Analysis and Provenience of Minoan and Mycenaean Amber, II. Tiryns

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THE GRAVE ROBBERS' HOARD known as the Tiryns Treasure includes two well-preserved and two (?) fragmentary gold-and-amber objects which have been fully described but as yet not satisfactorily explained. The hoard was found in December, 1915, in the area of the Mycenaean lower town southeast of the citadel of Tiryns. Karo[1] first thought that it had been buried in Geometric times but later[2] changed his view in favor of burial "before the fall of the Mycenaean culture (vor dem Untergang der mykenischen Kultur)." It is now generally accepted that the objects in the hoard range widely within the Late Helladic period.[3]

We are here concerned only with the gold-and-amber objects. Karo[4] described them as "a pair of curious, wheel-shaped ornaments of goldwire, the spokes of which are set with amber beads." He added that the hoard yielded sufficient additional goldwire and amber beads to account for a second pair, and suggested that they may have served as "Schläfenschmuck" like the wheels covering the ears of the lady of Elche.[5] In his first note, Karo[6] supplied a photograph giving an axial view of one "wheel" containing seven amber beads (now Athens National Museum no. 6217b) and a side view of the other (now Athens National Museum no. 6217a) in which the amber cannot be seen clearly.

In a somewhat later note, Philadelpheus[7] described these objects as "three crowns (διαδήματα) of woven gold wire . . . containing crossed bronze rods in which large, rounded amber pieces are mounted"; he gave the number as three: two virtually intact and one of which only

[1] G. Karo, *AA* 1916, 143–147.
[2] G. Karo, *AthMitt* 55 (1930) 119–140.
[3] H. W. Catling, *ProcPS* 22 (1956) 111.
[4] Karo, *supra* n.1.
[5] P. Paris, *MonPiot* 4 (1897) Plate 13/14.
[6] Karo, *supra* n.1.
[7] A. Philadelpheus, *Deltion* 2 (1917) Suppl., 17.

the amber pieces were found, although he listed two balls of gold wire (now Athens National Museum no. 6218). His illustrations show no. 6217a (with five amber beads) and no. 6217b (with seven amber beads); the third "crown" is represented by seven amber beads mounted on two modern metal rods, but without any gold wire. This is now Athens National Museum no. 6219.

In his full publication of the Tiryns Treasure, Karo[8] included photographs of the intact "crowns" in side views (Beilage xxx A, reproduced as our PLATE 1) and in axial views (Beilage xxxi). He gave

