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The Daphnē Aulos

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Abstract
The present paper concentrates on one of the musical instruments retrieved from Grave II at Daphnē, the wooden aulos. Only one pipe of the instrument, together with its bulbous mouthpiece, was found. In the organological account which follows, the pipe is described and assessed, and an attempt is made to reconstruct it and discover its scale.

Il presente lavoro si concentra su uno degli strumenti musicali recuperati dalla Tomba II a Dafni, l'*aulos* ligneo. Solo una canna dello strumento, assieme alla sua grossa imboccatura, è stata rinvenuta. Nella descrizione organologica che segue, la canna è descritta e interpretata, ed è fatto un tentativo di ricostruirla e di scoprire la scala da essa prodotta.

Keywords
organology, Classical Greece, aulos

1. Introduction

In his *London Times* article of May 25th 1981 on the Daphnē excavation, Mario Modiano made no mention of the wooden aulos found in Grave II together with all other artifacts contained in it.[1] A year later, Gilles Touchais does mention the aulos, describing it as a "wooden instrument resembling a flute".[2] The aulos fragments (together with the other wooden items from Grave II) were strengthened by a special solution, made up of one part movilit, half part acetone, and toluole.[3] The application of this solution is, presumably, responsible

[1] Modiano 1981.
[2] Touchais 1982: *un instrument en bois qui ressemble à une flute*.
[3] Peiraias Museum Restoration Diary.

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for the deep brown-almost black colour of the wooden surfaces. The fragments were subsequently glued together at the matching breaks.[4]

On the 4th of January 1991, during the period of his PhD research, the present writer saw the aulos at the Depository of the National Archaeological Museum, Athens, but only made a sketch of it, as he was not then allowed to measure and photograph it. The instrument had apparently undergone by then the necessary restoration work. It was briefly described in the relevant chapter of his doctorate thesis a little later.[5] The aulos was transferred to the Archaeological Museum of Peiraias in February 1996 (together with all the other finds of the two graves). It has not undergone any further restoration to this day.[6] In the 1998 book guide to the Museum, written by its Director at the time, Giorgos Steinhauer,[7] a paragraph was dedicated to the 'Tomb of the Poet', in which the aulos (together with the lyre and the harp) is mentioned, although no picture of it is printed.[8]

2. The Remains[9]

The Daphnē aulos comprises two pieces of wood (pl. V 1a): a smaller one in the shape of a bulb (ΜΠ 7448/NAM A27034),[10] and a larger tubular piece (ΜΠ 7447/

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[4] A number of tortoise carapace plaques were recovered from the same grave. Some of them have been placed back together, in an attempt to reconstruct the original shell, thought to be the resonator of a lyre. For a discussion of this reconstruction see Section 8, *Appendix B*, below.

[5] Psaroudakēs 1994 I, 274-5 and II, fig. 98.

[6] According to the Peiraias Museum Restoration Diary.

[7] Steinhauer 1998, 42-3.

[8] The aulos (together with the other two instruments) is again mentioned in Steinhauer 2001, 264, and an image of it (and of the reconstructed lyre soundbox) appears in the plate on that page.

[9] I would like to express my sincere thanks to the staff of the Archaeological Museum of Peiraias and of the National Museum, Athens, for their help and support during my study of the three musical instruments of Daphnē in collaboration with Dr Chrēstos Terzēs. I would especially like to thank Ms Ephtychia Lygkourē, Director of the Archaeological Museum of Peiraias at the time, archaeologists Ms Kornēlia Axiōtē and Ms Aggelikē Poulou, and restorer Ms Tatiana Panagopoulou at the same Museum. Special thanks also go to Dr. Nikolaos Kaltsas, Director of the National Museum, Athens, at the time, and archaeologist Nomikē Palaiokrassa, for allowing me access to the Excavation Archive of the 'Tomb of the Musician' at Daphnē, kept at the National Museum, Athens.

[10] Undoubtedly, the ovoid item No 43 in the Grave Sketch (pl. I 1), not appearing in the Materials Catalogue (pl. I 9). ΜΠ and NAM stand for 'Μουσεῖο Πειραιῶς' and 'Nat. Arch. Museum', respectively.

NAM A27051),[11] with circular holes along its axis. There is no difficulty in identifying the object: it is one of the two pipes of an ancient Hellenic aulos: body cylindrical; no bell at the exit; thumb hole in between holes I and II, displaced a little to the side of the 'keel' of the pipe; bulbous mouthpiece section—all the characteristic features of the aulos are present. Its counterpart, a second tube and bulb, are not to be found either amongst the physical remains or the items drawn in the Grave Sketch (pl. I 1). It is quite possible then that only one pipe of the pair was originally placed in the grave amongst the offerings.[12]

3. The Tube

Although part of the wall of the wooden cylindrical tube has perished, enough material survives to establish its original length: there is no doubt that the end surface of the exit is the original (pl. V 3a). The exit end shows a slight outward curvature, ending in a ring-like lip (pl. V 3b).

At the upper end of the tube there is a peripheral depression on the outside, 0.4mm in breadth (pl. V 1b). Inside the tube, at the same end, there is a socket 6.18mm deep, undoubtedly in order to receive the bulbous mouthpiece section. The overall length of the tube is 22.8cm, if measured along the curve of the tube with a flexible ruler (23cm if projected onto the longitudinal axis of the tube). Obviously, some warping of the tube has taken place over the years. The wall thickness of the tube is 2mm. The external diameter of the tube is 1.234/1.2cm (not being exactly circular in all places any more), and the internal diameter is 8mm. Enough material of the walls of the tube remains for us to be certain that holes I, T, II, III existed: I is intact, II is complete, despite the fracture of the surrounding wall, and a large part of the circumference of III is present (pl. II 2c). Thumb hole T lies, as expected, between I and II, and, as has already been said, it does not lie immediately below the line of the upper holes, but is displaced a little to the left of the 'keel' of the pipe, as seen by the player (pl. V 1c). It has been argued elsewhere that this clockwise shift of the thumb

[11] Undoubtedly, the elongated item No 46 in the Grave Sketch (pl. I 1), appearing as a number under "Woods" in the Materials Catalogue (pl. I 9).

