Whistling Bottles: Sound, Mind and Water

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ZUSAMMENFASSUNG

Pfeifgefäße wurden zwischen ca. 1200 v. Chr. und der Conquista im 16. Jahrhundert in vielen Kulturen Südamerikas und Mesoamerikas hergestellt. Trotz ihrer enormen zeitlichen und räumlichen Verbreitung wissen wir sehr wenig über diese Instrumente. Der Grund dafür liegt in dem fast vollständigen Fehlen von ethnographischem, archäologischem oder ikonographischem Vergleichsmaterial, das für das Verständnis ihrer kulturellen Bedeutung hilfreich sein könnte. Die Untersuchung einer Sammlung von 60 Pfeifgefäßen brachte Erkenntnisse über ihre akustischen und organologischen Eigenschaften. Über die die klanglichen Charakteristika beeinflussenden technischen Eigenschaften erhielt man durch Nachbauten der einzelnen organologischen Bestandteile nützliche Aufschlüsse. Einfüllen von Wasser führte zur Erzeugung von Klängen, ohne die Instrumente anblasen zu müssen. Abhängig von den organologischen Variablen erhielt man Klangeffekte von großer Komplexität. Auch wenn das Fehlen von Sekundärinformation eindeutige Schlüsse nicht zulässt, resultiert die vorliegende Untersuchung in reichen Kenntnissen über die Instrumente, die aufs Engste mit dem Ritual, der Bewegung und dem Klang in Verbindung standen.

INTRODUCTION

The “whistling bottles” are ceramic objects defined as organological specie whose characteristic is a “whistle”[1] joined to a “bottle”[2], which can be filled with water[3], which in turn can influence the production of the sound.

We find mention of whistling bottles in Bolaños[4], who describes the historical aspect, Amaro[5] who gives an hypothesis for use and function, Velo[6] who describes some organological facts, and Ransom[7] who gives an overview of the subject. From the 1970s, Garrett and Stat[8] put forward a hypothesis of the psychological characteristics of the sound. In a previous article I revised the organological variables including the acoustic ones and some hypotheses about use and function[9]. Now I am interested in the sonic side of these objects, from the point of view of a very specific playing technique. My investigation was based on direct experimentation with more than sixty whistling bottles covering the cultures explained below. Twenty-eight of these are from the Museo Chileno de Arte Precolombino collection.

The history of whistling bottles in the Andes begins with the Chorrera culture, around 1200 BC (see Fig. 1)[10]. The high ceramic specialization reached by Chorrera was the ground on which this complex artifact, that moves water and air to produce sounds, could be invented and developed to high perfection both as formal and as sound objects. Many later cultures were to develop new iconographic styles, but made little or no modification to the basic Chorrera water-air-sound system. They are, from around 500 BC: Jamacoaque, Vicús, Virú; from 200 BC: Recuay, Moche; from 600 AD: Lambayeque, Wari; from 900 AD: Chimú; and from 1180 AD: Chancay. All these cultures from the Andes have whistling bottles which I have studied. Other examples from the Andes, not studied by myself, have been reported from Bahía[11], Cotocollao[12], Nazca[13], Salinar[14],

1 Globular flute with air duct.
2 Normally a real bottle, sometimes a vase also.
3 In fact, we do not know what kind of liquid was used inside these objects. I will use the term “water” as a generic term, the discussion of this aspect is confined to use and function.
4 Bolaños 1997.
5 Amaro 1994.
6 Velo 1985.
7 Ransom 2000.
8 Garrett/Stat 1977.
9 Pérez de Arce 2004.
10 Townend (1999) wrongly cited Peru as the place where whistle bottles were born.
11 Lapinder 1976, Fig. 733; Vedova 1969, 70.
12 Porras 1980.
13 Dockstader 1967, Fig. 109.
14 Lapinder 1976, Fig. 237.

Calima[15] and Inca[16]. The last whistling bottles are some degraded Peruvian specimens dating from ca. 1600 AD, showing the Spanish green glazed finish (Fig. 2). Later ones have not been described. Unfortunately, no mention of these objects appears in conquest or colonial documents and no ethnographic evidence exists to help us to reconstruct their possible uses and functions. This means that we do not have any help in interpretation, save the instrument itself.

We also know examples from Mesoamerica in which the whistling bottles from Tlatilco[17] are as old as Chorrera ones; others have been reported from other mesoamerican cultures dating from the Preclassic period to the Late Classic period[18]. I lack sufficient information for them, and they deviate from the Andean norm, thus I will exclude these objects from the following description and discussion. In general, Mesoamerican whistling bottles seem to have a vase instead of a bottle. Jamacoaque is the only Andean culture with similar whistling bottles with vases instead of bottles. The stylistic affinity of Jamacoaque with mesoamerican patterns reveals a strong linkage with Mesoamerica (Fig. 3).

The whole spectrum of whistling bottles presents a wide array of cultural styles in terms of shape, colour and ceramic technique (see Fig. 4). It is easy to identify the cultural provenance of them by their styles of modelling. At the same time, all of them are the same organological specie we call “whistling bottle” with little or no variation. The instrument is the same, the sounds are similar[19]. Its cultural situation is privileged: whistling bottles represent the highest art in ceramics, the plastic material used extensively in prehispanic times and particularly in music to produce flutes.

Why was this instrument so popular? Why so long lasting? Why did it disappear in colonial times? Some of these questions will be reviewed. I will describe the ceramic structures involved in sound production, the basic melodic contour, the experimental study on “ocarina”[20] sound structures; the water incidence in sound production and some hypothesis on it use and function.

CERAMIC STRUCTURES INVOLVED IN SOUND PRODUCTION

The basic structure of the whistling bottle is simple. It is based on the relation between the “bottle” and the “whistle”; while the last produces the sound, the “bottle” regulates its air supply, through water movement.

The “whistle” corresponds to the organological group known as “globular flute”[21] (a sphere with a circular window through which to blow it). If we attach an “airduct” (a tube to direct the air for better acoustic results) to this “globular flute”, we have the organological type we call “ocarina”. Ceramic “ocarinas” have great importance in precolumbian times; they cover a great variety of instruments spread from Peru to Mesoamerica. Ceramic “globular flutes” are less present in this area, but extend south to Peru, Bolivia, Chile and Argentina. Both groups are comfortable to play (very efficient in ergonometrics), and many of them show fingering holes (Fig. 5). Looking at this whole panorama, we can see how in the great “globular flutes” group there is a more developed “ocarina” sector in which the most selected ones were the whistling bottles, which can produce sounds with the aid of water. This is an important aspect to take note of, because it helps us understand the relation of these instruments with society. The whole “globular flute” group (including “ocarinas” and “whistling bottles”) is the most important organological one of the Andes and Mesoamerica. It poses the same questions we described above; they were very popular, spread in a great number of varieties, have a great permanence over space and time, and disappear completely when European conquest occurs. In our days we have no ethnographic clues to interpret them as cultural objects, to the point that we have no local names to use as generics, and that is why I choose the Italian one “ocarina”[22]. The dilution of all this great tradition of “globular flutes” and “ocarinas” at the end of precolumbian times, from the Southern Andes to Mexico, leaving no trace, is one of the great mysteries of American History.

Whistling bottles are fine pieces, among the better ceramic art examples of prehispanic cultures. The evidence of this is clear in the zoo- and anthropomorphic iconography modelled on their surfaces. I know no whistling bottle without any three-dimensional representation. The unseen side

15 MNC 2004; Hernández de Alba 1983, 727.
16 Ransom 2000.
17 Marti 1955, 70; 1970, 36, 38; Fine Precolumbian Art 1981 No. 85.
18 Castellanos 1970; Pérez de Lara 2004.
19 Although some efforts have been made to ascribe particular sonic characteristics to different cultures, these seem not to correspond with a detailed study of the data, except the bass sounds of Jamacoaque ones. I discussed this previously (Pérez de Arce 2004).
20 I will use all generic organological terms between brackets to clarify their utilitarian function and avoid confusion. For the discussion of these names, see notes below.
21 I use the generic “globular flute” as the instrument without airduct.
22 The name “ocarina” (“little goose”) was first used by Italian maker Giuseppe Donati in 1853 for his ceramic whistles.

of this ceramic dexterity lies in the acoustics (Figs. 6–7). Through my observation of the pieces, using a direct view with the aid of little mirrors and lanterns, or via X-ray, I can describe the ceramic structures involved in sound production.

The "ocarinas" of these "whistling bottles" are the simplest of their kind; spherical "globular flutes" with no fingering holes[23] and a cylindrical "airduct". The sphere is small, around 1.5 cm to 3 cm in external diameter, with a circular window. Because of its small size it produces high pitches. The only exceptions to this are Jamacoaque ones (MCHAP 0049 and 0050) with bigger whistles (about 8 cm diameter) and a much lower voice. The "airduct" is a short tube (c. 3 cm long, 1 cm wide). "Globular flutes" and "airducts" were made separately, and placed inside the bottles probably at the final stage prior to baking, adjusting them for the desired sound.