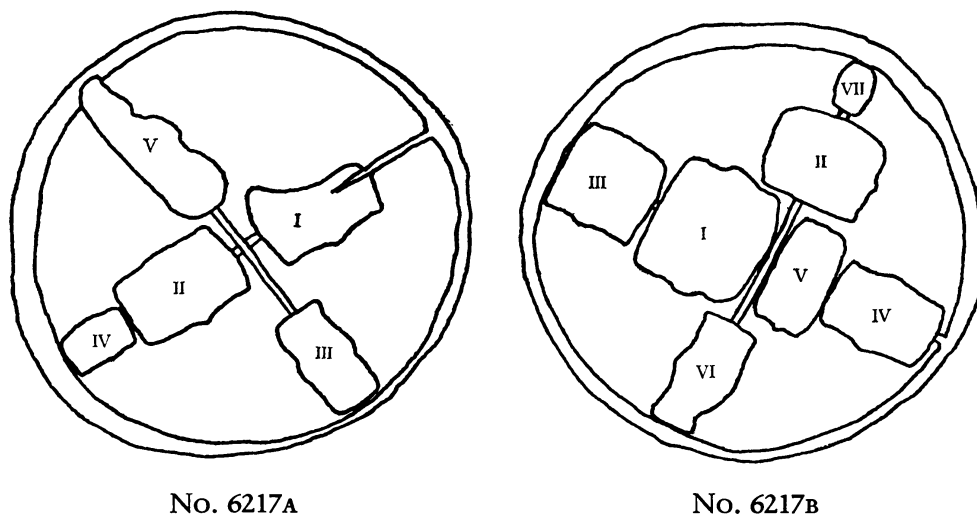No. 6217A   No. 6217B

Figure 1. THE TWO INTACT GOLD-AND-AMBER ORNAMENTS OF THE TIRYNS HOARD

measurements of the amber beads but no designations for them. We have numbered the beads with Roman numerals (in the order in which Karo listed them) as shown in Figure 1 and in Table 1.[9] Karo also illustrated the loose amber pieces mounted on their modern rods (Beilage xxxii); Figure 2 has been traced from his photograph. It shows, as did Philadelpheus' illustration,[10] seven pieces of amber: four mounted on one rod and three on the other. Again we have numbered these with Roman numerals in Figure 2 and in Table 1 in the order in which Karo listed them.

[8] Karo, *supra* n.2.

[9] Karo's and our measurements do not agree exactly in all cases (*cf.* Table 1), but they agree closely enough for identification. We will not claim that our measurements are more accurate than Karo's, although they were taken with slide calipers; many of the amber beads, closely mounted on their bronze rods, are not easily accessible. There may also have been a reduction of size by breakage, or an increase by the application of protective coatings.

[10] Philadelpheus, *supra* n.7.

TABLE 1. DIMENSIONS AND SPECTROSCOPIC CLASSIFICATION OF AMBER BEADS IN TIRYNS HOARD

| Athens National Museum Number | Desig- nation | Maximum Dimensions (mm) | | | | Spectrum Number | Extraneous Absorption | Computer Classifica- tion |
| | | Karo | | Authors | | | | |
		L	D	L	D			
6217	a-i	26	23	28	20.5	782	7.8 μ	Baltic
	a-ii	25	18	28	20	785	7.8 μ (weak)	Baltic
	a-iii	24	15	25.5	15	—		
	a-iv	19	14	18.5	15	809	none	Baltic
	a-v	39	22	42	15	786 and 790	7.8 μ	Baltic
	b-i	26	33	25	33	—		
	b-ii	19	29	19.5	22.5	783	7.8 μ	Baltic
	b-iii	24	24	25	23.5	—		
	b-iv	24	20	24.5	19.5	784	7.8 μ	Baltic
						791	7.25 and 7.8 μ	Baltic
	b-v	12	26	14	28.5	—		
	b-vi	27	17	29	16	808	none	Baltic
	b-vii	11	9	11.5	10	781	7.25 and 7.8 μ	Baltic
6219	i	31	34	31	34	787	7.8 μ	Baltic
						803	none	Baltic
	ii	27	36	29	36.5	799	7.25 and 7.8 μ	Baltic
						804	none	Baltic
	iii	20	37	19.5	36.5	806	7.25 and 7.8 μ	Baltic
	iv	20	31	18	32	807	7.8 μ (weak)	Baltic
	v	17	15	22	15	—		
	vi	21	11	22.5	11	788	7.8 μ (weak)	Baltic
	vii	13	20	no longer in collection				
	—	not listed		13.5	11.5	—		
	unnumbered fragment					805	none	Baltic
	unnumbered fragment					801	7.25 and 7.8 μ	Baltic
	unnumbered fragment					800	none	Baltic

However, we find only six amber beads mounted on the two modern rods in the National Museum, three on each. The seventh bead listed by Karo with a length of 13 mm and a diameter of 20 mm no longer exists. There is an unmounted bead, length 13.5 mm, diameter 11.5 mm, which cannot be Karo's No. 6219-vii and which is so badly weathered that it has been impossible to take a usable sample.

In addition, there were eight fragments which may well be what remains of Karo's No. 6219-VII and of which we have sampled three as shown in Table 1.
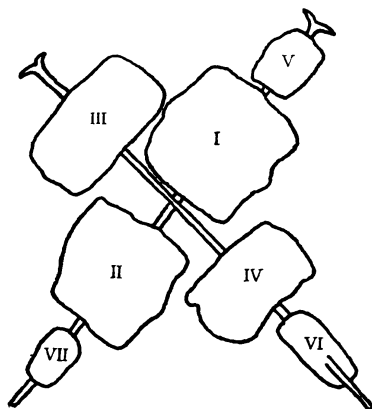
No. 6219

