Poesia, musica e agoni nella Grecia antica

Poetry, Music and Contests in ancient Greece

Atti del IV convegno internazionale di MOIΣA
Proceedings of the IVth International Meeting of MOIΣA
Lecce, 28-30 ottobre 2010

a cura di D. CASTALDO - F.G. GIANNACHI - A. MANIERI

RUDIAE
RICERCHE SUL MONDO CLASSICO
22-23
2010-2011

II Tomo

CONGEDO EDITORE

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The Hellenistic side Flute and the Koilē-Athens Instrument

Introduction

A wind musical instrument was excavated in Athens in 2000, which can be recognized as a side flute, an instrument about which a scholarly debate has been going on for years, not only about its ancient name (*plagiaulos*?), but even about its very existence amongst the Hellenes, and even the Etruscans and the Romans; some scholars maintain that the side flute came to Europe from India and the Far East in the 10th century AD via Byzantion.[1] It will be here concluded beyond doubt that the side flute, although a foreign import, according to the ancient relevant texts, did exist in the Hellenic world, in Athens and elsewhere, and not only in rural environments, as the textual references to it would have us believe.

The evidence of iconography on the Hellenistic side flute

Up to now, only one piece of good depictive evidence for the existence of the side flute was known to us: a mosaic from Korinthos, of Roman date but believed to have been a copy of an earlier, Hellenic (4th century BC), painting (fig. 1), depicting a shepherd side fluting to his cattle.[2] To this, a second piece of evidence, recently discovered in Thēbai, came in support of the Korinthian mosaic: a painted floor in the silhouette technique (fig. 2), dated as about 200 BC, of a man on a *bema*, playing the side flute.[3] His posture is very characteristic of side flautists, with the legs crossed over. In the background are depicted a wreath (probably, signifying victory in a music contest), and what looks like a flask of wine (the prize, perhaps).[4] Good evidence is also furnished by

[1] Most lately, Montagu 2001, p. 31.

[2] See Shear 1930. The suggestion is made, on stylistic grounds, that the original may have been a painting by Pausias or a member of his School, in 4th Ct BC Sikyon. See also Shear 1925 with fig. 9.

[3] See Koyntoyph 1997. I would like to express my sincere thanks to archaeologist Ms Helena Kountourē, of the 9th Ephorate of Prehistoric and Classical Antiquities (Thēba), for the permission to include this item in the present publication.

[4] A similar wreath, although less stylized, of more or less the same period (2nd Ct BC), can be seen on a squat jug of the Lagynos Group from the area of Pergamos (fig. 3); London, British Museum, Catalogue of Vases F 513 (Williams 1985, p. 69).

the mosaic floor depiction of a side flautist from Roman Knōssos (fig. 4), the so called 'Dionysos Villa', of the Hadrianus-Antoninus period (2nd century BC). It is described as a portrait of a satyr with a flute.[5]

Of lesser quality are the following iconographical items: (i) a statuette of Alexandrian times, now in the Hellenoegyptian Museum of Alexandria (fig. 5), undoubtedly depicting a side flautist;[6] (ii) an Etruscan relief (fig. 6) of ca 100 BC;[7] (iii) a late Roman (ca. 200 AD) statue (fig. 8) of a flautist (?) satyr, whose prototype may go back to the 4th century BC;[8] (iv) a coin (fig. 9) from the city-state of Caesaria Philippi,[9] dated as Hellenistic or Roman (4th BC-4th AD). Undoubtedly, a side flautist is being depicted, again with that characteristic crossing-over of the legs; (v) a second coin (fig. 10) from the same place and period, probably also depicting a side flautist leaning against a tree, and in the company of a sheep;[10] (vi) a third coin (fig. 11), same place and period, depicting a piper, probably a side flautist. Notice, again, the crossing over of the legs of the musician;[11] (vii) a series of more than fifty two Roman copies in various European museums of a Praxitelean (ca. 300 BC) original, depicting a side flutist.[12] In one of them (fig. 12), Pan is portrayed playing the side flute, although the instrument is a much later addition.[13] However, the position of the hands to the one side, the turning of the head in the direction of the hands, and, possibly, the crossing over of the legs, strongly suggest that originally a side flute was placed in Pan's hands. In a second copy (fig. 13), the right hand of the piper is much lower than the left

[5] KANKELEITE 1997.

[6] HICKMANN 1952, p. 111, fig. 3, identifying the instrument with the 'Castellani' pipes in the British Museum. Also, BRECCIA 1930 II 2, p. 286, pl. 58.

[7] A relief on an urn, in the Tomb of the Volumnii near Perugia. SACHS 1940, p. 142 with pl. VIIIa; FLEISCHHAUER 1964, pp. 44-45 with fig. 20; BROWN 1980, pp. 669, 670, fig. 5; MONTAGU 2001, p. 31, fig. 4.

[8] Roma, Museo Nazionale Romano Inv. n. 550. WEGNER 1963, p. 57, fig. 28; VASORI 1979, pp. 104-105; BROWN 1980, p. 669; MONTAGU 2001, p. 31.

[9] BRAUN 2002, fig. V.58.d (Collection of the American Numismatic Society). The Hellenic name of the city was Panéas or Panias, or Páneion or Pánion, ancient Palestine (fig. 7 top right), modern town Baniyas in Syria.

[10] BRAUN 2002, p. 294, fig. V.58.f (Ashmolean Museum). Braun identifies the instrument as a long or notched flute, that is, a slant flute as opposed to a side flute.

[11] BRAUN 2002, p. 293, fig. V.58.e (Jerusalem, Israel Museum, 1134). Braun identifies it with a reed instrument.

[12] My sincere thanks to Stephan Schröder, Curator of the Prado Museum, Madrid, for pointing out this series of copies to me, and providing me with his publication on the Louvre and Prado statues.

[13] Paris, Louvre, Inv. 595. SCHRÖDER 2004, p. 129, fig. 26.

hand, which is not a likely position for holding a side flute, although the head is turned to the direction of the hands.[14] Could the pipe then not be a side but a straight or slant flute? However, it would be safe to conclude that some sort of flute (*syrinx*) was meant.[15]

The Koilē-Athens side flute

The instrument (fig. 15) was found in 2000 by archaeologist Olga Bogiatzoglou of the 1st Ephorate of Prehistoric and Classical Antiquities, in a non-disturbed burial, in a grave of the Hellenistic cemetery of Koilē, the area between the hills of Pnyx and Philopappos, opposite the Athenian Acropolis.[16] Photographs of it were taken *in situ* by the excavators, and the instrument was raised from the ground together with the surrounding it soil and plant roots that had grown through it, and golden threads, perhaps belonging to the garment of the deceased (fig. 17). The fact that a strigil was also found in the grave indicates that the deceased was a man.[17] The burial has been dated as the period 1st century BC to 1st century AD.[18] The pipe was transported to the Laboratories of the Acropolis Ephorate for cleaning and restoration. A close collaboration of the present writer with the restorer over a fairly long period of time ensured that no significant information was lost to us in the process.[19] As will become apparent, almost all of the information that we would have wished to retrieve from the object we are able to get, and because it is an instrument that operates without a reed, its scale can be easily produced on a physical replica of the instrument.[20]

The pipe comprises five bone sections (fig. 16, here named from left to right A, B, C, D, E), jointed together in the well known socket-spigot

[14] Madrid, Prado Museum, Cat. No 118. Schröder 2004, p. 128 with fig. Interestingly, a multiple *syrinx* is hanging from the branch of the tree against which the figure is leaning, with legs crossed over.

[15] Table 3 (fig. 14) is a collective diagram in chronological order of all the available evidence on the Hellenistic side flute: iconography and real instruments.

[16] Ancient road of Koilē, Section A, Grave 22, Group 5, depth 96 cm. I would like to express my sincere thanks to Ms Olga Bogiatzoglou for granting me permission to examine the find, and proceed with its publication.

[17] However, strigils have been found in women's graves as well.

[18] This provisional date will be verified when all the other objects found in the grave, both metallic and ceramic, will have been studied.

[19] I would like to express my sincere thanks and appreciation to the restorer of the 1st Ephorate Ms Basilikē Mylōna, for the invaluable discussions and guidance on issues or restoration, and her most friendly attitude.

[20] See below, under 'Reconstruction and acoustics'.

manner, with bronze rings fitted over the joints.[21] The uppermost section is the mouthpiece with the mouth-hole, then a piece of simple tubing, followed by a first section with four holes and a second one with five holes, and a lowest section flaring out at the end, forming a gentle bell. Thus, there are nine tone holes in all, all of the same size: seven on top and two underneath (thumb-holes).[22] It goes without saying that with two thumb-holes, the instrument cannot be anything else but a single pipe, one thumb-hole for each hand. The thumb-holes (T_h and T_l) are second in order from above (I, T, II, III ...), as is always the case with the double *auloi* that we know of.[23] We can be sure that the pipe was played to the right (in contrast to the Korinthos mosaic but in accord with the Theban floor), because the thumb-holes are not exactly below the others in each section, but displaced with respect to them: clockwise (when seen from the mouthpiece side) in the case of the upper section, indicating that the left hand operated in the upper region (section C), and anticlockwise in the lower section, indicating that the right hand fingered those holes (section D).[24] Remnants of paste at the junction of sections D and E that could very well have been glue, is corroborative evidence to John Landels' hypothesis, that *auloi* sections were glued together.[25]

[21] The bone surfaces under the bronze rings have been coloured green by the products of oxidization of the copper contained in the alloy. The rings have lost all of their metal core; what survives is only products of oxidization.