Over some of the whistles, covering them, there is a second sphere provided with holes, so as to permit the air to come out. The number, position and size of these holes depends greatly on the cultural style (Figs. 8–9). I call it "mute", because its effect is to mask and soften the sound[24], but at the 4th Symposium of the International Study Group on Music Archaeology Friedemann Schmidt showed some Moche replicas in which it operates as a secondary resonator to produce the second tone of the "jump" melodic contour (see below). I could not obtain the same responses on the whistling bottles of the *Museo Chileno de Arte Precolombino*, because in many of them the holes were so small that it was not possible to give a tone by blowing into them, as Schmidt did (see Schmidt, this volume). When a wind noise was produced with a discernible tone, it did not mach the second tone of the "jump". Two Wari whistling bottles (MCHAP 300 and 301) which had a similar disposition and size of the holes as Schmidt's specimens, give a sound lower than the base tone of the whistle. In both cases the whistle gives an arced melodic contour, with no "jump", and the tone of the second sphere was lower than the bass of it.

Some bottles without this second sphere show that this "jump" tone can be achieved by the "ocarina" alone, with no "secondary resonator", something proved by my experimentation previous to the 4th Symposium of the International Study Group on Music Archaeology. In one Lambayeque whistling bottle (CP 17) and two Vicús (MCHAP 296 and 254, Fig. 10) and in the experiments to be described below I had the same experimental conclusion. Many whistles having this second sphere give only a single tone, demonstrating that its utility was to act as a mute, with no relation to a second tone. Until a better understanding of the acoustic production of the "jump" tone we must leave open the evaluation of this sphere as a resonator (perhaps in some Moche objects), or as a mute (as in my sample)[25].

Ergonometric principles proved to be very helpful in searching the original modes of playing on prehispanic ceramic flutes. As a rule, the way they fit the hand and mouth to achieve better performance is the most comfortable, and this has been confirmed when we find use marks. Whistling bottles show no particular ergonometric facility to play them blowing directly, but the best ergonometric way to move them with water (Fig. 11). After studying them, I concluded that the ceramic structures are developed specifically to sound through this water–movement. They give the idea of a highly controlled instrument, both in its ceramic and fluid (air and water) circulation.

This leads me to conclude that whistling bottles were meant to sound using the water movement playing technique, in spite of other possible ones[26]. Of course, all playing techniques studied on the whistling bottles are only hypotheses. We will never know how they were played in the past. We only know for sure they were played to sound beautifully, because this is the only way to test them (now and in the past), by sounding.

BASIC MELODIC CONTOUR.

The conclusion that the water movement was the right playing technique gives us a reference for sound. In 1982 I made experiments with water in the original pieces, but later conservation restrictions in the *Museo Chileno de Arte Precolombino* prevented me from making further experiments using this method. The blowing technique is the alternative way to sound them experimentally. When blowing without water, the whistling bot-

23 Amaro (1994:76.77) believes that the holes in the mute sphere were for fingering. I discussed this hypothesis as false, arguing on its ergonometrics and sonic negative evidence (see Pérez de Arce 2004).

24 The relation between this "mute" device and the colonial *manchaypuito* (a kind of *kena* flute mute) was discussed previously (Peréz de Arce 2004).

25 Ransom (2000) said that considerable changes in the whistle sound can be brought about by differences in the internal air pressure created by enclosing of the whistle and the number and size of holes in the cap allowing air to escape.

26 Blowing with or without water, filling with water, boiling water (Pérez de Arce 2004). This rule applies to all the samples, except one type specific to early Chorrera, in which blowing with the mouth is the only possible playing technique (MCHAP: 0091, 0230, 0300, 0310, 0381; CP: AN7O, 71).

tles react as any "ocarina" does (size and structure have almost no incidence on sound, save some laziness in response), but they lack all the water-like associated sounds and dynamics.

As they have no fingerholes, changes in sound can be obtained only through changes in air pressure. From the lowest pressure the sound changes its pitch upwards to stabilize in a static shrill, loud and penetrating sound with normal to high air pressure. The sound produced with the water movement technique lies in this low pressure section. The pressure exerted by water movement is small. It is very difficult to have control of this low pressure with human blowing and, using this method it is impossible to be sure that we are imitating the original sounds that would have been made using water.

When produced by water, sound from different whistling bottles shows a great number of differences in detail in rhythm, pitch, tone colour and volume. But melodic contours are very simple, ranging from no melodic contour at all to a combination of *glissando* and intervalic jumps. We can group them into four categories (Fig. 12)

1. The plain tone (no change of tone, one single note). If blowed too low, it becomes mute, and if too hard, it mutes also (MCHAP 231A, MCHAP 091A).
2. The arched movement (up and down in continuous *glissando*). From a certain pressure on, it sounds, going up and down with the pressure changes. MCHAP 295 and MCHAP 230 give a quart tone arc; MCHAP 310 a 1/2 tone; MCHAP 296 and MCHAP 233 one and half tone arc; MCHAP 453 a minor third arc.
3. The "jump" movement (the interval between the first low and the second higher tone, then again to the first). A little change of pressure produces an abrupt change in sound. The upper tone is stronger, giving the sonic image of a stepped pyramid. Vicús bottle MCHAP 254 gives a 2nd; MCHAP 599 (Chimú), a 4th.
4. The combination of arched and "jump" movement of sound. The same changes as the previous ones, plus the arced section, are produced in the same way. Vicús bottles MCHAP 243 gives 1/2 tone arc and 4th jump; MCHAP 241 and MCHAP 246 give 1/2 tone arc and 5th jump; MCHAP 229 adds to this some noises, "multiphonic" or "ghost sounds".

Different kinds of noises ("wind", "ghost sounds" and "multiphonic") are present in many examples. We ignore how many of these noises are results of the (generally small) wearing process on these ancient artifacts. The great ceramic knowledge expressed in the collection sugests that ancient ceramists controlled almost all variables of sound production.

EXPERIMENTAL STUDY ON "OCARINA" SOUND PRODUCTION

To understand how sound is produced Daniela Núñez[27] constructed the basic whistle in a series of sizes. She produced twelve "globular flutes", with different sizes and circular window diameters, and eight tubes of different diameters to be used as airducts (Fig. 13). Combining each of the "globular flutes" with each of the tubular airducts, we obtained the whole range of melodic contour described above. Minimal changes in the relative position of the organological elements affect the final sound (Fig. 14).

The best results were obtained between averages of about 10% to 30% of the circular window covered by the tube[28]. The smaller the "globular flute", the wider must be the opening (up to 80%), and the bigger the "globular flute", the smaller must be the opening (down to 0.5%). Beyond this position the "ocarina" produces no sound. Within these positions, we find the four basic melodic contours described above. The best obtained sounds are shown in Fig. 15, in relation to the "globular flute" – "tubular airduct" combination.

The fourth category of melodic contour is the most complex one, with an arched contour between 1/2 tone to a major 3rd, and a "jump" between the major 3rd to the 4th, which was obtained with the smallest "globular flutes", (26 and 23 mm) and the tubular airduct of biggest diameter (13.4 and 15.6 mm) (see Fig. 13A). To obtain the melodic jump only a minimum change of air pressure was necessary. As with the original whistling bottles, this little variation occurs at a very low blowing pressure.

The "jump" with no "arc" was reached in bigger "globular flutes" (30 to 33 mm) and tubular airducts of 10 to 13.4 mm diameter (see Fig. 13B). Intervals were between the 2nd, and 4th and also the 8th[29]. Here also, only minor variations of air pressure were necessary to produce the sound changes.

The "arched" category is reached in a wider number of combinations (Fig. 12C), and the plain tone in an even wider number (Fig. 13D). The rest

27 The title of Daniela Nuñez' project, ceramist at the *Escuelas de Artes Aplicadas Oficios del Fuego*, Santiago de Chile, was *Botellas Silbatos: Reproducción y Sonido*. It includes a reproduction of the MCHAP 243 specimen, the "ocarina" parts reproduction and the X-ray photography related to this article.

28 The percentages are not accurate and given only as a reference.

29 As with percentages, the intervals are given here only as a reference.

of the combinations give no tone at all, sometimes only a wind noise (Fig. 13E)[30].

The conclusion of these experiments is that through a very simple mechanism ("globular flute" and airduct) all the sonic responses found in the original whistling bottles can be obtained. All depends on the exact position and dimension of the "globular flute" and the tubular airduct. The making of these ceramic objects requires considerable skill to avoid shrinkage and consequent pitch alteration.

IMPORTANCE OF WATER IN SOUND PRODUCTION

The water movement technique can be considered as the "trademark" of the whistling bottle. The sound produced in this way is very delicate and of low intensity[31]. As well as the whistle sounds, water also produces gurgling sounds, trills, bubbling noises and the noises that are produced by the circulation of the liquid. The circulation of air and water depend on the internal geometry of chambers (bottles) and conduits (spouts, connecting tubes between two bottles, airducts, etc.).

