GLOBULAR WHISTLES FROM NEMRIK

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GENERAL INFORMATION

Discoveries of phalanges I and II of artiodactylous animals with deliberately made openings on the dorsal or lateral side have been known in archaeological excavation work since 1860. The first such object was discovered by E. Lartet in the Aurignac cave in France. Most artifacts of this kind are dated to the Stone Age, but there are also specimens from later times, even as recent as the Medieval period.

In the literature these objects are usually interpreted as tool handles or food remains despite the findings of their original discoverer who claimed they were whistles. In 1934 musicologists published their own studies with the conclusion that these objects are single-tone musical tools. Also Seewald believed that objects of this kind are indeed whistles, and his view was accepted by musicologists and archaeologists alike, including Absolon (1936), Bachman (1956), Häuser (1960), Megaw (1960), Baines (1962), Moeck (1969), Salmen (1970) and Klima (1983).

This report brings a description of four bone artifacts and lists results of experiments meant to explore the possibilities of making sound with them and to verify the hypothesis that relics of this kind are musical tools.

MATERIAL AND METHODS

The analysed evidence material[1] comprised four phalanges I of domesticated cattle with openings on the dorsal side (Fig. 1). These artifacts were uncovered during professor Stefan Karol Kozlowski's excavations at site 9 in Nemrik (Iraq, Dohuk province).

The artifacts were found in a refuse pit (denoted PT) shared by the entire community, in are 78 (square B-2, layer IX, and square C-2, layer IX). The pit is dated to the second half of the 7th millenium bc, i.e. to the end of the PPNB pre-pottery Neolithic period[2].

The study of artifacts from Nemrik comprised the following routines:

1. The objects were photographed and X-rayed; also made were drawings showing their appearance and state of preservation;

2. The artifacts were scrutinized under a binocular magnifying glass (magnification 20-100x);

3. The volume of bone marrow cavities and the area of openings on the objects' dorsal side were determined;

4. The average frequencies (Hz) and intensity (dB) of sound emitted by the objects were measured;

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1 The material for study was made available by professor Alicja Lasota-Moskalewska and professor Stefan Karol Kozlowski whom I wish to thank for their kindness.

2 Information supplied by professor Stefan Karol Kozlowski.

5. Experiments were performed to obtain the tremolo effect, whereby a single tone is repeated rapidly with the bone marrow cavities being filled with water;

6. The distance sound emitted by the artifacts travels in open flat land was measured.

RESULTS AND DISCUSSION

The individual artifacts were labelled A, B, C and D. All are phalanges I of adult domestic cattle. Specimens C and D may originate from the same animal, and even from the same pair of legs. A and B probably belonged to different animals. It must be stressed that the bones used to make these objects are of cattle in the earliest stages of domestication. The archaeozoological analysis and measurements of exterior dimensions were performed by Prof. Alicja Lasota-Moskalewska (Table I).

The studied bones feature openings, deliberately cut out with a sharp cutting tool, in the middle of their dorsal (front) side. The visible grooves left by this cutting implement are 2 to 5.5 mm long. There are no traces of bone structure crushing[3].

The walls of the oval opening in object A are perpendicular to the longer axis of the bone, while in object B they are perpendicular and in places inclined at about 60 to this axis. In object C the opening is roughly circular, while in object D it is irregularly quadrilateral; the walls of these openings are all perpendicular to the longer axis of the bones. The openings lead to the natural bone marrow cavities which appear to be unprocessed, there being no traces of their enlargement, of modification of their natural shape, etc. The marrow cavities are ellipsoidal in shape (Table II).

All four specimens are preserved very well. They are coated with loam and sand, both outside and inside. Small bone fragments have been chipped off during exploration, but these defects have no bearing on results of measurements or sound tests.

Artifacts similar to our domesticated cattle bone objects but made out of bones of wild artiodactylous animals (such as reindeer) are known from various periods and cultures since the Upper Palaeolithic to the Middle Ages. Finds dated to the Stone Age were uncovered, among others, in Orkeney (Great Britain), in French sites of Aurignac, Laungerie-Basse, la Madeleine (Aurignacian culture) and Solutré (Solutrean culture); in Govet in Belgium (Magdalenian culture), in Sveadberg I in Denmark (late Maglemosian culture), in Jaskinia Mamutowa (Mammoth Cave) in Wierzchowie (Poland, Eastern Gravetian culture?), in Dolni Vestonice in Czechoslovakia (Pavlovian culture), in Suljadals (Kunda culture) and Zwidze (Narva culture) in Latvia, and in Tamula in Estonia (W. Kaminski 1971, Klima 1983, Kozlowski 1975, Loze 1988).

