FISH AND SHELLFISH OF THE South Atlantic and Gulf Coasts

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CONTENTS

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EVER SINCE the first settlements were made in the region, the waters bordering the southern Atlantic coast and the shores of the Gulf of Mexico have furnished food. Shrimp, oysters, crabs, and shorefish, abundant in the warm southern bays and sounds, insured the early colonists against starvation and later formed an article of trade with settlements removed from the coast, upriver and in the foothills of the mountains. Little by little the fisheries of the region developed, and now the South supplies the United States with practically all of its shrimp, a third of its crabs, a fourth of its oysters, and a number of choice fishes that are not taken anywhere else in abundance, like the red snapper, the Spanish mackerel, and the pompano.

Although mature in years, the fisheries of the South Atlantic and Gulf coasts have by no means completed their development. With a coastline more than 2,500 miles long as the crow flies, the region produces only a little more than half a billion pounds of fishery products—14 percent of the total yield of the fisheries of the United States and Alaska. With a bewildering variety of life in its waters—more kinds of fish and shellfish than are found anywhere else in the country—the region has developed only five major fisheries: the menhaden, shrimp, mullet, crab, and oyster industries. Of all other species available, none are caught in quantities exceeding 10,000,000 pounds.

Part of this slow development has resulted from our lack of knowledge, both of the fishing grounds and of the fish. There has been little scientific exploration of the region, and the fishermen have confined their operations almost entirely to the waters close inshore. We do not know, with few exceptions, the areas where fish may congregate offshore, or whether such areas exist. We know very little of the life histories of some of the most important species of the region, so that we can only guess how large a fishery they might support. Some of the species which we know to be abundant cannot now be fully utilized because of the limitations of the present methods of handling the catch.

The southern fisheries are a fertile field for exploration which will reveal whether they may in time yield an even larger and more valuable seafood harvest.

THE FISHERIES

Cape Hatteras is the Mason and Dixon Line of the marine world. North of it lie the waters inhabited by the cold-water fishes of the northern ocean, species like the sea herring, the common mackerel, cod, silver hake, and pollock. South of the Cape the truly southern fauna begins. Spanish mackerel and kingfish, mullet, bluefish, spotted sea trout, red snapper, groupers—these are a few of the many species that belong to the warm waters of the South and are caught in important quantities nowhere else. To be sure, many of them make occasional or

TABLE 1.—*Fish and shellfish landed in the South Atlantic and Gulf states in 1940 in quantities exceeding 100,000 pounds.*[1]

Species	Pounds	Value to fishermen
FISH		
Alewives or river herring	9,115,900	$110,896
Bluefish	2,438,400	178,166
Blue runner	780,700	11,883
Carp	438,000	19,662
Catfish and bullhead	6,486,200	199,717
Crappie	741,900	23,857
Crevalle	238,700	3,385
Croaker	4,421,400	89,634
Drum:		
Black	857,900	37,945
Red or redfish	1,594,800	98,045
Flounders	1,064,900	83,555
Groupers	5,184,000	206,067
Harvestfish	434,500	12,735
Hickory shad	371,500	12,842
Jewfish	138,300	4,381
King mackerel	3,478,000	155,860
King whiting	1,426,600	41,721
Menhaden	250,076,800	823,202
Mojarra	394,900	6,688
Mullet	37,078,100	1,378,161
Muttonfish	404,000	23,098
Pinfish	130,100	2,586
Pompano	562,900	137,321
Sea bass	420,800	19,660
Sea catfish	377,500	7,056
Shad	1,344,400	189,529
Sharks	4,260,000	25,200
Sheepshead (salt-water)	628,900	19,415
Snappers:		
Mangrove	204,900	9,359
Red	6,523,800	577,341
Snook or sergeantfish	470,000	24,519
Spanish mackerel	6,450,900	320,746
Spot	5,448,500	85,989
Squeteagues or sea trout:		
Gray	3,630,500	181,745
Spotted	6,311,900	512,207
White	217,800	8,801
Striped bass	539,900	59,339
Sunfish	2,104,800	63,144
Tenpounder	227,100	5,052
White perch	108,200	3,795
Yellowtail	59,800	5,338
SHELLFISH		
Crabs:		
Hard	33,321,100	528,497
Soft and peelers	543,700	83,311
Shrimp	150,540,600	5,893,360
Spiny lobster	463,500	31,501
Clams, hard	1,240,900	112,638
Oysters, market:		
Public, spring	12,742,100	744,152
Public, fall	2,367,400	185,372
Private, spring	3,391,900	195,552
Private, fall	2,449,300	137,674
Scallops, bay	162,200	21,182
Turtles, soft-shell	146,600	2,204

[1] Source: Fishery Statistics of the United States, 1940. Statistical Digest 4, Fish and Wildlife Service.

even regular excursions into the northern area, but they reach their full tide of abundance only along southern shores.

Because it lies a third above and two thirds below Cape Hatteras, North Carolina has a fish fauna of mixed northern and southern forms. Some of the fish taken in large quantity in its waters—such as the croaker, spot, alewives, and gray sea trout—also are found in great numbers in the Chesapeake Bay and along the Middle Atlantic coast. These species are not described in the present bulletin because they are not abundant elsewhere in the South and their description is being reserved for a future publication on the fishes of the Middle Atlantic coast and the Chesapeake Bay.

In 1940, a year fairly representative of pre-war conditions, commercial fishermen of the States from North Carolina to Texas brought in a total of 573,533,000 pounds. An enormous variety of edible fish and shellfish were represented in that catch, in all more than 85 different kinds. But the diversity of the seafood produced by the southern fisheries is more apparent than real. Ninety percent of the entire catch consists of five species of aquatic life, while the remaining 10 percent is made up of 75 species caught in quantities ranging from moderate down to small or insignificant. The menhaden alone, a silvery member of the herring family which schools in enormous numbers at the surface, comprises nearly half the catch of all species for the entire region. Shrimp contributes another quarter. Mullets, crabs, and oysters make up 3 to 6 percent each. (Detailed statistics of the catch are given in table 1.)

As might be expected, the eight southern coastal States differ a great deal in the productivity of their fisheries. Florida, with its long coastline, has a larger catch than any other State in the group, contributing about one-third of the total yield. North Carolina is a close second, with 30 percent of the total, and Louisiana is third, with 22 percent. Mississippi furnishes 7 percent, Texas 4, and Georgia, Alabama, and South Carolina 1 to 2 percent each. (See table 2 for poundages.)

Not only are Florida's fisheries the most productive, they are also the most varied, drawing on 67 species—52 fish and 15 shellfish. This is exclusive of a number of fishes like the tarpon, bonefish, and others taken only by sport fishermen. North Carolina, with 43 commercial species, comes next, while Mississippi, drawing on only 17 species, has the least diversified fisheries (table 2).

TABLE 2.—*Miscellaneous information on the fisheries of the South Atlantic and Gulf States.*[1]

State	Number of species in commercial catch	Total landings (in pounds)	Value of catch to fishermen	Number of fishermen	Number of vessels[2]	Largest fishery of State	Most valuable fishery of State
North Carolina	43	170,581,000	$1,864,164	7,113	184	Menhaden	Menhaden
South Carolina	21	9,445,900	265,828	1,341	35	Crab	Oysters
Georgia	19	12,671,700	380,630	1,178	77	Shrimp	Shrimp
Florida	67	187,492,200	5,004,612	8,902	203	Menhaden	Mullet
Alabama	26	11,344,300	561,911	1,134	41	Shrimp	Shrimp
Mississippi	17	38,002,300	623,110	1,877	248	Menhaden	Shrimp
Louisiana	24	126,626,800	4,951,493	4,858	288	Shrimp	Shrimp
Texas	22	19,369,200	992,697	1,538	69	Shrimp	Shrimp
Total		575,533,400	14,644,895	27,941	1,145		

[1] Based on statistics for 1940.
[2] Exclusive of motor boats, row boats, and other small craft.

The menhaden industry of the South is centered in North Carolina, which produces slightly more than half the total yield of the area. Louisiana is the shellfish capital of the region, with the southern fisheries for shrimp, crabs, and oysters all most highly developed in that State. Florida, however, is the headquarters of a most imposing array of important fisheries: those for mullet, red snapper, Spanish mackerel, kingfish, bluefish, sharks, grouper, and redfish, as well as the smaller fisheries for spiny lobster, pompano, sheepshead, blue runner, jacks, and clams.

THE FISHING GROUNDS

It is 900 miles from Cape Hatteras to the Florida Keys, and it is 1600 miles from the Keys around the Gulf to the mouth of the Rio Grande. That is a total of 2,500 miles of coastline, measured directly and without following all the small irregularities, the numerous islands, the sounds and bays and marshes that make the South Atlantic and Gulf coasts the shore fisherman's paradise. Unlike the New England fishermen, who take most of their catch on grounds lying far offshore and perhaps hundreds of miles from the home port, the fishermen of the South do the greater part of their fishing in a narrow band of water only a few miles wide bordering the coast on its ocean side, and in the thousands of square miles of protected bays and sounds that are so characteristic of the southern coast.

South Atlantic coast

The eastern boundary of North Carolina is a chain of narrow islands that form a barrier protecting the coast from the pounding of the Atlantic breakers. Between the islands, locally called "banks," and the coast lie a series of sounds—Currituck, Albemarle, Pamlico, Core, and Bogue—some 3,000 square miles of fishing waters connected with the outside by several inlets. Shad, striped bass, and river herring pass through these sounds at spawning time, and sea trout, mullet, croakers, crabs, and oysters abound in them. On the ocean shore, off the banks, there is good fishing for other species. Famous bluefish grounds lie between Cape Henry and Cape Lookout. Every fall the spawning runs of mullet pass in enormous schools along the outer and inner shores of the banks. Some of the best menhaden grounds are in the waters off Cape Lookout, and sheepshead, drum, and Spanish mackerel are abundant in the deep, protected bight west of the Cape.

Southward along the coast an arc of almost unbroken beach extends from Cape Fear to South Carolina's Winyah Bay; then follows a broken coastline of marshes, bays, and barrier islands through the remainder of South Carolina and Georgia, nearly to the St. Johns River. Then the broad, sandy beaches of eastern Florida sweep in a long curve to the Keys and the beginning of the Gulf coast.

This much of the South Atlantic coastline can be seen and understood by everyone. We know much less about what lies beneath the surface, the undersea hills and valleys and currents that determine where the fish will congregate and in what numbers. Compared with offshore New England—fished, charted, and explored since the days of John Cabot—the South Atlantic and, as we shall see, the Gulf, are an unknown marine wilderness.

We do know that the continental shelf, the gently sloping portion of the ocean floor that extends from the tide lines out to the 100-fathom

depth, is only about 30 miles wide off Cape Hatteras and averages 75 to 100 miles south of Hatteras to midway down the Florida coast, when it narrows suddenly to a mere 5 or 6 miles off Palm Beach and Miami. Since most fish are confined to the shallow waters over the continental shelf, and seldom venture out over true oceanic depths, the width of the shelf has a direct bearing on the fisheries.

Offshore from Hatteras and Lookout, occasional beds of coral show the beginning of a truly southern fauna. Off the coasts of South Carolina and Georgia numerous fishing banks are scattered over the continental shelf between the 10-fathom and 100-fathom line. These are like submarine hills rising above a deeper-lying plain, their tops covered with sand, coral rock, waving sea fans, and shells. Sea bass, jacks, flounders, snappers, grunts, and sharks are some of the species fishermen take on the southern offshore banks.

Gulf coast

Off the southern tip of Florida a long chain of islands—the Florida Keys—stretches out south and west into the Gulf like giant stepping stones. Their southern border swept by the Gulf Stream, the Keys are almost inconceivably rich in marine life of all kinds, both fishes and the smaller invertebrate life they feed on. Some fish are more abundant on the southern side of the reef in the warmer Gulf Stream water, others on the north side. Not infrequently a "norther" drives kingfish and other species through the narrow channels between the reefs, making good fishing while the schools are concentrated in a restricted area.

Above the Keys, the west coast of Florida is broken into a maze of waterways about the "Ten Thousand Islands," then swings north in a long arc, interrupted here and there by deeply indenting bays. The continental shelf is very wide off this coast—as much as 130 miles—and is crossed and furrowed by ledges and gullies where fish abound. Its outer margin is rocky and dotted with patches of coral.

Westward, bays, sounds, marshes, and chains of islands mark the coast to the great delta of the Mississippi, built so far into the Gulf that off its tip the continental shelf is only about 10 miles wide. Beyond the Mississippi are more coastal marshes for mile after mile, bordered on the seaward side by barrier beaches, marked by vast nearly enclosed lagoons and bayous. These inside waters grow fine oysters, and they swarm with young shrimp. Redfish, trout, black drum and other fishes come in from the open sea as young fish and grow and mature in them.

Of the open Gulf we know very little, for it is a region that has been strangely neglected by oceanographers, and with the single exception of the combined fishery for red snappers and groupers, the Gulf fisheries have been confined to a narrow band of coastal waters. The area of the Gulf is about 700,000 square miles. Except at the mouth of the Mississippi and again at Vera Cruz, the continental shelf which rims its basin is wide—100 to 130 miles. The deepest part of the Gulf's floor —Sigsbee Deep off the coast of Yucatan—lies more than two miles below the surface, and much of the remaining area is from one to two miles deep. The Gulf has no offshore islands except the Keys of Florida and Yucatan, and the island of Cuba. Its tides have a range of only two to four feet; its currents sweep in a vast rotational movement about its shores, clockwise, leaving its boundaries by way of the Strait of Florida and pouring north through the Atlantic Ocean as the river of warm blue water known as the Gulf Stream.

BOATS, MEN, AND FISHING GEAR

Before the war, which made it necessary to use many fishing boats for other purposes, the fishing fleet of the South Atlantic and Gulf coasts was the largest in the United States and Alaska. While the number of large vessels was slightly below the number of similar craft used on the Pacific coast of the United States—1,145 compared with 1,563—the total number of vessels, motor boats, and miscellaneous small craft fishing out of southern Atlantic and Gulf ports was 16,194. The three Pacific Coast States had the next largest fleet, with 9,105 craft, and Alaska the third largest fleet of 5,138.

The largest vessels operating in the southern area are the menhaden purse seiners, which cruise about in the larger bays or in the open ocean with a lookout posted in the crow's nest watching for schooling menhaden. They take with them several small boats from which fishermen carry out the actual operation of setting the seine around the fish. The large menhaden seiners probably have the greatest annual production, per boat, of any vessels operating in the United States fisheries, running from 7,000,000 to 10,000,000 pounds.

Another large and important section of the southern fishing fleet is made up of the shrimp trawlers, which bring in most of the catch of this valuable crustacean. The trawlers drag cone-shaped nets along the bottom of the sounds or ocean where the shrimp congregate in greatest numbers.

Another good sized fishing vessel seen in the South is the schooner type, modeled after the famous Gloucester schooners, which operates chiefly out of Pensacola and visits the red snapper banks off the coast of Yucatan.

A variety of smaller boats is used in operating the gill nets, haul seines, and dredges which are important in many southern fisheries. Pound nets, common in North Carolina, but not farther south, are tended usually by small motor boats. Fyke nets, dip nets, and cast nets may be operated from the shore.