Figure 2. AMBER BEADS FROM THE TIRYNS HOARD MOUNTED ON MODERN RODS

Sample Contamination

We have taken samples of thirteen of the eighteen whole mounted beads and of three of the fragments, for a total of sixteen samples. The sampling, never an easy matter with archaeological amber artifacts, was very much complicated by thick coatings of foreign materials. Doubtless because of their uniqueness, the amber of the Tiryns wheels has received rather more conservation treatment than has been good for it for analytical purposes. One heavy coating, which completely fills many of the cracks and drill holes of some pieces, has a waxy consistency. A sample of it gave the unmistakable infrared spectrum of beeswax.[11] Inquiries at the National Museum yielded no information on this or other treatments; they were evidently made before records of conservation work were kept. A second treatment with a synthetic resin seems to have been made; again there is no record, and the resin now used at the National Museum, a commercial fingernail polish, is not the same as that contaminating the Tiryns amber, as the infrared spectra clearly show.

As had to be expected, these treatments produced extraneous bands in the infrared spectra of the amber. One of these, a band at about

[11] W. Kuhn, *Studies in Conservation* 5 (1960) 74.

7.8 μ (1280 cm^{-1}), due to beeswax, is perilously close to the 8 to 9 μ (1250 to 1110 cm^{-1}) region which we have found to be most useful for the identification of Baltic amber.[12] Where enough sample was available for duplicate tests (samples 6217b-iv, 6219-i, and 6219-ii), the inner surface of the sample chip which ought to be free (or freer) of contamination gave the better spectrum; indeed, in the two latter cases, it gave a perfect one. The second impurity is less prevalent. Five of the nineteen spectra run show a curious sharpening of the
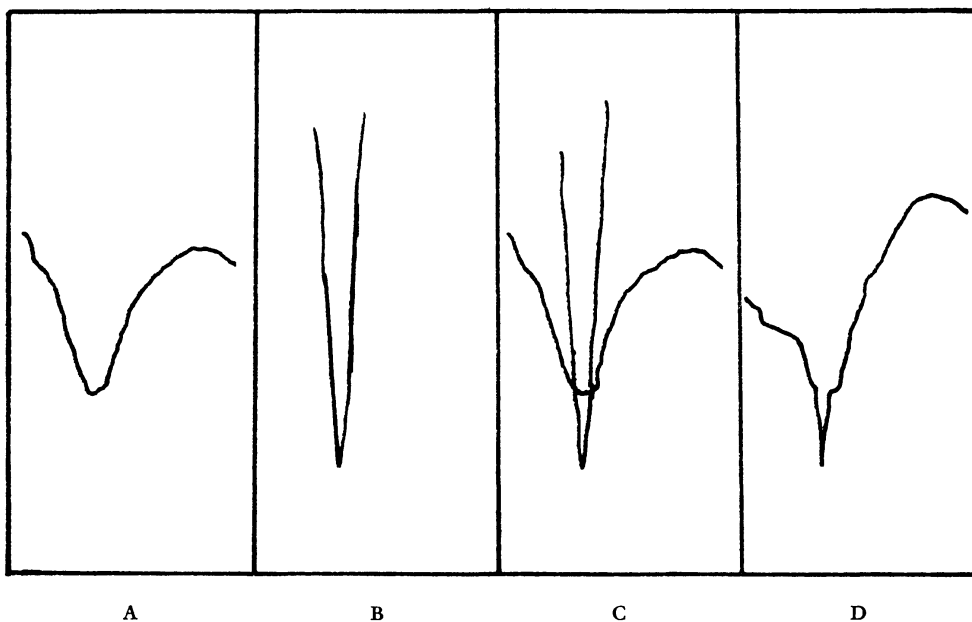

| A | B | C | D |

Figure 3.   EFFECT OF IMPURITIES ON THE 7.25 μ (1380 cm^{-1}) METHYL BAND OF AMBER

A. *Methyl band of amber.* B. *Methyl band of hypothetical synthetic resin.* C. *Superposition of* A *and* B.   D. *Methyl absorption band of contaminated Tiryns amber*

symmetrical methyl absorption at 7.25 μ (1380 cm^{-1}) as shown in Figure 3d. We have found a similar absorption pattern in the spectra of the surface, but not of the interior, of a Near Eastern amber object and we believe that the following considerations offer an explanation for it. Although the complete chemical composition of amber (and of all other fossil resins) is not yet known, all these resins give infrared spectra which leave no doubt that they contain several methyl groups in different molecular environments. Because of these slight differences in environment, the methyl groups absorb infrared radiation