A critical factor for this fluid circulation is the air reservoir placed below the "whistle" when filled with water (Fig. 16). Some Chorrera whistling bottles show no reservoir at all (Fig. 17); in this case the whistle can be sounded only by blowing into the spout. But this is the exception: in the rest of the sample it is the air reservoir that permits the sound to be produced by water movement. The base of this air reservoir is the water surface. When water moves, it changes the air reservoir shape and dimension, producing different kind of sounds. Sounds depend on the air reservoir dimension and movement.

The volume of air within the reservoir is critical for the sound production, between a precise minimum and maximum beyond which no sound is possible. Although a great variation of sizes can be found in the studied group, depending on the geometry of the system. Simple bottles (Fig. 13A) can normally have a small air reserve section. Here the circulation of water is fast and free, giving short wave–like sounds, short bursts of sound, clearly separated (MCHAP 453, MCHAP 234 see Fig. 18). Sometimes simple bottles can have a big air chamber (Fig. 19). The bigger ones are obtained in the ones with two bottles connected, one of them devoted to the air reservoir (Figs. 13C, 20). The greater this reservoir, the more sustained the notes can be. In Vicús MCHAP 243 the air chamber is made bigger with the addition of a second one inside the male body, connected through the arms and legs of the male (Fig. 21).

The movement of water produces different types of sound. When water fills the reservoir, air is forced to flow through the "ocarina", thus sounding it. When the tube connecting both bottles is long and thin, there is an effective control over the air pressure to produce a prolonged sound (Figs. 13D, 22).

Water movements inside the ceramic bottle produces their own kind of sounds, of minor intensity. They are clearly heard in the intervals between the whistle sounds, when the water regains its original position (Fig. 23). Sometimes these sounds resemble a "human breath" between the flute sounds (MCHAP 233, MCHAP 049, MCHAP 050, MCHAP254 and MCHAP296).

Sound depends on the structure of the bottle, the hydraulics implicit in it, the amount of water and its movement. We hear the natural sound of water filtered, amplified and modulated through an acoustic plan defined by the ceramicist.

In some bottles the whistle produces a trill effect, when water is gurgling inside (MCHAP 524, MCHAP 239, and see Fig. 24). This is because part of the air is forced back from the bottle containing the whistle to the one with the spout. Wind noises can be heard in some flutes (Vicús MCHAP 246, 230, 229, and 046, see Fig. 25).

In whistling bottles with two whistles we can hear the harmonic superposition of tones. The only example of this type that I studied (CP, AN 44) presents an interesting tonal relation; both whistles simultaneously produce a sound which is a major third apart, which jump simultaneously up a major third. Although scarce, there are whistling bottles with three whistles, and also whistling bottles with three, four, five and six bottles all interconnected[32]. No notices of their possible sonic function have been given so far (see Schmidt, this volume).

30 When blowing the 05.5 cm diameter tubular airduct alone a whistling tone can be perceived, that contaminates the "ocarina" sound when used in combination with the globular flutes.

31 Stat (1974) and Garrett /Stat (1977) supposes that the direct blown technique was preferred because it produces stronger sounds. This supposition is suited to our ideal of great audiences, nor to Andean intimate ones. Roberto Velázquez (2004) measured a commercial model of a ceramic whistling bottle from Texcoco, Mexico, and found that when blown, they give a maximum response of about 0.0004 watts, not very loud but enough to be heard at a considerable distance. When sounded with the movement of water, the same specimen gives a maximum response of 0.0003 Watts, almost ten times less than the previous, indicating that the instruments were sounded in small spaces in relative silence.

32 Garrett/Stat 1977.

INTERPRETATION: USE AND FUNCTION.

In spite of the lack of contextual data, as stated above, we know for sure something about whistling bottles:

1. They are funerary objects
2. They are well designed bottles to carry liquid
3. They are well designed flutes to sound with the movement produced by the liquid
4. They combine ceramics, water and air to produce the sounds.
5. They show zoo- and anthropomorphic motifs

1. Whistling bottles are funerary objects.Because of this fact they are well preserved. Their finding as part of the funerary context and the absence of use marks suggest they were no ordinary objects, but special ones specifically made for funeral practices. This means that funerary rites offer the most probable scenario for their use. Normally they are superb objects, among the finest expressions of ceramic culture.This means they were privileged cultural ("artistic" in our western concept) objects.

2. As bottles, they are designed to keep liquid. We do not know what kind of liquid was used inside, nor if different kinds of liquids were used for different occasions or for different cultures in place or time. Throughout the previous discussion I have used the term "water" because it was related to the most basic and natural liquid, found in the rain, the rivers and the sea, and ever present in every Andean Cosmology. But many Andean rituals involve other liquids as well, like "chicha" (fermented vegetable liquor), or psychotropic liquids of the sacred *Ayahuasca* (*Banisteriopsis caapi*), *Sanpedro* (*Trichocereus pachanoi*), or *Vilca* (*Anadenanthera colubrina*) plants[33]. Bottles containing these liquids have an important role in the ritual.

Whistling bottles are well designed with handles so as to retain the liquid without spilling when walking, in spite of the movement (Fig. 26). The ever present handle has always a good ergonometric design to carry the bottle in one hand. This means that they can be used to carry liquid while being sounded. The bottles are always well designed also to be deposited on a flat surface. Of course, we do not know what, in the past, were the appropriate movements to sound them, and walking is only one hypothesis. Crespo presents a convincing theory about the origin of the whistling bottles which may derive from the Machalilla culture (1500–1200 BC, previous to Chorrera)[34]. Machalilla bottles have a little hole placed in the base of the spout allowing the liquid to be poured out smoothly. Machalilla people provided a handle for a better method of transport. When handled this way while walking, tiny flows of air are produced out of the hole. Using these flows of air they add a "globular flute" and the whistling bottle was born.

Walking is part of the Andean concept and practice of ritual "moving sound". Movement and sound are inseparable in many modern Andean rituals. The movement with flute sound is linked with the movement of the sacred images, while the static position is related to the chanted prayer[35]. Summarizing we find that the hypothesis of sound production through walking movement is a fertile one. As every whistling bottle has a figurative representation, it can be explained as the representation of the supernatural being, which moves with the accompaniment of his own flute sound.

3. As flutes that sound through the movement of air and water, whistling bottles are unique in precolumbian times. They share the common aspects of the Andean "ocarina" sound with the addition of the noise of water.

"Ocarina" sounds resemble human whistling, that has an important role in the *ayahuasca* ritual of amazonic shamanism to call the spirits (Katz/Dobkins de Rios 1972, 323, 325). Did the voice of *Ayahuasca*, *Sanpedro* or *Vilca* spread out of these whistles, when they were moved to the last place of the deceased person? Perhaps it calls the precise spirit, or it was the spirit's own voice. Indeed, the sound can be described as sorrowful, mournful, sad, and perhaps for ancient Andean people also, specifically in the funeral ritual situation. The relation between flutes and death is well defined in Moche ceramics, and in the colonial myth *manchaypuytu* (scaring hell) we find an explicit link between a ceramic bottle filled with water, a muted flute and death (see Jiménez Borja 1951; for a brief description of this myth in relation to whistling bottles see Pérez de Arce 2004).

Some liquid sounds resemble human breath and could have been interpreted in this way. Other sounds we find in the whistling bottles, as the "ghost sounds" or "multiphonic sounds" have an aesthetic connection with present day Andean flute music rituals. In sum, the sound of whistling bottles presents a combination of characteristics common to a whole range of Andean ritual music, integrating the concepts of calling the spirits, death, and special aesthetic designs.

4. Air, water and ceramic are integrated to obtain the final sound. Their combination involves three domains: air – breath – wind, related to the concepts of life in Andean cultures; water – rain – sea, related to death (or psychotropic liquid, related to

33 The list of of ancient andean psichotropic beverages is greater: see Schultes et al, 2001 for a survey on this matter.
34 Crespo (1966.
35 Pérez de Arce 1993.

the other world, in the same domain); and ceramic – the plastic art of earth-water-fire, the domain of culture. The combination of them covers a great semantic portion of culture, giving room for an extensive field of hypothesis to explore. But my intention is not to explore semantics, over such an extended sample: only to mention the potential ritual richness of this ceramic – water – air flute, so as to explain its popularity through the Andean cultures.

There are other aspects to be considered in relation to this popularity. The "*varia poco*" (small variation) Andean aesthetic is expressed in the minimal air pressure and the minimal change in this air pressure needed to produce sound and its variations in the whistling bottles. Also the minimal changes in the relation to the "globular flute" and the tubular airduct position have drastic consequences on the desired sound. These soft, little variations of low intensity subtle sounds are dear to Andean aesthetics and reveal deep cultural roots in the area.

The preference for simplicity in the system to produce sound of whistling bottles also reveals a deep rooted cultural sign. Compared with ancient European, Hellenic or Egyptian machinery made of wheels, tubes, boxes and mechanisms to produce sounds, the simplicity of Andean culture emerges as part of a deep rooted cultural paradigm.