In 1940, approximately 28,000 persons were directly engaged in fishing in the States from North Carolina to Texas. Florida reported the largest number of fishermen—8,902. North Carolina and Louisiana followed, with 7,113 and 4,858, respectively. Each of the other States had between one and two thousand fishermen.

MARKETING THE CATCH

Although the South Atlantic and Gulf coasts furnish more than half a billion pounds of fish and shellfish annually, nearly half of this amount consists of menhaden, practically all of which is now processed into meal and oil and so does not enter the ordinary marketing channels. Some 250,000,000 to 300,000,000 pounds remain for distribution as fresh, frozen, canned, salted, or smoked products.

Most of the fish landed at southern ports enters the fresh-fish markets. Despite the recent introduction here and there of the modern processing methods of preparing fillets, steaks, and tenderloins, the most prevalent custom is to ship the fish in the round, that is, without preliminary dressing. This fact makes it difficult for the southern States to compete with New England as a fresh-fish center, for in that area much of the catch is routinely processed in modern plants which turn out a conveniently handled product, neatly packaged and quick frozen. At present the necessary shore facilities—filleting plants, freezing and

storage establishments, and the like—are extremely limited in the South. Likewise, the skilled labor necessary to operate such plants is almost unobtainable under war conditions.

The present methods of handling the catch are particularly unsatisfactory as applied to some of the most important fisheries of the region, such as the mullet and Spanish mackerel fisheries. Extremely heavy catches of these species are made in a short period, so that in practice it has often proved impossible for the fresh fish markets to handle all the fish that are caught. The problem could be solved if means were available to dress the fish by filleting or other suitable means, quick freeze it, and hold it for distribution in accordance with market demands.

Canning in the South is limited almost entirely to shrimp and oysters. It has been the practice to can the greater part of the shrimp, and this market form has undoubtedly been most familiar throughout the wide area in which shrimp is distributed, but there is now a strong trend toward freezing more shrimp and canning less. Practically all the oyster canning in the United States is done in the southern States, and Biloxi, Miss., cans more oysters than any other city in the world.

Geographically, the products of the southern fisheries (exclusive of the canned pack) are distributed chiefly in the area bounded by the Mississippi River on the west and the Ohio River on the north. Certain species, however, have a much wider distribution. Probably shrimp and red snapper are shipped to more distant cities than any other southern seafoods.

From the South Atlantic coast and all of Florida the heaviest shipments go north along the Atlantic coast. New York is an important market for this area, which ships as far north as Massachusetts, Michigan, and Illinois, and as far west as Texas and Kansas. From the Gulf coast many shipments go north by truck and freight up the Mississippi Valley. Shipments are also made to the Middle Atlantic area, the New England States, the Rocky Mountain area, and the Pacific coast.

BIOGRAPHIES OF THE FISH AND SHELLFISH OF THE REGION

Mullet (*Mugil cephalus* and *M. curema*)

The mullet is the most important food fish of the South. It supports the most valuable fishery in the States of Florida and South Carolina, and is caught in larger quantity than any other fish with the exception of menhaden in Florida, Alabama, and Mississippi. In the whole area from North Carolina to Texas, the catch of mullet is exceeded only by menhaden, which is used primarily for the manufacture of oil and meal, rather than as food, and by shrimp, the South's major seafood product.

Being an abundant and modestly priced fish, mullet is one of the staple foods of the lower income groups in southern coastal cities. Despite its low price, it is one of the better food fishes. It has a tender, firm-textured flesh which contains a clear yellow oil with a mild and nutlike flavor.

Mullets are found throughout the world and there are about 100 different species, most of which are tropical. The most abundant United States species, the striped or jumping mullet (*Mugil cephalus*) itself has a wide distribution. On our east coast it occurs all the way from Cape Cod to Brazil. Occasionally a few stray mullet appear

north of the Cape, in the Gulf of Maine, but such an occurrence is rare and there are no regular fisheries north of the Carolinas. On the Pacific coast of the Americas mullet are found from Monterey to Chile and westwood to the Hawaiian Islands and Japan. In the eastern Atlantic they are common on the southern European coast and in the Mediterranean. They are often mentioned in the writings of the ancient Romans, and in Egypt they have been cultivated for centuries in the overflow deltas of the Nile.

The white mullet, *M. curema*, is taken commercially in only a few localities, although it occurs all the way from Cape Cod to Brazil. It is abundant about Key West and the other Florida Keys, where it makes up the greater part of the mullet catch. It is so similar in

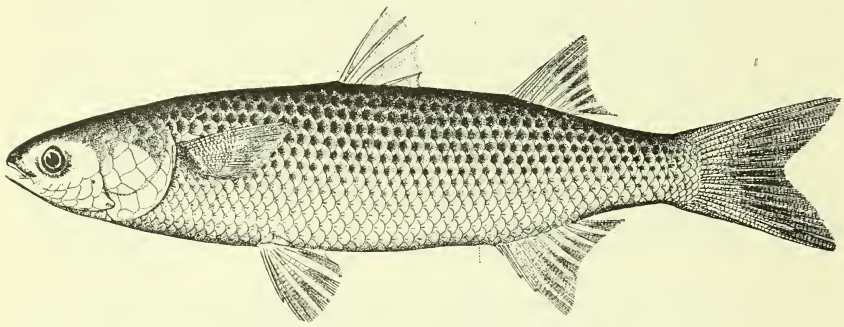

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Figure 1.—The jumping mullet gets its name from its habit of leaping as much as three feet out of the water, making it easy for fishermen to spot schools of this fish.

appearance and habits to the striped mullet that fishermen do not often distinguish between them.

In their relationships, the mullets are closest to the silversides, although much larger than these shimmering little minnows, and to the barracudas. The striped mullet is a rather stout bodied fish with large scales and averages 2 or 3 pounds in weight. Probably the record size is 10 pounds. A distinctive mark is the fact that it has two well separated dorsal fins, and that the more forwardly placed one is held stiffly erect, like a small sail, by its four spines. The color of the fish is a silvery grey, darker on the back, and with dusky stripings along the sides. Young mullet are a beautiful silver color, like a freshly minted dime.

Mullet live in coastal waters and often run up into brackish river mouths to feed. In South America, Dr. Samuel Hildebrand, ichthyologist of the Fish and Wildlife Service, has found them as much as one hundred miles above the mouths of rivers, sometimes above high waterfalls. They are seldom if ever found in fresh water in the United States.

In North Carolina, where there are important mullet fisheries, these fish usually spend the summer in the bays and sounds, feeding on the vegetation of the bottom. In the fall, apparently at a time when the spawn is maturing, the fish begin a mass exodus from these inside waters, passing out through the inlets and moving southward along the coast and presumably out to sea. At this time of year enormous catches —sometimes as much as 62,000 pounds in a single haul of the net—are made by the mullet fishermen.

Because mullet are schooling fish and especially because they have

a remarkable habit of jumping as much as three feet out of the water, fishermen can easily sight an approaching school and set their nets about it. On the North Carolina coast they usually wait on the beach, boats and net in readiness, until the lookout on top of a nearby dune gives the signal that the fish are coming. With one end of the net held on shore, the seine is then carried out in a large semicircle around the fish and the free end brought in to the beach. The men then jump out of the boats and wade out into the surf to hold down the lead line in the lower margin of the net with their feet, otherwise the mullet will escape under the net. At best a number of them will leap over the cork line, sometimes making the mistake of jumping into the boats. Often two nets are set, one outside the other, so that the fish that escape the inner net may be caught in the outer. The net is drawn in as rapidly as possible and finally the central part, which now forms a sort of bag containing the fish, is hauled up on the beach, all the mullet flapping against the wet sand in their efforts to escape.

In Florida mullet are caught chiefly at night. Although unable then to see the fish unless the night is bright, fishermen can hear a school splashing and so tell when to set the net. Gill nets, in which the fish become entangled as they attempt to pass through the meshes, are often used in Florida.

Almost three-fourths of the entire U. S. mullet catch of 35 to 40 million pounds is taken in Florida, chiefly on the west coast. Although far below Florida in production, Alabama ranks second in the mullet fishery, followed by North Carolina. Mullet are present in abundance throughout the Gulf of Mexico, but they have been almost entirely neglected in Louisiana and Texas. When these fisheries are developed, production of this excellent fish can be greatly increased and it can be supplied in larger quantity to northern cities.

The season of greatest abundance is from April through November. heaviest runs about Beaufort, N. C., occur usually in September, while the peak of activity in the Florida fishery comes in November. In that State the fishery in most counties is closed between December 1 and January 10, to protect the fish during the spawning period.

The mullet lends itself especially well to cultivation, and has been raised in ponds for many centuries in various parts of the world. The ancient Romans practiced mullet culture, and so did the native chieftains of the Hawaiian and Philippine Islands, who had large numbers of fish ponds built throughout the islands. The mullet and milkfish are still the principal species raised in these ponds.

Some recent experiments at the Beaufort, N. C., laboratory of the Fish and Wildlife Service indicate that mullet culture in shallow, enclosed areas along the South Atlantic coast may be a future fish-cultural development of some importance. Dr. Herbert Prytherch, in charge of the laboratory, says that mullet which he placed in such an enclosure as two- or three-inch fish grew to an exceptional size in two years' time. The mullet do not require feeding, provided the growth of vegetation is stimulated by fertilization.

At present mullet usually reach the market in the round, i.e., without being dressed, and these fish may be either fresh or frozen. Some mullet is now being filleted and popular demand will probably lead to more of them being prepared in this convenient form after the war, when labor and plant facilities permit. Part of the catch is salted, this product being chiefly for export. The roe also is eaten.

Quite a range of sizes is available for the purchaser—anything from half-pound fish, which are best suited for broiling, to large five-pounders,

which should be baked. The Fish and Wildlife Service will furnish, on request, a leaflet containing seven laboratory-tested recipes for the preparation of mullet.[1]

Spanish Mackerel *(Scomberomorus maculatus)*

The Spanish mackerel is predominantly a fish of warm southern waters but despite this fact its distribution is astonishingly wide. It may be found as far north as Maine and as far south as Brazil. It occurs on the far side of the Atlantic in waters that wash the African coast and it lives in the Pacific from San Diego to the Galapagos Islands. In the United States only a few thousand pounds are taken on the Pacific coast, however, and although commercial catches are reported on the east coast all the way from New Jersey to Texas, the real center of abundance of this species is in Florida.

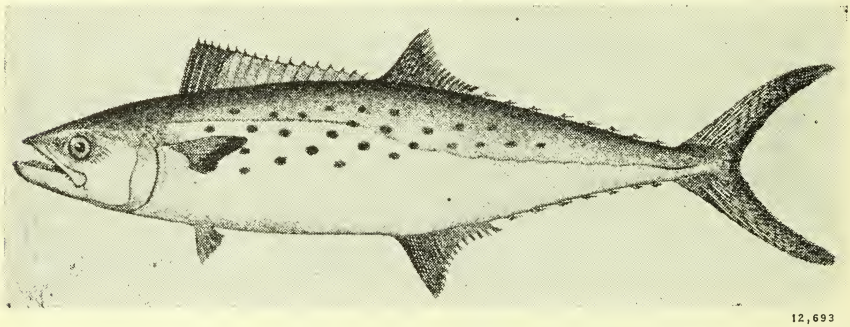

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Figure 2.—The Spanish mackerel roves the warm southern oceans in search of its prey, the smaller schooling fishes.

Only a little more than a hundred years ago, the Spanish mackerel was the subject of one of the shortest biographies ever written. "A fine and beautiful fish; comes in July," wrote the ichthyologist Mitchell in his "Fishes of New York," published in 1815. Even in the late 1800's not a great deal could be added to this one-sentence description. The Spanish mackerel was known only as an excellent food fish and a gamy fighter, which appeared in the Middle Atlantic area during the summer months, retiring in the fall to some unknown wintering ground. Where the fish goes in the winter is no longer a mystery, for most of Florida's 6,000,000 pound catch is made between November and March, when the Spanish mackerel is absent from more northern waters. It is now apparent that there is a northward migration in the spring, bringing it into the North Carolina area during April and into the lower Chesapeake Bay by May or June. With the first signs of fall and chilling waters, however, it returns to the more comfortable south.

Unlike the groupers, snappers, and drums, which lurk in coral patches or roam over deep-lying ocean bottoms, the Spanish mackerel live almost entirely at the surface. Traveling, they move in schools, and are easily seen at the surface as they pursue their food or clear the water in apparently playful leaps. According to Goode (1887) "the surface of the Chesapeake or the Gulf of Mexico is sometimes broken up for miles by the movements of large schools of these fishes, while the air is enlivened by the screaming flocks of terns, which follow them, to gather up the fragments of their feasts."

[1] Fishery Leaflet 48, Striped mullet and their preparation for the table. Mimeographed, 4 pp. Fish and Wildlife Service, Department of the Interior, Chicago 54, Ill.

Schools of menhaden are the principal source of food for the predatory Spanish mackerel, which also feed on any other schooling species, such as mullet, silversides, and the common Boston mackerel where the ranges of the two species overlap.

This is considered an even more beautiful fish than the famed dolphin. It is a deep blue with iridescent tones of gold and purple on the back and sides and silvery below, while along the flanks are three irregular rows of gold spots, "like new gold dollars," as an early writer put it.

When they are youngsters, only an ichthyologist could distinguish the Spanish mackerel from its close relatives the kingfishes or ceros (*Scomberomorus cavalla* and *S. regalis*) but the adults develop characteristics which make it fairly easy to tell them apart. The Spanish mackerel is a smaller fish than either of the others, averaging only about 2 pounds, and attaining a maximum weight of 20 to 25 pounds. *S. regalis,* which is abundant in this country only about the Florida Keys, averages 5 pounds and may reach 35; *S. cavalla* averages 7 and reaches a maximum of 50 to 75. Apart from size differences, if a fish of this group has yellow spots on its flanks and a gradually curving lateral line, it is a Spanish mackerel; if it has spots and one or two continuous black lines along its sides it is *S. regalis;* if it has no (or at most a scattered few) spots and a lateral line that drops abruptly opposite the second dorsal fin, it is *S. cavalla.*

The Spanish mackerel spawns while on its summer migration, at least from the vicinity of the Carolinas to Long Island, but we do not know whether spawning may also take place north and south of these limits. Hildebrand and Cable (1940) found larvae only a few days old in the open ocean off Beaufort, N. C., from late June until early September, but none in the inshore waters. The lower Chesapeake Bay, however, is a spawning ground for Spanish mackerel, although the fish are not as numerous in the Bay as they formerly were.

In Florida, where almost the entire commercial catch is made, fishermen take the Spanish mackerel in gill nets and purse seines. Most of the gill netting is done at night, because the fish are unable to see the net in the darkness and are more likely to gill themselves. The boats carry powerful searchlights to aid the crews in locating the fish. When the mackerel are sighted, the fishermen set their nets around the school as quickly as possible, marking its position by lanterns mounted on cork floats. The next step is to frighten the fish as much as possible, causing them to plunge against the net and become entangled by their gill covers in its meshes. This is done by splashing in the water with oars, or by rowing directly into the space enclosed by the nets. Although there is nothing to prevent the fish from swimming deep and escaping under the net, their habits are such that they ordinarily remain at the surface, either gilling themselves or escaping over the cork line.

