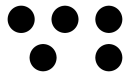
Tutti Fluti

A brief description of
different ways of sounding flutes

Jeremy Montagu



Hataf Segol
Publications
2018

Typeset in XɜLaTeX by Simon Montagu

CONTENTS

ORIGIN OF THE FLUTE

Anyone who can control the elements is powerful, and he who can emulate them, and so by sympathetic magic can make them obey him, is powerful indeed.

So who first heard the wind whistle across the top of a broken reed and learned to imitate that sound by his or her breath, and with it cause the wind to blow and call up the clouds that would bring the much-needed rain? This of course we can never know, for it was far back in prehistory.

Wind magic, rain magic, sometimes they must have worked if only by coincidence, even if sometimes they did not work, but one thing is certain, magic or no, that that breath created the origin of the flute.

All our flutes derive from that simplest of instruments, the end-blown whistle.

Such instruments are still with us today. People in a village in Thailand use a simple, short, tube of reed to lure a toad which they find delicious to eat. People everywhere blow one as a signal. Our children blow across the top of a bottle or, if any still use those archaic tools, the top of a fountain pen or a key with a hollow shaft. Musicians tie such tubes together, tubes of graduated length, to create a panpipe, that instrument of ancient Greek legend, the syrinx, that is still widely used both by musicians and our children. Folk musicians play it worldwide, Mozart wrote for

it in his opera *Die Zauberflöte*. To it and to many other derivatives of that earliest and simplest of wind instruments we shall return in other papers in this sequence on my website.

Simple indeed, for nothing is needed save the human breath and a tube, stopped at the lower end by a natural node, a plug, or a finger for the easiest of blowing. As one blows across the edge of the top, the physicists tell us that vortices are formed, alternately inside and outside the tube. If the periodicity, the rate at which the vortices form, i.e. the air-speed, matches the acoustic length of the tube, we have a sound. If the tube is long enough and we increase the air speed, we get a higher pitch, the first overtone a twelfth (an octave and a fifth) above the lowest pitch.

An open-ended tube is somewhat more difficult to sound. The angle of blowing, relative to the top of the tube, must be exactly right, as must the air-speed. The pitch for an open tube of the same length as the stopped tube will be an octave higher and the first overtone will be an octave above the basic pitch rather than a twelfth. These differences are beyond our control for they are fundamental laws of acoustics, though, as we shall see in other papers on this site, we can tinker with them a little so as to get a wider choice of pitches from what may appear to be a one- or two-note whistle.

What is the difference between a whistle and a flute? Nobody has an answer to this that can be universally accepted. A whistle produces one note, a flute many? No, for many whistles can be made to produce more than one note. A whistle is

for signalling, a flute for music? No, for some peoples may use a whistle for signalling and others may use an identical instrument for music, either within the same people or by neighbouring peoples. So any answer is purely arbitrary within the pages of any one paper. I will, probably with a few exceptions as we go along, use whistles for signalling, usually with only one or two notes as with cuckoo-whistles or dog calls, though far more with the boatswain's call, and will use flutes for those used for musical purposes, even though I have blown a cuckoo-whistle for an opera (drummers do not only hit things) and the swannee-whistle is much used for music as well as for a toy.

Flutes, and whistles, can be sounded in many ways. The simplest is as above, just blowing across the top of a tube, with an open or a closed end, or across a hole in a vessel of any shape but wider than a tube with no other outlet save, very often, one or more fingerholes. These first are called end-blown flutes or rim-flutes, the latter the more accurate term, because both notch and most duct flutes are also blown from the end, but the former is the more common term. Rim-flute is the better term since you blow across the rim of the end at the top of the tube or across the hole in the side of the vessel; these latter are called vessel flutes or ocarinas.

The tube can be somewhat easier to sound if at one point on the circumference of the blowing end a notch is carved with a sharp edge at its base, into which the air-stream can be aimed. There are comparatively few notch tubular whistles, though what

is often seen is a demi-lune lowering of one side of the blowing end, a stage intermediate between the edge-flute and the notch flute. So far as I know, there are no notch vessel flutes – or at least I have never met one. But there are many notch flutes, for which see a separate paper in this series of papers on Flutes.

Next, in what seems to be a developmental sequence, the notch get moved down the tube and is transformed into a window or a mouth (both terms are used, though mouth is preferable[1] with a passageway or duct leading the air-stream to the sharp edge at the base of the mouth. There are many forms of duct and many designs of mouth. The geometry of both, especially that of the mouth, will affect the sound but not all peoples have the same preferences for tone quality and sound. Just as one example: because of differences in the geometry of the duct and the mouth, the original baroque recorders sound very different from our modern versions of any 'baroque' recorder. Many original baroque recorders were revoiced by Arnold and Carl Dolmetsch to produce the sound that they preferred, just as all original Stradivarius violins were modified by Jean-Baptiste Vuillaume and others in the early nineteenth century, to produce the sound that they preferred, though this was also in the course of

[1]See Laurence Picken, *Folk Musical Instruments of Turkey* (London: OUP, 1975), 424-31, for a very detailed survey of the typology and nomenclature of flues and ducts.

modifying them to withstand the strains of modern performance and pitch.

The simplest of all ducts is provided by the player's tongue, protruding into the top of the tube, to aim the air to the mouth cut in the wall of the instrument. There is no way to tell, with archaeologically-found bone flutes and whistles, whether they are missing a plug or block (the latter the preferred term, as in the German name Blockflöte) of wood or other material, or whether they never had one and the player's tongue was used instead. Today, the preferred material for the block is wood (save with our plastic recorders and whistles), for the right kinds of wood are stable, provided the airway is regularly cleaned and dried after use, and will retain the desired geometry. In the past and still in many folk traditions, other materials are and have been in used, such as pith and wax, the latter often used, for example in South America, to transform a notch flute into a duct flute.

Because the duct automatically leads the air to the voicing edge, duct flutes and whistles are by far the easiest to blow and to play, and therefore the duct-flutes flutes and whistles, both tubular and vessel shaped, are equally by far the commonest forms of flute around the world.

But this does not mean that they are the best.

With a rim-flute or a notch flute, the player can produce many subtleties of tuning and tone quality which the use of a duct prohibits. By slightly varying the angle of the air-stream, or more commonly by slightly covering the upper end with the lip, the

area of the open end can be changed, opening it to raise the pitch slightly, covering it more to flatten the pitch. One of the problems of the flute, and also a useful property of the whistles, is that blowing slightly harder to increase the volume of sound also slightly sharpens the pitch. This was why Bach specified a *flauto d'echo* instead of a normal *flauto*, as the recorder was called in his day, for *Brandenburg Concerto no. 4*, in the slow movement of which phrases are repeated, first forte and then piano. With the normal recorder, the pitch would be slightly flatter in piano than it would be in forte, which means that Bach must have had some special form of recorder in mind for that work. By using the lip, this change can be countered on the rim-blown and notch flutes, as it is today by the players of our transverse flute. Equally, the players of these instruments can play in the many different tuning systems used around the world without the more complex adjustments of fingerhole covering that are necessary to do the same on duct flutes.

Therefore, within many cultures today around the world, especially perhaps in the Balkans and the Near East, one finds the professionals, or the most highly-regarded players, using end or notch flutes and the amateurs and the children using duct flutes.

'Duct flute' is the best term for those instruments, because the term 'whistle flute' leads to an obvious confusion – is it a whistle or a flute? And not all whistles have ducts as we have already seen. Another term, 'fipple flute', is a pure nonsense because the word 'fipple' has never been clearly defined. Many authors have

used it: some for the whole head, some for the block, some for the duct, some for the mouth. If everybody uses the word 'fipple' for a different part of the instrument, then indeed we have a nonsensical term, one which conveys no sense. The two things that are essential for a duct flute to work are a duct and a block. So if we leave block flute to our German colleagues, let us use duct flute in English if only because one form of the block, a human tongue, is ephemeral, leaving the head unblocked the moment the player ceases to play but re-creating the duct the moment he resumes.

As I have said, it would seem that this is a developmental sequence, rim-blown, then notch-blown to make it easier, and finally duct-blown to make to make it even easier, but we have, and can never have any evidence for this. That is because, if it really was a developmental sequence, it happened at such high antiquity, in or before the Neolithic period. This was when humans first learned to make pottery, or to grow crops in settled communities (the two basic criteria for the Neolithic) and to make and to play duct flutes. We have many such instruments from that period, those surviving being made of bone. This is because it is only bone that survives, buried in the earth, for many thousands of years. End-blown whistles are far earlier, dating back to the Upper Palaeolithic period, perhaps even to the times before our fully human species, *Homo sapiens*, came into existence. If we have evidence for bone whistles, and perhaps flutes, from Neanderthal times, then we must assume that the more easily made flutes and whistles of reed, cane, or wood were earlier still, perhaps into

the times of *Homo Heidelbergensis* and the common ancestor of Neanderthals and true humans.[2] But these have all rotted away, whereas bone survived. So these bone whistles and flutes, with some notch flutes, are our earliest flutes today, but they can never have been the earliest of all, if only because drilling a hole and shaping a mouth in bone is far harder to do than doing the same in the softer materials of reed or wood.