[22] Landels (1999, p. 72) anticipated that the ancient Hellenic side flute would have nine holes, but he gave the series $I_h\ T_h\ II_h\ III_h\ IV_h$ - $I_l\ II_l\ III_l\ IV_l$ (with only one thumb-hole), rather than the one we find on the Koilē instrument, which is $I_h\ T_h\ II_h\ III_h$ – $I_l\ T_l\ II_l\ III_l\ IV_l$ (with two thumb-holes). It is interesting that only four fingers of the upper hand are to be used, as opposed to all five of the lower hand. This is probably because it would be rather difficult to cover a fifth hole with the little finger of the upper hand, as the little finger would form an obtuse angle with the longitudinal axis of the pipe.

On the indices h and l see the next note.

[23] Indices h and l stand for 'high' and 'low' hand positions on the pipe. For a right handed musician, playing the instrument to his/her right, 'h' corresponds to the left hand and 'l' to the right hand.

[24] I have elsewhere argued that, in a double *aulos*, a clockwise shift of a thumb-hole (as perceived by the player) indicates a left hand pipe, while an anticlockwise shift indicates a right hand pipe (Psaroudakēs 2008). Perhaps, this shift to one side of the 'keel' of the pipe, allowed the thumb to fold at the first joint, and thus uncover the hole without any further movement. In this way, the first phalanx of the thumb assumes a position perpendicular to the pipe, with only the tip of the finger in contact with the pipe. The technique is easily demonstrated on a replica, and with very good results.

[25] Landels 1999, p. 33. Material remnants of glue texture have been observed by Ms Mylōna under the microscope on the inside surface of some rings, and on the outer surface of some spigots. It is very likely, therefore, that the bone sections were glued togeth-

The positions of the holes along the pipe are as follows (point 0 is the uppermost end of the spigot; capital letters indicate the upper ends of the relevant sections:

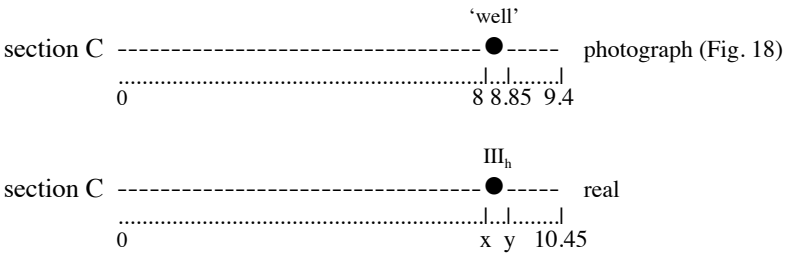
0	1.6	3.2	8.1	15.7	18.7	21.3	22.6	[25.066]	26.3	28.7	30.6	32	34	37.65	38.4	41.8	43.1	51.1	(cm)
spig.	A	emb.	B	C	I_h	T_h	II_h	III_h	D	I_l	T_l	II_l	III_l	IV_l	E	[——-—-]		end	

To this overall length (51.1 cm) must be added the depth of the plug, which, as has been assumed, is equal to the length difference between the spigot and the ring (2.422-1.6 = 0.822 cm). Thus, the overall length of the original instrument (not allowing for taphonomic alterations) was 51.922 cm (51.1+0.822). However, the functional length of the pipe is 51.1 cm, since this is the length of the vibrating air column when all the holes are closed, including the opening in section E.[26] The wall thickness of the pipe, measured at several places, is of the order of 3 mm.

Of the two central sections of the pipe, the left hand section (C) is fairly damaged: holes I_h, T_h, and II_h are discernible, but the existence of a hole III_h has to be assumed, as the bone in that area is missing. After all, the distance between hole II_h and hole I_l of the next section (D) is too large to have been without a tone hole in it. So, the position of a hole III_h must somehow be located by calculation. This is possible, because at the place where the hole must have been, a 'well' was formed inside the pipe and around the circumference of the hole before the fracture took place (fig. 17), possibly by material that entered the pipe through the hole and solidified, and came to hang from the edge of the hole like a stalagmite. This formation was stuck on the inside wall of the pipe (fig. 18). I propose we take the centre of this 'well' to correspond to the centre of the missing hole III_h. If we do this, then by working with length ratios off the photograph, the position of hole III_h can be calculated:

er in position, and that so were the metallic rings to the bone surface at the joints. Also, several small pieces of fiber have been located in between some rings and the bone underneath them, and inside the pipe in the region of some rings. Two of these fibers have been identified: one is of linen and the other of cotton. Another small piece of string, whose core fibers have survived, has left its clear stamp on the solidified mud under the ring at junction D-E; the shape of the trace indicates that the material of the string which surrounded the core was cotton. It seems likely, therefore, that, together with the use of glue, string was wrapped around the spigots, so as to create a tight joint, in very much the same way it is often done today on wind instruments (contra LANDELS 1999, p. 33).

[26] The operating length of the air column would not, of course, be 51.1 cm in the case the opening were left uncovered; it would be shorter.



x:8 = 10.45:9.4 → x = 8.8936 cm
y:8.85 = 10.45:9.4 → y = 9.8385 cm
diameter of 'well': y-x = 9.8385-8.8936 = 0.9449 cm[27]
position of centre of III$_h$: (x+y):2 = (8.8936+9.8385):2 = 9.3660 cm
position of III$_h$ along the pipe (0-C + C-III$_h$): 15.7+9.3660 = 25.066 cm

This value is acceptable, since it lies well between hole II$_h$ (at 22.6 cm) and the beginning of section D (at 26.3 cm). The estimated position of hole III$_h$ will be checked later, when the scale produced by a replica will be examined, to see whether it conforms with what is known from harmonic theory. Although the positions of the other three holes of section C can be established, their diameters cannot be measured, because not enough bone material survives along their circumference. However, they seem to be of the same size with the holes of the next section, D, which is in very good condition and measurements of hole diameters are possible. No recession is to be found around the holes: their edges are square cut. Their shape is slightly elliptical, the difference between longitudinal and transversal values being of the order of just under 1 mm (0.5 mm for mean values. Mean values are: 8.112 mm longitudinal and 7.58 mm transversal).[28]

The mouthpiece (fig. 19), at the upper end, has a prismatic platform on it, with a mouth hole (9.28 mm in diameter) through it. This platform has lost its right half (fig. 20) but, fortunately, we are able to reconstruct it precisely, because another three such mouthpieces are known to us from

[27] This value is larger than the other hole diameters of section D by about 1mm (larger, transverse values): I$_l$ 8.34; II$_l$ 8.46; III$_l$ 8.66; IV$_l$ 7.52 cm. This result is not too bad, if one takes into account the fact that some small error will have undoubtedly entered our measurements off the photograph, in which some curvature is present.

[28] Exact measurements (in cm) of the holes of section D (first figure longitudinal, second transverse):
I$_l$ 7.42x8.34; T$_l$ 7.58x7.94; II$_l$ 7.54x8.46; III$_l$ 7.72x8.66; IV$_l$ 7.28x7.52.

the archaeological record, and which are, in this way, of immense value. All three are in excellent state of preservation. One comes from Halikarnassos (fig. 21), and is dated as the 3rd century BC;[29] a second, from Dēlos (fig. 22), dated around 100 BC (150-70 BC);[30] and a third one from Korinthos (fig. 23), dated as around 200 BC (300-146 BC).[31] Although their respective sizes are not identical, their shape is exactly the same: on the cylindrical body of the pipe is carved into the same piece of bone a prismatic protrusion with a sharp edge at the apex, and a circular hole drilled at right angles to the longitudinal axis of the pipe. The mouth-hole lies in the middle of this platform. Thanks to these sections, the new mouthpiece can be safely reconstructed, since in all three sections, the prismatic platform is symmetrical about the mouth-hole. Interestingly, there exists today in African Guinea a side flute whose mouthpiece is quite similar to the ancient one (fig. 24). Obviously, with side walls on either side of the mouth-hole, a better focus of the air stream is attained.

There is a detail on the intact Halikarnassos mouthpiece (fig. 25), which, undoubtedly, is of significance: the mouth-hole is not symmetrical about its virtual longitudinal axis (fig. 26); its downstream side is slightly curved, as opposed to the other, upper, side which is practically vertical, undoubtedly for a better, more linear, air flow. The same feature can be clearly observed on the Dēlos mouthpiece.[32]

The upper spigot of the mouthpiece was embraced by a bronze ring (fig. 27), which is fairly longer than the spigot (by 0.822 cm). The question, therefore, arises: what is the purpose of this space? A close examination of the solidified clay occupying this area reveals traces of wooden or felt texture.[33] It seems, therefore, that a plug of wood or felt was in-

[29] London, British Museum, Inv. No. 1976.1-4. NEWTON 1862 II, p. 339; BÉLIS 1988, pp. 235-236, fig. 2.

[30] PAPADOPOULOU 2003. French excavations, now in the island Museum, B 21623.

[31] American excavations, now in the Museum of Ancient Korinthos, MF 9044. It was found in the South Stoa, Well in Shop VII: Well 1933-3. I would like to express my sincere thanks to the Curator of the Korinthos Excavations of the American School of Classical Studies at Athens, Ms Ioulia Tzonou-Herbst, for providing me with the photograph of fig. 23 (courtesy of the American School of Classical Studies, Corinth Excavations, I. Ioannidou and L. Bartzioti).

[32] I would like to express my sincere thanks to the Director of the 21st Ephorate of Prehistoric and Classical Antiquities (Kyklades), Ms Maria Martharē, and the archaeologist responsible for Dēlos, Mr Panagiōtēs Chatzēdakēs, for their permission to examine the auletic fragments in the Museum of Dēlos in the summer of 2010.

[33] Restorer, Ms Basilikē Mylōna expressed almost certainty on this.

serted in this empty space, closing thus the upper end of the pipe. The existence of a plug at this end has to be proven, since there exist side flutes in the world today which are open at the upper end (*e.g.* the Korean bamboo side flute), making the plug not a necessary feature in side flutes.

