

Key F—Continued

19. The caudal peduncle is slender and has a conspicuous longitudinal keel on either side; the pectoral fins do not reach back as far as the point of origin of the dorsal fin.....Pilotfish, p. 372
The caudal peduncle is deep and has no longitudinal keel; the pectoral fins reach back farther than the point of origin of the dorsal fin.....20
20. There are 6-8 short detached spines, each with a small triangular fin membrane, on the back in front of the dorsal fin.....Barrelfish, p. 369
There are no detached spines on the back in front of the dorsal fin.....21
21. The ventral fins stand far behind the bases of the pectoral fins; the point of origin of the dorsal fin is little if any in advance of the anal fin; the pectoral fins (Gulf of Maine species) are very long, reaching back nearly to the base of the tail fin.....Flying fish, p. 172
The ventral fins stand about under the base of the pectoral fins; the point of origin of the dorsal fin is far in advance of the anal fin; the pectoral fins are small, falling far short of the anal fin.....Black ruff, p. 370

Key G

Fishes as in Key F, except that at least the forward one-third of the single dorsal fin is spiny. There is no adipose fin behind the rayed dorsal nor fleshy flap in front of it (from No. 26, p. 6).

1. The body (tip of snout to base of caudal fin) is at least as deep as it is long.....Boarfish, p. 438
The body is considerably longer than it is deep.....2
2. The rear part of the dorsal fin is soft-rayed.....3
The whole length of the dorsal fin is spiny.....8
3. Sides of head bony, with knobs or spines.....4
No knobs or spines on the sides of the head.....5
4. Sides of head armed with conical spines; the spiny portion of the dorsal fin is at least as long as the soft part; the body is flattened sidewise.....Refer to Rosefish family, key, p. 430
Sides of head with low rounded knobs only; the spiny portion of the dorsal fin is considerably shorter than the soft part; body tadpole-shaped.....Arctic sculpin (Sculpin family in part), p. 453
5. The ventral fins are much larger than the pectorals; the eyes are very large.....Short big-eye, p. 410
The ventral fins are not larger than the pectorals; the eyes are not very large.....6
6. The pectorals are sharply pointed; the body is much flattened sidewise.....Refer to Porgy family, key, p. 411
The pectorals are rounded; the body is not much flattened sidewise.....7
7. The rear (soft) part of the dorsal fin is nearly as long as the front (spiny) part; the anal fin is much higher than long.....Seabass (Seabass family in part), p. 407
The rear (soft) part of the dorsal fin is less than half as long as the spiny (front) part; the anal fin is longer than high.....Refer to Cunner family, key, p. 473
8. The mouth is strongly oblique; there are no ventral fins.....Wrymouth, p. 500
The mouth is not strongly oblique; ventral fins are present (very small in one species).....Refer to Blenny fishes, key, p. 491

THE CYCLOSTOMES. CLASS AGNATHA

The lampreys are the most primitive of the true vertebrates, their skeletons being cartilaginous without any true bone, and their skulls hardly differentiated from the vertebral column which forms a simple notochordal sheath. They have no true jaws, no ribs, no shoulder or pelvic girdles, and no paired fins. They are eel-like in

appearance, but are easily distinguishable from the true eels and, indeed, from most of the true fishes, by their peculiar jawless sucking mouth situated at the tip of the snout, and, further, from all Gulf of Maine eels by lacking pectoral fins.

THE HAGFISHES AND LAMPREYS. FAMILIES MYXINIDAE AND PETROMYZONIDAE

These two groups are easily distinguished, one from the other, by the fact that the hags have several barbels on the chin, that their mouths are not disc- or funnel-like, that they have only one continuous fin fold on the back and around the tail, and that their eyes are not visible exter-

nally, whereas the lampreys have no barbels, their mouths are disc- or funnel-like, their eyes are well developed after the larval stage is past, and they have one or more dorsal fins separate from the caudal fin.

Hagfish *Myxine glutinosa* Linnaeus 1758

Bigelow and Schroeder, 1948, p. 34.