As long as Spanish mackerel have been caught, they have been considered one of the choicest species of the east coast, ranking close to the pompano in popular esteem. They are usually marketed whole, and are best broiled or baked. Shipments are made throughout eastern United States with New York one of the most important markets.

Kingfish *(Scomberomorus cavalla)*

The kingfish, giant relative of the prized Spanish mackerel, takes top rank among the game fishes of America and is only a little less valued than its relative as a food fish. It occurs in great numbers at certain

seasons off the coast of Florida and rarely is seen as far north as Cape Cod. Southward, the limit of its range is Brazil.

The only important production center for the kingfish in the United States is Florida, where three to three and a half million pounds are taken. A very small catch is made in Texas. In Florida the related species, *S. regalis*, taken chiefly about the Keys, is also called the kingfish and fishermen seldom distinguish between them.

The season for kingfish in Florida is about the same as that for the Spanish mackerel, or from November to March. It is taken along both the Atlantic and Gulf coasts, chiefly by trolling, and is found in large schools, ranging the waters of the open sea in search of menhaden and other small fish. It is noted for its remarkable leaps, often clearing the

A5656

Figure 3.—The kingfish is a favorite of Southern sport fishermen and also a choice food fish.

water by 10 feet or more. Fishermen seeking Spanish mackerel often take the kingfish incidentally, because of the similar habits of the two species, but it is so strong and has such sharp teeth that it does considerable damage to the gear.

Kingfish taken by trolling usually run from 15 to 30 pounds in weight, but the maximum size for the species is about 75 pounds. Its size, strength, speed, and great fighting powers make it one of the most important game fishes on the coasts of Florida and North Carolina.

Like the Spanish mackerel, it is a fish of fine flavor, with few bones. The larger fish are sold in steaks, the smaller ones whole. Most of the catch is marketed along the eastern seaboard, Richmond and New York being especially important markets for this species.

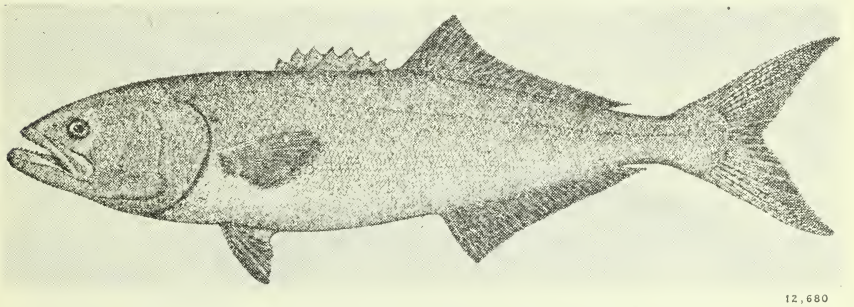
Bluefish *(Pomatomus saltatrix)*

The bluefish is another warm-water species which migrates up and down the Atlantic coast from Florida to Massachusetts following the schools of menhaden and other small fish and avoiding chilly climates. In midwinter bluefish are to be found in southern Florida, where the bulk of the commercial catch is made. Like migrant birds, they turn north with the spring, and by March and April large schools are passing the coasts of the Carolinas. They reach Long Island in late April or early May, Massachusetts by late May. In some years, probably when they are especially abundant, they pass Cape Cod and appear during the summer months in Massachusetts Bay and as far north as Maine, but these waters are beyond the range of their normal summer wanderings.

The total United States catch of bluefish was only 2,629,000 pounds in 1940, the most recent year for which we have a complete record. This was the low point of a catch that has been steadily dropping since 1936, when nearly 10,000,000 pounds were taken. The entire history of the fishery for bluefish is one of rapid changes in abundance. Probably the

largest catches—some 20,000,000 pounds—were made about 1900, but during several periods the yield has fallen as low as the present level.

We know too little about the natural history of the bluefish to be able to give a satisfactory explanation of these changes in its abundance. In lean bluefish years it is the custom for sport fishermen to say that scarcity of menhaden, probably the favorite food of the bluefish, is responsible. This supposition has never been proved and the records do not show that the changes in abundance of the two species coincide. A more probable explanation is that the bluefish, like many other marine species, is subject to extreme hazards during the first days and weeks of life from unfavorable winds, currents, and water temperatures, as well as from the attacks of natural enemies. In the case of the Atlantic



12,680

Figure 4.—The bluefish, a strong, swift fish of the open sea, may run up to three feet in length and is a deep bluish green above with silver below.

mackerel it has been proved that if, during the brief spawning period, the water is unseasonably cold or the set of winds and currents is such as to carry the young fish out of their normal nursery areas, practically the entire brood may perish. If this happens two or three years in succession, there is an acute shortage of mackerel. Perhaps something very like this happens in the life of the bluefish, but we shall have to wait until we know more of its life history before we can explain the ups and downs of abundance.

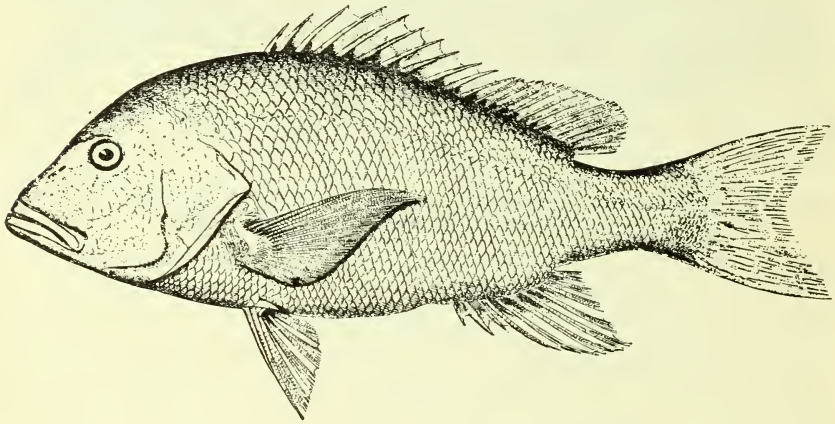
The bluefish, which commonly attains a weight of 10 pounds (the record specimen, taken at Nantucket Island, weighed 27 pounds), has quite a reputation for the size of its appetite and the ferocity of its attacks on schooling menhaden, mackerel, herring, or other small fishes. According to old and often quoted accounts, these attacks go far beyond what is necessary to satisfy the appetites of these bold sea hunters, which leave a trail of mutilated fish in their wake. Writers of past generations used to speculate about the number of fish destroyed by bluefish each year, seldom agreeing in their estimates but always arriving at astronomical figures.

Of all the fish tribe, the closest relative of the bluefish that is widely known is the pompano, generally voted the choicest food fish of the Atlantic coast. Like its relative, the bluefish is excellent eating. Since market sizes run from one to seven pounds, it is sold whole and may be baked, broiled, or fried, according to size and the preference of the cook.

In Florida, where the only important commercial catches are made, bluefish are taken usually between mid-December and mid-February. The same gill nets that take the Spanish mackerel also capture the bluefish, although small quantities are taken also by trolling. New York is an important market for these southern bluefish, which are available at a season when the fish are absent from northern waters.

Red Snapper *(Lutianus blackfordii)*

The red snapper is perhaps the most widely known of all the fishes of the Gulf of Mexico. Although the annual catch—6 to 7 million pounds—is not large compared with the major fisheries of the country, the red snapper is known and highly regarded in many cities in the north, to which considerable quantities are shipped. It is usually the most colorful item in a seafood market's display case or window—a large, brilliantly colored fish running up to 30 pounds in weight and 2½ feet in length. Although often sold whole, one of the larger snappers is likely to be beyond the modern family's capacity and so the present market forms include steaks and fillets, quick frozen and fresh. Red snapper is available throughout the year, and the housewife may use any method of preparation she likes, for it is good broiled, baked, steamed, or boiled. The meat is juicy, white, and of fine flavor. Most people consider a baked red snapper one of the choicest delicacies the sea provides.



12,945

Figure 5.—The Gulf coast's red snapper is known all over the United States as a choice food fish.

Most red snappers are caught in the Gulf, with the most extensive known fishing grounds—the Campeche Bank—lying off the coast of Yucatan and some 400 miles from Pensacola, the principal United States port for this fish. Small boats out of Galveston, Mobile, Panama City, and Tampa also fish on the Campeche Bank, taking both snappers and groupers, which commonly occur on the same grounds. There is also good fishing for these species around the edges of smaller banks, known as "lumps," off the United States coast of the Gulf.

At least five species of snappers are taken by United States fishermen, although the red snapper, *Lutianus blackfordii,* is caught in much the largest quantity. About Key West, the yellowtail, *Ocyurus chrysurus,* is the most important of all the snappers and is regarded as one of the choicest of the local food fishes. It averages about a pound and is commonly taken on the outer reefs. The gray snapper, *L. griseus,* is an even more abundant fish about Key West but because it is also exceedingly wary not as many are caught. This snapper has an interesting habit of traveling in schools that may number thousands of individuals. If not disturbed, such a school may hover in one place for hours, easily seen through the clear water. The gray snapper is a good food fish and

market sizes are from one-half to five pounds. In commercial importance, the muttonfish (*L. analis*) probably ranks next to the yellowtail in the Key West area. It averages about 3 pounds and is an excellent food fish. The schoolmaster, *L. apodus*, is also rather common in southern Florida but its commercial value is less than that of the other species.

Besides the species named many other members of the snapper family inhabit the waters of the West Indies, and these are among the most beautiful food fishes of the tropics. In his "American Fishes," G. Brown Goode, who first recognized and named the red snapper, says they are "the tanagers and grosbeaks of the coral reefs."

It is an interesting fact that the red snapper was not named until 1878, although it had been a favorite in southern markets long before that, and had even been introduced in the markets of New York, Washington, and throughout the Mississippi Valley. In 1878 Dr. Goode, then Assistant Secretary of the Smithsonian Institution, studied a number of specimens obtained from Florida and decided the fish was a species new to science. He named it *Lutjanus blackfordii: Lutjanus* (later spelled *Lutianus*) from an Asiatic name for a kindred species; *blackfordii* in honor of Eugene G. Blackford, then Commissioner of Fisheries of New York and an enthusiastic ichthyologist.

Strangely enough, very little is known about the life history of the red snapper, in spite of the high esteem in which it is held. According to fishermen, snappers move into comparatively shallow water in the summer and in the fall move offshore again. At all seasons they seem to shift from one spot to another according to food supplies. They are believed to spawn in deep water, during the late summer and fall.

Although the young of related species commonly appear along our southern shores and may be caught in beach seines, young red snappers are seldom if ever taken in such localities.

Offshore, the red snappers live in deep holes and rocky gullies where small fish, crabs, shrimps and other marine creatures which are their prey are abundant. Usually found on the same grounds with them are the groupers, which ordinarily outnumber the snappers about two or three to one. They prefer warm water and if the temperature falls below 50° they are likely to move off in search of a more congenial climate. Their only enemies are sharks and a few of the larger carnivorous fishes, such as the enormous jewfish.

The center of the red snapper fishery is now Pensacola. From that port, a round trip to the Campeche Bank takes about 23 days: 4 days each for the trip out and returning, 15 days fishing. Many of the red snapper boats are small craft but owing to the skill and experience of their skippers and crews they are able to weather the heavy blows and rough seas of the Gulf.

Snappers are taken in water several hundred feet deep, and most of the catch is made with hook and line. According to Jarvis (1935) a crew of 9 men can haul in from 7,000 to 10,000 pounds a day, depending on the depth of the water, the tide, and the wind. The large schooners which fish on the Campeche Bank take most of their catch between October and April, while the smaller boats fishing along the United States coast, being more dependent on good weather, operate largely during the spring and summer.

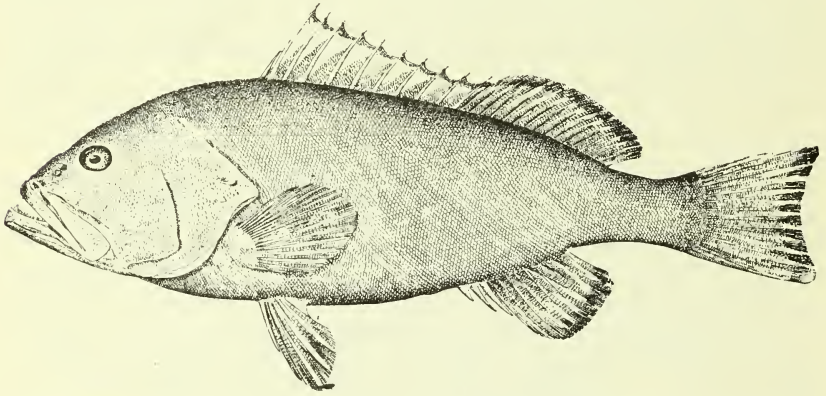
Groupers (*Genera Epinephelus and Mycteroperca*)

The groupers belong to one of the largest and most widely distributed families of fishes in the world—the sea basses or Serranidae. The sea

bass tribe is so numerous, affects other fish so directly because all its members are carnivorous, and is found in so many locations, that it is usually considered the dominant group of marine fishes. The larger members of the family are prized as food wherever they occur.

As might be expected in such a large family, many rather diverse fishes are included in it. The sea basses, groupers, jewfishes, and others belong to the group, which numbers about 120 species in North and Central America.

Common names of members of the sea bass family range all the way from gag, scamp, and tally-wag to such elegant designations as the princess rockfish. The name grouper is thought to be a corruption of the Portuguese "garoupa" for a similar species.



12,688

Figure 6.—The red grouper is one of the staple food fishes of the south. The five or six million pound catch does not permit large shipments to other areas.

Probably the most abundant of the groupers, and so the most important commercially, is the red grouper, *Epinephelus morio,* found from Virginia to Rio de Janeiro, and sometimes straggling northward as far as Woods Hole, Mass. It grows to a length of 2 or 3 feet and may weigh from 20 to 40 pounds. Also of some importance commercially are the Nassau grouper, *E. striatus,* common from Florida to Brazil and occasionally taken as far north as North Carolina, and three members of the genus *Mycteroperca*—the yellowfish grouper, *M. venenosa,* the black grouper, *M. bonaci,* and the gag, *M. microlepis.* All of these are found in greatest abundance on the Gulf coast but most also occur along the South Atlantic coast and both red and black groupers are reported from Woods Hole. Whether these are fish that have traveled north in the Gulf Stream or are permanent residents of New England is something that has not been determined.

The red grouper is commonly taken on the same grounds with the red snapper, and is caught with the same kind of gear. On some grounds the groupers outnumber the snappers by two or three to one, although they are rather solitary fish and seldom school.

Most groupers are masters of the art of camouflage. When resting among corals or seaweeds, where there is a background of mingled lights and shadows, their color pattern is usually banded. This banding, as a rule, fades out as soon as the fish rises from the bottom and begins to swim through open water. Then it usually is a very pale and ghostlike color which makes its outlines hard to discern. Apparently the changes

are not related to motion or inactivity alone; groupers have been seen to flash their color bands on and off at the approach of another fish of different species.