When the ring was taken away in the Laboratory (fig. 28), a thick reddish accumulation was revealed underneath, suggesting that leather had been most probably placed between the ring and the bone (tanines).[34] Notably, the spigots of both the Dēlos and the Korinthos mouthpieces (figs. 22, 23) have their surfaces prominently engraved all along their lengths with shallow circles, a feature observed on the Koilē mouthpiece spigot only when examined under the microscope. Perhaps, these engraved lines were not necessary in the case of the Koilē mouthpiece, because of the intermediate layer of leather used in this case; perhaps they are simply lathe marks. Undoubtedly, the piece of leather was there in order to create a good seal. The existence or not of a plug at the upper end of the pipe is of great significance, as it essentially defines the upper limit of the vibrating air column inside the pipe. The outer surface of the plug does not seem to have been covered by metal (fig. 27); there is no trace of a metallic disc, which might have been the 'bottom', so to speak, of the 'cap'. This means that the plug would have been inserted at the end, after the ring had been secured on the pipe. A small amount of conicity (fig. 29) is felt to be present in the ring, suggesting that the plug was not cylindrical but slightly conical. This makes good sense, since a conical plug would have affected a better seal than a cylindrical one (fig. 30).

The second section (B) of the Koilē pipe (fig. 16) is a mere cylindrical tube, without any tone-holes, essentially a piece connecting mouthpiece and first section with holes (section C). Enough material survives on B for us to reconstruct the junction A-B safely. The bronze ring of the junction extends over section B well beyond the bottom of the socket in B.

The pipe flares out at the exit (fig. 31), creating a gentle bell, which is encased in a bronze sheath. The bell is an acoustically significant feature, since the bore changes from cylindrical to conical over the last 2.7 cm of the section. The angle of the bell (ϕ) can be calculated by subtracting internal diameters in the cylindrical section and at the exit edge of the bell:

[34] Small pieces of leather have been located under the metal ring, and also in the solidified mud inside the pipe.

d_{imax}-d_i = 1.976-1.45 = 0.526 cm; 0526:2 = 0.263 cm
$\tan\phi$ = 0.263:2.7 = 0.09741 → $\phi \cong 5.5^{o}$

The exit section (fig. 32) has a curious feature on it: an elongated opening, in the shape of an animal's skin or of an ingot (length overall 1.534 cm; max width 0.7 cm), with the 'neck' of the 'skin' pointing upstream.[35] At its downstream end there is a shallow hollow, like a little 'cup'. There are two possibilities: either the opening was covered by some kind of tap, or left open for acoustic reasons ('vent'). In any case, as all five fingers of the right hand operated on the five holes of section D, a possible mechanism could not have been manipulated by the little finger (of hole IV_1), unless there was a leaver reaching up to the little finger.[36] However, no trace of any such mechanism survives, or any marks are left by it on the surface of the bone. Furthermore, what would be the point of giving the opening such an elegant shape, if it were to subsequently bury it under a mechanism? An acoustic function of the opening is, therefore, a more plausible proposition.[37] The question, of course, remains: why such a sophisticated design; to what purpose? If our skin-looking opening has this shape for some reason other that of practical necessity, one's mind goes to the Theban floor painting (fig. 2), where next to the victor side flautist appears a skin-looking object, which, as suggested earlier, could be a goat's skin filled with wine. Thus, is the shape of our opening merely a symbol, a reference to bucolic or rustic imagery? It is a tempting hypothesis. However, a satisfactory answer to the curious opening and its function can only really be given by experimenting with a replica, trying out various possibilities.[38]

Similar longitudinal openings can be found on a number of fragments. An *aulos* fragment in the National Archaeological Museum, Athens (fig. 33), comprises two bone sections, overlaid at places with bronze rings. Obviously, here we have the last two sections of a wind pipe (fig. 34), judging from the exit bell and the rectangular aperture of

[35] In fig. 32, a small piece of paper can be seen under the opening. This was placed for restoration purposes.

[36] Like there is, for example, on the Baroque side flute, where the lowest hole is covered by a key with a leaver, operated upon by the little finger; see, *e.g.*, BROWN 1980, pp. 672, fig. 10; 673, fig. 11. However, in this case the hole under the tap of the key is similar to all the other finger holes of the instrument, both in shape and size, and not an elongated opening, like we have on the Koilē pipe.

[37] This will be 'proven' later, when experimenting with the replica.

[38] See below, under 'Reconstruction and acoustics'.

the section on the right, two features that are found on the Koilē flute on its last, exit section.[39] Furthermore, the internal diameter of the tubes is relatively large, of the order of 1.36 cm, a value very close to the Koilē bore (1.45 cm).[40] These three characteristics strongly suggest that the 'Athens *aulos*' was a side flute. The exit bell is similar to that of the Koilē flute, and it is also wrapped in a thin foil of bronze. There is no sign of any material over or around the aperture, or any traces left on the external surface of the bone by a possible mechanism, which might have closed and opened the hole. Could the aperture then have been a mere vent hole of some kind? The dimensions of the aperture (1.438x0.824 cm) are very close to those of the Koilē flute (1.5x0.7 cm).

A very similar section to the one just described comes from Jerusalem (fig. 35), and is dated as the 1st half of the 1st Ct BC.[41] Again, this must have been the lowest section of a wind pipe, judging from the exit bell, covered in bronze, and the rectangular opening, which, in this case, has curved long sides, resembling to some degree the Koilē aperture. The item is not described in detail, so no information is provided regarding the bone surface around the aperture. However, from the available photograph, there seems, once again, that there was no mechanism for covering or uncovering the aperture, so the belief earlier expressed, that it was a mere vent hole, is now strengthened. Braun believes that the aperture was closed by a revolving ring, which made it possible for the instrument to play in different modes, but this is very doubtful; all our relative evidence (including the items which will be discussed immediately below) points towards a vent hole.

One of the Dēlos sections (B 22164) also has the orthogonal aperture (fig. 36). Its internal diameter is of the order of 1.3 cm (exact measurement 1.294 cm), again a value in the vicinity of the Koilē instrument (in-

[39] According to the Inventory Book of the National Museum, the item was found in a grave in Athens (no specified area) during an excavation by the Athens Archaeological Society at an early date, and was subsequently transferred to the National Museum, where it was classified under 'Bronzes' on 5 December 1979. I would like to express my sincere thanks to the Director of the National Museum, Mr Nikolaos Kaltsas, for the permission to examine the find afresh; the archaeologist Ms Polyxenē Mpougia, for her close collaboration and support; the archaeologist Mr Giōrgos Kabbadias, for showing and discussing with me the contents of the Museum's Inventory Book; the restorer Ms Geōrgia Karamargiou, for carrying out further, quite reveling, cleaning inside the pipe.

[40] See below for a discussion of bore diameters of surviving auletic fragments.

[41] Jerusalem, Archaeological Museum, EE 442. The instrument is presented and discussed to some extent by BRAUN 2002, pp. 223-224, fig. V.20. It was found on Mt. Zion in 1972, «in a room decorated with profane murals, including birds, festoons, and trees».

ternal diam. 1.45 cm). Very probably then, this Delian piece was part of a side flute.[42] The dimensions of the opening (1.288x0.5 cm) are slightly smaller than those of the Koilē pipe (1.5x0.7 cm). We cannot specify the position of the section along the length of the original instrument, because there are spigots on both ends. However, by comparison with the Koilē, Athens and Jerusalem sections, it could be said with some certainty that the edge closest to the aperture is more likely to have been the upstream side of the section. There is no sign of a tap mechanism or a trace of it on the bone surface.

One more similar section comes from Messēnē (fig. 37).[43] It was dated as the middle of the 1st century BC. The rectangular aperture is very much the size of the Koilē opening (Messēnē 1.5x0.67 ~ Koilē 1.5x 0.7 cm). Although some material is missing at the one end of the aperture, the original length is known, as a small part of the wall survives at that end. Interestingly, the internal diameter is 1 cm, which is in the vicinity of the double *aulos* bores (1 cm or less). Could this section, therefore, belong to a double *aulos*? And if so, was the function of the opening the same on that instrument as on the side flute? It is very doubtful, since none of the extant *aulos* pairs (Elgin, København, Pydna, Akanthos) have such an opening.[44] Instead, we find in the area between the lowest finger holes and the pipe exits circular vent holes, being very much in shape and size like the rest of the finger holes. Also, amongst the numerable known *aulos* fragments there is none with an opening of this sort.[45] The most probable then suggestion is that the Messēnē section comes from a narrow bore side flute, on the assumption that the feature of the rectangular exit aperture was an idiosyncrasy of side flutes. Compared with the Athens, Jerusalem and Dēlos fragments, this one has the aperture very close to one end, if that is a remark of any relevance. Again, there is no trace of a mechanism over the opening, reinforcing even further the idea of the aperture having been a large vent. It may be of some acoustic significance that the walls of the aperture are not vertical, but inclined inwards.

[42] For a discussion of a probable implication of the size of the bore to the type of wind instrument (reeded or flute type) see below.

[43] Catalogue No. 3215. ΘΕΜΕΛΗΣ 1990, pp. 66-69, fig. 3, pls. 40-43. The fragment was found in 1990, in a well inside a bath complex adjacent to the Asklēpieion. I would like to express my sincere thanks to the excavator of Messēnē, Professor Petros Themelēs, for the permission to study and publish the section, and the archaeologist Ms Evē Lampropoulou, for discussing with me aspects of chronology relevant to it.

[44] For the Pydna and Akanthos auloi, see PSAROUDAKĒS 2008.

