

WOODS IN EARLY AMERICAN KEYBOARD INSTRUMENTS AS EVIDENCE OF ORIGINS

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Introduction

THE COMPLEXITY OF WOOD USAGE IN fabricating musical instruments is generally far greater than with other types of objects. This is especially true of keyboard instruments such as pianos and harpsichords. While individual pieces of historical furniture were often made from a single species of wood, even the least complex historical keyboard instrument includes several species. For example, seventeenth-century Flemish harpsichords were typically made of five woods: poplar, spruce, oak, beech, and cherry.¹

Wood usage in musical instruments can be grouped into four categories:

1) Tone woods—used for the resonant parts such as the soundboard; often a softwood such as spruce (*Picea* sp.), as in Flemish harpsichords.

2) Functional woods—used for parts with particular structural or mechanical requirements. In Flemish harpsichords, for example, an appropriate wood was chosen for the specific function of each component. The bridge is usually of cherry (*Prunus* sp.), which is dense enough to hold the pins that guide the strings and to resist the formation of grooves under the pressure of the thin strings. The wrest plank, which must tightly hold the individual tuning pins and must withstand the accumulated tension of all the strings, is of oak (*Quercus* sp.). Poplar (*Populus* sp.), relatively low in density, was used for the key levers, which the player's fingers, therefore, can push down with ease. And the jacks (another part of the action consisting of a slotted body holding a pivoted tongue with a small mortise into which is inserted the piece of crow quill that plucks the string) are of beech (*Fagus* sp.), chosen both because of its strength, to resist the considerable stresses imposed, and because of its fine texture, suitable for the fashioning of small components.

3) Utility woods—used for parts of the structure in which resonance, appearance, and great strength were not important considerations. These were usually commonly available softwoods or hardwoods of moderate density, for example, the poplar used for the painted walls of Flemish harpsichords. Utility woods were usually inexpensive materials of more or less local origin.

4) Decorative woods—often used in the form of veneer or inlay. It is not unusual for these to have been obtained from all the ends of the earth.

Needless to say, these categories are quite broad and they frequently overlap. The black bog-oak sharp keys of Flemish harpsichords, for example, could be considered both functional and decorative.

Patterns of wood usage can become extremely complex in instruments with complicated actions or with decorative schemes employing veneer and inlay. For example, even a typical late-eighteenth-century English square piano made for the lower end of the market might include about ten different species of wood.² The apogee, perhaps, is reached in a grand piano made by John Broadwood and Son, London, 1796, with decoration designed by Thomas Sheraton.³ This instrument, now at the Museum of Fine Arts in Boston, includes no fewer than seventeen species of wood from no fewer than seven distinct world geographical regions. For example, the holly inlay was probably of British origin; the spruce soundboard was surely from the European mainland; the eastern white pine hammer rail, although possibly grown in England, was ultimately from North America; the satinwood veneer was from the West Indies; the purpleheart veneer was from South America; and the ebony sharp keys were from the Indian Ocean region.

Such patterns of employment of woods from diverse origins are commonly found even in less

distinguished instruments. Therefore, some cautions must be observed in ascribing origins to instruments on the basis of the woods their makers used. The *reductio ad absurdum* would be, for example, that a square piano mainly of solid mahogany must have been made in Cuba or Honduras. Context is all important. Fortunately, musical instruments, like clocks and other mechanical artifacts but unlike most furniture, were usually signed by their makers. Thus, one does not usually need to identify the woods to learn where the instrument was made. Nevertheless, it is important to determine the materials from which artifacts were made, if only to describe them accurately in museum catalogues and other sources of data intended for scholarly or professional use. My own efforts at systematically identifying, by classical wood-anatomical methods, the woods in musical instruments began as part of the research for my comprehensive catalogue of the fifty-four keyboard instruments at the Museum of Fine Arts in Boston, dating from the sixteenth through the nineteenth centuries and of European and American origins.⁴ This endeavor, which involved microscopic examination of well over a thousand samples, is analogous to the project begun in the 1950s at Winterthur to identify the woods in their entire collection of furniture.⁵ The Boston keyboard project, however, was, to my knowledge, the first and remains the only systematic project to identify scientifically the woods in a large and representative group of musical instruments.⁶ The information from the Boston instruments has been supplemented by my further analyses of woods in instruments in other museums and private collections.