For these interesting observations on camouflage as well as on many curious habits of groupers and other fishes of the coral reefs we are chiefly indebted to the late Dr. William Longley. During many hours spent in a diving helmet, he studied fishes in their natural surroundings and his accounts (Longley and Hildebrand, 1941) of what he saw made the sport of fish watching seem at least as interesting as bird watching, and nearly as practicable. Some groupers, on first acquaintance, would take food from his hand, while others were more shy. Red groupers, he found, would sometimes allow him to touch them even though he offered them no food. He describes one of the bolder fish—a Nassau grouper—as follows:

> One that I fed frequently usually appeared promptly upon my approach from under the coral heads and got under foot and picked at my pockets, in which I carried crawfish tails for it. It could scarcely be driven far enough away to photograph, and might easily have been captured with bare hands if it had not been so strong, hard, and slippery.

One of the grouper family, the spotted jewfish, *Promicrops itaiara,* is one of the largest of all fishes, the record specimen weighing 693 pounds. Small jewfish taken in shallow water weigh up to 10 pounds but the average weight of those caught commercially about Key West is about 125 pounds. The jewfish is caught on strong tackle resembling that used for sharks and is often brought in alive to the dock, where it is hitched to a stake in shallow water to await disposal in the markets. When the fish are dressed they are usually cut into steaks, and the local demand is so heavy that only limited quantities are available for other markets. The spotted jewfish is confined to tropical waters but is found on both Pacific and Atlantic coasts.

Most of the groupers when fully grown weigh as much as 40 or 50 pounds, although market forms usually range from 5 to 15 pounds. They are sold whole, or as steaks or fillets. They are usually fried or broiled, or the fillets may be baked in a sauce. Groupers are caught throughout the year. The chief market for groupers is in the southeastern States, which receive about three fourths of the catch. Outside this area, St. Louis, Cincinnati, and Chicago receive a limited quantity.

Sea Trouts *(Genus Cynoscion)*

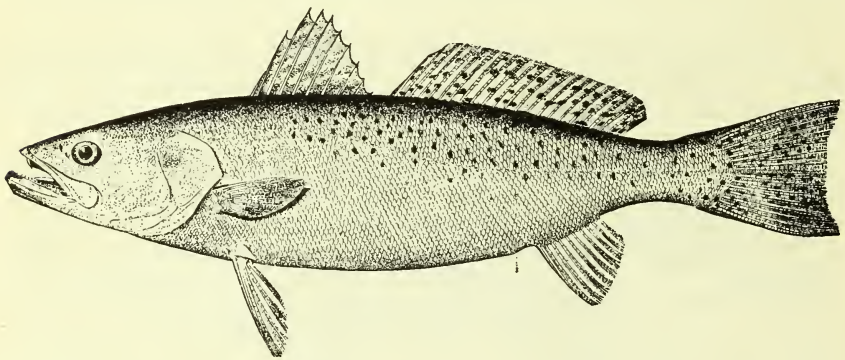
The sea trouts belong to the croaker family and so are related to the drums, croakers, and spots rather than to the well-known fresh water trout. They are exclusively marine fishes and one or more species are found all along our coast from Cape Cod to Texas. The spotted sea trout, *Cynoscion nebulosis,* is the most important of the group in the southern fisheries, being taken in some abundance from North Carolina south with the center of the fishery in the Gulf. The gray sea trout, *C. regalis,* is taken in greater quantity than the spotted in the fisheries of North Carolina, but farther south it is relatively scarce and in the Gulf it occurs only occasionally. A third species of some importance is the white or sand sea trout, *C. arenarias,* found only in the Gulf. Perhaps because it is small—11 to 15 inches—it is rather neglected by fishermen.

The spotted sea trout is an excellent game and food fish that brings a good price at all seasons of the year and is universally popular in the markets. The flesh is white, tender, and of delicate flavor. The smaller sizes are sold whole and are best broiled or fried. The larger sizes may

be baked, although they are often filleted and in this form may be broiled. They are taken throughout the year, but in greatest quantity in spring, summer, and fall.

The white sea trout, the smaller species, is a good pan fish. Although it is taken now in small quantities—about a quarter of a million pounds compared with seven million pounds of the spotted sea trout—probably it will receive proper appreciation in the future when the larger species are no longer able to meet the demand.

At least in some areas, the spotted trout, unlike most shore fishes, remains in the shallow waters inshore throughout the year, instead of moving out into deeper water to escape the cold. In North Carolina it is one of the few fishes available to the haul seine fishermen during the



12,712

Figure 7.—The spotted sea trout is the most abundant member of its family from the Carolinas to Texas.

lean winter season. Ordinary winter temperatures do not affect the spotted trout adversely, but a period of unusual cold will cause large numbers of them to become numb and helpless. At such times they can be picked up by the bushel along the shores. If taken into a heated room they quickly revive, so the numbing apparently is not necessarily fatal.

The larger trout travel in small schools, preying on shrimps and small fishes. They themselves are taken by large predatory fishes and sometimes are followed and harried by schools of porpoises. Unlike the mullet, famous jumpers, they swim low in the water, making little or no ripple at the surface. When close to the shore line, they usually move in with the rising tide and offshore with the ebb.

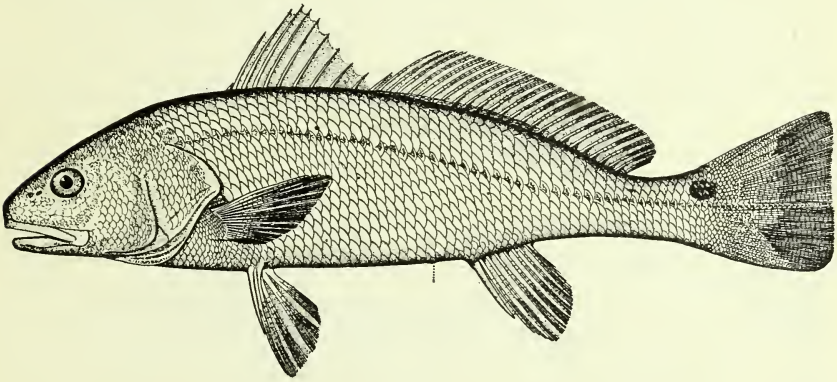
In contrast to the red and black drums, the spotted trout in Texas usually spawns in inshore bays and lagoons, rather than in the open Gulf. The spawning season extends from early April to September in Texas, in North Carolina probably from May into August. The spawning female produces from half a million to a million eggs. Probably most spotted trout mature and spawn for the first time when they are two years old, and about a foot long. As not infrequently happens among fishes, the males are smaller than the females, the average difference being about 2 inches.

In Texas most of the commercial catch is made with hook and line in the passes or channels and with drag seines in the bays and lagoons. A small amount of gill-net and trammel-net fishing is done during the winter along the northern Texas coast, and a few fish are taken with light surf seines along the beaches of the Gulf of Mexico. The largest

catches of the spotted trout are made on the west coast of Florida and in Texas and North Carolina.

Redfish or Red Drum *(Sciaenops ocellata)*

The redfish is really silver with a suffused gleam of red over its scales, like a color reflected on metal. Much of this illusive color disappears soon after the fish is taken from the water, so that the redfish in the market lacks the splendid coloration of the red snapper or the New England rosefish. It is, however, a graceful and handsome fish, longer and more slender than the related black drum, and bearing one or more conspicuous black spots at the base of the tail fin.



12,694

Figure 8.—The redfish is a member of the drum family, but in this species only the males are equipped to make the characteristic drumming noises, while the females are silent.

As might be expected of a fish that is found in commercial quantities all the way from New Jersey to Texas, the redfish is known by various names. Usually called redfish on the Gulf coast where it is most abundant, it is known as the red drum or spot bass on the Atlantic coast. Surf anglers, who ask for nothing better than a struggle with this gamy fish in the tumbling breakers, often call it the channel bass.

For market purposes, redfish from 2 to 25 pounds or so are taken, the larger sizes being dressed as steaks or fillets. Redfish larger than 25 pounds are of interest chiefly to sportsmen, being less tender and palatable than younger fish and also being protected in some States as a spawning reserve. The largest specimens on record were about five feet long and weighed about 75 pounds.

The redfish is one of the more important food fishes of the Gulf coast and is taken in some quantity also along the South Atlantic shore. The total catch is about a million and a half pounds, of which slightly more than half is caught in Florida. Most of the Florida catch, in turn, is taken on the west coast. In Texas, where the redfish ranks fourth in volume of catch among the fin fishes, about a quarter of a million pounds are caught. The spotted sea trout is the only fish taken in larger quantity in Louisiana. While the fishing seasons for redfish extend throughout the year in the various parts of the southern coast, production peaks come in the period from February to June and again in the fall in Texas, and from November to April in Florida.

Although the redfish has been known to fishermen for at least 60 or 70 years, much of its life history has been, and still remains, a mystery.

Pearson, (1928), studying the species on the southern Texas coast, found that the fish spawn in that area mainly in the fall of the year. This part of the coast is bordered by a chain of long, narrow barrier islands which lie off the mainland, separated from it by a series of bays. Several channels or passes connect the bays with the open Gulf, and Pearson found that the redfish tended to spawn to seaward of these passes, the newly hatched young then drifting in with the tides and currents to the bays and lagoons. In these protected waters they develop rapidly and soon reach a stage where they can swim under their own power and without regard to prevailing currents. They scatter widely, usually seeking the quiet, grassy bottoms where they find better protection from enemies than on bare, sandy bottom. Sometimes this habit reacts to their destruction, for abnormally low tides may occasionally drain the water out of these shallow flats and leave the young fish stranded by the thousand.

With the coming of the cold weather of their first winter, the young redfish, by this time from 2 to 6 inches long, find their way into the deeper bayous, which are inland channels between bays or running into the mainland from the bays. When spring comes they leave the inland waters for the first time, some going out through the passes to the open waters of the Gulf, others wandering through the inland bays and lagoons. Redfish less than a year old have been taken 75 miles from the nearest pass, through which they must have been carried as eggs or larval fish.

After their first year most redfish winter in the deeper bays or in the Gulf, returning to inside waters in the spring. The fall exodus is not especially noticeable, but the spring migration is undertaken by large bodies of fish moving together through the various passes, where a good many are taken by hook and line fishing.

The adult or bull redfish wander up and down the sandy shores of the Gulf throughout much of the year, assembling in the fall about the mouths of the passes to spawn. These large fish are seldom seen in the bays and lagoons, probably because they are easily frightened by the disturbances made by speedboats in the shallow waters, Pearson suggests.

Redfish are themselves no mean connoisseurs of seafood. Shrimp and crabs are their favorite foods. They also eat a few fish, especially mullet and small minnow-like forms, and on occasion take almost any of the small invertebrate sea life which they come upon in their wanderings.

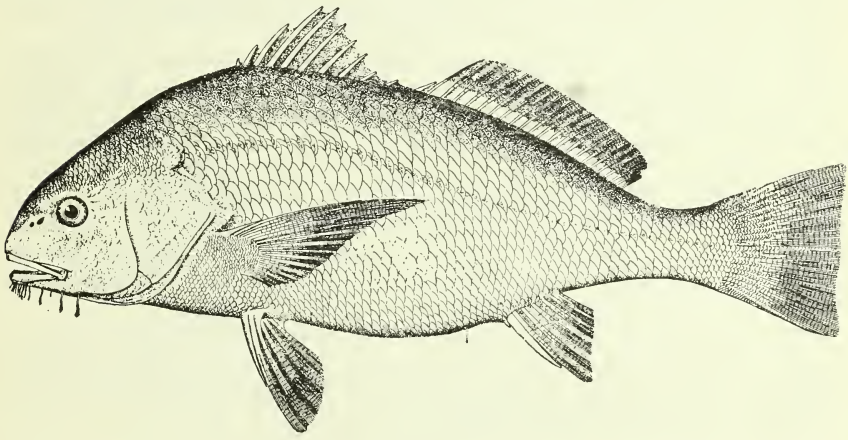
Redfish grow very rapidly. They are about 13½ inches long when a year old and about 21 inches by the end of the second year. It is believed that as a practical conservation measure, they should be protected from capture until they are about 16 inches long, or approximately a year and a half old. At this length they weigh about three times as much as at 12 inches, and are a more desirable market size.

Black Drum *(Pogonias cromis)*

The black drum may be taken anywhere from the shores of Long Island to the mouth of the Rio Grande, but it is only in Texas that it becomes a really important commercial species. In that State it ranks third among the commercial fisheries, only the red snapper and the spotted sea trout being taken in greater quantity. The amount of drum caught by all United States fishermen during recent years has run from one to two million pounds annually, and of this Texas furnishes from 50 to 80 percent. Florida, Louisiana, and North Carolina are next in order, and small amounts are taken in all the other southern States.

The drum is a heavyweight among fishes—the largest specimen known weighed 146 pounds—but for market purposes the smaller sizes ranging from 8 to 20 inches long are most desired. These are good food fishes and lend themselves to broiling or to baking, provided fat is added, for the flesh is somewhat lean.

Quite aside from its food qualities, the black drum is an exceptionally interesting fish. It is probably the best musician of all the large family of drums or croakers to which it belongs. People who have always supposed fish to be universally silent creatures are surprised to learn that many of them have voices so loud that they can actually be heard a considerable distance above the surface of the water. These vocal effects, in the case of the drums, are produced by the vibration of special



12,697

Figure 9.—The black drum is sometimes called the sea drum to distinguish it from its fresh-water relative, the sheepshead or gaspergou.

band-like muscles against the taut air bladder. The black drum is now believed to be the subject of the old Indian legends in the country about Pascagoula Bay. According to these tales, mysterious music of supposedly supernatural origin, described as sweet, plaintive, and low, could be heard on summer evenings apparently issuing from the water. Fishermen are now well acquainted with these sounds, and know that they indicate the presence of a large school of drums. Whether the drumming is a call to attract the opposite sex or an expression of contentment, as at feeding time, is uncertain, but some observers think the fish are most vocal during their spawning migration. The males are said to drum very loudly, while the females have softer voices.

The black drum has such large and competent pharyngeal teeth that it is not hard to guess that its favorite food is shellfish. While generally reported to be an oyster pirate of no small capacity, in Texas it actually prefers a small clam which is very abundant in the shallow bays of that State. These clam beds are well known to the fishermen as yielding good hauls of drum. The fish suck the clams up out of the mud in which they lie and crush the shells; although they swallow so many shell fragments along with the meats that at least two pounds of them have been taken from the stomach of a large fish. In some places in Louisiana stockades or fences have been built to keep the drums off the oyster beds. They apparently are great gluttons, and when feeding stand on their

heads with their tails out of the shallow water, oblivious to all but the meal at hand.

On the Texas coast the drums spend a great deal of their time in the shallow inshore bays, both summer and winter. Sometimes the water in the passages to the deeper bays becomes so shallow that they have great difficulty navigating these channels and often are badly lacerated by passing over the oyster reefs. It is said that farmers used to chase the large drum over the shallows with pitchforks.

Young drums look so different from their elders that they were formerly supposed, even by ichthyologists, to belong to a different species and were called the "banded drum" because of the broad brown and white bands on their sides. When fully grown the drum is a silvery black with black fins. Those taken in the open Gulf are often more silvery; those in inshore waters more black. The whisker-like barbels on the lower jaw are typical of the species.

The scales of the black drum are large and silvery and are extensively used in making ornamental objects and jewelry. They are so hard and so firmly embedded that it is necessary to remove them with a hatchet.