Description.—The hag, like the lamprey, lacks paired fins and fin rays. Its skeleton is wholly cartilaginous, without bones, its mouth is jawless; and its skin is scaleless. It is easily recognized by its eel-like form; by its single finfold (a fold of skin, not a true fin) running right around the tail and forward on the lower surface of the body with no division into dorsal, caudal, and anal fins; by the single gill pore on each side, just forward of the origin of the ventral finfold; by its lipless mouth, star-shaped in outline when closed; by the single nasal aperture at the tip of the snout; by its peculiar barbels or "tentacles," two flanking the mouth on either side and four surrounding the nostril; and by the evertible tongue studded with rows of horny rasplike "teeth." We might also mention the series of mucous sacs on either side of the abdomen, and point out that the dorsal finfold originates about two-thirds of the distance back from snout toward tip of tail, and the ven-

tral fin fold one-third the way back, with the vent piercing it.

Color.—Hags vary in color, perhaps to correspond with the color of the bottom, being grayish brown or reddish gray above, variously suffused, mottled, or piebald with darker or paler gray, with brown, or with bluish; they are whitish or pale gray below.

Size.—Gulf of Maine hags grow commonly to a length of about 1½ to 2 feet, with a maximum of 31 inches recorded off the coast of Maine.

Habits.—The hag is found chiefly if not exclusively where the bottom is soft mud, where (to judge from its actions during the brief time it survives in aquaria) it spends its time lying embedded in the clay or mud with the tip of the snout projecting. And it is at home only in comparatively low temperatures, cooler probably, than 50°, which confines it in summer to depths of 15 to 20 fathoms or more in the Gulf of Maine. It is not a true parasite, as has sometimes been suggested, there being no reason to believe it ever attacks living, uninjured fish, but is a scavenger.

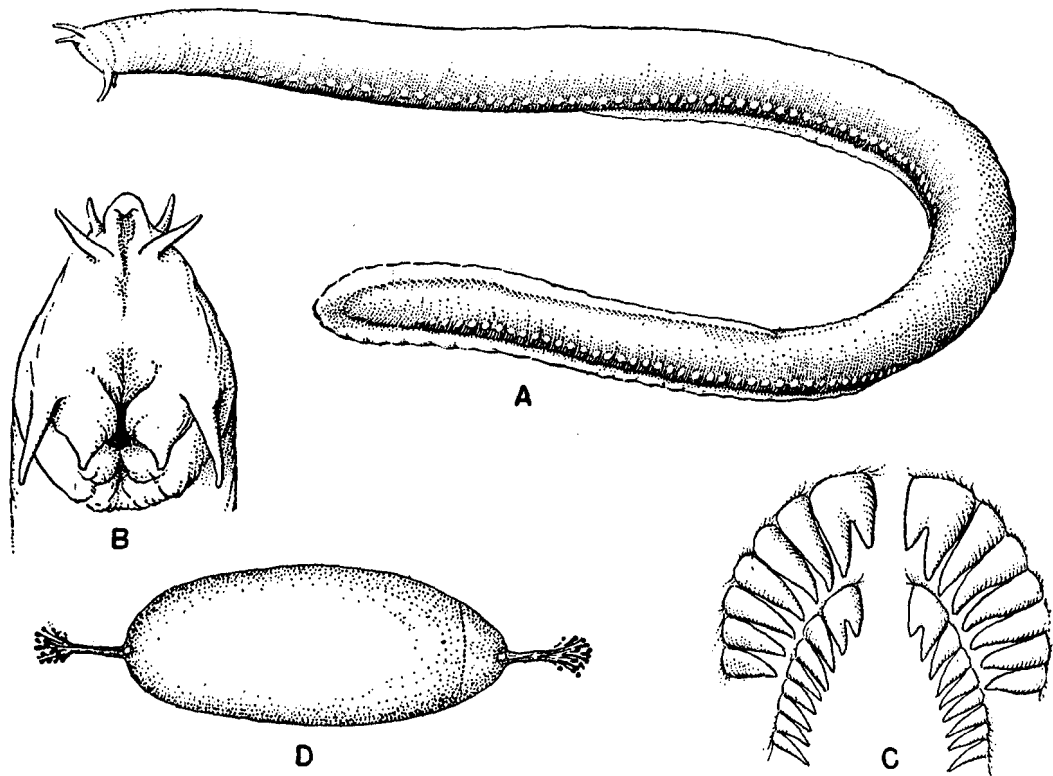


FIGURE 2.—Hagfish (*Myxine glutinosa*). A, adult, Gulf of Maine, from Bigelow and Schroeder, drawing by E. N. Fischer. B, lower view of head of same; C, tongue-teeth of same as seen from above, about 3 times natural size; D, egg, after Dean, about 2 times natural size.