[45] See PSAROUDAKĒS 1994.

Apart from the aforementioned cases of bone exit sections with an orthogonal opening similar to that of the Koilē flute, there are instances of rectangular apertures covered by metallic rings, presumably for opening or closing them. Amongst the *aulos* fragments from Meroë, dated as 15 BC, openings of comparable size (1.1x0.6 cm, average) are seen on five fragments.[46] All five comprise ivory cylinders of 1 cm bore, covered in bronze (fig. 38), and with rotating sleeves with finger knobs over them.[47]

A similar item, comprising a bone cylinder covered in bronze, with a rectangular opening in it, and a rotating metallic sleeve over it (fig. 39), comes from Dēlos (B 124). Although one end of the opening is broken, the point of fracture is discernible, thus giving us the original dimensions of the aperture (1.866x0.474 cm).

The 'Athens *aulos*' discussed above (figs. 33, 34), apart from the rectangular opening in the exit section, has another two, smaller, rectangular holes further upstream (lengths of openings: 1.07 and 1.264 cm), with rotating rings over them, made of bone and bronze, and possessing bone knobs (*kerata*) for finger operation.

This type of rectangular opening, with a rotating sleeve over it, operated by knobs (Meroë, Dēlos B 124, Athens), cannot be identified with the 'free' exit apertures described so far (Koilē, Athens, Dēlos, Messēnē). This is particularly obvious from the 'Athens *aulos*', in which both types of opening are present. Thus, the 'sleeved' rectangular holes must have had a different function from the 'free' ones. It is interesting that both types of opening, 'free' and 'sleeved', can be present on the same instrument. A pipe could, therefore, have had as many as at least two 'sleeved' openings in conjunction with one 'free' aperture, the latter below the former. It is very unlikely that these openings were finger holes. They must have altered the tonal level of the instrument ('key'), making the (*bombyx*) vibrating air column inside the pipe longer or shorter. All the *auloi* that we know of, which make use of revolving rings (*e.g.* the Pompeii *tibiae*), have the finger holes beneath them round and with a diameter of under 1 cm.[48]

Amongst the several auletic sections found on Dēlos, there are seven fragments, which could, probably, be regarded as belonging to side flutes rather than to double *auloi*, the criterion being the relatively large size of their internal diameter:

[46] Bodley 1946, pls. IV, nos. 11-15; IV, no. 1.
[47] Bodley 1946, p. 229.
[48] For a recent study of the Pompeii *tibiae* see Hagel 2008.

- No B 5140 (3003) (fig. 40). Two circular holes and one oval; bore of just over 1.3 cm
- No B 21621 (fig. 41). Two closely packed circular holes; bore of 1.35 cm
- No B 21622 (fig. 42). Bore of 1.3 cm
- No B 5142 (3440) (fig. 43). Two closely packed circular holes; bore of about 1.3 cm
- No III.7 (fig. 44). Bore up to 1.4 cm
- No 4 (fig. 45). Holes very near each other; bore of about 1.3 cm[49]
- No x (fig. 46). Bore of 1.3 cm

On the other hand, there are another nine fragments from Dēlos, including four double *aulos holmoi*,[50] which all have a much smaller internal diameter, ranging from 0.7 to 0.9 cm, that is, under 1 cm. (See Table 1, below). It appears, therefore, that there are two '*topoi*', so to speak, of bore values, one low, under 1 cm, and one high, above 1.3 cm. The fact that all four Delian *holmoi* are in the narrow bore category, suggests that all nine fragments with bore under 1 cm belonged to double *auloi*, while the fact that the Dēlos side flute mouthpiece (and all other side flutes: Korinthos, Halikarnassos, Koilē) is in the upper bore register, and so is the fragment with the rectangular aperture (No B 22164, fig. 36), does indicate that the seven Delian fragments with an internal diameter of 1.3 cm and over belonged to side flutes.

Narrow bore (cm)		Wide bore (cm)	
B 5141	0.9	A 7193	1.21
B 5167	0.9	B 22164	1.294 (rect. aperture)
B 5166	0.8	B 21623	1.3 (side flute mouthpiece)
B 5170	0.8/0.9	B 5149	1.3
B 21619	0.8 (*holmos*)	B 21621	1.3/1.4
B 21620	0.85	B 21622	1.3
B 5168	0.75 (*holmos*)	B 5142	1.3
B 5169	? (*holmos*)	III.7	1.3/1.4
III[2]	0.7 (*holmos*)	4	1.3
		x	1.3

Table 1: bore sizes of the Delian fragments of wind pipes

[49] There is a unique feature on this section: the thumb hole and the hole closest to it above it are almost on top of each other. This is the only occurrence known of a so 'densely populated' pipe section.

[50] Fig. 47 shows one of them (B 2119).

There is one exception to this rule: the 'Argithea *aulos*', a pipe which the present writer has interpreted as part of an *aulos* pair.[51] Perhaps, a second thought is required. There are three reasons for that: (1) a second pipe was never retrieved from the grave, although the burial had not been disturbed before excavation; (2) there is an exit bell very similar to that of the Koilē-Athens-Jerusalem type, which is much more pronounced than that of the double *aulos*; (3) the internal diameter is 1.31 cm, which exceeds by more than 3 mm the usual maximum bore of a double *aulos*. Against the side flute interpretation count: (1) the absence of a rectangular aperture near the exit of the pipe; (2) the presence of an ordinary circular hole ('vent') in that area - as is the usual case in double *auloi*; (3) the fact that there is no second thumb-hole. Therefore, the Argithea pipe, despite its large size bore (1.31 cm), does not seem likely to have been a side flute; perhaps, one pipe of a wide bored double *aulos*. Therefore, we should probably come to the conclusion that some *auloi* did, exceptionally, possess bores as large as those of side flutes (Argithea), and that rectangular openings were, occasionally, a feature on *auloi*, too (eg, Messēnē, Meroë): when present on the pipes of a double *aulos*, undoubtedly always supplied with rings, they functioned as progressive vents, for altering the tonal level ('key') of the pipes.

Reconstruction and acoustics of the Koilē side flute

An approximate replica of the Koilē side flute was constructed by the present writer, a first approximation, before an exact copy is made in bone: a plastic tube in one piece, of the same operating length and internal diameter, with the finger holes of the same size and in the same positions (figs. 48, 49). Only the exit bell is missing and a couple of extra millimeters from the width of the tube wall. However, we cannot be far off from the original tonal intentions of the maker. The platform of the mouthpiece of the replica is made with hard paper filled with plaster. The scale the replica produced was the following:[52]

sol ^{t} la ^{t} si ^{s} do ^{s} do# ^{s} re ^{t} mi ^{s} fa ^{s} fa# ^{s} sol(#)

Those acquainted with ancient melodic theory (harmonics), recognize that the above scale comprises two tetrachords in conjunction, that is, the end of the one coincides with the beginning of the second (si-mi-la), the

[51] See Psaroudakēs 2002.

[52] As measured against a piano, tuned at (central) a^1 = 442 Hz.

top tetrachord falling short of its uppermost note (la), and with two additional notes at the low end of the scale (sol, la):

sol ^{t} la ^{t} **si** ^{s} do ^{s} do# ^{s} re ^{t} **mi** ^{s} fa ^{s} fa# ^{s} sol(#) ^{t} [**la**

As in known from ancient melodic theory, there are certain tonal steps by which tetrachords proceed: the so-called 'diatonic' tetrachord ascends in the fashion 'semitone-tone-tone' (.s.t.t.), while the so-called 'chromatic' tetrachord has the form 'semitone-semitone-trisemitone' (.s.s.tr.). Thus, the above scale can be analyzed into two different scales, one of the diatonic and one of the chromatic form[53]:

sol ^{t} la ^{t} **si** ^{s} do ^{s} do# ^{s} re ^{t} **mi** ^{s} fa ^{s} fa# ^{s} sol ^{t} [**la**
sol ^{t} la ^{t} **si** ^{s} do ^{s} do# ^{s} re ^{t} **mi** ^{s} fa ^{s} fa# ^{s} sol ^{t} [**la**

and by allocating holes to notes:

vent IV_l III_l II_l I_l III_h II_h I_h
sol ^{t} la ^{t} **si** ^{s} do ^{s} do# ^{s} re ^{t} **mi** ^{s} fa ^{s} fa# ^{s} sol ^{t} [**la**
sol ^{t} la ^{t} **si** ^{s} do ^{s} do# ^{s} re ^{t} **mi** ^{s} fa ^{s} fa# ^{s} sol ^{t} [**la**
T_l T_h

We can, therefore, conclude - at least at this stage, using this approximate replica - that the Koilē side flute was designed in order to play in both the diatonic and the chromatic melodic genera. Interestingly, the holes have been opened at such places, so that the two chromatic notes (do#, fa#) are produced by the holes lying underneath, and operated by the thumbs (T_l and T_h). The Koilē instrument, therefore, reveals the intentions of its maker, the way he 'drilled', so to speak, the scale on the instrument.

If the rectangular aperture on the replica is closed, then the lowest note (sol) cannot be produced. This reinforces the conclusion previously drawn, that the opening functioned as a vent.[54]

[53] The top *sol* of the scale can be produced on the replica by partially uncovering hole I_h.

[54] The scale of the 'Orestes' melody (late 5th Ct BC), in its surviving form, and interpreted as chromatic rather than enharmonic, can be completely accommodated on the Koilē *plagiaulos*. For this melic fragment, see PÖHLMANN - WEST 2001, pp. 10-17.