Before the spawning season—from late February to May—the black drum move out through the passes into the Gulf, spawning later near the entrances. The young drum enter the inside waters soon after hatching, remaining there until they are at least 4 inches long. A year-old drum is about 10 inches long; a five-year fish, 23 inches. The fish spawn when about two years old (14 inches long) and annually thereafter. A four-foot drum produces about 6,000,000 eggs.

Sportsmen are seldom interested in the black drum, which is a more sluggish fish than its graceful relative, the red drum or redfish. Some of the commercial catch is made on hook and line, but the heaviest catches are made with gill nets and seines.

Shrimp *(Penaeus setiferus)*

The Gulf coast is the chief source of the most popular crustacean in the United States—the shrimp. The American people eat ten times as much shrimp as lobster and half again as much as they consume of crab. And of the 150 million pounds of shrimp taken from the sea each year for cocktails, salads, and appetizing cooked dishes, 85 percent comes from the Gulf coast and 66 percent from the State of Louisiana alone.

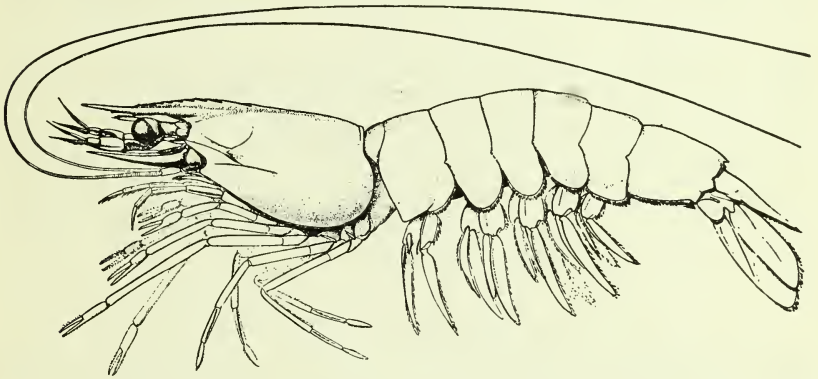
It is safe to assume that our fathers and grandfathers, unless they happened to live along the southern coast, knew very little about shrimp, for in the 1880's, when our first statistics were gathered, the catch was only about 10 million pounds. After the turn of the century it began to increase slowly—17 million pounds in 1905, 24 million in 1910, 57 million in 1920. By 1927 the yield of this small but delicious crustacean had passed the 100-million-pound mark, and in 1940 it reached 150 million pounds.

While canned shrimp has been for many years the most familiar market form, an interesting trend toward the greater use of fresh and frozen shrimp set in during the period of the war. During 1943, for example, the pack of canned shrimp on the Gulf coast declined 25 percent compared with the previous year, although the catch increased by about 10 percent. Although the immediate reasons for the decline of shrimp canning are the result of war conditions such as the shortage of cannery labor and the high prices obtainable for fresh shrimp,

many dealers predict that frozen peeled shrimp will be the mainstay of the postwar industry.

Since some shrimp are taken throughout the year, even the fresh product is available at any season, but much the heaviest production takes place in the late summer and fall—usually the months from August through December.

In life, the shrimp looks much like a small lobster. However, only the meat in the tail or abdomen is eaten, for the claws, which in the lobster furnish a good quantity of meat, are so small that most people would fail even to notice them. The so-called head contains the vital organs and is discarded by the packer, only the edible portions being shipped. The living shrimp is a pale green or gray creature and is



12,886

Figure 10.—The shrimp, a small relative of the lobster and the crab, supports the largest and most valuable food fishery of the South.

semi-transparent. The pink or reddish color develops upon cooking.

The life story of an individual shrimp begins in the spring or summer, when spawning takes place in the offshore waters. The eggs, mere specks of living matter, are discharged by the female and probably remain near the ocean bottom during the period of rapid development that precedes hatching. This habit of the shrimp is entirely different from that of the closely related crabs and lobsters, in which the females carry the eggs on the abdominal appendages until they hatch.

The young shrimp hatch from the eggs in a very short time—probably about 14 hours. The newly hatched larva is able to swim about for itself and probably leaves the sea bottom very soon and moves up into the surface waters. As it floats in the currents, feeding on the minute life about it, the baby shrimp undergoes a series of changes and finally comes to resemble the adult form. By this time the currents have carried it in to the coast line, where it enters the shallow inside waters and river estuaries and again takes up a bottom-dwelling habit. These inside waters are important nursery grounds for the young shrimp during the spring and summer.

Since the spawning season of the shrimp extends over a period of several months—from March or April to August or September—this means that some young shrimp are arriving in the coastal area throughout the entire summer. The earliest arrivals reach commercial size during the month of July and by September practically the entire catch is made up of young shrimp from the spawning of the preced-

ing spring. The small shrimp winter on the inside grounds and along the beaches, but most of the larger shrimp move out into the open Atlantic or the Gulf to escape the chilly inside waters. Winter fisheries for these large shrimp now exist, and the so-called jumbo shrimp are taken in March, April, May, and June. These mature shrimp, now somewhat more than a year old, are caught throughout the summer on the offshore fishing grounds, but by September, when a new crop appears on the outside grounds, the older shrimp make up a very small percentage of the catch. Presumably the life span of the shrimp is between one and two years.

Several of the southern States have adopted measures to protect the young, rapidly growing shrimp on their inshore nursery areas during the summer and fall. By waiting until the shrimp have made more of their growth, fewer individuals would be required to make up the normal 150-million pound annual catch.

About two-thirds of the entire United States catch of shrimp is taken in Louisiana. Texas follows with ten percent, while Mississippi, Florida, and Georgia each contribute 5 or 6 percent, North Carolina and Alabama 3 percent each, and South Carolina only 1 percent. Almost the entire catch is taken by small otter-trawl boats which drag baglike nets along the bottom. Cast netting, formerly rather important, still brings in a few shrimp and very small incidental catches may be made by other gear such as haul seines.

The Oyster *(Ostrea virginica)*

Southern fishermen make more money from oysters than from any other item in their catch except shrimp and mullet. The annual yield of oysters in the States from North Carolina to Texas is some 20 million pounds, from which fishermen get slightly more than a million dollars, actually a higher return per pound than they receive from the more productive shrimp and mullet fisheries.

Although the production of oysters now is about the same as fifty years ago considering the southern area as a whole, every State from North Carolina south shows a decline with the single exception of Louisiana. In contrast, that State produces four times as many oysters now as it did in the 1890's, and since its increase about matches the decline in all other southern coastal States combined, the total output shows little change.

The oyster that grows along the South Atlantic and Gulf coasts is the same species that occurs all the way up the Atlantic coast to Cape Cod, and sparingly beyond that point to Prince Edward Island in the Gulf of St. Lawrence. It is one of three species of oysters taken commercially in the United States, the other two being found on the Pacific coast, most abundantly in the State of Washington.

In point of size, the Atlantic coast or eastern oyster is midway between the tiny Olympia oyster of Puget Sound, the meat of which is about as big as a man's thumb nail, and the enormous Pacific or Japanese oyster, which has been known to grow a foot or more in length, although it averages much less. Under the best possible conditions, the eastern oyster might attain a length of 8 or 10 inches, but actually they are marketed when considerably smaller. Several standard market sizes of shucked oysters have been established by custom, the smallest being known as standards, medium size as selects, and the largest as counts.

Most oysters are now sold as shucked meats, having been removed

from the shells in shucking houses to which they are delivered by the tongers or dredgers. Depending on their size, there are from 150 to 300 eastern oysters in a gallon. Although the trade in shelled oysters is on the wane, some oysters are still shipped in the shell, the demand for this product coming chiefly from hotels and restaurants. Still others are canned. Practically all of the canned oysters produced in the United States are prepared in the southern area. The city of Biloxi, Miss., is now the world center for the canning of oysters, a title once held by Baltimore. In 1943, Mississippi packed 85,151 cases and Louisiana 79,614 cases, the remaining 50,090 cases coming from canneries in the States of North and South Carolina, Georgia, Florida, and Alabama. Normally, some oysters are canned on the Pacific coast, but there was no canning in this area in 1943 for reasons connected with the war.

Oyster cultivation, which reaches its greatest development in New England (Carson, 1943) is practiced in the South only in certain areas. The most important of these is Louisiana, where practically all oysters come from cultivated and privately leased bottoms. This practice of cultivation has kept oyster production in Louisiana at a high level, while other southern States have declined. There are indications that scientific oyster farming may be undertaken in North Carolina and some additional areas after the war.

Because of the long coastline, oysters grow under quite a variety of conditions between Hatteras and the southern Texas coast. Many people are surprised to learn that oysters never grow abundantly on the bottom of the ocean proper. Instead, they thrive best in enclosed bays, sounds, and river mouths, where the salinity has been reduced by the influx of fresh water from rivers and streams. In the more northern bays such as the Chesapeake or the Delaware, they may grow some distance offshore in water 30 or more feet deep, but along much of the southern coast the oyster beds are mainly between low and high water marks. In the shallow bays and estuaries of the Gulf coast, the natural oyster beds are seldom under more than 2 or 3 feet of water. In southern Florida, oysters sometimes grow attached to the aerial roots of the mangrove trees, submerged only by the high tide, and on the Gulf coast they sometimes grow on the grass at the edges of the marshes, in places where only the highest tides reach.

On the Gulf coast the spawning season of the oyster is a very long one, beginning in March and continuing into November. So prolific is the oyster that a female may produce from 15 million to 114 million eggs at one spawning, or several hundred million in a summer. The eggs and sperms, discharged into the water, unite by chance and the fertilized egg produces a free-swimming larva in only 5 to 10 hours. The young oyster swims about actively, propelling itself by the vibration of minute, hairlike cilia. For about two weeks it is a creature of the tides and currents, and may travel far from the place where spawning took place. At the end of this period it is a fully developed larva, about one seventy-fifth of an inch in diameter, and is now ready to become transformed into the juvenile form, which resembles the adult in general appearance. Before it can do this, it must give up its freedom of motion by attaching itself firmly (by means of a cementlike substance which it secretes) to a rock, shell, or other hard object. Once attached, an oyster is never able to move about again of its own accord, although oysters growing in soft mud may shift their position by brisk opening and closing of the shells.

The act of setting or striking, as the attachment of the larval oyster

is called, is full of danger, for even a few grains of drifting silt are enough to smother the tiny creature, and any larvae that come down on a surface covered with algae or other marine growths are unable to attach themselves and quickly die. Those which make a successful landing on a clean, hard surface soon change from the larval form into miniatures of the adult oyster, and in two weeks after setting—at the age of about four weeks—have shells a quarter of an inch long. Oysters from this size to two inches long are known as "seed oysters." In southern waters, where the water ordinarily is warm enough for oysters to grow and feed during the whole year, they reach market size in two to three years. About four years are required in Long Island Sound, where the cold winters cause them to go into a state resembling hibernation.

On the uncultivated reefs of the South are found many long, narrow, and irregularly shaped oysters which are known as coon oysters, a name said to have been given them because raccoons feed on them. These oysters are of little market value because the meats are small and poorly shaped. The coon oyster is the product of two conditions commonly found along southern coasts—soft, muddy bottoms and excessive crowding of oysters in a narrow zone along the shore. Single oysters tend to sink vertically into the mud so that the shell stands on one end and then to grow into long, narrow, sharp-edged specimens. Other oysters crowd in closely around it, attach to its shells, and further increase the distortion of shape. Small coon oysters broken apart and planted on firm bottom change their form and develop into the typical pear-like shape of a good market oyster. Galtsoff (1930) points out that the coon oyster is not a geographic race but a product of its environment, and says that in earlier days typical "coon oysters" existed in Long Island Sound, for they have been discovered in dredgings at the mouth of the Housatonic River.

During their comparatively short lives oysters face many dangers. On the Gulf coast, especially, flood waters from the rivers or the breaking of levees may reduce the salinity of the water over the oyster beds so greatly that large numbers die. Heavy storms may bury the beds under sand or dislodge clusters of oysters and throw them on the beach. Gales have sometimes been known to establish new beds by shifting oysters to areas where none had grown before. Besides storms and floods, oysters also have many natural enemies. Clams, conchs, and oyster drills which bore into their shells, and a peculiar sponge of a bright yellow color which bores into the shell and causes it to dissolve away are the most important of these enemies in the South.

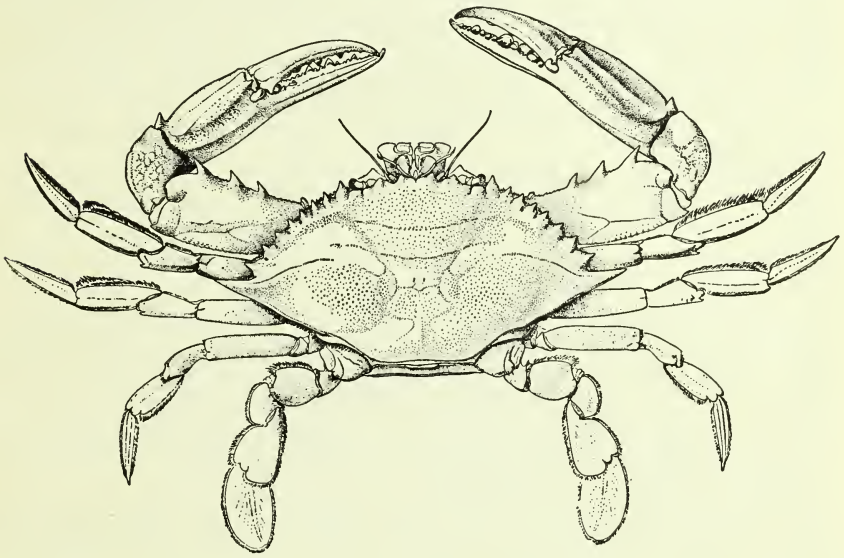
In its diet, the oyster is largely vegetarian. Most of its food consists of the minute, one-celled plants called diatoms which are carried to its mouth in the water which the oyster draws through its gills. The diatoms, like other marine plants, are nourished by the various minerals in the sea-water, and because of its diet the oyster itself is an excellent source of copper, iron, iodine, and other minerals essential in human nutrition. It also contains most of the essential vitamins, protein of high nutritive value, and starch in the easily digested form known as glycogen.

Blue Crab *(Callinectes sapidus)*

The common blue crab of the South Atlantic and Gulf coasts is taken all along the eastern seaboard from New York to Texas. While more blue crabs have always come from the Chesapeake Bay than from any other section, the yield from more southern areas has been growing steadily. The State of Louisiana now produces almost half as many

crabs as are taken in the Chesapeake. Compared with Louisiana's 14 million pounds, North and South Carolina produce about 4 million each, Florida about 6 million, Georgia, Alabama, and Mississippi 1 to 2 million each, and Texas only about 250,000 pounds.

Unlike its relative, the shrimp, the blue crab is only occasionally found in the open sea but prefers bays, sounds, and the mouths of rivers, where it lives in waters ranging from true ocean saltiness to brackish or even fresh. The so-called sweet-water crabs of the Atchafalaya River are taken in fresh water 25 miles from its mouth, and crabs are common in the Newport River of North Carolina. However, the chief commercial fisheries are in the bays and sounds, where the crabs are most numerous.



12,724

Figure 11.—The blue crab of the Atlantic and Gulf coasts is one of the best known crustaceans in the world.

