ZUSAMMENFASSUNG


The present paper attempts to go one step further in our understanding of the ancient Hellenic double pipe (dizyx aulos1). It is specifically concerned with fragments of an instrument that were found by the archaeologist Leónidas Chatzéagkelakês, of Volos, in 1991, in the necropolis (Grave 175, rectangular) of Argithea, the capital of Athamania2 (see Pl. 1). The city was built and inhabited by the Hellenic tribe of Athamainês whose history we are able to trace up to a certain, rather limited, extent.3

The fragments are first described, and an attempt is then made to reconstruct the pipe, by using comparative material from other auloi of which we have knowledge. Finally, the characteristics of the reconstructed pipe are compared with those of other extant auloi.4

The fragments are bone and bronze tubular pieces, dated to the end of the 3rd – beginning of the 2nd century B.C. (±200 B.C.), according to the

1 Nonnos Dionysiaka 8, 17/Rouse 1956, I, 272.
2 Today: locality Helleníka, village of Argithea, prefecture of Karditsa, Thessalia, Hellas.
3 See ΘΧιατΘζεαγγελάκης 1990, with English summary. I am indebted to Mr. Chatzéagkelakês for his generosity to share with me his thoughts on a possible reconstruction of the instrument, and for allowing me to study and publish the find.
4 For a catalogue of the auloi and fragments referred to in this article, see Pl. 18. The following are the relevant publications: Boulter 1953/Landels 1964 (Athenian Agora); Κωστόπουλος 1992, 93–95 with Pl. p. 94 (Akanthos); Furtwängler 1906, 429 with Fig. 337 (Aphaia, Aigina); Behn 1954, Taf. 27c (Berlin); Landels 1963 (Brauron); Deonna 1938/Bovon 1970, 233 with Pl. 38 (Delos); Schlesinger 1939, 411–420 with Pl. 17/my Pl. 23 (Elgin); Hogarth 1908, 194 with Pl. 37,12/my Pl. 22 (Ephesos); Olsen 1968/my Pl. 24 (Kephallenia); Bronner 1935, 73 with Fig. 18/Bronner 1947, 241 with Pl. 61, Fig. 21/Davidson 1952 (Korinthos); Bélis 1984b (Korykeion Antron); Blinkenberg 1931 (Lindos); Orsi 1917 (Lokroi Epizephyrioi); Bélis 1984a (Louvre); Dunbabin 1962 (Perachóra); Howard 1893/Behn 1954, 131, 132 with Taj. 58 (Pompeii); Μπάνιου 1997 (Pydna); Landels 1968 (Reading); Dawkins 1929 (Sparta); Bound 1991 (Giglio wreck). The following items are as yet unpublished: Athenian Akropolis (in the National Archaeological Museum, Athens – see Pl. 19); Korinthos A, B, C, D, E, F, I, J, K, L (in the Museum of Ancient Korinthos – see Pl. 20.1–4); Delphoi A, B, C, D (in the Museum of Delphoi – see Pl. 21); Rhodos, and Ialyssos A, B, C, D, E, F, G (in the Museum of Rhodos – publication in preparation). I should like to thank the Keeper of the Vase Collection in the National Archaeological Museum, Athens, Ms Tóst Zervoudakês (1993), for granting me permission to examine the auloi finds in the Collection of the Museum, and the archaeologists Bety Stasinopoulou, Nikê Kropiopou and Roza Proskynepoulou, for their help and friendly attitude. I express my gratitude to the Keeper of Greek and Roman Antiquities of the British Museum, Mr B. F. Cook (1992), and his successor, Dr Ian D. Jenkins (1993), for allowing me to examine the auloi kept in the Museum; also Ms Caroline Cartwright of the Research Laboratory, Mr Colin Johnstone of the Restoration Department, and Dr Andrew Middleton, who arranged for an endoscope and supplied me with X-rays of the Elgin pipes. I should also like to thank Ms Nancy Boukidou (1993), of the American School of Classical Studies, for kindly allowing me to examine the auloi fragments in the Museum of Ancient Korinthos.