Finally, the most recent type of flutes are the transverse, those blown across the side as in our modern orchestral instruments. Worldwide and historically, these are the rarest, common historically only in India and the Orient, whence they spread to the rest of the world.

[2]See the paper 'Origins of Music' on my website, or on the Frontiers publications site.
(https://www.frontiersin.org/articles/10.3389/fsoc.2017.00008/full.)

END-BLOWN OR RIM-FLUTES

These are the great virtuoso instruments of the Near and Middle East, North Africa, and in most of the areas that were once under the sway of the Ottoman Empire.

They are also known as rim flutes because the air-stream is directed across the rim of the top of the tube, and they should be better-known as such, for two other types of flute are blown from the end, the notch flute and the duct flute, though these two are known by those more specific attributes. Nevertheless, end-blown flutes is often the term commonly used for them.

The blowing end is sometimes plain, just the cut-off top, but more often the outside circumference of the rim is knife-chipped to make a sharper edge, which improves the sound, or evenly ground down to a bevel edge to make the edge smoother and the same thickness all round the top, and so avoid any perturbations of the air-stream. Occasionally, as in Turkey, a mushroom-shaped mouthpiece may be added at the top of the tube.

It is this type of flute that is known to date back to Palaeolithic times, the Aurignacian period, when humans first came into Europe between 50,000 and 40,000 years ago.[1] Because the instruments found are all of bone, with one or two of ivory, it has

[1]See the paper 'Origins of Music' on my website, or on the Frontiers publications site
(https://www.frontiersin.org/articles/10.3389/fsoc.2017.00008/full.)

to be assumed that they were preceded by similar instruments of cane and reed, and of course we cannot know how far back flutes of those materials had been used because they have not survived burial in the earth for so many thousands of years in the way that bone can survive. Nor, because so far there has been little archaeological investigation of such early sites in North Africa, do we as yet have any evidence for bone flutes from that area, through which some of the incursion into Europe seems to have happened, nor have as yet such flutes been found in the early Near Eastern sites, the other main emigration route from Africa. Iain Morley's book, *The Prehistory of Music* (Oxford: OUP, 2013), gives a list, with comprehensive details of all known whistles and flutes, from the earliest down to the end of the Neolithic period, and it also lists all those which had been thought to be flutes but which further investigation now suggests were not, with fingeholes and other indicators of musical use more likely to have been caused accidentally or by animals gnawing the bone.

The rim flute is normally played slightly obliquely, with the rim partly inserted between the slightly open lips at one edge of the mouth. Getting the angle and speed of blowing right to produce a full tone rather than just a hissing sound is a knack, but once secured and remembered, the player has little more trouble than players of other styles of flute. Most such instruments today have six or seven fingerholes, with or without a thumbhole, and sometimes a number of tuning vents below the lowest fingerhole. Six holes is enough for a diatonic scale, as all penny-whistle

players will know, and any chromatic notes required can be produced by cross-fingering (covering whatever holes are necessary below an open hole) or by partly opening a fingerhole (known as half-holing).

Subtleties of intonation, commonly needed in areas where quarter-tones and other microtonal tunings are used, are achieved by slightly altering the angle of the flute against the lips, or by slightly covering or opening that end against the lip. Covering the end flattens the pitch, and opening it raises it, because this decreases or increases the area of open holes. This may be necessary more often than one might expect because fingerholes are usually placed by finger-widths between them, rather than by precise measurement, and my fingers may be wider or narrower than yours. Also, the fingerholes of most instruments of reed or cane are bored by a hot iron rather than by any precisely measured drill bit and therefore their diameters vary slightly, and this affects the pitch when they are opened. Since a very common use of these instruments is playing alone, there is normally no precise basic pitch, whereas the intervals between each pitch do need to be exact if the performance is to be 'in tune', though for instruments that are to be played in ensembles, a precise length must be determined also.

In a number of areas, especially Turkey and those parts of south-eastern Europe which were once part of the Ottoman Empire, solo players often accompany their music with a hummed drone, known in Romania as the *ison*. As the melody moves, so

also may the pitch of the drone, from one base note to another. The use of the drone has a marked effect on the sound of the flute, adding a considerable richness to the tone, with a suggestion of much added overtones. Flutes of all sorts have on the whole a weaker overtone spectrum than reed-blown instruments, something much closer to a pure sine-tone, and the *ison* seems to fill up that spectrum.

As I said at the beginning, the rim flutes are virtuoso instruments, and this is because of the subtleties of intonation and tone quality described above and that are available to the players. In many of the cultures in which they are used, mostly the Middle and Near East and Central Asia, they are the first choice of the professional flautists, while the amateurs choose the duct flutes that are also available in the same areas for their ease of sound production. They are rivalled in virtuostic performance only by such notch-flute performers as those on the *shakuhachi* players in Japan and those of the great transverse flute, *bānsrī*, traditions of India.

Notches vary in shape, but all make the flute easier to play than the plain rim flute because the notch forms a small area into which one can focus the air-stream. While examples are known in many areas, the predominant uses are in the Orient and South America.

There is an area between the rim-blown and the notch flute which consists of slightly lowering a part of the rim, usually between two-thirds and a third of the circumference, so that it is not really a notch but a shallow crescent, and it is still a help to the player.

The best known flute of this crescent type is the Japanese *shakuhachi*, a bamboo instrument dating back to early mediaeval times; it derives from a Chinese instrument of the sixth century of which there are several examples in the Shosoin Repository in Nara. The name comes from its length, one Japanese foot (*shaku*) and point-8 of a foot (*hachi*), though other sizes are made today, and it is made from the root of a special species of bamboo with nine nodes, most of them clustered at the bottom of the body. The bore is comparatively wide (mine measures 18.5 mm) and it is normally lacquered internally. The lip has an insert of hardwood at which the player aims the air-stream There are four fingerholes and a thumb hole so that the basic scale is pentatonic, but the *shakuhachi* is fully chromatic in the hands of a skilled player because by partly shading fingerholes ('half-holing' in our terms)

and even more by slightly varying the angle of incidence of the air stream and by partly shading the upper end with the lip an almost infinite variation of pitch and of tone colour is obtainable. The *shakuhachi* has a major repertoire of music, as could be expected from its long history, and is also often used as a mode for meditation. Today many instruments are also made of wood and often of plastic.

The simplest notches, especially in materials such as bamboo and other giant grasses, are a knife-cut V, but this is not very efficient because the air-stream is somewhat scattered at each side of the V. Better is a U-shape and this is common in China and other parts of South-East Asia. Many of these flutes have a hole for a membrane, like that on the Chinese transverse flute *di*, though the hole for it usually at the side of the instrument, rather than in line with the fingerholes, and is also smaller in diameter than that of the *di*. The *xiao* (old spelling *hsiao*) is the long Chinese bamboo notch-flute and while sometimes the top is open with a small U-shaped notch in the rim, more often it is closed by a node of the bamboo, save for the notch itself. Exceptionally the node may be cut in an ornamental pattern of small holes, and the membrane, the inner skin of the bamboo itself, is placed over these holes to add the buzzing sound which is an integral part of this music.

One of the best-known flutes with a rectangular notch is the *qena* of Peru and the neighbouring areas of South America. This can often be heard with the panpipe-playing groups that appear as buskers in our streets and it is also a model that has been widely

copied by makers in other countries for those who wish to play exotic instruments.

It is this shape of notch that also forms the mouth of the duct flute, and it is in Brazil that one finds both forms, often in instruments made of the leg-bones of jaguar and other animals. Here a thin area of wax covering the top of the tube can convert a notch flute into a duct flute.

Notch flutes are also found in many other parts of the world, and so also are flutes with a dropped area part of the rim, coming between the rim flute and the crescent-notch flute such as the *shakuhachi*.

Ducts, the passage way that leads the air to the sharp edge at the base of the mouth (sometimes called a window), are most commonly internal as with our recorder and penny-whistle, but they can also be external or even both successively internal and external.