[12] Had both pipes of the aulos been placed in the grave, at least parts of the second pipe would have survived, as it is reasonable to suppose that the two lay next to each other, and therefore experienced the same taphonomic 'fate' since the moment of their burial. On the other hand, the possibility that the second pipe was placed on the other side of the deceased cannot be ruled out. Interestingly, the third side ('yoke') of the harp found in the grave has also perished, without leaving the slightest sign of its existence (see the paper by Chr. Terzēs in this volume). Could it be that the instrument was offered in this form, with its yoke missing?

		tube		I		T		II		III		IV	
| reed |mouthpiece|				O		⊙		O		O		O	| exit
		0		6.4		8.85		11.2		13.5		16	22.8cm
		|	6.4	|	2.45	|	2.35	|	2.3	|	2.5	|	6.8 | (cm)

Fig. 1. Daphnē aulos: distances of holes from upper 'lip' of tube.

	tube	I	T	II	III	IV	
| reed | bulb |		O	⊙	O	O	O	| exit
		0.7	0.656	0.692	?	?	diameters (cm) ↔
		0.654	0.628	?	?	?	diameters (cm) ↕

Fig. 2. Daphnē aulos: longitudinal (↔) and transversal (↕) 'diameters' of the holes.

hole indicates a left hand pipe.[13] It has also been argued that the left pipe in an aulos is the longer of the two members. Therefore, the pipe which we possess is, it is believed, the long one in the pair; we have lost the short pipe.[14] Part of the arc of the edge of a hole further down indicates the place of a hole IV (pl. V 2a). Below hole IV the wooden wall of the tube has perished, so there is no sign of, at least, a hole V (pl. V 2b). None of the holes have a recess around their periphery; there are several similar instances in the auletic record, where finger holes (other than vent V) are not recessed.

The distances of the finger holes (centres) from the upper 'lip' of the tube, as measured with a flexible ruler along the curve of the tube are given in fig. 1. The distance between hole IV and the exit is 6.8cm, a value large enough to have admitted a hole V, if required. The distances between the holes differ between themselves by small amounts, of the order of 0.5, 1, or 2mm. Usually, distances between holes vary by greater amounts (pl. V 9).[15]

It was possible to measure the diameters of holes I and T (both along the tube axis and across it), the longitudinal value of II, and nothing of III and IV, as not enough material survives in those places (fig. 2). The best readings are, of course, of hole I, as this is the only hole around which there is no crack or loss

[13] Psaroudakēs 2008, 202 and Psaroudakēs 2012, 524 with n. 24.

[14] In the long (L) pipes of all three surviving aulos pairs (Elgin, Pydna, Poseidōnia), the thumb hole (T) is located to the left of the 'keel' of the pipes, as is the case with the Daphnē pipe.

[15] The warping of the wood occurs below hole III, and is likely to have affected only distance III-IV. Holes I-T-II-III are still in alignment. For a concordance between the alphabetic symbols used in this paper for 'naming' the mentioned extant auletic fragments and their excavation or inventory numbers, see Section 7, *Appendix A*, below.

of material. The holes are practically circular, the difference between longitudinal and transversal values being of the order of under half a millimetre. The value 7mm for the diameters of the holes is, therefore, a reasonable mean.

4. The Bulb

The wooden bulb is of the same material, colour and finish as the tube (pl. V 1b). Its surviving length is 3.638cm. Since a second pipe and a second bulb do not exist, it is assumed that the bulb, as has already been said, belongs to the pipe described above.[16] The left end, despite the absence of material, retains its original lip. A very fine, narrow and shallow depression around the circumference of this end, and, very probably, a slightly conical inlet without a socket for the reed stem, strongly suggest, if they do not prove, that this was the reed end of the bulb.[17]

The other end of the bulb is broken; some material is missing. This means that we do not have the whole original length of the mouthpiece. Having established that the other side of the bulb is the reed inlet, it follows that this end is the part of the mouthpiece section which was inserted into the tube, the 'neck', so to speak, of the mouthpiece. The upper curve on the tube side of the surviving bulge (pl. V 1b), which, obviously, has not, as yet, streamlined itself with the tube, suggests that the whole of the neck is missing. Undoubtedly, as would be expected, the break occurred at the structurally weakest point of the section, that is, the transition from the bulge to the neck.[18] If 'x' were to be the missing length of the mouthpiece section, then the original overall length could be expressed as 3.638 + x + 0.618 cm, the latter value being the depth of the socket on the extension section, the receptor of the neck. An attempt will later be made to calculate the value of the missing 'x'.[19]

There is a small hole with a 0.8mm diameter through the wall of the bulb at a distance of 1.55cm from the reed end lip, and at the point of maximum external diameter of the bulb (1.138cm) (pl. V 1b). It is very unlikely that the hole is the result of taphonomy (e.g. damage due to wood-worm), since there is only

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16 In any case, the two bulbs of a pair of auloi are practically identical in shape and size.

17 Comparable bulb sections are: Elgin (pl. V 3c), Poseidōnia (pl. V 2c), Perachōra A and B (pl. V 3d, 3e resp.), Ialyssos F (pl. V 3f).

18 A similar situation is observed on the Ialyssos F mouthpiece section: the break has occurred at the transition point from the bulge to the neck, where the negative gradient of the outer curve becomes zero.

19 Section 6, below.

one in the (surviving) part of the bulb, while no other such small hole appears anywhere along the (surviving) body of the pipe. Although such small holes appear on a number of discovered mouthpiece sections of auloi and tibiae, it is only the Agora A aulos fragment (pl. V 4a) which has it in more or less the same place, that is, on the bulging part of the mouthpiece section, as opposed to the 'cup' (*holmos*), or the neck, or the area immediately below the mouthpiece.[20] It is most likely that the small hole on the Daphnē pipe is related to the so-called *syrinx* of the texts, a contrivance, apparently, which was fixed to the aulos/tibia on demand, and which facilitated the production of notes in a higher register.[21]

So far the main pipe (tube) and the mouthpiece section of the Daphnē aulos have been described in all significant detail. Let us now place our aulos amongst the other known auloi, complete or fragmentary, in attempting to draw information which might aid us in reconstructing the Daphnē aulos.

