percentages of standard length with the mean (variation in parentheses) of the American specimens followed by the same data for the European specimens. Head length 28.0 (26.3-29.6), 26.8 (25.4-28.9); eye 9.3 (8.0-11.1), 8.7 (6.0-9.7); interorbital 7.7 (7.1-8.3), 7.2 (6.7-7.9). These populations have not diverged far enough to warrant sub-specific recognition.

HABITS.—*A. silus*, like *A. sphyraena*, has also been taken with hook and line close to shore, but this is a rare event. *A. silus* is probably the deepest-living member of the genus. On the American side it has been taken at depths as great as 320 fathoms (R. C. Wilson, *in litt.*) but is most commonly encountered between 75 and 200 fathoms. It seems to prefer the edge of the continental shelf, but Bigelow and Schroeder (1953) give records from the deeper parts of the Gulf of Maine. Collett (1903) gives a record of 500 fathoms off Norway, but other Norwegian and British records are shallower and 50 to 200 fathoms is the general range. Fridriksson (1937) gives the bathymetric range off Iceland as 120 to 1100 meters: Data and experiments noted by Schmidt (1906) show the eggs and larvae to be bathypelagic at depths to 900 meters (the figure 1800 m. which some authors have cited from Schmidt is the amount of wire out, not the probable depth of the net) with the greatest concentration of eggs at 300 to 400 meters. Schmidt has taken eggs between May and September in the eastern Atlantic, while Bigelow and Schroeder (1953) note the occurrence of eggs in the Gulf of Maine during April.

Although *A. silus* is not a commercially important species, it is fairly commonly encountered in commercial catches, particularly those of the otter trawlers. These catches indicate that the fish is not a solitary species, but may occur in large aggregations. Firth (1931) records a catch of 15,000 pounds on the edge of Georges Bank. Wilson (*in litt.*) mentions a catch of 1000 individuals south of Nova Scotia near the 100 fathom line. Boulenger (1900) notes a large catch from the Norwegian coast marketed in England.

A specimen of *A. silus* with a nearly complete set of scales seems more flexible than *A. sphyraena*. This may perhaps indicate that *A. silus* is a more powerful swimmer, which might be correlated with its more extensive bathymetric range and generally more oceanic habitat. I have examined the stomach contents of several American specimens and found partially digested shrimplike crustaceans. Kotthaus and Krefft (1957) note the occurrence of the bathypelagic fish, *Cyclothone braueri*, in the gut of *A. silus*.

Fridriksson (1937) studied the growth of *A. silus* off the coast of Iceland. He found that sexual maturity occurred at 8 to 15 years of age, that about 60 percent of his sample consisted of females, and that the time of spawning was probably April and May. He also found growth to be relatively slow after the first several years. His oldest but not largest specimen was 24 years old and had a standard length of 51.0 cm.

NOMENCLATURE.—*A. silus* was originally described by Ascanius as

a member of the genus *Salmo*. On the basis of Ascanius' poor figure, Cuvier (1817) referred the species to the genus *Coregonus*. Reinhardt (1833) differentiated the fish from both *Salmo* and *Coregonus*, chiefly on the basis of jaw structure, and he proposed a new genus and species, *Silus ascanii*. The first to demonstrate the true relationships of the fish by placing it in the genus *Argentina* was Risberg (1835). Still another generic name, *Acantholepis*, was proposed by Krøyer (1846-49) who recognized the close relationship to *A. sphyraena*, but separated the two species generically because Cuvier's (1815) description of *A. sphyraena* stated the latter species lacked scales, whereas Krøyer noted strongly developed ctenoid scales on his specimen of *A. silus*. Nilsson (1855) listed *Acantholepis silus* in the synonymy of *Argentina silus* with no comment. He has been followed in synonymizing the two genera by all subsequent authors. *A. silus* was first recorded from the American coast by Goode and Bean (1879), who described it as a new species, *A. syrtensium*. In 1895 the same authors referred their nominal species to the synonymy of *A. silus* where it has remained to this day.

Mention should also be made of Müller's 1776 work (p. 279 in the addendum, which is absent from some copies) in which he includes *Salmo immaculatus*, presumably of Linnaeus (1758) in the synonymy of *Salmo silus*. He has been followed in this by various authors, the most recent being Ehrenbaum (1901). If *S. immaculatus* Linnaeus is conspecific with *S. silus* Ascanius, the name *S. immaculatus* would take precedence by reason of being proposed 18 years earlier. There are, however, several reasons to question the identity of *S. immaculatus* Linnaeus with *S. silus* Ascanius. First of all, Linnaeus places *S. immaculatus* in the section characini of his genus *Salmo*. He defines the characini thus: "Membr. branch. radiis tantum IV." However, *A. silus* has 6 branchiostegals. Furthermore, the anal, pectoral, and ventral counts given by Linnaeus are one ray below the minima I have found in *A. silus*. In the "Systema Naturae" Linnaeus (1758) records *S. immaculatus* from America. However, Krøyer (1846-9) tells us that in the "Museum S.R.M. Adolphi Friderici" (1754) where Linnaeus first described the species, he listed it as coming from India, far out of the range of *Argentina silus*. Last of all, Linnaeus states of *S. immaculatus*, "S. corpore immaculato" which is certainly not true of *Argentina silus*. It seems safe to conclude, therefore, that *Salmo immaculatus* Linnaeus is not conspecific with *Argentina silus* (Ascanius).

SPECIMENS EXAMINED.—

Norway: Nordaland county, Lofoten, BM 5203 (1); Sogn og Fjordane county, Askvold, BM 1849 (1); Sogn og Fjordane county, Lysterfjord, BM 3319 (1); Roga-

land county, W. Salhaus, BM 4212 (1); Rogaland county, Gannsfjord, BM 3074 (3); Rogaland county, Baasfjord, BM 3052 (13).

Denmark: "Michael Sars" st. 323 in Skagerrak, BM 2417 (2) and 2299 (2).

Scotland: 58° 46.5' N/ 3° 52' E, SU 49525 (5); 58° 25' N/ 5° 00' E, SU 49526 (4).

Ireland: 50° 57' N/ 10° 46' W, BM 2516 (1).

Canada: Probably Gulf of St. Lawrence, ROMZ 17634 (1); Atlantic coast, ROMZ 17633 (1); 48° 28' N/ 63° 10' W, ROMZ 10365 (1); 43° 18' N/ 64° 14' W, NFRS, 4965, 4968-9 (3); 43° 39' N/ 59° 08' W, SU 49585 (24); 42° 41' N/ 64° 13' W, MCZ 37765 (1).

United States: Massachusetts Bay, MCZ 32715 (1).

Argentina sialis Gilbert

Argentina sialis Gilbert, 1890 : 56 (original description, type locality: 29° 54' 30" N/ 113° 01' W in the Gulf of California, "Albatross" st. 3017, 58 fathoms, holotype: in U.S. National Museum). Goode and Bean, 1895 : 510 (type locality incorrectly cited). Jordan and Evermann, 1896 (description after Gilbert). Meek, 1916 : 143 (type locality incorrectly listed as California coast). Higgins, 1920 : 86 (300 specimens taken off Huntington Beach, California). Ulrey and Greeley, 1928 : 4 (coast of California, Huntington Beach). Ulrey, 1929 : 3 (listed). Jordan, Evermann and Clark, 1930 : 68 (coast of California). Hubbs, 1932 : 105 (redescription of holotype, comparison with original description and Higgins' (1920) specimens). Barnhart, 1936 : 18 (description, coast of southern California). Follett, 1945 : 143, fig. 1 (description, 36° 45' N/ 121° 53' W, Monterey Bay, California, discussion of type locality and past records). Fitch, 1949 : 43 (6 miles east of Gaviota, California, vicinity of Pt. Conception, California). Clothier, 1950 : 37 (vertebral, dorsal and anal counts; Oceanside, Rincon Pt. near Santa Barbara, Pt. Vicente and Pismo Beach all in California). Fitch, 1950 : 68, fig. 15 (description, summary of all records plus additional records from southern California).

DIAGNOSIS.—This species can be separated from *A. sphyraena* and *A. silus* by its smooth instead of spiny scales and by its 5 instead of 6 branchiostegals. *A. sialis* agrees with the above two species and differs from *A. striata* and *A. elongata* in possessing a silvery swimbladder. It can be differentiated from all other species of *Argentina* except *A. silus* by its larger number of gill rakers on the lower arm of the 1st arch (14 to 21 in *A. sialis*, 11 to 15 in *A. silus*, 5 to 10 in all other species of *Argentina*).

COUNTS AND MEASUREMENTS.—Based on 50 specimens. D. 12 (11-13); A. 14 (13-15); pectoral 16 (15-18); ventral 11 (10-12); gill rakers 8 (7-9) + 1 + 17 (14-20); lateral line scales 49 (48-51); standard length 91.4-200.5 mm.; preanal 81.6 (77.7-84.2); preventral 51.3 (48.9-55.3); predorsal 45.3 (41.6-47.5); prepectoral 28.0 (26.0-30.1) head length 28.8 (27.3-31.2); snout 9.7 (8.9-10.5); eye 7.0 (6.1-7.9); maxillary length 6.8 (5.9-7.3); maxillary width 2.0 (1.6-2.3); depth at dorsal fin 16.9 (12.1-

19.0); width behind head 10.6 (9.1-14.9); head depth 13.4 (12.0-15.8); interorbital 6.5 (6.0-7.2); depth of caudal peduncle 6.8 (6.0-7.6); vertebral count of two specimens, one Monterey Bay, the other Santa Barbara, 49 (Clothier [1950] gives 47 to 49 including the hypural); pyloric caeca 8 and 12 in two specimens from Monterey Bay, 10 in a specimen from Santa Barbara.

DESCRIPTION.—Body elongate but relatively deep and laterally compressed. Greatest depth at the dorsal origin, tapering to the caudal peduncle. A lateral view shows the dorsal profile of the head descending in almost a straight line from the nape and unbroken by the dorsal edge of the eye. The ventral profile rises to the snout in a gentle curve. The interorbital space between the supraocular canals is broadly concave. The frontals lateral to the canals arch upwards very slightly. The head of recently preserved or formaldehyde specimens has clear hyaline tissue covering the top of the head from the interorbital area forward to the level of the nostrils, also on the side of the head over the anterior part of the opercle and preopercle, and continuously connected with the posterior adipose lid of the eye. A narrow band of this clear tissue runs under the eye and connects with the tissue filling the area bounded by the dorsal profile of the skull and the canals of the jugal and lachrymal. There is a deep fold in the hyaline tissue along a semicircle at the anterior edge of the eye. The tissue then extends posteriorly as the anterior adipose lid of the eye. The dorsal portion of the maxillary lies tucked under the lachrymal and in some specimens extends to the jugal as well. The posterior edge of the maxillary lies closer to the eye than to the snout. The epidermis covering the ventral edge of the maxillary bears minute papillae which extend onto the upper lip where they meet a similar band from the other side. These structures are visible to the naked eye in some specimens, while in others they are seemingly absent. (These papillae may be what Hubbs (1932) has called "very weak" premaxillary teeth. In examining more than 200 *A. sialis*, including a number of alizarin specimens, I have encountered no premaxillary teeth, nor indeed have I found them in any other argentinoid fishes. Histological studies on the related *A. silus* show that maxillary and premaxillary papillae strongly resemble structures on the tongue and in the mouth and pharynx which may be sensory in function.) A small knob is present below the symphysis of the lower jaw. Both the upper and lower jaws are broadly rounded. In most specimens the jaws are subequal, but in others the upper or lower may protrude slightly.

The palatines and the head of the vomer bear a band from 2 to 4 teeth wide composed of small, closely spaced, posteriorly directed

teeth. There are 30 to 40 teeth on each palatine and 40 to 50 on the vomer. E. H. Ahlström (*in litt.*) reports the presence of up to 12 pairs of dentary teeth in the larvae. I have not found teeth on the dentaries of adolescents or adults. Very small sensory papillae are present along the lateral edges of the tongue. The ceratobranchial of the 5th gill arch bears 11 to 15 small, conical teeth. Two oval patches of short, conical teeth, 6 to 9 on the anterior patch and 15 to 20 on the posterior patch, appear at the anterior end of the 4th suprabranchial. The gill rakers are elongate and relatively widely spaced and compressed. The 4th raker forward from the angle on the lower arm of the 1st arch is equal in length to between one-third and one-fourth of the inter-orbital distance. The rakers on the upper arm are fewer in number and much smaller anteriorly.

