FRAGMENTS OF AULOI FOUND IN THE ATHENIAN AGORA

(PLATE 70)

AMONG the small bone and ivory objects found in the Agora excavations are some fragments of reed-blown pipes (*αὐλοί*): the purpose of this article is to examine, from a musicological standpoint, nine of these fragments which are sufficiently large and complete to provide valuable information on the structure of the ancient *αὐλός*.[1]

Firstly, a word about the materials. It is clear from ancient sources that a number of different materials were used to make the body of the *αὐλός*; probably the most common was *κάλαμος*, a reed-like plant with a hollow stalk; this same plant was also used to make the reed mouthpiece.[2] Another common material was *λωτός*, most probably to be identified with the species *Celtis Australis*, which grows in North Africa; the word *λωτός* is frequently used as a synonym for *αὐλός*.[3] Bone and ivory were widely used in Classical and Hellenistic times, and when keywork was developed the body was made of wood or ivory, with an outer layer of bronze or silver.[4] It is not surprising that the surviving instruments, with the exception of the Elgin pipes in the British Museum (of sycamore wood), are all of bone, ivory or metal; but it should be remembered that the materials which by their very nature have not survived—*κάλαμος* and *λωτός*—were probably the most commonly used.

FRAGMENT A (Inv. BI 593). Fig. 1, Pl. 70.

From a domestic quarter to the northwest of the Areopagus; indeterminate context.

[1] I am very grateful to Professor Homer A. Thompson, Field Director of the Agora Excavations, for having allowed me to examine and measure these fragments, several of which have not previously been published; also to Miss Anna Benjamin, who is compiling the catalogue of small objects from the Agora excavations, for checking some measurements for me and some details in the excavation records.

[2] Cf. Theophrastos, *H.P.*, IV, 11, 1-9; Pindar, fr. 233 Bowra (O.C.T.), schol. on *Pyth.*, XII init.

[3] E.g. Euripides, *Troades*, 544; Athenaeus, IV, 182D-E; *Anth. Pal.*, IX, 266; see also Theophrastos, *H.P.*, IV, 3, 4.

[4] The earliest reference to the use of metal is in Pindar, *Pyth.*, XII, 25-27, *λεπτοῦ διανισόμενον χαλκοῦ θαμὰ καὶ δονάκων.....κτλ.* but according to one scholiast, *χαλκοῦ* refers to the *φορβειά*. The same explanation is given by Hesychius and *Et. Mag.* on Alcaeus, Com. fr. 20 Kock (*CAF*, I, p. 761).

Horace, *A.P.*, 202 ff., almost certainly refers to keywork, *vincta* being applied to the bands or sleeves around the instrument.