5. The Daphnē Aulos in the Context of the Auletic Finds Record

i) The feature of a slightly curved pipe exit, a gentle and no doubt decorative 'bell', is known from several auletic specimens.[22] This lip-like end is often shown in the relevant iconography.

ii) Another common feature of the aulos tube is the ring-like depression around the external surface at the upstream end. It is found on both of the Elgin pipes (pl. V 3c), on Pydna L (pl. V 4b), Agora G,[23] Lindos F,[24] and Perachōra G, I (pl. V 4c), J.[25] It was probably a functional rather than a solely decorative feature: an inlaid ring of either leather or metal would have maintained a tight grip on the mouthpiece section by the tube, and would have also strengthened

[20] A number of extant mouthpieces do not have the little hole: it is absent from the Korinthos A-D bulbs (see Psaroudakēs 2002, 358, Pl. 20.1 for drawings), the two complete Perachōra A and B bulbs (pl. V 3d, 3e), and the Pydna ones (pl. V 4b).

[21] For a comprehensive study of the aulos syrinx see Hagel 2012 with Fig. 5, showing all the known mouthpiece sections with the little syrinx hole in them.

[22] Pipes: Elgin (pl. V 5a), Poseidōnia, Louvre, Akanthos, Pydna (only suggestively; see Psaroudakēs 2008, 207, Fig. 2). Fragments: Agora H, Akropolis C, Korinthos H, Lokroi Epizephyrioi B, Perachōra A′, B′, C′, D′, E′, F′, G′ (pl. V 6a), Sparta I.

[23] See Psaroudakēs 2008, 210, Fig. 12 for a drawing.

[24] See Psaroudakēs 2008, 210, Fig. 13 for a drawing.

[25] See Psaroudakēs 2008, 211, Figs 14-15 for drawings.

the joint at this rather statically weak point along the pipes. However, this is not a feature always to be found in the auletic record.[26]

iii) At the upper inner end of the tube there is always a socket, which is to receive the neck of the bulb section in 'Early' auloi, or the spigot of the bulb section in later aulos types. In the auletic record there are many instances of this feature.[27]

iv) The distance from the top of the tube to hole I is not always recoverable. However, in complete pipes or in tubes made of wood in one piece, this distance is known (fig. 3).[28]

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[26] Sparta G (see Psaroudakēs 1994, II, Fig. 126 for a drawing), an 'extension' section, and at least two 'extension' sections from Perachōra (pl. V 6b, right, second from top and last but one) do not possess this outer depression. The Poseidōnia pipes, also, lack this feature (pl. V 2c). Significantly, perhaps, all these items are of a relatively early date.

[27] Elgin pipes (pl. V 5b), Agora G, Lindos F, Perachōra G, I, J, K, L, M, N, O, Q (pl. V 4d), possibly R. Sparta G (see n. 23, above); Korinthos J—the latter, curiously, with sockets on both sides (see Psaroudakēs 2002, 360, Pl. 20.3 for a drawing). Similar sockets are also found on both Poseidōnia pipes (pl. V 2c), as their examination by the present writer in January 2012 at the Archaeological Museum of Paestum revealed. Amazingly enough, the depth of the sockets which receive the bulb sections in the Poseidōnia pipes are of the order of 5 or 6mm, a very shallow socket indeed. All other sockets in these pipes are from 1 up to 1.3cm. One would expect at this weak junction of mouthpiece to tube a socket of at least 1cm or more, for a better grip. A possible explanation for such a short 'spigot' on the mouthpieces could be that, when not in operation, the mouthpieces, together with the reeds in them, were stored away in the *glōttokomeion*; a long spigot might have broken more easily when withdrawn from the tube, having such small wall thickness.

I would like to express my sincere thanks to the Director of the Archaeological Museum of Paestum, Dr. Giovanni Avagliano, for granting me permission to examine the Poseidōnia/Tempa del Prete/Tomba 21 aulos. I would also like to thank the friendly people at the Restoration Laboratory of the Museum who helped me with the practicalities of my study, Ms Cynzia Marino and Mr Pietro Stasi.

Special thanks are due to my colleague Angela Bellia, for communicating to me prior to its publication an article of hers containing information on the Poseidōnia aulos (now Bellia 2011, 103 with n. 10 and fig. 47).

[28] Lindos F has been included in the 'short' pipes, because its top-of-tube to I distance is very small, ca. 2.68cm. It is probable, therefore, that the section belonged to the short member of the aulos pair.

Diacritics L and S stand for 'long' and 'short' pipe, respectively. The interpretation here of the Reading aulos as a left hand pipe [L], and hence the longer in the pair, is based on the clockwise shift of thumb hole T in relation with the upper holes (Landels 1968, 233, 238), according to the '4L-Rule', which states that '*longer* sections belong to the *longer* pipe in a pair, which is held in the *left* hand, and has its thumb hole, T, displaced a little to the *left* of the keel' (Psaroudakēs 2008, 202). Contra Landel's final position (Landels 1968, 238). The lowest interval of the Reading aulos scale (ca. a fourth), on the other hand, may be an indication that the pipe is not the left hand member of the pair (S. Hagel, private correspondence).

tube ←x→ I
| reed | bulb | extension | ○ ● ○ ○ ○ | exit

Long pipes	x (cm)	short pipes	x (cm)	difference
Louvre l	11.65	Louvre h	06.050	5.60
Elgin L	11.40	Elgin S	07.700	3.70
Akanthos [L]	?	Akanthos [S]	10.316	?
København L	10.50	København S	07.250	3.25
Poseidōnia L	09.80	Poseidōnia S	07.200	2.60
Pydna L	09.60	Pydna S	06.400	3.20
Daphnē [L]	06.40	Daphnē [S]	?	?
Reading [L]	06.20	Reading [S]	?	?
		Lindos F [S]	02.680	?

Fig. 3. Auletic record: distance (in order of decreasing value) of upper tip of tube to hole I (centre).

The table shows that as the distance from the top of the tube to hole I decreases in the long pipe of a pair, the corresponding distance in the short pipe decreases as well. A comparison between the Elgin, København, Poseidōnia, and Pydna pipes shows this parallel decrement. The Louvre pipes do not seem to comply with this rule, undoubtedly because they are of a later type, with their holes bored to a different system. Another conclusion drawn from this table is that the Daphnē aulos, although the long pipe in the pair, is still a relatively short instrument, compared with other finds.[29]

v) Bore diameter is a variable in the auletic record (pl. V 7). The narrowest bore is found in the small Ephesos pipe (6mm), and the widest in the Ialyssos G fragment (1.318cm). The Daphnē aulos, with a bore of 8mm, matches in that respect the Louvre pipes and the Perachōra F′ fragment, and is a very close 'neighbour' to the Elgin pipes.

vi) Finger hole diameter is also a variable in the auletic record (pl. V 8). The smallest holes are found in the little Ephesos instrument (5.5mm), and the largest in Perachōra I′ (1.1cm). The Daphnē pipe is located in the low region of values, and it is related to the smallest Perachōra and Akropolis fragments.