The external-duct flutes are common in Indonesia, especially in Java where the *suling* is used in the gamelan. They are made of a thin-walled bamboo or reed and the upper end is closed by a natural septum. At one point of the circumference of the head, the septum is carved away sufficiently to leave a passageway between the head and a strip of leaf, tied round the head, that leads to a mouth in the wall of the instrument. The number of finger-holes will vary according to whether the *suling* is tuned to *slendro* or *pelog*, the two scale systems used in that music, the former with six pitches and the latter with seven pitches to the octave.

The internal-and-external flutes seem to appear in parts of Melanesia in Oceania, and among the Navajo and some other tribes of the North American natives and in pre-Columbian Mexico. Jaap Kunst cites instruments in Flores, both single and multiple, where one blows in through the head which is blocked a short way down by a natural septum, where a small hole in the side of the head leads the air out to a passageway formed by a leaf that pierces the cortex of the body and forms a passageway that

leads to a mouth in the side of the instrument through which the airstream can enter the body. The American instrument works on the same principle but the external part is a carved wooden block, tied round the body, with a groove cut along its underside to form the duct. Elaborately carved blocks are seen in the codices of pre-Columbian Mexico but the instruments themselves seem not have survived – I have never seen one in a catalogue. We may, I think, assume that the North American examples, which are still used and often referred to as an Apache flute, derived from the south.

Far commoner and used almost worldwide, certainly from Neolithic times onwards, are those with an internal duct.

Here one blows into the upper end of the instrument where a block of wood or other material leaves a narrow channel between the wall of the instrument and the block (hence the German term Blockflöte) which leads the air to a small mouth in the side of the instrument with a sharp edge at its base. The airstream is divided by this edge both internally and externally, and if its periodicity will match the air column of the body, the instrument will sound. The geometry of the duct and of the mouth, both the dimensions of the duct and the height (the cut-up) and the width of the mouth, are critical to the quality of the sound, but these vary widely around the world because different peoples prefer different sound qualities. Even in our own world, the sounds of a baroque recorder and a modern one are very different for these reasons. Also some peoples like to carve the duct in the

side of the block; others shape the block or shape it of wax rather than wood, or of pith, to leave a passageway, and others carve a channel along the inside of the wall of the body, leaving the block cylindrical – this last is that used in our recorders and flageolets, because it makes it easier to replace the block if necessary. A more ephemeral method is to stick one's tongue into the otherwise empty head of the instrument, shaping the tongue to form the duct; these are known as tongue-duct flutes. These might well have been the earliest form of duct flute, for the Neolithic instruments never preserve their blocks and therefore there is no way to tell whether they were tongue-ducts or had a more permanent block.

Because with a duct all that one has to do is to put the head of the instrument into the mouth and blow, these are by far the commonest type of flute in the world – of course actually playing the instrument does take skill, but at least it avoids the additional skills required on the rim flute. As a result, in those cultures where both types are used, such as in Turkey, the rim flute (*kaval*) is preferred by the skilled musician and the duct flute (*dilli kaval*) by the amateur.

There are so many types of duct flute around the world that it is impossible to name or describe them all. They include many whistles, vessel flutes, overtone flutes, panpipes, tabor pipes, and the organ, each of which has its own article in this series, as well as others even in our own culture.

The three most prominent in our culture are the recorder, the flageolet, and the tin whistle. The last, also known as a penny-whistle, is widely used in folk music. In the nineteenth century it was often made of a cylindrical brass tube (others, especially those of tin-plate, are of contracting bore, widest at the head), but be careful of using these brass ones, for the block was often of lead, which can lead to serious health problems; modern ones, available in most music shops, have either wooden blocks or plastic heads.

The flageolet has distinct forms: the common English one was a short wooden instrument with six fingerholes, whereas the French, by Mersenne's time in the 1630s, had four fingerholes and two thumbholes. This was very much a professional instrument, often used for dance music and sometimes called a quadrille flageolet, and gradually acquired more and more keys for chromatic notes, culminating in a system derived from Boehm's conical transverse flute of 1832, with rings and keys. An elaborate, and elegant, version of the English type appeared around 1800, made of boxwood with ivory mounts and ivory spots between the fingerholes to aid placing the fingers correctly. These were sometimes single but often double, with two parallel tubes in a common head which contained a sponge to absorb moisture. There was even a triple version which could provide bass notes for accompaniment, operated by the thumbs of each hand. These were aimed at the gentleman amateur. One must always remember the amateur market with all instruments, which are nearly always more

elaborate in appearance or material than the equivalents made for the professional – ivory, glass, or other less-often seen materials, for until the days of the small portable radio or tape machine, music when required had to be played rather than just listened to. Hence all the walking-stick instruments (including flutes both duct and transverse).

The recorder dates back to at least the 1400s, both the instrument and its name, and it is distinct from other duct flutes in that it has both a thumbhole and a seventh fingerhole for the little finger. The little-finger hole was duplicated in the earlier one-piece instruments, hence the French name of *fluste a neuf trous*, the nine-hole flute, so that it could be played either left- or right-hand; the unwanted hole was blocked with wax. When, like the transverse flute, it was modified at the French court in the late 1600s, with a separate head, body, and foot, the foot could be turned to suit either hand and the ninth hole was eliminated; the flute then became known as the *flûte douce*, or simply as flute, for until the end of the eighteenth century 'flute' always meant recorder – the transverse flute was always adjectivally distinguished as transverse or German in whatever language that was employed.

Again there is so much literature available for the history of the recorder and other duct flutes that there is little need for more detail here, other perhaps than for one type that shows clearly the transition between the notch flute and the duct flute.

This is found in Brazil, where flutes are often made of animal bone as they were in the Neolithic period, often in Brazil of

jaguar leg-bones. These are often strung together as a necklace, and sometimes one finds an open head with a notch, and sometimes the top of the head is covered with wax, leaving a small hole in the wax to lead the air to the base of the notch and thus turn the notch flute into a duct flute. It is arguable that a similar process took place in other parts of the world also, and that in many cultures notch flutes likewise led to duct flutes for greater ease in performance.

TRANSVERSE OR CROSS FLUTES

These are so-called because they are held transversely across the player's face, and are played by blowing into a hole in the side of the tube, the embouchure, near the stopped upper end, 'the head', or near a stopper inserted further down the tube to aid the balance of the instrument.

They seem to have originated probably in India, where they are a common attribute of Krishna, an Indian deity as an avatar of Vishnu. Another possible origin is in China, though it seems more probable that they travelled there from India. Thence they went on into Japan where they became important instruments in the court orchestras from the sixth century CE onwards, or even before.

What appears to have been their earliest appearance on the peripheries of Europe is in Petra in Jordan and in contemporary Hellenistic and eastern Roman sites such as Halicarnassus, all around 100 BCE to 100 CE, both of which I published in *Early Music*. Thereafter there seems to be no further trace until the eleventh century or so in Byzantium. Intervening evidence may yet be found, but at present there seems to be none, so that we can only assume that there was a second revival of interest from the east. Even after the appearance of these transverse flute in the Byzantine manuscripts, there still seems to be no European evidence other than one bronze vessel cast in the form of a cen-

taur from Hungary, blowing a very short transverse flute about the size of a B-flat treble band flute, until we reach the *Cántigas de Santa Maria* in late thirteenth-century Spain, with one example illustrated there.

It seems likely that the transverse flute was still little used or appreciated, for it appears very seldom in mediaeval iconography. One appearance is in the Bodleian Library's great copy of the Romance of Alexander of around 1340, which was illuminated in Flanders and which I described in an *Early Music* article. Another is on the Crozier of William of Wykeham which must date close to 1366, at which date he was appointed to the see of Winchester, and which again I published in *Early Music*. Both of these appear to have been one-offs, both the size of our modern concert flutes, as were the Byzantine and earlier examples, with no other parallels found so far in the iconography.

Slightly earlier are the portraits of the German Minnesingers in the great *Mannesse Handschrift* in Heidelberg of around 1330, where several transverse flutes appear, but these are all short instruments, between B-flat and F band flutes in length. Similar flutes appear in the carvings in Cologne Cathedral, but I have not seen relevant literature on these carvings, for while some of the Cathedral is mediaeval in date, most is from the nineteenth century, and to which period the relevant carvings belong I do not know – they seem so similar in style to those in the Mannesse manuscript that I am a little suspicious.

When the transverse flute does more commonly appear in Europe is with the Swiss and German mercenary soldiers of the late 1400s onwards, when we begin to see soldiers carrying flute cases on their belts, with compartments for flutes of different lengths. We see them, too, played both left- and right-handed in The Triumph of Maximilian, first published in 1526. This is also when the pipe and tabor for marching units began to give way to the fife and drum (and perhaps when military units began to march in step). Thoinot Arbeau describes this in great detail in his book *Orchésographie* of 1589. It is clear, too, that this is when the transverse flute began to come into European civilian life again, for we have the famous series of paintings of the 'Ladies of the Half-length', which date from around 1530, in which respectable-looking young ladies appear willing to play an instrument that otherwise belongs to the rough soldiery.

