FORENSICS

SUPERSONIC SPORES

VIRTUOSOS SAY VIOLINS MADE BY AN ITALIAN MASTER THREE CENTURIES AGO CAN'T BE MATCHED BY MODERN INSTRUMENTS. BUT SCIENCE MAY JUST HAVE FOUND A SUBSTITUTE FOR AGE.

BY DANIEL WEISS

PHOTOS CHRISTIAN GRUND

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Is that the sound of fungus? Scientist Francis Schwarze hopes his team's research will lead to a new generation of biotech violins.

Just over a decade into his professional career, 33-year-old British violinist Matthew Trusler has already earned comparisons with some of the greatest players in history and impressed audiences with his talents as a soloist on five continents. But he had never played an engagement quite like the one he did in September last year, before a meeting of forestry and timber scientists in Osnabrück, Germany.

Hidden behind a curtain so the audience could not see him, Trusler played identical excerpts of violin concertos by Brahms and Mendelssohn on five different violins. One was Trusler's own 1711 Stradivarius, bought for his use two years earlier by a benefactor and valued at US$2 million. Two were contemporary instruments made from wood that had undergone an experimental fungus treatment devised by the Swiss Federal Laboratories for Materials Testing and Research to improve their sound. One had been treated for six months and one for nine months. The other violins, also contemporary, were made from untreated wood.

When Trusler finished playing, 190 of the scientists present answered two questions: Which violin did they like best and which did they think was the Stradivarius? The results: 90 judged that the nine-month "fungus violin" known as Opus 58 sounded best, compared with just 39 votes for the Stradivarius. Even more impressive, 113 thought that Opus 58 was the Strad.

SOUND OF SUCCESS

"The overwhelming choice of the fungal violin makes me think that with our treatment, we created a sound that emotionally touches the general public," says Professor Francis Schwarze, the scientist in charge of developing the fungal treatment. "Now a talented young violinist who can't afford to buy his or her own Stradivarius can play on a violin that sounds at least as good." If true, this would represent a massive step forward in modern violinmaking.

Violins crafted by the renowned Italian luthier (maker of stringed instruments) Antonio Stradivari, in the late 17th and early 18th centuries, are widely recognised as among the best

Violinist Matthew Trusler loves playing his US$2-million Stradivarius. But can a violin made from fungus-treated wood match its sound?

A MAESTRO'S LIFE

Antonio Stradivari was born around 1644 in or near Cremona, a town in Italy's Po valley, famous for violinmaking since the 16th century. He is thought to have apprenticed there with noted local luthier Nicolò Amati. For several decades after opening his own shop in 1670, Stradivari turned out violins nearly identical to Amati's. Then, in 1700, he entered his Golden Period, crafting the violins that are considered among the best ever made. Unfortunately, no written records of his methods remain, which helps explain why so many myths have grown up around them.

Stradivari died in 1737, labouring into his nineties to complete an impressive lifetime total of 1,100 instruments. While alive he attained wealth and fame, with foreign kings numbering among his clients. But he was quickly forgotten after his death, and by the mid-18th century the tradition of Cremona violinmaking was on the decline.

It took nearly a century for Stradivari's reputation to rise again in classical music circles, where it rapidly attained the heights it retains to this day. Today, violinmaking thrives anew in Cremona, where around 150 luthiers ply their trade. Many are graduates of the Scuola Internazionale di Liuteria A. Stradivari, founded in 1937, exactly two centuries after the maestro's death, to carry on his legacy.

PHOTOS: LEONARDO FILM GMBH; BRIDGEMAN; COURTESY OF MICHAEL RHONHEIMER

Luthier Michael Rhonheimer (top) works on Opus 58 in his studio in the Swiss town of Baden. An audience of forestry and timber scientists preferred the sound of one of the fungus violins he produced to that of a Stradivarius, such as the one pictured here.

ever made. Only 600 of the instruments are known to exist and they are coveted by collectors and musicians alike for their superlative craftsmanship and brilliant sound. In 2008, one sold for US$10 million – roughly 300 times the price of a top-of-the-line contemporary instrument.

Trusler says his Stradivarius stands out for its tonal range. "You can play a Strad for your whole life and never find all the sounds it can make," he says. "You can play a Strad very hard with huge strength, and the sound doesn't break. And when you play quietly, you can hear it at the back of a hall. All the world is wonderful when you are playing a Strad. I don't know quite why that is. I'm putting it down to magic."

Scientists have laboured for years to unlock the secrets of this magic. Some have speculated that special substances used to treat the wood or varnish the finished instrument play a key role. Others have argued that Stradivari carefully dried or aged his wood or that he recycled it from ancient castles and cathedrals. A competing theory holds that he used wood recently harvested from the Alps, which was ideally suited to violin making due to the unusually cold climate of the time.

In any case, there is little question that high-quality wood – particularly the Norway spruce (*Picea abies*) traditionally used for the instrument's top plate – is essential to making a high-quality instrument.

"The wood is definitely important if you want to create an instrument with a very rich sound, a lot of volume and high colour," says German luthier Martin Schleske, who has a background in physics, and helped to develop the new fungal treatment. "I have special equipment to measure wood's properties and I am lucky if I measure 1,000 pieces and choose 10 of them."

Rhonheimer looks on as Dutch professor Berend Stoel examines one of his violins with a CT scanner.

Yucky stuff in a laboratory – but this fungus could possibly help produce a new breed of tonally-superb violins.

