1 The cello: origins and evolution

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Introduction

Although it is the noblest and most profound in tone of the violin family, the cello is probably the youngest member and certainly the most recently perfected in form and proportion. Although its large size makes it particularly vulnerable to damage, its design (as with its smaller relatives, the violin and viola) has given it a remarkable longevity, and instruments made three hundred years ago are still used and treasured by discerning players.

The cello is a mechanically simple but acoustically complex instrument. (See Fig. 1.1.) The four tapered tuning pegs for adjusting the strings, tuned C–G–d–a, are made usually from hard rosewood (*dalbergia latifolia*) or boxwood (*buxus sempervirens*) for durability, and project laterally from a backward-curving pegbox. Proportionally, the pegbox is much broader than that of the violin, in order to accommodate thicker strings, and has distinctive squared shoulders at the lower end. At the upper end is the scroll, a Baroque adornment which is a characteristic feature of all the instruments of the violin family. The slope of the pegbox tensions the strings across the ebony nut, which is slotted to locate and raise them just clear of the surface of the ebony fingerboard, against which the strings are stopped by the fingers of the left hand.

The fingerboard is glued to the neck, which is carved in one piece with the pegbox and scroll from maple (*acer pseudoplatanus*). It has a curved top in cross-section, usually with a flattened area beneath the C string to allow for the wider vibration of this, the heaviest string. The fingerboard increases in width from the nut to permit wider string spacing at the bridge, allowing easier movement of the bow in string-crossing. The neck joins the body of the cello at the root, which extends to the full depth of the ribs, whilst the fingerboard extends further above the body.

The framework of the body is the rib structure, assembled from six thin maple strips bent to shape by dry heat and reinforced at the joints by interior blocks – one in each of the four outward-curving corners, one at the lower end, and the top block, into which the neck-root is fitted with a tapered mortice (prior to the nineteenth century, the neck was either glued to the outside of the ribs and secured with nails through the top block, or

