21

Ocean quahog
Arctica islandica

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The geographic range of the ocean quahog is extensive. This arcticid occurs along the east coast of North America north of Cape Hatteras to St. George's Bay, Newfoundland, Canada, off the southern coast of Iceland, off the Faroe and Shetland Islands, and along the European coast northward from the Bay of Cadiz, Spain, around the British Isles, in the North Sea, and off the Norwegian coast to the White Sea in Russia (Merrill and Ropes 1969, Ropes 1979). Off the Middle Atlantic coast it is common at depths of 35 to 75 m.

The sexes are separate, although hermaphroditism may occur (Mann 1982). A period of intense spawning from August into November has been found for ocean quahogs, although minor spawning activity has been observed in earlier and later months (Loosanoff 1953, Jones 1981, Mann 1982). Sperm and eggs are released into the environment where fertilization and larval development occur. In samples from off Long Island, NY, the youngest ocean quahogs that had attained sexual maturity were an age-5 male and an age-6 female (Ropes et al. 1984b). Growth of ocean quahogs is fairly rapid during the first 20 years of life but lessens greatly thereafter (Murawski et al. 1982, see Figure 1). Ocean quahogs of about 100 years and older are common; a maximum shell length of 140 mm (5.5 inches) and a maximum longevity estimate of 225 years have been reported (Ropes 1985).

Murawski et al. (1982) reviewed early studies that presented largely unsubstantiated age and growth observations for ocean quahogs. Earlier investigators interpreted dark concentric rings or bands found on the external valve surface of small quahogs ($\leq$60 mm shell length) as annual marks. Larger, older quahogs were not aged because the rings crowded together at the valve margin and became obscured by the thick, black periostracum.

Recent age determinations at the Woods Hole Laboratory have been based on enumeration of annuli in acetate peel preparations (Thompson et al. 1980a,b; Jones 1980; Ropes et al. 1984a,b). In light microscope examinations of these acetate peels, outer and inner layers of the three-layered aragonitic ocean quahog shell are quite obvious, unlike the very thin prismatic pallial myostracum, which separates the outer from inner layers. Annuli occur in the relatively thick outer valve layer, curve toward the umbo from exit locations at valve surface bands, and seem to merge with the prismatic pallial myostracal layer. Annuli in peels appear as dark lines; growth increments form a lighter, textured background (Figs. 2 and 3). Definite prismatic microstructures, considered to be annuli, were found by investigators at Princeton University (Thompson et al. 1980a, Jones 1980) that separated growth increments from predominantly homogeneous microstructures. Although the microstructures are only visible by scanning electron microscopy (Ropes et al. 1984a), light microscope examinations of acetate peels clearly revealed the periodicity of annuli in small and large marked quahogs (Figs. 2 and 3).

The left valves of ocean quahogs are prepared, since they have a single tooth that contains age marks, and correspondence in the number of marks in the tooth and valve adds confirmation to an age estimate for a specimen. The valves are sectioned by a diamond-impregnated blade on an Isomet slow-speed saw machine. A valve is oriented on the machine to make a cut through the umbo and to the ventral margin such that the broadest surface of the tooth remains in the anterior valve portion. This portion is immersed in bleach (sodium hypochlorite $\sim$ 5.25%) to remove the periostracum, rinsed in tapwater, and allowed to dry before embedding it in Epon 815 resin. After hardening, the embedded valve cut surface is exposed by grinding off excess resin and polished to a high luster

on a vibrating lap machine. Etching the cut surface of the valve for 1 minute with 1% HCl preceeds application of sheet acetate and acetone. The sheet is peeled off after the acetone evaporates. The image produced in the peel is a necessary procedure, since the thin-age annuli are microscopically indistinct on the external valve surface, in the cut surface, or thin-sections of ocean quahog shells. Although age annuli and growth increments are reproduced clearly in the peels, they must be examined microscopically. Optimal contrast between annuli and growth increments in examinations of peel preparations is possible under a compound microscope at low (40×) magnifications, low transmitted light intensity, and with the iris/diaphragm of the substage condenser closed down.

Various experimental evidence, including radiometric analyses (Turekian et al. 1982, Bennett et al. 1982), suggests that annual age marks are formed in the valves of ocean quahogs. Validation of an annual periodicity for these marks has been supported by a marking experiment (Murawski et al. 1982). Recovered individuals show the expected number of annuli formed during the period between marking and recapture (Figs. 2 and 3).

Problems in determining an age for an ocean quahog relate to the loss of the earliest-formed annuli in the valve from erosion of the outer valve layer, a condition not uncommon in old individuals. Annuli formed during the first 10-15 years in the life of an ocean quahog may split into multiple lines at the valve-surface exit locations. Careful observation will usually reveal that they merge at the pallial myostracum. These conditions can result in deviations in agreement between annuli counts of the valve and hinge tooth, and individuals have been found to have a confusing pattern of growth lines suggestive of aberrant growth (Ropes et al. 1984b). The labor-intensive preparation of acetate peels and ages approaching or exceeding 100 years for many ocean quahogs are additional problems.