The find from Visby on the island of Gotland (Sweden) dates to the late Roman period (Lund 1980), and the youngest object of this kind known to me, dated to the turn of the 12th and 13th centuries, was found in Poznan, Poland (Blaszczyk 1972).

There are several hypotheses in the literature regarding the function of phalanges I with holes on the dorsal or lateral sides. We will now confront these with the finds from Nemrik 9.

The first hypothesis according to which the openings were made to extract bone marrow for consumption is rejected by archaeo-zoologist Alicja Lasota-Moskalewska in view of the minute amount of marrow in this element of the skeleton.

Another hypothesis has it that these artifacts were tool handles. However, a careful scrutiny of the objects at 20- to 100-fold magnification failed to reveal traces of crushing of bone structure at the openings' rims. What is visible though are incisions left by the cutting tool used to make the openings. It is obvious that if these bones had been used as tool handles, these

3 Binocular magnifying glass observations were carried out by Jolanta Kaminska.

incisions would have been worn off. X-rays moreover reveal the absence of indentations which would have appeared as a result of pressure exefted by any tool set in the handle on the wall of the marrow cavity opposite the opening. What can be seen, however, is obvious gloss of the opening edges due to use in conditions of humidity (e.g. saliva). Given these facts, the second hypothesis must also be rejected.

To verify the hypothesis that artifacts of this type can emit sounds, each bone was tested as follows. The opening was brought to the lips and an air current was blown in with a technique similar to that used with contemporary flutes. Each artifact produced a sound. The results of the experiment are as follows:

Whistle A, inv. n'. NK/1620: The obtained sound of average frequency of 1831.5 Hz (Fig. 2a) is in the interval of the major terce G3-B3. It is clear, penetrating, of intensity up to 100 dB. In flat open terrain it is clearly audible within a radius of over 800 meters. Blowing is very easy.

Whistle B, inv. n'. NK/1680: The sound is muffled, of average frequency of 2187.5 Hz (Fig. 2b), in the interval of the major second B3-C sharp4. Intensity is up to 80 dB, and the sound is audible within about 300 meters. Blowing is very difficult.

Whistle C, inv. n'. NK/1573: The sound is fairly clear, of average frequency of 2100.6 Hz (Fig. 2c). Pitch is within the major second H3-C sharp4, intensity reaches 85 dB. The sound is audible within about 500 meters. Blowing is difficult.

Whistle D, inv. n'. NK/1573: The emitted sound is clear, of average frequency of 2021.5 Hz (Fig. 2d), and pitch within the minor terce A sharp3-C4; intensity reaches 95 dB which makes it audible at about 800 meters. Blowing this whistle is easy[4].

This experiment proved that the described phalanges may be treated as whistles, and the openings as mouthpieces.

All four Nemrik whistles share the following characteristics:

-a wide measure, or width-to-length ratio, of the chamber; in A the measure is 0.40, in B-0.54, in C-0.41, and in D-0.45;

-absence of melodic apertures;

-sound in the upper register of the three-line octave and in the lower register of the four-line octave;

-sound of shaky intonation.

Acoustically and instrumentally, the Nemrik whistles ought to be classified as aerophones (from the Greek *aer- air*, and *phone-sound*) in which sound is produced by a column of air vibrating in the pipe body. Aerophones are divided according to the method of inciting air vibration into flutes, reeds, and trumpets.

In the Nemrik whisles sound is produced by the friction of air blown against the almost vertical walls of the opening, which in this case serves as the so called knife-edge. This manner of blowing (incitation) is characteristic of rim-blown aerophones. Another feature according to which aerophones are classified is the shape of the air chamber (pipe). In our whistles the ellipsoidal marrow cavity acts as a convex chamber with a wide measure. Such a chamber is a feature of globular aerophones (cf. X-ray photos).

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4 Measurements of frequency and loudness of sounds were carried out at the Chair of Acoustic Music (Musical Academy in Warsaw) headed by professor Andrzej Rakowski. I wish to thanks professor Rakowski and Wilhelm Suski, M.Sc., for their kind assistance.

The Nemrik whistles may thus be classified as rim-blown globular aerophones.

Whistles made from phalanges I are the oldest aerophones in human history (Häuser 1960). The technology of their production was simple. After removal of the small quantity of bone marrow through a suitably cut opening, the cavity was ready to serve as an air chamber with no further processing needed. The main difficulty in manufacturing such whistles lay in cutting out the mouthpiece on the bone's dorsal side. It is possible that specimens C and D from Nemrik were made by the same person, given the highly probable fact that the phalanges used to make them came from a single animal.

