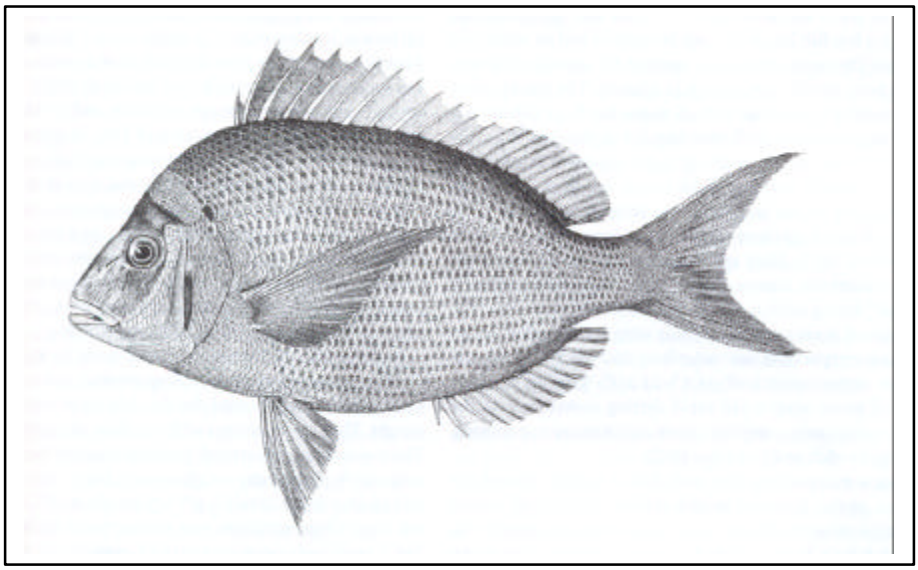
SCUP / ***Stenotomus chrysops* (Linnaeus 1766)** / Porgy / Bigelow and Schroeder 1953:411-416 (as *Stenotomus versicolor)*



Description. Body ovate-elliptical, about half as deep as long, laterally compressed (Fig. 233). Mouth small. Teeth small, narrow elliptical, almost conical; molars in two rows. Eyes situated high up on side of head. Margins of gill covers rounded. One long dorsal fin originating over pectoral fins, preceded by a forward-pointing spine; spiny and soft parts of fin continuous. Dorsal fin moderately high, first spine much shorter than others, rear corner rounded; fin fits in groove along midline of back. Anal fin under soft portion of dorsal fin nearly as long as soft part of dorsal, almost even in height from front to rear, but with first spine shorter than others. Anal fin depressible in conspicuous groove, like dorsal. Pectoral fins very long, reaching to below soft part of dorsal fin, sharply pointed, with slightly concave lower rear margins. Pelvic fins situated below pectorals, moderate-sized. Caudal fin deeply concave with sharp corners. Lateral line complete, slightly arched. Scales large, firmly attached.

Meristics. Dorsal fin rays XII, 12; anal fin rays III, 11 or 12; lateralline scales 46-55; gill rakers 12-20; vertebrae 10 precaudal + 14 caudal (Miller and Jorgenson 1973).

Color. Dull silvery and iridescent, somewhat darker above than below; sides and back with 12-15 indistinct longitudinal stripes, flecked with light blue, with a light blue streak following the base of the dorsal fin. Head silvery, marked with irregular dusky blotches; belly white. Dorsal, caudal, and anal fins dusky, flecked with blue; pectoral fins of a brownish tinge; pelvics white and bluish, and very slightly dusky; iris silvery; pupil black. Live fish can display black, vertical blotched bands along midbody:

Distinctions. Scup are easily recognizable by the fact that the spiny portion of the dorsal fin is considerably longer and higher than the soft-rayed portion, which, with its deeply lunate caudal fin, separates them from all other Gulf of Maine fishes of similarly deep and compressed bodies. They differ from butterfish in that the dorsal profile of the rather short head is slightly concave instead of convex and the scales are rather large, thick, and firmly attached, rather than small, thin, and easily detached as in butterfish. Small teeth and lunate pointed tail separate scup from their closest local relative, sheepshead.

Size. Scup reach a maximum length of about 40 cm (Gabriel 1998). The all-tackle world record scup, 2.06 kg, was caught in Nantucket Sound in June 1992 (IGFA 2001).