The pectoral fin originates slightly ahead of a vertical through the posterior tip of the opercle. The posterior end of the pectoral base forms an angle of 20 to 35 degrees with a plane parallel to the venter. The distance between the bases of the innermost rays is approximately equal to the least depth of the caudal peduncle. The greatest height of the dorsal fin is approximately equal to the depth of the body at the dorsal origin. The greatest height of the anal fin is equal to or slightly less than the depth of the caudal peduncle. The pectoral fins extend more than half the distance between the pectoral and ventral bases. The ventrals are slightly shorter than the pectorals.

The scales lack spines. Specimens with scales show an angular boxlike shape, but the body is more flexible than in *A. sphyraena*.

The peritoneum is silvery on its inner and outer surfaces and is lightly punctate with large chromatophores in a specimen from Montrey Bay, while an example from Santa Barbara is more densely punctate with smaller chromatophores. The gut is unspotted. The outer surface of the posterior curve of the stomach is smooth; the longest pyloric caeca extend to a point between the anterior and posterior curves of the stomach. From the caecal region of the gut the intestine runs to the anus in a straight line. The *Ringen* are weakly developed in the intestines of several specimens examined; however, the walls of the intestine are more muscular than in other species of *Argentina* and not at all transparent. The body cavities of all specimens examined contained considerable amounts of fat.

The swimbladder is heavily impregnated with silvery pigment and extends from the level of the anterior curve of the stomach to a point slightly past the origin of the ventral fins.

Two types of coloration are present in the fishes I have studied, undoubtedly caused by differences in preservation. Most of the speci-

mens are a uniform light brown with chromatophores scattered over the dorsum and the upper third of the sides. The muzzle is dusky, as is the nape and the upper portion of the opercle. The scales are iridescent. Other specimens have the body straw colored with a bright silvery band, about equal in width to the pupil, running along the side of the body at the level of the lateral line. The opercles, cheeks, isthmus, and irises are also bright silver. The body above the silvery band is slightly darker than the body below the band. The muzzle, nape, and dorsal third of the opercle are dusky. Adolescent specimens bear 8 to 10 dusky blotches along the upper half of the side.

DISTRIBUTION.—*Argentina sialis* has been recorded in California at various localities from Monterey Bay to Huntington Beach. The only other record is the type locality, off the coast of Sonora in the upper part of the Gulf of California (see Follett, 1945 for a discussion of the type locality and early records). E. H. Ahlstrom of the U.S. Fish and Wildlife Service has kindly furnished me with unpublished data on the distribution of *Argentina sialis* larvae during 1955, when larvae were taken from the Santa Barbara Channel south to Magdalena Bay. Dr. Ahlstrom states that the distributions in 1951 and 1952 were quite similar. During each of the 3 years larvae were most abundant at a locality slightly north of the north tip of Cedros Island, off the coast of Baja California. The U.S. Fish and Wildlife Service has also collected *Argentina sialis* at three localities inside the Gulf of California, two at the head of the Gulf, the third near the mouth of the Gulf on the west side.

HABITS.—The larvae and postlarvae are pelagic, while adults are generally taken closer to the bottom at depths ranging from 11 to 250 meters, the most common occurrence being between 50 and 80 meters. Fitch (1950), in summarizing 19 occurrences of *A. sialis* off California, concludes that seismic blasting during offshore oil explorations have shown this species to be more common than was previously thought. One of his records of interest is of a mixed collection of more than 1,000 pounds of *A. sialis* and the osmerid fish *Spirinchus starksi*; another is his record of three specimens taken from the stomach of a *Squalus*.

I found the stomach of a specimen of *A. sialis* from Monterey Bay tightly packed with small, stalk-eyed crustacea.

SPECIMENS EXAMINED.—

California: Monterey Bay, SU 36069 (1) and SU 35311 (2); Monterey Co., off Pt. Pinos, SU 49737 (3); San Luis Obispo Co., off Avila, UCLA W49-171 (3); 1-2 mi. below Pt. Conception, SU 15198 (2); Santa Barbara Co., 5-8 mi. east

of Gaviota, SU 15199 (1); Santa Barbara Co., 4½ mi. off Santa Barbara, UCLA W49-149 (5); vicinity of Santa Barbara, SIO 55-24 (7); 5 mi. southeast of Santa Barbara, SU 16873 (11); Santa Barbara Co., off Rincon Pt., UCLA W49-178 (7); Santa Barbara Channel off Rincon Pt., SIO 55-23 (58); 4½ mi. east of Santa Barbara, SIO 55-27 (33); Santa Barbara Channel, 34° 20' N/ 119° 34' W, SIO 55-26 (87) and SIO 55-25 (12); Santa Monica Bay, SU 35280 (6).

Argentina striata Goode and Bean

Argentina striata Goode and Bean, 1895 : 52, pl. 17, fig. 62 (original description, type locality: "Albatross" st. 2402, 28° 36' N/ 85° 33' 30" W, Gulf of Mexico south of Cape San Blas, Florida, 111 fms., syntypes: USNM 43858). Jordan and Evermann, 1896 : 526 (description, after Goode and Bean, *ibid.*). Gorman, 1899 : 403 (listed). Jordan, Evermann and Clark, 1930 : 68 (listed). Longley and Hildebrand, 1941 : 14 (Tortugas, 15 specimens, largest 190 mm., 160-190 fms.). Schroeder, 1955 : 362 (continental slope between Nova Scotia and Virginia, less than 200 fms.). Springer and Bullis, 1956 : 49 (localities in the Gulf of Mexico).

DIAGNOSIS.—This species can be separated from *A. silus*, *A. sphyraena*, and *A. sialis* by the absence of silvery pigment impregnating its swimbladder. It differs from *A. sphyraena* and *A. elongata* in having a higher pectoral ray count (18 to 20 in *A. striata*, 12 to 15 in *A. sphyraena*, and 13 to 17 in *A. elongata*). *A. striata* also differs from *A. elongata* in having more vomerine teeth (approximately 45 in *A. striata*, approximately 25 in *A. elongata*).

COUNTS AND MEASUREMENTS.—Based on 42 specimens. D. 11 (11-12); A. 13 (12-14); pectoral 19 (18-20); ventral 12 (11-13); gill rakers on first arch 3 (3-4) + 1 + 6; lateral line scale rows 51 (49-52); standard length 98.6-185.6 mm.; preanal 84.1 (81.6-86.5); preventral 55.0 (50.3-58.3); predorsal 47.3 (43.8-51.8); prepectoral 29.2 (26.8-33.0); head length 30.0 (26.1-34.3); snout 9.9 (8.5-11.1); eye 9.4 (7.3-11.0); maxillary length 5.5 (4.9-6.3); maxillary width 1.7 (1.3-2.0); depth at dorsal fin 12.8 (11.7-15.3); width behind head 11.3 (10.2-12.4); head depth 13.0 (12.0-14.9); interorbital 7.9 (6.9-8.9); depth of caudal peduncle 6.0 (5.5-6.8); vertebral count of three specimens 49; pyloric caeca of three specimens 9; branchiostegals 5.

DESCRIPTION.—Body elongate, slightly laterally compressed between the head and the dorsal base, more so from that point posteriorly. Greatest depth between the head and the dorsal origin, tapering to the caudal peduncle. The dorsal profile of the head descends in a gentle curve from the eye to the snout. The dorsal rim of the orbit projects slightly into the profile. The ventral profile of the head rises to the snout in an almost unbroken curve with a very slight angle at the union of the articular and the quadrate. The interorbital is broad

and flat between the supraocular canals, which are themselves raised slightly above the flat surface. Lateral to the canals the frontals are still further raised to accommodate the top of the eye. The dorsal edge of the maxillary lies under the lachrymal but does not extend to the jugal. The posterior edge of the maxillary lies slightly closer to the eye than to the snout. Extremely minute papillae are scattered on the membrane covering the maxillaries and premaxillaries of most specimens, but are seemingly absent in several. Both the upper and the lower jaws are rounded and the upper jaw projects slightly. The knob at the symphysis of the lower jaws is reduced or absent.

The palatines and the head of the vomer bear a continuous band of small, closely spaced, posteriorly directed teeth. The band varies in width from 1 to 3 teeth on the palatines to 4 to 5 on the vomer. There are about 35 teeth on each palatine and about 45 teeth on the vomer. The tongue bears 5 to 9 strong, recurved teeth. Sensory papillae were not observed on the tongue; however, many of the fishes examined had small, hemispherical protuberances raised from the surface and clustered along the tooth-bearing areas of the tongue. The ceratobranchial of the 5th gill arch bears 18 small, conical teeth. Two patches of short, conical teeth, about 11 teeth on the anterior patch and 17 teeth on the posterior patch, are present at the anterior end of the 4th suprabranchial. The gill rakers on the lower arm of the 1st arch are medium sized, very widely spaced, triangular in shape, and compressed. The base of the inner edge of each raker bears a fleshy pad. The 4th raker forward from the angle on the lower arm of the 1st arch is equal to slightly more than one-sixth of the interorbital distance. The 3 or 4 rakers on the upper arm decrease in size from the angle forward and are markedly smaller than those on the upper arm.

The pectoral fin usually originates in line with a vertical from the posterior tip of the opercles, although the origin may be ahead of or slightly behind this line. The posterior end of the pectoral base forms an angle of 40 to 60 degrees with a plane parallel to the venter. The distance between the bases of the innermost pectoral rays is slightly less than the least depth of the caudal peduncle. One specimen was noted which lacked the left ventral fin. No marks or scars of any sort were present, and dissection showed that the pelvic girdle on the left side was only partially formed. The fish seemed normal in all other respects.

The longest dorsal ray is equal to approximately the greatest depth of the body. The longest anal ray equals the distance between the bases of the outermost rays of the ventral fins. The tip of the pectoral fin extends to a point less than half the distance between the

anterior base of the pectoral and the anterior base of the ventral. The ventral fin is approximately equal in length to the pectoral fin.

The scales of this species are evidently very deciduous, for I have seen no specimens with complete squamation. Several specimens have a few scattered lateral line scales on the posterior half of the body. The scales are thin and lack spines.

The peritoneum is silvery on its outer surface; the dorsal half of the inner surface is lightly colored by large, relatively widely dispersed chromatophores; these are more closely crowded together on the ventral half of the body cavity and give this area a much darker appearance. The entire gut lacks pigment. The stomach runs forward to a point slightly anterior to the posterior tip of the pectorals before swinging downwards. The outer curve is smooth. The pyloric caeca extend to a point between the anterior and posterior curves of the stomach. Distal to the caecal section of the gut the intestine runs straight back to the anus as a narrow, thin-walled, transparent tube. About 12 or 13 weakly developed *Ringen* are present.

The swimbladder is similar to that of *A. sphyraena*, but lacks silvery pigment. In several specimens examined the bladder had an iridescent sheen.

In preserved specimens the ventral half of the body is light brown with a lighter brown band running along the lateral line, while a narrow dark brown band borders the dorsal edge of the lateral line band. The entire dorsum of the body is medium brown. The skin of some specimens gives an iridescent sheen and a few examples have the remnants of what must have been a broad silvery band running the length of the body with the lateral line as a dorsal border. The fins are all lightly flecked with brown except for the median half of the pectorals which are unspotted. The opercles of some specimens are bright silver, as are the cheeks, while in others the silver pigment has dissolved and the opercle is transparent with a sprinkling of chromatophores near the bottom and a rather thick concentration of chromatophores near the top. The top of the head is transparent posteriorly and translucent farther forward. The muzzle from the nostrils forward is dusky. Several specimens less than 97.0 mm. in standard length bear 11 faint dusky blotches along the dorsal half of each side of the body. I have been fortunate in being able to examine a postlarva of 35 mm. (through the courtesy of Giles W. Mead), and I find it bears a strong resemblance in color pattern to that of the postlarvae of *Glossanodon leioglossus* (see Schmidt, 1918). The specimen I examined bears distinctive transverse stripes along the body, one on the opercle, and one across the caudal fin. None of the stripes is continuous over

the dorsum, but the last 7 body stripes are continuous around the venter. The ventral fins are strongly pigmented, the bases of the pectorals less so.