The globular whistles from Nemrik have mouthpieces situated in the middle of the dorsal side of bone shafts, and this determines the manner of holding them against the lips-at right angles to their longer axis. Our experiments suggest that the users of these whistles produced sound with them by means of a technique similar to the one used today to play the flute.

It is possible to obtain the tremolo effect with globular whistles by partly filling the air chamber with water. My experiments showed that in the case of Nemrik whistles this is not practicable since water in the air chamber is expelled via the mouthpiece by the force of the air blown into the instrument.

The Nemrik whistles, similarly as other aerophones of this kind, may be regarded as individual single-tone musical instruments. The fact that they were all discovered in the same layer of a refuse pit, all not more than five meters apart, could suggest that they are elements of a single set of pipes known as the panpipe. To check this possibility, the whistles were arranged in a row along their longer axes. It turned out that the distances between mouthpieces, situated in the central parts of each whistle, were about 50 mm and this would make the hypothetical composite instrument impractical. The arrangement of the whistles with their distal ends forming a line precludes access to the mouthpieces. All this plus the fact that at least three of the whistles (B, C, D) emit a sound of practically the same frequency, speaks against the likelihood that all four finds were part of a single musical instrument.

Speaking of the possible functions of whistles of this kind, Baines mentions their collective (choral) use during hunting magic rites. This hypothesis must be rejected in the case of the Nemrik finds since these were made from bones of domestic cattle. I assume that a bone object connected with hunting magic would have probably been made from the bone of an animal that was hunted or lured.

The pitch of sounds emitted by vessel whistles depends not only on the volume of the air chamber but also on its shape and measure. This is especially evident in the case of specimen B which has the largest chamber but, contrary to expectations, emits the highest rather than the lowest sound of all the whistles (Table III).

The experimentally demonstrated instability of intonation is a characteristic feature of all globular aerophones. The differences in sound pitch-up to the major terce in the case of the Nemrik instruments-depend not only on the size and shape of the air chamber. They are also affected by the force with which the player blows and by the angle between his lower lip and the edge of the mouthpiece. The size of the mouthpiece significantly affects the ease of blowing and the purity of the emitted sound. In whistles B and C the excessively large opening leads to impure intonation of the produced sounds. Incidentally, too small a mouthpiece gives the same effect, all the way to "silencing" the whistle altogether.

Baines and Dauvois described the pitch of sounds emitted by most of the whistles of this type they studied as roughly in the C4-E4 range (Baines 1962; Dauvois 1989). The Nemrik whistles produce sounds from the upper register of the three-line octave and the lower register of the four-line octave, i.e. from the most common range. Experiments mentioned by Dauvois suggest that the present pitch of sounds produced by the Nemrik whistles does not differ significantly from the original one.

The whistles from Nemrik-or at least specimens A and D-could have served as signalling tools. This possibility was demonstrated in experiments carried out in flat open terrain. The sound they emitted was audible at a distance of several hundred meters. The unstable intonation is no obstacle in contacts between humans or in luring livestock, for it does not matter whether the sound is in A flat, A or A sharp. What could have mattered though was the rhythm in which the sounds were emitted.

Studies of ethnomusicologists showed that the most basic and primary forms in lithurgical music and songs of peoples in early stages of development are recitations based on single-tone melodies. The creative factor in these forms is rhythm (Sachs 1988). The Nemrik whistles-or at least those labelled A and D- may be used to play a rhythm of just about any complexity and speed. I am far from claiming that these whistles were used in Nemrik as accompanying instruments. One cannot however reject completely the possibility that they were used to produce single-tone melodies, possibly even artistic in nature.

All four whistles were discovered in a refuse pit shared by the entire settlement. Objects B and C were probably discarded because of the poor sound they were capable of emitting, this defect of theirs being caused by the faulty execution of the mouthpiece. As for whistles A and D, I am unable to suggest a reason for their presence in the refuse pit.

Studies of the four bone artifacts discovered in the course of archaeological excavations at site Nemrik 9 lead to the following conclusions:

1. The artifacts were made from phalanges I of domestic cattle.

2. All four artifacts are rim-blown globular aerophones, or whistles.

3. The finds represent the oldest aerophone type.

4. They are not elements of a single instrument.

5. The objects could have served signalling functions, could have been sound-emitting children toys, or served artistic purposes.

6. It is highly probable that whistles C and D were made by one person.

7. Whistles B and C are defective specimens.

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TABLE I. Site Nemrik 9 (Iraq). External dimensions of phalanges I (in mm)

Dimensions			Whistles		
		A	B	C	D
maximum length	73	74	71	71	
width of proximal end	34	38	36	36	
width of distal end		33	37	32	35
width of shaft	30	36	29	30	

TABLE II. Site Nemrik 9 (Iraq). Dimensions of openings and of air (bone marrow) chambers in phalanges I (in mm).