Even so, the transverse flute seems not to have become really respectable – in the Baroque period the 'flute' always meant the recorder – even for Bach and Handel, the transverse instrument was always specified as traversa, flauto traverso, fluste d'allemagne, traversiere, and so on. Even as late as the early nineteenth century we meet the English term of German flute to distinguish it from the recorder.

What made it respectable was its use at the French court and above all it becoming the favourite instrument of Germany's king, Frederick the Great – if he could play it, then so could anyone else even if they didn't have the benefits that he did of Joachim

Quantz as his tutor and Carl Phillip Emmanuel Bach as his court composer, and Sebastian Bach writing his *Musical Offering* for him, which includes a Trio Sonata for flute.

The earlier European transverse flutes were simply wooden tubes with a cylindrical bore and one hole for the embouchure and six slightly smaller holes arranged in two groups of three as fingerholes. We have many examples of these, especially in the Accademia Filharmonica in Verona. Their major improvement came in the court of Louis XIV in Versailles at the hands of the Hotteterre and Philidor families, who built the flute with a lowest pitch of D, a wholetone above middle C, and divided the instrument into three main pieces, a cylindrical head joint with the embouchure, a small link piece often of ivory, a body with the six fingerholes slightly tapering in bore, and a foot joint carrying a single key closing another hole for the lowest E-flat. From then on the history of the traverso (as it is called ungrammatically today, for the noun is feminine ending in -a and only acquires its masculine -o when used adjectivally with the masculine noun flauto) is so well known and described in so many books that it is unnecessary to go any further here.

Returning to where we began, the classical Indian flute is made of bamboo, much thicker than the small instruments that appear in Oxfam and similar shops, and about the same length as our concert flute. It has the six fingerholes that were standard in almost all transverse flutes until the Hotteterre modifications.

The Chinese transverse flute is similar, though rather lighter, again much the length of our concert flute or a little less (as distinct from the small ones available in the larger Chinese groceries) but it has more holes. Counting from the head we have the embouchure, then two or three inches lower a hole which is covered by a thin membrane made from the inner skin of a bamboo, then a few inches lower again the six fingerholes, and close to the foot two holes at the back of the tube through which a tassel is tied so that the flute can be hung up when not in use. Sometimes there may be one or two tuning vents between these tassel-holes and the lowest fingerhole. The membrane vibrates when the flute is played and adds a sweetening buzz to the sound. But what is important is that there are the conventional six fingerholes and not, as one sometimes reads in a museum catalogue, ten or twelve fingerholes – the Chinese have no more fingers than we do.

The Japanese transverse flutes of the Gakaku orchestra and the Noh plays are shorter and some of them thicker, with six oval fingerholes with either a ridge of the bamboo between each hole or a ring of thin strips of bamboo to help the fingers fall into place.

Transverse flutes appear in a few other places also, in New Guinea for example, with the long sacred flutes described among the Harmonic Flutes in a separate paper in this series. But there are shorter flutes in Papua New Guinea about a metre long with a single fingerhole, and even shorter ones, a foot or so long of bamboo, and very much wider, up to three inches in internal di-

ameter, without fingerholes but closed more or less with the palm of the hand over the open end.

Another is in the Honduras of the bulge of South America which have just one wide hand-hole in the side, which again is stopped to a greater or lesser extent to produce different pitches.

Other areas, for example among the Toradja people in Celebes (now Sulawesi), are where we find transverse flutes today, beautifully decorated in the traditional styles, but these were introduced by German missionaries in the late nineteenth century.

Of all the many styles and flavours of flutes in the world, the transverse were among the rarest of all worldwide until the late nineteenth- and twentieth-century adoption of our European band and orchestral instruments.

NOSE FLUTES

These are flutes blown via a nostril rather than the mouth. They are found most commonly in the Philippines and in many island groups both in Micronesia and Polynesia in Oceania. Their use is usually for ritual and very commonly for love-making and it seems (though this is speculative) to be the result of sensibility in that the breath of the nose is nearer to the soul, whereas the mouth is used for profane and common purposes such as eating and speaking – there is a link here with the common remark of 'Bless you' when somebody sneezes, for a sneeze can risk expelling a portion of your soul.

The Philippine nose flutes, *seruling hidong*, are quite long and made of thin-walled bamboo with the ennezure (one cannot call it an embouchure!) as a small hole in the centre of the septum that closes the upper end. There are three fingerholes plus a thumb-hole, all close enough together to be covered by one hand so that the other hand can close the unused nostril, thus strengthening the airstream from the blowing nostril; even then the sound is usually quieter than that of a mouth-blown flute. They are long enough and narrow enough in bore to be freely overblown and have a range of over two octaves.

The Oceanic nose flutes are more often a fairly stout segment of bamboo, closed by a septum at each end, with the ennezure very close to one end. Fingerholes are bored, normally burned,

along the upper surface, usually three or more and sometimes three at the mid-point of the body, one on the upper surface and one on each side. Acoustically these are vessel flutes (for which see a separate file in this sequence) so it is immaterial which holes are opened since all are of the same diameter. The flute is held facing forward so that while it is a side-blown instrument it is difficult to call it a transverse or cross flute. Again one thumb is often used to close the other nostril. There is often some pyrographic decoration.

In New Zealand the *nguru* is often referred to as a nose flute, but the evidence seems to be that it was normally mouth-blown. It is again a vessel flute as is another version made of a gourd.

A very different form of nose flute appears occasionally in our own culture – I have examples from both Germany and the USA, and others have been seen. These are modern instruments of plastic. They are held against both the nose and the mouth with a duct leading to a mouth or window opposite the player's mouth and they are variable capacity vessel flutes. The sound is generated via the duct like a recorder, but instead of having a tube with fingerholes, the player's mouth serves as the resonator and by varying the mouth-shape, as one does to produce different vowels, the pitch can be modified.

There seem to be no other references to nose flutes elsewhere in the world.

OVERTONE (HARMONIC) FLUTES

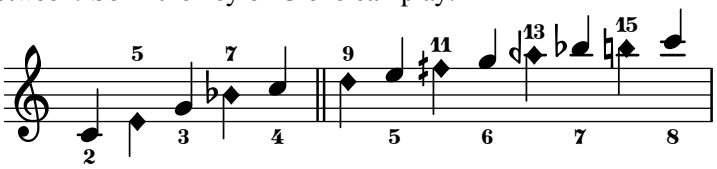
The simplest of all flutes, other than stopped whistles, is the rim-blown overtone- or harmonic-flute. Here all that one needs is a simple tube, usually between one and two feet long, long enough to get a series of overtones and not so long that the far end is beyond the reach of a finger of the hand that is not supporting the instrument. Any material will serve, cane, reed, wood, plastic, or metal. It is an instrument of unknown age that only fairly recently has become known to musicologists because unless one hears and sees it being played, who can recognize any odd bit of tubing lying around as a musical instrument? Thus no archaeologist will ever recognize it and it is only since folklorists have begun to describe their local instruments in books and articles that it has become known.

One of the simplest is the Romanian *tilinca*. Here, while a musician who is also a craftsman will make and often decorate a wooden tube for the instrument, any one else can pick up a discarded bit of water- or heating-pipe and start to play it. It will work better if the upper edge is chamfered externally, rubbing it down against a stone or with a file or emery or sand paper, or for wood and cane by chipping at the top, but this is not essential. We live in hope that an archaeologist may recognize that a bone tube has such a chamfered end, for then we would know, rather than suspect, that such flutes have existed since remote antiquity.

However, since few archaeologists are aware of musical potentials save when they can see an obvious series of fingerholes, or parts of well-known string instruments such as lyres, this seems unlikely to happen unless they read this and other articles on it.

Within the past century, Tiberiu Alexandru recorded many players of such simple harmonic flutes in his own country of Romania and thus has made the *tilinca* known to us.

With the far end of the tube open (represented in the musical example below by round noteheads and upward stems) it should be possible to get the first eight or more partials, from the second partial upwards, and, with the far end closed (represented by square noteheads and downward stems) with the finger, from the third partial, the partials of a stopped tube starting an octave lower. These interlock so that diatonic scales are available and, with some shading by only partly closing the end, a few notes in between. So in the key of C one can play:



giving an arpeggio plus a flat seventh, and then a scale.

Much easier to blow, and to recognize, is a tube with a duct in the head, just as it is with whistles. We find these in Slovakia,

for example, varying from 30cm or so long, which can produce that same sequence of notes.

