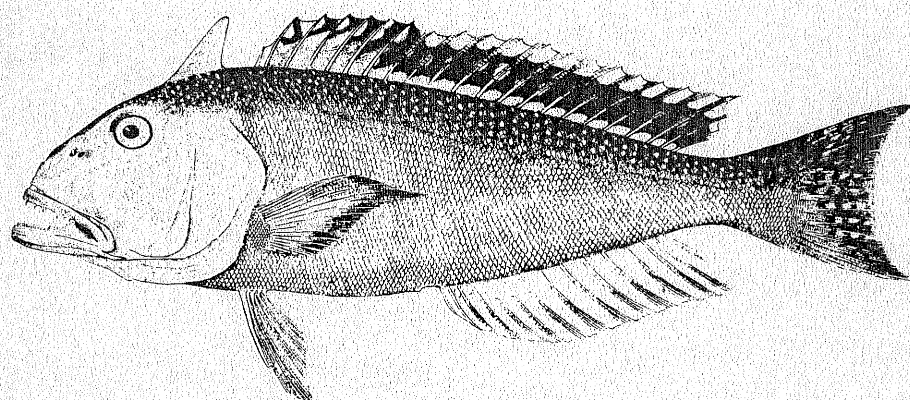

BIOLOGICAL & FISHERIES DATA ON TILEFISH, *Lopholatilus chamaeleonticeps* GOODE & BEAN

MAY 1977

Biological and Fisheries Data

on

tilefish, *Lopholatilus chamaeleonticeps* Goode and Bean

by

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1. IDENTITY

1.1 Nomenclature

1.11 Valid Name

Lopholatilus chamaeleonticeps Goode and Bean. The generic and specific names were first set forth in a publication of 1880 by G. Brown Goode and Tarleton H. Bean entitled, "Description of a new genus and species of fish, Lopholatilus chamaeleonticeps, from the south coast of New England". It was published in the Proceedings of the United States National Museum, vol. 2, 1879, pp. 205-209. The generic name is derived from the Greek word λόφος or "Lopho" meaning crest and "latilus" for the genus Latilus, which it resembles (see Günther, 1860; a group of fishes occurring in the Indian Ocean). The specific name is a combination of "chamaeleon", or chameleon, the various small lizards capable of changing their color, and "-ceps", head (Jordan and Evermann, 1896). Thus, a Latilus-like fish with a crest on its chameleon-shaped head.

1.12 Objective Synonymy

The original descriptive name is valid and there are no synonyms.

1.2 Taxonomy

1.21 Affinities

The classification follows Berg (1947) and more recently Greenwood, et al. (1966).

Phylum - Chordata (Vertebrata)
Class - Teleostomi
Superorder - Acanthopterygii
Order - Perciformes
Suborder - Percoidei
Family - Branchiostegidae
Genus - Lopholatilus
Species - Lopholatilus chamaeleonticeps

The type specimen (holotype) was a single individual (USNM) number 22899, (Earl 342) 788 mm FL (31 in.), caught offshore of southern New England. A few days after its capture in

July of 1879 this fish was sent to the United States National Museum and described. The specimen appeared to be related to the genus *Latilus*, but is distinguished from it by the presence of a large adipose fin or crest on the head, anterior to the origin of the first dorsal fin, and by a fleshy flap situated on each side of the lower jaw close to the angle of the mouth, pointing backward. A drawing of the holotype (Figure 1) was made by H. L. Todd and first appeared in its completed form in the "Fisheries and Fisheries Industries of the U. S." (Goode, 1884). A partially completed drawing of the holotype appeared in a report by Collins (1884). The generic description by Jordan and Evermann (1896) is as follows: "Body stout, somewhat compressed; mouth moderate, maxillary reaching anterior margin of the orbit; opercle and preopercle scaly, the latter finely denticulate; upper jaw with outer series of stronger teeth, behind which is a band of villiform teeth; lower jaw with a few large canines, and an inner series of small conical teeth; vomer and palatines toothless; nape with a large adipose appendage; a fleshy prolongation upon each side of the labial fold, extending backward beyond the angle of the mouth; stomach small siphonal, barely more than a loop in the very large intestine; alimentary canal short, less than total length of the body; air bladder simple, with thick muscular walls, strongly attached to the roof of the abdominal cavity by numerous root-like appendages, resembling somewhat that of *Pogonias*. Deep-sea fishes." Dooley (1974) gives a more detailed description as follows:

"Body quadriform, head rounded; vertebrae 10+14; first caudal vertebra with blade-like haemal process, not specialized structure, that abuts against air bladder. Dorsal fin elements VII-VIII, 14-15; anal fin I, 14 (rarely 13); pectoral fin 16-18 (usually 17); total first arch gill rakers 22-26; pored lateral line scales 66-75; cheek scales 6-10; opercular scales 6-10; scales above lateral line 7-11, below 23-34.

Body depth 21-31% SL; body width 11-18% SL; peduncle length 13-16% SL; peduncle depth 8-10% SL; head length 28-35% SL; predorsal length 30-39% SL; head depth 72-100% HL; snout length 27-51% HL; length of upper jaw 37-53% HL; length of lower jaw 43-56% HL; cheek depth 20-47% HL; opercular length 24-32% HL; snout to dorsal margin of preoperculum 74-80% HL; orbit diameter (allometric) 16-44% HL; suborbital depth 14-28% HL.

Upper jaw protrusile, slightly oblique and undershot, reaching posteriorly to a vertical just inside the anterior rim of the orbit; teeth strong and conical; lower jaw with approximately

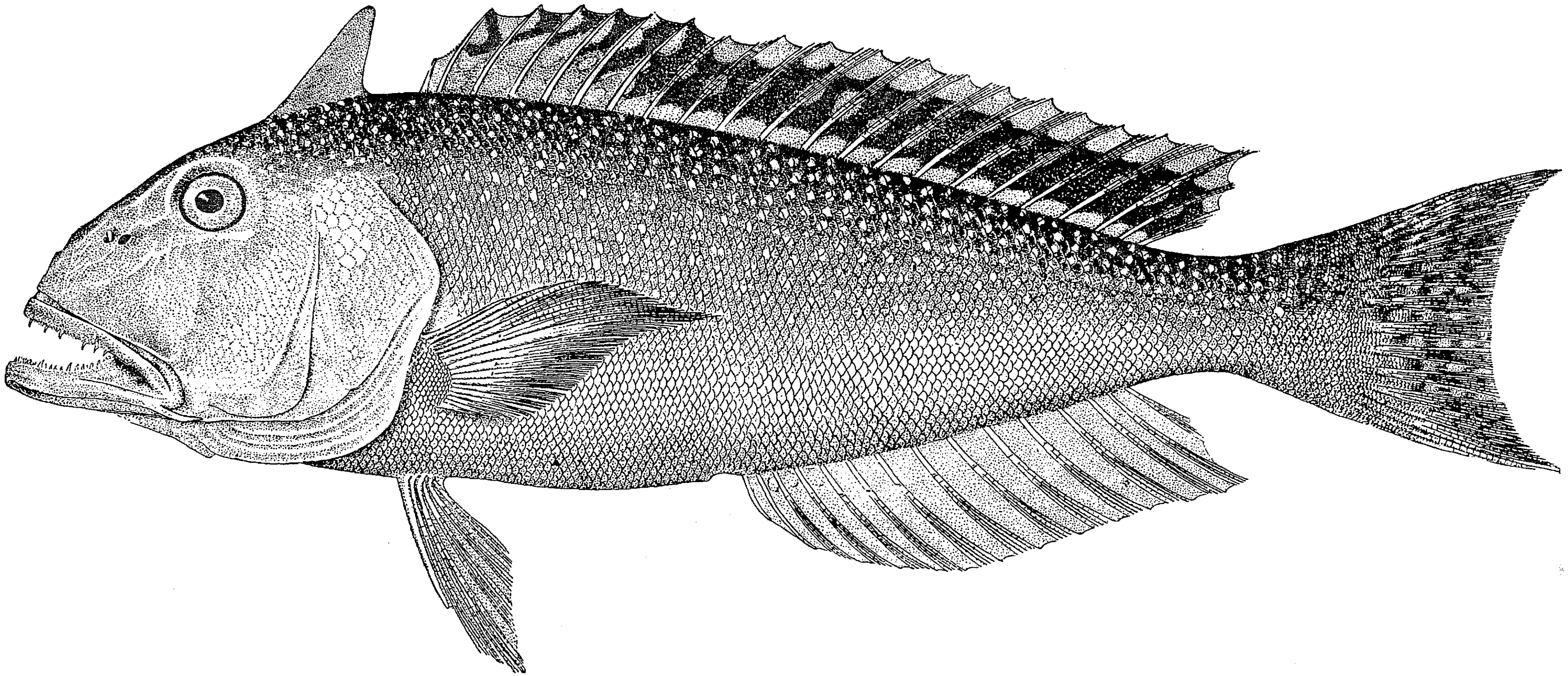

Figure 1. A mature tilefish from off southern New England. Drawing by H. L. Todd (1884) of the type specimen caught by Captain Kirby in 1879.

15-17 enlarged canines in a single row along outer margin of jaw with a patch of villiform or fine canines at symphysis; upper jaw with about 13-18 large canines in single row along outer margin with an inner patch of fine villiform teeth, wide at the symphysis and narrowing to a single row near the posterior end of the jaw.

Gill membrane free from isthmus; predorsal ridge prominent and may be developed into a fin-like flap of tissue just in front of dorsal fin; posterior margin of lower lip with or without cutaneous barbel; supraoccipital crest well developed, skull with many ridges and recesses, mesethmoid very forked and downcurved, orbit large; preoperculum finely serrate to angle, slightly indented above angle; operculum with blunt tab-like spine.

Scales ctenoid except in head region where many are cycloid; scales mostly replacement; non-replacement scales are found mainly under the pectoral fin bases; scales on cheek, operculum, caudal fin, and in a small patch on pectoral fin (other fins naked); scales on head reaching to about posterior fourth of orbit.

Dorsal fin continuous, spinous portion slightly lower than soft dorsal, base of fin 50-62% SL; origin over pectoral base; spines long and slender or stout, nearly the same length as rays; first spine from 1.3-1.9 in length of second spine, first two spines close together and joined at their bases; rays all divided, generally of equal length, with the exception of an elongate antipenultimate ray followed by two progressively shorter rays; elongate ray nearly reaching to hypural crease.

Anal fin about the same height or slightly higher than dorsal fin; origin between fourth and fifth dorsal rays; one thin spine from 2.15-2.33 in first ray; base of fin 27-33% SL; first ray usually segmented but not divided, remaining rays divided; first two or three rays slightly shorter than remaining rays, penultimate ray elongate reaching slightly less posteriorly than elongate dorsal ray.

Pectoral fins long and pointed reaching nearly to anus; origin between second and third dorsal spines; first ray stout, segmented and undivided, about 3.5 in longest ray; except for ventralmost ray, all remaining rays well divided; pectoral length 21-29% SL; base of rays with a small patch of scales.

Pelvic fins from about two-thirds to three-fourths the length of pectorals; length 13-25% SL; origin below pectoral base; spine stout and about 1.5 in longest ray; rays well divided.

