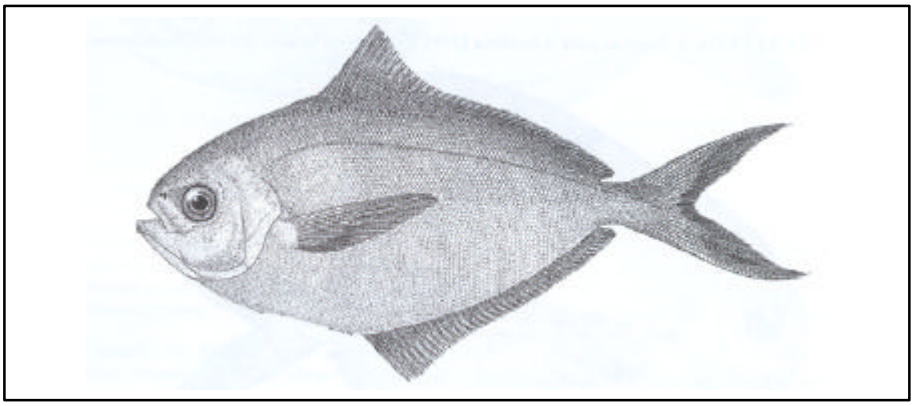
BUTTERFISH / ***Peprilus triacanthus*** **(Peck 1804)** / Bigelow and Schroeder 1953:363-367 **(as *Poronotus triacanthus)***



Description. Body very thin and deep, only about twice as long as deep to base of caudal fin (Fig. 282). Head short; snout blunt. Mouth small, terminal, with weak teeth. Dorsal fin single, long, soft-rayed, originating close behind axils of pectoral fins, tapering at first abruptly and then gradually backward. Anal fin almost as long as dorsal, narrowing evenly from front to rear. A very short forward-pointing spine close in front of dorsal fin and three very short spines almost wholly embedded in skin in front of anal fin, first of which points forward. Both dorsal and anal fins extend posteriorly almost to caudal base. Pectoral fins long and pointed. Caudal fin deeply forked; caudal peduncle short, slender, without keels. Scales very small, cycloid, and easily detached. A row of conspicuous pores below anterior half of dorsal fm. Lateral line high on sides, slightly arched.

Meristics. Dorsal fin rays II-IV; 40--48; anal fin rays III, 37-44; pectoral fm rays 17-22; gill rakers 22-25; lateral line scales 96-105; vertebrae3Q-33 (Horn 1970).

Color. Leaden bluish above and pale on the sides, with numerous irregular dark spots that fade after death. Belly silvery.

Size. Reaches about 30.5 cm (Hildebrand and Schroeder 1928); average length is 15-23 cm.

Distinctions. Absence of pelvic fins in adults separates them from jacks; lack of obvious dorsal spines distinguishes them from scup and John Dory. They are easily distinguishable from harvestfish by the much lower dorsal and anal fins and the presence of pores along the back.

Habits. Butterfish show a decided preference for sandy rather than rocky or muddy bottoms. General experience is that butterfish keep near the surface over depths of 22-55 m during their stay near the coast. They often come close inshore, where schools are frequently seen on shallow flats, sheltered bays, and estuaries. They appear to spend winter and early spring near bottom in depths down to 183 m. They are eurythermal and euryhaline, tolerating temperatures of 4.4°-21.6°C (Fritz 1965; Schaefer 1967; Horn 1970) and salinities from 5 ppt to full-strength seawater (Musick 1972). They travel in small bands or loose schools. Draggers reported catching several times as many by night as by day, whereas NEFSC survey results indicated that day catches were higher (Waring 1975).

Food. Identifiable stomach contents of 852 butterfish (Bowman et al. 2000) showed a predominance of urochordates (29% by weight: Larvacea 14%, Ascidacea 9.2%, and Thaliacea 4.8%) and thecosome mollusks (18.6%, mosdy *Clione).* Minor food items included cnidarians; ctenophores; chaetognaths; polychaetes (mainly Tomopteridae); and crustaceans such as amphipods, copepods, mysids, and euphausiids (Fritz 1965; Horn 1970; Bowman and Michaels 1984; Bowman et al. 1987, 2000).

A ctenophore, *Mnemiopsil' leidyi,* has been shown to be an important component of the diet of butterfish juveniles in Narragansett Bay; R.I., and feeding behavior of butterfish on ctenophores was observed in the laboratory (Oviatt and Kremer 1977). They fed both day and night and their usual mode was to bite at the ctenophores until they were consumed, rather than ingesting them whole. Night feeding may be facilitated by florescence of the ctenophores. Consumption of ctenophores by butterfish was 8.2 mg carbon.g dry wt-l.h-l (Oviatt and Kremer 1977). Basal respiration rate of juvenile butterfish has been calculated as 0.2 mg *Oig* wet wt-l.h-l.

