# **Tapping Tonewoods** by Dana Bourgeois

"How the Selection of Species Helps Define the Sound of Your Guitar"
Acoustic Guitar Magazine, March/April 1994

Why is it that different woods are used for acoustic guitars, and how do these woods affect the sound of the instrument? In the past, there was less opportunity for confusion on this issue, since most guitars were made of mahogany, rosewood, maple, ebony, and spruce. But with the dwindling availability of traditional tonewoods, particularly those cut from old-growth forests, major manufacturers and smaller luthiers have been compelled to consider the use of alternative species of tonewoods- some of them common and others decidedly uncommon. This article looks at the strengths and weaknesses of the woods most commonly used today for tops, backs and sides, fretboards, and bridges.

## Evaluating Tonewoods

Differences between woods can be as mysterious and complex as differences between people. Even within a species, no two pieces of wood are exactly alike. Environmental conditions, genetics, the age of the tree, annular growth patterns, grain orientation, curing conditions, and so on all have an effect on the tonal properties of a piece of wood. In addition, tonewoods respond differently in the hands of different makers. They can also take on different characteristics when used in different models of guitars – even those built by the same maker. And whether a particular wood sounds good or bad depends partially upon who's doing the listening. So any attempt to sort out distinctions between tonewoods can only be offered from a relatively subjective point of view.

When evaluating tonewoods, luthiers must take into account a wide variety of factors, some of which can be inscrutably subtle, and most of which are likely to vary in priority from one luthier to another. I tend to place a good deal of importance on a couple of elements that, when viewed together, illuminate much of my own understanding of tonewoods.

Velocity of sound refers to the speed at which a material transmits received energy. Simply described, plucked guitar strings transmit energy to the bridge. The bridge in return oscillates one surface of a ported enclosure, setting up sound pressure waves

that eventually reach the eardrum. In order to contain this chain reaction, one must design an efficient ported enclosure and then make it out of materials that facilitate the transmission of the vibrational energy. Lively materials – those with a high velocity of sound, or low internal dampening, make the best facilitators.

There are a number of ways in which luthiers judge the sound velocity of wood. The most common method is to hold the wood at a nodal point, tap it, and then listen for the response. (Nodal points are analogous to the locations on a guitar string where natural harmonics can be played.) The difference between a high and a low velocity of sound can often be so apparent that one demonstration is usually sufficient to teach an apprentice how to select most of the good sets out of a given stack of wood. Sometimes a piece of wood is so lively that it doesn't seem to matter where you tap it or where you hold it. I remember going through a large stack of aged Brazilian rosewood from which I was able to make my selection the moment I lifted a piece off the top of the pile; rubbing one piece of wood against another was enough to make the best sets ring!

In addition to testing for velocity of sound, luthiers also make use of the tapping technique to listen for harmonic content. Like a string, a piece of wood is capable of producing a fundamental tone and an array of harmonics. Though the presence and strengths of individual harmonics are distinctly influenced by changes in the geometry and mass of the piece of wood, elements such as clarity of tone, relative harmonic complexity, and high, low, or mid bias can readily be discovered by holding and tapping a piece of wood in a variety of ways.

### Soundboards

Each part of the guitar seems to play a role, be it significant or subtle, in determining the tonal characteristics of the instrument. In very general terms, the top, or soundboard, seems to affect the guitar's responsiveness, the quickness of its attack, its sustain, some of its overtone coloration, and the strength and quality of each note's fundamental tone. Most luthiers (but not all) believe that the wood chosen for the top is the single overriding variable that determines the quality of tone of a finished instrument.

Spruce is the standard material for soundboards. These days the most commonly used species is Sitka, due to its availability and to the high yield from its characteristically large-diameter logs. Quartersawn Sitka is quite stiff along and across the grain; high stiffness, combined with the relatively light weight characteristics of most softwoods, is a

recipe for high velocity of sound. A strong fundamental-to-overtone ratio gives Sitka a powerful, direct tone that is capable of retaining its clarity when played forcefully. Sitka is an excellent choice of top wood, then, for players whose style demands a wide dynamic response and a robust, meaty tone. On the other side of the balance sheet, the lack of a strong overtone component can result in a "thin" tone when played with a relatively light touch-depending, of course, upon the design of the guitar and the other woods used in its construction. The break-in period for a new Sitka guitar can also be longer than that of other spruces.