Habits. Scup occur from 2 to 180 m and are rarely caught any deeper. During their summer stay inshore, they tend to hug the coast so closely that a line drawn 8-10 km beyond the outermost headlands would probably enclose the great majority of the total population at that time of year. They occur inshore in spring and summer and move offshore in fall. Scup are inshore from early April at the mouth of Chesapeake Bay and from early May northward to southern Massachusetts. Most of them withdraw from the coast late in October, although a few fish linger through November and an occasional one into December even as far north as the vicinity of Woods Hole. Scup usually congregate in schools. The young come close to land in less than 1 m of water, but large fish are seldom caught in water shallower than 2-4 m (occasionally at the surface) or deeper than 27-36 m in summer. They prefer smooth to rocky bottom, which results in a very local distribution. They appear to avoid water temperatures below 7°C and are found in greatest abundance at temperatures of 13°- 16°C (Fritz 1965). They are so sensitive to low temperatures that considerable numbers (both large ones and small) have perished during sudden cold spells in shallow water. The critical thermal maximum for juvenile scup is dependent on acclimation temperature and varies from 30.2° to 35.6°C at acclimation temperatures of 14.8°-22.2°C. During extreme thermal stress, scup make rapid darting movements to the surface, experience complete loss of equilibrium, stop moving, and die (Everich and Gonzalez 1977).

Scup are schooling fish and, based on the pound net catches, probably school by size (Morse 1978). They appear to school more closely at night. Catch records showed that most fish have been collected near midnight and the fewest around noon (Fritz 1965). Steady swimming in schools is powered by a combination of red and pink muscles (Coughlin and Rome 1996, 1999). Pink muscle is used to augment red muscle power production at higher swimming speeds,

allowing a higher aerobically based steady swimming speed than is possible using red muscle alone.
Scup produce sound in response to electrical stimulation and when kept together in tanks, but not when solitary: The sounds, which have been described as guttural grunts, knocks, and stridulatory rasping, are probably produced by the simple thin-walled swim bladder and the upper and lower incisors (Fish and Mowbray 1970).

Food. Scup are bottom feeders, seldom rising far above the bottom, preying on cnidarians, squids, polychaetes, crustaceans, and fishes (Maurer and Bowman 1975; Bowman and Michaels 1984; Bowman et al. 2000). Smaller scup, up to 25 cm TL, eat a larger proportion of cnidarians, polychaetes, amphipods, and mysids, whereas larger scup (over 26 cm TL) consume more squids and fishes. Fish prey include *Ammodytes dubius* and butterfish (Bowman et al. 2000). Adult scup, as many other fishes, may cease feeding during spawning time, although there is a rod-and-reel fishery for spawning scup in May in Vineyard Sounl\ \). Galoraith, pers. comm., A.pril1994).
Juvenile scup in Narragansett Bay feed on polychaetes, mysids and other crustaceans, mollusks, and fish eggs and larvae (Michaelman 1988). Polychaetes and crustacea made up more than 50% of the diet by dry weight and averaged 88% of the identifiable seasonal diet. Crustaceans made up 41% and polychaetes 47% of the diet during the summer. Fish larvae accounted for 6-19% of the diet in August. Important species consumed were *Nephtys, Nereis, Pherusa affinis* (polychaetes); *Leptochirus* (amphipod); *Neomysis* (mysid shrimp), and *Cerianthiopsis* (coelenterate). Juvenile scup collected in MidAtlantic and southern New England coastal waters on groundfish surveys ate similar food (Bowman et al. 1987). They were divided into two size-groups, 6-10 cm and 11-15 cm. Both groups fed on polychaetes (31 and 32%, respectively). The scup measuring 6-10 cm ate amphipods (16% net weight); decapods (10%), mainly *Cancer irroratus;* mysids (9%), mainly *Neomysis americana,* and copepods. Larger scup ate mollusks (18%), mainly squids; amphipods (6%), and decapods (2%). Food habits of scup on the outer continental shelf (Sedberry 1983), were similar: amphipods and polychaetes were the two major components of the diet, with amphipods decreasing in importance with size and polychaetes increasing.
Juvenile scup in Narragansett Bay were daytime feeders. Feeding energetics of juvenile scup (average wet weight 67 g) fed *Crangon* shrimp showed that the daily ration was 3.99% dry weight. They ate an average of 5% of their wet weight per day. The exponential estimate of gastric evacuation rate (stomach contents in percent dry weight) was 0.34.h-l. The metabolic rate of scup was 0.23 mI °2.g-1 wet weight at 20°C for 1-year- old scup. Their metabolic expenditure was 1.86 dry weight. day-l, and their estimated rate of growth was 0.84% dry weight.day-l (Michaelman 1988).