From this fund of data one can begin to reach some general conclusions. One can say with some confidence, for example, that eighteenth- and early-nineteenth-century English harpsichord and piano makers never used poplar; that, however, poplar, not the superficially similar linden, was the common utility wood in Flemish and eighteenth-century French harpsichords; that red oaks and yellow-poplar (*Liriodendron tulipifera*) were never used in Europe; that quarter-sawn eastern white pine (*Pinus strobus*) was frequently used as a tone wood in late-eighteenth- and early-nineteenth-

century New England; and so on. From such observations the overall context becomes apparent within which one can begin to attribute origins to unsigned instruments according to the woods found in them.

Five Examples

Two major groups of keyboard instrument makers were active in the United States (or, previously, the British colonies) during the eighteenth and early-nineteenth centuries. The first group, centered in New England and New York, made instruments in the English style while the second group, centered in Pennsylvania, especially in the Moravian communities, worked in the German style. In both regions, instruments imported from Europe were also used. Although English and German makers and their American counterparts usually signed their work, in some instances they did not. In other instances inscriptions have been obliterated or the parts on which they might have been written have been lost. Thus, there are a number of instruments, some of considerable historical interest, whose places of origin are unknown, even though their provenances may suggest that they have long been present in North America. Five such instruments will serve as examples here.

A spinet (a type of small harpsichord) now in the Museum of Fine Arts, Boston,⁷ served as the model for the illustration of a typical English spinet in Frank Hubbard's classic book on historical harpsichord making.⁸ In the archives of a former owner of this instrument there survives a photo of an inscription, "I H 1771", on a part of the bottom board now lost. The initials "I", equivalent to "J", and "H" could stand for several known English makers, including John Harris, who, however, had emigrated to Boston in 1768. Because the principal decorative wood of the Boston-Museum IH spinet is mahogany identical to that used in London-made spinets, its external appearance is thoroughly English. Underneath, however, the IH walls were made of birch (*Betulus* sp.), while London makers typically used oak; the key levers are of eastern white pine, while London makers typically used linden (*Tilia* sp.); the decorative stringing and certain parts of the action are of hophornbeam (*Ostrya* sp.), while London

makers used holly; the bridge is of cherry, while London makers used beech; and the soundboard is of eastern white pine, while London makers used spruce. Although, as we have seen in the 1796 Broadwood piano, white pine was occasionally used, alongside spruce or Scots pine (*Pinus sylvestris*), as a utility wood by London makers, its use as a tone wood in the IH spinet is strong evidence of an American origin.⁹ Evidence just as compelling is the maker's use of birch, cherry, and hophornbeam; also black walnut (*Juglans nigra*), from which the jack-rail holder was made. These woods have never been found in English-made instruments. Thus, one should conclude that the IH spinet was made in Boston by John Harris, who used readily available materials. Mahogany could be obtained easily enough from the West Indies, and ebony for the sharps was probably obtained at some expense through London, but for the rest he used woods of local, New England origin. In each instance he made an appropriate substitution for the material that he would have learned to use during the earlier part of his career in London. The attribution of the Boston Museum's spinet to Harris is confirmed by a stylistic comparison with a signed spinet that he made in Boston in 1769, now in the Metropolitan Museum of Art, New York.¹⁰

The second example is an eighteenth-century German-style square piano in the Metropolitan Museum of Art.¹¹ Its former owner had purchased it in the 1960s in Indiana from a family with ancestors in eighteenth-century Pennsylvania but with earlier roots in Germany. According to family legend, the piano came from Gera, a German city where the noted maker Christian Ernst Friederici worked in the mid-eighteenth century.¹² Despite family legends, however, analysis of the instrument's woods demonstrates conclusively that it was made in America. Most telling, the soundboard and bottom are of eastern white pine, and the key levers are of yellow-poplar: these timbers were unknown in eighteenth-century Germany

(except, perhaps, as botanical specimens). Thus, the instrument was undoubtedly made in a Pennsylvania-German community.