Caudal fin square or slightly lunate with excerted tips, dorsalmost tip slightly longer than ventral tip; 17 principal rays all divided except dorsal and ventralmost rays; rays on five autogenous hypurals; caudal skeleton with three epurals and classified as a type Vb (a type shared by *Serranus*, *Perca*, *Tilapia* and certain Beryciformes) according to Monod (1968); caudal scales over most of its length."

Dooley (1974) reviewed the taxonomic work of tilefishes the world over. He followed Jordan (1923) and divided this group into two closely aligned families - Branchiostegidae and Malacanthidae - tracing chronologically the recognition of them as distinct families and combined with other families.

While there is only one species of Lopholatilus (*L. chamaeleonticeps*) in the western North Atlantic Ocean, another member of the genus, *L. villarii* (Mirando-Rebeiro, 1915), exists in the western South Atlantic Ocean. These two species appear to be similar with nearly all of their body proportions overlapping. However, *L. villarii* lacks the anterior adipose fin as well as the fleshy prolongation on each side of the labial fold. Also, *L. villarii* has fairly stout dorsal spines with the first going into the third 2.2 to 2.7 times. *L. chamaeleonticeps* has thin dorsal spines which are nearly uniform in length, with the first going into the third 1.1 to 1.8 times (Dooley, 1974). Both Norman (1966) and Dooley (1974) have identification keys to the genera of the family Branchiostegidae.

1.22 Taxonomic Status

There is no evidence to indicate that this is not a morphospecies.

1.23 Subspecies

No subspecies have been proposed.

1.24 Standard Common Names, Vernacular Names

Tilefish is the name used predominantly by United States fishermen and is also the one given *L. chamaeleonticeps* by the American Fishery Society (1970). It is sometimes called the golden tilefish, colorful tilefish or rainbow tilefish along our southeast coast to distinguish it from *Caulolatilus cynaops*, *C. microps* and *C. chrysops*, several species occurring with L. chamaeleonticeps but not as brightly colored. It is common in southeastern Florida markets for tilefish to be sold under the names golden snapper, yellow snapper and speckled snapper (Porter, 1976). Fishermen of New England formerly coined the name Leopard-fish, because of the yellow spots covering the back and sides; those fishing Campeche Bank in the Gulf of Mexico formerly used the name soap fish. Either of the last two names mentioned are seldom used today, if at all.

1.3 Morphology

1.31 External Morphology

The following is from Jordan and Evermann (1896):

"Head 3; depth $3^1/2$. D. VII, 15; A. II, 13[1]; scales 8-93-30. Body stout, somewhat compressed, its greatest width equaling length of caudal peduncle; intermaxillaries supplied with a series of from 19 to 23 canine teeth, behind which is a band of villiform teeth, widest at the symphysis; mandible with about 12 large canines; eye rather small, its diameter $6^1/2$ in head, and about twice length of labial appendages; distance between posterior nostril and eye equal first anal spine, and 1/2 distance from tip of snout to anterior nostril. Caudal fin emarginate, middle rays $1^1/2$ in outer rays; vent under interval between fourth and fifth dorsal rays. Back bluish, with a green tinge, iridescent, changing through purplish blue and bluish gray to rosy white below, and milky white toward median line of belly; head rosy iridescent, with red tints most abundant on forehead, blue under the eyes, cheeks fawn-colored; throat and under side of head pearly white, with an occasional tint of lemon yellow, most pronounced in front of ventrals and on anterior portion of ventral fins; back with numerous maculations of bright yellow or golden; anal purplish, with blue and rose tints, iridescent; margin of anal rich purplish blue, iridescent, like the most beautiful mother-of-pearl, this color pervading more or less the whole fin, which has large yellow maculations, the lower border rose-colored like the belly, base of the fin also partaking of this general hue; dashes of milk white on base of anal between the rays; dorsal gray; in front of the seventh dorsal and upper third posterior to the upper two-thirds dark brown;

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[1]Goode and Bean (1880) in the original description give the anal fin count as III, 13. Jordan and Evermann (1896) give it as II, 13, while Dooley (1974) gives it as I, 13-14 and adds that it is not III, 13 as in the type description.

spots of yellow, large, elongate, on or near the rays; adipose fin whitish brown or yellow, large group of bright yellow confluent spots at the base; pectorals sepia-colored, with rosy and purplish iridescence."

Bigelow and Schroeder (1947) compared a specimen from the Gulf of Mexico (Campeche Bank) with a specimen from off southern New England of about the same size. They found the Gulf of Mexico specimen had a relatively larger eye (4.5 in head as against 5.1), a somewhat longer pectoral fin, and a slightly smaller adipose fin. While these differences could be due to size or age, they mention that they could also be due to racial differences. There have been no investigations on possible racial differences or geographic variations of tilefish.

1.32 Cytomorphology

No information available.

1.33 Protein Specificity

No information available.

2. DISTRIBUTION

2.1 Total Area

The tilefish occurs along the outer half of the continental shelf and the upper part of the continental slope from the northeast corner of the Scotian Shelf (northern-most occurrence being 44°26'N lat., 57°13'W long.), along the entire coast of the United States, and the Gulf Coast to Campeche Bank, and off Venezuela, and Guyana, Surinam (southern-most occurrence being 7°17'N lat., 55°52-54'W long.) in South America (Figure 2) (Bigelow and Schroeder, 1953; Wolf and Rathjen, 1974; Wolf, 1974; Dooley, 1974; and Freeman and Walford, 1974, 1976). Within this area the tilefish is restricted to a relatively narrow band, in most places less than 37 km (20 miles) wide, which ranges in depth from 76 to 457 m (250 to 1,500 ft.) (Goode, 1884), though the depth varies with location. Thus, in the northernmost part of its range, i.e., off the Scotian Shelf, the few specimens that have been caught were in depths between 142 and 311 m (468 to 1,020 ft.), while in the Middle Atlantic Bight, i.e., between Cape Cod, Massachusetts and Cape Hatteras, North Carolina, it is caught between 82 and 439 m (270 and 1,440 ft.) but with the greatest numbers between 110 and 238 m (360 and 780 ft.).

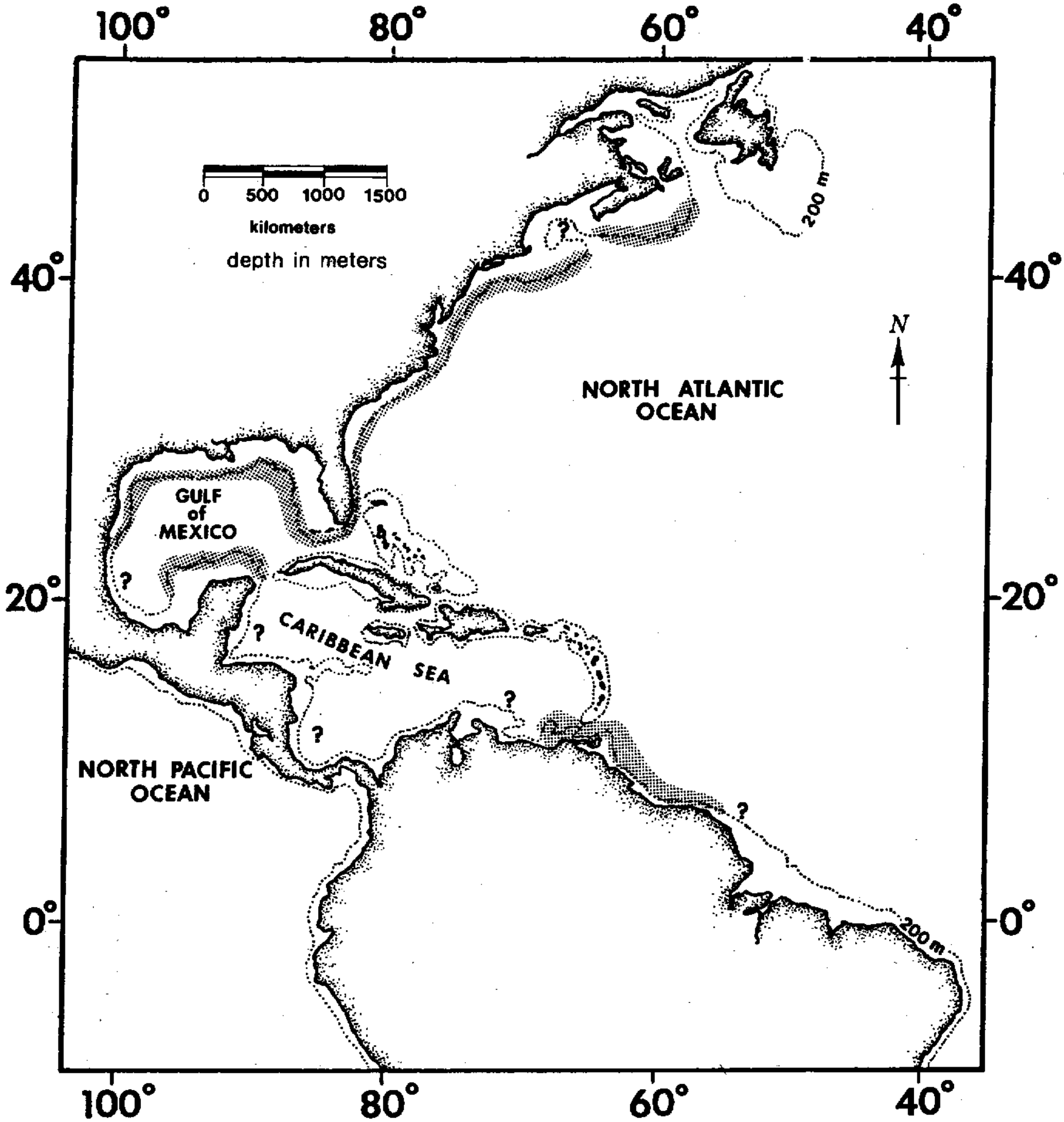

Figure 2. The distribution of tilefish (Lopholatilus chamaeleonticeps) as derived from captures.

In the southern part of its range, tilefish again occur in deeper depths. In the Gulf of Mexico, as well as the Atlantic Ocean off South America, it is caught in depths between 165 and 411 m[2] (540 and 1,350 ft.), with most being between 256 and 366 m (840 and 1,200 ft.) (Nelson and Carpenter, 1968; and Wolf, 1974).

The tilefish which occurs between Cape Cod and Cape Hatteras, and presumably over the rest of its range as well, occupies a very definite environment where the narrow band (37 km) of the sea floor is bathed almost always by 9.4° to 14.4°C (49° to 58°F) water. In this band the temperature varies by only a few degrees over the course of a year, while the bottom water both inshore and offshore is much colder (Rathburn, 1895; and Bigelow and Schroeder, 1953).

2.2 Differential Distribution

2.21 Spawn, Larvae and Juveniles

Presently there is no information available, although data is being compiled and analyzed.

2.22 Adults

Adults occur over the entire range of this species as given in Section 2.1. While they occur throughout the narrow band at the edge of the continental shelf from the shallowest (76 m, 250 ft.) to the deepest parts (457 m, 1,500 ft.), they tend to concentrate in depths greater than 110 m (360 ft.) along the east coast and 247 m (810 ft.) along the Gulf coast and off South America. And although when fishing it is often found that the various size specimens tend to group together no matter what depth, it can generally be said that as tilefish become increasingly larger, they tend to live in progressively deeper depths. This, however, is the general situation and there are always exceptions, such as the three large specimens weighing between 21 and 26 kg (47 and 58 lbs.) that were caught in 113 m (372 ft.) near Veatch Canyon and a 26 kg (58 lb.) specimen in 110 m (360 ft.) near Hudson Canyon (Pukas, 1975). Along the east coast of the United States, however, large size tilefish seem to occur in fewer numbers beyond about 238 m (780 ft.).