[12] C. W. Beck, *GRBS* 7 (1966) 191–211 and earlier work cited there.

over a range of wavelengths near 7.25μ (1380 cm^{-1}) leading to a typically broad and rounded absorption peak as shown for Baltic amber in Figure 3a. Pure compounds, on the other hand, if they contain only one methyl group per molecule, or if they contain more than one methyl group but in essentially identical environments, show very sharp absorption bands in this region, as in Figure 3b. This is precisely what would be expected from the theory of infrared spectroscopy, since only identically bonded methyl groups will require identical amounts of energy to support the vibrations which cause absorption of infrared light. Now if a sample contained a fossil resin with a broad methyl absorption band and, at the same time, a pure compound with a sharp absorption peak at the same wavelength, but of greater relative intensity, the absorption pattern would be a super-position of Figures 3a and 3b as shown in Figure 3c. This is precisely the shape of the 7.25μ (1380 cm^{-1}) absorption in five of the spectra of the Tiryns amber samples, and we conclude that these samples have been treated with a compound containing a large number of identical methyl groups. This criterion is met by synthetic resins. While it is not possible to identify the contaminant from the sparse spectral evidence, a synthetic lacquer of the vinyl acetate type is a very reasonable possibility.[13] We have tried to remove these impurities with organic solvents in order to gain a "clean" amber sample which would give an infrared spectrum free of all extraneous bands. Amber itself is not completely soluble in any known material.[14] To our disappointment, the contaminants proved to be exceedingly tenacious. Extraction with carbon tetrachloride, petroleum ether and ethyl acetate, in the cold or after boiling for as long as 30 minutes, failed to remove them, although it did reduce the intensity of the absorption bands which we ascribe to them. This in itself is good evidence that these bands are not caused by the amber, and we have therefore interpreted the spectra by ignoring them. As shown in Table 1, eight spectra have the band at 7.8μ (1280 cm^{-1}) which we assign to beeswax; five have both the sharp band at 7.25μ (1380 cm^{-1}), probably due to a synthetic varnish and the 7.8μ (1380 cm^{-1}) band of beeswax; only six spectra are entirely free from extraneous bands.

Because of the problems arising from such impurities we would

[13] Chicago Society for Paint Technology, "Infrared Spectroscopy" (Chicago 1961) Spectrum no. 23.

[14] L. Schmid, "Bernstein," in C. Doelter and H. Leitmeier, *Handbuch der Mineralchemie* IV.3 (Dresden and Leipzig 1931) 892.

like to exhort archaeologists to avoid treating amber artifacts in any manner unless a piece cannot be taken from the site without consolidation. In the very few instances where that is the case, we would recommend purified paraffin wax in preference to beeswax. Paraffin is quite as difficult to remove[15] as beeswax, but it has fewer absorption bands in the infrared because it contains only carbon-carbon and carbon-hydrogen bonds, and these do not absorb infrared radiation in the range of 8 to 9μ (1250 to 1110 cm^{-1}) which we have found most useful for the identification of fossil resins. Synthetic varnishes should be avoided because they are notoriously difficult to remove and because they give complex infrared spectra.

