

Hard clams

Mercenaria mercenaria

M. campechiensis

Contributors: Nancy Hadley and Loren Coen

DESCRIPTION

Taxonomy and Basic Description

Members of the genus *Mercenaria* are bivalve mollusks in the Veneridae family. Common names for *Mercenaria mercenaria* (Linnaeus 1758) include hard clam, quahog, quahaug, northern quahog, littleneck clam and cherrystone clam, although the latter two are actually referring to commercial size classes. The sister species, *M. campechiensis*, is commonly known as the southern quahog.



The hard clam has two thick, equal-sized valves that are elliptical in shape and marked with conspicuous concentric rings (Eversole 1987). The valves are joined dorsally by a dark brown external ligament just below the anteriorly-inclined umbo. Opposite the hinge is a distinct heart-shaped lunule. The external shell is generally tan-colored or off-white and may have reddish markings (*notata* form). The internal shell is white or pale yellow with a dark purple margin. The prominent adductor muscle scar may also be purple.

The body of the hard clam is surrounded by a mantle that secretes the shell. The clam filters through a pair of siphons fused at the bases. The incurrent siphon has sensory tentacles that are involved in food selection. The siphons are generally creamy white, but the margins may be colored in a range of yellows, browns, purples or reds. The clam has a large hatchet-shaped foot that is used for digging.

Clams may live for up to 46 years (Peterson 1986) and reach a size of 150 mm (5 inches) although the mean size is usually 60 to 70 mm (2 to 3 inches) (Stanley and Dewitt 1983).

Status

Hard clams are not state or federally listed; however, clams and other filter feeders are very ecologically important in marine ecosystems. Filter feeders affect nutrient cycling in estuarine habitats and improve water quality by removing suspended particles along with phytoplankton (Officer et al. 1982; Dame 1996; Dame et al. 2001; Newell 2004). A large adult clam filters an average of seven to eight liters (2 gallons) per hour. They also readily ingest bacteria, viruses and other water-borne pathogens that can cause human health problems. Although clam stocks appear to be in good shape based on high densities observed in some locations, they are a high priority for conservation in marine ecosystems.

Hard clams are harvested both recreationally and commercially and are the most valuable commercially harvested clam in the United States (Pritchard 2004). In South Carolina, the hard clam also supports a mariculture industry producing an estimated 'farmgate' value of 6.5 million dollars (J. Whetstone, SC Sea Grant Marine Extension Service, pers. comm., January 2005). There were 40 hard clam mariculture permits active in South Carolina in 2004. Wild stock commercial landings were down slightly in the 2004 season, but this is thought to be due to the soft clam market and displacement by maricultured clams rather than an actual resource decline (W. Anderson, pers. comm., January 2005). Kraeuter and Castagna (2001) provide a recent review of the hard clam fishery status and aquaculture.

POPULATION DISTRIBUTION AND SIZE

Mercenaria mercenaria is found from the Gulf of St. Lawrence to the Atlantic coast of Florida. This species has been introduced to other areas of the United States, notably Humboldt Bay, California (Murphy 1985), Washington State and Puerto Rico. It has also been introduced into Great Britain and Southern Brittany where it is well established, as well as the Mediterranean (France, Italy, Sicily, the Adriatic Sea) and China. A sister species, *M. campechiensis* (Gmelin 1791), is distributed primarily along the Atlantic coast from North Carolina to Florida and in the Gulf of Mexico (Dillon and Manzi 1989b). A subspecies, *M. mercenaria texana* (Dillon and Manzi 1989a) is found primarily along the Gulf coasts of Texas and Louisiana. *M. mercenaria* and *M. campechiensis* readily hybridize where their ranges overlap. Both *M. campechiensis* and hybrids have been reported in South Carolina (Dillon 1992; Dillon and Manzi 1992), but only as a small percentage of the population. Kraeuter and Castagna (2001) provide a recent review of the biology of the hard clam.

Hard clams are contagiously distributed (randomly clumped) in South Carolina estuarine waters at relatively low densities of 6 to 24 per square meter (Dame 1979; Rhodes et al. 1977; Anderson et al. 1978). A statewide survey in the 1970's (Anderson et al. 1978) estimated that 10 percent of estuarine waters in South Carolina contained clams, predominately at low densities (less than four per square meter). Most of the clams in this survey (68 percent) were in substrates composed of sand and shell; the fewest specimens were found in mud and sand mixtures. Small clams may be found in saltmarsh where the rhizomes provide protection from predators. Larger clams are often found in association with oyster reefs, burrowed under and adjacent to oyster clusters (Anderson et al. 1978). Larval clams (70 to 350 microns in length) are planktonic; they drift with currents and may be distributed considerable distances from where they were spawned (Wood and Hargis 1971).