Being blind, it doubtless finds its food by its greatly specialized olfactory apparatus. It feeds chiefly on fish, dead or disabled, though no doubt any other carrion would serve it equally well. And it is known to prey on marine annelid worms also, at least in Norwegian waters. It is best known for its troublesome habit of boring into the body cavities of hooked or gilled fishes, eating out the intestines first and then the meat, and leaving nothing but a bag of skin and bones, inside of which the hag itself is often hauled aboard, or clinging to the sides of a fish it has just attacked. In fact, it is only in this way, or entangled on lines, that hags ordinarily are taken or seen.

Being worthless itself, the hag is an unmitigated nuisance, and a particularly loathsome one owing to its habit of pouring out slime from its mucous sacs in quantity out of all proportion to its small size. One hag, it is said, can easily fill a 2-gallon bucket, nor do we think this any exaggeration.

In American waters the commercial fishes most often damaged by it are haddock and the hakes (*Urophycis*), these being the species most often fished for with long lines or with gill nets over the type of bottom the hag frequents. But it sometimes damages cod also, and European authors describe it as attacking ling (*Molva*) and other members of the cod tribe, herring, mackerel, sturgeon, and even mackerel sharks under similar circumstances.

Breeding habits.—The hag was formerly believed to be a functional hermaphrodite, with its single sex organ first developing sperm in the posterior portion, eggs later in the anterior portion. However, recent detailed studies of the sex organ appear to show that such is not the case, but that either the male portion of the common sex organ matures in a given individual with the female portion remaining rudimentary, or vice versa.¹³

It has long been known that the eggs are few in number (only 19 to 30 having been counted in any one female) and large (up to 25 mm. in length), and the horny shell has a cluster of anchor-tipped filaments at each end that make the eggs easy of identification. Until 1900 none had been found that certainly had been laid naturally. In that year, however, hag eggs were reported from the western part of Georges Bank and from the south

coast of Newfoundland by Dean (1900);¹⁴ from the neighborhood of the Faroe Islands by Jensen;¹⁵ from Norway by Hjort;¹⁶ off Morocco by Koe-foed.¹⁷ And they have been reported subsequently from the Bay of Fundy by Huntsman, from Frenchman Bay on the coast of Maine by Conel.¹⁸ The eggs are deposited on bottom, where they stick firmly to fixed objects of one sort or another by their terminal filaments and by threads of slime.

The hag spawns throughout its range; also it spawns throughout the year, for females nearing ripeness and others nearly spent have been recorded for winter and spring, as well as summer and autumn, in one part of its range or another. The few eggs so far reported have been from depths of 50 to 150 fathoms, most of them trawled on mud, clay, or sand bottom.

We need only add that, to judge from their behavior in aquaria, the females cease to feed at the approach of sexual maturity, as many other fishes do. Newly hatched hags have never been seen, but inasmuch as the smallest yet described (about 2½ inches long), probably not long out of the egg, already resembled the adult in external appearance there is no reason to suppose that the hag passes through a larval stage greatly different from the adult.

General range.—Arctic seas, and both coasts of the north Atlantic; Murman Coast and northern Norway south regularly to the Irish Sea, and to Morocco as a stray in the East; northern part of Davis Strait, south to the latitude of Cape Fear, N. C., in the west. It is represented in the corresponding temperature-belt of the Southern Hemisphere by a form (or forms) resembling it so closely that it is doubtful whether any sharp line can be drawn between them.

Occurrence in the Gulf of Maine.—Apart from one record for the northern part of Davis Strait, the most northerly reports of the hag off the American coast are from southern Newfoundland and from the Grand Banks.¹⁹ But it is generally distributed along outer Nova Scotia at appropriate depths. And it is only too common in the Gulf

¹³ Mem. N. Y. Acad. Sci., vol. 2, Pt. 2, Art. 2, 1900.

¹⁴ Vid. Meddel. Dansk naturhist. Forening, 1900, p. 1.

¹⁵ Rept. Norwegian Fishery and Mar. Invest., vol. 1, 1900, No. 1, ch. 4, p. 75.

¹⁶ Rept. Michael Sars North Atlantic Exped., Zool., vol. 4, No. 1, 1927, p. 18.