Whistling bottles are the culmination of a ceramic – music relation: not in terms of time, because this relation was obtained in full expression by the Chorrera people, at the very beginning of whistling bottle history, but in terms of the whole musical experience of prehispanic people. The "right" kind of material for making one particular instrument has a deep cultural importance in the Andes. Among these materials, bone, wood and stone were used extensively for different musical instruments, while ceramics and metal, the plastic material that adapts its form to the maker's wish, were used almost exclusively to produce a type unique to each. Metal rarely was used outside the idiophone organological group, nor was ceramic used outside the "globular flute" one[36].

5. The strong iconography associated with all whistling bottles, being so varied, prominent, explicit, and covering so many topics, has eluded almost all interpretation, save the one made by Amaro[37] on the Vicús whistling bottles, linking them with funerary rites themes. This subject must be studied culture by culture, in their own contexts, so it extends out of the reach of this panoramic study.

There are no clues to relate in a direct way the sound with the voice of the being represented. Every attempt to show that the sound imitates one of the represented animals has failed[38]. Mead[39], Amaro[40] and I conclude that there cannot be any logical connection detected. Perhaps the study of birdsong can give clues to some representations, but here we are faced with difficulties in identifying species in a stylised artistic representation; in the whole sample I identify a clear relationship with a genera in only one representation (Fig. 27). The whole iconographical study waits to be done (Fig. 28). In spite of the previous statement, the tendency to focalize the whistle inside the head of the representation seems to suppose an intention to represent its voice. Perhaps we should not try to search for a naturalistic relation, but a highly abstract one.

One important conclusion can be made, however, between the sound and iconographic contents of the sample. The permanence of sound contrasted with the great variation in their visual appearance, the great independence between external, iconographic styles and the internal, sound styles shows how the first are deeply influenced by culture, the second are almost unchanged by the same. This permanence of an organological type (and its sound) through great cultural changes produced in time and space is not strange to prehispanic organology[41]. Once again we can conclude that aesthetics of sound are a very stable part of the cultural processe.

CONCLUSION

In 2003 I discussed the opinions of Findlay[42] and Wright[43] on whistling bottles that can produce a state of trance when played simultaneously. They based their arguments on their personal psychoacoustic experiences. Although a similar way to induce trance is used today by many Andean cultures in shamanic rituals, now I am more convinced that whistling bottles were not used this way, because of two factors: one is that all known flutes in Andean cultures can, if used in that way, cause similar effects, but this does not mean that they necessarily were intended to be used that

36 Of course there are many exceptions in the precolumbian world about the cited restrictions. But if we focus on the area where whistling bottles are found in the Andes, we find some ceramic idiophones (rattles) restricted to certain cultures, and even less ceramic drums and ceramic trumpets. The same can be said about the use of metal (see Pérez de Arce 2000).
37 Amaro 1994, 72–76.
38 Crespo 1966, 75; Lumbreras 1979.
39 Mead 1903, 26
40 Amaro 1994, 73–77.
41 See Pérez de Arce 1997.
42 Findlay 1992.
43 Wright 1992.

way. Many instruments, not only flutes, can cause similar mind effects, but few are used in this way. The other is that the cited opinions suppose a blowing-without-water technique, which I do not think was the intended sound use of the objects.

The entire “globular flute” group has a common history; they appear in the Chorrera culture and end almost completely in the Spanish conquest (or a little earlier). But this is not the only end of a whole spectrum of prehispanic music: music played on metal instruments also died with the Spanish conquest, because all metal passed to the new leaders, leaving the native Indians with no sources for themselves. But ceramic did not have the same high cultural value for the Europeans, nor was its production restricted, or scarce. The end of the great ceramic music expression must be the result of an unknown factor of deep cultural significance perhaps related to the disappearance of the ancient rituals, including funeral ones.

In sum, we have a splendid corpus of objects related to a great tradition of sound from precolumbian times, with only a restricted area to interpret it. We know they were funerary ceramic bottles that sounded via the liquid movement, with an intense symbolism, evident in their iconography and probably present in many other aspects of their construction, intention and symbolism. But one of the most important clues to this family of objects is that it permits a unique perception and understanding of precolumbian cultural sounds. In fact, an important aspect of studying whistling bottles is that, used as autonomous flutes without the intervention of the human breath, they reproduce the original precolumbian sound without the unavoidable intentionality of modern playing techniques. This means we can approach the conception, perception and cultural modelling of the sound by prehispanic cultures, reducing the speculative and subjective aspect of our approach. This is the only example of this nature in the Andean world, and as such we hope future investigation can fill the many gaps in our understanding and help us to have a better appreciation of the world of sound of prehispanic Andean cultures.

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ABBREVIATIONS OF MUSEUMS AND COLLECTIONS

cp	Colección Particular.
csp	Colección Santiago Pérez, Santago (Today in the Museo de Colchagua, Chile).
ecbc	Museo del Banco Central de Quito, Ecuador.
mchap	Museo Chileno de Arte Precolombino, Santiago, Chile.
mnaa	Museo Nacional de Arqueología y Antropología, Lima, Perú.
MP	Museo de Metales Preciosos, La Paz, Bolivia.
OdelP	Museo del Oro del Perú, Lima, Perú.

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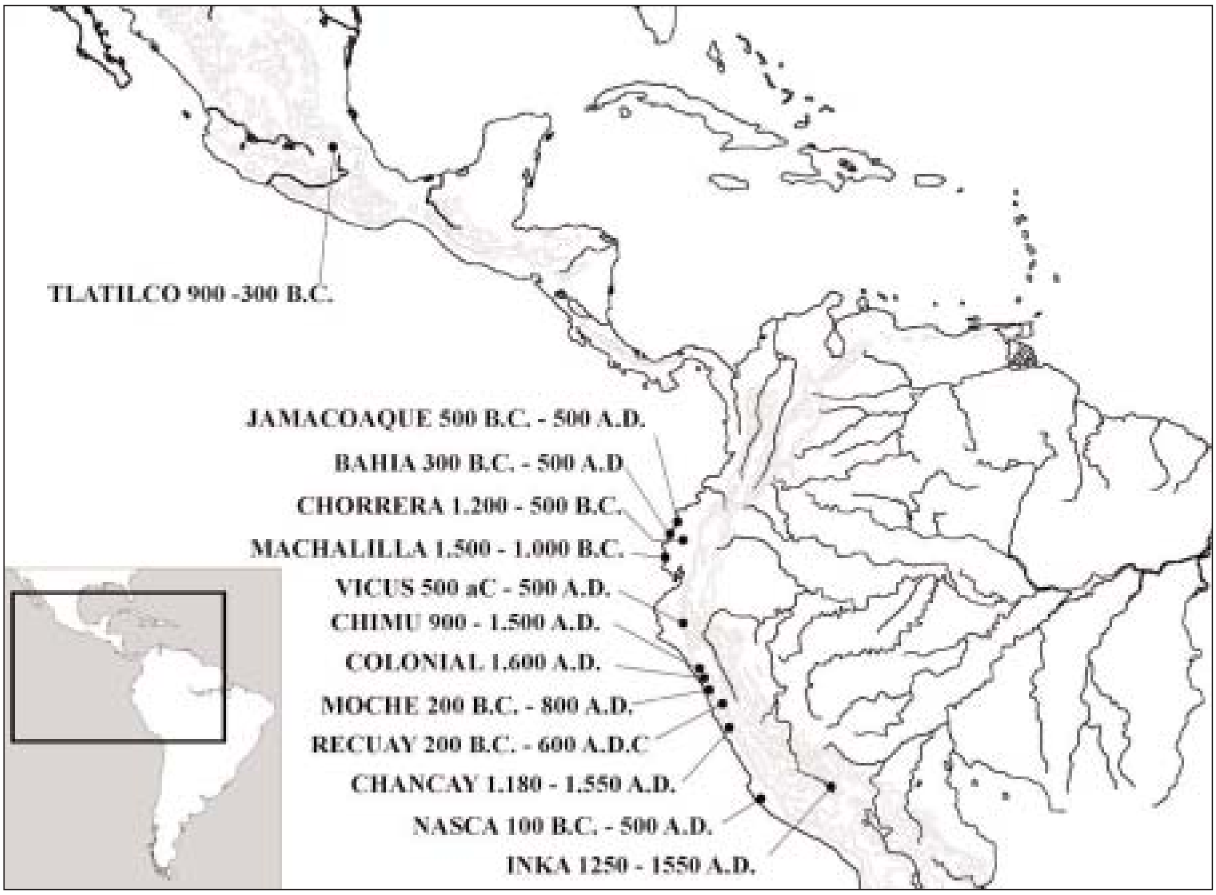


Fig. 1 Map of America showing the different cultures mentioned in the text.

Fig. 2 Colonial whistling bottle (Particular collection), probably provenance Northern Peru.
Two external whistles over the necks (one is lost).

Fig. 3 A: Two Jamacoaque whistling bottles (MCHAP 49 and 50) in front view: warrior throwing spear and musician with panflute. External whistle in the heads. They produce a single bass tone. – B: Rear view of the same, showing the vase container. – C: Playing position of the same.