Predators. Scup are eaten by elasmobranchs and bony fishes throughout their range, including 19 species, of which the three most frequent predators are spiny dogfish, smooth dogfish, and bluefish (Rountree 1999).

Parasites. The parasitic branchiuran *Argulus intectus* has been found on scup (Yamaguti 1963).

Breeding Habits. Median length at maturity is 15.5 cm and 15.6 cm for females and males, respectively (O'Brien et al. 1993). Male and female scup mature at age 2 (Finkelstein 1969b), corresponding to a length of about 16 cm (Finkelstein 1969a). Maturity is complete by age 3 at 21 cm TL (Gabriel 1998). Scup spawn once a year in coastal waters from May to August, with the peak during May and June (O'Brien et al. 1993). They spawn close to shore during daylight hours, usually in the morning (Ferraro 1980), and at temperatures of 10°-18°C on the bottom and 13°-23°C at the surface (Wheatland 1956). It appears that spawning does not occur over the continental shelf, as MARMAP surveys from 1977 to 1987 collected only 14 larvae from three stations near the mouth of Narragansett Bay (Able and Fahay 1998). Mean fecundity of scup 17.5-23.0 crn FL is about 7,000 eggs (Gray 1990).
Scup eggs are buoyant, transparent, spherical, and rather small, 0.85-1.15 mm average diameter (Wheatland 1956). pigmentation appears on the embryo at the 15- to 20-myomere stage as black and yellow spots scattered sparsely over the embryo and oil globule. As hatching time approaches, yellow chromatophores aggregate to form heavily pigmented areas (Hildebrand and Schroeder 1928). Eggs resemble those of silver hake, windowpane flounder, and fourspot flounder, but the oil globule is much smaller, and the pigmentation on the embryo and oil globule is sparse, whereas it is heavier and darker on hake (Colton and Marak 1969). Pigmentation is also heavier and darker on windowpane embryos. The fourspot egg is a bit larger with a mean size of 1.04 mm. Incubation occupies only 70-75 h at 18°C, 44-54 h at 21°C (Griswold and McKenney 1984), and 40 h at 22°C (probably 2-3 days in the June temperatures of Massachusetts Bay), judging from the spawning season at Woods Hole. It is not likely that development can proceed normally in water colder than about 10°C. At hatching larvae are about 2 mm long, the eyes are not pigmented, and the mouth is not functional. The head projects slightly beyond the anterior end of the yolk sac, the oil globule is in the posterior end. The larvae have a small group of melanophores scattered over the dorsal and dorsolateral part of the body There are small areas of yellow pigment on the dorsal and lateral part of the head, above the vent, and opposite the vent dorsally; a transverse band halfway from the vent to the posterior end of the body extends from the base of the pelvic finfold onto the dorsal finfold. There are black and yellow chromatophores on the oil globule (Kuntz and Radcliffe 1917).
The yolk is fully absorbed within 3 days at 18°C, when the larva is about 2.8 mm long, and there is then a characteristic row of black pigment spots along the ventral margin of the trunk. Fin rays first appear at 2.9 mm SL in the pectoral fin, at 4.3 mm in the caudal fin, at 5.5 mm in the dorsal and anal fins, and at 8.8 mm in the pelvic fin. The full complement of fin rays is present by 14 mm SL. The dorsal row of preopercular spines was first noted at 4.1 mm and increased gradually until they formed a serrate edge at 16.9 mm. Ossification begins in the skull at 6.1 mm and is completed by 18-19 mm, except for some sutures in the skull. Scales first appear between 9.9 and 10.8 mm, and larvae are completely scaly by 12.3-13 mm (Griswold and McKenney 1984). Larval pigmentation consists of a small group of melanophores over the dorsal area of the head, the dorsolateral aspects of the body along the myotomes, and on the oil globule. After yolk-sac absorption, the pigment pattern changes. There are a few areas of pigment on the head and lateral trunk, a conspicuous spot on the anterior edge of the vent, and a series of pigment spots along the ventral region of the tail. Pigmentation increases on the trunk and then turns into a barred pattern characteristic of the juveniles by 18.7-19 mm (Colton and Marak 1969; Griswold and McKenney 1984). At

25 mm, the pectoral fins assume their pointed outline and the caudal fin is slightly forked, but the pelvic fins are still very small and the body very slender.
Length-weight relationships of larval scup reared in the laboratory were determined by Laurence (1979). In southern
New England waters, juveniles of 5.1-7.6 cm, evidently the product of that season's spawning, have been taken in September; they are 6.4-8.3 cm long in October and may be as long as 10.1 cm at Woods Hole in November. Apparently young scup grow very little during the winter, for many of 10.1 cm are seen in the spring, probably the crop of the preceding season.