¹⁷ Science, N. Ser., vol. 75, 1932, pp. 19-20.

¹⁸ It has not been reported for certain from West Greenland (so far as we can learn), from the outer coast of Labrador, or within the Gulf of St. Lawrence though it is to be expected in the deeper parts of the latter.

¹⁹ See Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, ch. 2, 1948, pp. 35-36, for references.

of Maine; perhaps it is not absent there from any considerable area of smooth bottom. Thus, it is abundant off the north end of Grand Manan; is reported from Passamaquoddy Bay and from various localities near Eastport; is to be found off-shore on muddy bottom all along the Maine coast; and is caught at times in considerable numbers on the Boon Island-Isles of Shoals fishing grounds and about Jeffreys Ledge, where we found it plentiful enough in the spring of 1913 to have gutted 3 to 5 percent of all the haddock in the gill nets. Fishermen report it as equally numerous in the deeper parts of Massachusetts Bay. On the offshore banks the hag is well known, and it has been trawled at various localities along the outer edge of the Continental Shelf off New England at depths of from 100 to 200 fathoms, and deeper. We ourselves took 11 large ones in one set of a Monaco deep-sea trap in 260 fathoms off Nantucket on July 9, 1908, and it has been taken in from 300 to 500 fathoms off Marthas Vineyard; as deep as 524 fathoms on the southeast slope of Georges Bank.

Sea lamprey *Petromyzon marinus* Linnaeus 1758

LAMPREY; SPOTTED LAMPREY; LAMPER; EEL-SUCKER

Bigelow and Schroeder, 1948, p. 46.

Description.—Lampreys are eel-like in appearance, but have a soft, cartilaginous skeleton. They lack paired fins but have well developed

dorsal and ventral finfolds. In the adult the jaws are so rudimentary that apparently they are wanting; the mouth is a longitudinal slit when closed, but forms an elliptical disk at the tip of the snout when open, and is armed with many horny, hooked teeth arranged in numerous (11 to 12) rows, the innermost the largest. There are two dorsal finfolds, and there are seven open gill slits on each side, whereas the hag has only one gill pore on each side, and only one fin. The sea lamprey (the only member of its group known from our salt waters) can hardly be mistaken for any other fish, its eel-like appearance coupled with two dorsal fins and the jawless mouth placing it at a glance.

Color.—Small specimens (whether on their way downstream or in salt water) are white below and uniformly colored above, usually described as blackish blue, or as lead colored, and more or less silvery. But large specimens usually are olive brown above, or of varying shades of yellow-brown, green, red, or blue, mottled with a darker shade of the same color, or sometimes nearly black if the dark patches are confluent. The lower surface is whitish, gray, or of a pale shade of the same hue as the ground color of the back. During breeding season, the landlocked form takes on more brilliant hues, with the ground tint turning bright yellow.

Size.—The length at the time of transformation from the larval stage is about 4 to 8 inches (100–200 mm.). Sexually mature individuals, taken

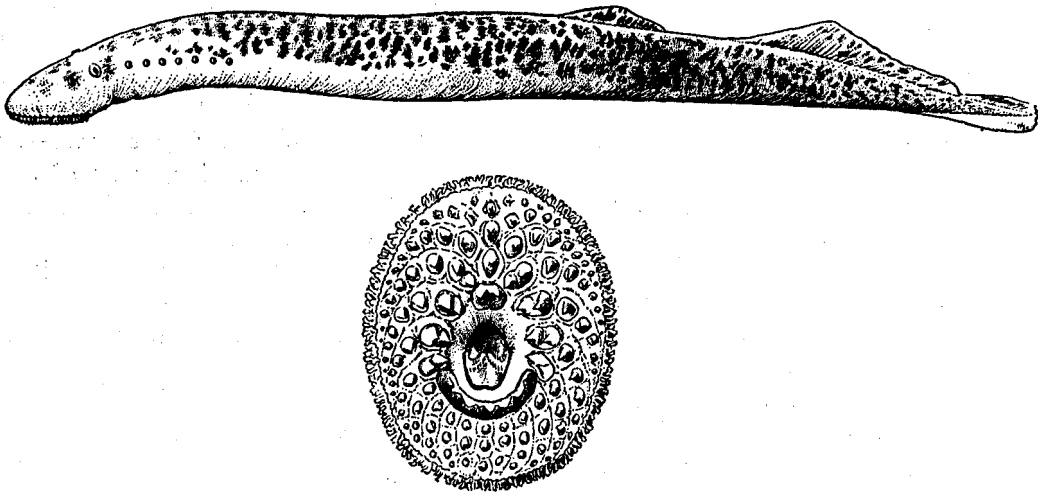


FIGURE 3.—Sea lamprey (*Petromyzon marinus*), about 18 inches long, Merrimac River; and open mouth disc of another Merrimac River specimen to show the arrangement of the horny teeth, about 0.9 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