A NAME FOR THE KOILĒ SIDE FLUTE

Discovering the ancient name of the Koilē side flute is not a difficult task: on the one hand, a careful examination of the relevant literary evidence on the term *plagiaulos* of late texts (table 2, below) has made it clear that the side flute was known in antiquity by the name *plagiaulos*,[55] while, on the other, the possibility that the *plagiaulos* might have been a side-blown reed pipe has been denounced on acoustic grounds, because «a reed cannot be made to function, [unless it is] end on to the resonator tube, and its stem is of the same diameter» as the bore.[56] We can, therefore, safely now call our side flute the Koilē *plagiaulos*.

◄ 300	200	100	0	100	200	300
Hēliodōros	Loukianos Loggos	Plinius	Philodēmos		ps-Theokritos Biōn Smyrn.	
.....						***plagiaulos*** ⌐
	Athēnaios Ploutarchos		Juba	Poseidōnios		
	Aelianus					
	Apuleius					
	Nikomachos					
.....						***phōtinx*** ⌐

Table 2: the literary evidence on the *plagiaulos* and the *phōtinx*

Thus, the thesis that the side flute "was unknown in Greece", and that it arrived at Byzantion in the 10th century AD probably from India, and from there it disseminated into Europe in the Middle Ages, cannot be upheld any more.[57] The side flute, whether an import from Libya (Polydeukēs) or an invention of kind Midas (Plinius), made its way into Hellas in Hellenistic times, perhaps as early as the 3rd Ct BC (Halikarnassos mouthpiece). Furthermore, as we find the instrument depicted on a late 2nd-early 1st century BC Etruscan relief (fig. 6), it means that it was present on Italian soil around about 100 BC, earlier, that is, than the Koilē find.

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[55] See BARKER 1984, p. 264, n. 20. The *phōtinx*, it is believed, was also a kind of side flute; see, e.g., WEST 1992, p. 113, n. 145.

[56] LANDELS 1999, pp. 71-72.

[57] MONTAGU 2001, pp. 29-31.

BIBLIOGRAPHY

BARKER 1984 — A. BARKER, *Greek musical writings*. I. *The musician and his art*, Cambridge 1984.

BÉLIS 1988 — A. BÉLIS, 'Studying and dating ancient Greek auloi and Roman tibiae: a methodology', in E. HICKMANN - D.W. HUGHES (eds.), *The archaeology of early music cultures. Third international meeting of the ICTM Study Group on Music Archaeology,* Bonn 1988, pp. 233-248.

BODLEY 1946 — N. BODLEY, 'The auloi of Meroë. A study of the Greek-Egyptian auloi found at Meroë, Egypt', *Am. Journ. Archaeol*. 50, 1946, pp. 217-240, pls. I-VIII.

BRAUN 2002 — J. BRAUN, *Music in Ancient Israel/Palestine. Archaeological, Written, and Comparative Sources*, American edition, Grand Rapids (MI) 2002 (Freiburg – Göttingen 1999).

BRECCIA 1930 — E. BRECCIA, *Monuments de l'Egypte graecoromain*. II 2. *Terracotte figurate greche e greco-egiziane del Museo di Alessandria,* Bergamo 1930.

BROWN 1980 — H. M. BROWN, *s.v.* 'Flute', in S. SADIE (ed.), *The new Grove Dictionary of Music and Musicians*, 1st ed., London 1980, VI, pp. 672-678.

CHARRY 2001 — E. CHARRY, *s.v.* 'Guinea', in S. SADIE – J. TYRELL (eds.), *The new Grove Dictionary of Music and Musicians,* 2nd edition, Oxford 2001.

FLEISCHHAUER 1964 — G. FLEISCHHAUER, *Musikgeschichte in Bildern*. II. *Musik des Altertums*. 5. *Etrurien und Rom*. Leipzig 1964.

HAGEL 2008 — S. HAGEL, 'Re-evaluating the Pompeii auloi', *Journ. Hell. Stud*. 128, 2008, pp. 52-71.

HICKMANN 1952 — H. HICKMANN, 'The antique cross-flute', *Acta musicologica* 24, 3/4, 1952, pp. 108-112.

KANKELEITE 1997 — A. KANKELEITE, 'Römische Mosaiken aus Griechenland', *Antike Welt* 4, 1997, pp. 309-318.

KOYNTOYPH 2002 — Ἔ. ΚΟΥΝΤΟΥΡΗ, 'Συνοικισμὸς (συμβολὴ τῶν ὁδῶν Ἁγίου Κωνσταντίνου καὶ Σμύρνης)', *Ἀρχαιολογικὸν δελτίον* 52, Β΄, *Χρονικά*, p. 370.

LANDELS 1999 — J. G. LANDELS, *Music in ancient Greece and Rome,* London - New York, 1999.

MONTAGU 2001 — J. MONTAGU, *s.v.* 'Flute. I. General', in S. SADIE - J. TYRRELL (eds.), *The new Grove dictionary of music and musicians,* 2nd ed., Oxford 2001.

NEWTON 1862 — C. T. NEWTON, *A history of discoveries at Halicarnassus, Cnidus, and Branchidae*. II. *The text,* London, 1862.

PAPADOPOULOU 2003 Z. PAPADOPOULOU, 'Section de plagiaulos avec embouchoir', in É. ANDRIKOU ET ALII (eds.), *Dons des Muses. Musique et danse dans la Grèce ancienne,* Athènes, p. 178.

PÖHLMANN - WEST 2001 E. PÖHLMANN - M.L. WEST, *Documents of ancient Greek music. The extant melodies and fragments edited and transcribed with commentary,* Oxford 2001.

PRICHARD 1998 J. PRICHARD (ed.), *Ἄτλας τῆς Βίβλου,* Athens 1998.

PSAROUDAKĒS 1994 S. PSAROUDAKĒS, *Tragōidia: Towards a description of lexis and melopoiia*, PhD in Classics/Music, Dept of Classics, University of Reading 1994.

PSAROUDAKĒS 2002 S. PSAROUDAKĒS, 'The aulos of Argithea', in E. HICKMANN – A. D. KILMER – R. EICHMANN (eds.), *Studien zur Musikarchäologie* III. (Orient-Archäologie, 10), Rahden, Westf. 2002, pp. 335-366.

PSAROUDAKĒS 2008 S. PSAROUDAKĒS, 'The aulos of Pydna', in A.A. BOTH – R. EICHMANN – E. HICKMANN – L.-C. KOCH (eds.), *Studien zur Musikarchäologie* VI. *Challenges and objectives in music archaeology. Papers from the 5th Symposium of the International Study Group on Music Archaeology at the Ethnological Museum, State Museums Berlin, 19-23 September 2006,* (Orient-Archäologie, 22), Rahden, Westf. 2008, pp. 197-216.

SACHS 1940 C. SACHS, *The History of Musical Instruments,* New York 1940.

SCHRÖDER 2004 S. F. SCHRÖDER, 'Junger Pan mit Querflöte, 310-300 v.Chr. Römischer Torso, 130-150 n.Chr.', in *Katalog der antiken Skulpturen des Museo del Prado in Madrid.* I. *Idealplastik*, Mainz 2004.

SHEAR 1930 T. L. SHEAR, 'The mosaics', in *Corinth* V. *The Roman villa,* Princeton 1930, pp. 19-26.

SHEAR 1925 T. L. SHEAR, 'Excavations at Corinth in 1925', *Am. Journ. Archaeol.* 29/4, 1925, pp. 381-397.

ΘΕΜΕΛΗΣ 1990 Π. ΘΕΜΕΛΗΣ, 'Ἀνασκαφὴ Μεσσήνης', *Πρακτικὰ τῆς ἐν Ἀθήναις Ἀρχαιολογικῆς Ἑταιρείας τοῦ ἔτους* 1990, pp. 66-69.

VASORI 1979 O. VASORI, 'Busto di satiro che suona il flauto (inv. n. 550)', in A. GIULIANO (ed.), *Museo Nazionale Romano* I 1. *Le sculture*, Roma 1979.

WEGNER 1963 M. WEGNER, *Musikgeschichte in Bildern.* 2.4. *Griechenland*, Leipzig 1963.

WEST 1992 M. L. WEST, *Ancient Greek Music*, Oxford 1992.

WILLIAMS 1985 D. WILLIAMS, *Greek Vases*, London 1985.

Fig. 1. Korinthos mosaic (post card).

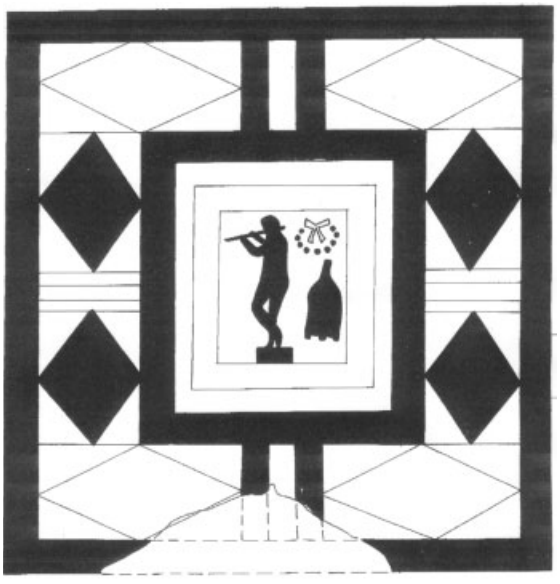

Fig. 2. Thēbai floor (KOYNTOYPH 2002).

Fig. 3. Pergamos lagynos (WILLIAMS 1985, p. 69).

Fig. 4. Knōssos mosaic (KANKELEITE 1997).

Fig. 5. Alexandrian statuette (HICKMANN 1952, p. 111, fig. 3).