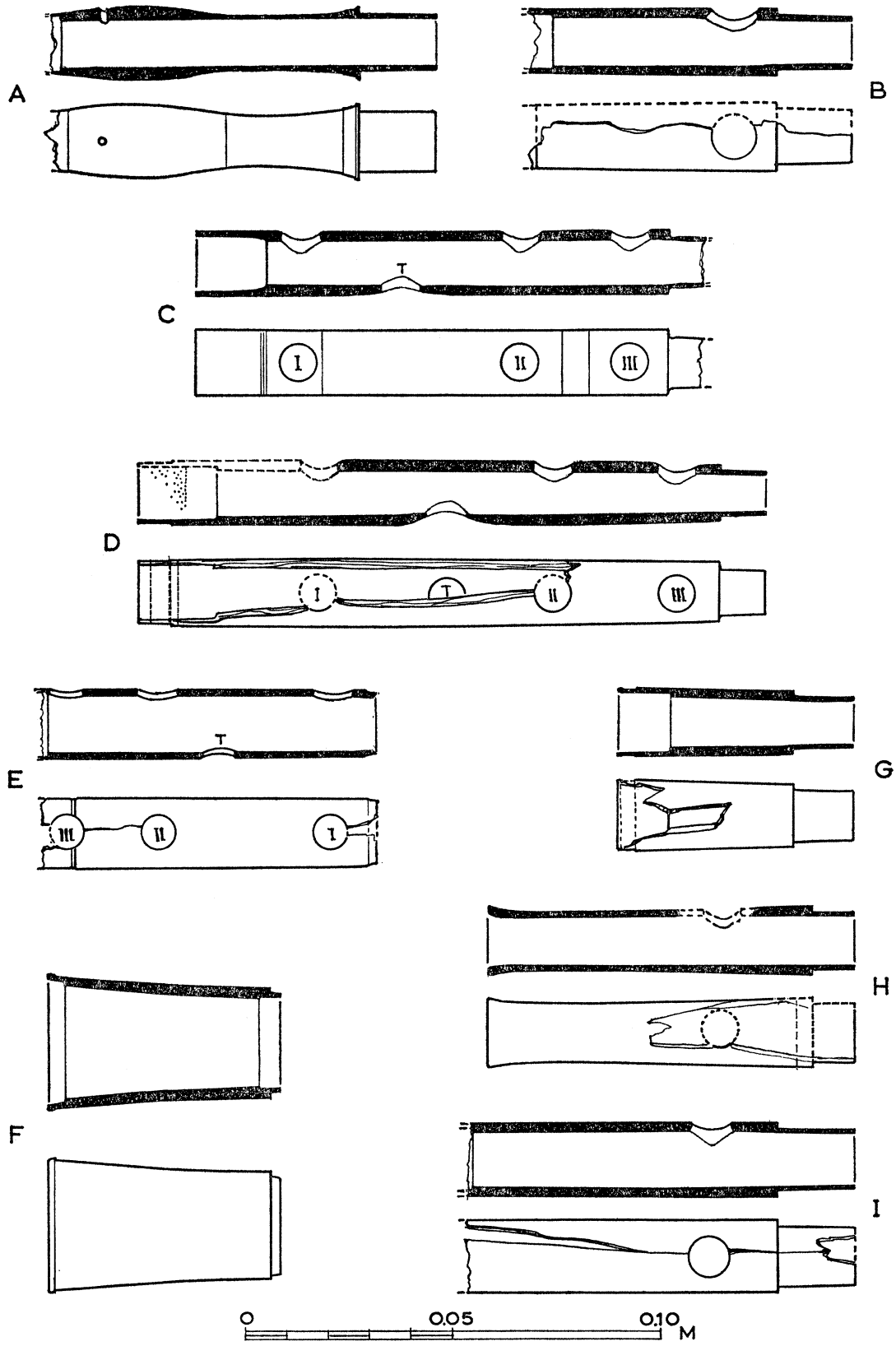

Fig. 1.

Overall length 8.95 cm.; length of spigot 1.85 cm.; maximum outside diameter 1.85 cm.; diameter of spigot 1.40-1.45 cm.

The bulb (ὅλμος) from the mouthpiece end of an aulos. Socket at one end and spigot at the other; spigot most probably fitting into the top of the body; socket for the insertion of a second bulb.[5] The material is bone (or possibly ivory) dyed by a dipping process to a very attractive gray-green, slightly mottled color. Delicately incised lines encircle the pipe near each end and the middle. The finish and workmanship are excellent. The inside diameter does not vary with the outside curvature, being almost exactly 1 cm. throughout; at one end it is enlarged to receive a spigot of outside diameter 1.3 cm. It is probable that this spigot was identical with the surviving one. Of the socket only small splinters remain; but most illustrations of auloi show the curvature of the ὅλμος as symmetrical, so it may reasonably be conjectured that the outside diameter of our piece expanded towards the end of the socket, and was the same at the missing end as it is at the preserved end, i.e. 1.65 cm. It is equally probable that the socket was the same length as the spigot; if so, the length of the visible part of the ὅλμος, which in the assembled instrument was the additive resonant length, was almost exactly 9 cm. Some vase paintings show a ὅλμος which appears to be about this length.[6]

There is one other feature which is interesting but very puzzling—a small hole about 0.15 cm. in diameter drilled in the side of the bulb. This is curiously similar to a hole in an aulos fragment found in Delos;[7] the only suggestion I can make at present is that it was some sort of speaker hole to enable the player to raise the pitch of all the notes on the instrument by a twelfth; but in order to test this hypothesis it would be necessary to make a facsimile of the ὅλμος and of a suitable pipe and mouthpiece, and carry out tests to discover whether this hole is of suitable size, and suitably located, to assist in the production of harmonics.