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[2]Bullis and Thompson (1965) report L. chamaeleonticeps as being caught at two of their stations. One was 77 m (252 ft.) deep, the other 19 m (63 ft.). If their data is correct, this is by far the shallowest depth in which tilefish have even been taken.

2.3 Determinants of Distribution Changes

Apparently the balance between the physiological requirements of the tilefish and the water in which it lives is so delicate that it is susceptible to mass mortality. Such a condition existed only a few years after its discovery. During the early spring of 1882, several vessels sailing offshore reported seeing great numbers of dead or dying fish floating at the surface of the sea between the latitudes of Cape May, New Jersey and Montauk Point, New York. Many of the fish were tilefish, an estimated 500 million of them (Collins, 1884).

The mass mortality of tilefish of the Middle Atlantic Bight was so complete that exploratory fishing trips over the succeeding five years failed to catch a single specimen, and scientists of that time considered it to have been extinct (Lucas, 1891). But 11 years after the disaster, several tilefish were caught proving that, indeed, they were not extinct and within 16 years catches indicated that tilefish were once again becoming abundant (Bumpus, 1899).

It is believed that the mass mortality of tilefish as well as other species of fishes and the rich fauna of invertebrates living in the narrow band of warm water lying along the edge of the continental shelf was due to a temporary offshore movement of normally cold shelf water. Since the warm-water band is not only bordered on its inshore edge by the cold shelf water but underlaid by cold water on its offshore edge as well, this displacement of bottom water from inshore to the edge of the shelf and beyond caused a sudden lowering of the temperature within this band trapping the fishes living there and causing the mortality (Verill, 1882). Although no temperature measurements were made during the mass mortality, those made the following summer showed that the bottom water was considerably colder than the previous years and that the rich, warm-water fauna that normally lived there was absent. It had been replaced by sparsely occurring cold-water organisms (Verrill, 1882).

2.4 Hybridization

No information available.

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

Tilefish as far as known is gonochoristic with no evidence of sexual dimorphism. It is evident, however, that females do not become as large as males. For example, after examining hundreds of specimens, we found that females weighed less than 12 kg (26 lbs.) and measured less than 86 cm (34 in.). The largest female we have examined weighed 15.5 kg (34 lbs.) and measured 99 cm (39 in.) while Bigelow and Welsh (1925) mention one of 16 kg ($35^{1}/2$ lbs.) that measured 108 cm ($42^{1}/2$ in.). Males commonly grow to 15-18 kg (33-40 lbs.) and 104-110 cm (41-$43^{1}/2$ in.), some even to 25 or 26 kg (55 or 58 lbs.) and 110-120 cm ($43^{1}/2$-47 in.). Although there has been no microscopic examination of gonadal material to settle the question of hermophroditism, it appears that females mature earlier in life than males resulting in an earlier slow down in growth. This could account for the relative scarcity of large females. Dooley (1974) suggests protogynous sex reversal in tilefish because of a disproportionate ratio of females to males, especially in specimens less than 90 cm ($35^{1}/2$ in.). He cites an observation in which 20 specimens ranging in length from 63.5 to 90 cm (25 to $35^{1}/2$ in.) were all females, while 16 specimens ranging from 90 to 109 cm ($35^{1}/2$ to 43 in.) were all males. Our data show a sex ratio of about 1:1 for immature fish, i.e., those measuring less than 70 cm ($27^{1}/2$ in.) (see 4.11). Also, a 1:1 sex ratio was found to be the case with 120 specimens ranging in length from 34 to 89 cm ($13^{1}/2$ to 35 in.) taken in the Gulf of Mexico off Texas (National Marine Fisheries Service, 1976). There have been no external distinguishing traits found to separate males and females.

3.12 Maturity

Morse (Ms.) found that female tilefish mature at about 70 cm ($27^{1}/2$ in.) and 4.3 kg ($9^{1}/2$ lbs.). After examining hundreds of specimens over a period of several years, we found the smallest mature female to measure 57 cm ($22^{1}/2$ in.) and weigh 3.0 kg ($6^{2}/3$ lbs.). During this same time, we have seen immature females of 67 cm ($26^{1}/2$ in.) and 4.7 kg ($10^{1}/4$ lbs.), and 71 cm (28 in.) and 4.7 kg ($10^{1}/4$ lbs.)

3.13 Mating

While mating has not been observed, it is believed to be promiscuous.

3.14 Fertilization

Fertilization is probably external.

3.15 Gonads

Morse (Ms.) estimates that a female tilefish produces from about two million to eight million eggs. He found that the number of eggs produced increased with the size of the fish, probably in a curvilinear relationship to the fish's weight. He estimates that from a half million to one million eggs are produced per kg of body weight. Morse gave the relation of gonad weight to body weight (x 100) of ripe females as ranging from about 1.2 to 5.5.

3.16 Spawning

It has been known ever since the discovery of the tilefish that it spawns during July (Collins, 1884). Some years later, running ripe females were taken in August (Bigelow and Schroeder, 1953). Dooley (1974) states that he observed ripe females in February, March, June and July. Whether or not these were running ripe fish he did not say. Morse (Ms.) reports ripe or running ripe females from March to August.

We have observed running ripe females throughout a seven month period, extending from mid-March to mid-September. Between October[3] and January, females are either seen spent or the ovaries are in the resting stage. During February, usually about the middle of the month, the ovaries of many females begin to enlarge very rapidly. The development is sufficiently rapid so that some females have running eggs by the second week in March. With time, progressively more females become ripe and a peak is reached during late May and June. Although Bigelow and Schroeder (1953) mention that eggs were running from 10 out of 11 females off New York on August 13, 1916, we have found that less than ten percent of the females have running eggs at that time. In general, we find progressively fewer females being ripe during July and August. By late August and early September, very few females are found to be ripe.

Morse (Ms.) found that the eggs fell in several size groups indicating that females spawn more than once during the spawning season, perhaps as many as three times.

The rather long spawning period covering more than half of the year is unusual for temperate-water fishes such as found off the Middle Atlantic coast. However, the temperature

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[3]A single ripe female was taken on October 14, 1971 from the Hudson Canyon area. This has been the only specimen we have seen later than mid-September in any stage except for spent or resting.

regime of the bottom water at the edge of the continental shelf where tilefish live is characteristic of subtropical conditions. And it is not at all uncommon for bottom dwelling fishes living under stable conditions within subtropical zones to have prolonged spawning periods.

3.17 Spawn

Eigenmann (1902) by a footnote in a paper on the conger eel (Conger oceanicus) first mentioned the ripe egg of a tilefish. Though he makes no mention, it was probably an unfertilized egg. He describes it as being 1.25 mm in diameter with a yolk of 1.09 mm and a yellow oil globule of 0.2 mm. Fahay (1971) collected ripe tilefish in August off New Jersey and artifically fertilized some eggs. Fertilization was successful and hatching was first observed in 40 hours and carried through to 60 hours. Eggs were held in ambient sea water which varied in temperature from 21.9° to 24.6°C (71° to 76°F). The spherical eggs were 1.16 to 1.25 mm in diameter, usually with a single oil globule of from 0.18 to 0.20 mm and a homogenous amber yolk of 1.09 mm. The shell was thin and colorless, it had reticulations which were visible under low (10x) magnification, and there was a moderate perivitelline space. The eggs were non-adhesive and appeared to be positively buoyant and pelagic. The specific gravity is not known.

3.2 Pre-Adult Phase

3.21 Embryonic Phase

Presently there is no information available, though study material is available from fertilization to hatching (see 3.17).

3.22 Larvae Phase

Presently there is no information available, though study material is available from hatching to one day old (see 3.17).

3.23 Adolescent Phase

No information available.

3.3 Adult Phase

3.31 Longevity

No information available.

3.32 Hardiness

See section 2.3.

3.33 Competitors

The information that exists on competitors of the tilefish comes almost entirely from rod and reel and longline catches. With few exceptions, once the tilefish grounds are located, nearly the entire catch is of this species. There are, however, several species of fishes occurring on the grounds, and while the tilefish is believed to be the top resident carnivore of its habitat, other fishes must certainly compete with it for food. These include the conger eel (Conger oceanicus), white hake and squirrel hake (Urophycis tenuis and U. chuss), armored searobin (Peristedion miniatum), goosefish (Lophius americanus), spiny dogfish (Squalus acanthias), dusky shark (Carcharhinus obscurus), sandbar shark (C. milberti), and tiger shark (Galeocerdo cuvieri).

The tilefish, as seen living along submarine canyons off southern New England and presumably throughout the rest of its range, frequent holes and burrows dug in the bottom. Since northern lobster do the same, it is quite conceivable that these two species compete for burrow space.

3.34 Predators

While small tilefish are sometimes preyed upon by spiny dogfish and conger eels, by far the most important predator of tilefish is other tilefish. It is not at all unusual to find small specimens in the stomach of large tilefish, indeed, quite a few of our smallest specimens have been taken this way. Nonetheless, large tilefish appear to be selective in the size of tilefish they eat, for we have never found any in their stomachs longer than 30 cm (12 in.), most being less than 20 cm (8 in.). At the same time, these large tilefish often have in their stomachs Atlantic mackerel (Scomber scombrus), sea herring (Clupea harengus), and silver hake (Merluccius sp.) measuring 35 cm (14 in.) and more.

It is also probable that large bottom-dwelling sharks of the genus Carcharhinus, especially the dusky and sandbar (C. obscurus) and C. milberti), prey upon free swimming tilefish. During the summer months, these species of sharks often attach tilefish that are hooked on long-lines and at times eat and mutilate enough of them to cause considerable loss to the fisherman. Blue sharks (Prionace glauca) and hammerhead sharks (Sphyrna sp.) at times attack tilefish as fishermen bring them to the surface, but these species of sharks when occurring at the edge of the continental shelf always seem to be at or near the surface. Thus, they probably are not natural predators of the bottom-dwelling fish.

The annual predation by man on tilefish larger than about 30 cm (12 in.) is nearly a million kg (2 million lbs.) (see 5.53).

3.35 Parasites, Disease, Injuries and Abnormalities

Linton (1901a, b) examined stomachs and intestines of several tilefish caught off southern New England and found them to contain cestodes, trematodes, nematodes and acanthocephala. We found upon examining nearly 150 specimens of tilefish taken at different times throughout the year that three quarters of them contained nematodes. The tilefish ranged in length from 35 cm (14 in.) to 105 cm (41 in.). And while nematodes were found in all size tilefish, their numbers generally increased as the size of the tilefish increased.

Tilefish are also parasitized by the sea lamprey (_Petromyzon marinus_). Infestation occurs mostly during late winter and spring and seems to be only by young lampreys, always by those measuring less than 30 cm (12 in.). The greatest infestation we know of occurred on February 12, 1974 when 15 tilefish, out of a catch of 470, had sea lampreys attached to their bodies or had open wounds recently caused by these parasites.