Another duct-blown overtone flute is the Norwegian *seljefløte*. Traditionally this was a springtime instrument, a tube of coiled willow bark (*selje* is Norwegian for willow) with a mouth near the top and a piece of wood, cut to form the duct, pushed into the upper end of the tube so that the flute could be blown transversely. When the bark dried out and fell apart, another strip could be coiled up and the wooden head transferred to that. However, it was only possible to make the *seljefløte* in the spring, because it is only then, when the sap is rising between the bark and the wood, that the bark can be removed easily. When players wanted to continue to use the instrument throughout the year, Egil Storbekken devised a tube of plastic in the 1960s, covered with bark, or imitation bark of printed paper for the sake of good appearance, with the traditional wooden head inserted into the near end. Such instruments can be obtained today in Norway, with variants, including one with a plastic head similar to those used on tin whistles, from many other sources.

Similar instruments seem to exist all over northern Europe, from Norway to Russia and down into Poland, made either of willow or birch bark, and more permanent versions, of wood or plastic, appear widely today on the internet.

As yet we have few reports of such instruments outside Europe, but one exception is Papua New Guinea, where the great secret flutes, two or three metres long, are used in pairs, hocketing

their overtones against each other. These flutes are side blown, transverse flutes, the pair, usually made of bamboo, a tone or two apart in pitch, with a very wide embouchure (mine are about 25mm in diameter). The two players face each other with the lower ends of the flutes resting on the ground. The upper ends are often closed by an elaborately carved wooden stopper, and these stoppers, without the flutes, can often be seen in museums as art objects. Shorter flutes are also used there, with the distal end stopped by the hand, 'the hand' because the bore is much too wide for a finger, around four or five millimetres in diameter. These are called secret flutes, sometimes sacred or spirit flutes because while all may hear them in the rituals in which they are used, only initiates may see or play them, certainly as so often with sacred objects, they may never be seen by women.

It would seem probable that so simple an instrument, whether end- , duct-, or cross-blown, must have been used in the past, and perhaps still today, in other areas that are as yet unstudied by ethnomusicologists, and one may hope that with more reports of their existence and use they may gradually become known to us.

PANPIPE OR SYRINX

The Panpipe or Syrinx is essentially, a set of whistles, a series of one-note tubes, without fingerholes, fixed together to form a melodic instrument. It has been found from antiquity and is still used over much of the world.

The names come from the European legend of its origin. The Greek god Pan was chasing the nymph Syrinx who cried to the river nymphs to save her from his clutches. Taking pity upon her, the nymphs turned her into a clump of reeds, whereupon Pan cut her into a series of tubes and played music upon her instead of what he had originally intended to do. The problem with using her name for the instrument in the plural is that a Greek plural in 'nx' becomes 'nges', thus leading to confusion with a common medical tool.

As well as the instrument just described, 'a series of one-note tubes, without fingerholes, fixed together to form a melodic instrument,' we have what may or may not have been a prototype or earlier version, a human panpipe as it were. A group of people each has a separate tube, each blowing across its top at the appropriate moment to produce a melody, a process known as hocketing because in mediaeval vocal music it sounds somewhat like hiccuping, with both words coming from the same root. Such ensembles are common in southern Africa, among the Venda people for example. A somewhat more complex version of the ensem-

ble exists in Lithuania, again a set of individual tubes but played by only two or three people, with each player holding two or more tubes of the set and again hocketing to produce the melody. Whether such uses precede the panpipes we do not know, for panpipes are found almost worldwide, whereas it is only among living peoples that musicologists have observed the use of the disjunct panpipes (the technical term for such sets). We have no archaeological records of disjunct sets, but yet it seems very possible that these were an earlier idea, starting perhaps with two or three pipes, before somebody hit on the labor-saving device of tying them together. Certainly panpipes do exist with as few as three pipes tied together, in East Africa for instance. The only areas that I know of without record of panpipes is Australia.

There is a number of forms of panpipes, the most common across the world being the raft, a single row, sometimes a double row, of pipes lashed together, often with split cane struts to support them, but also often just tied with cord or thread. Another form is the bundle, a group tied together in a circle and, in Thailand, for example, sometimes luted together with wax plus a handle by which to hold them.

The pipes are most commonly arranged in scalar order, lowest at one end of the raft and the highest at the other – some people playing with lowest to the left and others to the right, sometimes as a cultural practice, but probably more often as a personal choice. For us in Europe, it was the invention of keyboard instruments, beginning with the organ, invented by Ctesibius in

Alexandria around 250 BCE, that has led to the fixation of lowest normally to the left. The organ, since it is basically a box of whistles, is described in another paper here in this sequence. At least one people, though, the Quechua of South America, prefer a zigzag order of pipes. Whether this is random or in an order that suits a particular style of melodic pattern, I do not know – it would need a comparative study of specimens scattered over a number of museum collections to be certain, or the evidence from ethnomusicologists from many studies over a wide area of South America.

The tubes of panpipes, both conjunct and disjunct, are normally stopped at the bottom or at a point partway down the tube that produces the desired pitch. With the former, the bottom of the tubes make an evenly ascending line, but with the latter the top and bottom of the row may be parallel or again may ascend but not necessarily in the same pattern as the pitches they produce (the Quechua pipes are an example of this, for while the bottoms appear to be in zigzag order, the pitches may be in a different zigzag, as can be seen by looking to see where the nodes that stop the tube length are). Because the commonest material for the pipes is bamboo or reed, the commonest stopper is the natural node that separates the individual sections of many types of giant grass. Fine tuning of pitch is often adjusted by dropping pellets of wax into the tubes, rather than by recutting the top of each tube.

Most panpipes around the world are blown across the top, like rim-blown flutes, but in our culture they are more often duct-blown, as they are also in China and Japan. Rim-blown ones quite often have the edge further from the player's mouth lowered in a crescent, thus approaching the notch flute, though actual notches are rarely seen. This is useful for the organologist because it tells us for certain which way the pipe was played, whether ascending left to right or right to left.

Double raft pipes, often seen in Bolivia for example, may have both sets stopped, in which case one row is usually half the length of the other, so producing near octaves, or one row may be stopped and other open, in which case both are usually the same length so that, again they sound in near octaves. This is because a stopped tube will sound approximately an octave lower than an open tube, as will one tube half the length of another. The octaves are approximate, usually with a slight vibrato between them, because of an acoustic feature called end-correction. When one blows down an open tube the effective air-column length is slightly longer than the tube that contains it, the air stream continuing a little way beyond the end of the tube, rather as we try to travel a little way further when a vehicle in which we are sitting slows down. End-correction applies to both ends of the tube, and if one end is stopped, we lose the end-correction from that end and so the pitch is slightly higher than that of the octave above that of an open tube of the same length. And if we have two stopped tubes, one exactly half the length of the other, then because the

shorter tube is shorter, its end-correction is less than that of the longer. These very slight differences can be corrected of course, by careful cutting, but most peoples prefer the slight vibrato that results otherwise.

Many panpipes can be seen in museums from pre-Columbian Peru, carved in stone or more often made of pottery. Nowadays light reed and bamboo are the normal materials. It is today a common sight on street corners to see itinerant ensembles of Peruvians, Bolivians, Argentinians, and others playing their instruments in the hope of making money in this way.

Panpipes can be seen also on ancient Roman carvings and statues. These have an unusual appearance, with a short row of pipes suddenly followed by a longer row, presumably two groups a fifth or an octave apart. Very similar pipes appear also in some church carvings of the Romanesque period, which suggests that they must have survived in Europe from the Fall of Rome in the fifth century through to the eleventh.

We can presume, from Mozart's use in *The Magic Flute* that they were customarily used by bird catchers in Austria in the eighteenth century, for panpipes are well-adapted to imitating the calls of a number of different birds, and perhaps for teaching birds to sing.

In Spain and Portugal, instruments with all the bores drilled in a single flat piece of wood, often with a horse's head in profile as a finial, are blown by itinerant knife grinders as a trade call to announce their presence.

In Romania they have become a virtuoso instrument in folk ensembles, and many recordings exist of their music. The Romanian *nai* has its end-blown pipes fixed in a curve in a wooden cradle, the only panpipe made in that shape, though the form is now widely copied by makers elsewhere because the *nai* has become popular among other musicians.

Many showmen have used panpipes to call customers to their booths, and in Britain the panpipe was a common instrument for Punch and Judy stalls on beaches and showgrounds.

Today, it remains a child's toy in many places.