Because the Chesapeake fishery for crabs has been longest established and also because the bay apparently provides ideal surroundings for their propagation, the habits and life history of crabs are better known in the Chesapeake than anywhere else. The general features are probably similar in all sections, however.

Each year between the first of June and the end of August, in the Chesapeake Bay, a new generation of crabs is produced. At this season the female extrudes the tiny eggs, each about 1/100 inch in diameter, and these together form a large yellowish mass known as the "sponge" and remain attached to the female crab. As the young develop within the eggs the sponge becomes darker. They hatch in about 15 days. Each baby crab is about 1/25 of an inch long, is shaped somewhat like a question mark, and has seven pairs of appendages and a long tail. At this stage it is konwn as a "zoea." As it grows the zoea sheds its shell several times. After the fifth or sixth shedding it changes into a form that is more truly crablike. This is the "megalops." Probably the first molt of the megalops changes the developing youngster into the true crab form, but it is decidedly a miniature crab,

only 1/8 inch across. This stage is reached about one month after hatching.

After the megalops stage the crab molts about 15 times before reaching maturity, at first every 6 days and then after gradually lengthening periods up to about 25 days between final molts. Ordinarily the crab gains about one-third in size with every molt. Crabs reach their full growth and maturity, and cease to molt, during their second summer, when 12 to 14 months old.

For the female crab, mating occurs only once in her life—immediately after the last molt, when she is still in the soft-shelled condition. In the Chesapeake Bay this is usually during the last of July or August. The sperm received from the male at this time is retained by the female and used to fertilize such successive batches of eggs as she may lay during the remainder of her life. Usually the first spawning takes place when the female is about 2 years old, or during the summer following mating. It is believed that some females live over another winter and deposit more eggs when 3 years old, but that few or none live longer than this. The life span of the male is probably about the same length.

In the Chesapeake most of the young crabs hatched in the lower part of the bay soon begin a northward migration. Cold weather interrupts this journey and they settle to the bottom and cease to feed and also to grow until conditions are more to their liking. In the spring their migration is resumed, growth proceeds, and finally they reach Maryland waters as nearly mature crabs. It follows that the mating of the majority of the blue crabs of the bay takes place in Maryland. After mating the females return to the lower bay, but most of the males remain behind, spending the winter in deep holes or in creeks and rivers. Only about a fifth of the crabs taken in the lower part of the bay during the winter are males. Nearly all the sponge-bearing crabs are found in Virginia waters.

Many people have the mistaken impression that the so-called "soft crab" is a distinct species. The term refers to any crab which has shed its old shell, before the new shell has hardened. As the soft-shelled crab is considered especially good eating, large numbers of young crabs are sought in the spring and early summer while they are still molting.

A newly molted crab is particularly helpless to defend itself or even to escape by swimming. The actual casting of the shell requires only a few minutes if all goes well—up to an hour if the crab is disturbed or has suffered recent injury. In a series of convulsive movements, the crab withdraws its five pairs of legs from the old encasements, having greatest difficulty with the large claws, and backs out of the shell. Under the old shell the skin is soft and wrinkled and the animal is flabby and helpless. Ordinarily the crab selects some sheltered place to undergo the molt, for during the 12 hours until the new shell hardens it is in imminent danger of being set upon by large fish or even by its own kind, or of being scooped up in a crabber's dip net.

Crabs have the curious ability to cast off one or more of their legs and will use this habit to escape if caught and held by one leg. A sudden drop in temperature may sometimes cause one or several legs to be snapped off. The break always occurs across one of the joints, which protects the crab from the danger of bleeding to death. Ordinarily, the legs are regenerated. As many as three or four replacements of the same appendage are possible. In the regenerative process, three or four molts are sufficient to provide a new, full-size limb.

On the Gulf coast the heaviest production falls in the months of May, June, July, and August. Some crabs are sold whole as taken from the water, in which case they should be alive when purchased, whether in the hard or soft shelled condition. Many people, however, prefer to buy the meat ready for use, and so most of the crabs caught on the Atlantic and Gulf coasts go to the packing houses where they are cooked and the meat removed and packed in convenient containers. Except for one cannery in South Carolina and two in Louisiana, the canning of crabs is confined to the Pacific coast, where a different species is taken, and to a small canning industry for the rock crab in New England.

At the present time the most important markets for fresh crab are the cities of the Atlantic seaboard, which have long been familiar with this perishable product and know how to give it the special handling it requires. On the other hand, few mid-western cities know the blue crab as well, and as a result the interior markets to which the Gulf coast product could most profitably be shipped have not been fully developed. This lack of near-by markets for fresh crab has been an important factor in holding back the devolpment of a large fishery in the Gulf. Whether it could ever become as large as the Chesapeake fishery, however, is something that cannot be predicted until the crab populations of the region are investigated by a proper biological study.

Other Fish and Shellfish

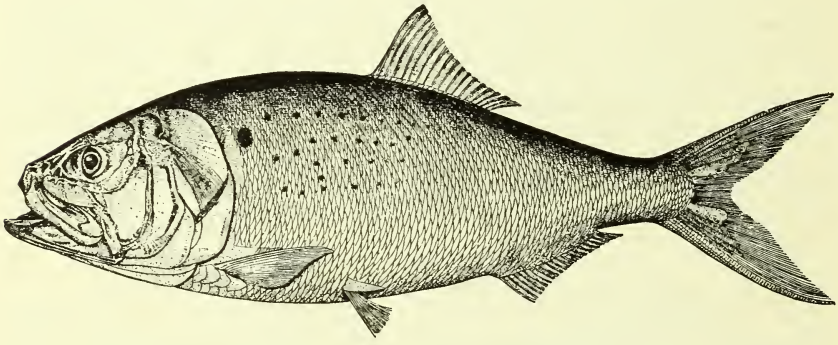
The **menhaden** is one of the most interesting fishes on the Atlantic seaboard. It supports one of the oldest fisheries in America, ranks second in volume of production among all United States fishes, and is caught in greater quantity on the South Atlantic and Gulf coasts than all other fin fishes combined. Despite its importance, it is one of the least known fishes in our waters, for few people have ever heard of it. The explanation of this surprising situation is simple. Although almost every person in the United States has at some time been indebted to the menhaden for something he eats, wears, or uses, the fish has seldom been used extensively as food and so has not become familiar to the public. It is included in this bulletin on food fishes for two reasons: the recent development of canned menhaden which may make this product generally available after the war, and the fact that meal and oil derived from menhaden are so important to our livestock and poultry industries that this fish is only one step removed from the ham, fried chicken, and eggs on all our tables.

Although the fact is seldom recognized, several species of menhaden are found in United States waters, the most important one on the Atlantic coast being *Brevoortia tyrannus*. The menhadens occur all the way from Nova Scotia to Florida, and southward to Brazil, but are seldom taken north of Cape Cod, and only small and scattered fisheries are carried on in the Gulf of Mexico. In the South Atlantic region the most important fisheries are located in North Carolina and Florida, the chief menhaden center being the town of Beaufort, N. C. The catch for the entire area amounts to about 250,000,000 pounds, or 68 percent of the catch of all species of fish, and 43 percent of the catch of all fish and shellfish combined. The total United States catch of menhaden is about 600,000,000 pounds.

Although enterprising Yankees canned menhaden as sardines a century ago, there had been little use of this fish as food—except by fishermen or other people in fishing communities—until a small canning indus-

try was developed at Fernandina, Fla., during the war. Practically the entire output of this enterprise has been sent to Great Britain through Lend-Lease channels, but some canning has also been done at Reedville, Va., and this product has found its way into the grocery stores of nearby States. In all probability, canned menhaden will become familiar to a much larger public after the war when large-scale canning becomes feasible.

Being members of the herring family, the menhadens resemble the more familiar shad and the river herrings or alewives in appearance and general characteristics. Like these relatives, they have a rich and oily flesh. Most of the oil is removed during the canning process and only the large, meaty cuts from the back region are packed.



8,816

Figure 12.—The menhaden, a member of the herring family, swims in large schools at the surface of the sea.

The food of menhaden consists entirely of the minute surface life of the sea which they strain from the water by means of a sieve-like structure in the back of the mouth. Large schools of feeding menhaden give the water a brassy tinge because of the strong yellow luster of their flanks, and this color helps fishermen to locate the schools.

For several generations the manufacture of meal and oil has overshadowed all other uses for menhaden. One third of all the fish meals and a quarter of the marine animal oils produced in the United States are products of the menhaden industry. The meals are fed to hogs and poultry to provide the indispensable animal protein in their diet; the oils are used in preparing fortified vitamin feeding oils for poultry. The industrial uses of menhaden oil are many. It is a constituent of many paints, varnishes, insect sprays, printing inks, and soap. The oil is used also as a lubricant of machinery, in aluminum casting, and in leather tanning.

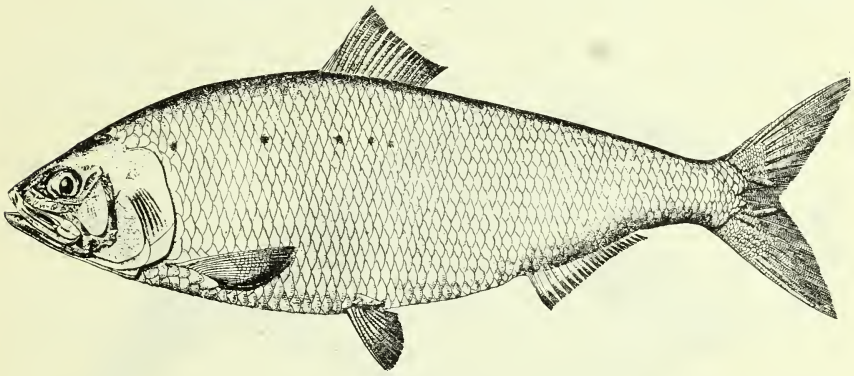
The **shad,** *Alosa sapidissima,* was formerly one of the most important food fishes of the South Atlantic coast, but the catch has now declined to only about a tenth of the 10,000,000-pound level at the turn of the century. Despite its reduced importance, however, it still brings the fishermen of Georgia a larger income than any other fin fish, and in South Carolina it is second in value only to the mullet. North Carolina, with an annual catch of about 800,000 pounds, ranks fourth among the States of the Atlantic seaboard in the production of shad.

Like the salmon, the shad is a fish that spends most of its time in the ocean but runs into coastal rivers to spawn above tidewater. The

young are hatched in fresh water and at the end of their first summer drop down stream and enter the ocean. They are not seen after they leave the streams until they return, three or four years later, as mature adults.

The shad is a seasonal fish all along the coast, and is caught earlier in Florida than anywhere else. The runs of shad begin there in December, and the first shad to reach northern markets come from Florida. The largest catches in that State are made in the St. Johns River, and at a considerable distance above its mouth. The shad runs in North Carolina begin in February.

The shad is the largest and most prized member of the herring family, and is generally regarded as one of the best food fishes of the Atlantic coast. In the 1870's it was transplanted to the Pacific coast, where it does not occur naturally, and it took hold so well in its new surroundings that it now occurs from California to southeastern Alaska, and shipments are regularly made from the Pacific coast to eastern markets. The decline in its abundance on the Atlantic coast is the result of ex-



8,105

Figure 13.—The shad may again be abundant in many southern rivers if proper conservation measures are applied.

cessive fishing and, in some waters, to pollution or to dams without adequate fishways. The fact that a complete recovery of the much depleted Hudson River runs has been brought about by careful regulation of the catch indicates that in the future, if proper management practices are followed, we may have more shad all along the Atlantic seaboard.

Shad is ordinarily sold fresh, although some is frozen in the Middle Atlantic area. Market sizes are from 1½ to 8 pounds. It is usually sold whole, and a baked, stuffed shad is considered one of the finest seafood dishes. A very choice market form, to be recommended for the ease of preparation, is boned shad fillets.

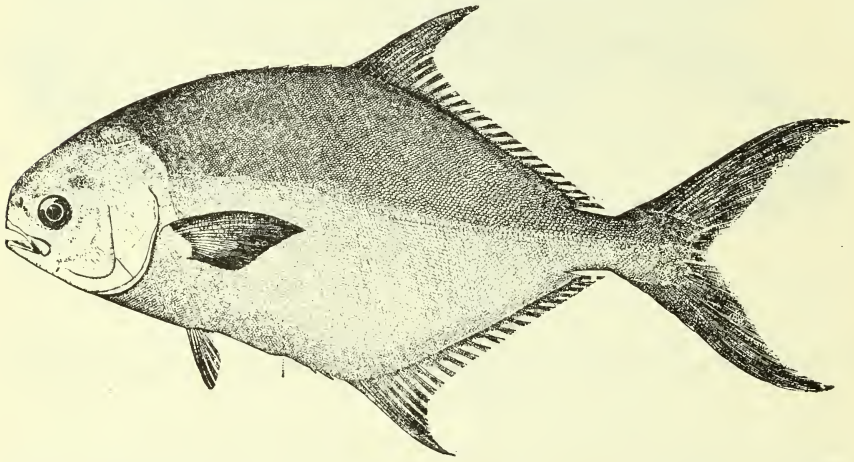
The common **pompano,** *Trachinotus carolinus,* is one of the choicest of all food fishes although the supply, unfortunately, is not large. The annual catch is only a little more than half a million pounds, almost all of which is taken in Florida. Because the pompano is so highly regarded for the rich, yet peculiarly delicate, flavor of its flesh, fishermen receive several times as much for it, per pound, as they do for most other fishes. The height of the pompano season is from late January to April. The average market size is about 1 to 1½

pounds. Most of the catch is marketed fresh, and large shipments are made to northern markets.

Adult pompanos are found from Virginia to Brazil and the young stray as far north as Cape Cod. Except for the wanderings of the young, this fish does not seem to migrate extensively.

The pompano is a member of the family Carangidae, which includes the amberfish, the jacks, and the lookdown fish. It is a thin fish with a deeply forked tail and is covered with small scales with a blue, silvery, or golden luster. It is toothless in the adult stage, but despite this fact feeds on small mollusks and crustaceans. Since it seldom takes the hook, it is not a game species.

Not a great deal is known of its life history. It seems to prefer sandy bottom near shore where it feeds. Schools of pompano are abundant about inlets, where they play in and out with the tides. In North Carolina small ones, from half an inch to two inches long, are often seen in the surf on the outer beaches, the waves repeatedly casting them out on the wet sand, from which they jump back into the next breaker.



12,716

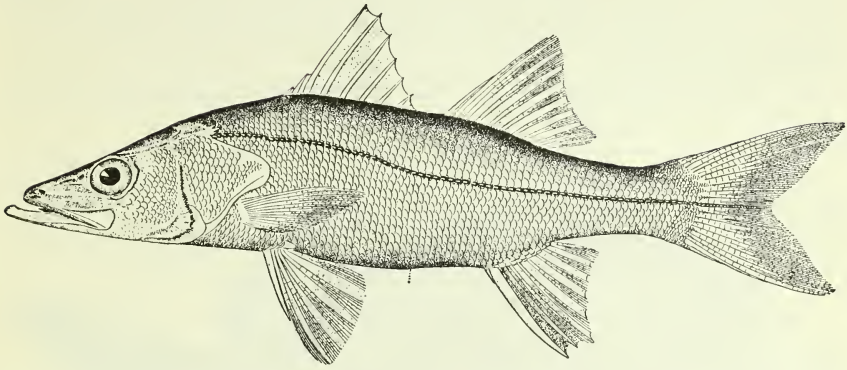
Figure 14.—Of the three species that occur on the Atlantic coast, only the common pompano, shown here, is an important food fish.