HABITATS AND NATURAL COMMUNITY REQUIREMENTS

Hard clams occupy intertidal as well as subtidal habitats. They burrow into the substrate to various depths; they can go as deep as 20 cm (8 inches), but more commonly burrow to a depth of 1 to 2 cm (0.4 to 0.8 inches) (Roberts et al. 1989; Eversole 1987). Hard clams are found in a variety of substrates including sand, mud, shell and mixtures of these. However, studies have demonstrated a preference for courser substrates that may relate to associated water currents (Stanley and Dewitt 1983). They are often most abundant where there is an overlying layer of shell or coarse sand (Anderson et al. 1978) which provides predator protection. Although clams

are infaunal, they can 'migrate' horizontally, as well as vertically (Toll et al. 2003). Adult clams have been shown to repopulate a harvested area in a relatively short period of time (Toll et al. 2003).

The hard clam is a moderately euryhaline 'osmoconformer.' Although it has been found in salinities ranging from 4 to greater than 35 parts per thousand (ppt) (Eversole 1987), growth is best at salinities between 24 and 28 ppt. However, clams can tolerate long periods of reduced salinity by closing their valves (Eversole 1987). Clams are tolerant of low dissolved oxygen and have been known to survive three weeks at 1 mg/l (Stanley and Dewitt 1983). Clams, especially larvae and juveniles, are sensitive to pH outside the range of 7.0 to 8.75 (Calabrese and Davis 1966).

Growth and reproduction in hard clams is largely controlled by temperature. Hard clams usually reach sexual maturity at a size of about 35 mm (1.4 inches) shell length. In South Carolina, clams usually spawn intermittently from May through October when water temperatures reach or exceed 24 degrees C (75 degrees F). The planktonic larval stage may last as long as two weeks during which time the larvae may be distributed widely by currents and winds. At the end of this stage, the clam metamorphoses to the adult form and rapidly burrows into the substrate (MacKenzie et al. 2002).

CHALLENGES

High turbidity, which can be a result of runoff, dredging and boating activities, as well as natural causes such as storm-induced flooding and winds, can negatively impact hard clams (reviewed in Ward et al. 1994; Coen 1995; Ward and Shumway 2004). As with other filter-feeding bivalves, high turbidity may interfere with feeding by potentially clogging or even limiting the time that hard clams attempt to feed (Stanley and Dewitt 1983).

Clams, like other filter feeders, can be adversely affected by blooms of certain types of phytoplankton (microalgae) (Gainey and Shumway 1988; Shumway and Cucci 1987; Shumway 1990). Most phytoplankton blooms result from a combination of physical, chemical and biological mechanisms and interactions that are only partially understood. Some phytoplankton species produce toxins and, in a bloom situation, can adversely affect other organisms. Even when such blooms do not harm the filter-feeding organisms, the toxins can accumulate in the filter-feeders and reach levels that can endanger consumers, including humans. Harmful algal blooms have increased in frequency and become more widely distributed in the last few decades; this suggests that human activities may be affecting bloom occurrence or distribution (Hallegraeff 1993; WHOI 2004). A specific concern with clams occurs when healthy bivalves from 'open' approved areas that have experienced harmful algal blooms are transferred to other bays or creeks that have not experienced such blooms. Such transfer is of interest because many of the phytoplankton species that cause harmful algal blooms can survive digestion (Shumway et al. 2002).

Mariculture-related importations of clams or other bivalves could inadvertently introduce new predators or diseases into South Carolina waters. The SCDNR has documented twenty-seven other species, including oyster drills and a number of crab species, at least one of which is not

indigenous to South Carolina, in hard clams transferred from Florida as part of a mariculture operation. Mariculture operations could also potentially modify the local population's genetic structure (Metzner-Roop 1994; Arnold et al. 2003). Recent research has suggested that hard clam populations may differ in susceptibility to certain diseases (Ford et al. 2002; Ragone-Calvo and Burrenson 2002; Camara et al. 2004; Ragone-Calvo et al. 2003). Clams imported for mariculture in South Carolina could be strains more susceptible to certain diseases. Interbreeding with local populations could result in increased susceptibility of native stocks to disease.