in American rivers, average 2 to 2½ feet long, up to a maximum of about 3 feet. One of 33 inches weighed 2¼ pounds.

Habits.—It has been known from early times that the sea lamprey breeds in fresh water. However, it does not enter all the streams within its range indiscriminately. As an illustration, we may cite outer Nova Scotia and the Bay of Fundy, where lampreys run in the St. Marys, Sackville, Annapolis, Shubenacadie, Petit Codioc, and St. Johns Rivers, but not in the Moser or Apple Rivers, although these last also are "salmon" rivers. Their requirements are a gravelly bottom in rapid water for their spawning beds, with muddy or sandy bottom in quiet water nearby, for the larvae.

In many small streams, and in larger ones if these are blocked by dams or high falls, they may spawn only a short distance upstream; even within the influence of the tide, although invariably in fresh water. But they are able to ascend falls, if these are not too steep and high, by clinging to the rocks by their oral discs and resting. And they may run upstream for very long distances in large rivers, as they did formerly in the Merrimac and probably still do in the St. Johns River. They are still to be found 200 miles or more from the sea in the upper tributaries of the Delaware and Susquehanna systems.

Since the breeding activities of the sea lamprey take place in fresh water, a brief account will suffice here. As the two sexes ripen, the males develop a strong ridge along the back, the females a crestlike fin between the anus and the caudal fin. Spawning, commencing when the temperature of the water is about 50° F. (10° C.) is completed by the time it has warmed to about 68°–70° (20°–21° C.), and a sea lamprey has been found to contain 236,000 ova. Working in pairs, sometimes with a second female assisting, they make depressions 2 to 3 feet in diameter and about 6 inches deep in the stream bed in stretches where the bottom is stony or pebbly, dragging the stones downstream in a pile with their suckerlike mouths. And they are able to move stones as large as one's fist. It is in these depressions that the eggs are deposited, not among the piles of discarded stones that have often been described as "nests." It seems that they all die after spawning; not only have they often been found dead, but their intestines atrophy, they are attacked by

fungus, and they become so debilitated that recovery seems out of the question.

The larvae are different in appearance from the adults: blind, toothless, with mouths and fins of different shape. They continue in this state for a period estimated as 3 to 4 years, during most of which time they live in burrows in the mud or sand, or hide under stones. They are abundant in the mud of flats near the mouths of small tributary streams of river systems such as the Delaware and Susquehanna, where lampreys still breed in large numbers, and they subsist on minute organisms. At the end of this larval period, when they have grown to a length of 4 to 6 inches, they undergo transformation to the adult form and structure, an event occupying about two months, August to September or October. They run down to the sea in November or December, to live and grow there for one or two years, so that large ones, not yet mature, are to be found in salt water all the year round.

Little is known of the habits of the lampreys while they live in the sea further than that their mode of life centers around a fiercely predaceous nature. Judging from their land-locked relatives and from the occasions on which they have been found fastened to sea fish, they must be extremely destructive to the latter, which they attack by "sucking on" with their wonderfully effective mouths. The lamprey usually fastens to the side of its victim, where it rasps away until it tears through the skin or scales and is able to suck the blood. Its prey sucked dry, it abandons it for another. Probably lampreys are parasites and bloodsuckers pure and simple, for we cannot learn that anything but blood has been found in their stomachs, except fish eggs, of which lampreys are occasionally full.²⁰

In salt water they have been found preying on mackerel, the various anadromous herrings, cod, haddock, American pollock (*Pollachius*), salmon, basking sharks, swordfish, hake (*Urophycis*), sturgeons and eels. Sometimes as many as three or four are fast at one time to a single shad, and they are said to be exceedingly aggressive in their attacks on other fishes. Occasionally they are found fast to driftwood, even to boats. When not clinging to anything they are strong, vigorous swimmers, progressing by an undulating motion.