Fragment B (Inv. BI 517). Fig. 1, Pl. 70.

From the northern room of the " Sculptor's Workshop " in the southwest corner of the Library of Pantainos, abandoned in A.D. 267. Cf. *Hesperia*, XVIII, 1949, p. 269.

[5] Most illustrations of the aulos on vases show two bulbs; when the instrument is not in the player's mouth, something which looks like a double reed mouthpiece is sometimes shown protruding from the end bulb. Some show one bulb only, and the Pompeian pipes in the Naples Museum have only one each. Others apparently have three, unless the end " bulge " represents the reed mouthpiece seen from another angle. See the following examples: Richter, *Red Figure Vases in the Metropolitan Museum*, pl. 155; Pfuhl, *Malerei und Zeichnung der Griechen*, pl. 381; Wegner, *Das Musikleben der Griechen*, pl. 11; *CVA*, Denmark VI, IV/e, pl. 245, 1a; *CVA*, Italy VI, IV/Dr, pl. 24, 2; Richter, *op. cit.* pl. 62; *CVA*, Great Britain III, III/I, pl. 28, 3-4; *CVA*, Great Britain IV, III/I/c, pl. 11, 1a-b (= Wegner, *op. cit.* pl. 19).

[6] *E.g. CVA*, Great Britain, IV, III/I/c, pl. 8, 2d.

[7] Cf. *Délos*, XVIII, *Le mobilier Délien*, pl. XCII, 813.

Agora Guide, 2nd ed., 1962, p. 85.

Overall length 7.25 cm.; length of spigot 1.85 cm.; maximum outside diameter 1.7 cm.

Section of an aulos with one fingerhole; socket at one end and spigot at the other. Split longitudinally, rather more than half missing. The material is bone (or possibly ivory) stained gray-green, similar to that of Fragment A. A delicately incised line encircles the pipe near the broken end. The outside diameter of the spigot cannot be measured accurately, as less than half the circumference is preserved; the spigot appears to taper very slightly. The one hole is 1.1 cm. in diameter (this is exceptionally large) with some "seating"—the outside edge has been smoothed and the hole itself hollowed out so that the player's finger can seal it more easily and reliably; this shows definitely that it was a fingerhole, not a vent-hole.[8] The nearer edge of the hole is 0.5 cm. from the joint. Though the fragment is mutilated, there is reasonable certainty that it had no other holes, either in line with this one or diametrically opposite. There is one very significant feature. Some material has been cut away from the inside surface on the edge of the fingerhole; apparently this has been done with a slender-bladed knife inserted through the fingerhole from outside. Here is a clear example of "under-cutting," a technique still used by instrument makers to correct the pitch of faulty instruments;[9] and it suggests that the pitch of the ancient aulos was not so inaccurate and unstable as some ancient authorities would have us believe.[10]

The fact that there is a spigot at one end of this fragment and a socket at the other shows conclusively that it is not the end section of an aulos. From the other surviving fragments it appears that four of the fingerholes (I, II, III and the thumbhole) were normally bored in one central section. There were sometimes two sections below this, one containing Hole IV (e.g. this fragment and Fragment I below), the other being the endpiece or bell, which sometimes had a vent-hole in it (e.g., perhaps, Fragment H below); sometimes these two parts were combined in a single section. There are two possible explanations for the arrangement whereby Hole IV was bored in a separate section from the others. One is that the stretch required to reach five holes at a given distance apart is slightly reduced if the hole covered by the little finger is slightly out of line with the others—displaced clockwise for the right hand and anti-clockwise for the left; this could be effected by twisting the lower section at the joint. The other possible reason is that bone of suitable size and shape was available only in short lengths; Fragment D, the longest of this group, is only 12.1 cm.