Relatively few diseases have been reported in *M. mercenaria*. The most notable is the parasite QPX, (Quahog Pathogen Unknown), which was originally observed in the 1950s in New Brunswick, Canada, where it caused observable mortalities. More recently, significant mortalities from epizootics have been observed in hard clam aquaculture plantings in parts of Atlantic Canada, Massachusetts, New Jersey and Virginia (Smolowitz et al. 1998; Whyte et al. 1994; Ragone-Calvo et al. 1998; Ford 2001). Recent mortalities in wild populations of clams have been noted near Raritan Bay (Bobo et al. 2004). However, no die-offs or instances of QPX have been observed in the Chesapeake Bay proper or south of Virginia. To date, the parasite has only been detected in near-market to market-sized clams (perhaps one to three years old). Recent research suggests that South Carolina clam populations may be more susceptible to QPX mortality than northern populations which may have developed some resistance through repeated exposure (Ford et al. 2002, Ragone-Calvo and Burrenson 2002). QPX has not been reported in South Carolina, either in wild or aquacultured populations (Bobo et al. 2004). Importations for mariculture from areas of QPX infestation could spread this disease into local waters where it could be a threat to wild populations as well as cultured clams.

CONSERVATION ACCOMPLISHMENTS

The South Carolina Department of Health and Environmental Control (DHEC) restricts harvest of shellfish, including clams, in approximately 30 percent of estuarine waters in South Carolina for human health reasons. There have been no outbreaks of human disease related to clam consumption in South Carolina.

The South Carolina Department of Natural Resources (SCDNR) regulates importations of hard clams and other bivalves for placement in South Carolina's waters for mariculture purposes. Importation from areas of known diseases, such as QPX, is restricted. Disease testing is required prior to importation. Shipments are inspected for the presence of predators, non-native species and other undesirable associated organisms (SCDNR 2004).

The SCDNR regulates and monitors the commercial clam fishery, including annual compilation of fishery statistics. The SCDNR also assess State Shellfish Grounds on an annual basis to evaluate clam and oyster population status and determine which State Grounds may need to be temporarily closed to allow populations to recover.

The South Carolina Task Group on Harmful Algal Blooms has many initiatives underway to investigate harmful algal blooms (HABs) in the state, including their interactions with filter-feeders, such as hard clams.

CONSERVATION RECOMMENDATIONS

- Regularly update importation policies of cultured clams to reflect changes in threats to native clams. Continue to regulate and monitor mariculture activities because they have the greatest potential for introducing diseases or non-indigenous predators and for affecting the native population genetic structure.
- Monitor for signs of the QPX disease in wild and cultured clam populations.
- Continue to monitor population status through surveys and analysis of fishery trends.
- The Task Group on Harmful Algal Blooms should continue to investigate the causes of harmful algal blooms and possible effects on hard clams and other mollusks.
- Work with appropriate agencies to improve and implement Best Management Practices (BMP) in order to protect water quality and prevent turbidity caused by urban and agricultural runoff.

MEASURES OF SUCCESS

Determining that populations of hard clams are stable through annual fishery statistics and population monitoring within South Carolina would result in a measure of success. Another way to measure success is absence of disease in native clam populations. Further, absence of human health problems associated with consumption of clams would indicate successful conservation actions for this species.

LITERATURE CITED

- Anderson, W.D., W.J. Keith, F.H. Mills, M.E., Steinmeyer and J.L Bailey. 1978. A comprehensive survey of South Carolina's hard clam resources. SC Marine Resources Center Technical Rept. 32. South Carolina Wildlife and Marine Resources Department, Charleston. 14 pp.
- Arnold, W.S., S.L. Walters, S.C. Peters, T.M. Bert and J.S. Fajans. 2003. Influence of congeneric aquaculture on hard clam *Mercenaria* spp.) population genetic structure. J. Shellfish Res. 22(1):318.
- Bobo, M.Y., D. Richardson, L. Coen and W.D. Anderson. 2004. SCDNR-MRD. Fact Sheet for Quahog Parasite Unknown (QPX).
- Calabrese, A. and H.C. Davis. 1966. The ph tolerance of embryos and larvae of *Mercenaria mercenaria* and *Crassostrea virginica*. Biological Bulletin. 131(3):427-436.
- Camara, M.D, L.M.R. Calvo, R.B. Carnegie and S.K. Allen, Jr. 2004. Line-crossing within and among five commercial strains of hard clams, *Mercenaria mercenaria*: Growth, survival, and susceptibility to QPX disease at differing salinities. J. Shellfish Res. 23 (1):283-284.
- Coen, L.D. 1995. A review of the potential impacts of mechanical harvesting on subtidal and intertidal shellfish resources. SCDNR-MRRI. 46 pp.