Age and Growth. Finkelstein (1969a) investigated growth of scup in Long Island waters using fish-length to scale-length relationships. He determined the von Bertalanffy growth functions by sex, where length is FL in mm: $Lt = 342.5(1 - e^{-0.Z688(tn + 0.40531)})$ for males; $Lt = 374.1(1 - e^{-0.ZZ47(tn + 0.47047ry}$ for females.
Scup live for 13-20 years (Finkelstein 1969b; Hamer 1970; Gabriel 1998). Smith and Norcross (1968) had difficulty aging fish older than 2 years. Length-at-age data are given in Penttila et al. (1989) (Fig. 234).

General Range. Scup live in the western North Atlantic, from Sable Island Bank, N.S., to Cape Hat teras, N.C., but are infrequent north of Cape Cod (Scott and Scott 1988).

Occurrence in the Gulf of Maine. Although scup are among the most familiar shore fishes right up to the elbow of Cape Cod, few find their way past Monomoy Point into the colder waters of the Gulf of Maine. Massachusetts Bay records are from Rockport, Swampscott, and Cohasset Narrows (Collette and HarteI1988). Northern records are from Eastport, Maine; St. Mary's Bay, St. Margaret Bay, and Sable Island Bank, N.S.; and the St. Croix River estuary and Murr Ledges, south of Grand Manan, Bay of Fundy, N.B. (Leim and Scott 1966; Scott and Scott 1988).
The first definite mention of scup caught north of Cape Cod is Storers statement that one was taken at Nahant in 1835, and another in 1836, but that they had never been seen there before. Possibly these and one picked up dead at Cohasset in 1833 were survivors of a smack load that had been liberated in Boston Harbor a year or two earlier, and a similar plant was made in Plymouth Bay in 1834 or 1835. There is no reason to suppose that these planted fish established themselves.
When the practice of setting mackerel nets outside Provincetown Harbor was first adopted (about 1842), a few scup were taken in them from year to year. Fish were caught in Cape Cod Bay yearly and between Boston and Cape Ann during the period from 1860 to 1867; a number were taken in a weir on Milk Island near Gloucester in 1878. There were a few scup in northern Massachusetts waters in most years (or terms of years) down to the first decade or so of the twentieth century; alternating with other years (or terms of years) when only an occasional fish was taken.
The cataclysmic shrinkage that took place in the stock of scup off southern Massachusetts between 1896 (prior to which the annual catch had usually run from 1 to 3 million lb) and 1902 (when it fell to only about one-tenth as much) appears to
have involved scup in Cape Cod Bay as well for none was reported there from 1907 through 1911 or from 1918 to 1920, but there was an unusually large run there in 1917. However, 1908, 1909, and 1919 were good scup years for the north shore of Massachusetts-good, that is, for those northerly waters, suggesting that when conditions are favorable, a small independent population may be present there. Perhaps the fact that larger catches than usual are not always registered in both these regions in the same year is also an indication. No scup were reported from Essex County for 1919, 1928, or 1930, nor were enough taken in Cape Cod Bay in those years to cause any local comment. Lawton et al. (1984) reported 245 individuals taken by otter trawl and several in gill nets near the Pilgrim Nuclear Power Station at Plymouth in western Cape Cod Bay. Scup are taken sporadically in Cape Cod Bay off Wellfleet on the bay side 0. Galbraith, pers. comm.). It is not known whether they come through the Cape Cod Canal or around the Cape.

Seasonal Migrations and Movements. Scup are summer migrants along the New England coast (Pearcy and Richards 1962; Richards 1963b). They move into estuaries with bluefish, kingfish, mullet, weakfish, and butterfish, and are the most important migrant species in both Long Island Sound (Richards 1963b) and Narragansett Bay (Oviatt and Nixon 1973).
Migration patterns are seasonal and have both a north-south and an inshore-offshore component. Scup winter in offshore waters between New Jersey and North Carolina. In spring they migrate northward and inshore to New Jersey; New York, and southern New England. They remain there until fall, when a reverse migration occurs (Finkelstein 1971). Scup have been taken during winter in depths of 81-126 m off southern New England in numbers large enough to show that part of the northern contingent of the species simply moves offshore in autumn, to come inshore again in spring. Differences in locations of the largest catches in cool vs. warm winters make it likely that a preference for water at least as warm as about 21°C is the factor that determines how far seaward the scup move off any part of the coast in any particular winter.