[8] The distinction is clearly visible on the Brauron aulos; see my article in *B.S.A.*, LVIII, 1963, pp. 116-119.

[9] Cf. Anthony Baines, *Woodwind Instruments and their History*, Faber and Faber, 1957, p. 49; Philip Bate, *The Oboe*, Ernest Benn, 1956, pp. 133-134.

[10] E.g. Plato, *Philebus*, 56A; Aristoxenos, *Harm.*, II, ch. 43 (Macran, pp. 133-134).

long excluding the spigot and socket, and this would not be long enough for all five holes.[11]

It is not possible to say with certainty which way up this fragment fitted in the instrument; if the socket fitted on to the central section (that containing holes I-III) the distance between the hole in this fragment and Hole III must have been at least 7 cm.—a long, but not impossible stretch. More probably it was the other way up, the spigot fitting into the central section.

A word remains to be said concerning the possible connection between the two fragments so far described; they are similar in the following respects.

(a) The material of each is the same, dyed the same characteristic color and by the same process; where fracture has occurred the natural white color is visible, with the green dye penetrating a little way in from the surface.

(b) The spigots are exactly the same length, and both are slightly tapered.

(c) Both fragments have been lathe-turned, being exactly round on the outside and not (as in some examples) the natural oval shape of the bone. On each there are some lightly tooled lines around the outside, corresponding roughly with the inner ends of the sockets.

(d) It is not possible to measure the inside diameter of Fragment B with accuracy; but it appears to be the same, or very nearly the same, as that of Fragment A.

(e) Both show the same very high standard of workmanship.

These resemblances suggest that the two fragments were the work of the same instrument-maker, if not parts of the same instrument.[12] But difficulties arise from consideration of circumstances in which they were found: Fragment A outside the southwest corner of the Agora, Fragment B in the Library of Pantainos.[13] However,

[11] The distances between the holes in Fragment D are: I-T 3.2 cm. (app.), T-II 2.6 cm., II-III 2.95 cm. Even if Hole I had been bored very close to the socket, Hole IV could not have been bored in the same section unless it was within 2.35 cm. of Hole III, and that is most unlikely; the distances between holes tend to increase at the lower end.

[12] They cannot have been adjacent parts of the same instrument; there must have been at least one section between them. I have suggested that the spigot on Fragment A was at the lower end, and that on Fragment B at the upper end; if so, the intermediate section must have had a socket at each end. This is a little surprising, but does not present any serious difficulty.

[13] The design indicates that Fragment B was not fitted with keywork; but unfortunately it is not possible to date it with any confidence on this basis. Keywork was probably introduced by the end of the 5th century B.C., but the " old-fashioned " type of aulos, with six holes and no keywork, was certainly in general use for a long time after that. The manipulation of keywork—a difficult business—was probably beyond the scope of any except virtuoso professional players; it is doubtful whether those more humble *αὐλητρίδες* whose talents were not primarily musical ever graduated beyond the simple form of the instrument.

it is for the archaeologist, not the musicologist to decide whether the possibility of linking these two fragments is to be admitted or ruled out.

FRAGMENT C (Inv. BI 672). Fig. 1, Pl. 70.

Found in a well in the north central part of the Agora together with much pottery of the mid-5th century B.C. (*Hesperia*, XXII, 1953, p. 114, No. 194, pl. 41). The design of the pipe is entirely consistent with such a date.

Overall length 11.3 cm.; maximum outside diameter 1.6 cm.; diameter of spigot 1.15-1.35 cm.

This formed the central section of an aulos, with three fingerholes and a thumbhole. It is of bone, split longitudinally into two pieces but complete except for the spigot. The outside surface retains some marks of the original bone, in particular a shallow groove along the thumbhole side. Several lightly incised lines encircle the pipe. The inside diameter is approximately 1 cm. throughout, except for a crudely made socket at one end, apparently for the insertion of a spigot. The bore has been enlarged over about 1.7 cm. with a conical reamer, reaching a maximum diameter of 1.25 cm. (the same as the outside diameter of the spigot).