The most common alternative to Sitka is Engelmann spruce, another domestic western species. Engelmann is often more expensive than Sitka due to the lower yield from its smaller logs and because most logs have a spiral-grained structure that renders them unsuitable for proper quarter-sawing. Engelmann is considerably lighter in color than Sitka spruce, lighter in weight, and usually less stiff, resulting in a slightly lower velocity of sound. Engelmann also tends to exhibit a weaker fundamental tone, although it produces a noticeably broader and stronger overtone component. It is therefore a good choice for players who require a richer, more complex tone than can be obtained from most Sitka tops, particularly when the instrument is played softly. The downside is that Engelmann tops can have lower "headroom" than Sitka tops, which is to say that clarity and definition are often sacrificed when the guitar is played loudly.

European or silver spruce, the spruce of choice for makers of classical guitars, shares a number of characteristics with Engelmann spruce, including color, lightness of weight, harmonic complexity, and fullness at the lower end of the dynamic range. Because of its visual similarity and significantly higher cost, its name has been affixed more than once to a piece of Engelmann spruce by unscrupulous (or uninformed) wood dealers and luthiers. European spruce differs from Engelmann in its potentially quicker response and greater headroom. The availability of anything better than mediocre European spruce (which is easily exceeded in quality by the better grades of Engelmann that is still readily obtainable) is sharply limited, unless the boards are selected at the source in Europe.

Eastern red spruce, also known as Adirondack or Appalachian spruce, was the primary top wood used by American manufacturers before World War II. Its use was all but discontinued due to over-harvesting of the resource, but has recently been reintroduced thanks to 50 years of regeneration and to the legendary status that this traditional

tonewood has attained. The small size of most logs and a shortage of wood conforming to market preference for even color and regularity of grain conspire to keep the price of red spruce extremely high.

Red spruce is relatively heavy, has a high velocity of sound, and has the highest stiffness across and along the grain of all the top woods. Like Sitka, it has strong fundamentals, but it also exhibits a more complex overtone content. Tops made out of red spruce have the highest volume ceiling of any species, yet they also have a rich fullness of tone that retains clarity at all dynamic levels. In short, red spruce may very well be the Holy Grail of top woods for the steel-string guitar. If players and builders were able to overcome phobias about unevenness of color, grain irregularity, minor knots, and four-piece tops, many more great-sounding guitars could be produced while the supply of potentially usable red spruce is still available. Old-growth woods are disappearing so fast that such an attitude change will need to be scheduled sometime in the near future, unless the majority of new guitars are to be made of synthetic materials.

Before leaving the spruces, I should mention bearclaw figure, or hazelficte, which is a delightful pattern in the grain occasionally occurring in all species of spruce. Bearclaw, like the curl in curly maple, is a rippling of the longitudinal fibers, which divides the surface of the wood into shimmering patterns. Unlike the even waves that usually occur in maple, bearclaw usually appears on asymmetrical or randomly broken patterns. This phenomenon almost always occurs in older trees that have dense, stiff grain structure and high sound velocity. Thus bearclaw is usually a reliable indicator of the better examples of tonewoods within any given species of spruce.

Western red cedar ranges in color from honey brown to light chocolate. It has a quickness of sound that exceeds any of the spruces, a higher overtone content, lower fundamental content, and lower stiffness along the grain. Additionally, cedar tops require a significantly shorter break-in period than spruce tops, a phenomenon that a few dealers of new guitars are beginning to pick up on.

Since World War II, cedar has been used extensively by makers of classical guitars. Cedar-topped guitars are characteristically lush, dark-toned, and bursting with flavor. They are often less powerful in projection than their spruce cousins, however, and they tend to lose clarity near the top of their dynamic range. Having enough bottom end is never a problem for a cedar guitar, although preventing the sound from getting muddy

sometimes is. Because of its pronounced weakness along the grain, I find cedar to be used to its best advantage in smaller-bodied guitars or with non-scalloped braces. Redwood is usually darker in color than cedar and often displays the same general tonal characteristics, leaning slightly toward darker tones, less definition in the bass, and lower velocity of sound.

Koa and Mahogany have been used for soundboards since the ‘20s, and makers have recently begun to use Maple. These hardwoods have in common a relatively low velocity of sound (as compared to softwood tops), considerable density, and a low overtone content. They therefore tend to produce a solid tone (though not an especially rich one) and respond best at the upper end of the dynamic range. Mahogany-topped guitars exhibit a strong "punchy" tone that is well-suited to country blues playing. Koa has a somewhat more mid-rangy tone that works well for rhythm and truly shines in guitars made for Hawaiian style slide playing. Maple, in particular, having the lowest velocity of sound of the three, can be downright flat sounding – a blessing in disguise when a guitar is amplified at high sound-pressure levels.