The Aulos of Argithea
Stelios Psaroudakês
style of the rest of the grave offerings. The fragments are kept in the Archaeological Museum of Volos, Inventory No BE 13355. There is no doubt the fragments are sections of an aulos – the tubes, of bone, have all the characteristics of an aulos: they are cylindrical, evenly bored, with large, aligned side holes (including the special “thumb” hole), spigots and sockets, and bronze bands around the ends. The pieces are: three cylinders of bone (here called Fragments A, D and E), part of a thin bone cylindrical tube, dyed green up to a certain length (here called Fragment B: four small, matching parts glued together at restoration), one small cylinder of thin bronze (here called Fragment C), one slightly conical “ring” of thin bronze (here called Fragment F), and a few chips of bone (the largest of which is here called Fragment G). The bone pieces will be examined first.

Fragment D is the most characteristic part of an aulos, and this because, apart from the three aligned holes on the one side, there is a thumb hole on the opposite side, between the two uppermost holes. It is the position of the thumb hole (T) which indicates the orientation of this section, since T is always on extant auloi – except for the second hole from the mouth end of an aulos. The names of the finger holes, from right to left, are III, II, T, I, which means that the direction of flow is from right to left. At the exit of the fragment (left), a bronze band, pierced at hole III, is set in a recession of the outer bone surface. The fragment has a socket at the exit, undoubtedly in order to receive the spigot of another section. The upstream end is broken off, so we do not really know the original length of the section. One should expect a spigot at this end, as there is a socket at the other.

Fragment E has two holes and a socket at one end. The other end is broken, leaving no trace of either socket or spigot. However, a spigot is more likely at this end, since the other end is provided with a socket. The socket end is shaved off externally, undoubtedly to provide room for another bronze band over this joint. The green colour of the bone at this point suggests that a bronze sleeve embraced the bone at this joint. Section E is certainly the continuation of Section D: the perished spigot of E was undoubtedly inserted into the downstream socket of D, making the socket of E an exit. The holes are therefore identified, from right to left (the direction of flow in D), as V, IV, as with Fragment D, because of the broken off end, we do not know the original length of section E.

Fragment A is similar to the other two in appearance and size but has no holes pierced in it, at least along the surviving length. Again, one end is broken to such an extent that we cannot determine whether there was a spigot or a socket at that end. However, as there is a spigot at the surviving end, we could assume that there was a socket at the perished end. The direction of flow cannot be decided on the amount of information available thus far. Again, the original length of the section is unknown. The question now arises: how was Section A connected to the unit E–D? Two possibilities suggest themselves: 1) that A was joined to the exit of E (connection: A → E ← D), or 2) that A was joined to the entrance of D (connection: E ← D → A). Let us assess the merits of the two possible connections.

Connection 1 (A → E ← D). If A was fitted to E, we should expect the length of the entrance spigot of A to be equal to the depth of the exit socket of E, that is, \( l_{spA}(1.9 \text{ cm}) = d_{soE}(2.02 \text{ cm}) \). The two values are rather close, taking into account the possibility of error in measurement. We should also expect the external diameter of the entrance spigot of A to be equal to the internal diameter of the exit socket of E, that is, \( \phi_{spA}(1.5 \text{ cm}) = \phi_{soE}(1.6 \text{ cm}) \). Again, the two figures are rather close. The two requirements are therefore, more or less, met. However, the fact that the spigot of A is green, undoubtedly dyed by a rusted overlaying bronze band (now missing), cannot easily be explained, for spigots are made to fit tightly into their sockets. Also, the external recession of the spigot is much deeper than the recession of the exit sockets of the other two fragments. The exit socket of D preserves its metal collar, and the exit socket of E is green, suggesting, together with the existence of an external recession, that there was a bronze collar embracing E (now missing). There is an added problem: if A followed E the resulting length would exceed that of any other aulos of which we know, whether that extra length did or did not have a hole in it. The two possibilities will now be examined in turn.

\[ \text{Connection 2 (A ← E → D).} \]

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5 The grave was rich in offerings: clay lamps, scent containers, prochoi, coins (one silver from Istiaia, one silver from Rhodos, one silver tetradrachmon from Athens, one bronze from Ambrakia), remains of golden thread, small golden leaves, iron spearheads, two decorative garment discs – one bearing the attributes of Zeus, the other those of Déméter – and a few more objects. The grave also contained two human crania, one at the west end, the other on the eastern side.