[29] A measure of the shortness of this aulos member is given by a comparison between the lengths of the tubes (i.e., without mouthpieces) of the following auloi: Elgin L 34.4cm; Pydna L 30.35cm; Poseidōnia L 30cm; København L 28.8cm; Elgin S 31.2cm; København S 26.8cm; Poseidōnia S and Pydna S 26.5cm. The Daphnē tube is by 3.7cm shorter than the shortest S tube.

vii) Inter-hole distance is yet another variable in the auletic record (pl. V 9). As the graph shows, although there is a general tendency for adjacent hole distances to increase with increasing I-T distance (all four curves, corresponding to holes I to IV, exhibit a rightwards 'swell'), some auloi, even early ones, go against this tendency, with the most prominent discrepancy in the Louvre pipes. If the Louvre aulos were to be withdrawn from the diagram (pl. V 10), on grounds of late dating, then the curves would assume a more regular form, though not without local 'retreats', most prominently in the case of the Pydna pipes (cemetery dated as 400-350 BC), and, curiously, of the early Poseidōnia pipes (500-450 BC), and, also, of the Ialyssos D fragment. The Daphnē pipe, too, shows a regression, perhaps because the aulos was bored with a near-equidistant pattern of holes in mind.[30]

viii) As has already been said, the distance of hole IV to the exit of the pipe is 6.8cm, and had there been a fifth, vent hole (V), the question would arise whether its position could be located. The presence of a hole V would, in any case, influence only the lowest note of the aulos, the *bombyx*, and not the rest, the upper part of the scale. The question will, for the time being, remain pending.

6. Reconstruction of the Daphnē Aulos

A large number of similar, 'Early' aulos bulbous mouthpiece sections have been recovered from excavations. The nearest to the Daphnē mouthpiece are, of course, those of the Elgin pipes (pl. V 3c).[31] Bulbous sections with necks are also found on several complete auloi, such as the København, Poseidōnia (pl. V 2c), Pydna (pl. V 4b), and Akanthos (pl. V 4e) instruments. Amongst the fragments, similar bulbous sections are items Ialyssos F (pl. V 3f), and Perachōra A and B (pl. V 3d, 3e). Thus a characteristic feature of the 'Early' aulos is that the bulbous section has a long neck, which is inserted directly, without a spigot, into the socket of the next section ('extension'). In this way, the external diameter of the bulb's neck is narrower than the external diameter of the extension.[32]

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[30] See the paper by S. Hagel in this volume.

[31] It has been argued elsewhere (Psaroudakēs 1994 I, 280-286 with II, Figs. 102-104) that the bulbs of the Elgin aulos in the British Museum have not been placed back correctly in their original positions. Instead of embracing the surviving stems coming out of the tube sockets, they should be the continuation of these stems, which are, in essence, part or the whole of the 'missing' necks of the mouthpiece sections of this aulos.

[32] The feature is best exemplified on the Poseidōnia aulos (pl. V 2c).

aulos		bulb length	b	n	b/n	Daphnē neck (cm)
Perachōra	A	6.600	3.500	3.10	1.129	3.222
Ialyssos	F	7.076	3.938		1.254	2.901
Pydna	L	[7.556]	[4.128]	3.43	1.203	3.024
	S	7.556	4.128	[3.43]	1.203	3.024

Fig. 4. Auletic record: bulb sections.

		tube		I		T		II		III		IV	
| reed |	mouthpiece|			O		⊙		O		O		O	| exit
0		5.92		12.32		14.77		17.12		19.42		21.92	28.72cm
	5.92	|	6.4	|	2.45	|	2.35	|	2.3	|	2.5	|	6.8 | (cm)

Fig. 5. Daphnē aulos: distances of holes from upper 'lip' of mouthpiece.

Three bulbous mouthpiece sections can be measured with certainty or near certainty: Perachōra A, Ialyssos F, and Pydna. In fig. 4 values are given for the bulging length (b) and neck length (n) of the mouthpieces, and for the ratio bulge:neck (b/n). It can be observed that the ratio b/n values are very close to each other, ranging from 1.129 to 1.254cm (mean value 1.2cm).[33] By applying these three ratio values to the Daphnē mouthpiece, three neck lengths can be calculated for it, ranging from 2.901 to 3.222cm.[34]

As the Daphnē aulos is the shortest of the extant L pipes, the value of 2.901cm is here adopted as a best approximation. Thus, the overall length (l) of the Daphnē mouthpiece becomes 3.638+2.901 (bulge+neck) = 6.539cm. The exposed length (l^o) of the section then is 6.539-0.618 (overall length-socket) = 5.92cm. The missing neck (x) is, thus, 2.901-0.618 (neck-socket) = 2.283cm. The exposed length of the pipe, thus, is calculated to be 5.92+22.8 (l^o+tube) = 28.72cm (fig.5).

A replica of the Daphnē aulos in beech wood turned on a lathe, corresponding exactly in all respects to the above reconstruction and furnished with an 11mm wide, 2.5cm extrusion length reed, produced the ascending series of intervals tetrachord-tone-semitone-tone-tone, which, in ancient theoretical terms, can be described as two disjunct tetrachords (4chord-tone-4chord): a lower one, comprising only the fixed notes (*hestōtes phthoggoi: hypatē-mesē*), and an upper, complete tetrachord (*paramesē-tritē-paranētē-nētē*). The upper

[33] Interestingly, the Perachōra A ratio (1.129) is very near the 9:8 ratio (1.125); the Ialyssos F ratio (1.254) very near the 5:4 ratio (1.25); the Pydna ratio (1.203) very near the ratio 6:5 (1.2).

[34] By solving for n in the equation: Daphnē b/n = 3.638/n = other ratios in turn.