- Dame, R.F. 1979. The abundance , diversity and biomass of macrobenthos on North Inlet, South Carolina intertidal oyster reefs. Proc. Natl. Shellf. Assoc. 69:6-10.
- Dame, R. 1996. Ecology of marine bivalves: an ecosystem approach. CRC Marine Science Series. Boca Raton, Florida. 254 pp.
- Dame R, D. Bushek and T. Prins, 2001. The role of suspension feeders as ecosystem transformers in shallow coastal environments. In K. Reise (Ed), The Ecology of Sedimentary Coasts. Springer-Verlag, Berlin. Pp. 11-37.
- Dillon, R.T. and J.J. Manzi. 1989a. Genetics and shell morphology of hard clams (genus *Mercenaria*) from Laguna Madre, Texas. Nautilus. 103(2): 73-77.
- Dillon, R.T. and J.J. Manzi. 1989b. Genetics and shell morphology in a hybrid zone between the hard clams, *Mercenaria mercenaria* and *M. campechiensis*. Marine Biology. 100: 217-222.
- Dillon, R.T. 1992. Minimal hybridization between the hard clams *Mercenaria mercenaria* and *M. campechiensis*, co-occurring in South Carolina. Bulletin of Marine Science. 50:411-416.
- Dillon, R.T. and J.J. Manzi. 1992. Population genetics of the hard clam, *Mercenaria mercenaria*, at the northern limit of its range. Canadian Journal of Fisheries and Aquatic Sciences 49:2574-2578.
- Eversole, A.G. 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic)--hard clam. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.75). U.S. Army Corps of Engineers, TR EL-82-4. 33 pp.
- Ford, S.E. 2001. Pests, parasites, diseases and defense mechanisms of the hard clam, *Mercenaria mercenaria*, pp. 591-628, In J.N. Kraeuter and M. Castagna, eds. The biology of the hard clam, *Mercenaria mercenaria*, (Linné). Elsevier Science Publishers, Amsterdam.
- Ford, S.E., J.N. Kraeuter, R.D. Barber and G. Mathis. 2002. Aquaculture-associated factors in QPX disease of hard clams: density and seed source. Aquaculture. 208:23-38.
- Gainey, L.F. and S.E. Shumway. 1988. A compendium of the responses of bivalve molluscs to toxic dinoflagellates. J. Shellfish Research. 7:6223-628.
- Hallegraeff, G.M. 1993. A review of harmful algal blooms and their apparent global increase. Phycologia. 32:79-99.
- Kraeuter, J.N. and M. Castagna, eds. 2001. Biology of the hard clam. Developments in Aquaculture and Fisheries Science-31. Elsevier, Amsterdam, 751 pp.