The holes are all truly circular, 0.85 cm. in diameter except III, which was probably the same size but now appears slightly larger owing to the splitting. Apart from the spacing of the fingerholes, this fragment yields another item of information. It is virtually certain that the socket end lay towards the mouthpiece, and that Hole I was the fingerhole giving the highest note. Holes I, II and III are in line with one another, but the thumbhole is not, as might be expected, diametrically opposite to them; it is displaced from that position by about 5-10 degrees (it is difficult to estimate exactly) in an anti-clockwise direction. The simplest explanation is that this was the left-hand pipe of a pair; the most comfortable position for the left thumb is slightly to the right of " bottom dead center."

FRAGMENT D (Inv. BI 579). Fig. 1, Pl. 70.

From a domestic area to the northwest of the Areopagus; late Hellenistic context.

Length overall 15.1 cm.; length of socket 1.9 cm.; length of spigot 1.1 cm.; maximum outside diameter 1.75 cm.; diameter of spigot 1.25 cm.; diameter of holes 0.9 cm.

Another central section of an aulos, also of bone, with three holes and traces of a fourth. Three lightly incised lines near one end of the section. There is some " seating " around the thumbhole (cf. Fragment B above); the hole appears to be not quite diametrically opposite to Holes II and III; but the displacement (in a clockwise direction) is so slight that the pipe might have been fingered (or, rather, thumbed) with either hand. Traces of Hole I are visible on the side of the split; they suggest

that it was " seated." It may have been slightly out of line with holes II and III, to the right from the player's viewpoint.

FRAGMENT E (Inv. BI 27). Fig. 1, Pl. 70.

Found in a pithos at the north foot of the Areopagus along with much domestic debris of the mid 2nd century B.C. Mentioned in *Hesperia*, III, 1934, p. 369.

Preserved length 7.8 cm.; outside diameter 1.8 cm.; inside diameter 1.25 cm.

Another central section of an aulos, with four holes; of bone, slightly oval in section. Both ends are damaged; there was probably a socket at one end; traces remain of the rebating and some splinters outside it. The other end is unusual in not having a stepped section; the end of the pipe is slightly bevelled with an inward slope. Part of Hole III is missing; its lower edge must have been within a very short distance of the end of the socket. A pair of delicately incised lines encircle the pipe near one end. The holes are all circular, of diameter 0.8 cm. The workmanship is rather inferior; the maker has " made do " with a piece of material which was not really long enough for his purpose.

FRAGMENT F (Inv. BI 624). Fig. 1, Pl. 70.

From a domestic deposit of the late 1st century B.C. to early 1st century A.D. at the northwest foot of the Areopagus.

Overall length 5.6 cm.; outside diameter 2.65-3.25 cm.; diameter of spigot 2.4 cm.; inside diameter 1.85-2.9 cm.

The bell of an aulos of later and more elaborate design than those examined so far. Made of bone or possibly ivory, probably part of an instrument with bone or ivory body and metal keywork, approximately the size of a modern B$^{\flat}$ clarinet. The inside surface is rebated for a distance of about 0.3 cm. in from the large end, the rebate being approx. 0.05 cm. deep; this was probably to take the lapping from the outside metal covering, which would have extended around the lip of the bell and a short distance inside. Around the outside of this end is a slightly raised band 0.15 cm. wide. The outside surface of the bell is unpolished, which suggests that it was not visible. This fragment bears a remarkably close resemblance to the bells of auloi found at Meroe in Egypt; see N. B. Bodley, " The Auloi of Meroe," *A.J.A.*, L, 1946, pp. 217-240, particularly plate IV, item 16 (text p. 229) and plate V, item 2. Those instruments have been dated to about 15 B.C., and so must be close in date to Fragment F.

FRAGMENT G (Inv. BI 645). Fig. 1, Pl. 70.

From a context of the late 4th century B.C. below the Stoa of Attalos.