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                        tube      I        T        II       III      IV
| reed |mouthpiece|              O        ⊙        O        O        O                  | exit
0    2.5          8.42        14.82    17.27    19.62    21.92    24.42                31.22cm
| 2.5 |   5.92     |    6.4    |   2.45   |   2.35   |   2.3    |   2.5    |   6.8     | (cm)
                              do#       si       la       sol#     fa#                do#
                                   t        t        s        t          4chord              diatonic
                              do#                la#← la   sol#     fa#                do#
                                        tr       s        s        t          4chord              chromatic
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Fig. 6. Daphnē aulos replica: distances of holes from upper 'lip' of reed and scale.

tetrachord may be either diatonic (semitone-tone-tone) or chromatic (semitone-semitone-trihemitone), according to whether the thumb hole T is utilised or not: by employing hole T, the diatonic series (*sol#-la-si-do#*) is produced; by blowing a little harder on the *tritē* (hole II open), and not engaging hole T, the chromatic series (*sol#-la-la#-do#*) is formed (fig. 6).

The upper three notes (*la-si-do#*) in the scale, but not the lower ones, may be raised by a whole semitone if the strength of the breathing is increased a little. Thus, *la* can go up to *la#*, as already said, *si* can rise to *do*, and *do#* can easily reach *re*. The tonal level of the scale is from *do#*^{4} up to *do#*^{5}.

7. Appendix A: Extant Aulos Sections Mentioned—A Concordance[35]

Agora G (BI 645).
Korinthos A (MF 9173), C (MF 9043), H (MF 4770A), H (BI 594), B (MF 8975), D (MF 3628), J (MF 4159).
Lokroi Epiz. A+B (Lucif. T. 1050).
Perachōra A (A 428), B (A 424), G (A 432), I (A 423), J (A 421+A 422), K (A 414), L (A 418), M (A 419), N (A 420), O (A 417), Q (A 412), R (A 415), A′ (A 404), B′ (A 395), C′ (A 396), D′ (A 402), E′ (A 399), F′ (A 401), G′ (A 398), I′ (A 394).
Sparta A (CLXI.1c), B (-), C (-), D (CLXI.1b), E (-), F (-), G (CLXI.1a), H (-), I (CLXI.3), J (CLXI.4), K (-), L (CLXI.2), M (-).
Ialyssos F (7928), D (7931), G (7930).
Akropolis C (7209).
Lindos F (453).

[35] For the relevant bibliography, and a table bringing together a large selection of auloi and fragments, see Psaroudakēs 2002, 335, n. 4, and 356, Pl. 18.

8. Appendix B: The Daphnē Lyre

A number of tortoise carapace plaques were collected from Grave II. They were from the beginning thought to be parts of a lyre sound box. They appear in the Materials Catalogue (pl. I 9) under 'Pieces of a tortoise carapace', and are given the numbers 26, 28, 31, 33. In the Grave Sketch (pl. I 1) numbers 28 and 31 appear in the area between the right lower leg of the skeleton and the nearby sarcophagus wall, while number 33 is located on the other side of the skeleton, next to the proximate wall. Number 26 is not included in the Sketch. Given the fact that the burial was found undisturbed, it would be logical to infer that Group of plaques 28+31 and Group of plaques 33 belonged to different shells.

In the Archaeological Museum of Peiraias, a number of plaques have been joined together in an attempt to reconstruct the original carapace, and this is now on exhibition (pl. V 11). A few more plaques, not in a good state of preservation, are kept in a box in the Laboratory of the Museum. The missing plaques in the recreated shell and various small gaps have been filled in with special crystalline wax. A comparison, however, between this shell and any of the three Hellenic species of *Testudo* (*Graeca, Hermanni, Marginata*), proves that the Daphnē reconstruction contains a larger number of plaques than it ought to (pl. V 12, pl. V 13).[36] The Daphnē shell cannot, as a result, be studied as a lyre resonator, until the plaques have been correctly reassembled.

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[36] Ancient tortoise carapaces retreaved during excavations exhibit the same pattern of shell plaques and the same number of plaques with those living today in the country. A very good example is the best preserved of the two lyre resonators discovered at Ambrakia (see Zachos 2003, 165, fig. 54).

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Plate V 1a. Daphnē aulos: bulbous mouthpiece and tubular body.
Photo: Author.

Plate V 1b. Daphnē aulos (detail): bulb and upstream end of tube.
Photo: Author.

Plate V 1c. Daphnē aulos: tube underside, with thumbhole T.
Photo: Author.

Plate V 2a. Daphnē aulos (detail): part of the tube, with holes II, III, IV. Photo: Author.

Plate V 2b. Daphnē aulos (detail): the end part of the tube. Photo: Author.

Plate V 2c. Poseidōnia aulos (detail): mouthpieces, extensions and part of the central sections. Photo: Author.

Plate V 3a. Daphnē aulos (detail): downstream end of tube in frontal view. Photo: Author.

Plate V 3b. Daphnē aulos (detail): downstream end of tube in profile. Photo: Author.

Plate V 3c. Elgin aulos (detail): bulbs and upper parts of tubes. Photo: Author.

Plate V 3d. Perachōra A mouthpiece section. Photo: Author.

Plate V 3e. Perachōra B mouthpiece section. Photo: Author.

Plate V 3f. Ialyssos F fragmented mouthpiece section. Photo: Author.

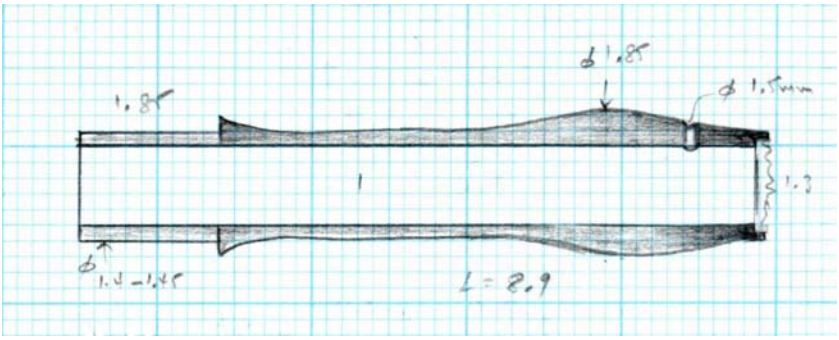

Plate V 4a. Agora A mouthpiece section: drawing 1:1 reduced.
Photo: Author.

Plate V 4b. Pydna aulos (detail): mouthpieces and extensions. Photo: Author.