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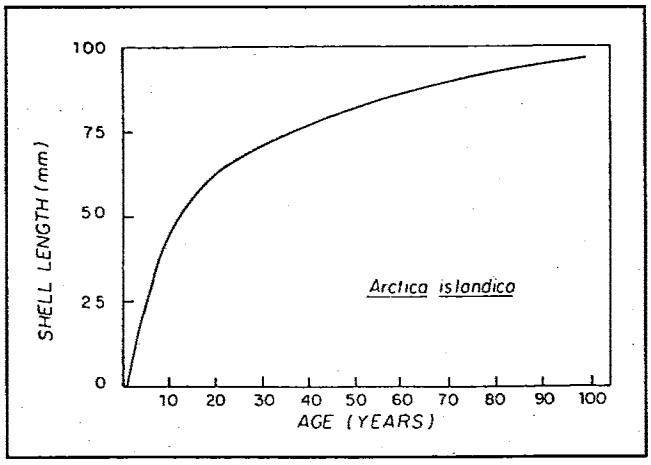

Figure 1
Relationship between age and growth in ocean quahogs.

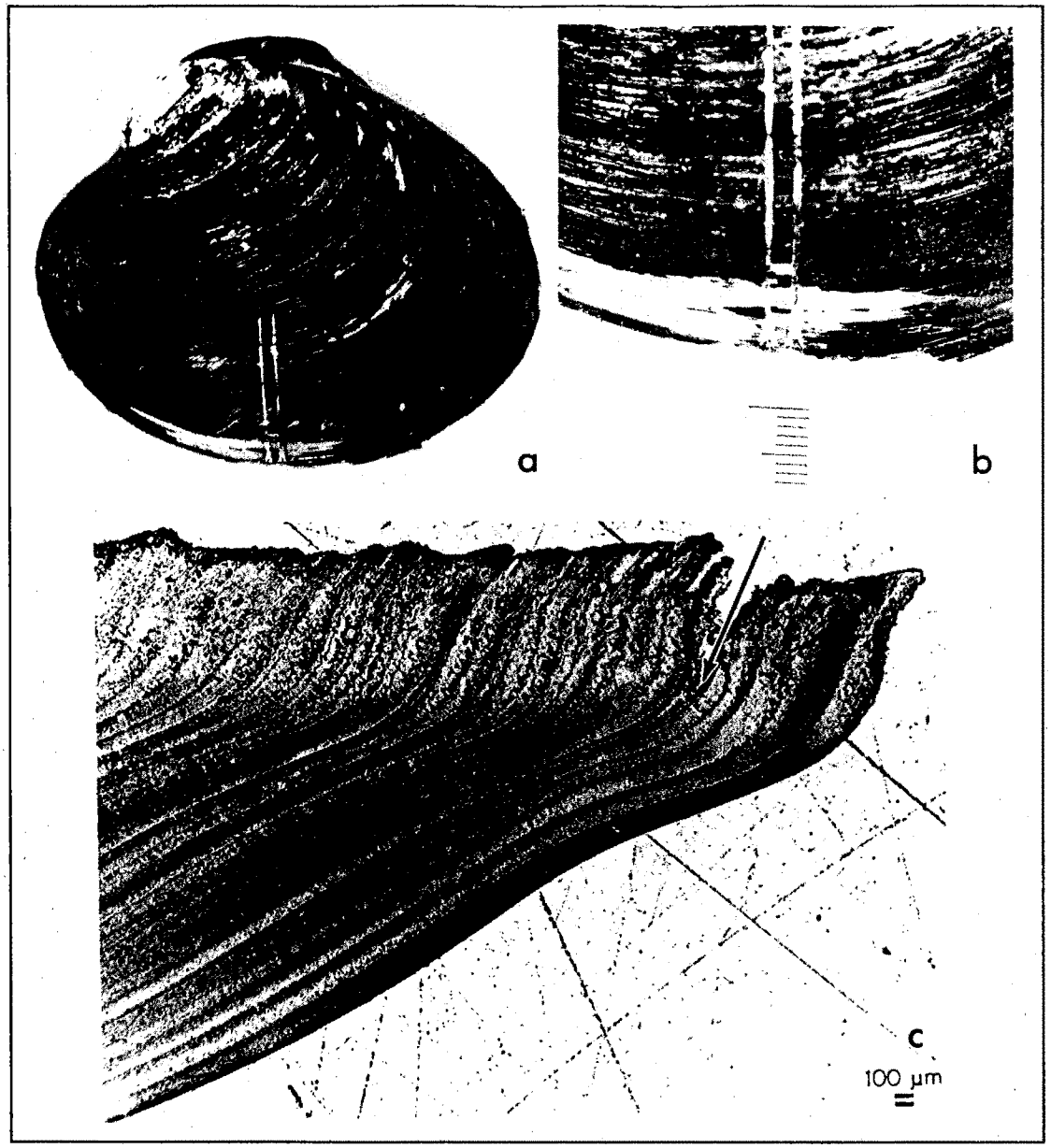

Figure 2

(a) A 110-mm (shell length), age-125 ocean quahog, *Arctica islandica*, released after marking in 1978 off Long Island, NY, and recovered 6 September 1983 before the annulus had formed for that year; (b) enlargement of the marked area; (c) photomicrograph of the