3.4 _Nutrition and Growth_

3.41 Feeding

Tilefish are primarily daytime feeders, the greatest amount of feeding probably being between 10 a.m. and 3 p.m. when light penetration to the bottom is the greatest and when they are the most active. Most, if not all, of the feeding is within 3 m (10 ft.) of the bottom (see 3.52). Equipped with both tearing and crushing teeth, tilefish are able to chase and capture fast swimming fishes, such as Atlantic mackerel, as well as slow moving ones and sessile organisms. Judging from tilefish caught on longlines and anglers' hooks, they feed even when running ripe. It seems that most tilefishes feeding is on fresh food, for fishermen's catches, or lack of them, show again and again that they often reject putrid bait.

3.42 Food

The examination of stomach and intestinal contents by various investigators reveal that the tilefish feeds on a great variety of food items, though mostly on crustaceans (Collins, 1884; Linton, 1901a, b; and Bigelow and Schroeder, 1953). Among those items identified by Linton (1901a, b) were several species of crabs, mollusks, annelid worms, sea cucumbers, anemones, tunicates and fish bones. To the list Bigelow and Schroeder (1953) added shrimp, sea urchins and several species of fishes.

Our observations support these early studies. After examining nearly 150 tilefish ranging in length from 29 cm to 105 cm ($11^1/2$ to $41^1/2$ in.) over the past several years, we found that crustaceans were the principal food items of tilefish. And that the squat lobster (Munida) and spider crabs (Euprognatha) were by far the most important crustaceans. Also, we found that small tilefish, i.e., those measuring less than 50 cm (20 in.) and weighing 3 kg ($6^1/2$ lbs.), feed more on mollusks and echinoderms than larger tilefish. But still, crustaceans were the most important food items regardless of the size of the tilefish. The presence of fish parts in all sizes of tilefish indicate that they are capable of capturing rapidly swimming organisms, though this ability progressively increases as the tilefish become larger. A list of food items of tilefish is found in Table 1.

Besides naturally occurring organisms, tilefish will seek out and devour nearly anything along the bottom that resembles their usual food, a habit that is similar to the one of cod, Gadus morhua. Several tilefish caught during an exploratory fishing trip in the late 1800's contained lamb-chop bones that had been disposed of overboard as garbage earlier in the day (Collins, 1884). More recently, potato peels had turned up in other specimens, the peelings too having been disposed of as garbage several hours earlier (Westcott, 1974, pers. comm.). And even a polished brass laundry pin measuring 15 cm (6 in.) was taken from a 16 kg (35 lb.) tilefish just several years ago (Freeman, unpub.).

3.43 Growth Rate

Other than the fact that progressively larger tilefish feed on prey having a relatively high nutritional conversion rate, i.e., thin-shelled crustaceans, squid, fish, opposed to bivalve mollusks and thick-shelled crustaceans, there is no other information available.

TABLE 1. Food items of tilefish (*Lopholatilus chamaeleonticeps*) occurring off the Middle Atlantic States

- SIPUNCULOIDEA (Peanut worms)
  - Unidentified
- MOLLUSCA (Mollusks)
  - Gastropoda (Univalve mollusks)
    - Unidentified
  - Pelecypoda = Bivalvia (Bivalve mollusks)
    - Protobranchia
      - Nuculanidae
        - *Naculana acuta*
    - Pteroconchidae
      - Mytilidae
        - *Musculus discors*
      - Pectinidae
        - *Cyclopecten nanus*
    - Eudesmodontida
      - Pandoridae
        - *Pandora inflata*
  - Cephalopoda (Squids, octopuses)
    - Unidentified
- ANNELIDA (segmented worms)
  - Polycheata (Sandworms, tube worms)
    - Eunicida
      - Lumbrinereidae
        - Unidentified
- ARTHROPODA (Joint-footed animals)
  - Crustacea (crabs, barnacles, lobsters)
    - Stomatopoda
      - Lysiosquillidae
        - *Heterosquilla armata*
    - Isopoda
      - Cirolanidae
        - *Cirolana polita*
      - Unidentified isopoda
    - Decapoda
      - Crangonidae
        - *Crangon septemspinosa*
      - Nephropsidae
        - *Homarus americanus*
      - Galatheidae
        - *Munida iris*
      - Paguridae
        - *Catapagurus sherreri*
      - Calappidae
        - *Acanthocarpus alexandri*
      - Majidae
        - *Euprognatha rastellifera*
        - *Callodes robustus*
      - Cancridae
        - *Cancer borealis*
        - *C. irroratus*
        - *C.* sp.
    - Unidentified decapoda
  - Unidentified crustacea
- ECHINODERMATA (Echinoderms)
  - Stelleroides = Asteroidea (Starfishes)
    - Unidentified
  - Ophiuroidea (Brittle stars)
    - Ophiurida
      - Amphiuridae
        - *Axiognathus squamata*
        - *Amphiura centiculata*
- CHORDATA (Chordates)
  - Tunicata = Urochordata (Tunicates)
    - Ascidiacea (Ascidians)
      - Unidentified ascidian
  - Agnathostomata
    - Agnatha (jawless fishes)
      - Myxinidae
        - *Myxine glutinosa* (Atlantic hagfish)
  - Gnathostomata (Jawed vertebrates)
    - Chondrichthyes (cartilaginous fishes)
      - Squalidae
        - *Squalus acanthias* - Spiny dogfish
    - Osteichthyes (bony fishes)
      - Clupeidae
        - *Brevoortia tyrannus* - Atlantic menhaden
        - *Clupea harengus* - Atlantic herring
      - Myctophidae
        - *Ceratoscopelus maderensis* - "Lantern fish"
      - Congridae
        - *Conger oceanicus* - Conger eel
      - Ophichtidae
        - *Omochelys cruentifer* - Snake eel
      - Gadidae
        - *Merluccius albidus* - Offshore hake
      - Serranidae
        - *Pronotogrammus aureorubens* - Streamer bass
      - Branchiostegidae
        - *Lopholatilus chamaeleonticeps* - Tilefish
      - Scombridae
        - *Scomber scombrus* - Atlantic mackerel
      - Scorpaenidae
        - *Helicolenus dactylapterus* - Blackbelly rosefish
      - Ammodytidae
        - *Ammodytes americanus* - American sand lance
      - Stromateidae
        - *Poronotus triacanthus* - Butterfish
      - Pleuronectidae
        - *Paralichthys oblongus* - Fourspot flounder
        - *Limanda ferrugnea* - Yellowtail flounder
      - Lophiidae
        - *Lophius americanus* - Goosefish

3.44 Metabolism

No information available.

3.5 Behavior

3.51 Migrations and Local Movements

It is very unlikely that tilefish migrate extensively. After the catastrophic fish kill in 1882 off the Middle Atlantic states, none were taken on formally productive grounds for more than ten years. If tilefish migrated to any extent, certainly some of those still living to the north or to the south would have repopulated this area, even if only sparsely. But apparently this was not the case (Bumpus, 1899). The largest size specimens (6 kg, 13 lbs.) which were included in the very first catch made after the catastrophic kill, could very well have grown to that size in the intervening 11 years, even if the growth rate is as slow as we believe (see 4.12). Further, the fact that the first few catches consisted to a large extent of immature fish, i.e., less than 70 cm (27 1/2 in.), indicate that repopulation of the area was mostly by local reproduction.

The pattern of fishermen's catches and the retrieval of broken fishing hooks used in one particular area turning up in another area several miles, indicates there is some local movement. This movement, however, seems to be restricted to a rate of only a mile or two a day.

A dozen or so tilefish ranging in length from 30 cm to 43 cm (12 to 17 in.) and judged in good physical condition were tagged and released in the Hudson Canyon area during March of 1973. No recoveries have as yet been made.

3.52 Schooling

Nearly all of what we know about the habits and behavior of tilefish comes from commercial and recreational catches made during the last seven years. From the patterns of these catches and from a few diver observations, we can say with reasonable certainty that tilefish do not school in such a way as do cod. Rather, tilefish seem to occur in clusters or pods, often with similar-size fish occurring in close association; dissimilar-size ones more spread out. As usually happens when fishing lines from a drifting boat, several fish are caught in succession, then a lull, then several more fish, etc. When fishing longlines, there are often three or four fish, then five or ten empty hooks, another few fish, more empty hooks, etc.

Divers have observed tilefish living in clusters along the heads and sides of submarine canyons. When seen during the day, they swam slowly about the bottom or remained motionless, often in association with various obstructions, such as large stones or lobster pots. When frightened, they would almost inevitably swim very rapidly into nearby burrows (Cooper, 1974). It may be the location and abundance of these burrows that governs the clustering of the tilefish. Yet they move en masse from one area to another, for good catches made during one day in a certain area may be very poor the next, and conversely, poor catches made one day in an area may be very good the next.

Very few species of fishes or invertebrates are caught with tilefish. In fact, if fishermen catch any quantity of other species of fish, for example, hake (Urophycis sp.), when looking for new tilefish grounds, they immediately know that they are either in too shoal or too deep water for tilefish.

As indicated by their food items (see 3.4) and what is known from fishing for them, tilefish occur close along the sea floor. A line fished straight down to the bottom with hooks placed at two foot intervals caught 95 percent of the tilefish on the bottom hook, and none were caught higher than ten feet off the bottom (Puskas, 1973). Bigelow and Schroeder (1953) state that "The presence of pelagic amphipods (Euthemisto) and of salpae in the stomach of tilefish caught on longlines proves that they sometimes feed at higher levels---." Kane (1966) states that Parathemisto (Euthemisto) are found to depths of at least 200 m and Verrill (1881) states that a large species of salpae occurs commonly close to the bottom. Thus, the conclusion drawn by Bigelow and Schroeder does not necessarily follow, based upon what we now know of the habits of these invertebrates.

3.53 Respones to Stimuli

Catches made during daylight compared to those made at night indicate that tilefish are day active. Otter-trawl, long-line, and rod-and-reel fishing at night yield very few tilefish. Catches during daylight hours increase with the amount of sunlight, the best being made between 10 a.m. and 3 p.m., when the sun is at its highest position (Puskas, 1974; and Westcott, 1974). It is assumed that daytime activity is indicative of feeding activity.

Mention has already been made of the response of tilefish to temperature (see 2.3).

4. POPULATION

4.1 Structure

4.11 Sex Ratio

Bigelow and Schroeder (1953) give a sex ratio of 1 male to 29 females in a sample of 39 fish they examined. Dooley (1974) speaks of a sample of 36 fish in which 20 were males (all measured 90 cm in length or more) and 16 were females (all measured less than 90 cm in length). A sample of 120 tilefish from off the Louisiana and Texas coast taken by the research ship Oregon II showed the sex ratio of 1:1 (United States Department of Commerce, 1976). These specimens ranged in length from 34 to 89 cm ($13^1/2$ to 35 in.), with 75 percent of them measuring from 40 to 50 cm (16 to 20 in.). We have found in a sample of 111 immature tilefish, i.e., those measuring less than 70 cm ($27^1/2$ in.), that there were 58 males and 53 females, a sex ratio very nearly 1:1. These fish were collected over several years and during all seasons (see 3.11). And while the sex ratio of individual samples of these immature fish was quite variable, that of mature fish, i.e., those longer than 70 cm ($27^1/2$ in.), was even more so. Some catches are heavily dominated by males in a ratio of 20:1; others nearly equal, 1:1; still others dominated by females, 3:1. It seems the only generalization to be made is that catches dominated by large size fish, i.e., those measuring more than 90 cm ($35^1/2$ in.), always have a sex ratio weighted heavily in favor of males.