Plate V 4c. Perachōra I extension section. Photo: Author.

Plate V 4d. Perachōra Q extension section. Photo: Author.

Plate V 4e. Akanthos aulos (detail): mouthpieces and extensions. Photo: Author.

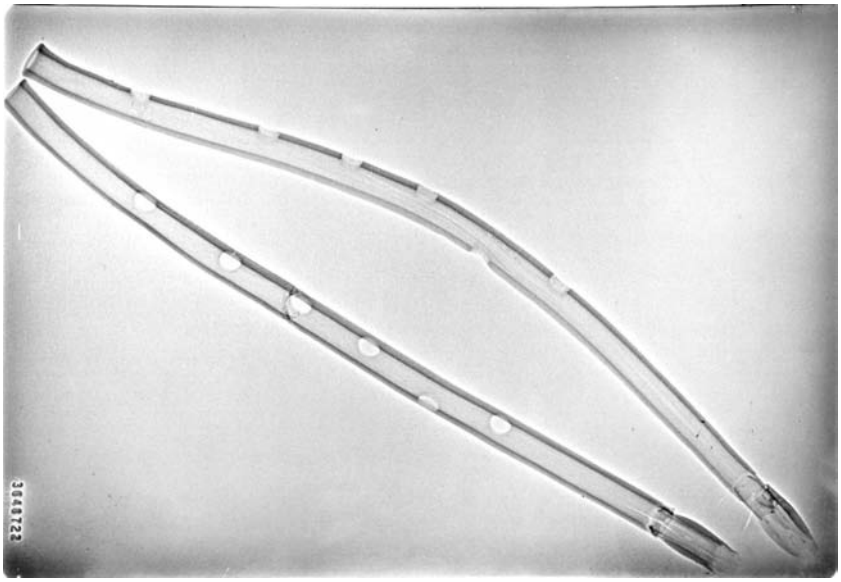

Plate V 5a. Elgin aulos: X-Ray image. Photo: courtesy of the British Museum.

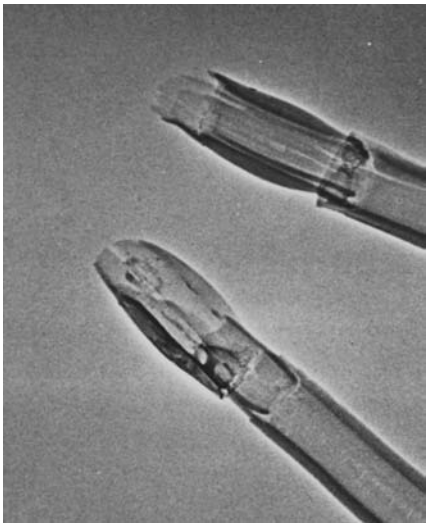

Plate V 5b. Elgin aulos (detail): X-Ray image of the bulb-tube connections. Photo: courtesy of the British Museum.

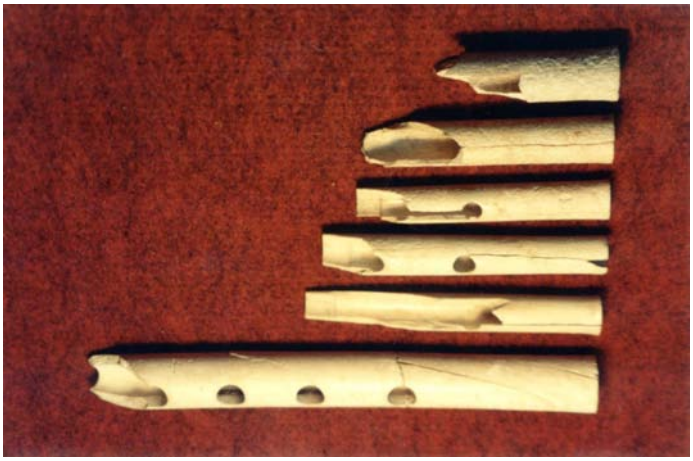

Plate V 6a. Perachōra end sections. Photo: Author.

Plate V 6b. Perachōra mouthpieces and extensions. Photo: Author.

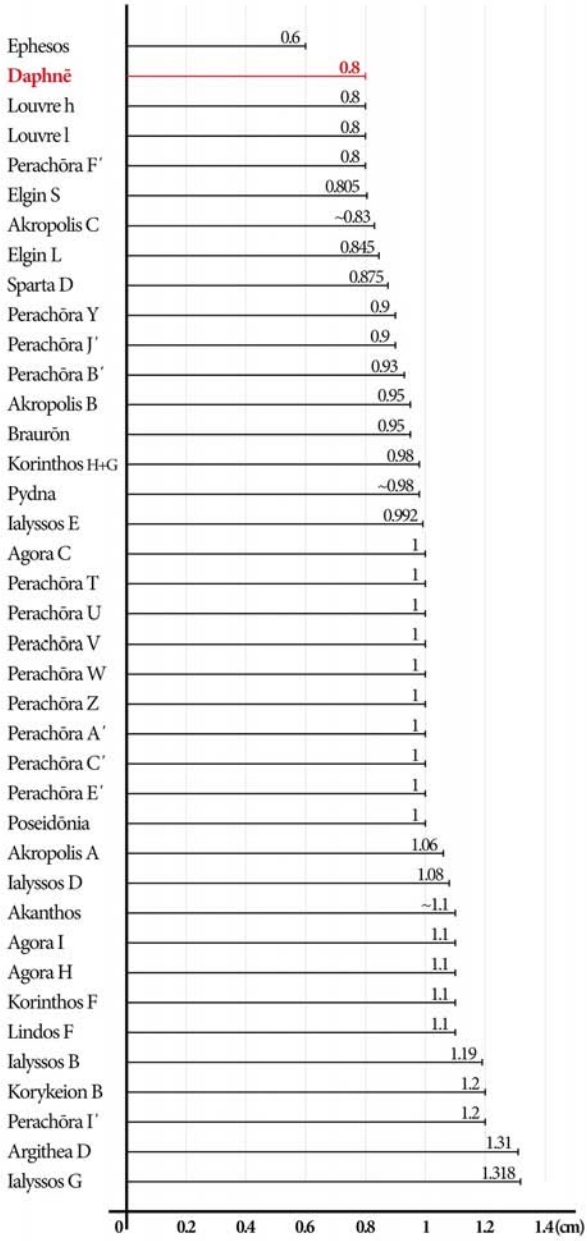

Plate V 7. Auletic record (selection): bore diameter variation.