			Whistles		
Dimensions		A	B	C	D
length of opening		20	16	17	20
width of opening	13	20	18	13.5	
approx. area of opening	190	234	274	240	
height of air chamber	44	44	43	40	
width of air chamber		18	24	18	18
depth of air chamber		18	18	17	17
approx. volume of air chamber	12560	13816	10676	11304	

TABLE III. Site Nemrik 9 (Iraq). Dependence of sound frequency on volume and measure of air chamber of vessel whistles.

Whistle	Hz	Volume	Measure
A	1831.5	12560	0.40
B	2021.5	11304	0.45
C	2106.0	10674	0.41
D	2187.5	13816	0.54

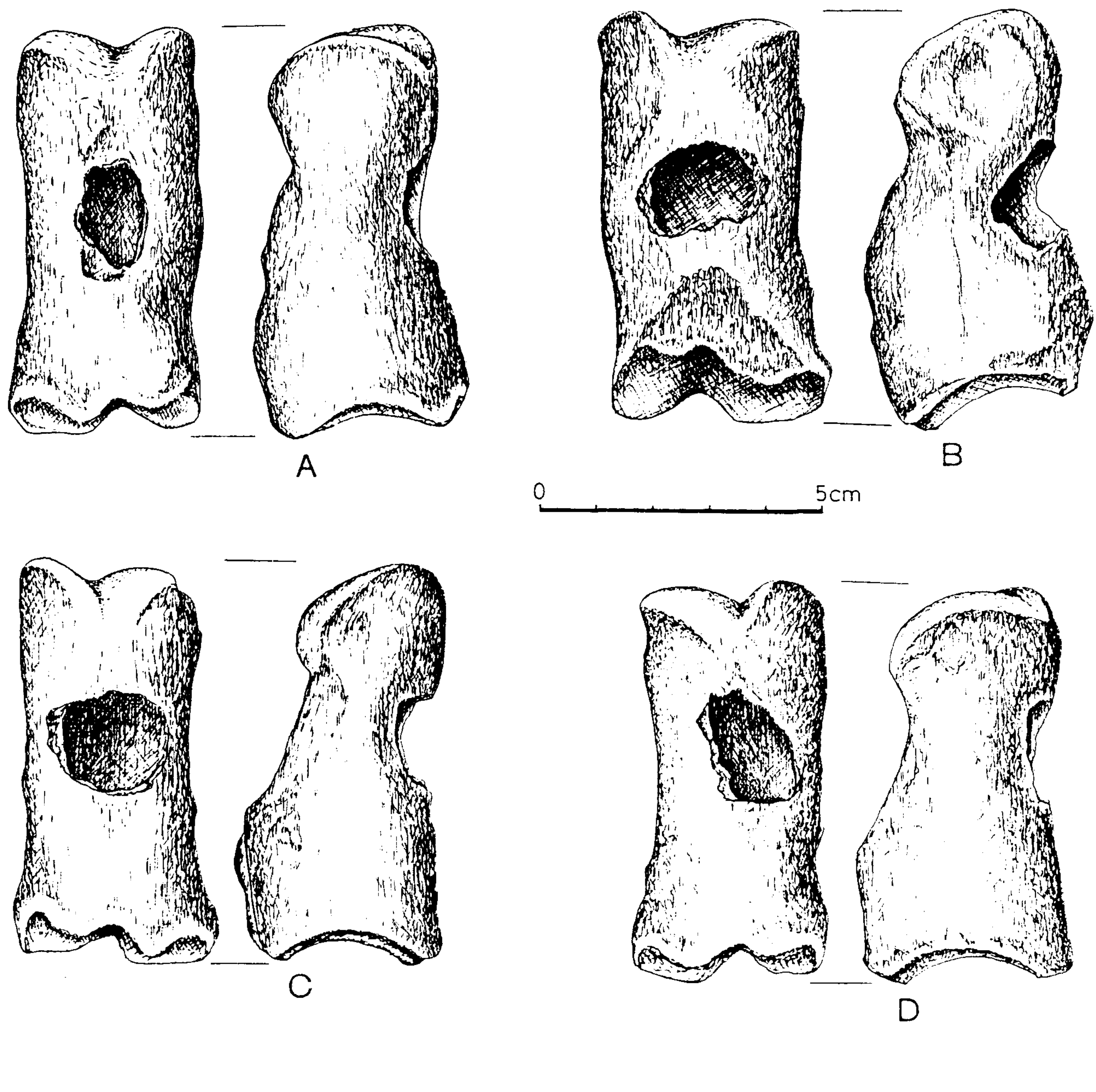

Fig. 1. Whistles from site Nemrik 9 (Iraq). Dorsal and lateral sides of bone shafts. Actual size. Drawings by Ewa Guminska.