The **snook, robalo,** or **sergeant fish,** *Centropomus undecimalis,* is a common fish of the southwest coast of Florida, where it supports a small commercial fishery and is also one of the most important sport fishes of the region. It also occurs on the coast of Texas and southward through the West Indies. In the United States it is the only well known representative of its family, a group of tropical fishes found on both coasts of America.

In Florida the snook is taken by several different kinds of gear, of which hand lines are the most important. Large fish often swim close inshore, where most of the fishing is done. The snook also ascends streams, but seldom goes above the limits of brackish water.

The snook is a good food fish, with an excellent flavor and a white and flaky meat. The annual catch runs to about half a million pounds. The average size is 3 pounds, though a large snook may weigh as much

as 30. The larger fish are marketed as steaks, and are best baked or broiled.



8,087

Figure 15.—Called Gulf pike, sergeant fish, brochet de mer, and snook, this is by any name an excellent market fish and a favorite of sportsmen.

The **grunts** make up a large family of fishes which are related to the snappers and are found chiefly in tropical waters. Many of them are important food fishes wherever they are locally abundant. One of the best known along the South Atlantic coast is the pigfish, *Orthopristes chrysopterus*. Fishermen often take it in haul seines, for it is common on sandy shores. Averaging about half a pound—although some weigh as much as two pounds—the pigfish falls in the panfish category and is considered very good eating.

Several grunts of the genus *Haemulon* are among the staple food fishes of the Key West area, where, according to the colloquial expression, when all other food supplies fail the natives fall back on "grits and grunts." The white and yellow grunts, *Haemulon plumieri* and *H. sciurus*, are the most abundant there.

Grunts are so named because they are able to produce as audible sound, although scientists disagree as to just how this is done. Some believe it is by scraping the pharyngeal teeth against the gill arches, with the air bladder acting as a resonator.

Grunts are often seen in shallow water and about docks, where they nose into cracks and crevices in search of food. Schools of them lie rather quietly during the day, but break up and scatter to feed at night.

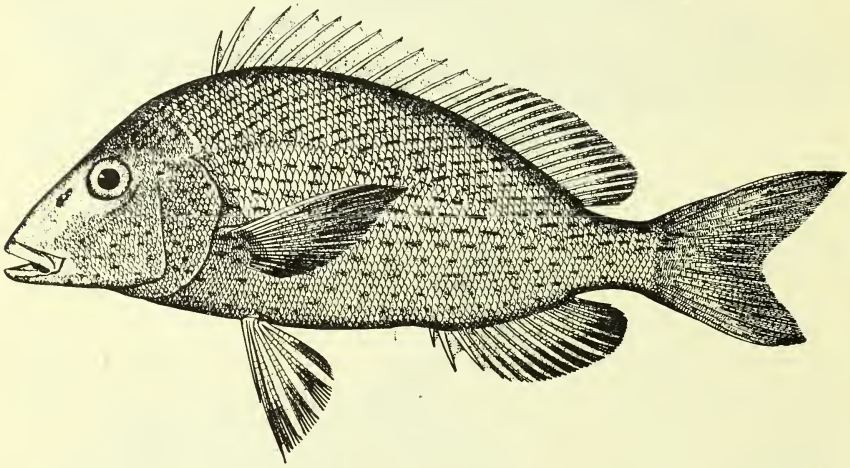
Some species of grunts are remarkable in having the inside of the mouth colored a brilliant red. Just what purpose this color serves is uncertain, but two fish in pugnacious mood will sometimes rush at each other with their mouths wide open and the brilliant interiors fully displayed.

The **sheepshead,** *Archosargus probatocephalus*, of the Atlantic and Gulf coasts might be seen anywhere from Texas to the Bay of Fundy, but it is abundant only in the South and the center of the commercial fishery is on the west coast of Florida. The annual commercial catch now amounts to half a million pounds or more, although formerly it was much larger. As a member of the porgy family the sheepshead is closely related to the familiar scup or porgy that is an important commercial fish northward from Virginia. It is not to be confused with the freshwater sheepshead, which is a member of the drum or croaker family.

The sheepshead is often taken about wharves, breakwaters, and sunken wrecks where it finds abundant food. It is fond of crabs, oysters,

and other shellfish which it crushes easily in its strong teeth. In inlets, it moves in and out with the tides and in the South does not seem to migrate extensively. During the spawning season, which occurs in the spring, the sheepshead assemble in schools and move into shallow water to deposit the eggs.

The largest sheepshead on record weighed about 20 pounds but the

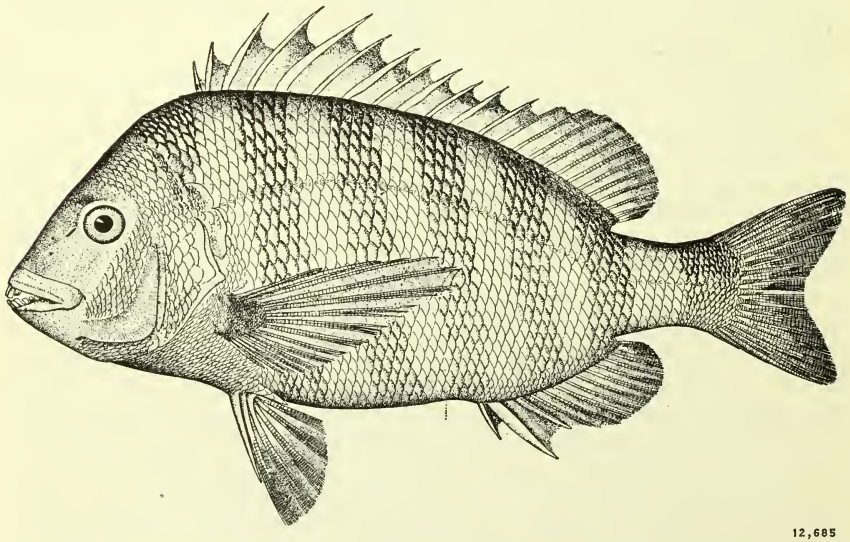


12,940

Figure 16.—The pigfish is one of the commonest food fishes along South Atlantic shores.

average size is, of course, much less. The larger fish may be filleted, the smaller sold whole. The meat is white, tender, and pleasantly flavored.

A related species, the pinfish *Lagodon rhomboides,* is a food fish of some importance in Florida and North Carolina.

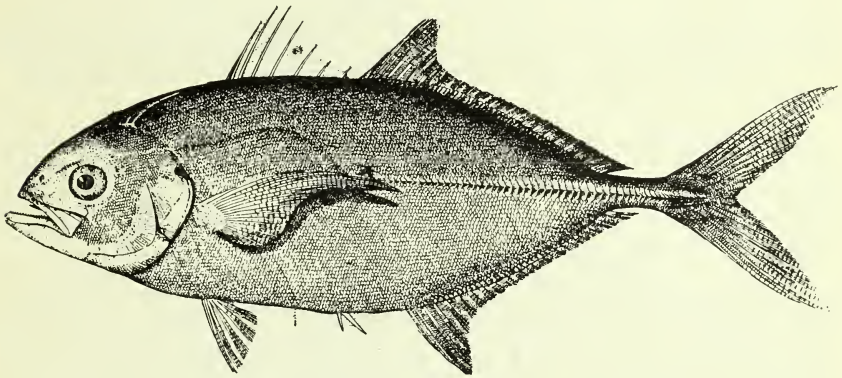


12,685

Figure 17.—Salt-water anglers as well as commercial fishermen take the sheepshead, a fish that prefers warm southern waters.

The **blue runner** or **hardtail,** *Caranx crysos,* has always been esteemed as a food fish on the Gulf coast, where it seems to be most abundant, but it has never been taken in large quantities, the catch usually falling well below a million pounds. Recently, there has been some increase in the production of this fish and in 1942 some 700,000 pounds were taken on the east coast of Florida, in addition to the Gulf coast catch. Too little is known about the biology of this fish to predict how large a fishery it could support, but it seems likely it could provide a considerably larger poundage than is now being taken.

Like the pompano, the blue runner is a member of the family Carangidae, all of which are active swimmers inhabiting warm seas. Although found all the way from Cape Cod to Brazil, the blue runner is taken



12,939

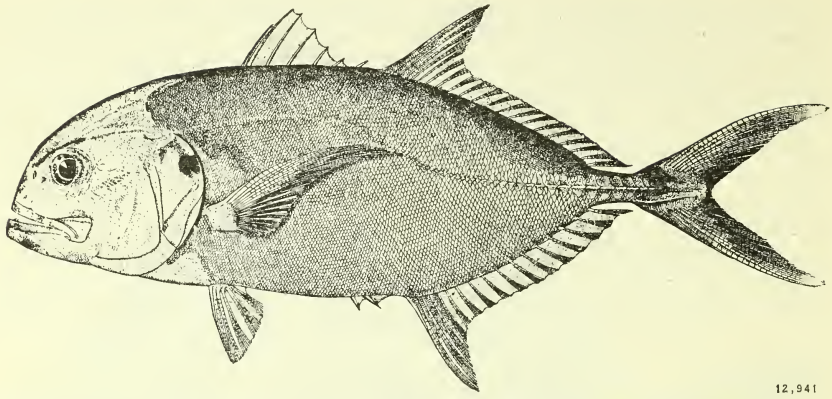
Figure 18.—The blue runner is one of the under-utilized species of the South.

commercially only in Florida and Alabama. It has many different common names: horse crevalle in North Carolina, jurel, skipjack, and jack-fish in Florida.

In the vicinity of Pensacola, the migratory schools of the blue runner appear in April, are most numerous in May. Along the southern coast of Florida they are abundant in winter. They follow schools of small fish, sometimes leaping out of the water in pursuit of them. They, in their turn, are chased by sharks and porpoises, and are sometimes driven ashore in numbers.

The blue runner is a slim bodied fish, rather more green than blue above, golden yellow or silvery below. It attains a length of 20 inches and a weight of 4 pounds. Most of the catch is taken in haul seines, which are operated in shallow water along the shore.

The **crevalle** or common jack, *Caranx hippos,* a close relative of the blue runner and the pompano, is taken in quantities of about a quarter of a million pounds on the west coast of Florida, but nowhere else in important numbers. This is the most abundant of the various species of jacks or runners that are found about Key West. It is a good food fish, commanding a ready sale in the markets. Most of the commercial catch is taken in gill nets, but the crevalle may also be taken by trolling and is of some interest to anglers. The average weight is about a pound, although it not infrequently runs to 10 pounds and the record weight is about 20. Although it is found throughout the year, it is most common during the winter months.

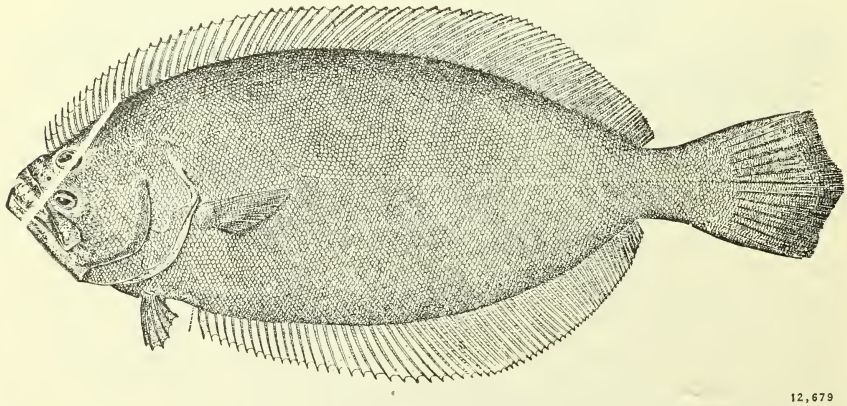


12,941

Figure 19.—The crevalle, which occurs on the eastern seaboard as far north as Massachusetts, has a number of common names, such as albacore, horse mackerel, cavally, and jack.

The **flounders** are excellent food fishes, with white, flaky, and delicately flavored meat, but the total catch in the south amounts to only about a million pounds by commercial fishermen. While some are taken in each of the coastal States, the largest catches are made in North Carolina, Florida, and Texas.

Three kinds of flounders are taken along the South Atlantic and Gulf coasts, although one of them is so small that it has little commercial importance. These are the summer flounder, *Paralichthys dentatus,* found on the Atlantic coast as far south as the northern part of Florida; the southern flounder, *P. lethostigmus,* common on both South Atlantic and Gulf coasts; and the small flounder referred to above, *P. albiguttus,* which also occurs on both Atlantic and Gulf coasts. For the market no distinction of species usually is made, all species being lumped together as flounders. For those who wish to tell one flounder from another the following suggestions may be helpful. In southern Florida or anywhere on the Gulf coast the problem is simple, for only two species occur—*lethostigmus* and *albiguttus. Lethostigmus* is uniformly dark colored on the upper surface, while *albiguttus* has a number of conspicuous spots, each dark with a white ring around it. From North Carolina to northern Florida the identification is a little more difficult because three species



12,679

Figure 20.—The southern flounder, found from Chesapeake Bay to Texas, is the common market flounder on the Gulf coast.

are concerned. However, *lethostigmus* is still easy to recognize because it lacks spots. As between *dentatus* and *albiguttus,* both of which bear the ringed spots, remember that *albiguttus* is small and that its spots are fewer—usually three placed in a rough triangle plus several accessory spots, compared with six major and many accessory spots in *dentatus.* To be sure of his identification of these two species, however, the biologist counts the gill rakers and fin rays.

All flounders have flat, compressed bodies and a peculiar habit of lying on their sides. They are not born with this habit but acquire it early in life. Several amazing structural changes accompany the transformation, most important of which is the fact that the eye on the under side moves across the forehead and comes to lie beside the other on the uppermost side of the fish. In this way the flounder is saved the inconvenience of continuously looking into the mud with one eye. Some flounders habitually lie on the left side, others on the right. The southern flounder, for example, lies on its right side. Ordinarily, the under side becomes uniformly light in color, the upper side uniformly dark.

Flounders are predatory and their diet consists in large part of other fishes, although they also eat shrimps, crabs, and other aquatic animals. Often they lie partly buried in the sand with only the eyes exposed. Their air of sluggishness is most deceptive, however, for when a fish passes by they dart up with surprising rapidity and seize it. People who have kept flounders in laboratory tanks say that they will strike with great force at a finger and can inflict a painful wound.

About Beaufort, N. C., Hildebrand and Cable (1930) found very young flounders off Beaufort Inlet much more often than inside the harbor, from which they inferred that most or all of the spawning takes place at sea. The principal spawning season in that area seems to be November and December. The young soon move into the inside waters, where, like the adults, they live on or near the bottom.

