spectral evidence, based on the 25 November flight, can be fitted to a bremsstrahlung spectrum at about 10^7 degrees Kelvin, a black body spectrum at about 5×10^6 degrees Kelvin, and a synchrotron spectrum with $\gamma = -1.1$.

If Oph XR-1 is truly associated with supernova 1604, it may be meaningful to compare it with Tau XR-1, since both are presumably Type I supernovae. Recent distance estimates place the Crab at 1.5 kpc and the Kepler supernova at 9 kpc. Distance alone should make the Crab approximately 50 times as bright, but its x-ray flux is only twice as bright. The Crab, however, is 550 years older, and the weakness of its x-ray flux may be attributed to aging at the rate of about 5 percent per year.

In view of the theoretical predictions of x-ray emission from the region of the galactic center (*8*, *9*), it is interesting to note that Sgr XR-1 is indeed close to the direction of the galactic center. We have located the x-ray source about 2.3° from Sgr A. The displacement appears to exceed our estimated positional uncertainty, but the difference is not so great as to rule out positively the possibility of a coincidence between the x-ray and radio source.

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Ancient Oyster Shells on the Atlantic Continental Shelf

Abstract. *Shells of long-dead* Crassostrea virginica *are reported at 71 stations in depths of 14 to 82 meters. The depths exceed those of the estuaries where the species flourishes. Radiocarbon measurements indicate that the oysters were alive 8000 to 11,000 years ago. It is concluded that the oysters lived in lagoons or estuaries which became submerged when the sea level rose at the end of the latest glacial epoch.*

Many oyster shells were found in samples of bottom materials from the continental shelf between Cape Cod and Cape Hatteras. None of the samples contained living oysters. The oyster shells were identified as those of *Crassostrea virginica* (Gmelin) (*1*), the common edible species in estuaries along the Atlantic coast of the United States (*2*). The possibility that the shells were recently carried by currents from the mouths of present-day estuaries was not supported by the pattern of distribution. Nor was this possibility supported by the condition of the oyster shells, which, after they had dried, were observed to flake away easily as though the organic matrix in them had decomposed. Thus the depth, distribution, and character of the shells were suggestive of subfossils. Radiocarbon measurements of oysters from selected samples confirmed that the oysters were indeed ancient.

The oyster shells were found between Cape Cod and Cape Hatteras in dredge samples at 33 out of 113 stations of R/V *Delaware* (Cruise 60-7) in an investigation conducted by the U.S. Bureau of Commercial Fisheries during 1960 (*3*). A review of earlier data of the Bureau revealed the presence of the shells at one station of R/V *Albatross III* in 1955. During 1963, additional shells were found in large samples of bottom materials at 37 out of about 300 stations of R/V *Gosnold* between Cape Cod and Delaware Bay. These stations were occupied as part of a study of the geological history of the Atlantic continental shelf (*4*) being conducted by the Woods Hole Oceanographic Institution and the U.S. Geological Survey. The positions of all 71 stations where oyster shells were collected are given in Fig. 1. About 600 other bottom-sampling stations have been occupied by ships of the U.S. Bureau of Commercial Fisheries and the Woods Hole Oceanographic Institution east and northeast of Cape Cod, but no oyster shells were noted in that region. Samples south of Delaware Bay were largely restricted to the outer half of the continental shelf, thus accounting for the apparent restriction of oyster shells to that area (Fig. 1).