4.12 Age Composition

Very little is known about the age composition of tilefish. Bigelow and Schroeder (1953), after examining several specimens, suggest that the usual length of one year of age is about 11 cm ($4^1/2$ in.). The specimens they examined ranged in length from 6.5 to 11 cm ($2^1/2$ to $4^1/2$ in.) and were captured during April and July.

Although the existence of an annual growth mark has not yet been verified, what we believe to be such a mark is discernible on otoliths and on those scales that we find not to be regenerated[4]. If this is a true annulus, then the following

[4]After looking at scales from scores of tilefish ranging in length from 13 cm to over 100 cm (5 to $39^1/2$ in.) we found most of them to be regenerated. Specimens as small as 13 to 18 cm (5 to 7 in.) often have as many as 70 percent of their scales regenerated. The large number of damaged scales from small size fish as well as large ones strongly supports the contention that tilefish commonly rub against obstacles and live in burrows along the bottom.

should hold true: a 10.5 cm (4 in.) fish is likely to be 1 year old; a 34 cm (13 1/2 in.) fish, 5 years; a 56 cm (22 in.) fish, 10 years; a 70 cm (28 in.) fish, 15 years; an 81 cm (32 in.) fish, 20 years; a 91 cm (36 in.) fish, 25 years; and a 96 cm (38 in.) fish, 30 years. Thus, a mature fish would be expected to be 13 years old or older, and many of the largest fish of 110 to 125 cm (43 to 47 in.) would be 40 years old or older.

4.13 Size Composition

What is known about the size composition of tilefish is derived almost entirely from longline and rod-and-reel catches, the principal methods of capturing them. Their length-weight relationship is seen in Figure 3. One of the most interesting aspects of the population structure of these fishes occurring off the Middle Atlantic states is the rather large average size, between 74 and 89 cm (29 and 35 in.) and 6.4 and 11 kg (14 and 24 lbs.). And it is reasonable to assume that this is a biological phenomenon, not an artifact of the fishing gear, for tilefish as small as 42 cm (16 1/2 in.)[5] and 1 kg (2 1/4 lbs.) are as likely to take a baited hook as others to 120 cm (47 in.) and 26 kg (58 lbs.)[6]. There is, however, a different average size between those fish caught on a still bait, as on a longline, and on a moving bait, as from a drifting boat. Tilefish caught on a longline average from 4.5 to 8.2 kg (10 to 18 lbs.) while those caught by anglers from a drifting boat from 7 to 12 kg (15 to 26 lbs.). Apparently, a bait moving along the bottom will be attacked more aggressively by larger fish.

The average size of tilefish from the Gulf of Mexico by longline fishing is between 2 and 3 kg (4 1/2 to 6 lbs.) (Nelson and Carpenter, 1968; and U. S. Department of Commerce, 1976). Those caught off northeastern South America averaged about 6 kg (13 lbs.) (Wolf, 1974).

When tilefish were fished by otter trawls off the Middle Atlantic states during the 1950's and 1960's, their average weight fluctuated between 4.1 and 9.5 kg (9 and 21 lbs.)

---

[5]Tilefish as small as 15 cm (6 in.) have been taken on baited hooks.

[6]There is some size selectivity for large fish. Certain areas known to have high numbers of small tilefish are often avoided by longline fishermen because they bring a lower price in the market.

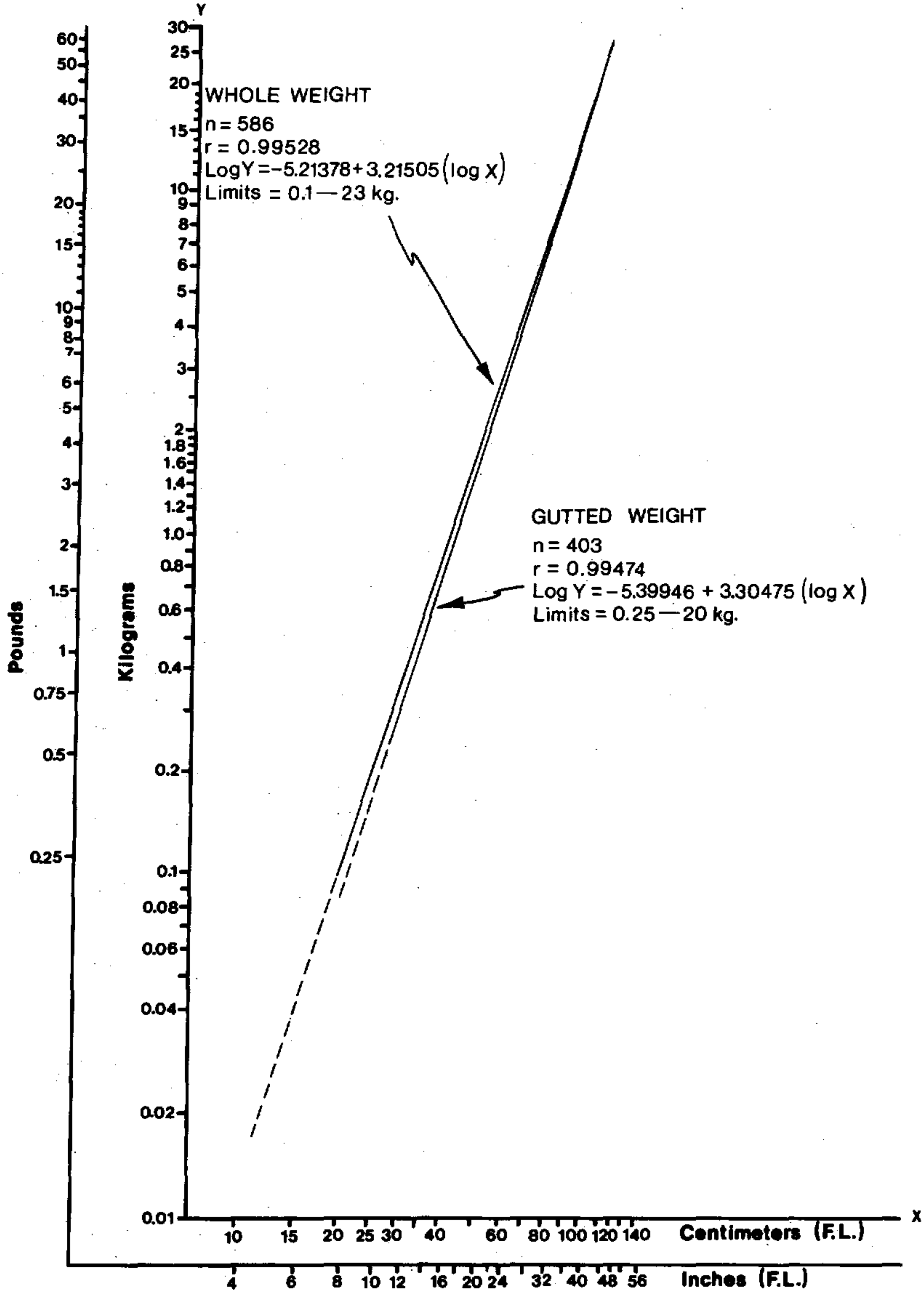

Figure 3. Length-weight relationship of tilefish, (*Lopholatilus chamaeleonticeps*), caught off the Middle Atlantic and New England states between 1971 and 1976.

(Westcott, 1974). Even the outer trawls having a mesh size small enough to retain small specimens, less than 10 percent of the catch were as small as 2.7 kg (6 lbs.).

Mature tilefish, i.e., those larger than 70 cm ($27^{1}/2$ in.) and 4.8 kg ($10^{1}/2$ lbs.), occur from the shallowest to the deepest depths over its range (see 2.2), while immature ones, especially those smaller than 19 cm ($7^{1}/2$ in.), tend to occur in depths from 82 to 128 m (270 to 420 ft.), and again in depths from 200 to 238 m (660 to 780 ft.).

4.2 Abundance and Density

4.21 Average Abundance

While the tilefish appears to be the most abundant fish species occurring along the bottom of the outer edge of the continental shelf, there have never been any studies to determine its population size. From fishing accounts during the early 1900's, Bigelow and Schroeder (1953) estimated that there was a potential supply of two or three million pounds a year off southern New England and the Middle Atlantic states.

4.22 Changes in Abundance

For changes in abundance because of change in the water temperature, see 2.3.

4.23 Average Density

Very little is known concerning the density of tilefish. As already mentioned in section 3.52, tilefish occur in clusters or pods, these being distributed over the grounds, probably in areas having a suitable bottom type. How many individual tilefish occur in each cluster is not known, nor do we have very much information as to how often or how far they move. During a six month period within an isolated 4.8 by 4.8 km (3 by 3 mile) area, some 5,000 tilefish were caught amounting to 36,400 kg (80,000 lbs.). This was a newly discovered area at the time and fished only by one boat (Puskas, 1974). But whether these fish were ones living only in this area or those which had immigrated there over the six months is not known.

4.24 Changes in Density

While there is considerable variation in the amount of fish in an area with time, it cannot be correlated with season.

A particular area may yield good catches for a week or two, then suddenly yield very poor ones. It may continue yielding poor catches for some time, then quite suddenly yield very good ones once again.

Generally, it can be said that large fish tend to occur in deeper depths than smaller fish, but we have seen so many times when the largest specimens were taken in depths of 115 to 135 m (378 to 444 ft.) that this generalization must be used cautiously. Townsend (1915) mentions a catch of 816 tilefish weighing 5,000 kg (11,000 lbs.) in which most of the large specimens were caught in mostly depths of 113 m (370 ft.), while the small specimens were in depths of 183 m (600 ft.) or more. It appears that various size fish tend to gather in certain areas (see 3.52).

4.3 Natality and Recruitment

4.31 Reproduction Rates

4.3.1

No information available.

4.32 Factors Affecting Reproduction

While we know that tilefish feed heavily on various invertebrate species found in the relatively warm, narrow band at the edge of the continental shelf, and that many of the invertebrate species occur only in this band, whether or not the tilefish could reproduce or even survive were their food to disappear, it is not known. And other than that fact that we know cannibalism occurs among tilefishes, very little else can be said concerning factors that may affect reproduction.

4.33 Recruitment

No information available.

4.4 Mortality and Morbidity

4.41 Mortality Rates

No information available.

4.42 Factors Causing or Affecting Mortality

Some of the causes of mortality in tilefish have already been discussed (see 2.3 and 3.35). Except for the catastrophic event in 1882 in which cold water probably moved over the edge of the continental shelf and caused a mass mortality of the various aquatic organisms living there, man seems to be the most important predator.

4.5 Dynamics of Population

No information available.

4.6 The Population in the Community and the Ecosystem

Tilefish occupy a narrow band of relatively warm water along the edge of the continental shelf. Within this band the physical properties of the bottom water remain very stable enabling the existence of a warm-water community that is isolated both from a cold-water community inshore and offshore of it. Although tilefish is the top carnivore in the food web of this warm-water community, it depends for its food mostly on species occurring only within the warm band (see 3.42).