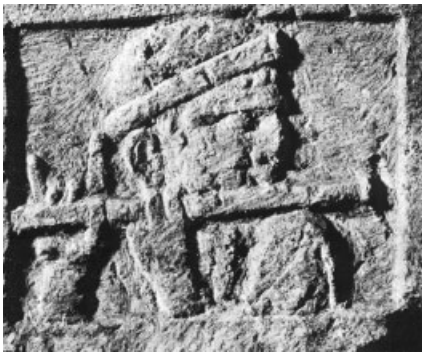

Fig. 6. Etruscan urn relief (MONTAGU 2001, fig. 5).

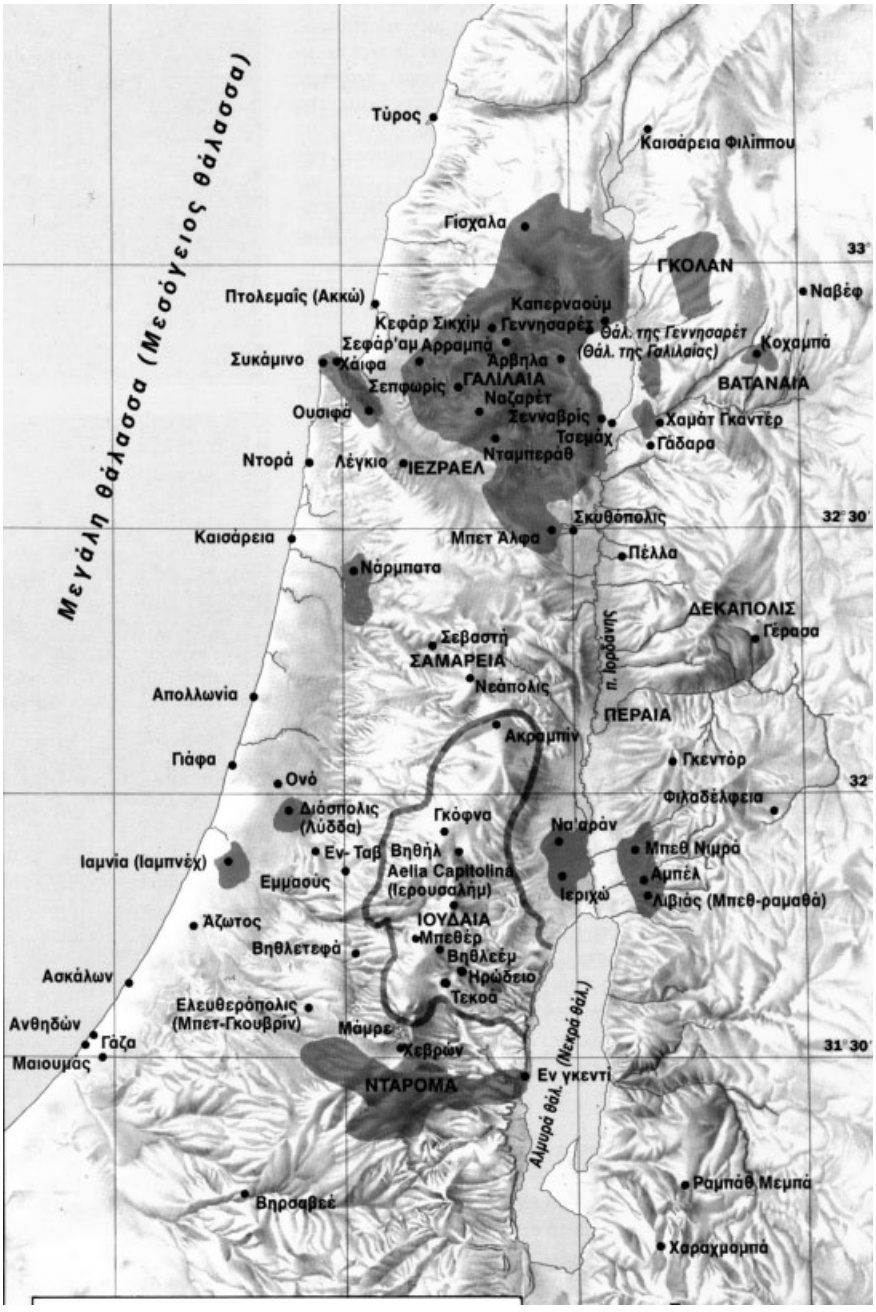

Fig. 7. Map of ancient Palestine (PRICHARD 1998, p. 181, fig. 1).

Fig. 8. Statue of a satyr (WEGNER 1963, p. 57, fig. 28).
Fig. 9. Paneas coin [1] (BRAUN 2002, fig. V.58.d).
Fig. 10. Paneas coin [2] (BRAUN 2002, p. 294, fig. V.58.f).
Fig. 11. Paneas coin [3] (BRAUN 2002, p. 293, fig. V.58.e).
Fig. 12. Louvre statue of Pan with pipe (SCHRÖDER 2004, p. 129, fig. 26).

Fig. 13. Prado statue of a piper (SCHRÖDER 2004, p. 128).

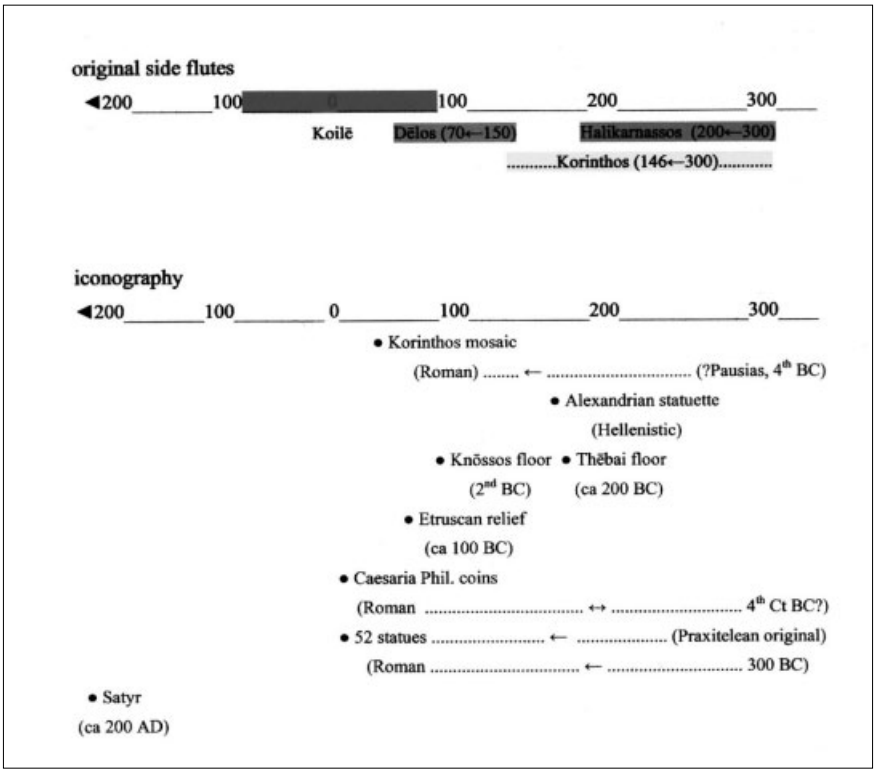

Fig. 14. Table 1. Hellenistic side flute: surviving instruments and iconography.

Fig. 15. The Koilē flute: sections joined (photograph by the author).

Fig. 16. The Koilē flute: the five sections (photograph by the author).

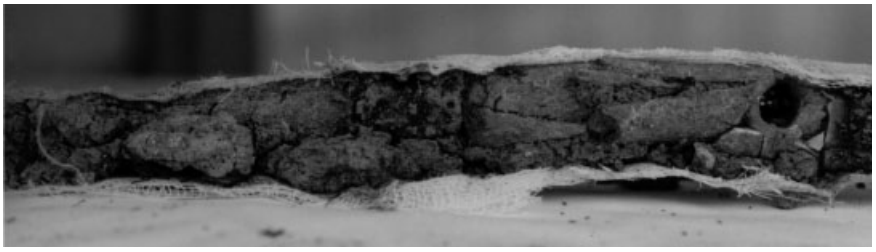

Fig. 17. The Koilē flute: sections B and C before cleaning (photograph by B. Mylōna).

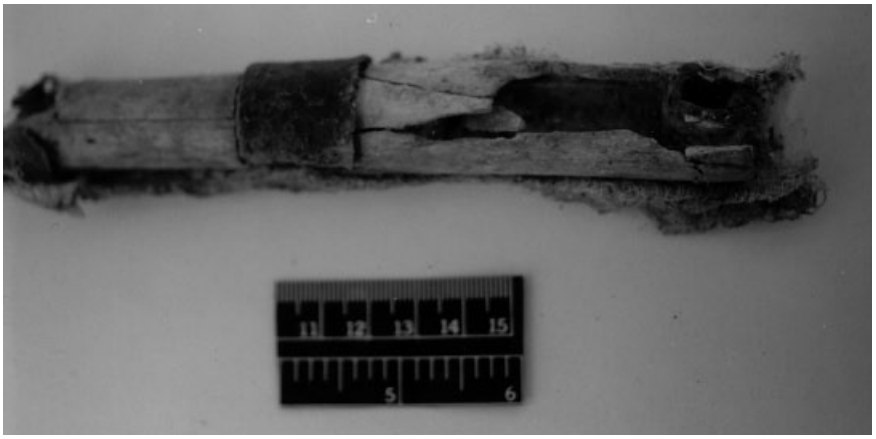

Fig. 18. The Koilē flute: sections B and C after partial cleaning (photograph by B. Mylōna).

Fig. 19. The Koilē flute: section A, mouthpiece; side view (photograph by the author).

Fig. 20. The Koilē flute: section A, mouthpiece; plan view (photograph by the author).