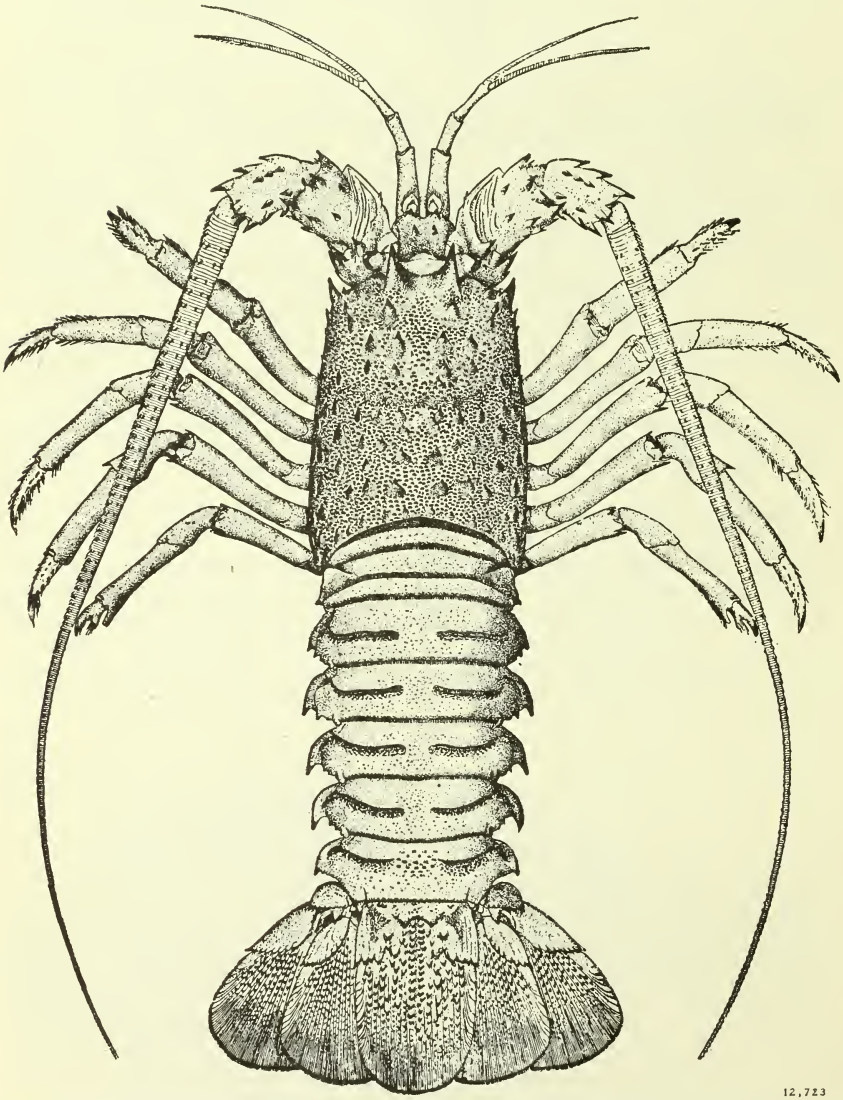
Sharks as food are becoming a regularly occurring item in such United States markets as can obtain a steady supply. Although they have a long and honorable history of utilization in other countries, sharks had been largely neglected by the American public as food until wartime shortages prompted a search for new sources of protein foods. A thriving fishery for sharks already existed—especially on the Pacific coast and in North Carolina and Florida in the east—but only the vitamin-rich livers and the hides were saved, while millions of pounds of meat were being discarded at sea. The first experimental shipments of shark meat were so well received that a brisk market has now grown up, and the supply for consumers is limited only by the ability of fishermen to catch and process the sharks. The meat is placed on the market chiefly in the form of frozen steaks or fillets. The present heavy demand suggests that shark meat will continue popular after the war, when formerly plentiful foods have been restored to our tables.

The chief centers of shark fishing on the Atlantic coast are Morehead City in North Carolina and Mayport, Salerno, Cortez, and Key West in Florida. Many different species are taken—probably fifteen to twenty—with the leopard, dusky, brown, sand, hammerhead, and nurse sharks being among the most important. Gear used by Florida shark fishermen resembles the long trawl lines still used to some extent in New England for cod, except that chains are substituted for the lower part of the line because of the sharp teeth and the strength of many of the sharks.

Sharks are classified by zoologists as fishes, but are distinguished from the bony fishes by the fact that the skeleton is not ossified, by the presence of a series of gill slits along the side of the head, and by other

less conspicuous anatomical features. The general habits of sharks are very similar to those of most of the larger, predatory bony fishes. Their food consists largely of crabs, lobsters, small fishes, and mollusks. One of the largest of all sharks, the basking shark, lives on the minute surface life of the sea which it strains through its gills.

Many kinds of sharks differ from most bony fishes in an interesting respect—they bring forth their young alive. These sharks produce eggs with well developed shells like other fishes, the difference being that the eggs hatch within the body of the mother, instead of first being expelled. However, while the cod, for example, produces millions of eggs, the shark may give "birth" to only a dozen or so young. This great difference in



12,723

Figure 21.—The spiny lobster of Florida, also called the sea crayfish or rock lobster, is a handsome crustacean mottled with blue, rich yellow, and brown and studded with numerous spines.

fertility is probably compensated in Nature's scheme by a higher survival rate. The young sharks, at birth, are of good size, active, and obviously ready to take up an independent existence.

The **spiny lobster** of Florida, *Panulirus argus,* is not closely related to the New England lobster, although people sometimes confuse the two. One of the chief differences is the fact that the spiny lobster lacks the giant claws that are a characteristic feature of the New England lobster and provide a considerable quantity of choice meat. All the meat of the spiny lobster comes from the flexible abdomen or "tail." The frozen lobster tails, still encased in their shells of mottled green and brown, are the common market form.

Present catches of the spiny lobster amount to slightly less than half a million pounds, taken chiefly on the Florida Reef from Miami to Dry Tortugas. Although this species occurs as far north as Beaufort, N. C., United States fishermen seldom take it outside the State of Florida. The best fishing grounds are along the southern shores of the reefs and keys. A related form is found on the Pacific coast, south of Point Conception.

The average market size of the Florida spiny lobster is about 9 to 10 inches, exclusive of the long antennae. The largest specimen of which the Fish and Wildlife Service has authentic record measured over 17 inches and weighed 8 pounds.

Most of the catch is made at night in pots which the lobsters enter as they crawl about to feed, for they are nocturnal prowlers. During the day they lie hidden under rock ledges or among sponges, where they may be detected in clear water by the protruding antennae. Coral reefs, rocky bottoms, and other grounds which provide good cover are their favorite haunts.

The **hard-shell clam**, *Venus mercenaria,* occurs along the shores of the South Atlantic and Gulf coasts all the way from North Carolina to Texas, but only the States of Florida and North Carolina have important clam fisheries. Florida produces about 700,000 pounds and North Carolina 500,000.

The southern hard-shell clam is the same species as the well known quahog of New England and in the South is sometimes called the "round clam" or "little neck clam." On the Gulf coast of Florida the clams grow so much larger than along the South Atlantic coast that they are considered a distinct sub-species, known as *Venus mercenaria mortoni.* The shells of the Florida clams may be 5½ to 6 inches long and the clam may weigh several pounds.

Probably the largest clam bed in the United States occurs off the Gulf coast of Florida, in the region of the Ten Thousand Islands. It is some 40 miles long and at its widest parts extends out into the Gulf a distance of about 5 miles. The clams are distributed over about 150 square miles of bottom, occurring, as might be expected, more thickly in some places than in others.

In the Florida clam fishery two kinds of gear are used, both of which apparently are unique in the United States. The bulk of the catch is taken by a dredge, which in general appearance resembles a houseboat. The digging apparatus picks up the clams on its curved teeth and deposits them on a moving wooden escalator or conveyor which, in turn, carries the clams past two or three men who pick out the live clams. Dead clams, shells, and debris are automatically discarded when the conveyor passes under water again. The dredge is at one end of a 1,200 foot cable which is attached to an 800-pound anchor. It moves along

slowly by taking up the cable. When a run is completed the cable is released and the dredge drifts back with the wind and tide. Each run of the dredge follows a course like the radius of a circle, with the anchor at the center.

Besides the dredge, some small boats are operated. Clam diggers in these boats use a long-handled probe which bears four prongs of flexible steel. The probe is thrust into the bottom repeatedly until a clam is felt, then an additional thrust secures the clam between the prongs so that it may be drawn out.

All of the boats now working the clam bed are operated in connection with a local cannery, where the entire catch is processed. In North Carolina another clam cannery is operated, but part of the catch in that State is sold fresh.

Besides the hard clam, one other species—the small coquina clam—is marketed in Florida for use in broths and chowders, but the annual production is only about 15,000 pounds.

The **bay scallop**, *Pecten irradians*, is taken commercially in only two areas on the South Atlantic and Gulf coasts—in Carteret County, N. C., and on the Gulf coast of Florida, principally about Fort Myers, Tampa, and Apalachicola.

At the present time, the Florida production is much the larger, amounting to about 130,000 pounds, compared with approximately 35,000 in North Carolina. The small quantity of scallops now taken in North Carolina is the result of the strange disappearance, about ten years ago, of a marine plant known as eelgrass, in which the young scallops find necessary protection. When the eelgrass was killed out by an unexplained disease which struck suddenly over a wide area along the Atlantic coast, the scallop population in the affected areas was virtually wiped out, so close is the ecological dependence of the mollusk on the sheltering vegetation. The blow dealt the scallop fishery of North Carolina is revealed in the following figures: in 1927 the catch was 835,000 pounds; in 1940, 34,000 pounds. Eelgrass does not grow south of Bogue Sound in North Carolina, hence the Gulf coast fishery was not affected. It has, however, shown some decline due to other causes, probably economic.

Like oysters and clams, scallops have two shells—hence are called "bivalves"—but they differ considerably in their habits from these sedentary relatives. Scallops swim about actively by rapidly opening and closing the shells, the forcible closing expelling a jet of water which furnishes the means of propulsion. A large muscle controls the shell movements, and this muscle (sometimes called the "eye") is the only part of the scallop that is eaten. Europeans eat the entire scallop, just as whole oysters and clams are eaten, but Americans have not yet learned to eat anything but the excellently flavored muscle.

APPENDIX

The Nutritive Value of Fish and Shellfish

Most people eat fish because they enjoy their varied flavors and their adaptability to many different methods of preparation. There are further benefits from eating aquatic food, however, for fish are good natural sources of calcium, phosphorus, iron, and copper, and provide protein of unexcelled quality. Some species also furnish vitamins in appreciable quantities and sea fish are rich in iodine.

Fish are an important source of proteins, a type of food which must be included in the diet to provide the elements needed to grow and repair worn-out body tissues. Some proteins are complete in that they supply all of the elements needed; others are incomplete and must be supplemented with other protein foods if the body is to remain in normal health. Fish proteins, like those in beef, pork, and other meats, are complete in themselves and proteins of this type should supply about one-third of the daily protein requirement.

Fish are an excellent source of most of the minerals which the body needs to develop properly and perform its functions. Calcium and phosphorus (without which proper development of bones and teeth is impossible) occur in fish fillets in about the same quantities as in beef round. Marine fishes are especially rich sources of iodine, containing 50 to 200 times as much of this essential element as any other food. Oysters, shrimp, and crabmeat, compared with milk, provide half as much calcium, five times as much magnesium, and slightly more phosphorus. Iron and copper, which build up the hemoglobin content of the blood and prevent or remedy nutritional anemia, are easily obtained by eating most fish. Oysters and shrimp are the best known sources of these two minerals.

Although fish-liver oils have long been recognized as first-class sources of vitamins A and D, it is less widely known that the flesh of fish is also a source of several vitamins. On the average, daily vitamin requirements could be obtained from ordinary serving portions of fish to the following extent: vitamin A, 10 percent; vitamin D, more than adequate amounts; thiamin (vitamin B_1), 15 percent; riboflavin (vitamin B_2), and nicotinic acid (another element of the vitamin B complex), 70 percent.

General Guides for Selecting and Preparing Fish

How to buy.—Insist upon freshness. A fresh fish may be recognized by the following: firm and elastic flesh, scales that cling to the skin in most species, reddish gills free from disagreeable odor, eyes bright and full, not sunken. In selecting shellfish like clams and oysters, be sure that the shells are tightly shut, indicating that the animals are alive, unless you prefer to buy the meat separately as shucked shellfish. Crabs and lobsters should be bought alive or as cooked meat. However, uncooked shrimp may be bought in the shell provided it feels firm to the touch. Cooked shrimp is sold either with or without the shell, with the heads already removed.

When to buy.—In general, the fish of any species are of highest food quality when most abundant, for at these periods fishermen are making their catches in the shortest time and shipping them promptly. Usually, but not always, fish are cheapest when most abundant.

Common market forms.—Fresh (refrigerated) fish and completely frozen fish should be equally good if the freezing is done by the modern

methods now well known to the industry. Both are marketed in a variety of convenient forms, as follows:

Whole or round fish are those marketed in the form in which they come from the water, and are of three kinds: fish that keep as well or better without dressing, small fishes, or the small sizes of larger species. Before cooking, whole or round fish are eviscerated, and in all but the very small sizes, the heads, scales, and sometimes the fins are removed.

Drawn fish are those marketed with only the entrails removed. To prepare these fish for cooking, the heads, scales, and (if desired) the fins are removed, and the fish may be split or cut into serving portions if too large to be cooked whole.

Dressed fish have had the head and entrails removed and the tail and fins may be cut off. If dressed fish are large, they may be cut into pieces in preparation for cooking. Very large dressed fish are sometimes marketed in pieces.

Steaks are slices (usually about half an inch thick) cut across a large dressed fish.

Fillets are meaty slices cut lengthwise from the sides of the fish. Fillets contain no bones or other waste. Their weight varies with the size of the fish from which they are cut.

Stocks are crosswise or lengthwise cuts of fillets.

Canned fish.—Besides the universally familiar canned salmon, tuna, and sardines, many kinds of fish are canned for use in main dishes, salads, and appetizers. For the duration of the war, however, the amount of canned fish available for civilians will be considerably less than normal.

Salt or Smoked fish.—Tasty variations in the menu are provided by salt or smoked fish. Salt fish ordinarily requires one-half to several hours' soaking before further preparation; while smoked fish usually is ready to eat as it is, or may be heated.

Fat content of fish.—For best results in preparing a fresh fish, it is always desirable to know whether it is fat or lean. Fat fish are especially suitable for baking, and may also be broiled, while lean fish are best adapted to steaming, boiling, and frying. Medium-fat fish are prepared like the lean, or may be dressed with strips of salt pork or bacon and baked. Most cook books classify fish as follows:

Fat fish are those containing more than 5 percent fat. Examples are mullet, Spanish mackerel, and pompano.

Lean fish are those containing less than 5 percent fat. Examples are red snapper, sea trout, and groupers.

Sauces and garnishes.—The attractiveness of almost any dish consisting of fish will be increased greatly by the use of sauces that subtly enhance or complement the flavor. Any good cook book contains excellent suggestions as to the choice and preparation of such sauces.[2] Fresh and colorful garnishes also do much to create a dish as pleasing to the eye as to the palate, thereby whetting the appetite and helping to make the serving of fish a pleasurable and often repeated experience.

2 Sauces for seafoods. Fishery Leaflet 53. Mimeographed, 4 pages, may be obtained on request from the Fish and Wildlife Service, Chicago 54, Ill

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