5. EXPLOITATION

5.1 Fishing Categories

Tilefish are sought both by commercial and recreational fishermen. Commercial fishermen annually catch from four to six times as much fish by weight as recreational fishermen, 1,140,000 kg (2,500,000 lbs.) compared to 242,000 kg (532,000 lbs.). Commercial fishermen catch some ten times as many fish by numbers as recreationalist, 250,000 compared to 25,000. The value of the catch to commercial fishermen is about a million dollars, while it is half that for recreationalist (see 5.53).

5.11 History of the Commercial Fishery

A commercial fishery for tilefish was initiated in October of 1915, mainly through the efforts of the U. S. Bureau of Fisheries who undertook a massive public campaign to popularize this species as an excellent food (Smith, 1917). The program was immediately successful and tilefish plentiful enough so that dory schooners out of New York setting longlines (Figure 4) along the bottom caught nearly two million kg (4.4 million lbs.) during the first eight months of this new fishery. Moreover, during the first calendar year of fishing, nearly four and a half million kg (10 million lbs.) were landed (Table 2), but for some reason, perhaps because of the low price of cod and haddock at the time, the price of tilefish did not hold up, and this caused fishing to fall off (Bigelow and Welsh, 1925).

TABLE 2. Landings of tilefish in thousands of pounds, and value in thousands of dollars, 1915-1976[1]

Year	MA		RI		CT		NY		NJ		Wash., D.C.		VA		East Coast FL		TOTAL	
	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$
1915	-[2]	-	-	-	-	-	327	-	<1	<1	-	-	-	-	-	-	327	(<1)[3]
1916	873	24	-	-	-	-	9,050	-	-	-	-	-	-	-	-	-	9,923	(25)
1917	1,211	45	-	-	-	-	1,481	101	257	17	-	-	-	-	-	-	2,949	162
1918	299	20	-	-	-	-	-	-	-	-	12	-	-	-	0[4]	-	347	(23)
1919	188	10	0	0	0	0	-	-	-	-	14	-	-	-	-	-	203	(10)
1920	0	0	-	-	-	-	-	-	-	-	11	-	-	-	-	-	11	-
1921	-	-	-	-	-	-	1,133	77	0	0	21	-	-	-	-	-	1,154	(77)
1922	-	-	-	-	-	-	1,153	-	-	-	5	-	-	-	-	-	1,158	-
1923	-	-	-	-	-	-	1,364	-	-	-	10	-	-	-	-	-	1,374	-
1924	38	3	0	0	200	14	1,262	-	-	-	4	-	-	-	-	-	1,504	(17)
1925	-	-	-	-	0	-	1,015	-	-	-	10	-	-	-	-	-	1,017	-
1926	-	-	-	-	13	1	1,975	-	0	0	7	-	-	-	-	-	1,992	(<1)
1927	-	-	-	-	-	-	2,777	-	-	-	-	-	-	-	-	-	2,787	-
1928	-	-	-	-	-	-	2,365	-	-	-	-	-	-	-	-	-	2,372	-
1929	305	19	0	0	1,672	85	2,644	115	0	0	-	-	-	-	-	-	4,620	219
1930	0	-	0	0	1,783	97	2,312	88	0	0	-	-	-	-	-	-	4,096	185
1931	0	-	0	0	1,637	65	1,021	30	0	0	-	-	-	-	-	-	2,658	95
1932	0	-	0	0	249	11	1,870	50	0	0	-	-	-	-	-	-	2,119	61
1933	0	-	0	0	207	10	1,350	68	<1	<1	-	-	-	-	-	-	1,517	78
1934	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1935	1	<1	0	0	160	8	2,494	94	<1	<1	-	-	-	-	-	-	2,655	102
1936	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1937	16	1	0	0	0	0	2,390	102	<1	<1	-	-	-	-	-	-	2,427	103
1938	367	14	0	0	0	0	808	24	<1	<1	-	-	-	-	-	-	1,175	39
1939	260	13	0	0	0	0	626	25	0	0	-	-	-	-	-	-	886	37
1940	9	<1	0	0	0	0	584	35	0	0	-	-	1	<1	-	-	593	35
1941	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1942	-	-	-	-	-	-	136	11	0	0	-	-	-	-	-	-	136	11
1943	-	-	-	-	-	-	17	3	<1	<1	-	-	-	-	-	-	17	3
1944	27	1	0	0	0	0	18	2	4	<1	-	-	1	<1	-	-	48	4
1945	56	4	0	0	0	0	27	2	2	<1	-	-	3	<1	-	-	88	7
1946	75	4	2	<1	54	4	153	16	-	-	-	-	1	<1	-	-	285	25
1947	53	3	2	<1	126	11	187	18	53	3	-	-	1	<1	-	-	422	35
1948	251	19	6	<1	140	12	563	56	53	6	-	-	12	<1	1	1	1,025	94
1949	201	14	33	2	38	3	914	66	49	3	-	-	3	<1	-	-	1,284	89
1950	955	51	201	10	45	3	1,047	85	111	6	-	-	44	4	-	-	2,401	158
1951	1,130	96	454	37	131	11	447	39	96	7	-	-	16	1	-	-	2,274	193
1952	984	85	447	48	218	24	377	38	90	6	-	-	10	<1	-	-	2,125	202
1953	2,117	182	650	47	117	6	212	26	75	6	-	-	2	<1	-	-	3,173	268
1954	1,881	145	1,067	67	34	2	399	28	105	7	-	-	2	<1	-	-	3,488	250
1955	1,926	152	1,181	79	67	5	309	24	104	6	-	-	6	<1	-	-	3,592	266
1956	837	110	493	52	2	<1	175	23	49	5	-	-	4	<1	-	-	1,559	191
1957	240	36	144	21	0	0	123	14	41	5	-	-	8	1	-	-	556	77
1958	1,093	96	214	19	0	0	89	12	82	6	-	-	3	<1	0	0	1,481	113
1959	394	58	335	44	0	0	66	10	26	3	-	-	16	1	0	0	837	115
1960	1,193	65	1,019	69	0	0	78	9	45	2	-	-	11	1	-	-	2,346	146
1961	357	37	284	24	<1	<1	102	13	82	6	-	-	29	3	-	-	855	82
1962	61	8	68	7	0	0	125	15	92	7	-	-	26	3	0	0	642	39
1963	93	13	101	11	0	0	28	4	31	3	-	-	14	1	0	0	267	32
1964	226	19	935	57	<1	<1	82	8	67	4	-	-	3	<1	0	0	1,314	89
1965	234	20	1,053	63	0	0	45	5	18	1	-	-	4	1	<1	<1	1,354	89
1966	28	2	806	90	3	<1	121	17	6	1	-	-	<1	<1	<1	<1	965	110
1967	4	1	60	9	0	0	18	2	18	2	-	-	11	1	<1	<1	111	15
1968	3	<1	50	8	0	0	6	1	7	1	-	-	<1	<1	4	<1	70	11
1969	4	<1	29	6	0	0	10	1	23	3	-	-	1	<1	5	1	72	11
1970	16	2	79	17	-	-	7	1	21	4	-	-	3	<1	6	1	134	25
1971	1	<1	46	8	-	-	55	4	33	5	-	-	3	<1	9	1	146	19
1972	4	<1	6	1	-	-	12	2	244	78	-	-	<1	<1	4	<1	270	83
1973	112	25	38	14	0	0	7	1	711	234	-	-	<1	1	35	13	873	306
1974	358	90	47	14	-	-	49	22	838	263	-	-	0	0	87	31	1,380	421
1975	383	103	222	59	-	-	5	1	956	361	-	-	0	0	147	57	1,713	581
1976	468	112	123	30	-	-	50	20	1,583	725	-	-	0	0	(200)[5]	(74)	2,224	961

[1]Although only states with important landings and Washington, D. C., are included here, the totals are the sums of all states and Washington, D. C.
[2]The information is not available.
[3]Parentheses indicates that the total value applies only to a portion of the yearly landing.
[4]Tilefish are listed in the catch statistics, but none are reported as landed.
[5]Estimated for 1976.

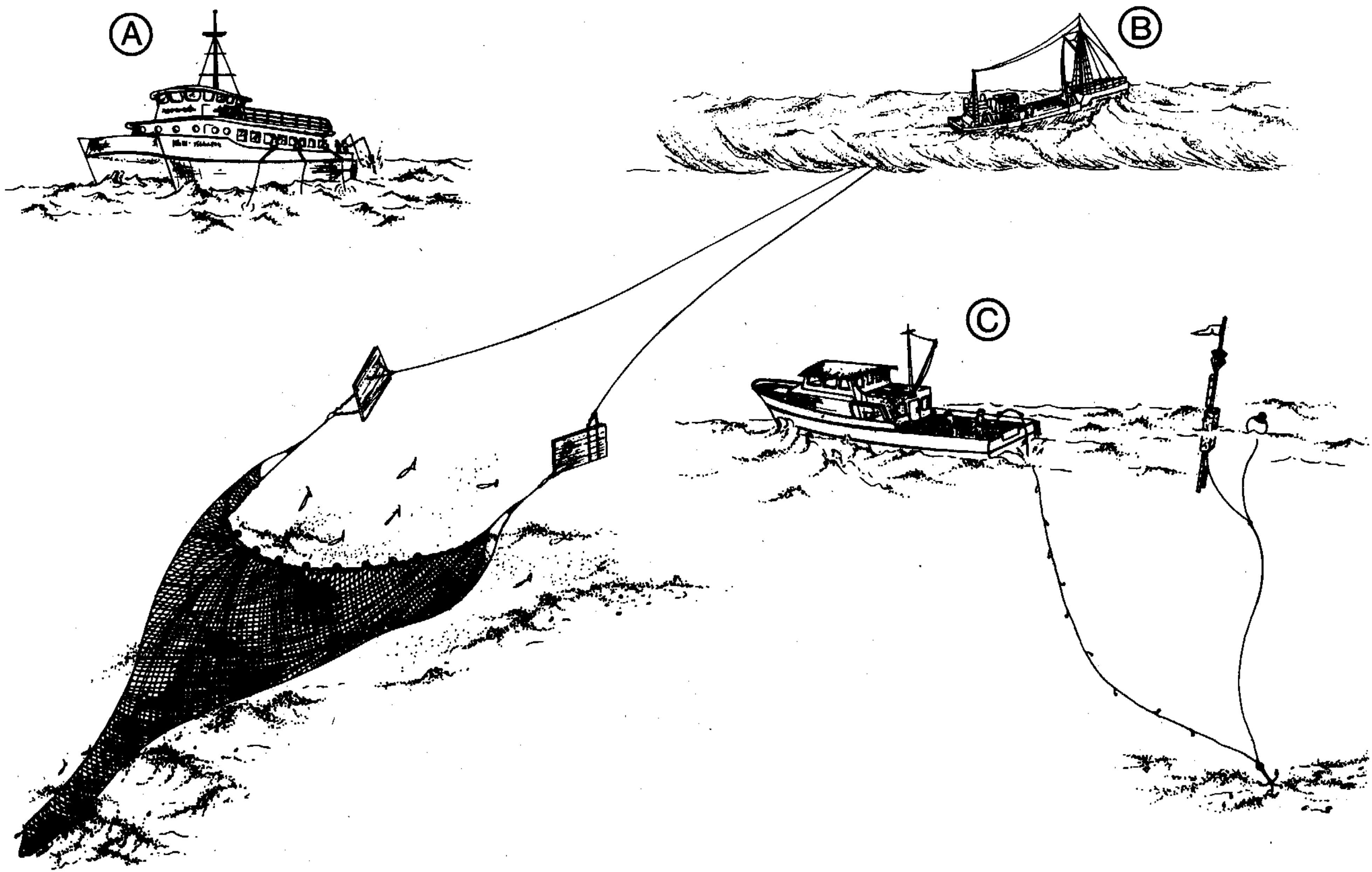

Figure 4. Various types of fishing gear used to capture tilefish, *Lopholatilus chamaeleonticeps*. A. recreational fishermen using rod and reel, B. commercial fishermen using an otter trawl, and C. commercial fishermen using a longline.