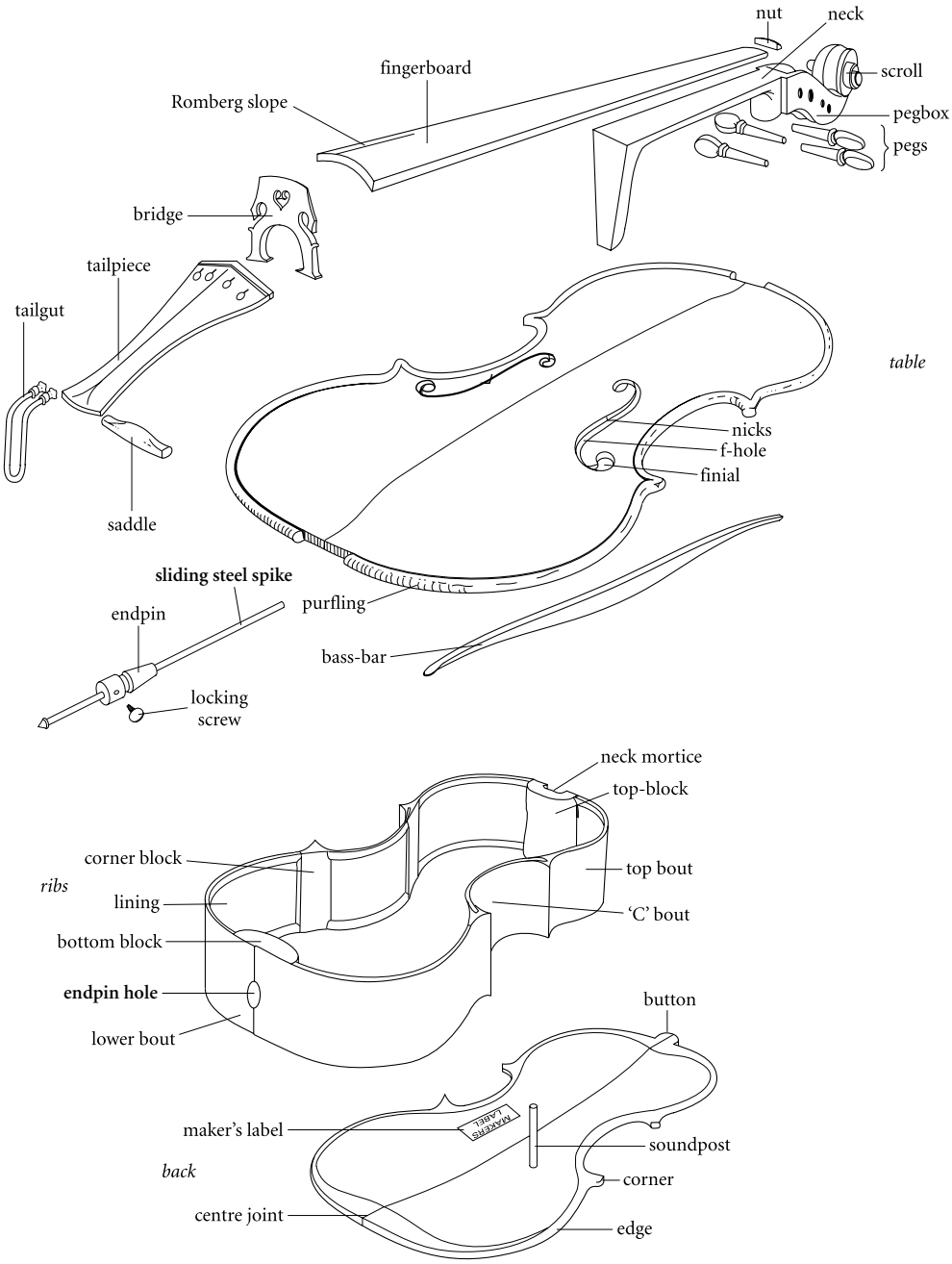

Fig. 1.1 An 'exploded' view of a cello

simply continued inside the body of the instrument forming its own top block, with the upper ribs inserted into slots cut in either side). The six ribs correspond to the six main curves of the cello outline: the upper bouts, the inward-curving middle or 'C' bouts, and the wide lower bouts, symmetrically arranged on treble and bass sides. To ensure a strong glue-joint between the extremely thin ribs and the table and back of the cello, strips of pine or willow, known as the linings, are glued along the upper and lower inside edges of the ribs.

The Classical makers of seventeenth- and eighteenth-century Italy assembled the ribs around a shallow hardwood mould, and this remains the accepted method today. Proportionally, the ribs of the cello are much deeper than those of the violin or viola (and consequently more vulnerable to damage), so many makers, including the greatest of all, Stradivari, chose to reinforce the inside of the ribs with linen strips.

The back of the cello is usually made from one or two matched pieces of maple jointed along the length. Maple trees of sufficient girth to provide flawless planks wide enough for cello backs are not easy to come by, and poplar, willow and even beech are not infrequently substituted, the softer woods often seeming well suited to the mellow tone-quality of the cello. Once jointed and planed flat, the outline of the cello is drawn and sawn out from the timber, and the arching (the outward swell of the back) is carved with gouge, planes and scrapers. The inner surface is also carved out to give a finished thickness in the centre of about 7 mm, reduced around the edges to about 4 mm. The height and shape of the arching, in combination with the precise finished thicknesses, are fundamental factors in determining the tonal quality of the instrument.

The appearance and strength of the back are also affected by the way in which the wood is cut from the tree (See Fig. 1.2a). The most common and strongest method is to join two pieces cut 'on the quarter' (Fig. 1.2b). This shows the horizontal 'figure', resulting from ripples in the grain of the wood, to good effect, matching mirror-fashion on either side of the joint. If the back is made from a single piece of quarter-sawn wood, it is usually made from the larger varieties of poplar or willow, which rarely show horizontal figure (See Fig. 1.2d). If the wood is cut 'on the slab' (See Fig. 1.2c), the figure is more diffuse in maple, although the 'contour lines' formed by the grain are more apparent. Wood so cut is not quite as stiff and is slightly more vulnerable to splits, but can yield a particularly warm and rich tone. Whichever variety is chosen, from the most desirable imported Balkan maple to the plainest local-grown willow, the back is always made from hardwood, which has a complex structure of interlocking cells and is relatively dense and strong.