Overall length 5.7 cm.; length of socket 1.2 cm.; length of spigot 1.4 cm.; outside

diameter 1.6 cm.; diameter of spigot 1.3 cm.; inside diameter 1.0 cm. Both spigot and socket taper slightly.

Section of an aulos with no holes; spigot at one end and socket at the other. Made of bone; a small portion missing from the socket end. Encircled by a thin incised line near one end. This fragment presents something of an enigma. It cannot have had any fingerholes of the usual size, though there may possibly have been a very small hole in the missing part. Its function would depend on its position in the assembled instrument.

a) If it were inserted between the section containing Hole IV and that containing the vent-hole, it would lower the note from the latter by about one tone if the instrument was of average size.

b) It could not, in my opinion, have been inserted between the central section and that containing Hole IV; that would increase the span between Holes III and IV by about 4.3 cm., and even if the span was previously less than the normal, it would make the fingering very uncomfortable indeed.

c) It might have been a part of the mouthpiece assembly, a simplified form of ὅλμος,[14] with or without a speaker hole in the missing part (cf. Fragment A above).

d) It might have been a "crook" or mouthpiece extension, which could be inserted between the mouthpiece assembly and the central section. Its effect would be to lower the pitch of all the notes of the pipe, and alter the intervals between them; such an arrangement is not normally usable except on pipes with equidistant fingerholes.[15]

FRAGMENT H (Inv. BI 594). Fig. 1, Pl. 70.

From the same location as Fragment A.

Overall length 8.9 cm.; length of spigot 1 cm.; maximum outside diameter 1.7 cm.; outside diameter of spigot 1.3 cm. (with slight taper); maximum inside diameter 1.1 cm. The outside diameter varies as the natural oval shape of the bone has been left unaltered. The bore is also slightly oval.

The lower end section of an aulos; of bone, with spigot at one end. A wedge-shaped piece missing from the top surface, extending along about half the total length.

[14] Some illustrations show a ὅλμος with no curvature, the section being indicated by thin lines drawn around the pipe, e.g. Richter, *op. cit.*, pl. 35; *CVA*, France II, III/1/c, pl. 24, 3.

[15] K. Schlesinger, in her book *The Greek Aulos*, Methuen, London, 1939, argued that Greek modal scales were derived from such pipes, and that the method by which Pronomos "played three different scales on the same pipes" (Pausanias, IX, 12, 5-6; Athenaeus, XIV, 631E) was to add or subtract bulbs from the mouthpiece assembly. But the evidence she adduced for equidistant positioning of the fingerholes of Greek pipes was very inadequate, and the fragments discussed in this article do not lend any support to her theory. Bodley's reconstructions of the Meroe pipes (cited under Fragment F) are all based on Schlesinger's principle.

A delicately incised line encircles the pipe near the joint end. There is no socket at the end opposite the spigot; this indicates that we have to do with an end section. Traces of one hole are visible on the edge of the missing portion; its size cannot be assessed but its center appears to have been approximately 5.7 cm. from the end of the instrument and 2.2 cm. from the joint. It is not possible to say whether this was a finger-hole or a vent-hole.

FRAGMENT I (Inv. BI 630). Fig. 1, Pl. 70.

From a domestic cistern to the northwest of the Areopagus; context of mid 2nd century B.C.

Overall length 9.15 cm.; length of spigot 1.8 cm.; outside diameter 1.8 cm.; diameter of spigot 1.35-1.4 cm.; inside diameter throughout 1.1 cm.

Section of an aulos, from between the central section and the lower end, with one hole (probably Hole IV). Bone, damaged at both ends; spigot at one end and traces of a socket at the other. One hole, circular, diameter 0.95 cm., its nearest point 1.15 cm. from the preserved joint. Definitely no other holes. Probably the same portion of the pipe as Fragment B, *q.v. supra.*

I was able to examine eight other similar fragments: of these, two (BI 549 and BI 570) are too small or too badly damaged to yield useful information. Four of them (BI 12, 13, 14 and 556) are not, in my opinion, parts of auloi. The remaining two (BI 50 and 664) are bone flutes of Turkish manufacture, dating from about the 17th century. These are interesting to the historian of more recent musical instruments, but bear no relation to the ancient fragments.