By 1921, the price of tilefish had risen again and for the next 17 years it remained high. During that time, the catch was between 455,000 and 2,273,000 kg (1 million and 5 million lbs.). Then another decline in the fishery, this time for nine years, and once again it was the market conditions that dictated the amount of fishing that was done and not the abundance of tilefish. The end of naval hostilities and the need for large amounts of protein following the end of World War II stimulated longlining for tilefish and the fishery flourished once more.

During the late 1940's, otter trawls (Figure 4) were first used for tilefishing. A few enterprising fishermen from southern Massachusetts and Rhode Island began using medium-sized draggers of about 90 net tons to catch tilefish and during the next few years otter trawls replaced longlines almost entirely (Figure 5). Then, nearly all of the fishing was east and north of Block Canyon. Poor prices in the market and increased competition for the available fish on the southern New England grounds from foreign vessels led more and more fishermen away from tilefishing so that by the late 1960's tilefish were taken only incidentally with other, more sought after species of fishes.

In the early winter of 1971, a New Jersey fishermen exploring grounds in the Hudson Canyon area succeeded in catching tilefish with a longline set from a small boat (20 m). His success in using rather inexpensive fishing gear and a small crew quickly prompted others to try this type of fishing. Many of the boats that entered the winter fishery were party and charter boats that would normally be laid-up for want of customers at that time of year. Presently, a few boats that tilefish the year round account for most of the catch, even though more than 20 boats fish during the winter months when commercial fishing for other kinds of fishes is at its lowest point and tilefish prices are at their highest. Winter fishing is carried on by boats sailing from various ports stretching from Chatham, Massachusetts to Sea Isle City, New Jersey.

During the past few years, a tilefishery has begun along the southeastern coast of Florida. Tilefish is caught along with various groupers and snappers by boats using wire lines and electric reels (Porter, 1976). Prior to this fishery, a few hundred kg were landed each year incidental to snapper catches.

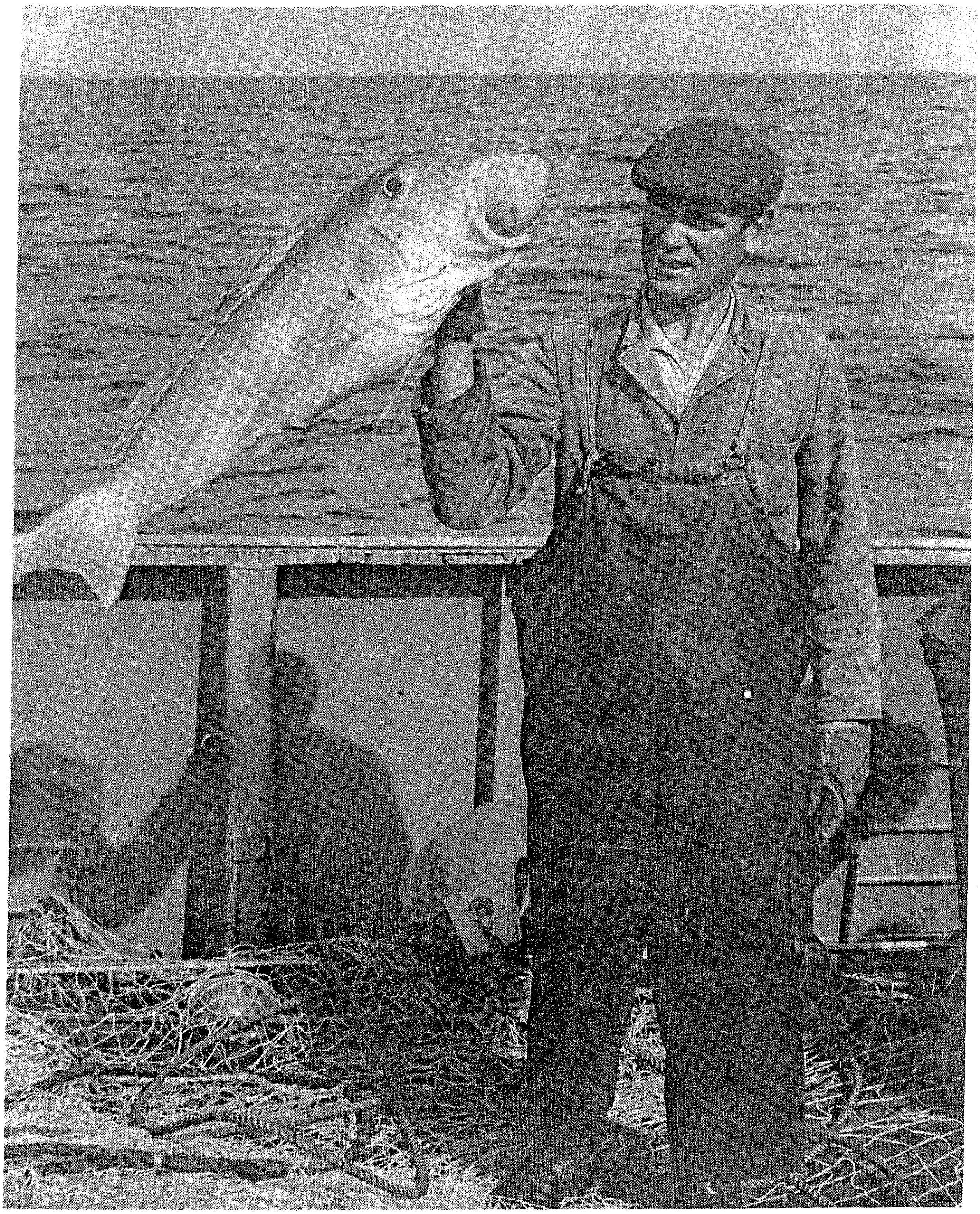

Figure 5. A large (95 cm) tilefish taken by an otter trawl off southern New England. The air bladder extending out of the mouth, i.e., poke blown, is the usual condition of the fish when brought to the surface.

5.12 History of the Recreational Fishery

During the fall of 1902, several men sailing out of Stonington, Connecticut, on a pleasure yacht fished the Block Canyon area (see Figure 8) and caught tilefish. At first they used handlines and caught fish as fast as the bait reached bottom. Later, they used a short piece of longline and also caught a number of tilefish. These men had sailed offshore to verify information on the whereabouts and the abundance of tilefish and the fish they caught were given away (Smith, 1905).

The next record of tilefish being caught for recreation or sport was more than 60 years later, in the summer of 1963. The catch was made in the Hudson Canyon area off New Jersey when five anglers caught over 140 kg (300 lbs.) in less than a half hour of fishing (Dixon, 1974). Except for a few more catches that year and the next, it remained until 1969 before another tilefish was caught by recreational fishermen. Then, a party boat sailing some 90 miles out of Atlantic City, New Jersey, by chance fished a spot along the edge of the continental shelf and caught several specimens. This unusual catch at the time led other party and charter boat captains to try for tilefish (Figures 4 and 6). Within less than a year, scores of boats were fishing out of ports along a stretch of coast from eastern Long Island in New York to Atlantic City in New Jersey. Each year sees more and more boats from as far north as Massachusetts and as far south as Maryland, many of them large private boats, making the necessary 200-mile-round trip to the tilefish grounds.

5.2 Fishing Equipment

5.21 Gears

A longline set along the bottom is the most important gear now used for catching tilefish (Figure 4). It is usually carried loose coiled in large baskets or tubs, one tub holding about a km (1/2 mile) of mainline (Figure 7). Every 4.6 m (15 ft.) or so, shore branchlines, called snoods, are tied to the mainline, thus giving 400 hooks each 1.6 km (1 mile). The length of a snood is usually 0.4 m (18 in.), somewhat shorter than the length between where it and the next one is tied to the mainline, thus preventing the hooks from fouling each other. This longline gear, locally called "gear" is nearly identical with that used for cod (*Gadus morhua*) fishing. And it was this kind of fishing equipment that was first used to catch tilefish in the late 1800's as well as during the succeeding 70 years.

Figure 6. Tilefish caught from a party boat fishing the Hudson Canyon area off New Jersey.

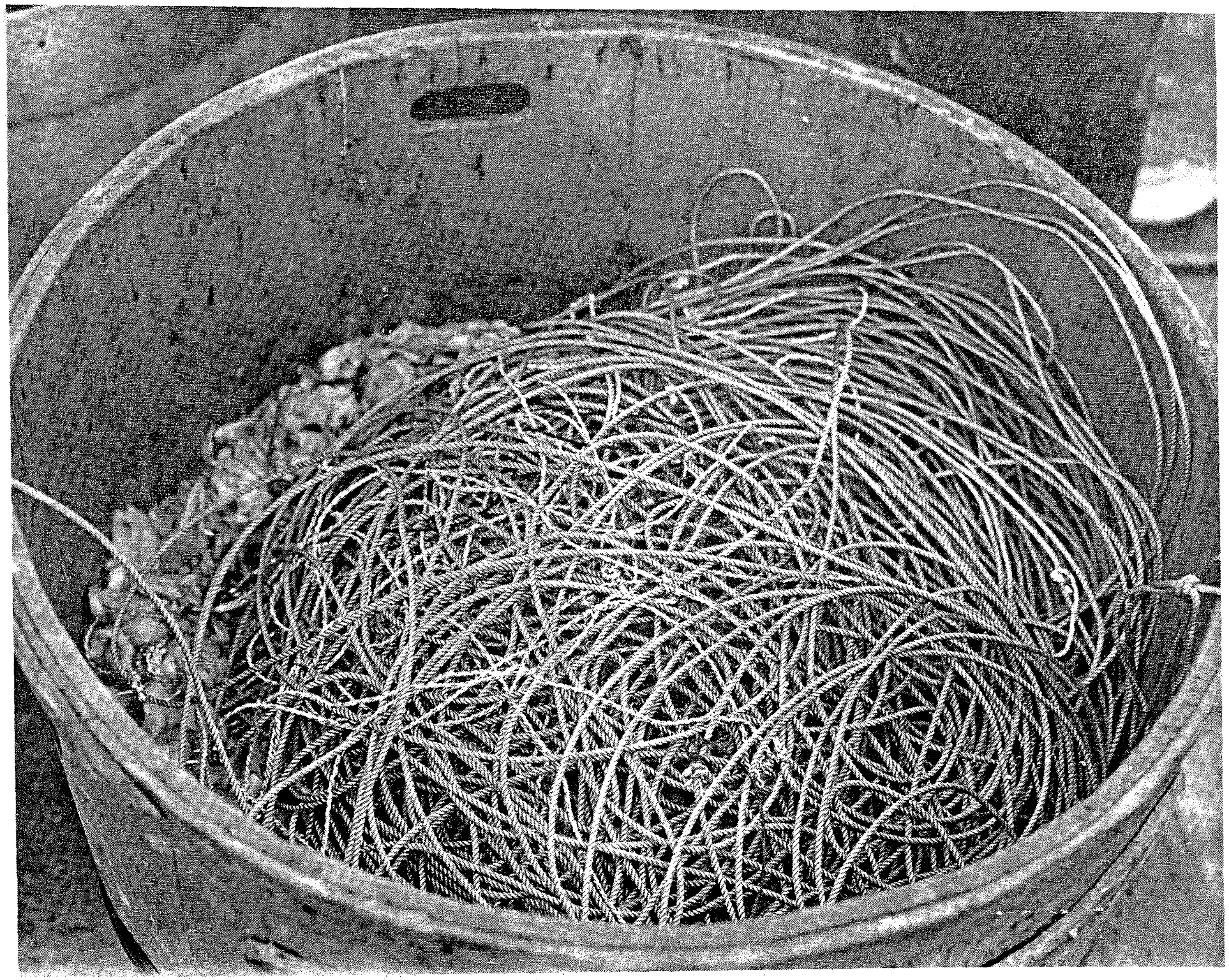

Figure 7. A baited tub of loose coiled longline ready to be set. Each such tub is about one km (one-half mile) long and contains some 200 baited hooks.