DISTRIBUTION.—Until 1955 *A. striata* had been known from only two localities in the Gulf of Mexico. Recent biological explorations by the U.S. Fish and Wildlife Service in the western Atlantic have added considerably to our knowledge of the distribution of this species. Springer and Bullis (1956) list 26 localities for *A. striata*, ranging from north of the Yucatan Peninsula south to Campeche Bay and to the coasts of Texas, Louisiana, Alabama, Florida, and the vicinity of Tortugas. Schroeder (1955) captured *A. striata* at several localities off the Atlantic coast between the northern Gulf of Maine and the Virginia Capes at depths greater than 100 fathoms. I have also examined specimens from several places along the east coast of Florida and from the Atlantic coast of Venezuela southeast of Trinidad.

HABITS.—*A. striata* has been captured at depths ranging from 52 fathoms to 250 fathoms, although it has been taken most often between 100 and 200 fathoms, and most frequently over a mud bottom. All the specimens I examined from the Gulf of Mexico were taken in shrimp trawls which, according to Springer and Bullis (1956), selectively sample the area above but not directly on the bottom. Depth probably plays an important part in limiting the distribution of *A. striata* and perhaps other species of the genus as well. *A. striata* is conspicuously absent from the catches of the "Oregon" along an extensive stretch of the east coast of Mexico and the southeast coast of Texas and south coast of Louisiana. The station records of the "Oregon" given by Springer and Bullis (1956) show that most of the collecting in these areas was in depths shallower or much deeper than the known bathymetric range of *A. striata*.

The stomach and intestines of several specimens I examined were empty, but one from 163 fathoms at 25° 08' N/ 84° 19' W, northwest of Tortugas contained what appeared to be the remains of sponges with siliceous, monaxial spicules. Intermixed with the sponge remains were a considerable number of calcareous protozoan skeletons.

Nothing is known of the eggs and larvae of *A. striata*.

SPECIMENS EXAMINED.—

Venezuela: 9° 41' N/ 59° 47' W, USNM 159356 (3); 9° 45' N/ 59° 45' W, USNM 159357 (11) and UF 8026 (6); 9° 53' N/ 59° 53' W, UF 5237 (6).

Gulf of Mexico: 22° 41.9' N/ 86° 41.2' W, CNHM 45728 (1); 19° 37' N/ 92° 40' W, SU 49721 (1); 26° 46' N/ 96° 20' W, UF 1316 (2); 26° 55' N/ 96° 25.5' W, CNHM 46266 (2); 27° 15' N/ 96° 15' W, CNHM 45050 (1); 29° 15' N/ 88° 18' W, SU 49727 (1); 29° 15.5' N/ 87° 53' W, SU 17441 (1); 29° 20' N/ 87°

42' W, CNHM 46269 (5) and SU 49722 (4); 29° 27.5' N/ 87° 26.5' W, CNHM 46268 (2) and SU 49723 (3); 28° 30' N/ 86° 11' W, SU 49724 (2); 28° 19' N/ 86° 04' W, CNHM 45932 (2); 29° 09' N/ 85° 59' W, SU 49725 (4); 28° 48' N/ 85° 40' W, CNHM 46270 (12); 25° 08' N/ 84° 19' W, CNHM 59880 (21) and SU 49726 (4).

Atlantic between Florida and Virginia: 28° 03.5' N/ 79° 55.5' W, SU 49754 (3); 29° 47' N/ 80° 12' W, SU 49755 (1); 37° N/ 74° W, MCZ 38305 (1); 37° 38' N/ 74° 15' W, MCZ 38213 (1).

Argentina elongata Hutton

See subspecies for synonymies and counts and measurements.

DIAGNOSIS.—*A. elongata* differs from *A. sphyraena* and *A. silus* in having only 5 branchiostegals instead of 6 and in having smooth rather than spiny scales. It further differs from the above two species and from *A. sialis* as well in lacking silvery pigment on the swimbladder. It can also be distinguished from *A. sialis* by having fewer gill rakers on the lower arm of the 1st arch, (5 to 10 in *A. elongata*, 14 to 21 in *A. sialis*). It differs from *A. striata* in having a lower pectoral fin count (13 to 17 in *A. elongata*, 18 to 20 in *A. striata*), and in having fewer vomerine teeth (approximately 25 in *A. elongata*, approximately 45 in *A. striata*).

DESCRIPTION.—Body elongate, adults slightly laterally compressed to the dorsal fin, more so posteriorly; adolescent specimens almost square in cross-section. A lateral view shows the dorsal profile of the head descending to the snout in a gentle curve which is not broken by the dorsal edge of the orbit. The ventral profile of the head rises more gently in an unbroken line to the snout. Both the upper and lower jaws are broadly rounded, with the lower jaw bearing only a slight suggestion of a point below the symphysis.

The gill rakers are short, widely spaced, triangular in shape, and compressed. The bases of the inner edges of the rakers on the lower arm of the 1st arch bear fleshy pads.

The pectoral fin usually originates in line with a vertical from the posterior tip of the opercle. The posterior end of the pectoral base forms an angle of 35 to 45 degrees with a plane parallel to the venter. The distance between the innermost rays of each pectoral fin is equal to or greater than the least depth of the caudal peduncle. The longest dorsal ray is equal to or greater than the depth of the body at the dorsal origin. The longest anal ray is approximately equal to the distance between the bases of the outermost rays of the ventral fins.

The scales are deciduous, but scattered patches on specimens of each of the three subspecies indicate they mold the body into the typi-

cal, boxlike *Argentina* shape when a full set of scales is present. The scales lack spines.

The gut is unpigmented.

The swimbladder lacks silvery pigment, but in other respects seems similar to that of *A. sphyraena*. The anterior end is slightly anterior to the level of the posterior curve of the stomach, while the posterior end is at the level of the ventral fins.

GEOGRAPHICAL VARIATION.—Although series of *A. elongata* from Australia and New Zealand and *A. kagoshimae* from Japan are separable by a combination of characters, the three populations do not seem sufficiently divergent morphologically to warrant recognition as full species. Therefore I accord them subspecific rank.

Key to the Subspecies of *Argentina elongata*
(See also table 2)

- 1a. Gill rakers on lower arm of 1st arch 6 (5-7)
 - 2a. Pectoral rays 16 (15-17); maxillary length 4.2 (3.7-4.6) percent of standard length . *Argentina elongata kagoshimae* p. 141
 - 2b. Pectoral rays 13 (13-14); maxillary length 5.4 (4.9-5.9) percent of standard length . *Argentina elongata australiae* p. 138
- 1b. Gill rakers on lower arm of 1st arch 9 (8-10); pectoral rays 15 (13-16); maxillary length 5.1 (4.2-5.7) percent of standard length
 *Argentina elongata elongata* p. 135

TABLE 2

VARIATION IN NUMBER OF GILL RAKERS ON LOWER ARM OF FIRST ARCH AND IN NUMBER OF PECTORAL RAYS IN THREE SUBSPECIES OF *Argentina elongata* Hutton.

	Gill rakers					Pectoral rays					
	5	6	7	8	9	10	13	14	15	16	17
<i>A. e. kagoshimae</i>	2	10							6	9	2
<i>A. e. australiae</i>		9	1				8	3			
<i>A. e. elongata</i>				5	12	13	1	9	9	1	

A. e. australiae is closer to *A. e. kagoshimae* with regard to gill raker counts, while it agrees with *A. e. elongata* in having a relatively longer maxillary than *kagoshimae*. *A. e. elongata* is intermediate between the other two forms with regard to pectoral rays. Other less distinctive

differences between the subspecies are presented in the descriptions which follow.

NOMENCLATURE.—*Argentina elongata* Hutton, 1879 should not be confused with *Argentina elongata* Weiler, 1943, a species described from a fossil otolith from the early Tertiary of southern Rumania. I informed Dr. Weiler that his fossil species is a homonym of *A. elongata* Hutton; he replied that he intends to emend the name of his fossil species in one of his next publications.

Argentina elongata elongata Hutton

Figure 7

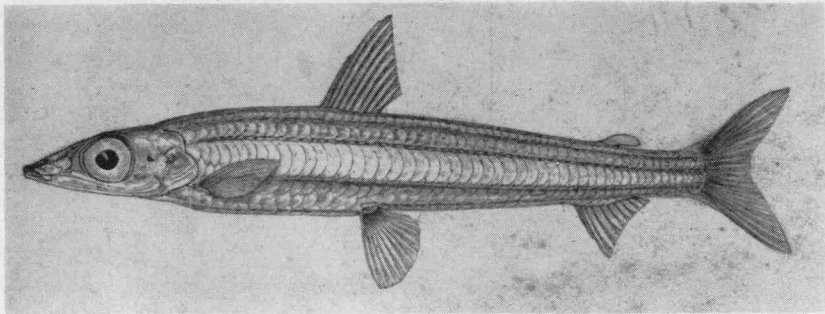


Figure 7.—Photograph of a watercolor sketch of the holotype of *Argentina decagon* by F. E. Clarke. Published with the permission of the Dominion Museum, Wellington, New Zealand.

Argentina elongata Hutton, January 1879 : 53 (original description, type locality: Cape Campbell, Marlborough, South Island, New Zealand, holotype: British Museum). Günther, 1887 : 218, pl. 55, fig. B (redescription and figure of holotype). Goode and Bean, 1895 : 52 (in key). Hutton, 1904 : 51 (listed). Waite, 1907 : 10 (listed). Waite, 1911 : 161, pl. 24 (description, synonymy, Otago to Bay of Plenty, Chatham Islands, 16-105 fathoms). Waite, 1923 : 63, fig. (in part, description, distribution). Phillipps, 1927a : 14 (synonymy). Phillipps, 1927b : 11 (listed). Graham, 1939 : 402 (in and around Otago Harbor, New Zealand). Phillipps, 1940 : 45, fig. (description, synonymy). Graham, 1953 : 121, fig. (description, distribution, habits, food). Munro, 1957 : 15, fig. 199 (in part, description, distribution).

Argentina decagon Clarke, May 1879 : 295, pl. 14 (original description, type locality: South Spit, Hokitika, South Island, New Zealand, holotype: unknown). Gill, 1893a : 112 (listed). Waite, 1907 : 10 (listed).

Argentina sphyraena Günther, 1887 : 218 (in part, listed). Hutton, 1904 : 51 (in part, listed).

COUNTS AND MEASUREMENTS.—Based on 21 specimens. D. 11 (10-12); A. 13 (11-14); pectoral 15 (13-16); ventral 11 (11-13); gill rakers on

first arch 2 (1-3) + 1 + 6 (6-7); lateral line scale rows 54 (51-54); standard length 78.9-216.0 (Graham [1953] states this fish reaches a size of 18 inches [511.2 mm.]); preanal 82.8 (79.2-85.2); preventral 51.7 (49.3-59.7); predorsal 45.2 (42.5-47.6); prepectoral 28.0 (25.2-30.0); head length 28.0 (25.2-30.0); snout 9.8 (8.9-10.8); eye 8.0 (6.8-9.2); maxillary length 5.1 (4.2-5.7); maxillary width 1.5 (1.3-1.6); depth at dorsal fin 13.3 (11.9-15.3); width behind head 9.6 (8.4-11.3); head depth 12.1 (10.9-13.6); interorbital 6.6 (6.2-7.2); depth of caudal peduncle 6.3 (5.7-6.9); vertebral count of two specimens 53 and 54; pyloric caeca in two specimens 12 and 13; branchiostegals 5.

DESCRIPTION.—Greatest depth at dorsal origin, tapering to caudal peduncle. The medial area of the interorbital, between the supraorbital canals, is flat. The canals are only slightly raised above the medial area. The supraorbital portions of the frontals lateral to the canals are raised only slightly if at all from the level of the canals. Well-developed adipose eyelids are present. The posterior lid is continuous with a clear, hyaline layer covering the cheek, while the anterior lid extends forward for a distance about equal to the width of the iris and then doubles back on itself for about a third of the above distance and then runs forwards to the level of the nostrils. The area bounded by the frontals and the canal running from below the eye to a point immediately below the nostrils is covered by the anterior extension of the adipose eyelid. The dorsal edge of the maxillary usually lies under the lachrymal only, but in some specimens extends to the joint between the lachrymal and the jugal. The posterior tip of the maxillary is about midway between the tip of the eye and the snout. The membranes covering the ventral edge of the posterior portion of the maxillary bear papillae only in larger specimens. Much weaker papillae are present on the epidermal covering of the premaxillary in larger specimens. The upper jaw projects slightly in most specimens but is subequal in several.