valve margin showing the annulus formed soon after marking (arrow) and four additional annuli.

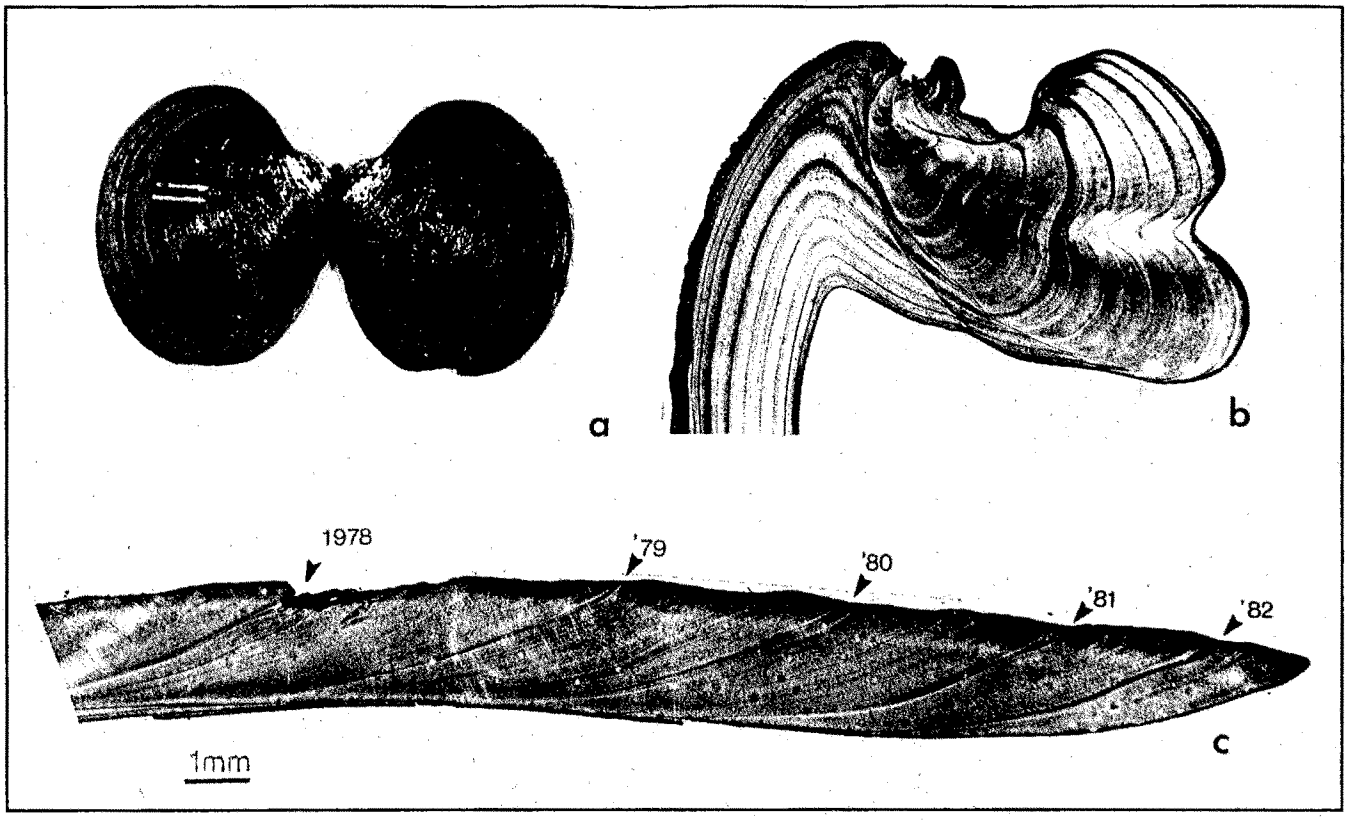

Figure 3

(a) A 62-mm (shell length), age-11 ocean quahog, *Arctica islandica*, released after marking in 1978 off Long Island, NY, and recovered 6 September 1983 before the annulus had formed for that year; (b) hinge tooth showing 11 annuli; (c) photomicrograph of the valve margin with each annulus identified by the year of its formation.