The table is made in a similar way, but using spruce (*picea abies*, *picea*

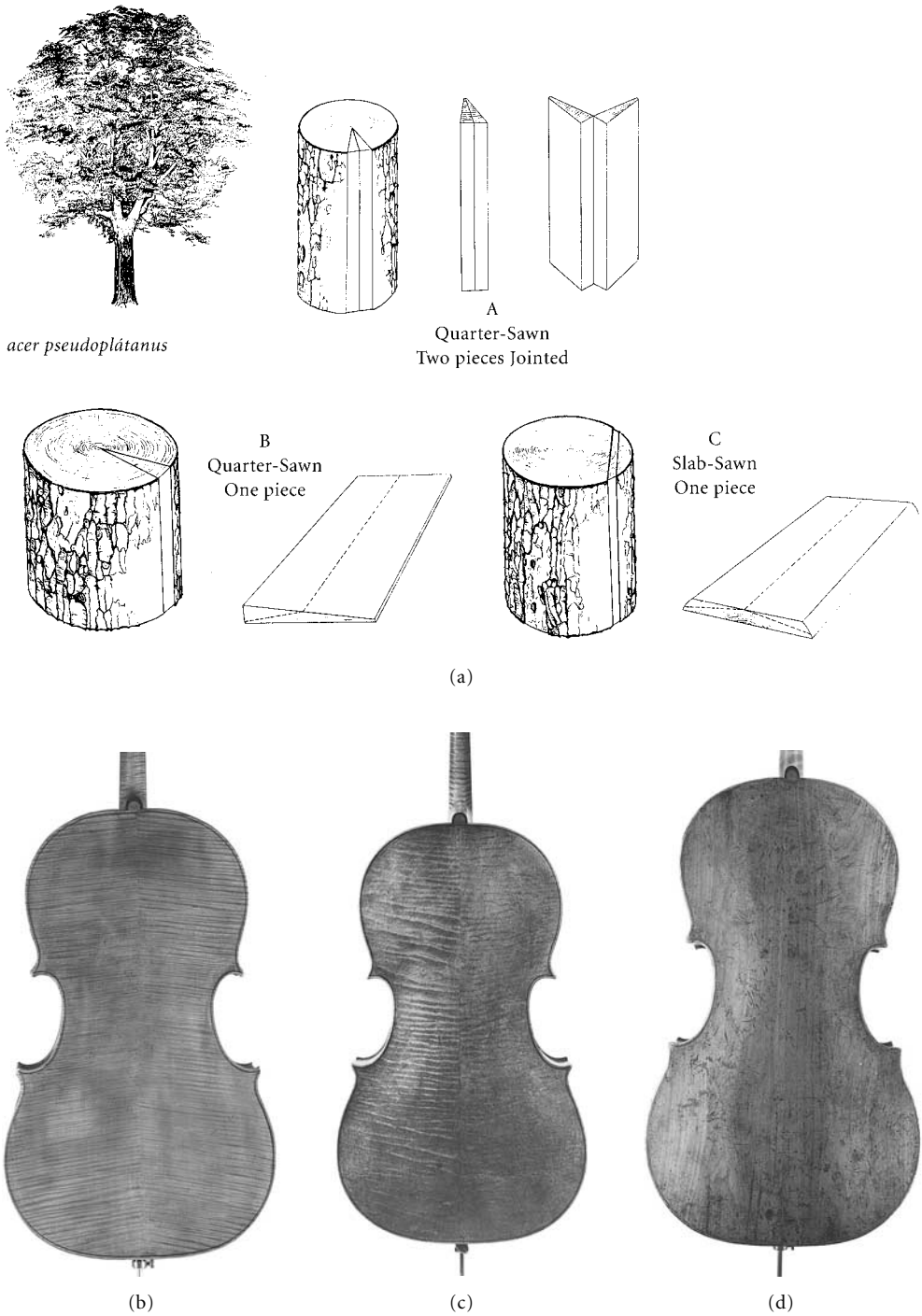

Fig. 1.2(a) Cutting the back of the cello: three different methods. (**b**) The back of a cello by G. B. Rogeri of Brescia, dated 1714, showing the characteristic transverse markings of quarter-sawn maple. (**c**) The back of a cello by Francesco Rugeri of Cremona, *c.* 1690, showing the more diffuse and irregular pattern of slab-sawn maple. (**d**) The back of a cello made by Bartolomeo Cristofori in Florence, 1716, a single piece of poplar wood of typically plain appearance