Predators. Butterfish are preyed upon by 30 species of fishes and squids (Rountree 1999). They form an important part of the diet of a number of commercially important fishes, including haddock, silver hake, swordfish, bluefish, weakfish, and summer flounder (Horn 1970; Rountree 1999); goosefish and hammerhead shark (Maurer and Bowman 1975; Armstrong et al. 1996); as well as longfin squid (Tibbetts 1977; Rountree 1999).

Parasites. Butterfish are infected by a monogenetic trematode, *Microstyle poronoti* and a digenetic trematode, *Lepidapedon elongatum* (Murawski et al. 1978).

Breeding Habits. Butterfish begin to mature in their second summer (age I) at about 180 mm SL (Horn 1970) and are fully recruited by their third summer (age 2) (DuPaul and McEachran 1973). Median length at maturity for female and male butterfish was 120 and 114 mm, respectively, and median age at maturity was 0.9 year for both sexes (O'Brien et al. 1993). They are reported to be broadcast spawners with no special courtship behavior (Horn 1970), although no direct observations of spawning have been made. There is no information on fecundity. They spawn once a year.
Spawning occurs primarily in the early evening (Ferraro 1980) in late spring and summer, with most activity in June and July (O'Brien et

al. 1993; Berrien and Sibunka 1999). Butterfish eggs were collected by MARMAP surveys from April to September (Berrien and Sibunka 1999: Fig. 19). As the season advances and water temperatures rise, spawning proceeds shoreward in a south to north progression extending onto Georges Bank and into the Gulf of Maine (Murawski et al. 1978; Berrien and Sibunka 1999); it probably does not take place below 15°C (Colton 1972). Spawning in the Gulf of Maine begins in June, soon after the butterfish arrive; the height of the reproductive season is in July; and maximum egg concentrations occur in August (Berrien and Sibunka 1999). On the Scotian Shelf, spawning occurs from July to October (Markle and Frost 1985).

Early Life History. Butterfish eggs are buoyant, transparent, spherical, 0.68-0.84 mm in diameter, usually with a single oil globule of about 0.17-0.21 mm (Markle and Frost 1985; Able and Fahay 1998). In newly spawned eggs, there may be two globules that coalesce as development advances. The yolk is homogeneous and unpigmented, and the perivitelline space is narrow. Butterfish eggs resemble those of red hake and fourbeard rockling, but have unpigmented yolks, whereas the two other species show dark pigment on the yolk. Scup eggs are very similar to those of butterfish but are larger, 0.85- 1.15 mm (Elliott and Jimenez 1981). The incubation period is about 48 h at 18°C and 72 h at an average temperature of 14.6°C (Colton and Honey 1963).
MARMAP surveys made from 1977 to 1984 from Cape Hatteras, N.C., to Cape Sable, N.S., showed that butterfish larvae ranked l0th of the 19 numerically dominant species collected in the Gulf of Maine and 18th out of 20 collected on Georges Bank. They were most abundant from July through October (Morse et al. 1987). Larvae are about 1.68-1.75 mm TL at hatching and are characterized shortly after by their short, deep form, their 30 myomeres, and the row of black spots along the ventral edge in the postanal region. The oil globule is at the posterior end of the yolk. The vent, located some distance from the posterior end of the yolk sac a little more than halfway down the body; opens at the finfold margin (Colton and Honey 1963). Butterfish larvae resemble those of scup, but the latter have more closely spaced melanophores in the ventral row of pigment (Colton and Marak 1969). Dorsal, anal, and caudal fin rays are visible in larvae of 6 mm, when the body has already begun to assume the deep, thin form characteristic of adults. At a length of 15 mm, the caudal fin is deeply forked, the dorsal and anal fins are formed, and the little fish resembles an adult sufficiently well for ready identification. A detailed description of larval development is given by Ditty and Truesdale (1983).
During the first summer young butterfish often live in the shelter of large jellyfishes and Goode graphically described larvae of 50-65 mm as swimming among the tentacles of the red jellyfish *(Cyanea),* sometimes ten to fifteen little fish under one jellyfish, where they find protection from predators but to which they sometimes fall prey. This association, however, is not essential to their welfare, for larvae are often seen living independently at the surface, particularly in sheltered bays west and south of Cape Cod. They end their association with jellyfish by about 60 mm and assume the adult schooling behavior.

Age and Growth. The maximum age reported for butterfish is 6 years (Draganik and Zukowski 1966); the typical life span is probably 2-3 years. Fish sampled from waters of the Gulf of Maine to Cape Fear show two types of otolith growth patterns (Dery 1989c), although they are not always clearly differentiated. The offshore pattern is characteristic of butterfish sampled in waters deeper than 27 m. These are predominant in survey and commercial catches and exhibit more clearly defined annular zones. Checks may be prominent but can be distinguished from annular zones and do not normally complicate age determination. The inshore type of otolith growth pattern is characteristic of specimens collected at depths of less than 27 m, especially from the New York Bight to Cape Fear. These are often difficult to age. The pattern has numerous checks and diffuse annuli, and the otoliths are often poorly calcified. The fish most difficult to age are those that occur in shallow waters off Maryland, south to Cape Fear. Age-length curves have been published for fish from southern New England (Waring 1975); the York River, Va. (DuPaul and McEachran 1973); and ICNAF Subarea 5 and Statistical Area 6 off the northwest Atlantic (Kawahara 1978). Otoliths examined by Waring (1975) and Kawahara (1978) exhibited the offshore pattern and are most typical of fish found in the Gulf of Maine.
Butterfish grow to about half their adult size in their first year. There is a difference in growth between those spawned early in the year and those that hatch later. Modal sizes were June, 0-4 mm,July-August 0-4 and 5-9 mm, September 15-19 and 35-39 mm, and October 70-74 mm (Perlmutter 1939). Larval growth rates of 0.23 mm.day-l for fish up to 30 mm have been reported, based on analyses of otolith increments (Rotunno 1992). Estimates for length-at-age of butterfish are given in Fig. 283 (Penttila et al. 1989).