The palatines and the head of the vomer bear an irregular band of small, closely spaced, posteriorly directed teeth from 2 to 3 teeth wide. There are about 30 teeth on each palatine and about 25 teeth on the vomer. The tongue is armed with 4 to 8 strong, recurved teeth. Strongly developed papillae are present along the lateral edge of the tongue. The ceratobranchial of the 5th gill arch bears 15, small conical teeth. Two oval-shaped patches of short conical teeth, about 8 teeth on the anterior patch and 17 on the posterior patch, are present at the anterior end of the 4th suprabranchial. The 4th raker forward from the angle on the lower arm of the first arch is equal in length to

about one-seventh of the interorbital distance. The rakers on the upper arm are much reduced in size.

The peritoneum is lightly stippled with chromatophores; these are closer together on the ventral portion and make this area slightly darker. The outer curve of the stomach bears a small protuberance. The thin-walled intestine has about 13 well-developed *Ringen* in a specimen 170 mm. in standard length. A considerable amount of fat is present in the body cavity. Several examples I examined were heavily parasitized with roundworms.

The body color in alcohol is a uniform brownish yellow. The caudal and dorsal fins bear a few scattered chromatophores, the other fins are unmarked. The opercle is silvery and the top of the muzzle is darkly pigmented. The top of the skull behind the eyes is reddish brown where the pigment on the inner surfaces of the brain case shows through the transparent cranium. Graham (1953) describes live fish as follows: ". . . glistening, silvery body, though in medium sized fish the colour is yellowish with pale brown criss-cross bands, but these bands do not extend below the lower half of the body. There is a bright, polished, glistening silvery band along the middle of each side over the lateral line. The fish has blue eyes, with a silvery patch above the pupil."

DISTRIBUTION.—The northernmost record for *A. e. elongata* is the Bay of Plenty on the North Island of New Zealand. It has been taken at various localities along the east coasts of both North and South Islands as far south as Dunedin and has also been recorded from the Chatham Islands. Hokitika, the type locality of *A. decagon* on the west coast of South Island, is the only locality recorded for *A. e. elongata* in the Tasman Sea.

HABITS.—The known bathymetric range is between the surface and 105 fathoms. Graham (1953) gives considerable data on the habits of this fish around Otago Harbor, where he has found them most often in tidal areas. They are taken on hook and line, but mostly in seines and trawls. He also notes seasonal migrations into and out of the harbor, but his data on this point seem rather confused. He gives further information indicating the populations of this species in the Otago area are subject to considerable fluctuations in abundance. He notes population increases for 1916, 1924 to 1925, and 1930 to 1933. *A. e. elongata* was canned at one time in New Zealand; however, a decline in the catch ended the enterprise. It is of interest to note a general agreement between those periods of abundance of *Argentina* and periods of abundance Graham (1953) gives for the New Zealand species of

Sardinops. He states the most common food of *Argentina* consists of, "crabs (especially *Cyclograpsus lavauxi*), Whalefeed, isopods and worms (especially *Glycera ovigera*)." He also found that red cod (*Physiculus bachus*) and groper (*Polyprion oxygeneios*) were predators of *A. e. elongata*. Live *Argentina* invariably died from scale loss when transported for aquarium exhibits.

NOMENCLATURE.—This form was first described in January of 1879 by Hutton as *Argentina elongata*. In May of the same year it was re-described as *Argentina decagon* by Clarke, who had evidently not seen Hutton's description. Günther (1887) recognized *A. elongata*, but placed *A. decagon* in the synonymy of *A. sphyraena*. He was followed in this by Hutton (1904). In 1907, Waite listed both *A. elongata* and *A. decagon* with no comment, but in 1911 he pointed out Günther's error and placed *A. decagon* in the synonymy of *A. elongata*, an arrangement that all later authors have followed.

SPECIMENS EXAMINED.—

New Zealand: North Island.—Bay of Plenty, DMW (1); Castlepoint, on east coast, SU 49732 (3). South Island.—Off Cape Campbell, SU 49527 (4), SU 49729 (12), DMW (2).

Argentina elongata australiae, new subspecies

Argentina elongata McCulloch, 1911 : 18 (description, Oyster Bay, Tasmania; east coast of Flinders Island, Bass Strait, 30 fms.; 15 miles off Norah Head, New South Wales, 45-58 fms.). McCulloch, 1914 : 87 (80 miles west of the meridian of Eucla, Western Australia, 80-120 fms.). McCulloch, 1921 : 29, pl. 6, fig. 61a (key, references, figure of *A. e. elongata* from Waite, 1911). Waite, 1921 : 42, fig. 61 (synonymy, record from McCulloch, 1914; figure of *A. e. elongata* from Waite, 1911). Waite, 1923 : 63, fig. (in part, description, figure of *A. e. elongata* from Waite, 1911). Lord and Scott, 1924 : 34 (description, Tasmanian records). Waite, 1928 : 4 (listed). McCulloch, 1929 : 44 (listed). Norman, 1937 : 52 (42° 40' S/ 148° 27' 30" E, off Tasmania). Fairbridge, 1951 : 122 (food of *Neoplatycephalus macrodon*, localities along the southeast coast of Australia between Newcastle, New South Wales and Gabo Island, Victoria; 38-65 fms.). Whitley, 1954 : 29 (seined off Pt. Phillip, Victoria). Munro, 1957 : 15, fig. 199 (in part, description, distribution, figure of *A. e. elongata* from Waite, 1911).

COUNTS AND MEASUREMENTS.—Based on 12 specimens. D. 11 (10-12); A. 13 (12-13); pectoral 13 (13-15); ventral 12 (11-13); gill rakers 1 (1-2) + 1 + 6 (6-7); lateral line scale rows 54 (51-54); standard length 61.1-123.0 mm. (McCulloch [1911] records a specimen 125 mm. long); preanal 83.8 (82.5-85.0); preventral 53.0 (50.6-54.8); predorsal 45.5 (43.9-47.0); prepectoral 28.7 (26.3-30.1); head length 28.3 (22.8-30.4); snout 9.9 (9.4-10.4); eye 8.2 (7.5-9.7); maxillary length 5.4 (4.9-5.9);

maxillary width 1.4 (1.2-1.5); depth at dorsal fin 10.8 (10.1-11.5); width behind head 10.3 (9.5-11.0); head depth 11.0 (10.5-11.4); interorbital 7.1 (6.6-7.8); least depth of caudal peduncle 5.5 (4.8-6.2); vertebral count of one specimen 50; pyloric caeca in one specimen 6; branchiostegals 5.

DESCRIPTION.—Greatest depth between head and dorsal origin, tapering to the caudal peduncle. The medial area of the interorbital, between the supraorbital canals, is weakly concave. The canals are only slightly raised above the medial area. The supraorbital portions of the frontals lateral to the canals are flush with, or below the level of the canals. Remains of adipose eyelids are present in several specimens. The dorsal edge of the maxillary lies under the lachrymal only and does not extend to the jugal. The posterior edge of the maxillary lies midway between the snout and the anterior edge of the eye. No papillae are found on the epidermal covering of the maxillary and premaxillary, possibly because I have only relatively small specimens. The upper jaw projects slightly. The palatines and the head of the vomer bear an irregular band of small, closely spaced, posteriorly directed teeth from 2 to 4 teeth wide. There are about 25 teeth on each palatine and about 25 teeth on the vomer. The tongue is armed with 5 to 9 strong, recurved teeth. Papillae are present on the tongue. About 8 small, conical teeth are present on the ceratobranchial of the 5th gill arch. Two oval-shaped patches of short, conical teeth, about 5 teeth on the anterior patch and 13 on the posterior patch, are present at the anterior end of the 4th suprabranchial. The 4th gill raker forward from the angle on the lower arm of the first arch is equal in length to about one-ninth of the interorbital distance. The rakers on the upper arm are reduced to small stubs. The tip of the pectoral fin extends to a point less than halfway between the anterior base of the pectoral and the anterior base of the ventral. The ventral fin is approximately the same length as the pectoral.

The peritoneum has a silvery outer surface and is punctate on its inner surface. The muscular stomach runs posteriorly only for a short distance after entering the body cavity and then swings downward. The outer surface of the curve is smooth. The pyloric caeca extend past the curve of the stomach. The *Ringen* of an example 86 mm. in standard length are so poorly differentiated from the *Grundnetze* that it is impossible to count them with certainty.

Many of the paratypes have been preserved in a manner that has left a considerable amount of silvery pigment on the specimens. The body of the fish below the lateral line is straw colored except for a

silver stripe running from the head to the base of the caudal fin immediately below the lateral line. At its anterior end the stripe is equal in width to the vertical diameter of the pupil; it becomes narrower as it runs posteriorly. The body above the lateral line is slightly darker. Along the upper half of the body are 9 to 11 dark blotches which are not continuous over the dorsum. In some specimens the posterior 5 blotches alternate with smaller blotches placed along the lateral line. The opercle, cheeks, isthmus, and iris are a bright silver. The posterior part of the cranium is transparent, the anterior part translucent, and the upper part of the muzzle is dusky. The scales are iridescent.

DISTRIBUTION.—First recorded from Australian waters by McCulloch (1911) who found the subspecies at Tasmania, Bass Straits and the southern coast of New South Wales. Since that time it has been recorded north to Newcastle along the coast of New South Wales. The westernmost record is McCulloch (1914) near Eucla on the Great Australian Bight.

HABITS.—Most of the available information on the habits of this fish is given incidentally by Fairbridge (1951) in his study of the biology of *Neoplatycephalus macrodon*, a species taken by the southeastern Australia trawl fishery. *Argentina* was taken at depths ranging from 38 to 65 fathoms, generally over a mud bottom and in company with *Apogonops anomalus*, *Trachichthodes affinis*, and *Chlorophthalmus nigripinnis* as well as *Neoplatycephalus*. *Argentina* was found to be of some importance as a forage species for *Neoplatycephalus*, especially in Tasmania. Fairbridge notes that most of the *Chlorophthalmus* taken were juveniles and that size and abundance were correlated with depth. This may also be true of *Argentina* in Australia, as all the specimens I have examined from fisheries collections have been juveniles and the southeastern Australia trawl fishery is centered in waters generally shallower than the bathymetric center of distribution of other species of *Argentina*.

NOMENCLATURE.—The name *australiae* refers to Australia, the habitat of this subspecies.

SPECIMENS EXAMINED.—

Australia:

Holotype.—New South Wales, off Eden, collected November 1948, received from Ian Munro, SU 49730.

Paratypes.—Data as for the holotype, SU 49731 (1); Victoria, within 50 miles of Lakes Entrance (38° S/ 148° E), 20-30 fathoms, collected by

fishermen from the throats of *Neoplatycephalus macrodon* from January to June 1955, received from Dudley E. Kurth, SU 49528 (12).

Argentina elongata kagoshimae Jordan and Snyder

Argentina kagoshimae Jordan and Snyder, 1902 : 590, fig. 5 (original description, holotype SU 6854, poor condition, type locality: Kagoshima, Kyushu, Japan). Jordan, Tanaka, and Snyder, 1913 : 46 (listed). Schmidt, 1931 : 21 (description, Nagasaki, Kagoshima). Tanaka, 1931 : 49 (in part, listed, synonymy). Okada, Uchida, and Matsubara, 1935 : 73 (description). Matsubara, 1943 : 64, figs. 16, 17 (description, references, comparisons with *A. semifasciata*, Kunino-Nada, off Maisaka). Kamohara, 1952 : 13 (description, Prov. Tosa, Shikoku, Japan). Böhlke, 1953 : 16 (holotype in Stanford Museum). Matsubara, 1955 : 216, pl. 14, fig. 54 (description, distribution).