As said above, panpipes are or have been used over much of the world, certainly over much of Asia, Europe and the Americas. In many areas they survive as folk instruments, certainly all over South America, China and Japan as we have seen, and in parts of Europe.

TABOR PIPES OR ONE-HAND FLUTES

These are a specific type of Duct flutes. They normally have only one thumbhole and two fingerholes, placed low on the tube, but by combining these with the first few overtones, a diatonic, and with some examples a chromatic range of a twelfth or more is practicable. The reason for their design was so that the other hand could play a rhythmic accompaniment on a drum or other instrument.

The pipe and tabor (as the small drum commonly used was called) was a standard one-man dance band from the European Middle Ages into the Renaissance, and it is one that survives in southern Europe to this day and, with variants to which we will come later, in South America. Our earliest examples in the iconography come from the thirteenth century, with a misericord in Exeter Cathedral dated to 1240 and in the manuscript of the *Cántigas de Santa Maria* in Spain a few decades later. Thereafter they appear widely in carvings and manuscripts throughout Europe and there are many references to their use in documents of all sorts, including court records, thus showing that their use was by no means confined to the peasantry.

The three surviving illustrated manuscripts of the *Cántigas*, songs in praise of the Virgin Mary, traditionally ascribed to Alfonso X, king of Castile and known as El Sabio, The Wise (1221-84) are today in the Escorial Library near Madrid and in Florence.

The most important for our purposes, variously known as Escorial j.b.2 or B.I.2, is illustrated with 40 miniatures of musicians from the three cultures then co-existing in Spain, the Moors, the Jews, and the Christians, playing a very large variety of instruments, most but not all clearly deriving from the Muslim cultures of North Africa and the Levant, as we can tell from survivals and from local records from those areas. However, there is no known parallel from those areas for the pipe and tabor, and it would seem that this combination may well have been indigenous to Europe and perhaps to Spain, as we shall see shortly.

The way that the pipe and tabor works is by starting the range from the second partial, which we often write as D, followed by opening the finger- and thumbholes to obtain E, F or F sharp (modern tabor pipes vary between the two), and G, covering all three again for the third partial A, with two fingerholes for B and C sharp, all covered for the upper D, and so on up. However, the two earliest illustrations that we have, Exeter and the *Cántigas* show the player with his fingers in the middle of the tube, not near the end as on all later tabor pipes, and this suggests a link with the Catalan folk one-hand flute, the *fluviol*. This also is fingered in the middle of the tube but it has two extra holes, one for the ring-finger on the front and the other for the upper-side of the little finger at the back of the tube. It seems possible that an instrument such as this may have been the origin of the tabor pipe, which was later simplified by moving the holes down towards the end of the tube and taking advantage of the overblown partials.

We know what the tabor pipe could have played, and it covers the range of most dance tunes surviving from the period, but not until 1588, when Thoinot Arbeau published his dance manual *Orchésographie*, do we have music specifically printed for it. Arbeau's real name was Jean Tabourot, the surname, or as common then the ascribation, for 'surnames' were usually an identification by trade or other feature, strongly suggesting that he was a pipe and tabor player himself ('piper' usually then referred to a bagpiper, 'taborer' to a pipe and tabor player). Arbeau illustrates the steps for all the common dances of his day, and in many cases he provides the musical accompaniment, while he also clearly describes the pipe and tabor and its use in his text.

As we said above, pipe and tabor survive today in southern Europe, especially in Provence, the Basque country and Navarre as well as other areas of Spain and Portugal. In Provence a much larger tabor is used than elsewhere, the *tambourin*, some two feet deep from head to head, and a well-known imitation of its sound can be heard in Bizet's *L'Arlésienne* music, though quicker than any taborer could play it – when used for dance music it is played at half Bizet's speed or even slower. In Navarre, a string drum, the *txun-txun* among several other names, was often used instead of a normal drum, a long wooden body with four or so heavy gut strings running down it, tuned to the tonic and dominant of the music, struck across all the strings simultaneously, with a wooden stick to provide a rhythmic harmonic drone. Examples of its use come, for example, in many of Rameau's ballet scores.

With both these a tabor pipe of fairly standard pattern is used. But in the Basque country a rather larger pipe is used, the *txistu*, pronounced like chistu, with a foot ring for the ring finger to help hold it by so as to free the little finger to partially stop the open end of the pipe. By doing so, sharps and flats can be obtained, and the *txistu* is a fully chromatic tabor pipe and one with the most elaborate range of music. Unusually, and unlike in all medieval and folk illustrations, the tabor used with it is struck upwards on the lower head with a very fluent technique, quite different from the simple rhythms illustrated by Arbeau. For some music, a second rather longer pipe is used with it, along with a side-drummer. Traditionally the *txistu* is made of a heavy dark wood such as ebony or African blackwood, but like many others today, some are made of plastic, particularly those made for beginners.

As with so many other instruments of the sixteenth century, the pipe and tabor was taken to the Americas by the Conquistadors and it survives there to this day, in Ecuador with a small cane pipe with a neatly cut figure-8 mouth, but further south with different forms of pipe. The pipe that we know, being played by many folk and early music groups today, is replaced by either a panpipe or by a single-reed pipe, sometimes with a cow-horn bell.

The European tabor pipe today has a number of forms, both folk and reproduction, but all are short as they were in most illustrations of the period. Praetorius shows a longer form with a long mouthpipe running up the side, and two surviving pipes, found in the wreck of Henry VIII's warship *The Mary Rose*, which sank in

1545, are very much longer than any known save in some Flemish woodcuts of that period. These are some 80cm long and require a very long stretch of the left arm to reach the fingerholes (almost every contemporary illustration shows the pipe played with the left hand and the tabor with the right). Since one of these has a maker's name (and a shorter one also found in the ship has the famous double-plume or rabbit's-foot mark), it is clear that these were serious instruments and not just made casually by a player.

Finally we come to a very large variant, so large, up to two metres long or even more, that it has to be played with both hands, for the fingers of one hand cannot stretch sufficiently to cover the three holes. This is the Slovakian *fujara*, traditionally played by shepherds to entertain themselves and the sheep but now by many folk musicians, both locally and elsewhere. A mouthpipe runs up the side of the instrument to a duct at the top. In the traditional music, flourishes of high overtones, far more than are available on pipes of normal length, obtainable due to the much greater tube length, open and punctuate melodies played in the lower ranges. Many urban makers are producing these instruments today.

VESSEL FLUTES

Here we have a body of air in a more or less globular body, rather than a column of air in a tube, and its acoustical behaviour is rather different. The pitch depends upon two factors: the volume of the body and the area of open holes, both the hole one blows into and any fingerholes that are opened. The position of any of the fingerholes on the body that are opened is immaterial, all that matters is the total open area, so that the player has considerable flexibility about in which order the holes are opened.

Vessel flutes are either rim-blown across a hole or are duct-blown; I have never seen one notch-blown and transversely-blown are very rare – one example is the Oceanic bamboo nose flute, which is acoustically a vessel flute but is described in this series under 'Nose Flutes', because it is held straight out rather than transversely – it is however side-blown which could have brought it here. Of course many modern duct-blown ocarinas are held transversely, but being duct-blown takes priority in description.

Many such instruments around the world are natural objects, often gourds or other emptied seed shells. One early one used in the European late Middle Ages and early Renaissance was a wild-goat horn, called a *gemshorn*, nowadays more often reproduced with a cow horn; it seems always to have been duct-blown.

They are also made of wood, often with two fingerholes near the embouchure plus a fingerhole in the end, and are used, for

example in Africa, by some peoples as signal whistles and others as musical instruments; this dual use of the same instrument is one of the difficulties in dividing whistles from instruments proper.

Others have been made in pottery, again over much of the world, for we have examples from Papua New Guinea with two fingerholes, from pre-Columbian and modern South America with six or more fingerholes, often in a bird or animal shape, from China where the *xun*, egg-shaped in pottery, had an important ritual role, and from Europe as well as elsewhere. Body shapes are almost infinitely variable. They are also often mass-produced as 'fairings' either as souvenirs of a major fair, or as children's toys.

The best-known of the European ones are, from the nineteenth century onwards, duct-blown in what is called a torpedoe-shape with a duct projecting from one side. These were first invented by Giuseppe Donati of Budrio, developing a toy called the ocarina into a serious musical instrument capable of playing a full scale, using ten or twelve fingerholes. This was not, of course, the first European vessel flute, for at least one has been found in a Neolithic context, and one can , as usual, assume that vegetable forms preceded the pottery ones.

More recently, in the 1960s, John Taylor of London invented the small four-hole vessel flutes capable of playing a full diatonic scale, that have been reproduced for players around the world, often suspended round the neck on a thong.