- MacKenzie, C.L., A. Morrison, D.L. Taylor, V.G. Burrell, Jr., W.S. Arnold and A.T. Wakida-Kusonoki. 2002. Quahogs in Eastern North America: Part I, Biology, Ecology, and Historical Uses. *Marine Fisheries Review*. 64(2):55 pp.
- Metzner-Roop, K.L. 1994. The effect of aquaculture on the genetics of natural populations of the hard clam, *Mercenaria mercenaria* (L.). *J. Shellfish Res.* 13:487-491.
- Murphy, R.C. 1985. Factors affecting the distribution of the introduced bivalve, *Mercenaria mercenaria*, in a California lagoon- the importance of bioturbation. *Journal of Marine Research*. 43:673-692.
- Newell, R.I.E. 2004. Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve mollusks: A Review. *J. Shellfish Res.* 23:51-61.
- Officer, C.B., T.J. Smayda and R. Mann. 1982. Benthic filter feeding: a natural eutrophication control. *Mar. Ecol. Progr. Series*. 8:203-210.
- Peterson, C.H. 1986. Quantitative allometry of gamete production by *Mercenaria mercenaria* into old age. *Mar. Ecol. Progr. Series*. 29:93-97.
- Pritchard, E.S. Editor. 2004. Fisheries of the United States 2003. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics. Silver Spring, Maryland.
- Ragone-Calvo, L.M, J.G. Walker and E.M. Burreson. 1998. Prevalence and distribution of QPX, quahog parasite unknown, in hard clams, *Mercenaria mercenaria* Virginia, USA. *Dis. of Aquatic Organisms*. 33:209-219.
- Ragone-Calvo, L.M. and E.M. Burreson. 2002. QPX susceptibility in hard clams varies with geographic origin of brood stock. VA Sea Grant Marine Resource Advisory No. 74, VSG-02-18. 7 pp.
- Ragone-Calvo, L.M., G.M. Burreson, S.F. Ford, J.N. Kraeuter, D.F. Leavitt and R. Smolowitz. 2003. Host genetic origin an important determinant of QPX disease. *J. Shellfish Res.* 22:322.
- Rhodes, R.J., W. J. Keith, P. Eldridge and V.G. Burrell, Jr. 1977. An empirical evaluation of the Leslie-Delury method to estimating hard clam, *Mercenaria mercenaria*, abundance in the Santee River estuary, South Carolina. *Proc. Natl. Shellf. Assoc.* 67:44-52.
- Roberts, D., D. Rittschof, D.J. Gerhart, A.R. Schmidt and L.G. Hill. 1989. Vertical migration of the clam *Mercenaria mercenaria* (L.) (Mollusca: Bivalvia): environmental correlates and ecological significance. *Journal Experimental Marine Biology and Ecology*. 126:271-280.
- Shumway, S.E. and T.L. Cucci. 1987. The effects of the toxic dinoflagellate *Protogonyaulax tamarensis* on the feeding and behaviour of bivalve molluscs. *Aquatic Toxicology*. 10:9-27.

- Shumway, S.E. 1990. A review of the effects of algal blooms on shellfish and aquaculture. J. World Aquaculture Society. 21(2):65-104.
- Shumway, S.E., A. Lewitus, L. Coen, J.S. Springer and J.M. Burkholder. 2002. Shellfish transfer and transplantation as vectors for introduction and establishment of harmful algal blooms via dinoflagellate cells and cysts: potential or imaginary risk? Presented at the ICSR Meetings in Charleston, SC.
- Smolowitz, R., D. Leavitt and F. Perkins. 1998. Observations of a protistan disease similar to QPX in *Mercenaria mercenaria* (hard clams) from the coast of Massachusetts. J. Invert. Pathol. 71:9-25.
- South Carolina Department of Natural Resources, Office of Fisheries Management. 2004. Policy on Importation of Molluscan Shellfish. (Guidelines for South Carolina Code of Laws Section 50-5- 1005). 10 pp.
- Stanley, J.G. and R. Dewitt. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) -- hard clam. U.S. Fish Wildl. Serv. FWS/OBS-82/11.18. U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.
- Toll, R.B., R.S. Prezant and H.B. Rollins. 2003. A novel method for locating tagged infaunal bivalves: Submersible pulse technology metal detectors. Journal of Shellfish Research. 22:501-503.
- Ward, J.E., R.I.E. Newell, R.J. Thompson and B.A. MacDonald. 1994. *In vivo* studies of suspension-feeding processes in the eastern oyster, *Crassostrea virginica* (Gmelin). Biological Bulletin. 186:221-240.
- Ward, J.E. and S.E. Shumway. 2004. Separating the grain from the chaff: particle selection in suspension- and deposit-feeding bivalves. Journal Experimental Marine Biology and Ecology. 300:83-130.
- Whyte, S.K., R.J. Cawthorn and S.E. McGladdery. 1994. QPX (Quahog Parasite X), a pathogen of northern *Mercenaria mercenaria* from the Gulf of St. Lawrence, Canada. Dis. of Aquatic Organisms. 19:129-136.
- Wood, L. and W.J. Hargis, Jr. 1971. Transport of bivalve larvae in a tidal estuary. Pages 29-44. \In\ (D.J. Crisp, ed.). Fourth European Marine Biology Symposium. Cambridge University Press, Oxford.
- Woods Hole Oceanographic Institute (WHOI). 2004. The Harmful Algae Page. Available: <http://www.whoi.edu/redtide/>. Accessed: January 2005.