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# 1 History of Wood Conservation

Wood is one of the oldest materials used by people for making tools, utensils, shelter, ships and vehicles because it can be easily worked with simple tools. It soon became apparent that wood is susceptible to the effects of fire, weathering, and various organisms. The Bible referred to decay fungi and wood borers as pests. Thus, it is not surprising that people attempted to improve the durability of wood by various means.

People observed from nature that the wood of certain trees was either less susceptible to pests or even avoided by them altogether. Australian aborigines used the termite and fungus resistant bloodwood for their graves about 5000 B.C., the Mayas built a temple in Guatemala about 700 A.D. with a termite-resistant wood, and Theophrastos (371–287 B.C.) made a list of durable woods. It was also believed that the season when trees were felled influenced the natural durability of wood. Ancient literature has many references to the most suitable season and phases of the moon for felling trees (Indian Rig-Veda, 1000–400 B.C.; Hesiodos, about 700 B.C.; and Confucius, 551–479 B.C.), and even Napoleon demanded in 1810 that warships be built of winter felled timber, but present-day insights do not attach any importance to these criteria. Recommendations for debarking and careful storage in air or water in order to minimize attack by pests and to prevent checking and splitting of the wood have also been handed down.

Large quantities of wood have been used for building ships and houses, and it is apparent from many structural details that there were attempts to guard wood members against destructive agents in order to prolong their useful life. The buildings on stilts of the stone age, the temples of the Mayas, and the Norwegian stave churches which lasted for 800 years are telling examples of the continuing development of methods to preserve wood in structures.

Attempts were made to increase the durability of wood, even before working it, by treatment with preservatives. Early beginnings of chemical preservation included charring, storage in salt water, and brushing with oil, tar, or pitch (Appendix Table 1). Decay fungi, wood borers, shipworms, and termites as persistent pests threatening wood in use forced people to search for ways to preserve it. Columbus' report on his fourth journey shows how serious the situation could be: "the shipworms have attacked the ships so severely that they look like honeycombs" and "there is no remedy against the

scourge of the worms.” In the eighteenth century the dikes in Holland were hit by a catastrophic attack of shipworms, which led to the proverbial expression “Holland in need.” In 1784 the Royal Society of Arts resolved to award a gold medal to the person who could discover the origin of wood decay in houses and control it effectively.

During the Middle Ages, the recipes of antiquity were by and large adopted, but new chemical substances also found their way into wood preservation. It is known that Leonardo da Vinci (1452–1519) coated the wood panels for his paintings with mercury(II) chloride and arsenic(III) oxide. The physician and chemist Homberg (1652–1715) in 1705 also recommended mercury(II) chloride to control wood borers. The substance attributed to him, *sal sedativum Hombergi* or boric acid, is today one of the most important preventive wood preservatives. In 1718 a “Holtz-Balsam” (wood balm) was patented, and at the beginning of the nineteenth century the *Encyclopedia Britannica* already contained lists of wood preservatives. The English chemist Kyan, after years of experimentation, was awarded a patent for the soaking treatment of wood with mercury(II) chloride in 1832, thus marking the beginning of modern wood preservation. Other substances and processes soon arrived into a developing market. In 1874, the work of R. Hartig on the principal decay fungus attacking buildings in Europe was published, which recognized the origin of the attack as being due to invasion of fungi. This book stimulated further search for suitable wood preservatives, which culminated around the turn of the century in many new preparations.

The rapid advances in industrial wood preservation had virtually no impact on practices in the conservation of wood artifacts. As late as 1852–1855, A. Stifter treated the Kefermarkt altar in Austria (Fig. 1.1) with table salt which is completely ineffective against insects. Councillor Bolle’s attempts to drive off the altar’s wood borers by brushing with petroleum and hexachloroethane during 1916–1918 were equally unsuccessful. It was not until 1929 that the use of hydrogen cyanide, which had been in use in America against pests in plants and stored products since 1880, brought the desired success (Appendix Table 2). Since then, fumigants have played an important role in freeing cultural property of wood-destroying pests. Most recently, attempts have been made to replace such highly toxic, environmentally unfriendly substances as hydrogen cyanide, bromomethane, and ethylene oxide with inert gases such as carbon dioxide, nitrogen, or argon. The destruction of insects by reduction or replacement of vital oxygen with these gases goes back to a method practiced in antiquity, where grains were stored in hermetically sealed containers which caused the oxygen content to be reduced so much that insect pests had no chance of survival.

Control of wood-destroying insects and fungi by heat application is also not new (Appendix Table 3). Statements in the older literature, however, often do not make it clear whether the treatment is a matter of drying of the wood or a destruction of the causative pests, or both. The environmentally friendly hot air treatment has been an important method for controlling the