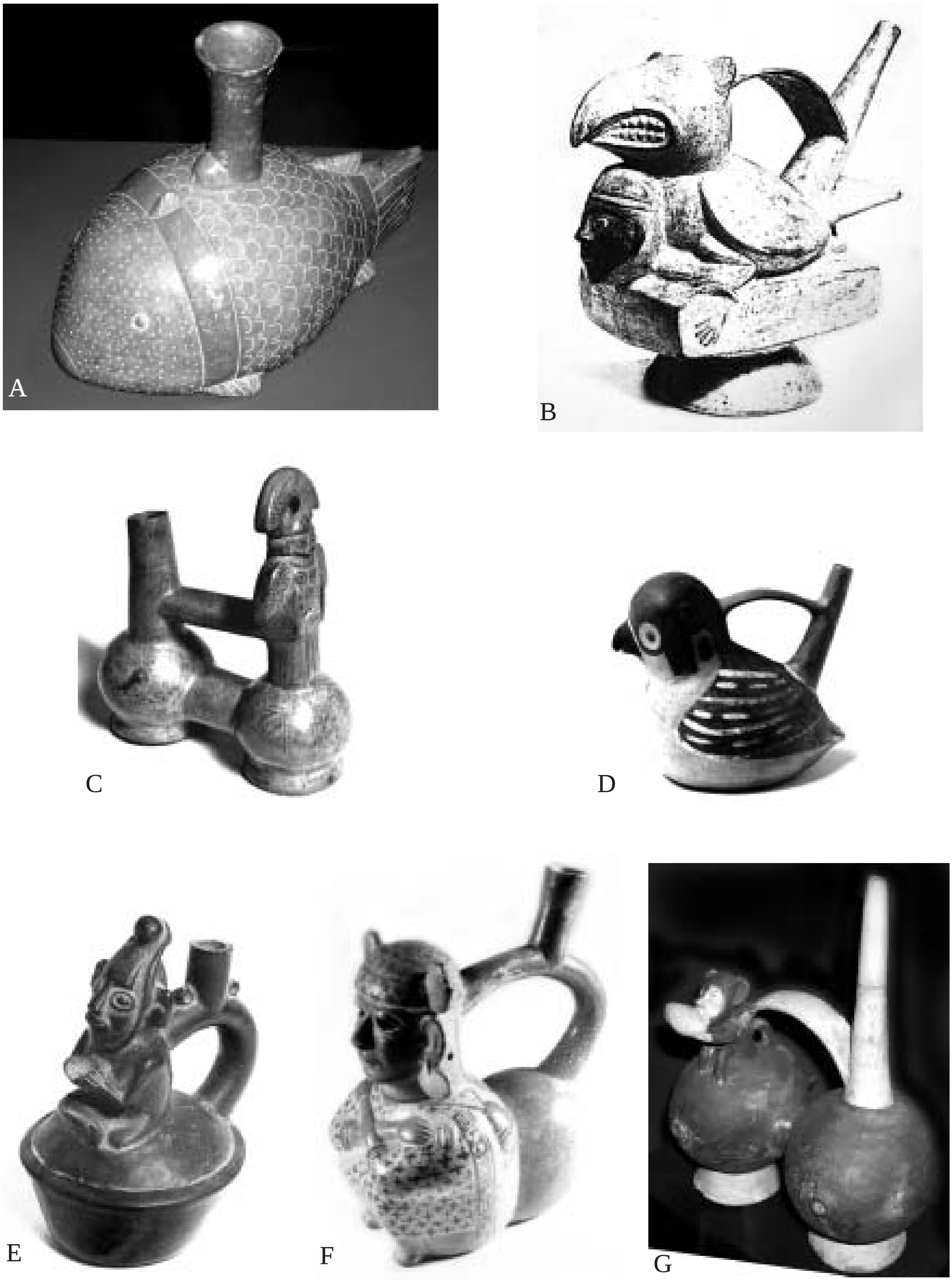


Fig. 4 A: Chorerra whistling bottle (MCHAP 381): fish. External whistle at the base of the sprout. Mute because of false restoration. – B: Early Vicús whistling bottle (MCHAP 296): bird over man. Single tone. – C: Lambayeke whistling bottle (MCHAP 554): antrophomorphic owl. External whistle in the base of the body. The upper part of the body and the head form a globular flute to be blown by mouth, with no connection with the whistling bottle. Whistle with one single tone. – D: Wari whistling bottle (MCHAP 300): bird. Whistle inside the head (covered). Single tone. – E: Chimú whistling bottle (MCHAP 231): man. Exposed whistle in the head. – F: Chimú whistling bottle (MNAA 1008): skeletical representation. Whistle inside the head (covered). Two tones. – G: Chancay whistling bottle (MCHAP 542): monkey playing a seed – like globular flute. External whistle in the globular flute. Single tone.

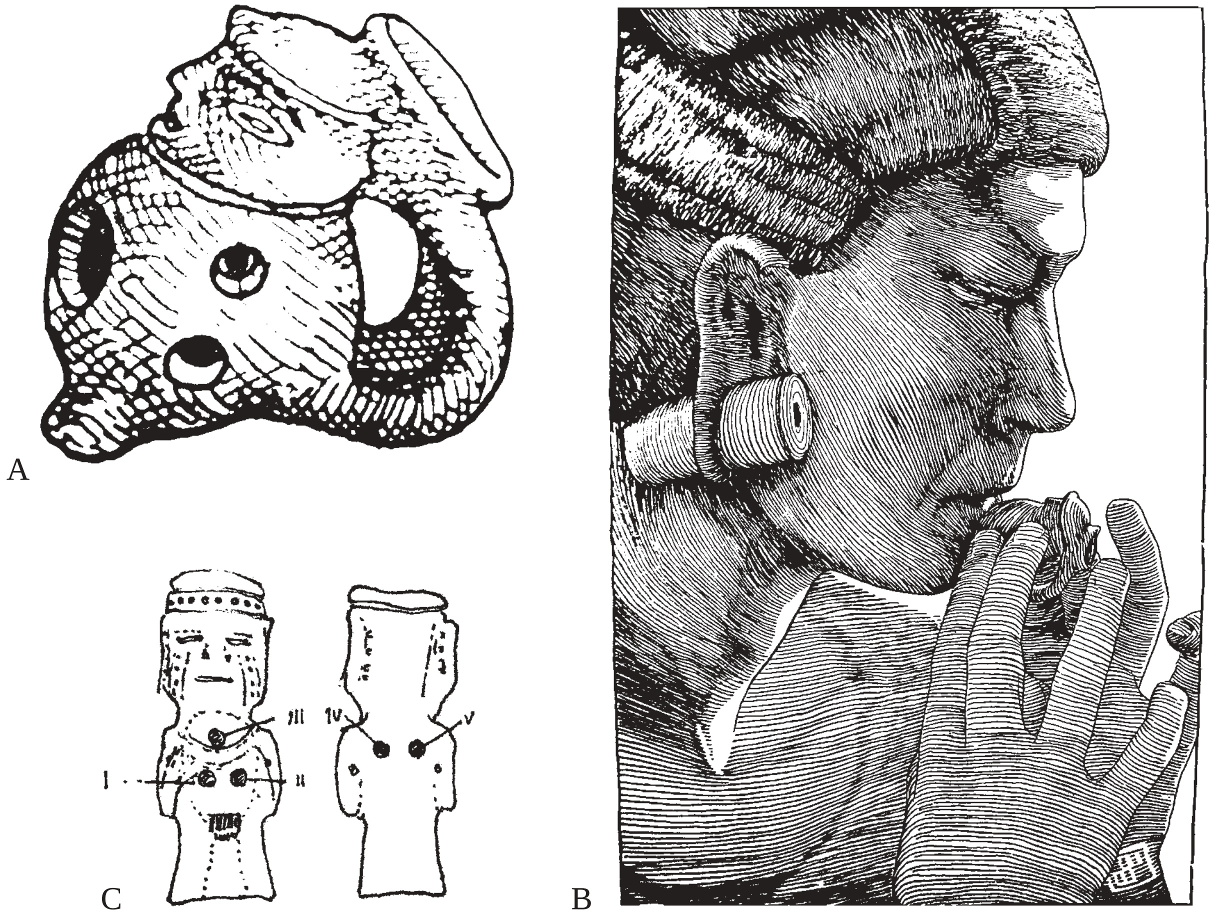


Fig. 5 A: Chorrera globular flute (CSP s/n): antrophomorphic. – B: the same, showing the way to play it. It ergonometric is very comfortable and efficient. – C: Ceramic Ocarina. Ecuador, probably Manta (CP). Drawing showing the internal airduct and the five fingerholes. Although very small (5 cm) it is easy to play.

Fig. 6 A: Chorrera whistling bottle (MCHAP 045): bird over a house. Two tones. – B: the same in a cross section. The "whistle" is inside the body of the bird.