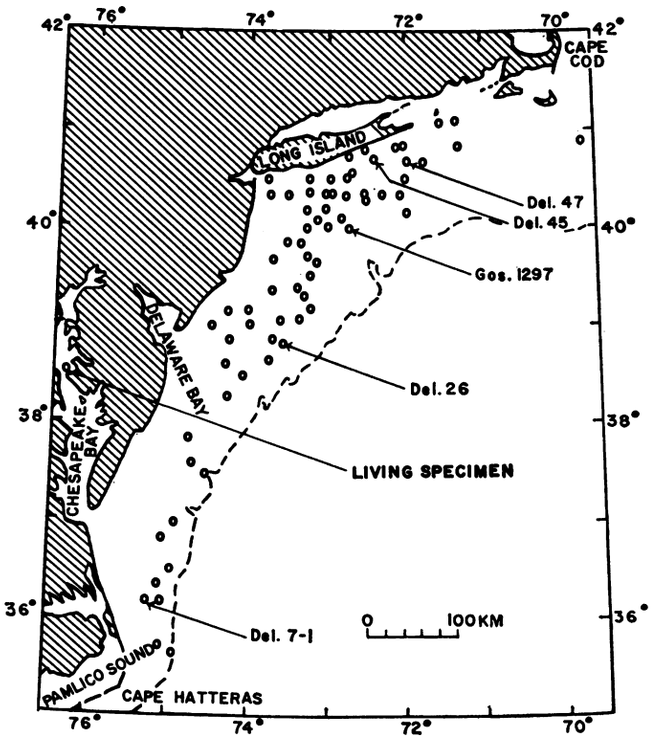
As shown in Fig. 2, the shells were found at water depths between 14 and 82 m, and there were some indications that they occurred in greater numbers at depths of about 38 m and 59 m. The water depths at all of the stations far exceed the depths at the intertidal or slightly subtidal positions of living oysters along the Atlantic coast. Compilation of the biological measurements showed that, on the average, the largest total numbers and weights of shells occurred at stations where the water depth was more than 30 m. Photographs of the bottom taken at the same time that the samples were collected aboard R/V *Gosnold* (*5*) showed the oyster shells resting on the surface of the bottom (Fig. 3) at only two stations. Evidently, most shells are buried in the sediment, where they were recovered from depths to 30 cm below the surface, the maximum depth of penetration of the large grab-sampler.

Studies of the geological history of the continental shelves of the world indicate that the shelves were exposed above sea level during the Pleistocene glacial stages (*6*). The latest such glaciation reached its climax about 18,000 years ago, after which the sea level gradually rose and allowed the shoreline to transgress the width of the continental shelf. Stages of transgression are recorded by drowned barrier bars and by terraces that commonly are four or five in number and occur throughout the world (*7*, *8*) as well as within the area of Fig.

Table 1. Ages of *Crassostrea virginica* estimated by radiocarbon dating.

Station No.	North latitude	West longitude	Depth (m)	Bottom type	Age (yr)	Lab. No.*
(Living specimen)†	38°33′	76°13′	2		Modern	W–1399
Del. 7–1	36°09′	75°20′	33	Sand and shell	8,130±400	W–1402
Del. 26	38°49′	73°39′	55	Sand and shell	9,780±400	W–1403
Del. 45	40°43′	72°25′	37	Sand	9,920±400	W–1400
Del. 47	40°40′	71°59′	51	Sand and shell	10,850±500	W–1401

* U.S. Geological Survey, Radiocarbon Laboratory. † Collected by Jackson in 1924 (*12*).



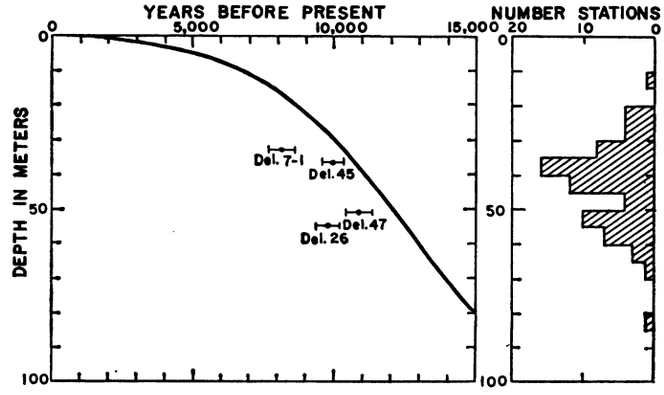


Fig. 1 (left). Positions of stations where shells of *Crassostrea virginica* were recovered in dredgings or grab samples of the bottom materials. The numbered stations are those from which specimens were selected for radiocarbon dating (Del., R/V *Delaware*) or where they were photographed (Gos., R/V *Gosnold*). Dashed line represents shelf break at a depth of about 150 m. Fig. 2 (above). Ages of shells (estimated by radiocarbon dating and shown as years before present) of *Crassostrea virginica* plotted against water depth at Delaware stations (numbered 7-1, 26, 45, and 47) where the specimens were collected (short horizontal lines). The curved line is the position of sea level during the past 15,000 years based upon a compilation of many radiocarbon dates by Shepard (*13*). The graph on the right shows the frequency of the present depths (below sea level) of all bottom samples containing the oyster shells (Fig. 1).