²⁰ Goode, Fish. Ind. U. S., Sect. I, 1884, p. 677.

General range.—Atlantic coasts of Europe and of North America; from the west coast of Greenland to Florida in the western side of the Atlantic; from northern Norway to the Mediterranean in the eastern;²¹ running up fresh rivers to breed, and landlocked in certain American lakes.

Occurrence in the Gulf of Maine.—No doubt the sea lamprey occurs along the whole coast line of the Gulf of Maine, for it is recorded in or at the mouths of numerous rivers and streams in Nova Scotia, New Brunswick, Maine, and Massachusetts; specifically in the St John, Annapolis, Petit Codioc, and Shubenacadie Rivers and from the St. Andrews region in salt water in the Bay of Fundy; from Eastport, Bucksport, Casco Bay, and the Presumpscott, Kennebec, and Penobscot Rivers in Maine; from the Merrimac River system; from the Exeter and Lamprey Rivers, tributaries of Great Bay, New Hampshire; and from the Parker River in northern Massachusetts.

Since lampreys never take the hook or are captured in nets except on rare occasions they are seldom seen in salt water; only when running up our rivers are they familiar objects. But they have been taken as far offshore as the seaward slopes of Banquereau, Sable Island, and LaHave Banks off Nova Scotia; on Browns Bank; in the deep gully between the latter and Georges Bank, and over the continental slope off Nantucket and off Marthas Vineyard.

Lampreys have long been known to run up New England rivers a little earlier in the spring than shad, perhaps beginning to work upstream as early as the beginning of April or even the end of March. In the rivers tributary to the Gulf of Maine the runs are at their peak during May and early June, with few, if any, entering later than that. The larvae have been reported by Doctor Huntsman as plentiful in the Shubenacadie (emptying into the Bay of Fundy) and no doubt they are to be found in the Merrimac system, in the Exeter River, and in other Gulf of Maine streams.

Abundance.—The construction of impassible dams has sadly reduced the numbers of lampreys

in the larger rivers of New England. In the Merrimac, for example, once a famous lamprey river,²² so few now succeed in surmounting the succession of dams that a recent survey yielded no evidence of any now having access to the upper reaches. Some lampreys, however, are said to breed in the river below the Lowell dam;²³ we have seen what resembled their "nests" in the Squannacook, a branch of the Nashua tributary to the Middle Merrimac, and they still continue numerous in some Gulf of Maine streams where they can reach suitable spawning grounds without too great difficulty. We may quote catches of up to 119 recently in the Shubenacadie, where larvae also have recently been reported in abundance,²⁴ and of more than 100 each on several occasions in the Exeter River,²⁵ where they are familiar spectacles, as they gather at the falls at Exeter, N. H. But we ought perhaps to caution the reader that while lampreys, like other anadromous fishes, may seem plentiful when condensed between the narrow bounds of a river's banks, their numbers as a whole do not rival those of the more abundant of the salt-water fishes.

Importance.—Lampreys were esteemed a great delicacy in Europe during the middle ages (historians tell us Henry I of England died of a surfeit of them) and considerable numbers were captured of old in the rivers of New England for human food, particularly in the Connecticut and Merrimac Rivers. But the lamprey fishery has been scarcely more than a memory for 40 years past except locally and in a small way for home consumption, or to supply the needs of biological laboratories. In the salt water of the Gulf of Maine the lamprey has never been of any commercial importance; the average fisherman might not see one in a lifetime, nor is there any sale for the few that are picked up by chance. But larvae are taken in considerable numbers for bait in the Susquehanna River, and perhaps elsewhere along the middle Atlantic coast.

²² For an account of the lamprey fishery in New England during the first half of the 19th century, see Goode, Fish. and Fishery Ind. U. S., Sect. 1, 1884, p. 680.

²³ Bailey, Biol. Survey Merrimack Watershed, New Hampshire Fish and Game Dept., 1938, p. 155.

²⁴ Information gathered for us by Dr. A. G. Huntsman.

²⁵ Collected for the Biological Laboratory, Harvard University.

²¹ Also reported from "West Africa" by Günther, Cat. Fishes British Museum, vol. 8, 1870, p. 502.