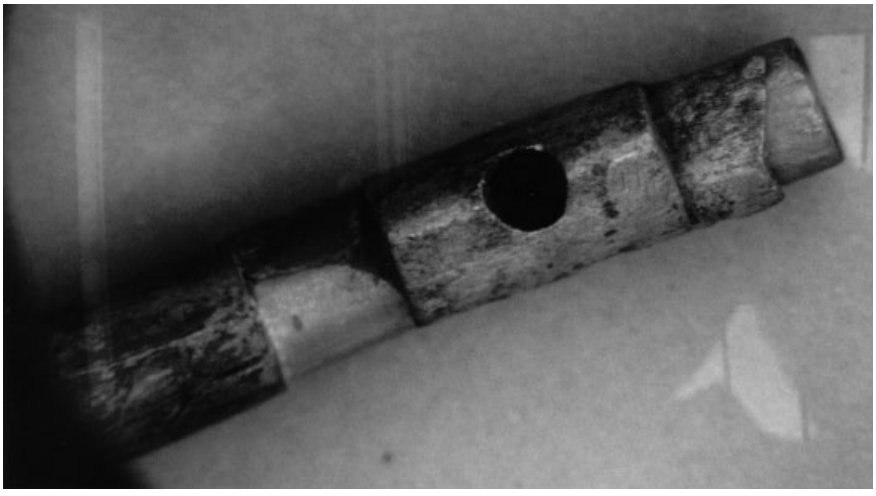

Fig. 21. The Halikarnassos mouthpiece (photograph by the author).

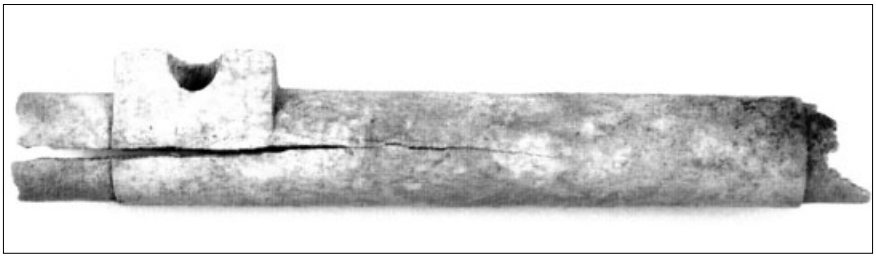

Fig. 22. The Dēlos mouthpiece (PAPADOPOULOU 2003).

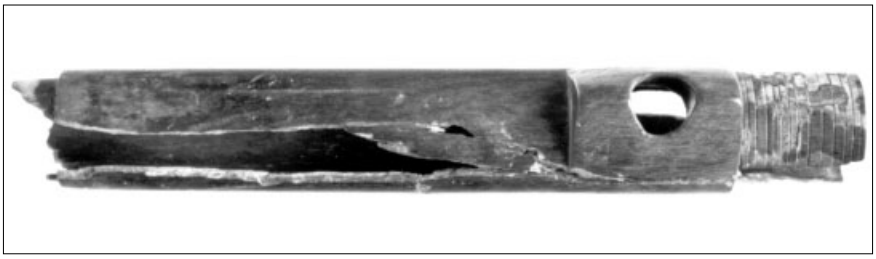

Fig. 23. The Korinthos mouthpiece (photograph; courtesy of the American School of Classical Studies, Corinth Excavations, I. Ioannidou and L. Bartzioti).

Transverse flute of the Maninka

Fig. 24. Side flute of Guinea (CHARRY 2001, fig. 6).

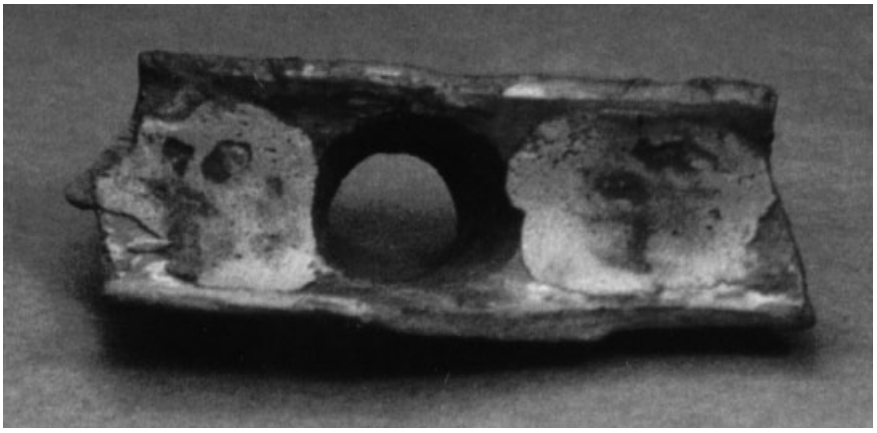

Fig. 25. The Halikarnassos mouthpiece; detail (photograph by the author).

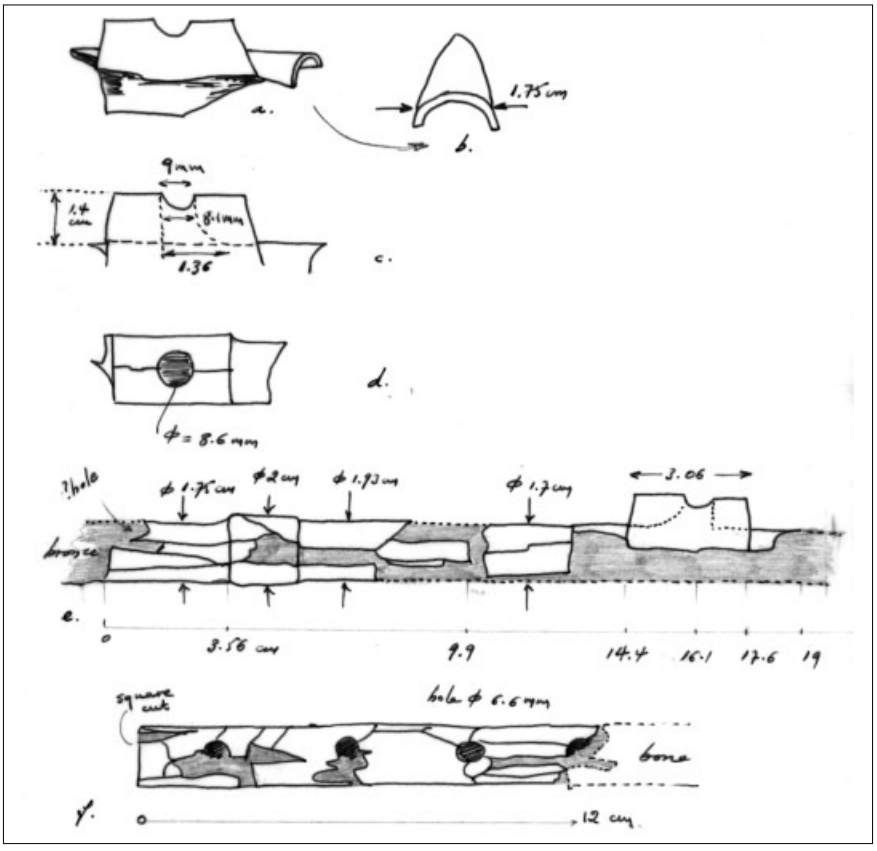

Fig. 26. The Halikarnassos side flute remains (drawing by author).

Fig. 27. The Koilē flute: section A, mouthpiece; bronze ring over spigot (photograph by B. Mylōna).

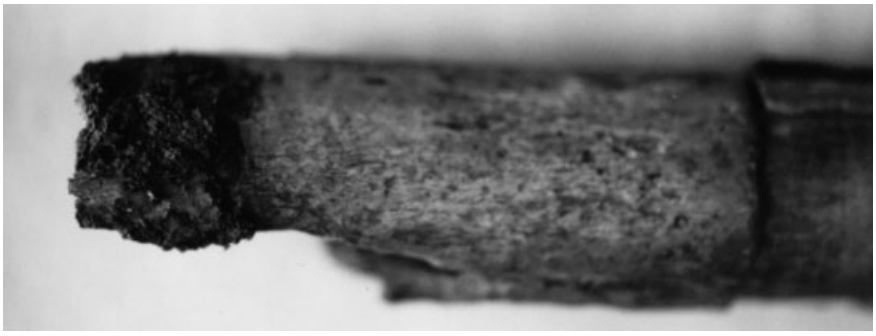

Fig. 28. The Koilē flute: section A, mouthpiece; the reddish accumulation under the ring (photograph by B. Mylōna).

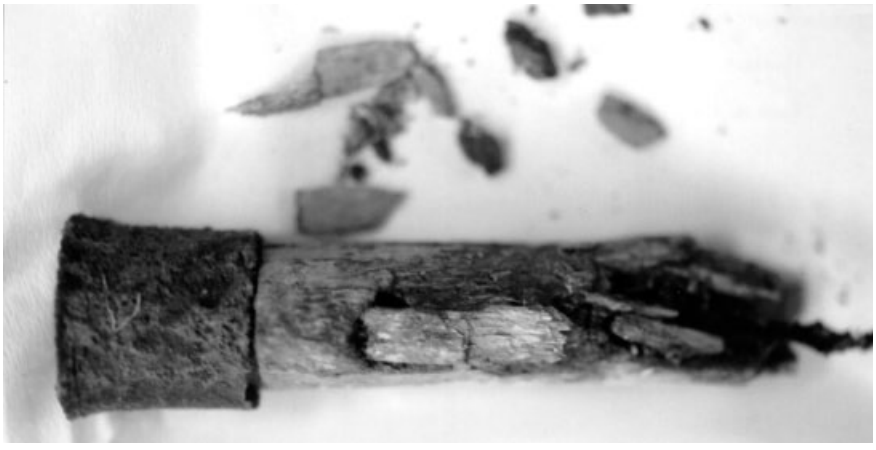

Fig. 29. The Koilē flute: section A, mouthpiece, plan view; after first stage of cleaning (photograph by B. Mylōna).