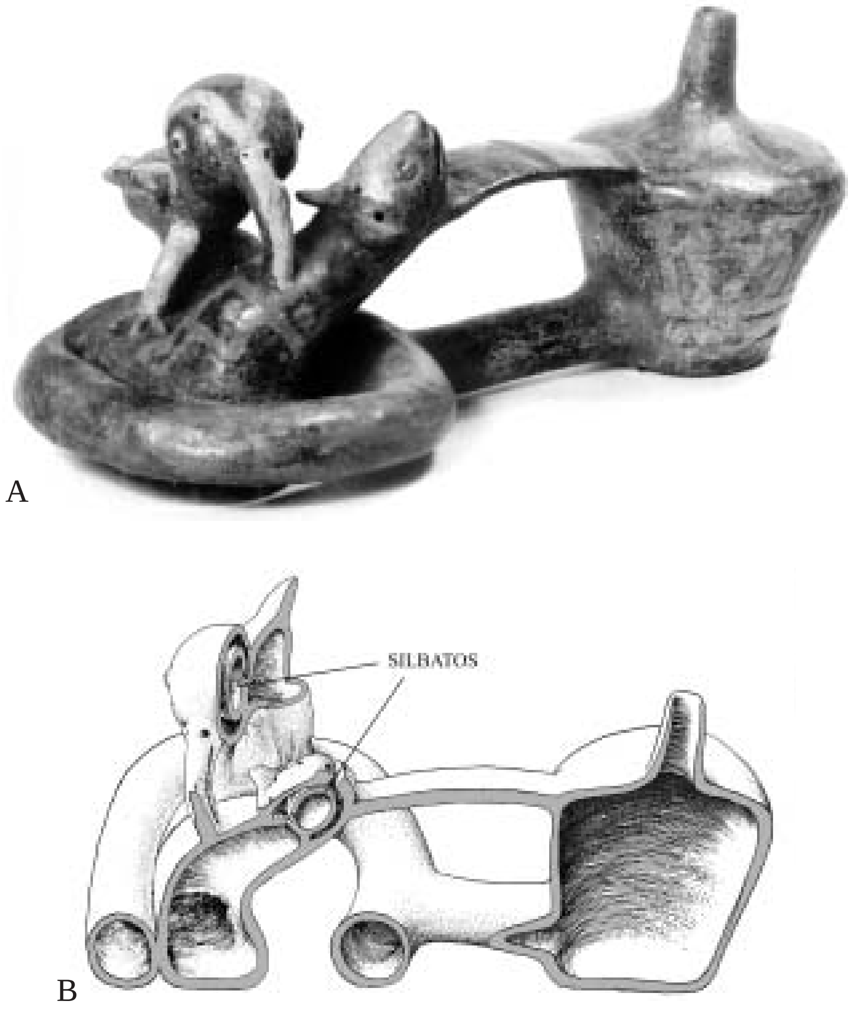
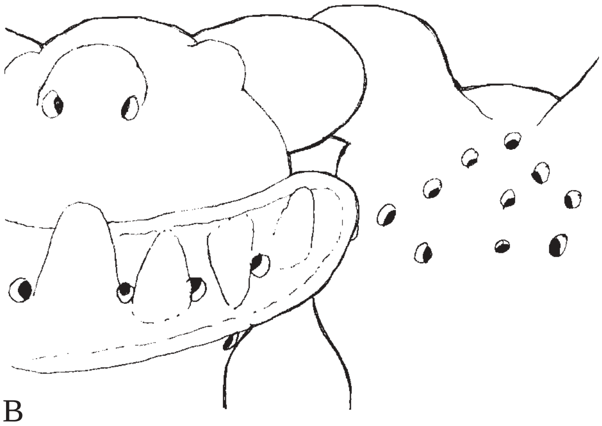


Fig. 7 A: Vicús whistling bottle (MCHAP 241): bird and serpent. – B: the same in a cross section with two “whistles”, each inside of each heads. Mute because of restoration.

Fig. 8 A: Vicús whistling bottle (MCHAP 2076): man playing a pan flute. Whistle inside the head (covered). Single tone. – B: the same, showing the holes in the back of the head.

A



B

Fig. 9 A: Vicús whistling bottle (MCHAP 233): feline. Whistle inside the head (covered). Single tone. – B: The same, showing the holes in the head.

Fig. 10 Vicús whistling bottle (MCHAP 254): bird. External whistle in the head. Gives two tones in a “jump” melodic contour.

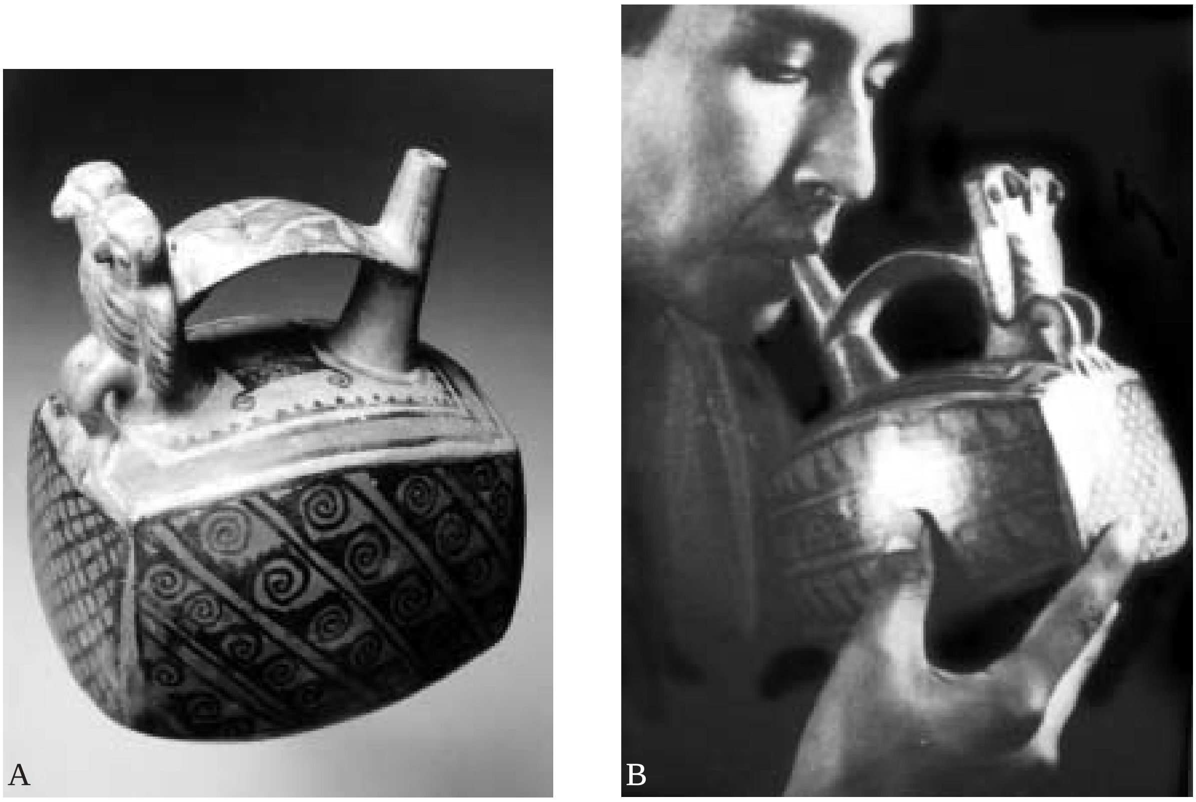


Fig. 11 A: Wari whistling bottle (MCHAP 310): two birds. Exposed whistle in the base of the handle. Single tone. – B: The same. It is easy to blow directly by mouth, but the specific position of the hand has no reference in the ergonometry nor in visible marks of use.

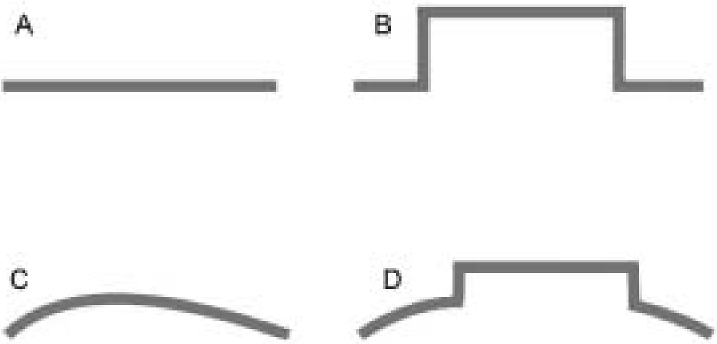


Fig. 12 Scheme showing the four basic melodic contours described in the text.

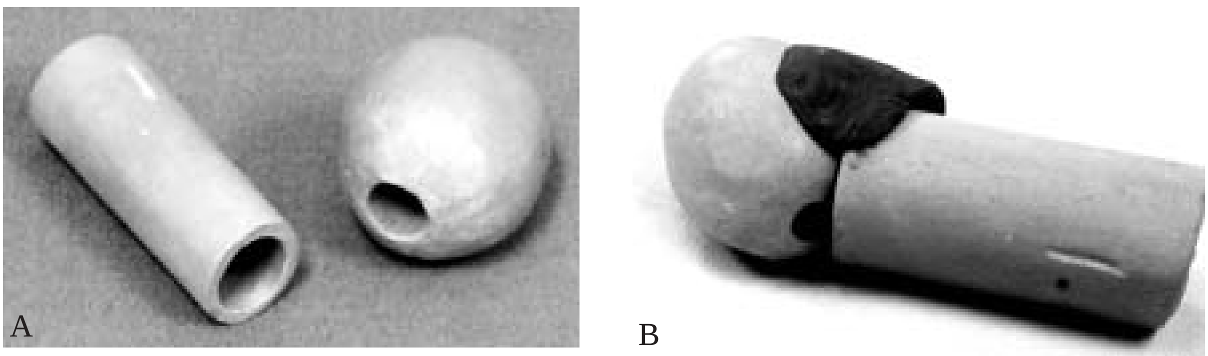


Fig. 13 A: Reproduction of globular flute and airduct, separated. – B: The same joined to form an “ocarina”.