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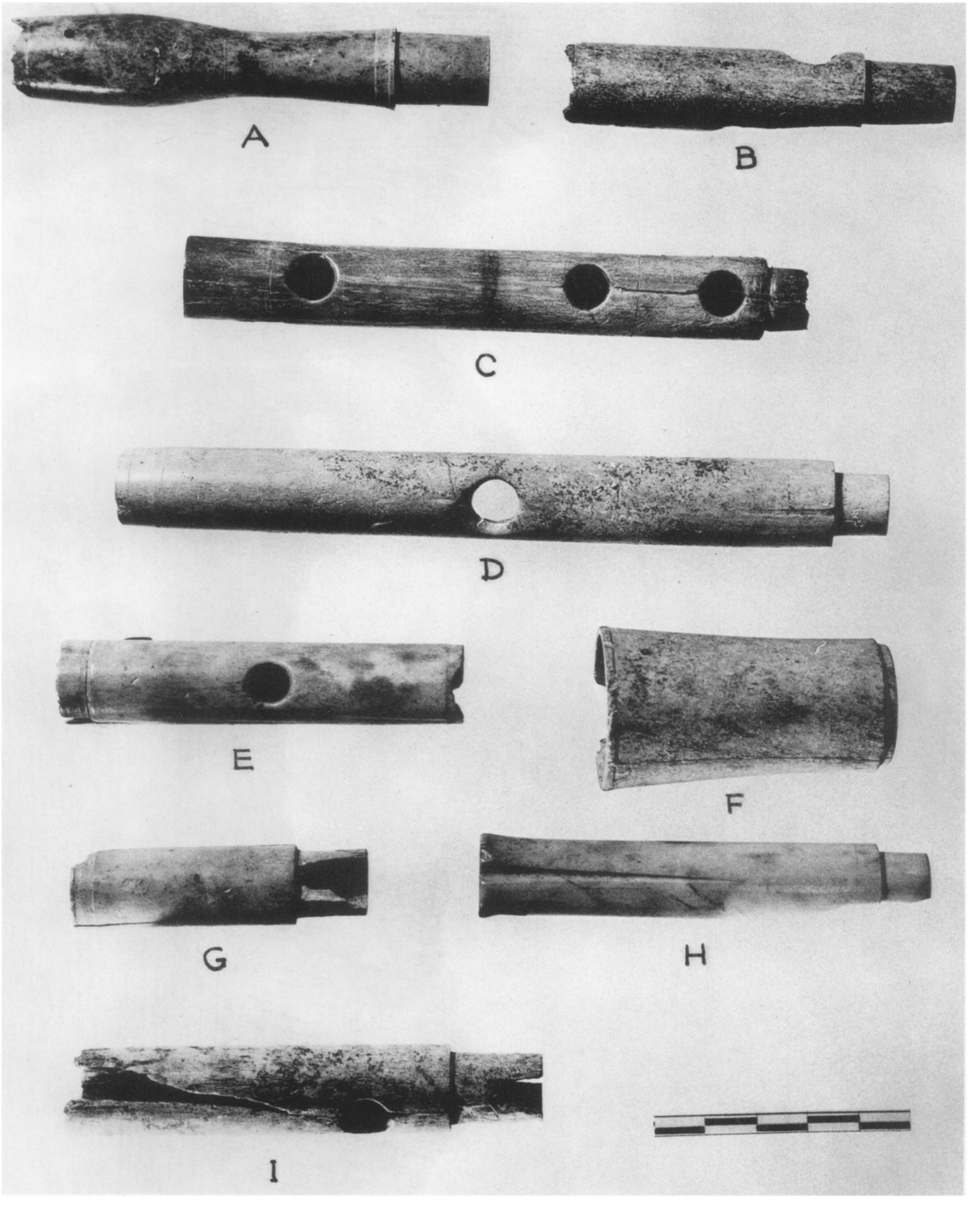
PLATE 70



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