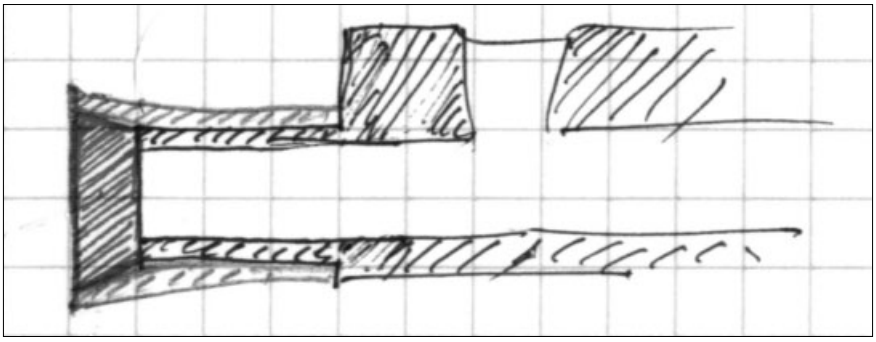

Fig. 30. The Koilē flute: section A, mouthpiece; reconstruction of upper end closure (sketch by the author).

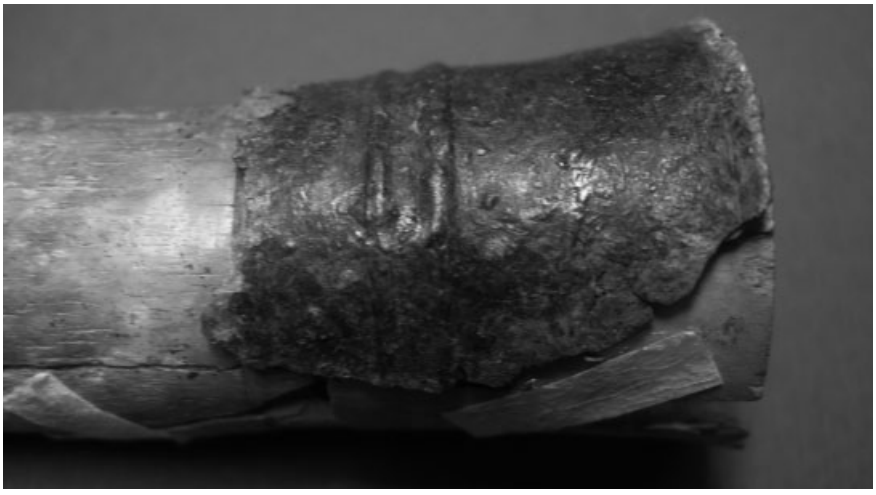

Fig. 31. The Koilē flute: section E; exit bell (photograph by the author).

Fig. 32. The Koilē flute: section E; the 'orthogonal' aperture (photograph by the author).

Fig. 33. The Athens *aulos*: sections joined (photograph by the author).

Fig. 34. The Athens *aulos*: sections apart (photograph by the author).

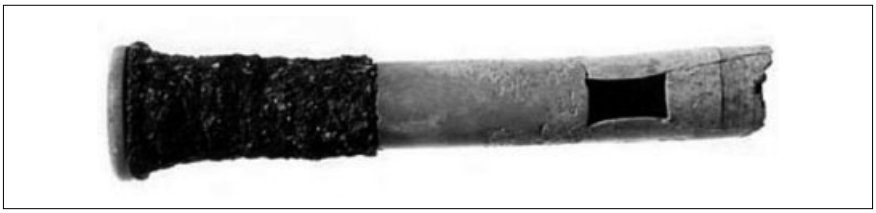

Fig. 35. The Jerusalem section (BRAUN 2002, p. 224, fig. V.20).

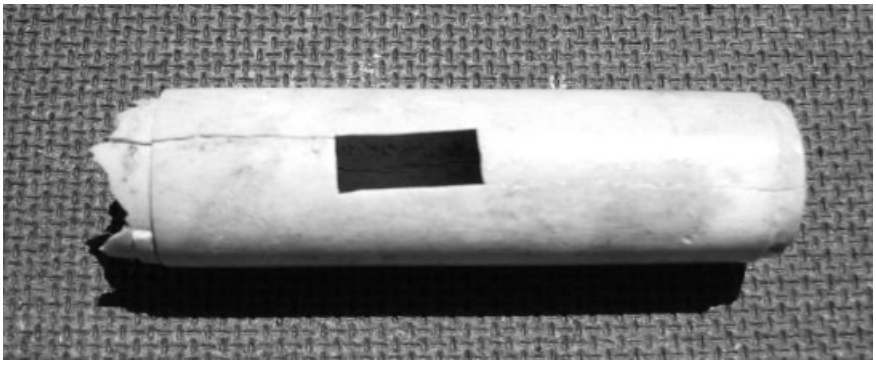

Fig. 36. Dēlos Fragment B 22164 (photograph by the author).

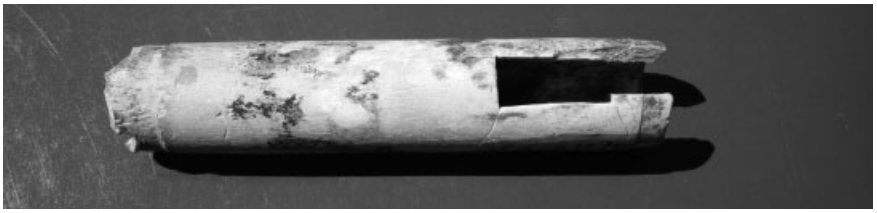

Fig. 37. The Messēnē section (photograph by the author).

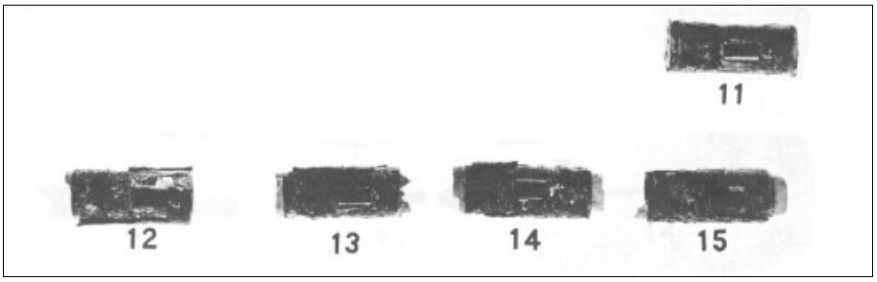

Fig. 38. Meroë Fragments IV.11-15 (BODLEY 1946, pl. IV, nos. 11-15).

Fig. 39. Dēlos Fragment B 124 (photograph by the author).

Fig. 40. Dēlos Fragment B 5140 (photograph by the author).

Fig. 41. Dēlos Fragment B 21621 (photograph by the author).

Fig. 42. Dēlos Fragment B 21622 (photograph by the author).

Fig. 43. Dēlos Fragment B 5142 (photograph by the author).

Fig. 44. Dēlos Fragment III 7 (photograph by the author).

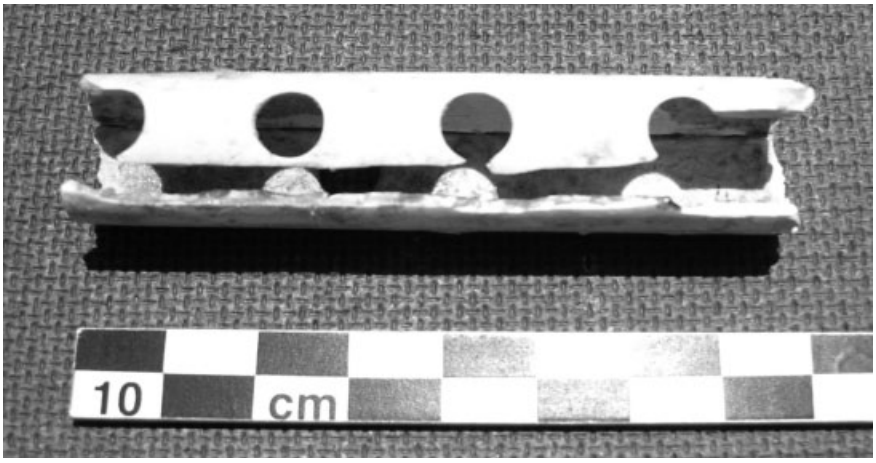

Fig. 45. Dēlos Fragment 4 (photograph by the author).

Fig. 46. Dēlos Fragment x (photograph by the author).

Fig. 47. Dēlos Fragment B 2119, *holmos* (photograph by the author).

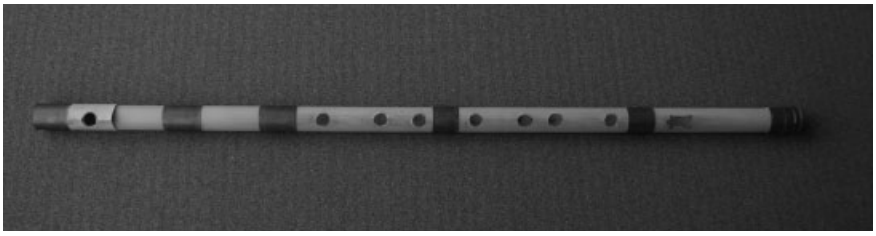

Fig. 48. The Koilē flute: approximate replica; plan view (photograph by the author).

Fig. 49. The Koilē flute: approximate replica; view from below (photograph by the author).