6 See Pl. 2a–b for photographs and Pl. 7 for a drawing.

7 However, another socket at the upper end cannot be ruled out completely, since we do have instances of sections with sockets at both ends: Korinthos J (see Pl. 20.3); Perachora Q and R (see Pl. 18 and Dunbabin 1962).

8 See Pl. 3a–b for photographs and Pl. 7 for a real-size drawing.

9 However, see n. 7.

10 See Pl. 4a–b for photographs and Pl. 7 for a real-size drawing.

11 However, see n. 7.
Possibility 1.1) If A did have a hole in it (see Pl. 8a), the hole should be labeled VI, giving a distance VI←V of 9.794 cm, a rather large figure, if compared with the corresponding distances on the two Louvre pipes (Pl. 8b).12

Possibility 1.2) If A did not have a hole in it (Pl. 9a), then the distance exit-of-A←V would be 12.95+b, where b is the missing length of A. A comparison of this figure with the corresponding ones on another five pipes (Pl. 9b), namely Elgin S (c. 6.7 cm), Lokroi (c. 5.5 cm), Elgin L (c. 4.3 cm), Braurōn (c. 4.2 cm) and Korinthos H←G (c. 3.9 cm), shows that it is rather too large.13 We must, therefore, conclude that, despite the relatively matching values of spigot-socket diameters and lengths, the connection A←E←D is improbable, for the reasons outlined above.

Connection 2 (E←D←A). In this connection (Pl. 10a), because the meeting ends of the pieces are both broken, we cannot know the original combined length. However, we can now safely assert that A did not have a hole in it, since the thumb hole, T, is always the second hole on all extant auloi. The piece would have therefore been an “extension”, intervening between the mouthpiece and the first section with holes. Numerous extensions of this kind have been found: on the København, Akanthos, Pydna and Reading auloi (complete pipes); Ialyssos A and C; Korinthos J; thirteen pieces from Perachōra (G, H, I, J, K, L, M, N, O, P, Q, R, S); Spartā G and H, and, of course, on the Elgin and Louvre pairs, though not as independent members but incorporated into the lengths of the pipes (each pipe having been made out of a single piece of wood). The resulting distance I←o is 10.73+c (where c is the missing length at the joint D←A, and o is the entrance of the extension). This value agrees rather well with the corresponding distances on four of the extant aulos pairs – the long pipe in each pair (see Pl. 10b): Louvre I (11.65 cm), Elgin L (11.4 cm), København L (10.05 cm), and Pydna (9.6 cm). Obviously, the Argithea aulos was the longest of the two pipes comprising the pair. According to the graph, we should expect its shorter counterpart to have had a distance of entrance-of-extension to hole I (I←o) about 7.5 cm (a mean value, between Elgin S and København S (7.7+7.25)/2=7.475).

The connection E←D←A is therefore the most plausible one, and it is here proposed as the original design (see Pl. 11a–b). The outlined areas at the joints of the sections represent their broken-off parts. The slight bell at the exit is suggested by Fragment F (see Pl. 6b), the conical bronze “sleeve”. It is likely that it covered a bone end bell with an entrance spigot (now perished), to match the exit socket of E. The recession over the green exit socket of E suggests that this part, too, was covered by bronze. The mouthpiece is missing, unless Fragment B (see Pl. 5a–b) is part of it. The presence of a tiny hole, drilled at an angle in the wall of E, reinforces this belief: such minute holes appear on three surviving aulos mouthpieces: Agora A (diam. 1.5 mm)14, Délos G15 and the Reading aulos (diam. 4 mm).16 Argithea B resembles the Reading mouthpiece, as regards the external metallic coating; the small hole appears in both cases immediately after the coating. Whether or not a “speaker” hole,17 its presence increases the likelihood of Fragment B being part of the missing mouthpiece. Internally (see Pl. 5b), the green end of B is shaved off a little, as if to provide adequate reception for the reed (glōttā). Comparable pieces are: Korykeion Antron A, Perachōra S, Ialyssos F; and, on a larger scale, Korinthos A (see Pl. 20.1). The usual, however, mouthpiece has a square entrance socket, into which, undoubtedly, the reed was inserted. Here are some examples of mouthpieces with entrance sockets: Elgin (cylindrical); Korinthos B and C, Louvre, Perachōra A and B (conical).