1 (*9*). Other terraces have been buried under later sediments so that they can be detected only by deep borings or by continuous seismic profiling. Examples have been found in the area of Fig. 1 (*10*). Also relict from shallow water during the transgression are sediments which are coarser grained than those now being deposited nearer shore and which commonly are stained by iron (*8*). These phenomena have been interpreted as indicating the presence of former lagoons and estuaries on the present continental shelf and that the features became submerged as the sea transgressed and deepened (*11*).

Shells recovered from the Atlantic continental shelf in the area of Fig. 1 at depths of 145 to 165 m have been identified as shallow-water (less than 40 m) forms (*6*, *10*). Attempts to estimate the age of these shells by radiocarbon dating revealed only ages in excess of 30,000 years. Valves of *Crassostrea virginica* are better than most shells for radiocarbon dating because their thickness provides resistance to solution and disintegration. The depths at which the oyster shells were found (Table 1) are less than those of the previously investigated shells, suggesting that the ages of the oyster shells might be within the range of the radiocarbon method. Shells were selected on the basis of station position and depth (Figs. 1 and 2), weight of the valves (50 to 200 g), and lack of weathering, recrystallization, and encrustation. Specimens from four stations (Fig. 1) were chosen for analysis at the radiocarbon dating laboratory of the U.S. Geological Survey. In addition, the shell of a specimen collected alive in 1924 (before testing of nuclear weapons) from shallow water in Chesapeake Bay (*12*) was investigated in order to determine whether a correction to the ages estimated by radiocarbon dating should be applied because of the radiocarbon age of the lagoonal or estuarine waters in which the oysters must have lived. The results (Table 1) reveal that the living specimen is modern (about zero age) for the method; thus no age correction is necessary.

Ages of the shells from the continental shelf range from 8130 to 10,850 plus or minus 400 or 500 years. As shown in Fig. 2, these ages are 1000 to 3000 years less than the ages given by an average curve of sea level plotted against past time (*13*). Conversely, the water depths are 10 to 30 m greater than those of the curve. A possible cause of decreased apparent age is the inclusion of the remains of boring organisms or incrustations composed of calcium carbonate younger than the shell itself despite precautions taken to avoid using shells that showed this form of contamination. Only a slightly better fit of the oyster shell data to the curve would be provided by adjusting the points to account for a possible average water depth of 6 m (*14*) at the sites where the oysters lived. Extensive reworking and movement of the shells eastward into deeper water after the growth site was submerged is considered unlikely because the shells were more abundant and heavier at the deeper stations. Postdepositional tectonic movement of the continental shelf may be a factor, but

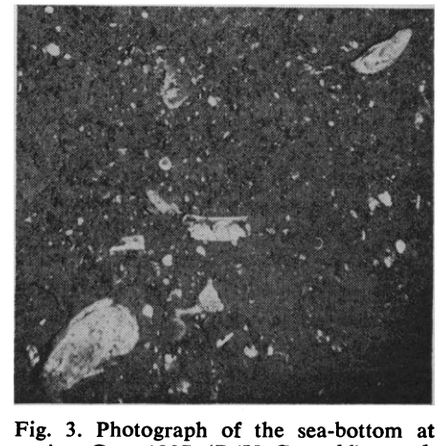


Fig. 3. Photograph of the sea-bottom at station Gos. 1297 (R/V *Gosnold*), south of Long Island (39°59.4′N; 72°45.4′W; 56 meters). Two empty shells of *Crassostrea virginica* (bottom left and upper right corners) lie on the medium- to coarse-grained brown sand. The photograph covers a bottom area of about 40 by 40 cm.

evidence is incomplete. In spite of these uncertainties, the points shown in Fig. 2 are probably as good as most of those for low sea levels about 10,000 years ago; in fact, they fall within the scatter of points based on many kinds of materials through which the curve of Fig. 2 was drawn by Shepard (*12*).

Medcof (*15*) reported several age determinations of oyster shells; one shell, aged 10,600 ± 130 years, came from Georges Bank (42°05′N; 67°15′W) and was at a depth of 53 m of water. Another, aged 6850 ± 100 years, came from Northumberland Strait in the Gulf of St. Lawrence (46°00′N; 62° 37′W), from a depth of 37 m. These results (*16*) corroborate and seem likely to extend our own findings.