General Range. Atlantic coast of North America from off South Carolina and coastal North Carolina waters to the outer coast of Nova Scotia and Cape Breton; northward as a stray to the Gulf of St. Lawrence and to the south and east coasts of Newfoundland; southward to Florida in deep water.

Occurrence in the Gulf of Maine. Butterfish are regular summer visitors to the Gulf of Maine, locally abundant along the shores of Massachusetts off Barnstable, Plymouth, and Essex counties; less common along the coast of Maine (Map 33). They are also common in some years along the Nova Scotian coast of the Gulf but they appear only irregularly and in small numbers on the New Brunswick shore of the Bay of Fundy, although they have been taken frequently in Passamaquoddy Bay.
Butterfish also appear in the Nantucket Shoals region and on Georges Bank in summer, often in large numbers. They occur off the coast of Nova Scotia in St. Margaret Bay and Halifax Harbor in summer and autumn, and are said to be common eastward as far as Canso. This appears to be the normal limit to their range, for only strays have been taken in the Gulf of St. Lawrence and on the Newfoundland coast.

Migrations. Butterfish north of Cape Hatteras display definite migratory patterns in response to water temperature (Colton 1972). Summer movements are both inshore and northward (Horn 1970; Fritz 1965). South of Cape Hatteras, there is no inshore-offshore migration (Caldwell1961; Horn 1970).
Butterfish are warm-season fish in the Gulf of Maine. They may appear off Rhode Island by the last half of April and at Woods Hole by the middle of May, although they are not plentiful in the Woods

Hole region until June. It is likely that these early comers move in across the shelf from offshore, rather than following along the coast. They occur on Georges Bank in early June, but it is not until the end of that month or early in July that they are plentiful anywhere north of the elbow of Cape Cod. From that time on they are found in the *inner* parts of the Gulf and on Georges Bank throughout the late " summer and autumn. They are exceedingly irregular and unpredictable in their appearances and disappearances. Most leave the Gulf by November, but they all vanish from the coast by the end of December at the latest, not only from the Gulf, but also from the more southerly part of their range. They, overwinter along the 183-m contour off the continental shelf, but the offshore movement is not so extensive south of Delaware Bay and there is apparently some movement to the south j in shallower waters (Waring and Murawski 1982).

Importance. Bigelow and Schroeder described butterfish as one of the best table fish: fat, oily, and delicious. They were often used to enrich land in planting during the first half of the nineteenth century; and appreciation of the fact that they were too good for this use was a later development.

Butterfish have been landed by domestic fishermen since the 1800s. From 1920 to 1962, the annual domestic harvest averaged 3,500 mt (Overholtz 1998a). An historical summer of catches in Massachusetts is given in Bigelow and Schroeder and for New England from 1880 to 1965 in Murawski et al. (1978). In the 1960s distant-water fleets began to exploit butterfish and landings peaked in 1973 at 19,500 mt (Murawski and Waring 1979; Fig. 284). Following the phase-out of foreign fishing, annual landings declined and since 1985 have averaged less than 5,000 mt.year-l (Fig. 284). The commercial catch is made mostly (98%) by otter trawl. Butterfish and longfin squid *(Loligo pealei)* exhibit high degrees of overlap in temperature and depth preferences but seasonal and areal management measures could result in significant reductions of the by-catch of either species if this becomes desirable (Lange and Waring 1992). Other gears used are pound nets, gill nets, floating traps, and purse seines.

Butterfish are managed by the Mid-Atlantic Fishery Management Council under provisions of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. Demand for butterfish for export to the Japanese market has decreased and overall it appears that the butterfish stock is underexploited and at a medium abundance level (Overholtz 1998a).

Stocks. The population of butterfish from Cape Hatteras to the Gulf of Maine is considered to be a unit stock for management purposes (Overholtz 1998a). Meristic and morphometric studies indicate two separate stocks south of Cape Hatteras, which appear to be depth-isolated (Caldwel11961; Horn 1970). The inshore population occurs to depths of 20 m from Cape Hatteras south to Florida. The deeper water form is shallower-bodied with 18 or 19 caudal vertebrae and spots. The inshore form is deeper-bodied with 17 or 18 caudal vertebrae and no spots. There appears to be a certain amount of genetic mixing but not enough to group them as a single stock.

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