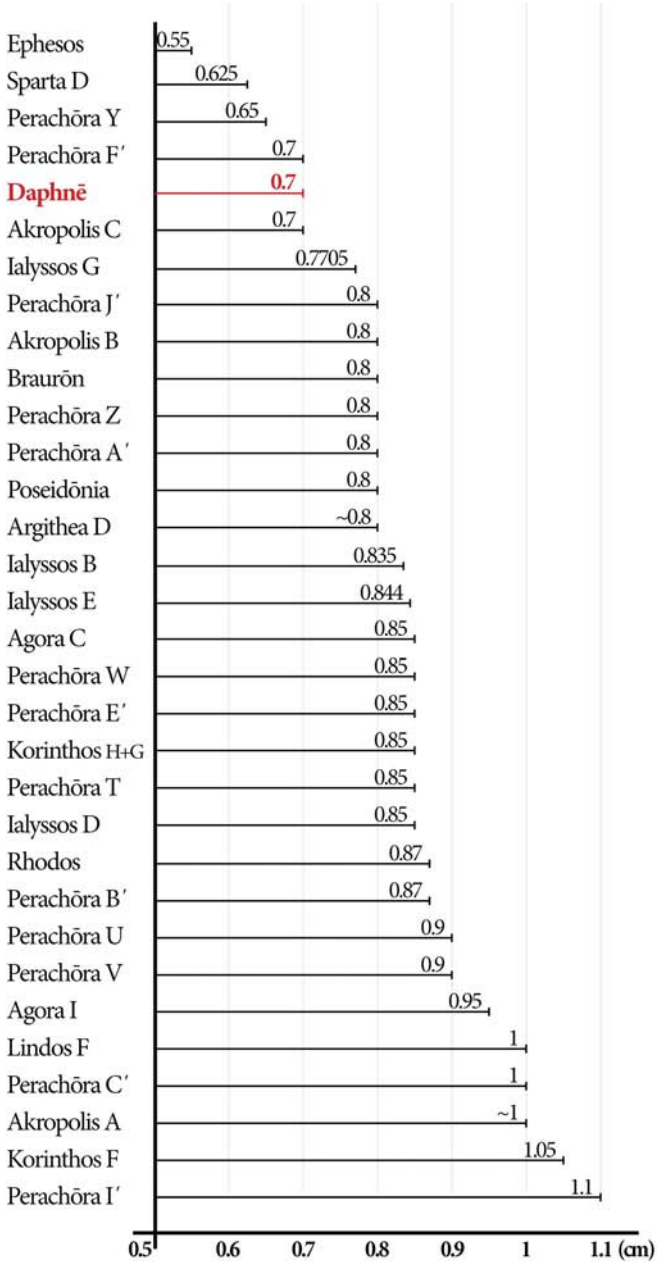

Plate V 8. Auletic record (selection): finger hole diameter variation.

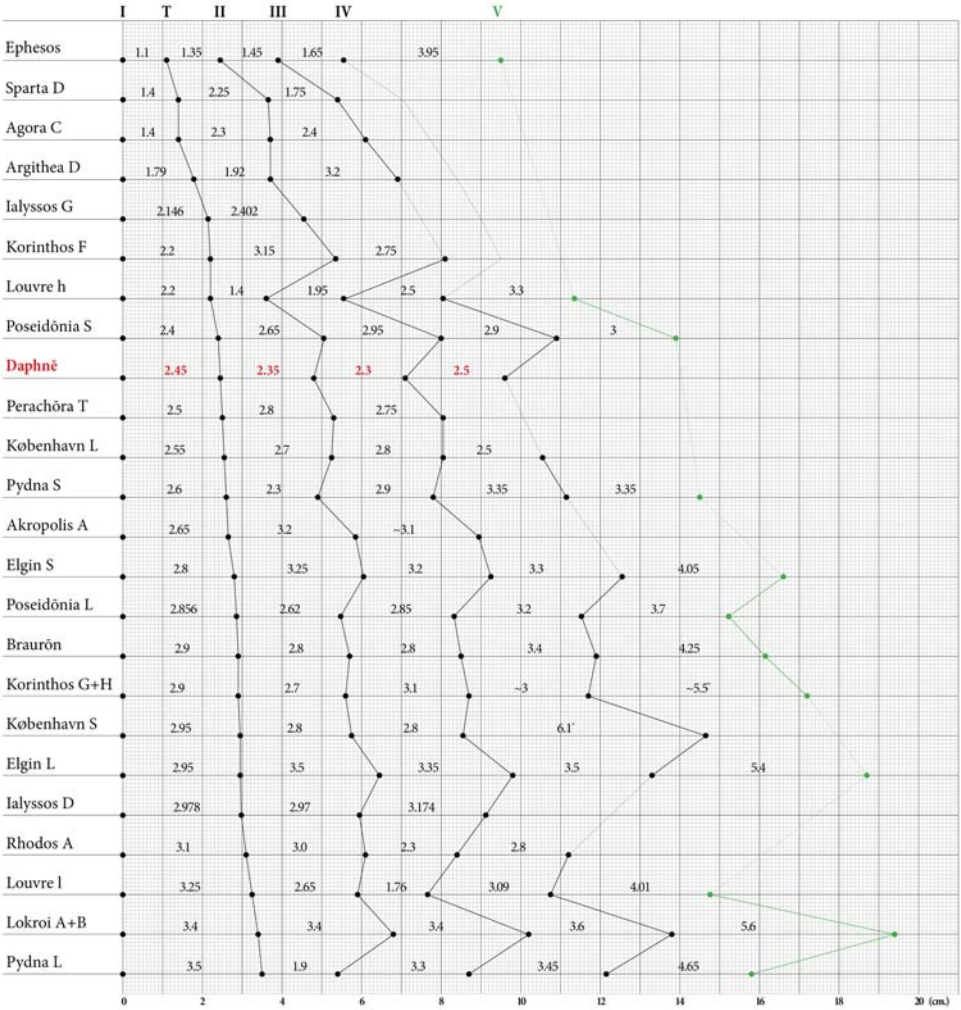

Plate V 9. Auletic record (selection): interhole distances.