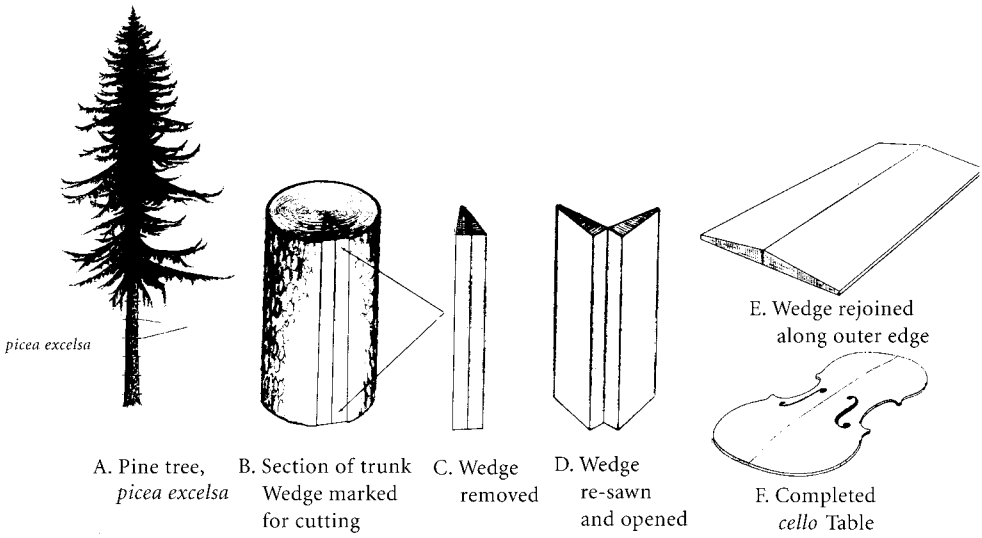

Fig. 1.3 Cutting the table of the cello

excelsa or *picea alba*), always cut on the quarter and carefully selected for straight and even grain, and the finished thickness is usually about 4.5 mm throughout (see Fig. 1.3). The wood is thus a coniferous softwood whose simple, light and rigid structure is essentially a bundle of hollow tubes which transmit vibration more readily along the grain rather than across the width.

Just inside the edge of the front and back is a narrow inlay, known as the purfling. This comprises three separate strands of wood, the outer two of ebony or pearwood stained black, the inner strand generally of poplar, the whole approximately 1.4 mm thick. As well as being decorative, the purfling serves an important purpose in inhibiting the development of cracks from the edges, which are especially vulnerable since they project outside the delicate ribs by a margin of 3–4 mm. On the back, this overhanging margin incorporates the button which substantially strengthens the neck joint and assists it in resisting the considerable tension of the strings.

The table, sometimes called the belly or front, is pierced by two soundholes, known by their shape as f-holes. They comprise three elements: a long curving arm, at each end of which is a circular finial. The bridge, whose precise location on the table is indicated by the small nicks cut in the middle of each f-hole, is held in place by the pressure of the strings alone and is cut from a wedge of hard maple. Its intricate shape is designed to reduce the mass of wood, without reducing its strength and rigidity beyond practical limits. The top curve of the bridge matches that of the fingerboard (though without the flattened section under the C string), and allows the bow to sound one string at a time, without fouling

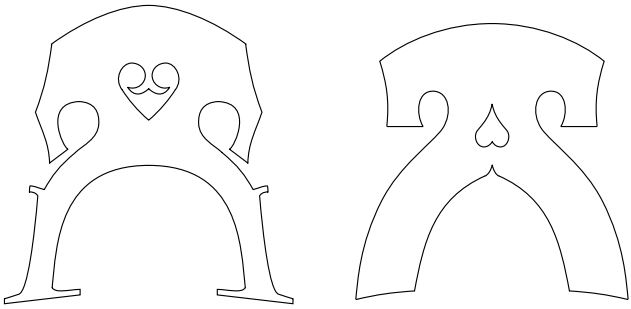

Fig. 1.4 Modern and seventeenth-century bridges contrasted

the adjacent strings (Fig. 1.4). Inside the cello, just behind the outer edge of the bridge 'foot' on the a-string side is the soundpost. This is a spruce rod, 11 mm in diameter, which is fitted precisely to the interior contours of the table and back and lightly wedged into position. Its exact position and 'tightness' are carefully regulated to adjust the instrument's tone to optimum effect for each player and for differing conditions. In a symmetrical position beneath the bass 'foot' of the bridge on the inside of the table is the bass-bar, a supporting strut of spruce which is roughly three-quarters of the length of the table.