The third example is a late-eighteenth-century German-style square piano at the Shrine to Music Museum, Vermillion, South Dakota (fig. 1).

Its provenance can be traced back only to an auction in Massachusetts in the early 1970s. The key levers are of spruce, which in America seems to have been used only as a tone wood, never as a functional or utility wood, as it was often used in Europe. The bottom and the original portion of the soundboard are of fir (*Abies* sp.), which I have never found to have been used for any purpose in an American instrument. Thus, the piano was almost certainly made in Germany.

This piano's history is, however, somewhat more complex. The major portion of the soundboard is a replacement made of eastern white pine, and the core wood of the nameboard is yellow-poplar. Both replacement parts have the appearance of considerable age and are of competent workmanship. No experienced American repairman would have made a white pine soundboard after about 1830, and no European would have done so at any period. Thus, it appears that this Ger-



Simon Spicer

Figure 1. Square Piano, maker unknown, Germany, about 1775. The Shrine to Music Museum, Vermillion, South Dakota (cat. no. 5259). Purchase funds gift of Mr. and Mrs. James H. Nyberg, 1991.

man instrument was exported to America not long after it was made in the late eighteenth century. Within the next few decades there was presumably some disaster that necessitated replacement of the soundboard and nameboard by an American craftsman who used familiar native woods.

The fourth example, is a primitive upright piano in the Whitefield House of the Moravian Historical Society in Nazareth, Pennsylvania.¹³ According to local tradition it was brought to America by a Moravian immigrant about 1745 and has been in the Whitefield House ever since. This account is quite plausible in that most of the Moravian settlers came from Saxony and there are mid-eighteenth-century published descriptions of such instruments having been made in Saxony or nearby Thuringia. Because only one such instrument is known to be extant in Germany and it might have been made later in the century,¹⁴ the piano in Nazareth is potentially of exceptional historical importance as an example of one of the earliest pianos, made, moreover, in J.S. Bach's time and place. Identification of the instrument's woods, however, shows it to have been made in America. Various parts are of red oak (the wrest plank), Atlantic white-cedar (*Chamaecyparis thyoides*; the soundboard, the back, and probably the key levers), and yellow-poplar (the keyboard frame). None of these timbers was known or used in Europe. Furthermore, Atlantic white-cedar has been found in signed instruments made in eighteenth-century Pennsylvania: John Clemm, for example, used it for the soundboard of a spinet (now in the Metropolitan Museum of Art) made in Philadelphia in 1739.¹⁵ Clemm was a Saxon-born and trained craftsman who later, in 1759-1760, actually resided in Nazareth's Whitefield House.¹⁶

The final example is an unusual nineteenth-century upright piano combined with a reed organ, now in the Metropolitan Museum of Art.¹⁷ There are inscriptions in the interior by Frank S. Shillow and W. Hershey who, according to old county directories, were farmers in and around Columbia, Pennsylvania, in the 1870s and 1880s.¹⁸ Because, however, the style of the instrument suggests a dating several decades earlier, these men might only have repaired the

instrument. Thus, it might have been made anywhere. The identification of eastern white pine (used as a utility wood for parts of the case) and hemlock (*Tsuga canadensis*; used for the soundboard) points clearly to an origin in the American northeast, where these trees are common. Much of New York and northern New England, however, can be ruled out by the use of yellow-poplar as a utility wood. One of the instrument's components (the rails against which the valve springs in the wind chest bear), however, was made of black locust (*Robinia pseudoacacia*) for no apparent reason other than that the wood was at hand. The very restricted natural range of this tree is consistent with the instrument's origin in south-central Pennsylvania, near farmers Shillow and Hershey.