Incidental catches of tilefish are made using otter trawls, usually by fishermen dragging offshore for lobster (*Homarus americanus*) or for summer flounder (*Paralichthys dentatus*). As has already been mentioned, there was an otter trawl fishery for tilefish during a 17-year period beginning about 1949 (see 5.11). Various shape and size nets and otter-doors have been used successfully. The most useful nets, however, are those with a heavy foot rope that digs into the bottom and with a long belly that prevents the inflated, i.e., poke blown, fish from spilling out of the net's mouth when hauling back (Westcott, 1973). And it is only those areas having a relatively flat and firm bottom that can be fished with otter trawls. Precluded are bottoms composed of soft mud or are rough and with obstructions, i.e., those commonly frequented by tilefish. Otter trawls equipped with rollers only occasionally catch tilefish.

Electric snapper reels equipped with wire lines are used by commercial fishermen along the southeastern coast and in the Gulf of Mexico.

Conventional rod and reel and some electric reels mounted on conventional rods are used by recreational fishermen.

5.22 Boats

From the beginning of the commercial fishery in 1915 and for the following 30 years, the dory schooner was the principal vessel for tilefishing. These were of wood construction, ranged in length from 27 to 33 m (90 to 110 ft.) and carried up to 20 dories. These were replaced in the late 1940's by medium-size New England draggers. These were of wood construction, 18 to 30 m (60 to 100 ft.) in length and powered by a diesel engine. The longline boats fishing during the last seven years are of either wood or metal (steel or aluminum) construction, 15 to 27 m (50 to 90 ft.) in length, and powered by diesel engine.

Recreational fishing boats are of wood, metal or fiberglass construction, 15 to 37 m (50 to 120 ft.) in length, and powered by diesel or gasoline engines. Some of these boats are twin hulls (catamaran), though most are of a single hull.

5.3 Fishing Areas

5.31 General Geographic Distribution

The commercial fishery along the east coast of the United States is centered in two locations, off southern New England, New York and New Jersey; and off southeastern

Florida (Figure 8). The northern grounds are by far the most important, accounting for 96 percent of the catch. There the fishing is carried on in the area from just north of Veatch Canyon to just south of Hudson Canyon. The southern grounds are located off southeastern Florida from about Melbourne to Miami.

Recreational fishing covers a more extensive area than commercial fishing. It occurs in three geographic areas as follows: from Block Canyon to Baltimore Canyon, from off Cape Fear, North Carolina to Jacksonville, Florida, and from off Vero Beach to Miami, Florida. The greatest majority of the fish are caught in the northern grounds, mostly off New Jersey and New York.

5.32 Geographic and Depth Range along the East Coast

Tilefish range along the outer part of the continental shelf and the upper part of the continental slope from the Scotian Shelf (44°26'N lat., 57°13'W long.) to southern Florida (24°30'N lat., 81°0'W long.). The distance from shore varies with the configuration of the shelf and ranges from 24 to 149 km (15 to 90 miles). Within this area, tilefish are caught along the bottom in depths from 82 to 439 m (270 to 1,440 ft.), but mostly in 110 to 238 m (360 to 780 ft.) (see 2.1).

5.4 Fishing Seasons

Tilefishing is carried on year round by commercial fishermen. At the northern grounds it is carried on from spring to fall by recreational fishermen; on the southern grounds, mostly in late winter and spring. There seems to be no difference in catch rates throughout the year, only that strong winds and the adverse weather of winter preclude fishing by anglers in the north and the abundance of more desirable fishes arriving in the south cause tilefishing there to fall off.

5.5 Fishing Operations and Results

5.51 Effort and Intensity

Most of what we know about fishing effort is restricted to the last seven years or so. Within that time, the total effort by the commercial boats has increased considerably. Both the average number of hooks set each trip and the trip length have increased at least threefold. Nonetheless, there has been no large detectable change in the catch rate.

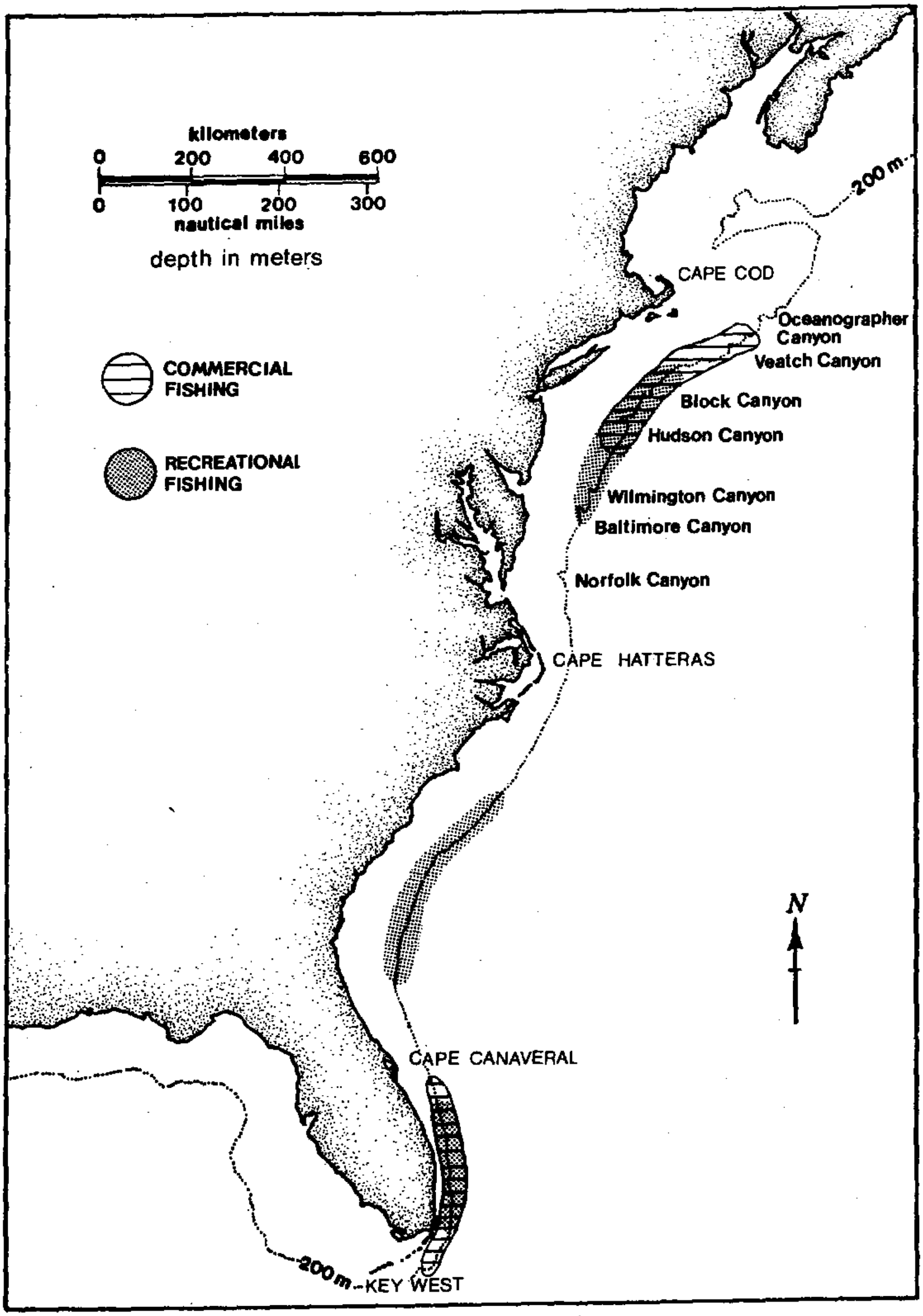

Figure 8. Fishing areas for tilefish (Lopholatilus chamaeleonticeps) along the east coast of the United States.

Catch rates usually range from 0.04 to 0.28 kg per hook hour (0.10 to 0.61 lbs/hook hr.)[7].

The effort and intensity of fishing by recreational fishermen has decreased by a third since a high point during the 1972-73 season. This decline is due mainly to the high price of fuel for the boats. The catch rate for anglers has remained about the same at 1.2 to 5.4 kg/hook hour (2.6 to 12 lbs/hook hr.). The high rate of catch per unit of effort for anglers compared to commercial men can be explained by the fact that their hooks are being drifted along the bottom and the probability of catching a fish is much greater than for a still bait.

5.52 Selectivity

Because of the tilefish's large mouth and its aggressive behavior, hook selectivity is of little consequence in fish larger than 42 cm (16 1/2 in.) and 1 kg (2.2 lbs.). Commercial fishermen, if at all possible, try not to catch specimens as small as 42 cm for they are paid a lower price for them. However, except for a few locations where the small ones are known to congregate, the fishermen never know the size of the fish they are catching until they are brought to the surface.

5.53 Catches

The annual tilefish catch for commercial fishermen is about 1,140,000 kg (2,500,000 lbs.) and for anglers 242,000 kg (532,000 lbs.) (Table 2). More than 90 percent of the total annual catch (1,000,000 kg or 2,200,000 lbs.) comes from the northern grounds.

6. PROTECTION AND MANAGEMENT

6.1 Regulatory Measures

There is insufficient biological data to determine what, if any, regulatory measures are necessary for tilefish. It seems that if any measures are deemed necessary, those fish living north of Cape Hatteras, North Carolina should be managed separately from those living south of this cape. Moreover, those living in the Gulf of Mexico may need to be managed separately from those living off South America.

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[7]A fishing trip made by the U. S. Fish Commission in 1902 had longline catches that ranged from 0.27 to 0.35 kg per hook hour (0.59 to 0.77 lbs/hook hr.) (Smith, 1905). This trip was to grounds known to contain tilefish but not fished for over 20 years. Thus, these catch rates can be considered to be very high for longlines.

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