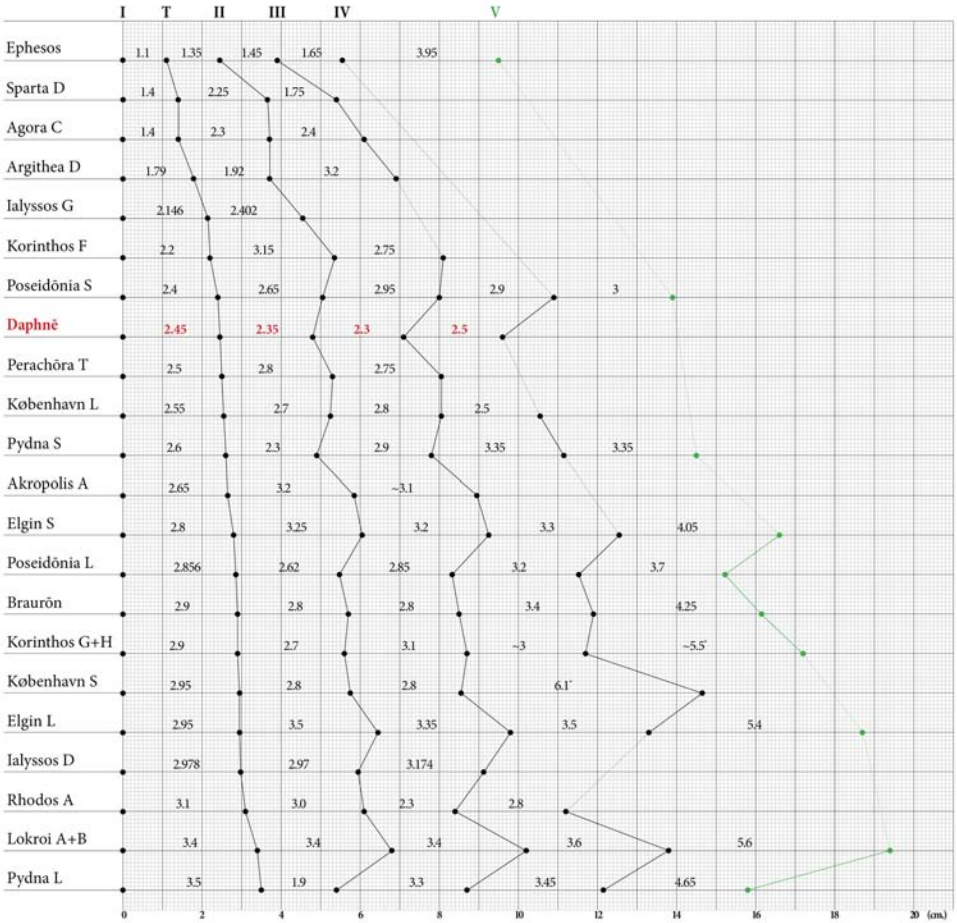

Plate V 10. Auletic record (selection): interhole distances, excluding the Louvre aulos.

Plate V 11. The reconstructed Daphnē tortoise carapace. Photo: Author.

Plate V 12. Modern *Testudo Marginata* carapace with its plaques identified. Photo: Author.

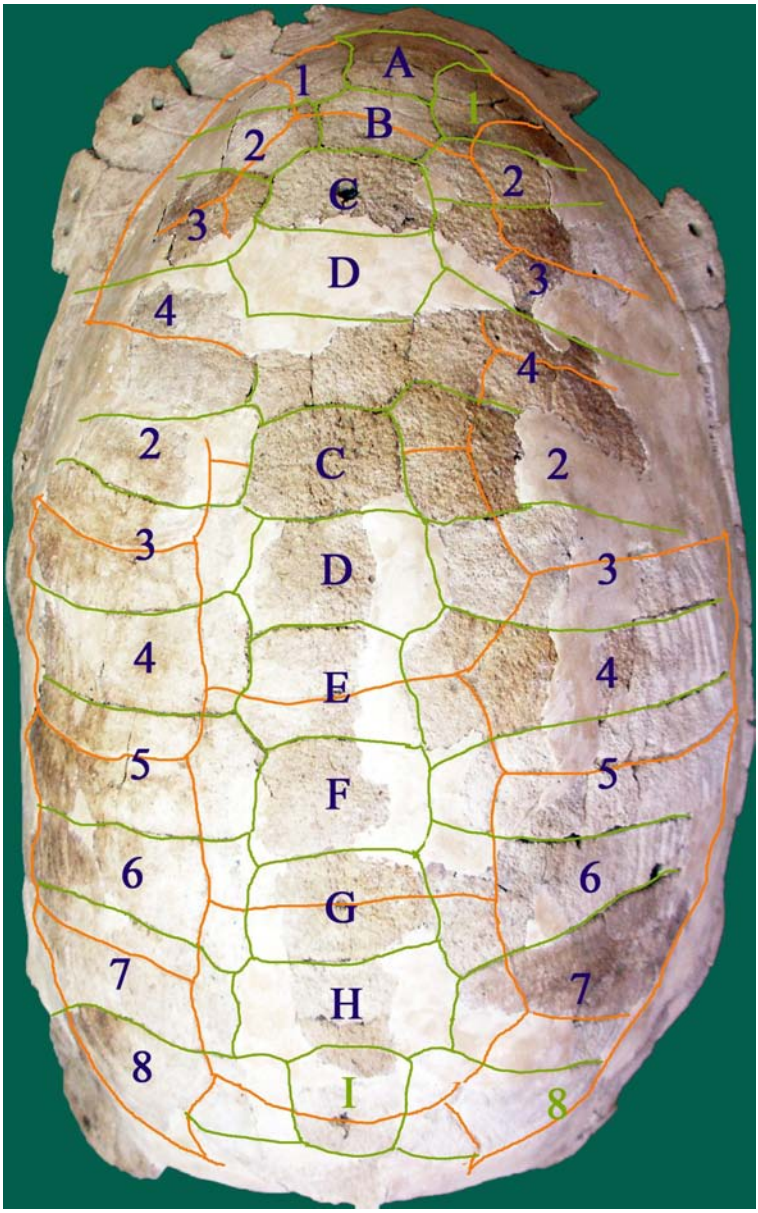

Plate V 13. The reconstructed Daphnē tortoise carapace with its plaques identified. Photo: Author.