The strings, having passed over the bridge, are secured to the tailpiece, traditionally made of rosewood, ebony or boxwood, but often now from lighter materials such as plastic or metal alloys and incorporating mechanisms for fine tuning. The tailpiece is secured to the cello by a loop of gut, or more commonly now nylon or wire, which runs over a saddle of ebony let into the bottom edge of the table, and around the endpin. This latter is a hardwood plug set into the lower block, through which runs the retractable metal spike which supports the instrument in its modern playing-position.

The adhesive used throughout the construction process has always been traditional animal glue, which is extremely tenacious but can easily be released when necessary with hot water, for repair work. That it is possible for the cello to be quite readily dismantled and repaired is a major factor in its remarkable longevity, enabling it to be modified to accommodate the various changes in sound ideal.

The cello is covered with a protective varnish, the quality of which is more than merely an indicator of the quality of the instrument. The Classical Italian makers appear to have used different formulations for the ground coat, which seals and protects the wood and can bring out the natural beauty of even the commonest plank of poplar wood, and the top coats, which were tinted with rich red, yellow and golden brown colours. Different combinations of oils and resins give different degrees of hard-

ness and flexibility; a well-judged varnish allows the cello to speak with its full voice for centuries, whilst a poor one will stifle it. Re-creating the varnish of past masters has been one of the greatest challenges to present makers; recent research suggests that walnut or linseed oil was the major constituent of the finest old Italian varnish, which was later supplanted by inferior recipes based on shellac and alcohol.

Origins and antecedents

Tracing the origins of the cello is not easy. Instruments played with a bow appear in European iconography from around AD 900, but interpretation is difficult and terminology seems to vary and overlap. Broadly speaking, however, these instruments fall into four main categories: the rebec, the medieval and Renaissance fiddle, the lira da braccio and the viol. Of these, the first three are generally accepted as ancestors of the violin and viola, because of their playing positions and sizes. It has also been suggested that they were all originally carved out of a solid block, with a simple soundboard added, a technique only practical with the smaller sizes of instrument.

With the viol, however, more complex and sophisticated constructions and musical applications are apparent, and the idea of the consort of instruments of the same family, but played in different registers, became fixed. This idea was very quickly applied to the violin after its appearance, probably at the beginning of the sixteenth century. In the fresco decorating the cupola of Saronno Cathedral, painted by Gaudenzio Ferrari in 1535 and thought to be amongst the very earliest depictions of the violin family (see Fig. 1.5), recognisable violins and also at least one three-stringed cello are discernible. In short, the distillation of the various families of instrument, such as the three-stringed rebec and the seven-stringed lira, into the four-stringed violin with carved back and front, provided a form which could easily be extended to the larger sizes for the consort, the viola supplying the middle voice and the cello as the bass instrument. The full name of the instrument, the 'violoncello', did not become widely agreed until the late seventeenth century, the instrument being described variously as 'violoncino' or even 'violone' in Italy,[1] the 'bas de violon' or 'basse de violin' in France and 'bass violin' elsewhere until well into the eighteenth century.

The oldest surviving cello is the work of Andrea Amati, the maker also of the earliest attributable violins, and is dated 1572. It was made as part of a group of instruments for Charles IX, King of France 1560–74, and shows that the cello was established as a member of the violin family at a very early stage.

Fig. 1.5 Detail from the cupola of Sarrono Cathedral painted by Gaudenzio Ferrari (1535), showing a cellist. Although distorted by the curved surface of the painting, the cello is clearly depicted, and appears to have three strings.

Development

The development of the cello as a distinctive and formally acknowledged instrument was inhibited by the practice, which continued well into the seventeenth century, of preferring the viol to the cello as the bass instrument in string ensembles. The fretted six- or seven-stringed viol with its flat, rather than carved, back evolved from a quite different background to the violin family. In England particularly, the viol enjoyed a reputation for refinement and delicacy of performance even into the eighteenth century, as it was capable of greater articulation than the early cello, with its rather clumsy tones. The practice derived from the slow acceptance of the violin as a court instrument, it having previously been regarded as the instrument of the street musician to whom volume of sound was more important than articulation. Nevertheless, cellos made by the earliest violin makers still survive today, though in a greater variety of forms than the violin.