Provenience of the Tiryns Amber

The infrared spectra of the 16 samples listed in Table 1 are shown in Figure 4 over the range of 8 to 9μ (1250 to 1110 cm^{-1}). Where two spectra were made of a given sample, the better one is shown. The slope of the absorption in this range is the most useful criterion for the recognition of Baltic amber. In a well-preserved specimen it has a value of zero between 8.0 and 8.5μ (1250 and 1175 cm^{-1}), i.e. there is a horizontal line or "shoulder";[16] absorption then increases and reaches a maximum value at 8.7μ (1150 cm^{-1}).[17] In archaeological samples this pattern is almost invariably changed in varying degrees by atmospheric oxidation resulting in continuously increasing absorption over the entire range from 8.0 to 8.7μ (1250 to 1150 cm^{-1}).[18] This oxidative effect is most pronounced in spectra 800, 805 (both of sample 6219; unnumbered fragments), 807 (sample 6219-IV) and 808 (sample 6217b-VI). In most samples, however, the horizontal shoulder is well preserved, most markedly so in spectra 804 (sample 6219-II), 782 (sample 6217a-I) and 788 (sample 6219-VI). In those spectra which have a strong extraneous beeswax peak near 7.8μ (1280 cm^{-1}), the slope of the absorption pattern near 8μ (1250 cm^{-1}) is affected with the result that the slope assumes a positive value between 8.0 and 8.2μ (1250 and 1220 cm^{-1}). Spectrum 784 (sample 6217b-IV) is an example.

[15] M. Wheeler, *Archaeology from the Earth* (Penguin 1961) 197.

[16] Beck, *supra* n.12; C. W. Beck *et al.*, "The Infrared Spectra of Amber and the Identification of Baltic Amber," *Archaeometry* 8 (1965) 96–109.

[17] Since infrared spectra are normally plotted with zero absorbence at the top of the scale, a maximum absorption will deflect the recording pen downward so that the curve appears to have a minimum if read from the bottom.

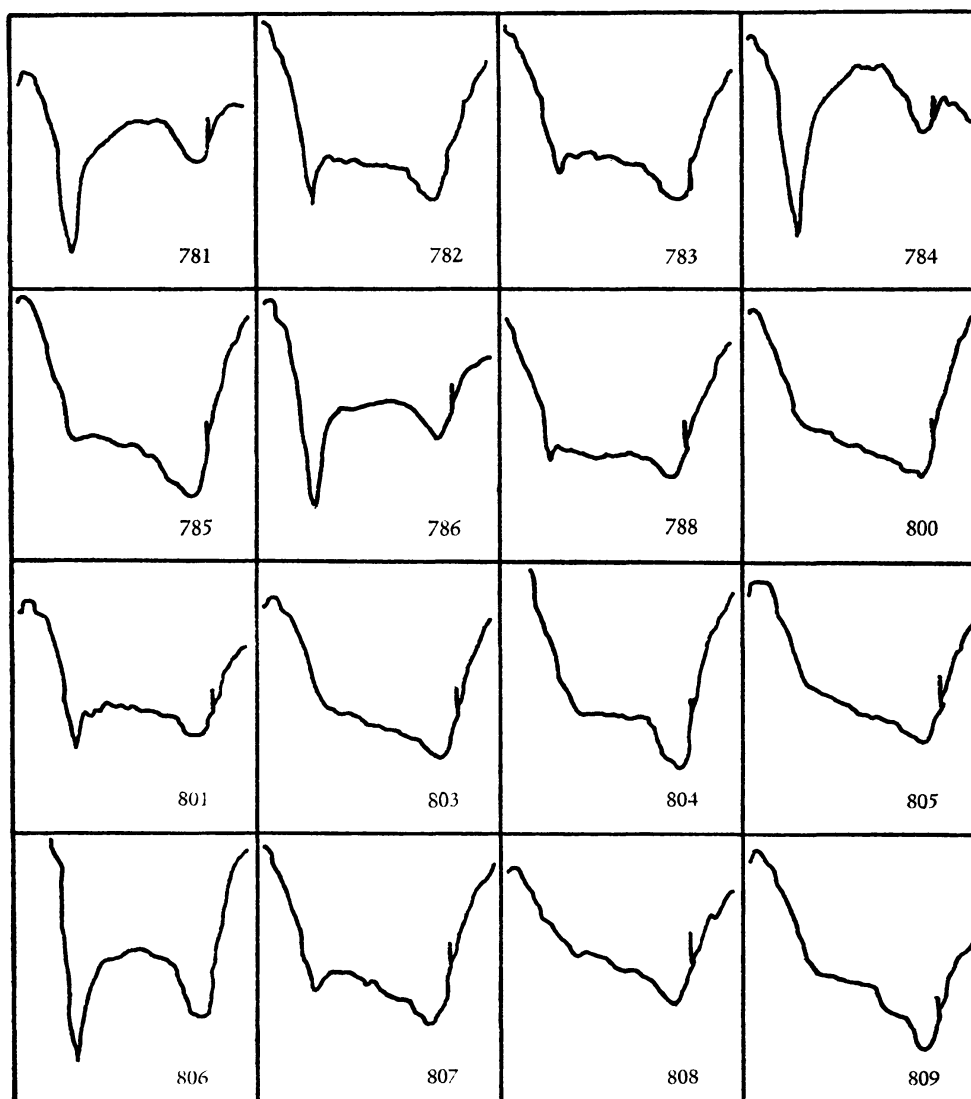[18] Beck, *supra* n.12, figs. 1 and 2.