### Back and Sides

Besides serving to form the enclosure of the sound-box, the back and sides of the guitar also act as a sympathetic resonator whose oscillations contribute greatly to the harmonic mix. When judiciously selected (with due consideration given to design criteria and the other tonewoods used in the instrument), the back and sides can have a tremendous effect on the overall tone of the instrument.

Brazilian and Indian rosewood have an extremely high velocity of sound and a broad range of overtones. The rosewoods, as well as their various rain forest cousins (Cocobolo, Kingwood, Morado, and the like) have strongly pronounced low overtones, usually the lowest resonating frequencies in the entire guitar. These lows help to create a complex bottom end and to impart an overall darkness of tone to the instrument. Strong mids and highs serve to reinforce overtones generated by the top, contributing to a fatness of tone on the upper registers. Guitars made of rosewood also have a pronounced "reverb" tone, caused by a strong, clear set of sympathetic harmonics with a delayed onset and slow decay.

I’ve found that Brazilian rosewood has everything that Indian rosewood has, only more. I say this with great trepidation in light of that species’ likelihood of extinction within a

couple of generations. An international embargo on trade on Brazilian rosewood products guarantees that the relatively few sets remaining in this country, which may be used only on domestically sold guitars, will continue to spiral in price as the supply dwindles.

Mahogany and Koa have relatively high velocities of sound when considered as materials for backs and sides and thus contribute much to overtone coloration. Lacking the low-end frequencies of the rosewoods and also their sustaining reverberation, these woods have an altogether different sound. Where rosewood guitars can be thought of as having a "metallic" sound, mahogany and koa guitars are better described as sounding "woody", although the harder, more dense examples of these woods can take on some of the characteristics of the rosewoods. Between the two, Koa seems to have a little more fullness in the midrange, while mahogany tends to favor the bass (to some extent) and the treble.

Maple and walnut tend to be more acoustically transparent than other tonewoods, due to a low velocity of sound and a high degree of internal damping. That is to say that they allow tonal characteristics of the top to be heard without the addition of extraneous coloration and may even serve to attenuate some of the overtones emanating from the top.

The harder, denser examples of these woods, such as sugar maple and black walnut (particularly quartersawn examples) tend to lean slightly more toward the tonal direction of mahogany, while softer examples, such as Bigleaf maple and Claro walnut, tend toward greater tonal transparency. Curly, quilted, or bird's-eye figures do not seem to have much effect on the tone of the wood, but they can be used, like bearclaw, as an indicator of other properties. Quilted figure, for example, occurs most often in softer species and is best displayed when the wood is flat sawn (two characteristics that tend to produce higher damping properties).

### Fretboards and Bridges

Players of electric guitars with bolt-on necks have long been hip to the fact that neck and fretboard materials can have a significant bearing on tone. Maple necks can impart a bright, poppy tone that can do much to reinforce the top end of a large-bodied guitar, while mahogany necks help push the overall palette into a warmer, more woody tonal range.

Fretboard materials also exert an influence on overall tone, although they probably act more as icing on the cake than as a layer of the cake itself. Brazilian rosewood fretboards and their denser rain forest counterparts add sparkle and ring, and Indian rosewood fretboards can help fatten up the midrange. Wenge, a dense, dark-colored African hardwood unrelated to the rosewoods, has tonal properties remarkably similar to those of Brazilian rosewood.

Ebony, the traditional fingerboard material found on violins, classical guitars, and high-end steel strings, has the lowest velocity of sound of all the woods commonly used in lutherie and has definite damping characteristics. This may not prove to be much of a problem for large-bodied guitars made out of red spruce or Brazilian rosewood, but it may be something to consider when designing smaller guitars, particularly those using some of the less resonant woods for tops and backs.

Bridge materials, like fretboards, cannot make or break an instrument, but they serve to enhance or edit the tonal contributions of other materials found on the guitar. The woods discussed above-ebony, Brazilian rosewood, and Indian rosewood-contribute similar tonal qualities when they are used as bridge materials as when they are used for fretboards.

It is important to remember that wood, when considered generically, can be responsible only for certain aspects of the tone of any guitar. Equally important are the design of the guitar, the skill of the maker, and the quality of the individual pieces of wood from which the guitar is made. Species selection can, however, be a determining factor in the creation of a very special guitar or a guitar designed for a specific purpose.