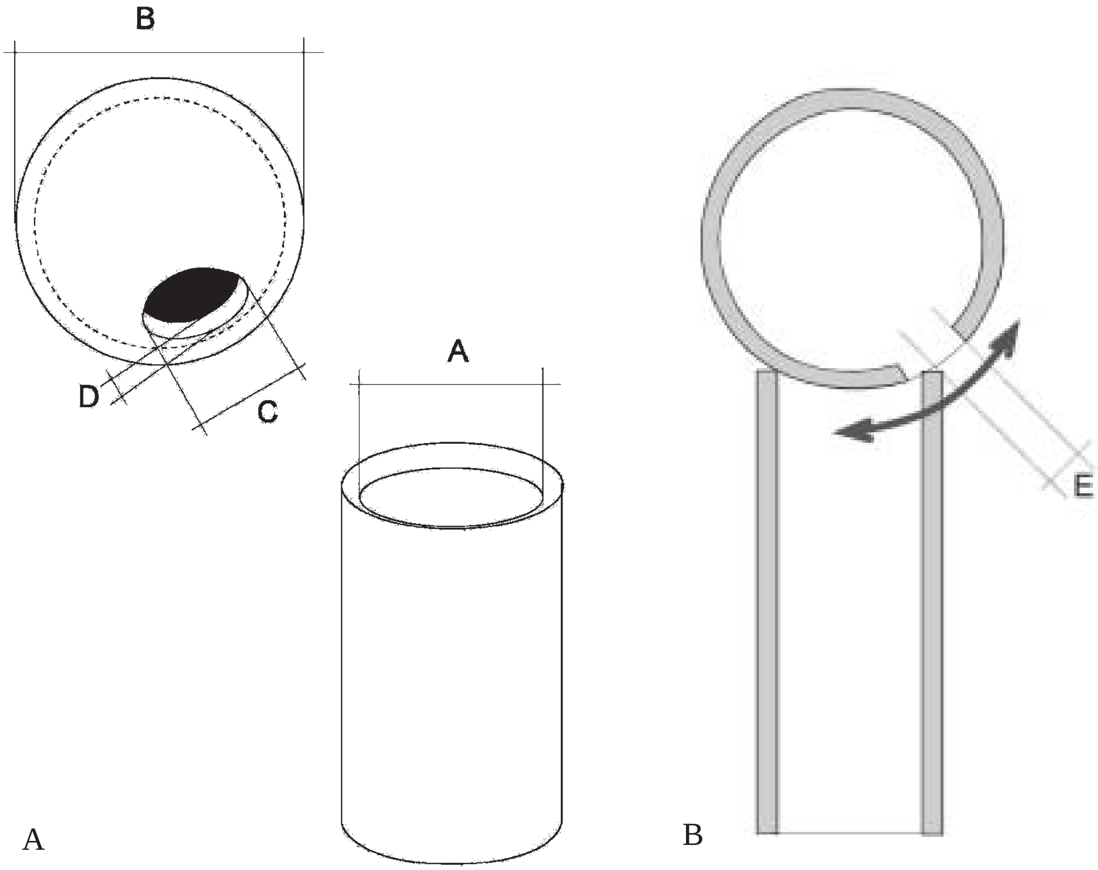


Fig. 14 A: Geometry of the globular flute and the airduct cylinder. – B: The relative position of both, showing the percentage of opening of the circular window.

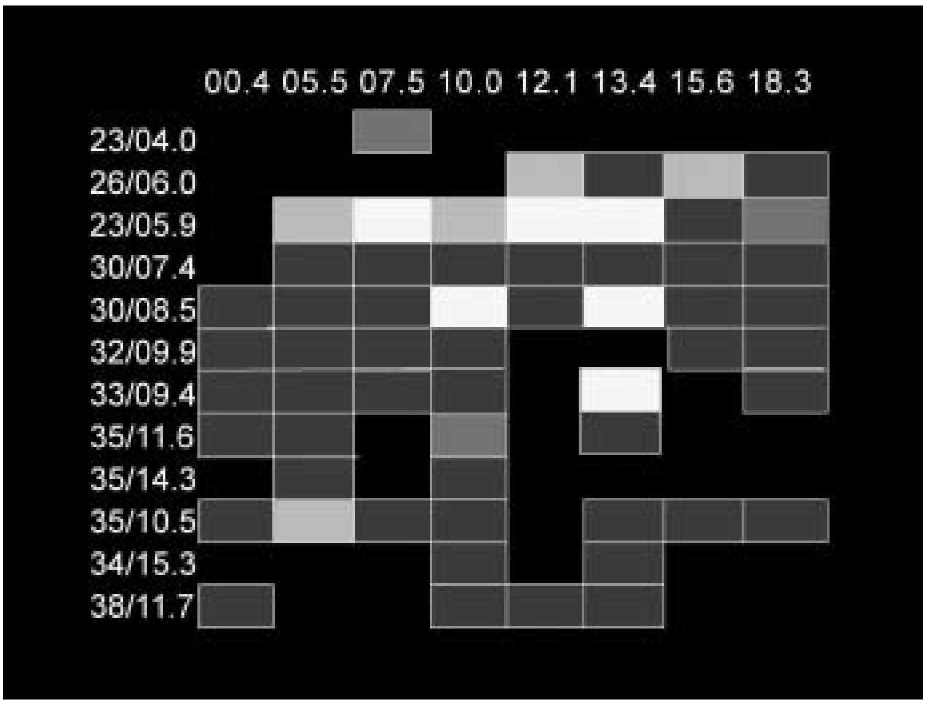


Fig. 15 Diagram of the combination of globular flutes and airduct cylinder showing the zone where the four melodic contour were obtained (see text). White: "jump and arc". Light gray: "jump". Dark gray: "arc". Darkest gray: plane tone. Black: no tone.

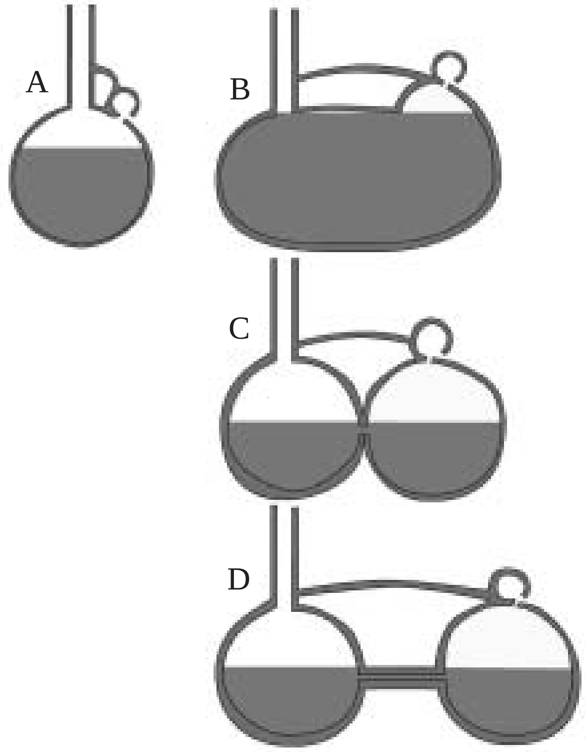


Fig. 16 Schematic basic forms of the bottles. – A: simple bottle, with no air reserve. – B: simple bottle, with air reserve. – C: double bottle, jointed. – D: double bottle with long and narrow conduct.

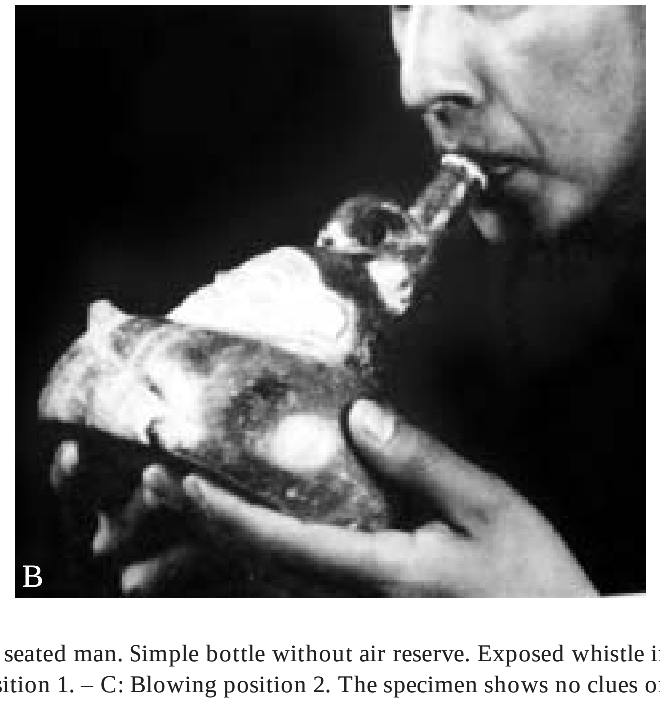


Fig. 17 A: Chorrera whistling bottle (MCHAP 91): seated man. Simple bottle without air reserve. Exposed whistle in the base of the handle. Single tone. – B: Blowing position 1. – C: Blowing position 2. The specimen shows no clues on ergonometric or use marks.