PHOTOS: CHRISTIAN GRUND; LEONARDO FILM GMBH

SECRET SUBSTANCES

In the search for the secret of the Stradivarius, many have speculated that Stradivari must have used special ingredients to treat or varnish the wood in his instruments. Some of the proposed recipes have been truly bizarre, such as one published in 1747 featuring chimney soot and the urine of a child. Another, uncovered in 1804, called for "half a dram of saffron" and an unspecified quantity of "dragon's blood", a resin derived from palm trees and used as a red dye.

Other purported ingredients have included volcanic ash, amber, myrrh and proteins derived from eggs or animal skins.

Joseph Nagyvary, a professor emeritus of biochemistry at Texas A&M University in the United States, argues that the ingredients Stradivari used to protect against degradation also helped produce a more brilliant sound by making the wood more stiff and its surface more brittle.

Ingredients proposed by Nagyvary have included borax, an insecticide also used to preserve Egyptian mummies; fruit gums, to protect against mould in humid northern Italy; and powdered quartz and glass, to frustrate woodworms.

To test his hypothesis, Nagyvary burnt minute quantities of wood from a Stradivarius violin and cello and analysed the chemical composition of the resulting ash. In a study published last year, he reported finding evidence of borax along with several other chemicals that do not occur naturally in wood. However, a separate study published last year that analysed wood samples from four violins and one viola by Stradivari found nothing more than a mundane mix of oil, resin and dye.

SPORES AND MORE

As part of his work studying the effects of decay fungi on urban trees, Schwarze discovered some fungi were unusual in that they degraded the wood without affecting the speed which sound travelled through it. During a chance discussion with Schleske about the qualities of wood coveted by luthiers, Schwarze realised that these unusual fungi had the potential to help produce better-sounding violins.

The fungal treatment improves the wood's tonal qualities by reducing its density up to 15 percent, without drastically reducing its stiffness. This means that sound waves are transmitted through the wood at a barely reduced speed. Since the amount of sound from the instrument is proportional to the speed at which sound travels through the wood divided by its density, the treated wood can radiate sound up to 15 percent more powerfully.

"This results in a violin that has a louder sound, which is obviously favourable if you are playing in a big concert hall," says Schwarze.

The treatment also significantly increases the dampening of high notes, which can otherwise sound harsh and grate on the ear. "You end

PHOTO: CHRISTIAN GRUND

up with a violin that has a very mellow and warm sound," says Schwarze.

In the treatment, stones covered with the fungi are used to colonise the wood, which is then left for several months to let the fungus work its magic. Two different strains are employed: *Physisporinus vitreus*, a white-rot fungus, for the Norway spruce used in the violin's top; and *Xylaria longipes*, a soft-rot fungus, for the sycamore or maple used in its bottom portion.

These fungi act by thinning the cell walls of the denser dark wood that build up late in the growing season when temperatures drop. As a result, the difference between the density of the late wood cells and that of the less dense early wood cells that grow during the warmer part of the year is reduced. Preliminary computed tomography (CT) scans of the wood in violins made by Stradivari and his contemporaries have found indications of a similar homogeneity of density.

More study is necessary, but it appears that the fungal treatment makes modern wood more like the wood found in a Stradivarius. "It shifts the quality of the wood up to a new class," says Schleske. "If you have average wood, it will become good wood. If you have good wood, it will become extraordinarily good."

The collaborators continue to refine the fungal treatment, which now takes just a month or two to treat the wood. Schleske is hard at work making three new violins from the treated wood, and he and Schwarze are gathering data before and after treatment in order to determine precisely how the fungi alter the wood's structural and acoustic properties.

TRIED, THEN TESTED

The wood will undergo CT scanning to gauge how the density of light and dark wood changes, and will be subjected to modal analysis (vibration dynamics testing) to determine how the range of sounds it produces is changed by the fungal treatment.

Similar tests on Strads and other fine 18th-century violins have measured particularly strong outputs at the lowest pitches emitted by the instruments, which gives them a warm, enveloping sound.

Strads also typically show increased sound production at the frequencies associated with bright, clear sounds favoured by musicians, and diminished sound production at the frequencies associated with disfavoured mid-range nasal sounds and harsh, high sounds.

WILL IT WORK?

It remains to be seen whether the fungus-treated violins will match the Stradivarius in structural and modal analysis, much less the subjective judgment of connoisseurs. Based on his experience playing in the blind test, Trusler, for one, is highly sceptical. While he thought the modern violins in the test – made by Swiss luthier Michael Rhonheimer – were excellent, he says they did not measure up to his Strad.

"For me it was unbelievably obvious which fiddles were which," Trusler says. "There are so many things that differentiate the Stradivarius that it's craziness to even compare them to modern fiddles. I felt that it was a slightly flawed test because the people in the audience weren't necessarily trained to know what they were hearing. I think the results didn't really tell us anything."

Nevertheless, Schwarze stands by the response of the audience. "I think if you go to a concert, you have a mixture of people there, and only a minority are music experts," he says. "There was no coincidence that so many people liked the fungal-treated violin."

Looking towards the future, Schwarze sees applications for fungus-treated wood in guitars, piano soundboards and wood cones for the membranes of loudspeakers. "If you can say your violin or your guitar or even your loudspeaker membrane has been treated by the 'Stradivari' fungus," he says, "that is a unique selling proposition." ■

The soft-rot fungus *Xylaria longipes* (top) has a peculiar effect on wood. It thins the cell walls of the dense dark sections (right) which could help make superior violins.

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