It should be constructive to compare the reconstructed Argithea aulos with other extant auloi, in all possible respects:

1) In chronological order (see Pl. 12). The earliest auloi finds are those of Spartā, late 7th century B.C. There follow those of Ephesos, Perachōra, Lindos, Giglio and Akropolis, in the 6th century B.C. Dated to the 5th century B.C.: Agora C, Aphaia, Korinthos J and H+G, Lokroi Epizephyroi, Braurōn, Delphoi, and the Elgin pair. The Reading aulos, the Louvre pair and Agora G belong to the 4th century B.C. The Hellenistic finds are more difficult to date closely: Korinthos A, C, B, D and Agora E. The Argithea aulos, at ±200 B.C., lies before Korinthos K, of 146 B.C. A few more finds, including the Pydna and Akanthos pairs, are not included in the graph.

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12 It must be pointed out that none of the extant complete auloi, namely the Elgin, København, Pydna and Akanthos pairs possess a hole VI. Indeed, on both the København and Pydna pipes, the last hole is V, while on the Reading aulos the last hole is IV. Auloi with holes beyond VI seem to be of a rather late date. Apart from the Louvre pipes, with last holes VIII and VI, four wooden auloi in the Ägyptisches Museum, Berlin are of this type, and so are the four Pompeii tibiae, and possibly Korykeion Antron B.

13 “S” and “L” stand for “short” and “long” (pipe in the pair), respectively. In the case of the Louvre pair, where the two pipes are of equal length, the diacritics “h” and “l” are here used, to denote “high” and “low” (hole I). In other words, the distance between the reed and hole I is smaller in the “h” pipe and larger in the “l” pipe.

14 See Landels 1964, 394.

15 See Deonna 1938, Pl. 92 Fig. 813.7.


17 See Landels 1968, 234; Landels 1964, 394.
2) In the (mean) diameter of finger holes (see Pl. 13). The smallest hole diameter appears on a small Ephesos pipe in the British Museum (0.55 cm), and the largest on Perachôra I' (1.1 cm). All other diameters lie in-between, with a preference for the values 0.80–0.85 cm.19 The finger holes of the Argithea aulos are of the order of 0.80 cm, roughly mid-way between the two extremes.

3) In the diameter of bore (see Pl. 14). The smallest bore occurs on the Ephesos pipe (0.6 cm), and the largest on Ialyssos G (about 1.32 cm). The difference between the extremes is about 5 mm. Argithea is on the large side, with a bore of 1.31 cm.20

4) In the relationship of bore diameter to (mean) finger hole diameter (see Pl. 15). Bore diameter is plotted against finger hole diameter. Some degree of correlation is discernible: hole diameter increases with bore, in a straight, more or less, line.21 Interestingly, all but one of the Ialyssos fragments and the Argithea aulos exhibit a relatively large bore/hole ratio, in other words, their holes are rather small for their bore size. Actually, no other extant aulos has such small holes in relationship to its bore as has the Argithea aulos. Strangely enough, on the same three Ialyssos pieces (D, B, G), the hole diameter decreases as the bore increases, though not by more than a millimeter or so. The Perachôra fragments, on the other hand, show a more regular bore-to-hole relationship. Should one conclude that Rhodian auloi had smaller holes than mainland auloi of the same bore?

5) In the distances between consecutive finger holes (Pl. 16). From the smallest T–I value, on the Ephesos pipe (1.1 cm), to the largest, on Pydna L (3.5 cm), the variation is about 2 cm, an appreciable difference. The Argithea value is on the small side, with 1.79 cm, over a centimeter smaller than the respective distance on Elgin L and almost two centimeters smaller than that on Pydna L. Distance II–T on the Argithea aulos is also on the small side, a mere 1.92 cm, as compared to the 3.25 and 3.5 cm of the Elgin pair. The next distance, III–II, is large on the Argithea pipe, 3.2 cm, equal, this time, to the corresponding distances on the Elgin pipes, 3.2 and 3.35 cm. Distance IV–III cannot, unfortunately, be measured on the Argithea aulos, because the meeting ends of sections E–D are, as already said, both broken, and, as a result, the combined length is unknown.