COUNTS AND MEASUREMENTS.—Based on 17 specimens. D. 11 (10-12); A. 12 (11-13); pectoral 16 (15-17); ventral 12 (11-12); gill rakers 2 (0-3) + 1 + 6 (5-6); lateral line scale rows 54 (51-54); standard length 61.0-200.5 mm. (Kamohara [1952] reports a specimen 220 mm. in standard length); preanal 85.0 (83.1-87.2); preventral 50.7 (48.0-52.5); predorsal 43.1 (41.8-45.2); prepectoral 26.2 (23.8-27.9); head length 26.6 (24.0-27.9); snout 9.1 (8.2-10.0); eye, 7.8 (5.9-9.8); maxillary length 4.2 (3.7-4.6); maxillary width 1.4 (1.2-1.5); depth at dorsal fin 12.5 (10.4-14.7); width behind head 11.0 (9.4-12.1); head depth 11.1 (10.4-12.6); interorbital 7.1 (6.4-8.2); depth of caudal peduncle 5.8 (5.5-6.4); vertebral count 51 in two specimens; pyloric caeca in two specimens 12 (Matsubara [1943] gives 9 to 11); branchiostegals 5.

DESCRIPTION.—Greatest depth at the dorsal origin, tapering to the caudal peduncle. The medial area of the interorbital between the supraorbital canals is weakly concave. The canals are only slightly raised above the medial area. Supraorbital portions of the frontals lateral to the canals are raised only slightly, if at all, from the level of the canals. The dorsal edge of the maxillary lies under the lachrymal only and does not extend to the jugal. The posterior edge of the maxillary lies closer to the snout than to the eye. The membrane covering the ventral edge of the posterior portion of the maxillary bears minute papillae only in larger examples. Papillae are seemingly absent on the covering of the premaxillary. The upper jaw projects slightly. The palatines and the vomer bear a band from 2 to 4 teeth wide composed of small, closely spaced, posteriorly directed teeth. There are approximately 45 teeth on each palatine and about 25 teeth on the vomer. The tongue is armed with 5 to 9 strong, recurved teeth. Papillae about half as long as the tongue teeth are present on the lateral margins of the tongue (see Matsubara, 1943, fig. 17). On the ceratobranchial of the 5th gill arch are 8 to 12 small, conical teeth. Two oval-shaped patches of short, conical teeth, about 7 teeth on the

anterior patch and 14 teeth on the posterior patch, are present at the anterior end of the fourth suprabranchial. The 4th raker from the angle on the lower arm of the 1st arch is equal in length to about one-eighth of the interorbital distance. The rakers on the upper arm, when present, are reduced to small stubs.

The tip of the pectoral fin extends to a point about half the distance between the anterior of the pectoral base and the anterior of the ventral base. The ventral fin is approximately the same length as the pectoral fin.

The peritoneum is lightly stippled with chromatophores which, being closer together on the ventral portion give this area a slightly darker appearance. The stomach runs posteriorly only a short distance before swinging downwards. The outer surface of the curve is smooth. The longest caeca extend beyond the curve of the stomach. The gut runs straight back from the caecal portion of the stomach. The thick-walled intestine has 10 or 11 weakly developed *Ringen* in a specimen 121 mm. in standard length. A considerable amount of fat is present in the body cavity.

The color of preserved specimens is light brown ventrally, slightly darker dorsally. Along each side of the body above the lateral line are 10 or 11 dusky, well-defined blotches in specimens as large as 160 mm. in standard length. Between each of the well-defined blotches is a lighter-colored smaller blotch. The fins have only an occasional chromatophore. The muzzle and the dorsal third of the opercle is dusky; the remainder of the head is unpigmented.

DISTRIBUTION.—As far as known this subspecies is restricted to Japan, where it is found along the coasts of Kyushu, Shikoku, and the southern half of Honshu. The northernmost record along the Pacific coast of Japan is given by Matsubara (1943) as "off Maisaka" (roughly 34° 45' N/ 137° 40' E). *A. e. kagoshimae* has been taken on Kyushu Island as far south as Kagoshima and also at Nagasaki. There is no record in the literature for the Sea of Japan; however, I have examined a single specimen with locality data "probably Uōzu or Namerikawa," both of which are on Toyama Bay on the Japan Sea.

HABITS.—Matsubara (1943) has taken this form at depths of approximately 125 fathoms.

SPECIMENS EXAMINED.—

Japan

Honshu: probably Uotsu or Namerikawa, on Toyama Bay, Japan Sea, TU 46255 (1); Mie Prefecture, off Owashi, SU 49530 (10).

Shikoku: Kochi Prefecture, off mouth of Ukitsu River, TU 39178 (1).

Kyushu: Nagasaki, TU 2689, (1), TU 32251-3 (3); Kagoshima, SU 6854 (1), holotype; Kagoshima, Sakurajima, off Kurokami Village, TU 44274 (1); Kagoshima Market, TU 24146 (1), TU 23882 (1).

GENUS GLOSSANODON GUICHENOT

Glossanodon Guichenot, 1867 : 7 (type species *Argentina leioglossa* Valenciennes, 1848, by original designation).

Argentinine fish that have the medial ends of their maxillaries in contact or separated by a narrow space less than one-fourth the width of the narrow, underlying mesethmoid. The medial portion of the maxillary is enlarged in some species. Distal to the median line the maxillary sends down a prong (not shown in fig. 5a) which articulates with the posterior face of a prong sent up by the premaxillary.

The vomerine dentition consists of small, conical teeth placed in an irregular row across the head of the vomer and set back from the edge a distance equal to three or more times the length of a tooth. The palatine dentition varies in the subgenera. The palatine and vomerine teeth are easily distinguished, as an area of unossified cartilage generally separates the two bones. The lingual teeth, when present, are placed only at the anterior end of the tongue and are absent along the lateral edges.

Anteriorly the body is laterally compressed slightly, posteriorly more so. A slight but distinct knob is usually present below the symphysis of the dentaries. The posterior tip of the maxillary is closer to the eye than to the snout. The distance between the bases of the innermost rays of each pectoral fin is approximately equal to the least depth of the caudal fin. As far as known, the scales lack spines.

HISTORY.—Guichenot proposed the genus *Glossanodon* for *Argentina leioglossa* on the basis of the absence of tongue dentition. The genus never gained recognition. Furthermore, more careful observations by Schmidt (1918) showed that small teeth are present on the tongues of many specimens. Chapman (1942) listed *Glossanodon* as a synonym of *Argentina*. In this paper I have removed *Glossanodon* from synonymy and assigned to it the species *G. semifasciatus*, *G. polli*, *G. lineatus*, and *G. pygmaeus*, as well as the type species.

Key to the Subgenera and Species of *Glossanodon*

- 1a. Distance from vent to anterior end of anal fin base equal to or less than half the depth of caudal peduncle; lateral line scale rows 48 to 56; pectoral rays 18 to 22; dentary teeth present in most adults. (Subgenus *Glossanodon* p. 144.) 2

- 2a. Dentary teeth not extending more than half the distance from the angle of the gap to the symphysis of the dentaries 3
- 3a. Stomach with dark pigment; medial ends of maxillaries without large knobs . . . *Glossanodon leioglossus* p. 144
- 3b. Stomach without dark pigment; medial ends of maxillaries with large knobs . . . *Glossanodon semifasciatus* p. 148
- 2b. Dentary teeth always extending more than half the distance from the angle of the gape to the symphysis of the dentaries, usually to the symphysis 4
- 4a. Lateral line scales 48 to 51; branchiostegals 5 *Glossanodon polli* p. 151
- 4b. Lateral line scales 56; branchiostegals 4 *Glossanodon lineatus* p. 154
- 1b. Distance from vent to anterior end of anal fin base equal to or greater than the depth of the caudal peduncle; lateral line scales 43 to 46; pectoral rays 12 to 14; dentary teeth absent in adults. (Subgenus *Prosoarchus* p. 155.) . . . *Glossanodon pygmaeus* p. 156

Subgenus *Glossanodon* Guichenot

The subgenus *Glossanodon* differs from the subgenus *Prosoarchus* in having the anus closer to the anterior end of the anal fin base, a distance equal to one half or less, than the depth of the caudal peduncle in *Glossanodon*, compared to a distance equal to or greater than the depth of the caudal peduncle in *Prosoarchus*. Furthermore, dentary teeth are present in most adult specimens of each of the species of *Glossanodon*, while dentary teeth are absent in adult specimens of *Prosoarchus*. *Glossanodon* also has a lateral line count of 49 to 56 compared to 44 to 46 in *Prosoarchus*, and a pectoral ray count of 18 to 22 compared to 12 to 14 in *Prosoarchus*.

Glossanodon (*Glossanodon*) *leioglossus* (Valenciennes)

Argentina leioglossa Valenciennes, 1848 : 27, fig. 624 (original description, type locality: harbor of Alger, Algeria; syntypes: in Paris Museum, poor figure). Guichenot, 1850 : 97 (description of syntypes). Schmidt, 1918 : 1, figs. 1 (1), 2-5, chart 1 (comparison with *A. sphyraena*, figures of postlarvae, Cadiz Bay, southern Mediterranean coast of Spain, Corsica, Sardinia, near Naples, Tunisia, Algeria). De Buen, 1926 : 49 (Gulf of Málaga, Spain). Sanzo, 1933 : 22, pl. 2, figs. 1-11 (description of developmental stages from egg to 42.4 mm., comparisons with developmental stages of *A. sphyraena*, Tyrrhenian Sea, Straits of Messina, Ionian Sea). De Buen, 1935 : 47 (references). Bertin, 1940 : 307 (paratypes = syntypes in Paris Museum). Lozano Rey, 1947 : 131, fig. 29 (description, distribution). Karlovac, 1949 : 127, figs. 1-3, 1 map (postlarvae in the Adriatic).

Argentina lioglossa Günther, 1866: 204 (emendation of *A. leioglossa*, description).
Günther, 1887: 217 (listed). Carus, 1893: 556 (description). Soljan, 1948:
185, fig. (description).

Glossanodon leioglossum Guichenot, 1867: 7 (description).

Argentina sphyraena Giglioli, 1880: 12 (in part, variability in dentition of tongue,
lumps *A. sphyraena* and *A. lioglossa*). Goode and Bean, 1895: 51 (in part,
description, synonymy). Meek, 1916: 143 (in part, distribution).

Argentina silus (non Ascanius) Murray and Hjort, 1912: 394, fig. 261 (26° 03' N/
15° 00' W, figure is *A. silus* [Ascanius] after Smitt). Fowler, 1936: 196, fig.
84 (after Murray and Hjort, 1912, figure is *A. silus* [Ascanius] after Goode
and Bean).

DIAGNOSIS.—This species can be distinguished from *G. semifasciatus* in having dark pigment on the stomach, and in lacking knobs on the medial ends of the maxillaries. *G. leioglossus* differs from *G. lineatus* in having a lower anal fin ray count (11 to 13 in *G. leioglossus*, 15 in *G. lineatus*), a lower lateral line count (49 to 50 in *G. leioglossus*, 56 in *G. lineatus*), and a higher branchiostegal ray count (5 in *G. leioglossus*, 4 in *G. lineatus*). *G. leioglossus* differs from *G. polli* and *G. lineatus* in having dentary teeth extending only half the distance from the gape to the symphysis, while in the latter two the dentary teeth extend to, or almost to the symphysis.

COUNTS AND MEASUREMENTS.—Based on four specimens. (Also included are several measurements given by Schmidt (1918) based on six specimens 25.5-88.0 mm. in standard length.) D. 13 (13-14); A. 12 (11-13); pectoral 21 (20-22); ventral 12; gill rakers on first arch 11 + 1 + 24 in a specimen from the Adriatic; lateral line scale rows 49-50; standard length 51.0-111.0 (Karlovac [1949] lists a specimen of 14 cm.); preanal 82.7 (81.3-85.2); preventral 53.8 (52.7-54.9), Schmidt gives 51.0-54.3; predorsal 49.5 (49.4-49.7), Schmidt gives 47.1-50.0; prepectoral 30.8 (29.7-32.3); head length 30.7 (29.9-32.3), Schmidt gives 26.0-30.1; snout 9.5 (9.0-10.3); eye 9.3 (9.0-9.4); maxillary length 8.4 (8.0-8.6); maxillary width 3.0 (2.9-3.4); depth at dorsal fin 12.3 (11.4-13.9); width behind head 10.6 (9.9-11.9); head depth 13.7 (13.5-14.1); interorbital 7.3 (7.2-7.4); depth of caudal peduncle 6.4 (5.5-7.2); vertebral count of a specimen from the Adriatic 49; branchiostegals 5.