Ethical and Practical Considerations

These five examples, I believe, demonstrate the usefulness of wood identification in the study of historical musical instruments. Results and implications such as I have described need not, however, be limited in their application to the relatively narrow field of musical history. Many instrument makers were originally trained as cabinetmakers and, in any case, their sources of materials were the same as those available to other artisans. Thus, results drawn from signed and dated musical instruments could be applied not only to unsigned instruments but also to other wooden artifacts, especially furniture. For example, I have found eastern white pine used as a utility wood not only in the London-made Broadwood piano of 1796, mentioned above, but also in a harpsichord made by the same firm in 1772.¹⁹ Therefore, if a drawer bottom or the back of a Chippendale bureau is found to have been made of white pine, one should not jump to the conclusion that it must have been made in America.

As mentioned above, it is important to have a large fund of data in order to understand the context of each individual object. There are limitations to the preciseness of identifications based on classical wood-anatomical methods, which are the only practicable methods available. Diagnosis can usually proceed down only to the level of genus, not to species. Thus by

gross or microscopic examination alone one cannot tell, for example, whether a piece of fir is a European, American, or Asian species of the genus *Abies*. Knowing, however, that keyboard instruments were not made in Asia and that early American and British piano makers never used fir for anything, one may be confident that an early piano with parts of fir was made on the European continent.

In pointing out the desirability of systematically gathering data from scores of objects, one might well be accused of being contra-conservational by advocating, in effect, the mutilation of artifacts by destructive testing. I cannot think of a situation where it would be necessary to know the precise genus or species of a piece of wood in order to conserve it. Often, however, even normal museum circumstances are often inherently contra-conservational: most artifacts would be better off if they never saw the light of day. Much “conservation treatment” is really cosmetic restoration, which, however circumspectly executed, is not, strictly speaking, necessary for preservation. Therefore, we inevitably find ourselves in an ethical continuum. The identification of materials in museum objects should be regarded as part of a museum’s ethical mission to document its collections and to advance knowledge. Thus, for example, the sampling and sectioning of paint layers is an accepted practice. Because the scientific examination and documentation of artifacts is generally the responsibility of conservators, it is up to us to proceed as carefully and non-destructively as possible.

In practical terms, most historical wooden artifacts have abraded areas or small splinters that can be removed without significantly affecting the integrity of the object. Often, these are in areas that were not intended to be seen. Even if samples are available only from undamaged areas, these are frequently on multiple parts: there are usually several drawer rails or several dozen harpsichord keys or whatever, and to remove a minuscule sample from one of these will not at all affect the others. Minuscule should, of course, be the operant concept, and it is here that the advantages of on-site analysis become apparent. If a sample is taken to be sent to an external laboratory, it must be large enough for

the outsider both to examine it macroscopically, that is, with a 10× magnifier, and to make tangential and radial sections for microscopic examination. Examination of gross features is not possible unless the sample is very large indeed. A further advantage of in-house work is that fruitful exchange of information bearing on the interpretation of findings can readily take place between the curatorial and scientific staff.

Fortunately, the techniques of wood-anatomical identification are not difficult to learn; the tools, principally a microscope, are generally already present in any conservation laboratory; and a collection of reference materials adequate for routine purposes can be obtained for a few hundred dollars. The in-house conservator or on-site consultant is able to observe gross and even macroscopic features on the objects themselves. Some woods, such as beech or oak, will rarely need to be sampled at all. Sections, when necessary, can sometimes be made directly from the object. For routine identification of many softwoods one needs only to view a radial section to observe the ray parenchyma crossfield pitting and certain other distinctive features, for example, the dentate ray tracheids by which Scots pine (*fig. 2*) can be distinguished from eastern white pine (*fig. 3*).

Most commonly used hardwoods, on the other hand, are more distinguishable in tangential section. For example, poplar (*fig. 4*) has rays one cell wide and alternate intervessel pitting, while the superficially similar yellow-poplar (*fig. 5*) has rays mostly two or three cells wide and opposite intervessel pitting.