Acoustically, vessel flutes are blown Helmholtz resonators, and this is the simplest form, with one hole to blow into and another to open or stop – any other further holes are simply the acoustical equivalent of a larger sound hole. They cannot normally be overblown into a higher register, but their fundamental (closed-hole) pitch can be varied by use of a slide to increase the air-volume. Their tuning can be controlled in this way, and extreme chromatics such as microtones are playable by part-covering fingerholes. Normal chromatics are produced most simply by providing fingerholes of differing diameter, although examples with holes all of the same diameter can produced chromatics by part-covering a hole, so reducing its area. The sound is somewhat hollow, due to the lack of overtones and approaches what acousticians call a sine-tone.

WHISTLES

Rim-blown whistles are widely used for many purposes, chiefly of course for signalling. Their potential is considerably enhanced by the introduction of a fingerhole in or near the lower end, for with two pitches many instructions can be given, even though, as Boy Scouts were instructed in my youth, one note suffices for the Morse code. My own earliest whistle came from Akko (Acre) in northern Israel and analysis showed the instrument to be of brass: %Iron 0.4, Nickel <0.1, Copper 67.8, Zinc 28.1, Arsenic 0.2, Lead 1.7, Silver <0.1, Tin 1.5, Antimony 0.1. Unfortunately this mixture was used for many centuries, so dating can be no more precise than from Roman to Crusader. It is most likely to have been a military or naval instrument, for warfare was endemic in that area and Acre was a seaport as well as a garrison town throughout that period and before. The bottom end is closed, and with one fingerhole near the foot, it can produce much more than its basic two pitches by altering the embouchure, protruding the lip over more or less of the open end and so changing the area of that open hole, thus producing glissandos to higher or lower pitches. It has a lug at the back with a hole in it for suspension.

Organologically similar are whistles from Africa, for example one of bronze or brass from Ghana and one the tip of an antelope horn with a wax head in which are embedded tiny red and mauve beads in linear patterns, from the Batanga people in the Kariba

area of Zimbabwe. The former is horn-shape with a suspension ring on the convex side, and is of unknown purpose, the latter was said to be used at funerals. Each has a small fingerhole in the distal end.

Some other African whistles, mostly of horn, are known as hunting whistles. Kirby describes and illustrates a number as does Söderberg, indicating that they are used everywhere from the lower Congo southwards.

Somewhat more elaborate are the dagger-shaped whistles from the Congo and the somewhat anthropomorphic whistles from further west. These usually have three fingerholes, one at the end of the bulge on each side of the swellings of the former or at the elbow of the akimbo arms of the latter, and the third at the tip. The embouchure of the former is at the base of two projecting horns and of the latter in a recess of the somewhat phallic head. It is of the dagger-shaped that some are said to have been used as hunting whistles and others as melodic instruments among the pygmies of the same area.

There are many more of all the above and of other shapes in many collections – Laurenty illustrates some hundreds from Congo and he and that area are not alone in Africa and elsewhere.

Several of these whistles, both those where one blows between the projecting horns and those like the Batanga whistle, where the blowing edge is slightly dipped, are verging towards the notch whistle, but those with an actual notch seem to be fairly rare. Jaguar bone notch whistles, often several strung on a cord,

are used in South America especially in Brazil, with shallow rectangular notches. V-notch whistles appear in much of Africa.

Transversely-blown whistles seem not to exist at all – certainly I have never seen any. The nearest that I have met are those with an off-centre embouchure, when by closing each end alternately or together a small range of notes can be obtained, but these count as flutes, even when they are only three or four inches long.

The form that is by far the most widely distributed is, as one would expect, the duct-blown whistle, for with this one only has to put it in the mouth and blow, without any of the problems of, frequently in haste or emergency, trying to get the blowing angle correct.

Duct whistles take many forms, the commonest being either the tubular, a straight tube with a duct in the head or a tapering tube, wider at the head and narrower at the foot, or the snail shape as with the well-known Acme Thunderer, the commonest referee's whistle.

Any of them, but especially the snail-shape, may have a 'pea' inside. Traditionally, in Britain at least, this was indeed a pea, inserted through the mouth while fresh and thus compressible. Nowadays a cork ball is more common, for cork, after soaking or chewing, can also be compressed. Once dried it regains its natural shape and can no longer fall out through the mouth. This 'pea' imparts a rolling quality to the sound which seems to make

it carry better through ambient noise, such as that of a football crowd.

One of the best-known tubular types is the police whistle. I have seen many of these, made of brass, plated or plain, or of other metals, with different stamps on the side such The Metropolitan, Garde Republicaine, Boy Scout, and so on. Silver, or maybe silver-plated, are common as army officers' whistles, occasionally mounted on the top of a swagger-stick, but more usually on a lanyard, carried in one of the breast pockets of the uniform. These, also are sometimes tapering, rather than a straight tube. Others are made of wood, I suspect often as children's toys, and all are stopped at the lower end.

Police whistles are usually duplex, two separate D-shaped tubes side by side within the one tubular casing, each with its own mouth, and one of the tubes always slightly shorter than the other, for the slightly different length produce two slightly different pitches. The vibration between the two, usually around five or six Hz, considerably amplifies the sound. One unusual example in my own collection is triplex, the usual duplex police whistle at one end, and a referee's pea whistle, with an expanding tube instead of the snail, at the other. One wonders whether this was designed for a referee at football matches between two police teams! Or perhaps one end was blown to stop playing after a foul and the other to call the police to subdue the ensuing riot.

Other tubular shapes may be rectangular, either as dog whistles with a single fingerhole, or as toys, such as the commonly seen

train whistle with two or even three bores side by side within the body – these are often seen in souvenir shops at historic railway sites.

Rectangular tube duct-whistles of wood were often used by the peoples of the North-West Coast of Canada. These are made of two pieces of wood, split and hollowed and then reunited. I was lucky to obtain one each of the three main types: the single, the double with two bodies side by side, and the duplex, two bores within the one body, front and back, this one made of three pieces of wood, a central block and another piece on each side.

In the nineteenth century babies' whistles were often made for children, a very short tubular whistle in the top of a rattle. Many of those preserved in collections were made of silver, which is why they survive, for those of less precious materials would have been broken or discarded as the baby became a child. I assume that such would be prohibited today, lest the babies poked their eyes out!

I mentioned the army officer's whistle above. The naval whistle was very different. The bo'sun's (boatswain's) call has a long tubular duct (the gun, to use British naval parlance) leading to the mouth which is set immediately above a hollow ball, with a flat metal keel holding the two together. By holding the ball within the palm of the hand, moving the fingers and the upper part of the palm over the ball interrupts the air stream and produces a wide variation of pitch for the different pipes, as the signals are called. The call is of unknown antiquity. It certainly dates back

to the sixteenth century, for a number were found in Henry VIII's warship, The Mary Rose, and others have been found in wrecks of the Spanish Armada of 1588. Some of those in the Mary Rose were very small, presumed to have been the badges of high officers, others were of normal size, though even the smallest ones can be blown, though their sound might only be audible to dogs and bats. Patterns vary only slightly. The British one, today, has a curved gun, as the tube is called, whereas the Mary Rose and the modern US naval ones have a straight gun. The British are usually silver-coloured (often of real silver), whereas the Dutch seem usually to have been copper. Those small ones for officers' badges were sometimes of gold but otherwise almost always of silver. The bo'sun's call is unique in that the variations of pitch are controlled by movement of the fingers affecting the escaped air outside the instrument rather than by altering the length or shape of the internal air column by opening fingerholes or closing the end. The bo'sun was the equivalent of the major-domo of a palace or household – he was responsible for all the working of the ship under the orders of the officers and so his signals were the instructions for all that was to be done on board.

The one great advantage of the whistle, one which explains its worldwide use, is that its sound is louder, and can be better heard through ambient noise and further away, than that produced by the human lips.

THE ORGAN AS A BOX OF WHISTLES

The basic form of the organ up to the late fifteenth century, when reed pipes such as regals were sometimes added, was simply a conglomeration of duct flutes, or as it is sometimes called, 'a box of whistles'.

It was invented in Alexandria by a hydraulic engineer called Ktesibios in around 250 BCE, and it was described by several Latin authors, pre-eminently Vitruvius, with the air supply controlled by water pressure and therefore called a Hydraulis. It is illustrated in a number of well-known mosaic floors. The earliest surviving instrument was found in Aquincum, the Roman suburb of Budapest, and it has been dated to CE 228. It is in a fragmentary state but all, or almost all the of the metalwork survives, including parts of the pipes, all of which were duct whistles. These were arranged in four ranks of thirteen pipes each. This organ was very small, even smaller than the mediaeval portative organ, which we will come to shortly. The air supply is presumed to have been pneumatic, probably a pair of bellows and the air pressure probably stabilized by a lead weight rather than by a tank of water, so its name would have been a Pneumaticon rather than a Hydraulis.