The question now arises as to how distances of consecutive finger holes relate to bore diameter: is there any correlation between the two? Graphs are plotted, of bore diameter versus distances of consecutive holes, namely IV–III, III–II, II–T, T–I (see Pl. 17.1–2). As is evident from the graphs, there is no correlation between the two magnitudes: for a particular bore, each distance between consecutive holes may assume any value within a range. For example, for a bore of 1.1 cm, distance T–I (see Pl. 17.1a) can be either 2.95 cm (København – hole diam. 0.8 cm), or 2.2 cm (Korinthos F – hole diam. 1.05 cm), or 3.1 cm (Reading aulos – hole diam. 0.6 cm). It is similarly for all other bore values and hole distances. However, this lack of correlation should be expected in a case like this, where more than one variable is involved, namely bore, hole, hole distance, overall length. Ideally, we should keep two of these variables constant (as “parameters”), while varying the other two and observing their interdependence. Unfortunately, the complete auloi at our disposal are few, and without their reeds, while the rest of the pieces are too fragmentary. Perhaps a future study may look towards spotting fragments which might belong to the same pipes, and thus fix some of the variables. This might produce more informative graphs.

A graph of distance III–I versus its frequency of occurrence (“histogram”) amongst twenty surviving pipes and fragments is plotted (see Pl. 25). The graph clearly shows that in the majority of them distance III–I is of the class 8–9 cm which is fairly larger than Argithea’s 6.91 cm.22 Interestingly, pipes belonging to a pair have unequal III–I class values: on Louvre h it is 5.55 and on Louvre l 7.66; on Elgin S it is 9.25 and on Elgin L 9.80; on Pydna S it is 7.80 and on Pydna L 8.70; on København L it is 8.05 and on København S 8.55. With the exception of the København pair, the pipes in the pairs have a smaller III–I value on their L component and a larger one on their S component.23

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18 Although two small auloi from Ephesos are reported in the bibliography (see West 1992, 97 & 99 Table 4.1), there was only one pipe to be found in the British Museum in September 1991, when the present writer requested to examine them, along with other finds.

19 A word of caution: the values given in Pl. 13 are not those of different pipes but of different fragments, some of which might belong to the same pipe. For example, Spar-â‘ A+D+G is, according to Dawkins, a unit.18

20 Again (see n. 19) the values appearing in Pl. 14 refer to bore diameters not of individual pipes but of fragments, some of which might come from the same instrument. The Elgin bores are difficult to measure, for the originally cylindrical pipes have been compressed. However, taking the mean between two measurements at right angles to each other, a “working” value of 8.45 mm and 8.05 mm can be calculated for L and S pipes, respectively.

21 This must not be taken literally: a bore of 10 mm, for example, corresponds to four different hole values, namely 0.8, 0.85, 0.9, 10 mm.

22 See Byrne (2000, 281 with 285 Fig. 6) for a similar histogram for thirty-six auloi and fragments (not named). His “peak” comes, also, at about 8.5 cm.

23 Perhaps, this is an indication that the København pipes need a second re-assessment as regards the correctness of matching the various sections.
Byrne plots distance III–I versus distance I–entrance-of-mouthpiece (I–ε) for six complete “un-faked” pipes (Louvre; Berlin 88, 89, 90; Brussels 8; Reading). Interestingly, the graph is a straight line, which means that any change in distance III–I is accompanied by a proportional (not directly so) change in the “height” of hole I. If that were to be true of all auloi, then the Argithea aulos, with a III–I value of 6.96 cm (2 x 0.8 + 2.45 + 2.91; see Pl. 7b), should have an I–ε distance of about 15.5 cm, which is small but reasonable. Thus, since I–ε = 15.5 = z + mouthpiece = 10.73 + c + mouthpiece (see Pl. 10a), the missing part (c + mouthpiece) of the Argithea aulos should be about 4.77 cm (15.5 = 10.73 + c + m → c + m = 15.5 - 10.73 = 4.77).

In conclusion, therefore it should be said that the ancient aulos hole-maker seems to have had specific tonal patterns on his mind when he drilled holes into his pipes, and sought to realize these patterns on his instruments by selecting the appropriate parameters: diameter of bore, diameter of holes, overall length, distances of holes, and, undoubtedly, the optimum reed. Exactly how he did that, how he guaged the parameters involved in the realization of tonal patterns, or how he produced tonal pattern (scale of pipe) compared with the intended pattern, remain to be discovered.