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Photochemical Action Spectrum of the Terminal Oxidase of Mixed Function Oxidase Systems

Abstract. *The reversal of the carbon monoxide inhibition by bands of monochromatic light was determined for the oxidative demethylation of codeine and monomethyl-4-aminopyrine and the hydroxylation of acetanilide by rat liver microsomes and for the hydroxylation of 17-hydroxyprogesterone at carbon-21 by bovine adrenocortical microsomes. Maximum reversal occurred at 450 millimicrons, the light absorption maximum of the CO compound of the CO-binding pigment of microsomes. The agreement between photochemical action spectrum and spectrophotometric difference spectrum supports the conclusion that the CO-binding pigment is the terminal oxidase of mixed function oxidase systems of mammals.*

Mixed function oxidases, also termed mixed function oxygenases or aerobic hydroxylases (*1*), catalyze the incorporation of atmospheric oxygen into organic compounds (AH) according to Eq. 1:

$$AH + TPNH + H^+ + O_2 \rightarrow AOH + TPN + H_2O \quad (1),$$

where TPN and TPNH are triphosphopyridine nucleotide and its reduced form. The enzymes are strongly inhibited by sulfhydryl reagents but they are not inhibited by respiratory poisons such as cyanide and azide. However, Ryan and Engel (*2*) discovered that one of these enzyme reactions, the hydroxylation of corticosteroids at carbon-21 by the steroid 21-hydroxylase of bovine adrenocortical microsomes, was inhibited by carbon monoxide and that the inhibition was reversed by light. This potential clue to the nature of the oxygen-activating enzyme of hydroxylase systems was not further exploited because Ryan and Engel were unable to detect in their preparations a pigment that combined with carbon monoxide. Re-examination (*3*) of the difference spectrum of bovine adrenocortical microsomes with appropriate spectrophotometric methods revealed that the preparations contained the so-called CO-binding pigment previously observed in liver microsomes by Klingenberg (*4*) and Garfinkel (*5*) and designated by Omura and Sato (*6*) as an

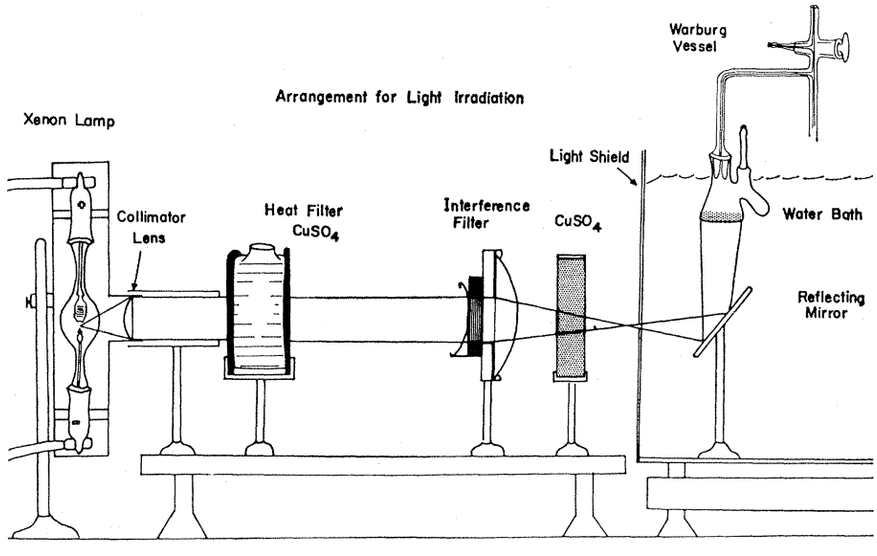

Fig. 1. Arrangement for determining the photochemical action spectrum. The collimated beam of a 1600-w high-pressure xenon lamp passes through heat filter (5.0-cm layer of 7 percent $CuSO_4$ solution), interference filter and neutral density filter if required, focusing lens, and 2.5-cm layer of $CuSO_4$ solution for absorption of the second order spectrum, enters the light-shielded glass-walled water bath through an opening in the shielding, and is reflected by the mirror onto the bottom of the Warburg vessel, which is shaken within the area of the beam at 130 oscillations per minute. Less than 1 percent of the irradiating light was absorbed by the bottom of the incubation vessel and the reaction mixture. The half band width of the interference filters was ± 10 to 12 mμ for filters with transmission maxima at 401, 465, and 502 mμ (*13*) and ± 4 mμ for the filters at 412, 419, 426, 433, 441, 450, and 475 mμ (*14*).