There is evidence for organs in Byzantium, both long before and after the Ottoman conquest of that city in 1453, and one is said to have been presented to the Holy Roman Emperor Charle-

magne in the mid-eighth century, presumably in Aix-la-Chapelle, known more often today as Aachen and now in Germany. By the tenth century organs were widely known in Europe, with, again, the earliest surviving set of pipes, but no other parts of its mechanism, found in Bethlehem, and dating probably to the time of the Latin Kingdom of Jerusalem in the early twelfth century. My article 'The Oldest Organ in Christendom', describing it in detail, is also on this website. Again, these 220 surviving pipes were all duct whistles.

The Roman organ at Aquincum had stops so that any one, or all of the four ranks of pipes could be played alone or together, and a keyboard, but these ideas had been forgotten by the ninth or tenth century, and organs were played by pulling out and pushing back a handle for each note, which meant that the music could be played only fairly slowly, and with only two notes at a time, one for each hand, unless, as shown in some manuscripts such as the Utrecht Psalter, there were two players who could interlock their parts. Also, being without stops, only a single note could be played at a time, or else a fixed chord by mounting a group of pipes of different pitches on each key, known as Blockwerk – the number of pipes of the same lengths found at Bethlehem makes it plain that this practice was adopted there.

There many illustrations of such organs in mediaeval manuscripts of that period and before, always with the pipes arranged in scalar order, longest at one end and shortest at the other, though sometimes with one long drone pipe at the shorter end. By the

thirteenth century we see, in many mediaeval manuscripts and church carvings, a very small organ which could be carried around by the player, supported with a strap over the shoulder and played with one hand while the other hand pumped a small pair of bellows; these are called portatives, and they often have two rows of pipes.

A century or so later the positive organ was introduced, a medium-sized organ that could be moved around within the building to where it could be most usefully played – such organs are still widely available and are frequently used as continuo instruments for concerts of Baroque music, and these also are merely boxes of duct flutes, despite the fact that most Baroque European composers, pre-eminently J. S. Bach, had far bigger organs at their disposal when performing their music.

By the mid-fifteenth century organs were arranged as most, until recently, have been, with the longest pipes in the middle, and the rest dwindling progressively on each side. By the seventeenth century, and possibly earlier, longer bass pipes were added in towers at each end, still a common sight today. By the eighteenth century in Britain, when Handel was writing his organ concertos, the organ there was still a box of whistles, though in Bach's Germany at the same time, added ranks of reed pipes were already common.

So from the third century BCE until the eighteenth century CE, at least in some places, the organ was nothing but a box of whistles, a multitude of one-note duct flutes.

It seems inappropriate in a group of articles about on flutes to go into greater detail of how an organ works, so that one player could control many hundreds of pipes, but information on this will be found in my *Origins and Development of Musical Instruments* and in all the normal encylopaedias such Grove.

Nevertheless, it should never be forgotten that the basic organ was and still is a great gathering of flutes.

ANOMALOUS FLUTES

There are some flutes which fit into none of the categories described elsewhere in these articles. They are neither end-, notch-, duct-, nor transverse-blown. Nevertheless they are obviously flutes of some sort; Laurence Picken, in his book on the Folk Instruments of Turkey, categorised one of them (the second below) as 'Flutes that are not flutes'.

One of them is known as the 'owl hoot'. This is a human instrument: the hands are cupped together with the two thumbs aligned with each other, and the player blows between the middle phalanx of each thumb. The different pitches are produced by varying the cubic capacity of the hands and by moving the fingers to open apertures. Thus they must be categorised as variable capacity vessel flutes, but there is no sharp edge, and a sharp edge, or at least a sharpish edge against which one can blow, has always been regarded as a prime requisite for identification as a flute.

Another is known as a widgeon whistle. This consists of two small shallow discs fixed together edge to edge to form a curvilinear box, with a small hole in the centre of each disc; a children's version is a fruit stone rubbed against a rough surface to form a hole in each side, and then the content extracted to empty the stone. The whistle is held between the lips and the teeth and the instrument is sounded by both ex- and inhaling through the holes, the pitch depending on air speed and mouth shape.

Another is a stone whistle, the stone soft enough that it is easily worked by a tool; alabaster would be one such stone. The stone is hollowed out from one edge and a hole is bored on one side to meet the hollow. The whistle is held partly within the mouth and the pitch again depends on air speed and mouth capacity, with tongue movement to direct the air.

At least all three of these instruments create their sound by generating a regular series of vortices within an air body, and this, another of the diagnostics of a flute, is common to all three.

Doubtless there are also some others which I have not yet encountered. And although two of the three above are termed whistles, nevertheless they have a range of pitches and so, in normal terminology, they should be thought of more as flutes than as whistles.

PERCUSSION FLUTES

One of the rarest categories of Flutes is the Percussion Flute. This type of instrument is one in which the air is driven to the voicing edge, usually via a duct, by being struck, rather than by being blown by a player's lungs. The striker can be a player's finger on a miniature drum or on a bag filled with horsehair or other material to hold it open so that is air-filled. An example of this is the Quail Lure, the subject of an article among the Downloads on that page on this site.

Another example is one that I met in Israel, although I encountered another similar example more recently (made in China) at the St Giles Fair here in Oxford. These are plastic hammers, the two sides of the hammer-head being the bellows, with a duct on each side and a short tube (one longer than the other so as to produce two different pitches) where the head meets the handle. In Israel, on festive occasions such as Independence Day, these are sold in the streets and children run about banging unwary people on the head with these hammers. The shaft of the hammer also includes a normal duct whistle so that the child can also make obstreperous noises by blowing it when no passing heads are available.

So far as I know the percussion flute is unknown in the organological literature, other than these quail lures and plastic toys, and it would be interesting to know whether anyone can produce

any other examples of a whistle where the air is driven to a duct by percussion.

So far as Classification is concerned, they would come under the head of Implosive Aerophones, where air is driven into a tube, in contrast with Explosive Aerophones where air is driven suddenly out of a tube – a pop-gun is an example of that.

A very different example of an Implosive Aerophone is the West African *shantu*, a long narrow gourd, open at each end, which is struck against the player's thigh or with the palm of the hand. These are used by women in polygamous households to 'talk' from hut to hut within a compound, by shading the distal end of the gourd with the other hand to obtain the different pitches of drum-language. They differ from the quail lures and hammers in that they do not have a duct; the air is simply driven into the tube between the thigh or the hand to produce a sort of pitched plopping sound. And because air is driven in in this way, they are quite different from stamping tubes, whose sound is generated by striking the closed end of a tube on the ground. They are thus also Percussion Aerophones but, like the *shantu*, they are not Percussion Flutes.

SUCTION FLUTES

Like Percussion Flutes these are also very rare – I can think only of two examples and both are whistles, rather than flutes on which one could play anything very elaborate.

The first example is the Twirl-a-Tube, a child's toy which was popular a while ago and I think still exists. It is a corrugated plastic tube about two and a half to three feet long; legend has it that the origin was a vacuum cleaner's tube. It is simply whirled round in the air and, depending on its speed through the air, it produces overtones of its fundamental pitch, up to about the 4th harmonic. It was initially thought that the voicing edge was at the far end, the air catching on the open end of the tube as it whirled, but experiment showed that the voicing edge was the end that was in the hand and that the air was sucked out of the tube by centrifugal force.

This experiment was not mine but, if memory serves aright, it came to me from John Burton many years ago.

I used them in lectures to demonstrate that overtones are sounded by the increase of airspeed; using such things as examples helps to imprint a fact on a student's memory.

The other example is both suction and blowing: those very small whistles, often called Labial Whistles, small containers with a hole on each side, held between the lips and the teeth and both blown and sucked. Children make them out of apricot stones and

similar fruit, as Laurence Picken said in his *Folk Musical Instruments of Turkey*, rubbing each side on a stone to make a hole and then picking out the seed. Commercial ones are made of two tinplate discs placed hollow to hollow and fixed together with, as I said, a hole in the centre of the face on each side. They are used often to imitate bird calls (Widgeon Whistle is another name), the pitch depending on the airspeed.

I can't think of any other examples among flutes, but sucked trumpets are quite well-known, such as the nolkin and the byrgy. And among free-reed instruments the American organ is an obvious example, as also are concertinas, some forms of accordion, and also those harmonicas which have reeds for both blow and draw.

Can anybody produce examples of double or single reeds which are sucked? I have been unable to think of any.