DESCRIPTION.—Greatest depth behind the head, tapering to the caudal peduncle. A lateral view shows the dorsal profile of the head descending in a gentle curve from the nape to the snout. The dorsal profile is interrupted slightly by the eye in the largest specimen examined, not in the others. The ventral profile rises in a gentle curve from the posterior edge of the preopercle to the union of the articular and the quadrate, from whence it runs in a straight line to the tip of

the lower jaw. The interorbital area between the supraocular canals is broad and flat posteriorly, weakly convex anteriorly. The canals rise slightly above the level of the median area and the frontals lateral to the canals arch slightly upwards from the canals.

The dorsal edge of the maxillary lies under the lachrymal and extends back under the jugal as well. The medial ends of the maxillaries are not enlarged into knobs, but instead bear articulating surfaces which receive enlarged knobs sent up by the premaxillaries. The palatines bear 10 to 20 short, widely spaced, conical teeth in an irregular row which is single posteriorly and 2 to 3 teeth wide anteriorly. The 10 to 15 vomerine teeth are arranged in an irregular band 1 to 3 teeth wide which resembles the palatine teeth bands. The tongues of all four specimens examined bear teeth, 2 teeth in 2 fishes, 3 teeth in each of the others. Schmidt (1918) found from 3 to 4 small teeth on the tongues of all specimens he examined. Two to eight short, conical teeth are scattered on the inner face of the dentary as far forward as the midpoint of the distance between the angle of the gape and the symphysis. Pharyngeal teeth were not examined. The gill rakers are elongate and closely spaced. The 4th raker forward from the angle on the lower arm of the 1st arch is equal to from one-third to one-half of the interorbital distance.

The posterior ends of the pectoral bases form angles of 45 to 60 degrees with a plane parallel to the venter. The tips of the pectorals extend to a point slightly farther than the midpoint of the distance between the pectoral base and the base of the ventrals. The ventral fin is equal in length to the pectoral fin.

The inner surface of the peritoneum is colored a light brown ventrally by very small brown chromatophores; dorsally the peritoneum is transparent. The dusky stomach has an elongate elbow which reaches to the level of the posterior tips of the pectoral fins. The entire gut is stippled with brown.

The swimbladder, which lacks silvery pigment in a specimen from the Adriatic, originates above the posterior curve of the stomach and terminates at the level of the tips of the ventral fins.

A preserved specimen from the Adriatic has a light chocolate ground color. A lighter brown band, equal in width to the diameter of the pupil, runs down the midline of the body. A narrower and darker brown stripe runs along the dorsal edge of the light-colored band. The muzzle, upper third of the opercle, and posterior portion of the skull including the brain case are pigmented, while the remain-

der of the head is uncolored. The throat and the transparent opercles bear a few remnants of silvery pigment. The dorsal and anal fins are slightly pigmented, the other fins are not. The three smaller specimens are badly faded, but it is possible to make out 8 to 10 dusky blotches along the dorsum. Sanzo (1933) gives color figures of larvae and postlarvae showing 9 dark transverse bands along the side of the body and a broad horizontal silver stripe down the side of a specimen 42.4 mm. long.

DISTRIBUTION.—*G. leioglossus* occurs in the western part of the Mediterranean from near the straits of Gibraltar to the Ionian Sea. Karlovac (1949) reports the species from a considerable number of localities in the southern two-thirds of the Adriatic. It has been recorded from two localities in the eastern Atlantic, one the Bay of Cadiz and the other north of the Canary Islands at 26° 03' N/ 15° 00' W. The latter record was referred by Murray and Hjort (1912) to *Argentina silus*; I have examined their specimens and find, as Schmidt (1918) suggested, that the specimens are *G. leioglossus*.

HABITS.—The young are pelagic in the Mediterranean at depths of 100 to 200 meters according to Schmidt (1918), while Karlovac (1949) finds postlarvae in the Adriatic between 80 and 360 meters and adults closer to the surface. The Murray and Hjort specimens from the Canary Islands were taken in a trawl from between 267 and 280 meters.

Schmidt (1918) states that spawning in the Mediterranean takes place in the winter and spring, and Karlovac (1949) finds the Adriatic population in general agreement with this. Karlovac also notes that adults together with postlarvae are taken only in the southern third of the Adriatic, while farther north only postlarvae, presumably carried by currents, are found.

NOMENCLATURE.—After the original discovery of *G. leioglossus* in 1848, the species was not taken again until 1880, when Giglioli examined what was undoubtedly a mixed collection and, considering only the dentition of the tongue as a specific character, lumped the species with *Argentina sphyraena*. He was followed by several workers until 1918, when Schmidt was able to show other ways of separating the two species.

SPECIMENS EXAMINED.—

Yugoslavia: Adriatic, 43° 18.4' N/ 16° 25.5' E, SU 49736 (1).

Canary Islands: 26° 03' N/ 15° 00' W, "Michael Sars" st. 39 B, BM 3233 (3).

Glossanodon (Glossanodon) semifasciatus (Kishinouye)

Argentina semifasciata Kishinouye, 1904a : 110 (original description, type locality: Toyama Bay, holotype: unknown). Kishinouye, 1904b : 197. Jordan, Tanaka and Snyder, 1913 : 46 (Toyama Bay, Nagasaki). Jordan and Hubbs, 1925 : 152 (Sea of Japan). Tanaka, 1931 : 49 (in part, listed). Okada, Uchida and Matsubara, 1935 : 73, pl. 21, fig. 1 (description, colored figure). Matsubara, 1940 : 317 (Kambara, near Numazu, Sizuoka Prefecture). Matsubara, 1943 : 66, figs. 18, 19 (description, references, compared with *A. kagoshimae*, Kumanonada off Heta). Kuroda, 1951 : 318 (Sagami Bay, Saruga Bay, Kumanonada, Kii, Shikoku, Kyushu). Kamohara, 1952 : 12, fig. 8 (description, off Prov. Toša, Shikoku). Mori, 1952 : 37 (Fusan and Pohang, Korea). Ochiai, 1952 : 139, figs. 1-4 (analysis of length-weight relationships). Ochiai, 1954 : 968, figs. 1-3 (studies on the gonads, Maizuru, Kanaiwa, Ogi, Owase, Mimase). Matsubara, 1955 : 216, pl. 15, fig. 5 (description, distribution). Okada, 1955 : 59, fig. 55 (description, distribution, common names, habits).

DIAGNOSIS.—This species can be distinguished from *G. leioglossus* by the absence of pigment on its stomach and by the knobs developed on the medial ends of the maxillaries. *G. semifasciatus* differs from *G. lineatus* in having a lower anal fin ray count (11 to 13 in *G. semifasciatus*, 15 in *G. lineatus*), a lower lateral line count (50 to 53 in *G. semifasciatus*, 56 in *G. lineatus*), and a higher branchiostegal ray count (5 in *G. semifasciatus*, 4 in *G. lineatus*). *G. semifasciatus* differs from *G. polli* and *G. lineatus* in having dentary teeth only half the distance from the gape to the symphysis; in *polli* and *lineatus* the dentary teeth extend to, or almost to the symphysis.

COUNTS AND MEASUREMENTS.—Based on 32 specimens. D. 12 (11-13); A. 12 (11-13); pectoral 19 (18-21); ventral 12 (10-12); gill rakers on first arch 11 (10-12) + 1 + 24 (21-27); lateral line scale rows 51 (50-53); standard length 93.5-206.0 mm. (Ochiai [1952] records a specimen 224 mm. long); preanal 83.3 (82.0-85.9); preventral 54.7 (52.9-58.5); predorsal 47.8 (46.0-49.3); prepectoral 25.9 (26.6-29.1); head length 28.1 (27.0-29.4); snout 10.3 (9.7-11.3); eye 7.4 (6.6-8.3); maxillary length 6.5 (5.3-7.9); maxillary width 2.3 (1.9-2.8); depth at dorsal fin 12.3 (10.4-15.8); width behind head 10.6 (9.0-12.3); head depth 13.2 (11.3-14.4); interorbital 6.4 (5.6-7.8); depth of caudal peduncle 5.5 (4.8-6.6); vertebral count 48 in two specimens from Tottori Prefecture and one specimen from Maizuru; pyloric caeca 8-11 (Matsubara [1943] gives 15-18); branchiostegals 5.

DESCRIPTION.—Greatest depth between the head and the dorsal origin, tapering to the caudal peduncle. A lateral view shows the dorsal profile of the head descending in an almost straight line from the nape to the snout. The dorsal profile is not broken by the dorsal rim of the orbit. The ventral profile rises in a gentle curve from the

posterior edge of the preopercle to the union of the articular and the quadrate from whence it runs in a straight line to the tip of the lower jaw. The interorbital space between the supraocular canals is a broad flat area, lower than the supraocular canals. The frontals laterally are slightly below the level of the canals.

Almost the entire maxillary lies under the lachrymal, occasionally extending to the jugal. The medial ends of the maxillaries are enlarged into knobs which are connected by a strong ligament to a flat face on the premaxillary below. The epidermis covering the ventral edge of the maxillary and the premaxillary bears minute papillae in only a few specimens, while they seem absent in most. The upper jaw is rounded; the projecting lower jaw is bluntly pointed.

The palatines bear a single, irregular, widely spaced row of 20 to 25 short, conical teeth. The vomer carries an irregular band of 5 to 15 similar teeth. The tongue bears 2 to 6 small teeth which are often buried in the mucous membrane. The lateral edges of the tongue are serrate. Matsubara's figure (1943, fig. 19c) shows the serrations, but no teeth. The tongue also has very small papillae scattered along its lateral edges. From 5 to 10 short conical teeth are present in a single row on the inner face of each dentary up to a point midway between the angle of the gape and symphysis. Several specimens examined lacked teeth on the dentary. Absence of teeth was not correlated with size. On the ceratobranchial of the 5th gill arch are 1 to 3 small, conical teeth. Two oval-shaped patches of short, conical teeth, about 3 teeth on the anterior patch and 10 to 12 teeth on the posterior patch, are present at the anterior end of the 4th suprabranchial. The gill rakers are elongate and closely spaced. The 4th raker forward from the angle on the lower arm of the 1st arch is equal in length to from one-third to one-half of the interorbital distance.

The posterior ends of the pectoral fin bases form angles of 20 to 35 degrees with a plane parallel to the venter. The tip of the pectoral extends to a point about one-third of the way between the anterior of the pectoral fin base and the anterior of the ventral fin base.

The peritoneum is silvery on its outer surface. The inner surface is lightly punctate ventrally, while the chromatophores are smaller and closer together dorsally. The entire gut is immaculate. The stomach has a posterior elbow which stretches to a point midway between the pectoral and the ventral bases. The anterior curve of the stomach is located at the level of the tip of the pectoral fin (see Matsubara [1943] for diagrams of the gut, dentition, and gill rakers). The ventral section is short, equal to half the length of the posterior elbow, and displaced toward the right side of the body. The pyloric caeca

extend only slightly past the anterior curve of the stomach. In a specimen 145.7 mm. in standard length the intestine has about 12 strongly developed *Ringen* which seem to be arranged spirally. The *Grundnetze* is present as a few strongly developed ridges.

The swimbladder is similar to that of *Argentina* in form. It lacks silvery pigment, but does have a faint iridescent sheen. The origin of the bladder is above a point midway between the anterior and posterior curves of the stomach and its termination is a point slightly behind the origin of the ventral fins. *G. semifasciatus* agrees with *Argentina* in lacking a centralized *rete*; however, the surface of the bladder carries a considerable number of parallel blood vessels in series of 2 to 6. At the anterior end of the bladder a pair of veins run from the sides of the bladder to the kidneys. In the specimens available it was not possible to observe the arterial supply.

The color of specimens in alcohol varies from light straw to light brown ventrally, while the dorsal half of the body is a darker brown. Almost all specimens bear 7 to 10 dusky blotches along the dorsolateral contour of the body. Each flap of skin marking a lateral line scale pocket bears a small brown spot. The fins are all lightly flecked with black. The opercle, isthmus, cheek, and iris are silvery, while the muzzle, the most posterior part of the roof of the cranium, and the upper portion of the opercle are dusky. The portion of the cranium covering the brain is transparent, allowing the brown pigment on the inner surface of the brain case to show through, while the anterior part of the skull is translucent. Okada, *et al.*, (1935) give a color plate of *G. semifasciatus* which shows the head and body below the lateral line silvery and the body above the lateral line brown with indistinct blotches.