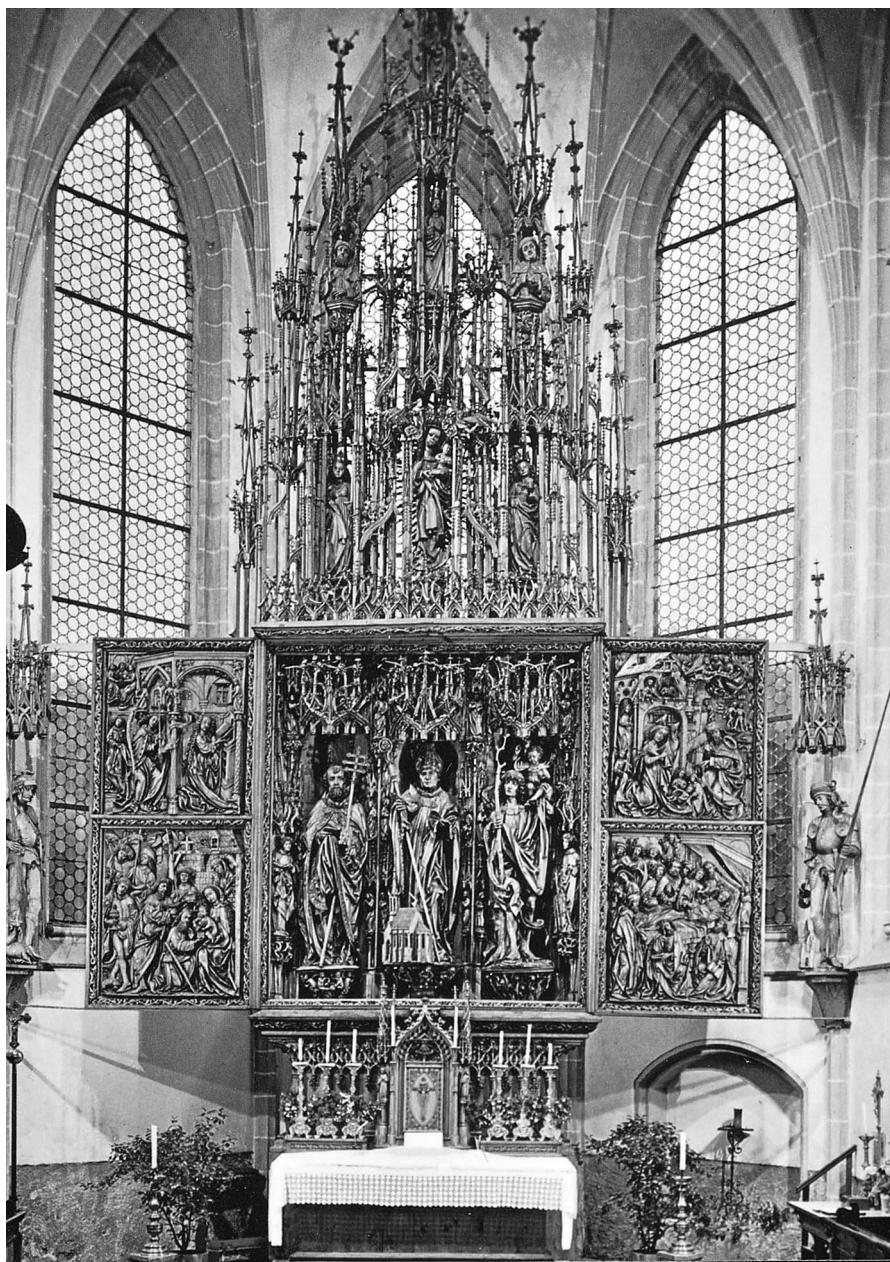


Fig. 1.1. The Kefermarkt altar in Austria

larvae of wood borers in registered historical buildings. Museum objects attacked by insects can also be treated with low temperatures, microwaves, or gamma radiation, while other electromagnetic waves are used comparatively seldom.

With regard to consolidation of deteriorated wood, moisture content is very important. Accordingly, we can make a fundamental distinction between consolidation methods for deteriorated dry wood in structures, monuments, and museum objects, on the one hand, and wet or waterlogged wood finds from archaeological excavations, on the other.

During the eighteenth and nineteenth centuries, stabilization of valuable cultural property such as wood carvings of altars which had been severely damaged by insects was carried out primarily by impregnation with glue (Appendix Table 4). Approaching the twentieth century, oil, varnish, and natural resins and waxes were added which were used either alone or, more commonly, as mixtures. New products based on cellulose nitrate or cellulose acetate also came into use as wood consolidants at that time. The development by D. Rosen of the wax immersion method for consolidating biologically deteriorated sculptures was the outstanding event in wood consolidation in the 1930s. Following World War II, the plastics industry underwent rapid development, and its products were also tested by conservators for their suitability for the stabilization of deteriorated wood artifacts. About 10 years after the industrial production of wood-plastic combinations by impregnation with monomers and polymerization *in situ*, this method was first applied to cultural property. During the second half of the 1980s, a number of publications appeared which contained long overdue critical evaluations of the properties of various wood consolidants.

The recovery of the first large objects of waterlogged wood in Scandinavia in the middle of the nineteenth century created an urgent need for a suitable conservation method. Thanks to the Danish restorer C.F. Herbst, many threatened objects could maintain their external form and be stabilized by exchanging the water in the wood with alum (aluminum potassium sulfate; Appendix Table 5). In this manner, between 1858 and 1958 about 100,000 individual objects could be stabilized and preserved for future generations at the Denmark National Museum. Beginning in the 1930s, extensive research was conducted at the United States Forest Products Laboratory in Madison, notably by A.J. Stamm, on various methods for modifying wood to minimize its shrinkage. One of these was treatment with poly(ethylene glycol), PEG, which replaced the alum treatment. PEG was used for treating the Swedish warship *Wasa* recovered in 1961. PEG was also selected for the stabilization of the remains of the *Mary Rose*, the flagship of Henry VIII of England. Smaller wood objects have been pretreated with low molecular mass PEG and freeze-dried. W. Powell was awarded a US patent in 1904 for treating wood with sugar to minimize shrinkage. This treatment was not a commercial success, but most recently there is growing interest in using beet or cane sugar or sugar alcohols for the stabilization of waterlogged wood finds.

Overviews relating to the history of wood conservation have been published by Broese van Groenou et al. (1952), Lohwag (1967), Brorson Christensen (1970), Graham (1973), Bill and Mühlethaler (1979), Schiessl (1984), Grattan and Clarke (1987), Clausnitzer (1990), Richardson (1993), Tsoumis (1995) and Schiessl (1998).

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