Thus, one can proceed sequentially, first taking a radial section if the gross features of a piece show it to be softwood but taking a tangential section if it is hardwood. This will often be sufficient. If, however, examination of this first section is inconclusive, one can then proceed to sample and examine a section in the opposite plane. To be even more confident that the wood seen in tangential section in *fig. 5* is yellow-poplar, one could examine a radial section to see the scalariform perforation plates (*fig. 6*).

A fundamental principle of scientific research

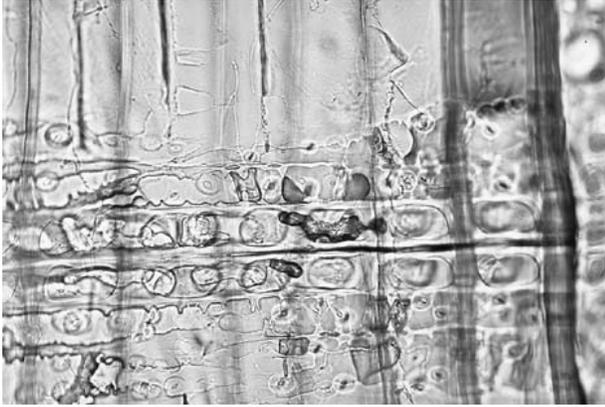


Figure 2. *Pinus sylvestris* (Scots pine) from the bottom board of a square piano by Melchior Guante, Münster (Westphalia), Germany, about 1805 (Museum of Fine Arts, Boston; acc. no. 1977.62). Radial section, photographed at 100x. The fenestriform (window-like) crossfield pits identify the genus as *Pinus*, and the dentate (tooth-like) walls of the tracheids at the margin of the ray are characteristic of *P. sylvestris*.



Figure 3. *Pinus strobus* (eastern white pine) from the bottom of a spinet by John Harris, Boston, 1771 (Museum of Fine Arts, Boston; acc. no. 1977.58). Radial section, photographed at 100x. The smooth-walled ray tracheids are characteristic of *Pinus strobus*.

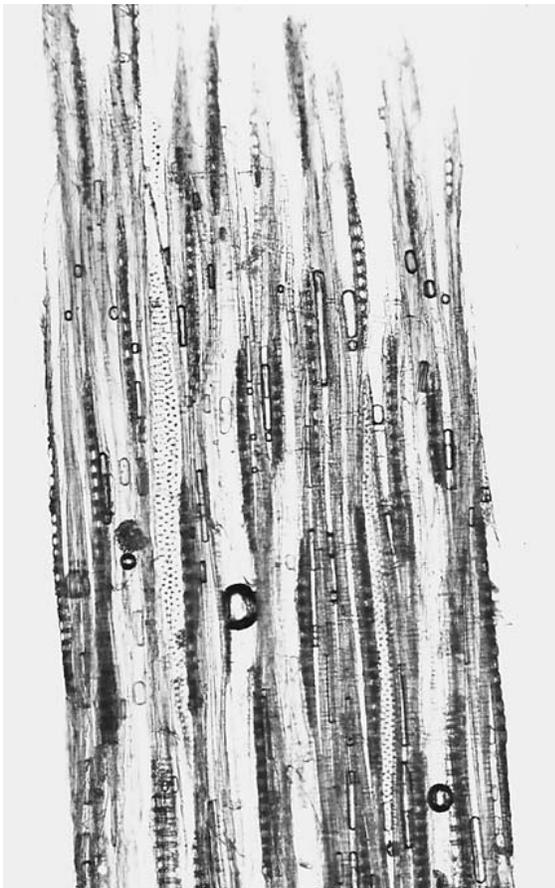


Figure 4. *Populus* sp. (poplar) from the key lever of a virginal by Andreas Ruckers, Antwerp, 1610 (Museum of Fine Arts, Boston; acc. no. 17.1792). Tangential section, photographed at 25x.