DISTRIBUTION.—*Glossanodon semifasciatus* is, so far as known, restricted to the southern half of Japan and southeastern Korea. The northernmost record for the species on the Pacific side of Japan is Sagami Bay (Kuroda, 1951). It has been taken at various localities southward and westward along the coast to Heta near the southern tip of Kyushu. On the western coast of Japan the fish has been taken from Nagasaki in the south, north to Niigata (approximately 38° N). Mori (1952) gives Pusan and Pohang as the only Korean records.

HABITS.—Okada (1955) states: "In Toyama Bay, it is caught in great quantities at the depths of 70 to 240 m., from late February to late March. After March it migrates to deeper bottom, and spawns in the latter part of May and in June." Matsubara (1943) reports specimens from 125 fathoms in the Kumano-Nada.

SPECIMENS EXAMINED.—

Japan

Honshu: Mie Prefecture, Owashi, TU 23736 (1); Wakayama Prefecture, Tanabe, TU 23630-2 (3); Japan Sea, Matsue, TU 31481 (1); Tottori Prefecture, SU 49733 (12); Kyoto Prefecture, Miyazu, TU 24349-53 (5), TU 24396 (1); Japan Sea, Maizuru, SU 49529 (10); Toyama Bay, Namerikawa, TU 34303-8 (6); Toyama Bay, probably Uotsu or Namerikawa, TU 45133-4 (2), TU 46224 (1), TU 46252-4 (3), TU 46256 (1), TU 46297 (1), TU 46312-4 (3), TU 46716 (1); Niigata, TU 23429 (1), TU 24397 (1), SU 23441 (5).

Shikoku: Mimase, near Kochi, TU 24268 (1); off Kochi Prefecture, TU 16730-1 (2).

No data: TU 39178 (1), TU 26309-10 (2).

Glossanodon (Glossanodon) polli, new species

Figure 8

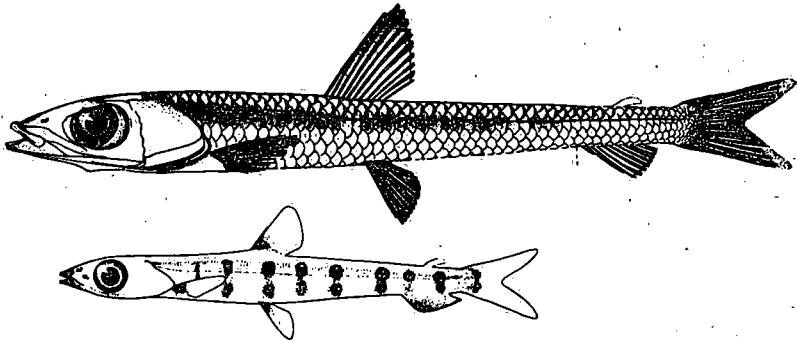


Figure 8.—*Glossanodon polli*. Adult and adolescent specimens from off West Africa (from Poll, 1953).

Argentina sphyraena (non Linnaeus) Poll, 1953: 53, fig. 20 (description, habits, 30° 05' S/ 9° 25' E, 9° 31' 30" N/ 16° 23' W).

DIAGNOSIS.—*G. polli* differs from *G. leioglossus* and *G. semifasciatus* in having dentary teeth extending more than half the distance from the angle of the gape to the symphysis. In most specimens the teeth extend to the symphysis. *G. polli* differs from *G. lineatus* in having 13 to 14 anal rays and 48 to 51 lateral line scales, while *lineatus* has 15 anal rays and 56 lateral line scales. *G. polli* has 5 branchiostegals, *G. lineatus* has 4.

COUNTS AND MEASUREMENTS.—Based on six specimens from the eastern Atlantic: D. 12 (12-14); A. 14; pectoral 21 (19-22); ventral 12 (12-13); gill rakers on first arch 10 + 1 + 24 (21-25); lateral line scale rows 49 (48-50); standard length 64.0-134.0 mm.; preanal 83.8 (82.3-85.2); preventral 53.4 (51.9-54.1); predorsal 48.6 (47.8-49.5); prepectoral 28.9 (28.4-29.7); head length 28.7 (26.9-29.8); snout 8.9 (8.0-9.4); eye

8.6 (8.1-9.4); maxillary length 6.8 (6.3-7.3); maxillary width 2.3 (2.2-2.5); depth at dorsal fin 11.3 (9.4-12.3); width behind head 11.0 (10.2-11.7); head depth 12.2 (11.7-12.6); interorbital 7.3 (6.7-7.7); depth of caudal peduncle 5.7 (5.2-6.3); branchiostegals 5.

The following counts and measurements are based on two specimens from the western Atlantic: D. 12, 12; A. 13, 13; pectoral 21, 22; ventral 12, 11; gill rakers 11 + 1 + 22, 10 + 1 + 20; lateral line scale rows 51, -; standard length 75.0 mm., 100.5 mm.; preanal 84.7, 82.1; preventral 53.3, 50.8; predorsal 48.7, 46.8; prepectoral 29.9, -; head length 30.0, 26.9; snout 9.1, 8.9; eye 9.3, 7.4; maxillary length 6.7, 6.6; maxillary width 2.6, 2.0; depth 9.6, 10.9; width behind head 9.4, 9.9; head depth 12.0, 10.9; interorbital 8.1, -; depth of caudal peduncle 6.0, 5.5; branchiostegals 5 (?), 5 (?).

DESCRIPTION.—Greatest depth behind the head, tapering to the caudal peduncle. A lateral view shows the dorsal profile of the head descending in a gentle curve to the snout. The dorsal profile is not broken by the dorsal rim of the eye. The ventral profile rises in a gentle curve from the posterior edge of the preopercle to the union of the articular and the quadrate, from whence it runs in a straight line to the tip of the lower jaw. The interorbital space between the supraocular canals is a broad flat area, lower than the supraocular canals. The frontals lateral to the canals slope downwards over the orbit.

The dorsal edge of the maxillary lies under the lachrymal and extends to the joint between the lachrymal and the jugal. The epidermis covering the ventral edge of the maxillary and the premaxillary bears minute papillae. Both the upper jaw and the slightly projecting lower jaw are rounded.

Each palatine bears 20 to 35 short, conical teeth which are restricted to the lateral edge of the bone in several specimens, but may be scattered about the surface or in a row along the medial edge of the bone in others. The vomer bears a patch of 20 to 25 similar teeth across its head. Lingual teeth are apparently absent. From 10 to 20 short, conical teeth are present in a single row on the inner face of each dentary extending from the angle of the gape past the midpoint of the dentary and usually to the symphysis. The branchial arches were not examined for teeth. The gill rakers are elongate and closely spaced. The 4th raker forward from the angle on the lower arm of the first arch is equal in length to from one-third to one-half of the interorbital distance.

The posterior end of the pectoral fin base forms an angle of 45 to 60 degrees with a plane parallel to the venter. The tip of the pectoral extends to a point about two-thirds of the way between the anterior

of the pectoral fin base and the anterior of the ventral fin base. The ventral fin is slightly shorter than the pectoral fin.

The peritoneum is silvery on its outer surface. The inner surface is densely punctate with dark brown chromatophores at the anterior end of the body cavity and more lightly colored posteriorly. The stomach appears to lack pigment.

The swimbladder has no silvery pigment.

The body of a preserved specimen is light tan. A dark brown streak, equal in width to the diameter of the pupil, runs along the dorsolateral contour of the body. Eight or nine more densely pigmented areas are present along the band and are more pronounced in smaller specimens. An iridescent band, below and equal in width to the dark brown stripe, runs along the lateral line. Some of the scale pockets along the dorsum are edged with brown. The muzzle is dusky; the inner surface of the braincase shows dark brown through the transparent frontals and parietals. The isthmus, opercles, cheeks, and irises are bright silver. The postlarval color pattern consists of 9 dark lateral streaks along the side of the body (fig. 8).

DISTRIBUTION.—This species has been collected at three localities by the recent Belgian Oceanographic Expedition along the coasts of West Africa. One of the localities is, unfortunately, unknown. The other two are off French Equatorial Africa and off the border of Sierra Leone and French Guinea. In addition, I have examined specimens, apparently referable to *G. polli*, collected off the Brazilian coast close to the equator. The western Atlantic population may prove to be separable when more material is available.

HABITS.—The known bathymetric range in the eastern Atlantic is 150 to 200 meters. One collection was made over a sand bottom and the other over a sand and rock bottom. Poll (1953) states that a stomach examined contained crustaceans and that larger specimens from the northern locality (collected in June) were sexually mature or almost so.

Western Atlantic specimens were taken at depths of 175 to 225 fathoms with a 40-foot shrimp trawl.

SPECIMENS EXAMINED.—

Eastern Atlantic off Equatorial Africa:

Holotype.—9° 31' 30" N/ 16° 23' W, 150-200 meters, rock and sand bottom, temperature at 145 meters 15.38° C., salinity 36.68 ppm, oxygen 1.79 grams per liter, trawl hauled for 1½ hours, collected by the Expedition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948-1949), st. 214, 6-7 June, 1949, RCB 95.005.

Paratypes.—Data as for the holotype, RCB 95.006-9 (4); 3° 5' S/ 9° 25' E,

150-200 meters, sand bottom, temperature at 145 meters 14.53° C., salinity 33.6 ppm, oxygen 2.27 gm. per liter, trawl hauled for one hour, same expedition, st. 162, 25-26 March 1949, RCB 90.004 (1).

Off Brazil: 1° 49' N/ 46° 48' W, 225 fms., 17 November 1957, "Oregon" st. 2083, USNM 159355 (1); 1° 52' N/ 46° 54' W, 175 fms., 17 November 1957, "Oregon" st. 2081, USNM 159352 (1).

Glossanodon (Glossanodon) lineatus (Matsubara)

Leuroglossus lineatus Matsubara, 1943 : 70, figs. 20, 21 (original description, type locality: Kumano-Nada, holotype: no. 4247 Matsubara fish collection; emendation of Microstomidae to receive *Leuroglossus*). Kamohara, 1952 : 13 (Mimase, Shikoku). Matsubara, 1955 : 217, fig. 57 (listed in family Bathylagidae).

DIAGNOSIS.—*G. lineatus* can be separated from the other species in the subgenus *Glossanodon* by its higher lateral line count (56 in *G. lineatus*, 48 to 53 in the other species), a higher anal fin ray count (15 in *G. lineatus*, 11 to 14 in the other species), and fewer branchiostegal rays (4 in *G. lineatus*, 5 in other species). *G. lineatus* resembles *G. polli* and differs from *G. leioglossus* and *G. semifasciatus* in having dentary teeth extending to, or almost to, the symphysis.

COUNTS AND MEASUREMENTS.—Based on two specimens and given for each. Measurements given in millimeters. D. 12, 13; A. -, 15; pectoral 21, 18; ventral 12, 11; gill rakers on first arch 9+1+16 (?), -, (Matsubara [1943] gives 8-9+19-20); lateral line scale rows -, 56; standard length 89.9, 97.4 (Kamohara [1952] notes a specimen which is damaged but "about 120 mm. long"); preanal 84.0, 83.2; preventral 51.4, 52.4; predorsal 48.3, 48.2; prepectoral 25.8, 25.9; head length 26.4, 27.5; snout 8.2, 8.3; eye 8.2, 7.3; maxillary length 6.9, 6.2; maxillary width 2.3, 2.6; depth at dorsal fin 11.1, 12.1; width behind head 10.9, 9.7; head depth 11.7, 11.3; interorbital 6.7, 6.1; depth of caudal peduncle 5.7, 5.6; branchiostegals apparently 4 (I have not examined an alizarin preparation of this species).

DESCRIPTION.—Body slender with the greatest depth between the dorsal fin and the head, tapering to the caudal peduncle. The dorsal profile of the head slopes gently to the snout and is unbroken by the orbit. The ventral profile of the head rises gently from the posterior margin of the opercle to the union of the articular and the quadrate, from whence it rises more steeply. The interorbital space between the supraocular canals is a broadly rounded, slightly convex area, lower than the supraocular canals. The frontals lateral to the canals are on a level with the canals. The dorsal edge of the maxillary lies under the lachrymal and the jugal. Both the upper and the projecting lower jaw are rounded, the upper jaw more broadly so.