Seventeenth-century paintings which depict the cello are much rarer than those which show either the violin or viol. In Dutch and Flemish paintings, the cello is almost invariably shown in the hands of street musicians or in tavern scenes, whilst courtly settings are usually graced by viols.

The early cello would probably have been more suited to supplying simple bass lines than the agile counterpoint associated with the viol. Indeed, the first description of a bass violin, by Martin Agricola in 1529, mentions only three strings, tuned to F–c–g;[2] and the beautiful cellos of Andrea Amati were probably made to accommodate only three strings, the pegbox having been modified later to accept a fourth peg.

Tuning is the first problem encountered in tracing the early development of the cello. After Agricola, most descriptions cite four strings,[3] the extra one being added below the F to give a tuning of B♭^{1}–F–c–g, a tone below modern tuning. This 'B♭^{1}' tuning was suggested quite logically by moving downward in fifths respectively from the tunings of the violin (g–d^1–a^1–e^2) and viola (c–g–d^1–a^1). However, having the instrument pitched naturally in a flat key made ensemble playing awkward, and the present tuning, with the cello doubling the viola an octave below, was current in Italy in the early seventeenth century;[4] it spread only slowly, the old 'B♭^{1}' tuning continuing to appear in England until the following century.

The early cello was not only tuned in different ways, but it was also made in a wide range of sizes. The first instruments made in Cremona by Andrea Amati and his family were of large size, sometimes referred to as the 'bassetto', *c.* 79 cm in length of back. However, almost contemporary with these were smaller cellos made in Brescia, with the back measuring only *c.* 71 cm. These two sizes seem to have persisted as alternatives well into the eighteenth century, and they have provoked some discussion amongst modern scholars as to whether they were one and the same instrument or, rather, two variants designed for different usages and tunings. The *c.* 71 cm shorter model obviously derived from doubling the back length of the 35.5 cm violin, but other considerations must have given rise to the *c.* 79 cm larger model. Makers seem to have chosen one model or the other, but a few, such as Gofriller of Venice (working between 1690 and 1720), seem to have produced almost equal quantities of both. Two of Stradivari's surviving templates for cello necks bear the interesting inscriptions 'measure of the ordinary cello neck', and on another, some 31 mm longer and 5 mm deeper at the root (indicating the height of the ribs), 'measure of the Venetian cello neck'. In England, the first cellos appeared at the end of the seventeenth century; an example by William Baker of Oxford, attributed to 1672 when the low B♭^{1} tuning was commonplace in this country, is of the smaller *c.* 71 cm size.

The unfortunate result of the preference for the larger model in Cremona is that most seventeenth-century cellos made by the greatest violin makers have been cut down for modern use and have thereby lost the original integrity of their design. Those which survive in their original

Table 1.1
Measurements for the Stradivari 'Forma B' cello, which is now an accepted standard (although dimensions of the body can still vary considerably)

length of body	756 mm
widths: upper bout	167 mm
middle bout	108 mm
lower bout	207 mm
depth of ribs at neck	117 mm
depth of ribs at endpin	123 mm
length of neck, from nut to belly edge	280 mm
length of stop, from bridge to belly top edge	400 mm
length of scroll	205 mm
maximum width of scroll	68 mm

form are not popular with players accustomed to the ease of playing the modern size of instrument.

The standard measurement today is a back length of approximately 75 cm, a median measurement between the two earlier sizes which was first arrived at in Cremona towards the end of the seventeenth century. Stradivari had already made several instruments of the larger pattern when Francesco Rugeri began to work to a 75 cm model. Stradivari's revised pattern on that size, the 'B' form introduced after 1707, was one of the greatest achievements of his distinguished career, and a wonderful legacy to modern cellists (see Table 1.1).

Stradivari's work did much to gain for the cello its current status in music, his refined designs giving a greater range of expressiveness and sheer power of tone to the soloist and ensemble player. Early cellos largely follow a very bulbous form, with the back and front highly arched; this can provide a resonant bass, which was mostly all that was required of the cello in the seventeenth century. By flattening the arch, Stradivari increased the projection and focus of sound on all four strings. The balance between a dark, powerful bass, and a bright, singing treble has always been the greatest challenge to the cello maker, and Stradivari has come the closest to achieving that ideal (see Fig. 1.6).

These improvements were made possible by progress in the manufacture of strings. Early bass strings were enormously thick strands of gut and were difficult to play with clear articulation. Rope-twist and overspun (i.e.