Figure 5. *Liriodendron tulipifera* (yellow-poplar) from the keyboard frame of a primitive upright piano (Whitefield House, Moravian Historical Society, Nazareth, Penn.). Tangential section, photographed at 25x.



Figure 6. Radial section of the same piece as in fig. 5; photographed at 50x.

is that extraordinary claims require extraordinary proof. It is, for example, extraordinary to claim that the instrument in Nazareth, perhaps the unique extant exemplar of a primitive Saxon piano, was made in Pennsylvania. In such cases, the examination of samples should be as thorough as possible. For example, the typical short rays of red oak are apparent to the naked eye looking at the back of the wrest plank inside the Nazareth piano. This diagnosis is confirmed by observing the round, thick-walled latewood vessels (fig. 7) by which red oaks, not used in Europe, can absolutely be distinguished from white oaks, which have angular, thin-walled latewood vessels.²⁰

Similarly, while the generally darker color and larger-diameter earlywood vessels of American black walnut (*Juglans nigra*) can serve to distinguish it from European walnut (*Juglans regia*), these features may overlap among individual samples of the two species. The presence of crystals in axial parenchyma cells, often regarded as a distinguishing feature of black walnut,²¹ is,

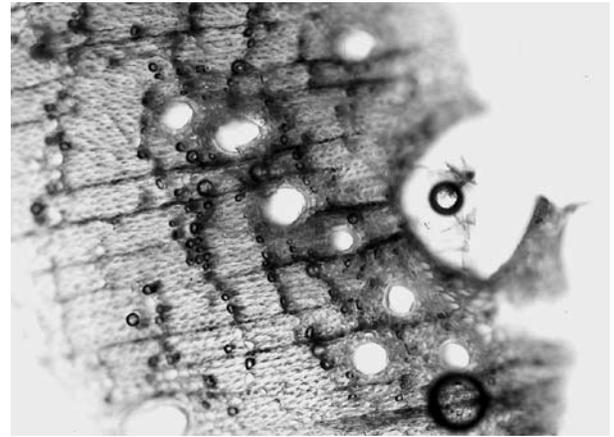


Figure 7. *Quercus* sp., red oak group, from the wrest plank of the upright piano in the Whitefield House. Cross section, photographed at 25x.

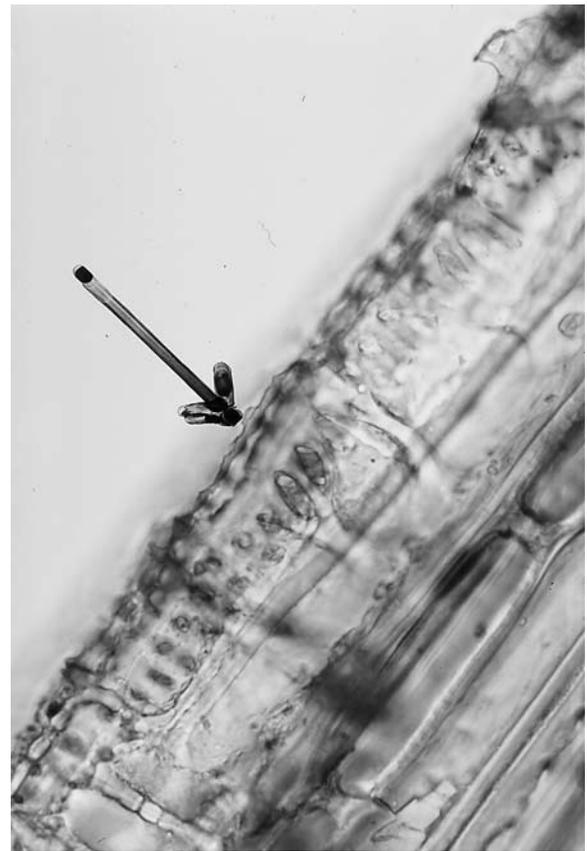


Figure 8. *Juglans nigra* (black walnut), from the jack-rail holder of the spinet by John Harris, Boston, 1771. Radial section, photographed at 125x. The arrow points toward reticulate thickenings in a latewood vessel.

however, not reliable evidence: crystals are also found in European walnut.²² Positive separation of black walnut from European walnut can be provided by the reticulate thickenings (“gash-like pits”) in latewood vessels of the American species (fig. 8).²³

Although these thickenings can be very difficult to find (they are visible only in a small percentage of the vessels) it is worth going to the trouble in important cases.