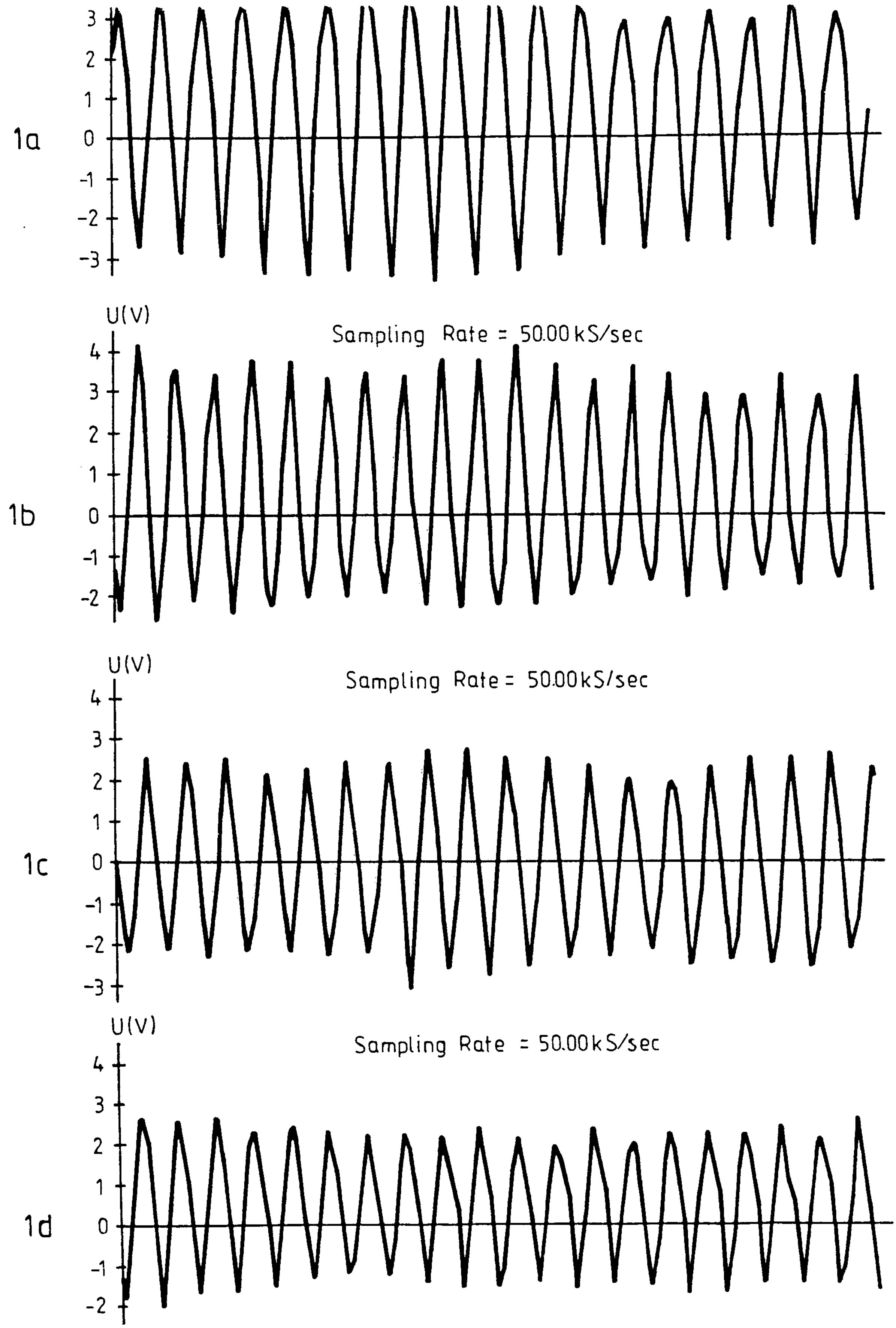

Fig. 2. Diagrams. Whistles from site Nemrik 9 (Iraq). Curves of frequencies of sounds emitted by whistles (in Hz). Plotted by Wilhelm Suski.
U[V] - amplitude [V]

X-ray photograph. Whistles from site Nemrik 9 (Iraq). Shape of air chamber viewed from the dorsal and lateral side of bone shafts. Actual size. Photo by Piotr Szczerbinski.