Importance. Scup are never plentiful enough anywhere, north of the elbow of Cape Cod to be of importance either commercially or to the angler, but they are an important food fish to the west and south, where they are plentiful. A summary of scup landings from Massachusetts to Virginia from 1879 to 1973 was given in Morse (1978), and commercial landings from 1966 to 1996 are shown in Fig. 235.

Scup, black sea bass, and summer flounder are harvested by several types of gear in the Mid-Atlantic Bight and southern New England (Shepherd and Terceiro 1994). For each of the three species, otter trawls produce more than 60% of total landings. The commercial trawl fishery is primarily in winter, generally targeting summer flounder and, less frequently, scup. Significant landings of scup are also made by pound nets, floating trap nets, and fish traps.
Historical catch statistics for the trap net fishery for Cape Cod and Massachusetts bays are summarized in Bigelow and Schroeder. A popular account of the Narragansett Bay trap fishery is given by Page (1978). Trap fishing still continues in the bay but the number of traps has decreased from a high of 283 in 1910 to only a few. Sissenwine and Saila (1974) investigated the possible effects of dredge spoil disposal on the scup fishery in Narragansett Bay but did not find anything that could not be attributed to natural population cycles of abundance and scarcity.
Annual commercial landings fluctuated between 18,000 and 27,000 mt (including the distant-water fleet) between 1953 and 1963, but

declined to about 4,000 mt in during the early 1970s (Gabrie11998). Beginning in the early 1970s, commercial catches increased steadily, reaching a peak of 9,800 mt in 1981 (Fig.235). Thereafter, commercial landings generally continued to decline, except for 1990-1991, to a low of 2,179 mt in 1997.

Spawning stock biomass declined steadily from 1990 to a record low in 1995-1996 (Gabriel 1998). Recruitment at age 0 also declined to a record low level in 1996. Fishing mortality rates have been very high since 1990, far in excess of biological reference points. The stock of scup is overexploited and at a low biomass level. The age structure of the stock is highly truncated, which is likely a reflection of prolonged high fishing mortality.

By-catch and discard mortality is at times very high for scup (Kennelly 1999). Discard rates measured by observers in the trawl fishery in the offshore Mid-Atlantic and southern New England fishery showed variability in time and space, but one area off Long Island was consistently high, averaging 3191b.h-l. The overall average throughout the region was 37.5 Ib.h-l.

This area appears to be frequented by migrating juveniles, which are particularly vulnerable.

A 16-year time series of research trawl catches, commercial landings, and effort data was used to evaluate two areas protected from mobile gear fishing off Cape Cod and assess effects of the spring otter trawl fishery for longfin squid on local abundance of finfish frequently taken as by-catch (Cadrin et al. 1995). Catch rates among a seasonal closure, a permanent closure, and adjacent waters open to mobile gear fishing were compared. Winter flounder and scup were more abundant in the two protected areas. Decreased local density of finfish in open areas was not related to inshore spring squid trawling effort or landings. Regional trawl effort on Georges Bank and in southern New England did have significantly negative effects on local finfish density.

The fishery is managed under Amendment 8 to what is now the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan. Management measures include moratorium permits, gear and minimum-size restrictions, commercial quotas, and recreational harvest limits (Gabriel 1998).

Recreational Fishery. Porgy, as they are commonly called along that part of the coast, are also a favorite with anglers, fol they bite readily and are a good pan fish. Porgy bite very greedily throughout the summer on clams, bits of crab, and sea worms *(Nereis),* as do immature fish throughout their stay; Many are caught on hook and line for home consumption. The recreational fishery for scup peaks during spring and fall, when fish are found in estuaries and coastal waters (Shepherd and Terceiro 1994). Recreational catches have accounted for 20-50% of the total annual catch since 1990. The 1995 recreational catch of 600 mt and the 1996 catch of 1,000 mt were the lowest in the 1979-1996 time series (Gabriel 1998).

Utilization. Jhaveri et al. (1984) compared chemical composition and protein quality of several underutilized species. Protein quality of scup was superior to the other fishes compared and to squids, but cholesterol level was somewhat higher and mineral values were variable.

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