The conical palatine teeth are arranged in two separate rows, one along the lateral edge of the bone, and the other along the medial edge of the bone. Each palatine bears 20 to 25 teeth. The vomerine teeth number about 15. Each dentary has about 15 small pointed teeth in an irregular row extending from the angle of the gape to the symphysis of the dentaries. Teeth are apparently absent from the tongue. The gill rakers are elongate and closely spaced (Matsubara, 1943, fig. 21).

The pectoral base forms an angle of about 45 degrees with a plane parallel to the venter.

The peritoneum is silvery on the outside, while the inner surface is densely punctate with dark brown pigment. The body of an alcohol specimen is straw colored and has a dark brown stripe along its dorso-lateral contour. About 6 brown blotches are distributed along the body on the stripe. Matsubara (1943) mentions the presence of a silvery band below the brown stripe. The muzzle and upper part of the opercle are dusky.

DISTRIBUTION.—Recorded from only two localities on the Pacific coast of southern Japan, one the type locality, Kumano-Nada off Honshu, and the other off Mimase, Shikoku.

HABITS.—Taken at about 125 fathoms.

SPECIMENS EXAMINED.—

Japan:

Honshu:—Kumano-Nada, CKM 4245 (1), paratype; Kumano-Nada, off Owashi, CKM 18867 (1).

Subgenus *Prosoarchus*, new

Type species *Glossanodon (Prosoarchus) pygmaeus*, new.

The subgenus *Prosoarchus* differs from the subgenus *Glossanodon* in having the anus more advanced. In *Prosoarchus* the anus lies at a distance equal to or greater than the depth of the caudal peduncle in front of the anterior end of the anal fin base, while in *Glossanodon*, the anus lies at a distance equal to half or less, than the depth of the caudal peduncle in front of the anterior end of the anal fin base.

Prosoarchus also differs from *Glossanodon* in having a lower pectoral ray count (12 to 14 in *Prosoarchus*, 18 to 22 in *Glossanodon*), and a lower lateral line count (43 to 46 in *Prosoarchus*, 48 to 56 in *Glossanodon*).

The name *prosoarchus* is from the Greek *proso*, forward, and *archos*, anus, in reference to the forward position of the anus.

Glossanodon (Prosoarchus) pygmaeus, new species

Figure 9

COUNTS AND MEASUREMENTS.—Counts based on 18 specimens, measurements based on 14 specimens. D. 11 (10-12); A. 12 (11-13); pectoral 13 (12-14); ventral 10 (10-12); gill rakers on first arch in four specimens 10 (9-11) + 1 + 22 (21-23); lateral line scale rows 46 (43-46); standard length 52.5-98.5 mm.; preanal 81.5 (80.1-84.8); preventral 54.2 (51.6-58.7); predorsal 47.6 (45.3-49.6); prepectoral 28.3 (26.7-30.0); head length 28.7 (27.2-30.1); snout 9.2 (8.0-10.2); eye 8.9 (8.1-9.7); maxillary length 8.0 (6.7-8.9); maxillary width 2.8 (2.4-3.3); depth at dorsal fin 12.1 (10.1-14.0); width behind head 10.4 (8.5-11.3); head depth 13.0 (12.0-14.3); interorbital 7.2 (6.1-8.8); depth of caudal peduncle 6.0 (5.3-6.8); vertebral count of a single specimen 43; pyloric caeca 8 in two specimens, 9 in another, branchiostegals 5 (the first ray on each side much reduced).

DESCRIPTION.—A small species with a slender body, even in gravid females. Greatest depth behind the head, tapering gradually to the caudal peduncle. A lateral view shows the upper profile of the head descending to the snout in a gentle curve which is unbroken by the dorsal margin of the eye in smaller specimens, but in larger ones the eye projects somewhat. The ventral profile rises more gently from the posterior edge of the preopercle to the union of the articular and the quadrate, from whence it rises more rapidly. The interorbital space between the supraorbital canals is flat. The canals are raised slightly above the central area, and the frontals lateral to the canals arch upward very slightly.

The dorsal edge of the maxillary lies tucked under the lachrymal and the jugal. Minute papillae are distributed on the skin along the ventral edge of the premaxillary. The ventral edge of the maxillary, however, seems to lack papillae. In most specimens the lower jaw projects slightly, though in several the jaws are subequal.

The tooth-bearing areas of the palatines are poorly ossified. The anteriormost portion of the bone is a thin, tooth-bearing plate which is present in the same body of cartilage as the main body of the palatine, but is not connected with it by bone. The main body of the palatine bears an irregular row of 10 to 25 conical teeth. The row is usually single on the posterior part of the bone and 2 or 3 teeth wide on the anterior part of the palatine proper. The anterior plate of the palatine bears 10 to 17 teeth in a band 2 to 4 teeth wide, which represents a continuation of the tooth band on the anterior part of the palatine proper. The vomer also bears a continuation of this band con-

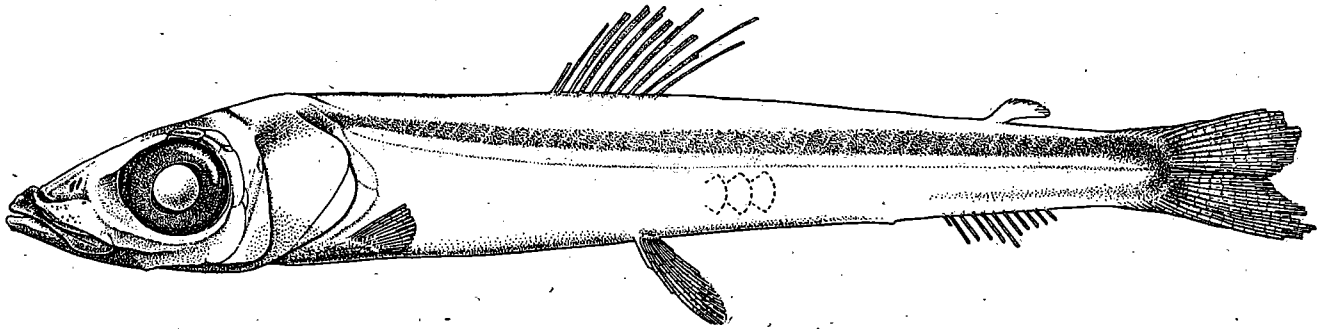


Figure 9.—Holotype of *Glossanodon (Prosoarchus) pygmaeus*. CNHM 64345.

sisting of 11 to 18 widely scattered conical teeth. The vomer is also poorly ossified, especially in a hemispherical area at the tip. The tongue is armed with 2 to 6 teeth. The ceratobranchial of the 5th gill arch bears 4 small conical teeth. Two oval-shaped patches of short conical teeth, about 2 teeth on the anterior patch and 7 on the posterior, are present at the anterior end of the 4th suprabranchial. The gill rakers are elongate and closely spaced. The 4th raker from the angle on the lower arm of the 1st arch is equal in length to about one-half of the interorbital distance.

The posterior end of the pectoral base forms an angle of 45 to 55 degrees with a plane parallel to the venter. The longest dorsal ray is slightly longer than the greatest depth of the body at the origin of the dorsal fin. The tip of the pectoral fin extends more than half of the distance between the anterior end of the pectoral fin base and the anterior end of the ventral fin base. The ventral fin is shorter than the pectoral fin.

The inner surface of the peritoneum is densely punctate ventrally, appearing almost solid black, and considerably lighter dorsally. The gut is unpigmented. The smoothly rounded posterior curve of the stomach extends almost to the level of the posterior tip of the pectoral fin.

The intestine of a mature individual 77.2 mm. in standard length is transparent for most of its length and has the *Ringen* so poorly differentiated from the *Grundnetze* that it is impossible to make a count.

The swimbladder lacks silvery pigment.

Alcohol specimens have a uniform light tan ground color. In some specimens a dark brown stripe, equal in width to half the interorbital, runs along the dorsolateral margin of the body and continues onto the upper edge of the opercle; in others the stripe is reduced to a lightly pigmented band. A faint iridescent sheen along the lateral line suggests a silvery band may have been present. Large brown chromatophores sprinkled along the lateral line form a poorly defined band ventral to the one mentioned above. A similar poorly defined band is present on the ventrolateral contour of the body above the area between the anus and the caudal base. The dorsal and ventral areas of pigmentation meet at the caudal base, coloring the entire area a light brown. In many specimens the scale pockets on the dorsum and the venter are neatly outlined by dark brown chromatophores. The muzzle is dusky; the rami of the lower jaw and the ventral third of the opercle and preopercle are lightly washed with brown. The isthmus is colored a darker brown by large brown chromato-

phores. The posterior portion of the cranium is lightly dotted with very small brown chromatophores through which the outlines of the brain are visible. The dorsal fin rays are colored by evenly distributed brown chromatophores. The caudal fin is also pigmented, but less evenly, while the pectoral, ventral, and anal fins are pigmented at their bases but not on their distal portions. Several smaller specimens have faded considerably and show only faint remnants of the above pattern. In one of the smaller specimens the dorsolateral stripe is broken into 8 or 9 faint dusky blotches.

DISTRIBUTION.—*G. pygmaeus* has been taken off the coast of South Carolina, in the northern half of the Gulf of Mexico off the coasts of Texas and Florida and northwest of Tortugas Island, off the coast of Venezuela southeast of Trinidad, and off the coast of Brazil near the equator.

HABITS.—The known bathymetric range of *G. pygmaeus* is 52 to 163 fathoms. Three collections are from over a mud bottom, while a third is from a sand and gravel bottom. *G. pygmaeus* was taken several times in company with *Argentina striata* which it strongly resembles in color pattern.

The gut of one specimen contained several copepods along with a considerable amount of unidentifiable organic matter.

G. pygmaeus is evidently a small species, or at least reaches sexual maturity at a small size. A specimen 77.2 mm. in standard length had ripe eggs in the ovary, while another specimen 86.6 mm. in standard length had well-developed testes.

NOMENCLATURE.—The name *pygmaeus* is Latin for dwarf and refers to the small size of this species.

SPECIMENS EXAMINED.—

Gulf of Mexico off Tortugas:

Holotype.—25° 08' N/ 84° 19' W, 163 fathoms, sand and gravel bottom, bottom temperature 10° C., 40-foot shrimp trawl, 2115-2300 hours, "Oregon" st. 1026, 19 April 1954, CNHM 64345.

Paratypes.—

Gulf of Mexico off Tortugas: Data as for holotype, CNHM 64346 (6), SU 49735 (1).

Gulf of Mexico, southeast of Pensacola Bay, Florida: 30° 05' N/ 86° 55' W, 52 fms., blue-mud bottom, bottom temperature 15° C., 40-foot shrimp trawl, 1430-1500 hours, "Oregon" st. 858, 29 Oct. 1953, CNHM 45933 (1).

Gulf of Mexico, southeast of Port Aransas, Texas: 27° 22' N/ 96° 08' W, 103 fms., mud bottom, bottom temperature 15° C., 100-foot shrimp trawl, 1550-1700 hours, "Oregon" st. 156, 27 Sept. 1950, CNHM 46267 (1); 26° 55' N/ 96° 25' W, 125 fms., gray-mud and shale bottom, bottom temperature 19° C., 40-foot shrimp trawl, 1535-1600 hours, "Oregon" st. 550, 18 April 1952, SU 49734 (1).

- N. Atlantic off South Carolina*: 32° 58' N/ 77° 52' W, 32° 56' N/ 77° 56' W, 74 fms., "Albatross III" cruise 31B, st. 8, tow 1, USNM 152104 (2).
- N. Atlantic off Venezuela*: 9° 45' N/ 59° 45' W, 40-foot shrimp trawl, "Oregon" st. 1989, USNM 159351 (3); 9° 41' N/ 59° 47' W, 150 fms., 40-foot shrimp trawl, "Oregon" st. 1985, 3 Nov. 1957, UF 8027 (2).
- N. Atlantic off Brazil*: 2° 41' N/ 47° 48' W, "Oregon" st. 2067, USNM 159350 (1).

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