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24 Byrne 2000, 281 with 285 Fig. 5.
25 However, if a similar graph is plotted (see Pl. 26) for the Louvre, Köbenhavn, Elgin and Pydna pairs, a straight line is not produced. One would expect the points of, at least, the Louvre and Elgin pairs (which are made of one piece of wood, and not of sections, which might be assembled in the wrong way) to lie on the same straight line, but this is not the case.

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Pl. 2 Argithea aulos, Fragment D (photographs by the author). a) Seen from above. – b) Seen from below.

Pl. 3 Argithea aulos, Fragment E (photographs by the author). a) Seen from above. – b) Seen from below.
Pl. 4 Argithea aulos, Fragment A (photographs by the author). a) Seen from above. – b) Seen from below.

Pl. 5 Argithea aulos, Fragment B (photographs by the author). a) External view. – b) Internal view.

Pl. 6 Argithea aulos. a) Fragment C. – b) Fragment F. (Photographs by the author).
Pl. 7 Argitha aulos. The three bone sections: Fragments A, D, E (drawing, scale 1:1).
Pl. 8 Argithea aulos. Assessment of connection A→E. Possibility 1.1. a) With a possible hole V in A (drawing, not to scale). – b) Comparison of distance VI-V with those of the two Louvre pipes (graph).
Pl. 9 Argithea aulos. Assessment of connection A→E. Possibility 1.2. a) Without a hole V in A (drawing, not to scale). – b) Comparison of distance between hole V and exit of pipe (e→V) with those of another five extant pipes (graph).
Pl. 10  a) Argithea aulos. Assessment of connection D–A (drawing, not to scale). – b) Distance between hole I and entrance of “extension” (I→o): comparison between the Argithea aulos and the long pipes of the Louvre, Elgin, København and Pydna pairs (graph).
Pl. 11. Argithea aulos: the proposed reconstruction (drawing not to scale. Dimensions given in cm). a) Longitudinal cross-section. - b) View from above.
Pl. 12 A selection of extant auloi in chronological order (time advances from right to left): a comparison with the Argithea aulos (graph).
Pl. 13 Diameters of finger holes (mean values) in a number of aulos finds: a comparison with the Argithea aulos (graph).
Pl. 14 Diameter of bore in a number of aulos finds: a comparison with the Argithea aulos (graph).
Pl. 15 Relationship between bore diameter and finger holes (mean) diameter in a number of aulos finds: a comparison with the Argithea aulos (graph).
Pl. 17.1 Relationship between bore diameter and distances of consecutive holes for a number of extant auloi: a search for correlation (graphs). a) Distance T–I. – b) Distance II–T.
Pl. 17.2 Relationship between bore diameter and distances of consecutive holes for a number of extant auloi: a search for correlation (graphs). c Distance III-II. d Distance IV-III.
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<td>0.87**</td>
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Pl. 18 A selection of extant auloi and fragments: names, dates and measurements (table. * an uncertain value; ** a mean value).
Pl. 19 Aulos fragments (A–D) from the Akropolis of Athens, National Archaeological Museum, Athens (drawing, scale 1:1, reduced).

The Aulos of Argithea
Pl. 20.1 Aulos fragments from Korinthos (A–D). Museum of Ancient Korinthos (drawing, scale 1:1).
Pl. 20.2 Aulos fragments from Korinthos (E, F, I). Museum of Ancient Korinthos (drawing, scale 1:1).
Pl. 20.3 Aulos fragments from Korinthos (G, H, J). Museum of Ancient Korinthos (drawing, scale 1:1).
Pl. 20.4 Aulos fragments from Korinthos (K, L). Museum of Ancient Korinthos (drawing, scale 1:1).

The Aulos of Argithea

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Pl. 22 The Ephesos aulos. British Museum (drawing, scale 1:1).
Pl. 23 The Elgin aulos pair. British Museum (drawing, scaled down by 50% to scale 1:1).
Pl. 24. The København aulos pair, as reconstructed by the present writer (drawing, scaled down by 50% to scale 1:1).
Pl. 25 Histogram of distance III–I on a number of auloi and fragments (graph).
Pl. 26 Variation of distance III–I with distance I–ε on four extant pairs of auloi and one single pipe (graph).