Much nonsense has been written about the use of woods by the master musical instrument makers of the past. Only by the careful gathering of objective data through such scientific pursuits as wood identification can we begin to understand these artifacts in a fully rational manner.²⁴

Notes

1. An example of this wood usage is a harpsichord by Gommaar van Everbroeck, Antwerp, 1659, at the Shrine to Music Museum, Vermillion, South Dakota (cat. no. 3985).

2. An example is a square piano of the early 1790s inscribed by the London dealer John Bland, at the Museum of Fine Arts, Boston (acc. no. 94.312); see John Koster, *Keyboard Musical Instruments in the Museum of Fine Arts, Boston* (Boston: Museum of Fine Arts and Northeastern University Press, 1994), pp. 147-150. This instrument contains at least ten different woods: mahogany (*Swietenia* sp.; case walls, lid, and hammer shanks), Scots pine (*Pinus sylvestris*; bottom board and some interior framing), spruce (*Picea abies*; soundboard and some interior parts of the case), oak (*Quercus* sp., white-oak group; back wall of the case), ebony (*Diospyros* sp.; sharp keys), linden (*Tilia* sp.; key levers, key-front molding, and hammer heads), maple (*Acer* spp., probably both *A. pseudoplatanus* and *A. platanoides*; interior veneer), redcedar (*Juniperus* sp.; veneer banding on the nameboard and key cheeks), holly (*Ilex aquifolium*; nameboard cartouche), and beech (*Fagus sylvatica*; hitch-pin plank, wrest plank, bridge, and stand). One or two additional species might have been used for the geometrical stringing and inlay on the nameboard.

3. Now at the Museum of Fine Arts, Boston (acc. no. 0 1985.924); see Koster, op. cit., pp. 161-180. Its woods are: British and continental European—spruce (soundboard and interior framing), Scots pine (part of the bottom and interior framing), maple (interior veneer, bridge, and some action parts), holly (decorative inlay), beech (the “nut” bridge on the wrest plank), oak (wrest plank and some interior framing), walnut (hammer heads and hitch-pin rail), service or pear (*Sorbus* sp. or *Pyrus communis*; action parts), and linden (key levers); North American—eastern white pine (hammer-rest rail); Central American or Caribbean—redcedar (*Juniperus* sp.; hammer shanks) mahogany (hammer-hinge rail, action parts, and core of lid), and satinwood (*Xanthoxylum flavum*; veneer); South American—tulipwood (*Dalbergia* sp.; veneer banding), purpleheart (*Peltogyne* sp.; veneer), and “bullet” or “beef” wood (*Manilkara* sp.; hammer-axle wire holders); and Indian or Indian Ocean region—ebony (sharp keys). Note that Thomas Sheraton’s *Cabinet Dictionary* (London, 1803) indicates the West Indies as the source of “Cedar or Juniper” and of “Sattin Wood”; Honduras and Cuba as sources of mahogany; and Madagascar as the source of ebony.

4. Koster, op. cit.

5. See Charles F. Montgomery, *American Furniture, the Federal Period, in the Henry Francis du Pont Winterthur Museum* (New York: Viking Press, 1966), pp. 27-38. The identification work was principally done by Gordon K. Saltar, who is estimated to have analyzed more than 10,000.

6. A significant precedent was, however, provided by Scott Odell, who, in “The Identification of Wood Used in the Construction of 17th and 18th Century Keyboard Instruments,” *Bulletin of the American Group, IIC* 12, no. 2 (April 1972), pp. 58-61, reported on the analyses of thirty-six wood samples from ten European instruments at the Smithsonian Institution. The identification work was done by the U.S. Forest Products Laboratory, Madison, Wisconsin.