Fig. 18 Virú whistling bottle (MCHAP 453): feline with a small animal between the teeth. Exposed whistle in the base of the handle. Single tone.

Fig. 19 Vicús whistling bottle (MCHAP 229): singing man while chewing coca. Whistle inside the head (covered). Single tone.

Fig. 20 Chimú whistling bottle (MCHAP 559): antropomorphic figure. Exposed whistle in the base of the handle. Single tone.

Fig. 21 Vicús whistling bottle (MCHAP 311): warrior. Whistle inside the head (covered). Single tone.

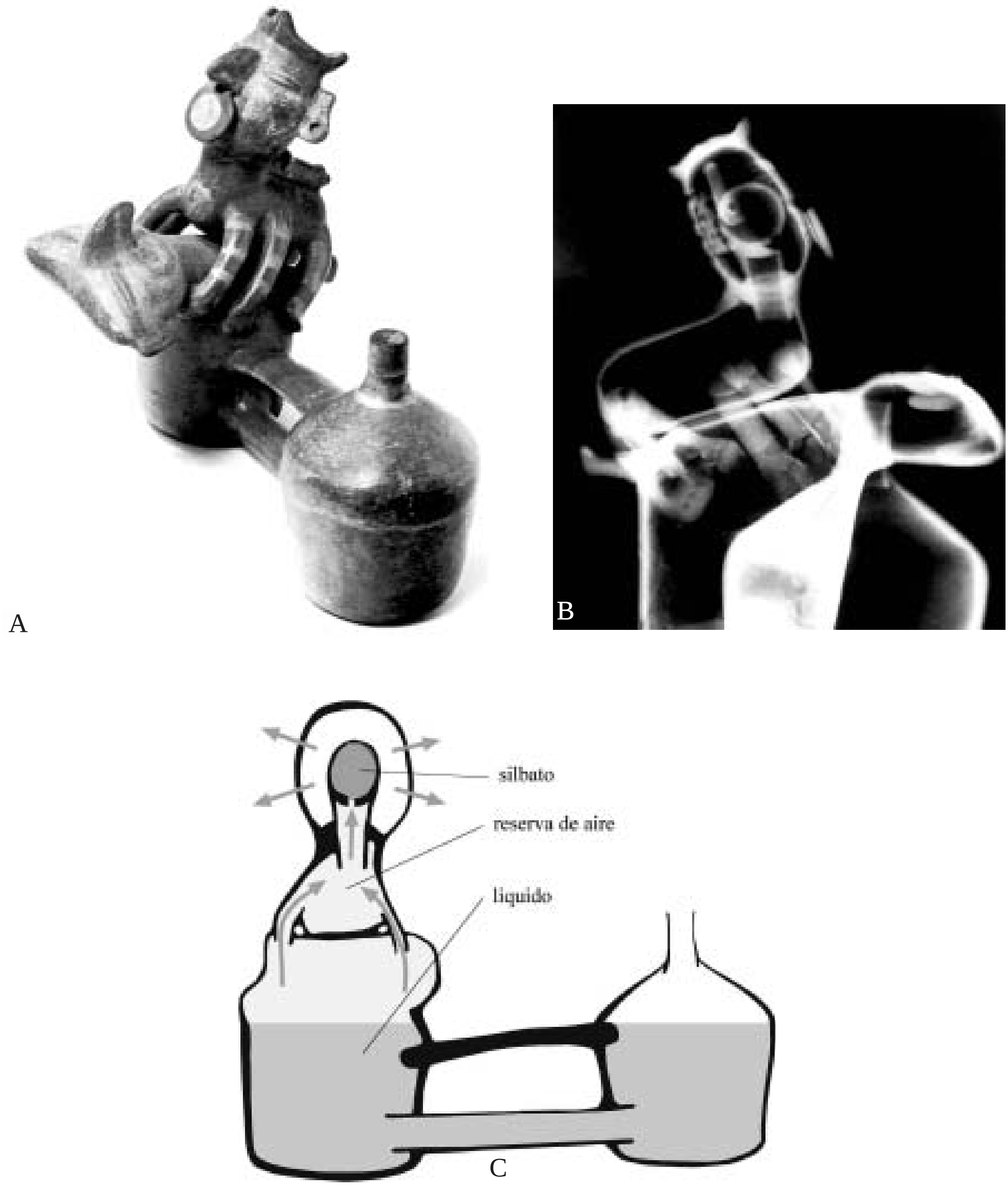


Fig. 22 A: Vicús whistling bottle (MCHAP 243): man and woman, sexual relation. Two tones. – B: The same trough X-ray photography. – C: the same in a cross section drawing to interpret the inside sections. The arms and legs of the man are hollow, the whistle is inside his head.

Fig. 23 Vicús whistling bottle (MCHAP 239): naked man. Whistle inside the head (covered). Single tone.

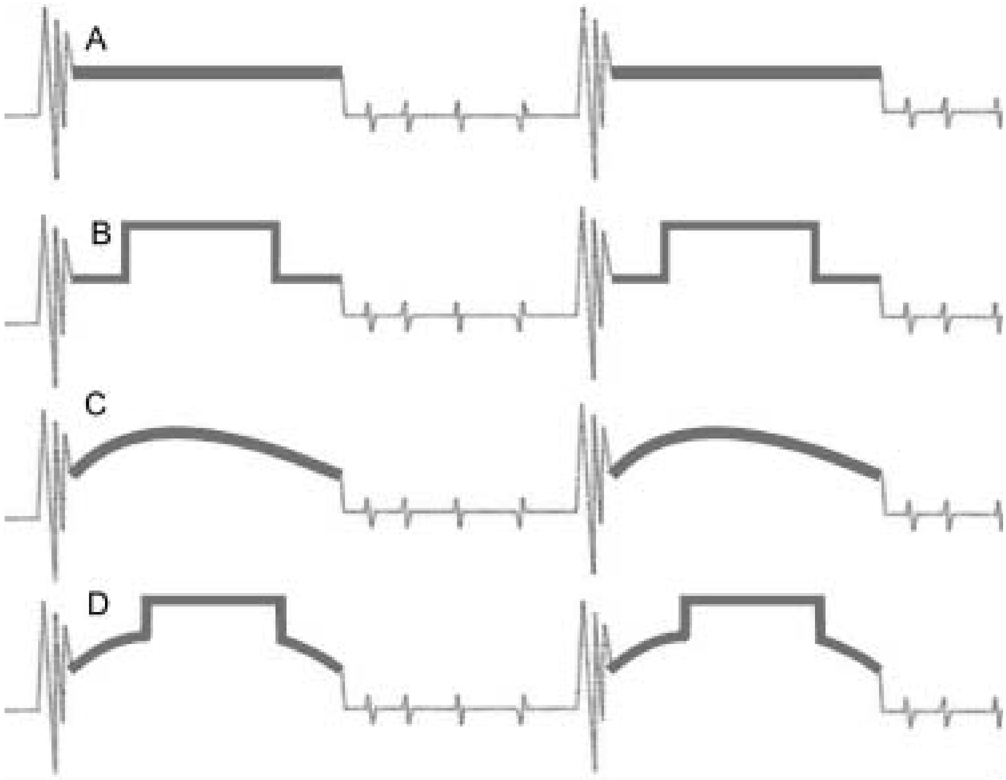


Fig. 24 Schematic interpretation of the four melodic contours with the water melodic contour added in between.

Fig. 25 Vicús whistling bottle (MCHAP 246): two penises. Whistle inside the glans (covered). Mute because of restoration.

Fig. 26 Vicús whistling bottle (MCHAP 230): antropomorphic head and bird. Whistle inside the head (covered). Single tone.

Fig. 27 Wari whistling bottle (MCHAP 301). Represents a guacamayo (*psittaciforme*). It can be one of two species: *ara guacamaya* (bright blue over, bright yellow below) or *ara chiroptera* (red body and tail, blue wings). Nor the colors or the sounds are replicas of the original. Whistle inside the head (covered). Single tone.

Fig. 28 Chimú whistling bottle (MNAA). Over the top there is a painted *strombus* seashell, used as a trumpet by the Chimú. The applications below are in the form of pan flutes. The whistle sounds resembles none of them. Whistle inside the top of the bottle. Single tone.