7. Acc. no. 1977.58; see Koster, op. cit., pp. 123-126.

8. *Three Centuries of Harpsichord Making* (Cambridge, Mass.: Harvard University Press, 1965), pl. 23.
9. Another example of an early Boston-area instrument with an eastern white pine soundboard is a square piano by Benjamin Crehore, Milton, Mass., about 1800, now at the Museum of Fine Arts, Boston, acc. no. 1992.95; see Koster, op. cit., pp. 191-195.
10. Acc. no. 1976.229; see Laurence Libin, *American Musical Instruments in The Metropolitan Museum of Art* (New York: The Metropolitan Museum of Art and W.W. Norton, 1985), pp. 159-160 and color pl. 10.
11. Acc. no. 1987.229; see Laurence Libin, "A Unique German-American Square Piano," *Early Keyboard Journal* 9 (1991), pp. 7-20.
12. See Maribel Meisel, "The Search for a Square Piano's Origins," *Early Keyboard Studies Newsletter* 2, no. 3 (June 1986), pp. 10-11. Meisel, although not doubting the instrument's supposed European origin, discovered useful archival information about the family that owned the piano.
13. See Laurence Libin, "Nazareth Piano May Be Among America's First," *Moravian Music Journal* 33, no. 1 (Spring 1988), pp. 2-6.
14. See Georg Kinsky, *Musikhistorisches Museum von Wilhelm Heyer in Cöln, Katalog*, vol. 1 (Leipzig: Breitkopf & Härtel, 1910), p. 127. Kinsky regarded as inauthentic the date 1735 written on the instrument, which is now at the Musikinstrumenten-Museum of the Universität, Leipzig (cat. no. 106).
15. Acc. no. 44.149; see Libin, *American Musical Instruments in The Metropolitan Museum of Art*, pp. 156-158. The identification of the soundboard wood was done by the U.S. Forest Products Laboratory, Madison, Wisconsin, in 1976.
16. See Libin, "Nazareth Piano," p. 2.
17. Acc. no. 89.4.2098; see Laurence Libin, "A Unique Organized Piano from Pennsylvania," *The Organ Yearbook* 18 (1987), pp. 95-108.
18. *Ibid.*, p. 95.
19. Harpsichord by Burkat Shudi and John Broadwood, London, 1772, at the Museum of Fine Arts, Boston, acc. no. 1977.57; see Koster, op. cit., pp. 127-132.
20. See A.J. Panshin and Carl de Zeeuw, *Textbook of Wood Technology*, 4th ed. (New York: McGraw-Hill, 1980), p. 568.
21. See, for example, R. Bruce Hoadley, *Identifying Wood: Accurate Results with Simple Tools* (Newtown, Conn.: Taunton Press, 1990), p. 117.
22. See Fritz Hans Schweingruber, *Anatomie europäischer Hölzer / Anatomy of European Woods* (Bern and Stuttgart: Paul Haupt, 1990), pp. 430-431.
23. See Regis B. Miller, "Reticulate Thickenings in Some Species of Juglans," *American Journal of Botany* 63, no. 6 (1976), pp. 898-901.
24. For providing access to instruments in their care, for permission to remove samples, and for their help and encouragement, I should like to thank: Sam Quigley and Darcy Kuronen (Museum of Fine Arts, Boston); Laurence Libin (The Metropolitan Museum of Art, New York); Susan M. Dreydoppel (Moravian Historical Society, Nazareth, Penn.); and André P. Larson (The Shrine to Music Museum, Vermillion, South Dakota). Some of the research reported in this paper was supported by a Travel to Collections grant from the Division of Fellowships and Seminars of the National Endowment for the Humanities and by a General Research Mini-grant award from the Office of Research of the University of South Dakota. I am also deeply grateful to R. Bruce Hoadley and the University of Massachusetts, Amherst, for conducting the week-long workshop that provided me and many others with introductory training in wood identification.