Figure 4. INFRARED SPECTRA OF THE TIRYNS AMBER FROM 7.5 TO 9 μ (1330 TO 1110 cm⁻¹)

Computer Classification of Amber Spectra

The distinguishing features of the infrared spectra of fossil resins, and especially of archaeological amber artifacts, are subtle; classification more often relies on variations of slope than on the presence or absence of strong, sharp absorption bands. We have been aware that the interpretation of these spectra calls for a practiced eye and we are sensitive to the charge that a practiced eye may be merely a euphemism for a subjective view. In order to reduce the personal element

from the determination of the provenience of amber by infrared spectroscopy, and in order to compare new spectra quickly to well over a thousand reference spectra, we have programmed an IBM 360 Model 30 Computer to analyze and classify the infrared spectra of fossil resins. After trials with a variety of numerical inputs read from the spectral curves, we have found that a rather simple mathematical analysis of the slopes between 8 and 9μ (1250 and 1110 cm^{-1}) serves well to characterize Baltic amber and to distinguish it from all the other fossil resins we have tested so far. This range also gives promise to permit the absolute identification of non-Baltic resins, *e.g.* simetite from Sicily, schraufite from the Bukowina, walchowite from Moravia, etc., but it will require more samples and more work to reach the point where the computer can identify these resins with reasonable certainty. At this time we have only a program which allows the computer to identify all but two of 60 samples of Baltic amber and to reject all but one of the 58 samples of non-Baltic amber which we have tested by using geological samples of known origin.

The program is simple enough.[19] The computer is given intensity readings at 0.1μ intervals between 8.0 and 9.0μ. After standardizing these readings by dividing them by the intensity at 8.0μ, it then computes simplified slopes and their second derivatives over selected 0.1 and 0.2μ intervals.[20] Using a combination of four of these functions as criteria, the computer classified all but three of 118 samples, or 97.5%, accurately as Baltic or non-Baltic.

Since computers, like women, are more widely admired than understood, we hasten to add that we do not see in this approach more than a rapid and convenient way of doing what could be done equally well, though much more laboriously, with pencil and paper. The computer does not select the intensity readings to be used or the functions to be calculated; we selected these as the most useful ones after much trial and error which would not have been practical or economical without using the computer. The program merely compares four functions from one spectrum to four corresponding limits determined by the function values of a large body of spectra of Baltic and non-Baltic amber of known origin. We are satisfied that any sample which agrees in these respects with the substantial number of

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[19] Details of the programming procedure will be published elsewhere.

[20] The term slope is used loosely. The computer actually finds the differences between the standardized intensity values. A slope, *sensu stricto*, is the ratio between two differences on the abscissa and the ordinate.

samples of authentic Baltic amber does in fact come from the area of natural distribution[21] of this species.

By these criteria, the computer classification of all the 19 spectra of the Tiryns amber is that of Baltic amber.

Origin of the Tiryns "Wheels"

Our proper task is the provenience analysis of archaeological amber artifacts. The uniqueness of the Tiryns "wheels" may excuse some additional comments.

Our analyses establish firmly that the amber of these remarkable ornaments is of the Baltic variety. It does not reveal the place where the "wheels," or even the amber pieces in them, were fashioned into their present form. The shape of the amber beads is one of the enigmata which these extraordinary objects present to the archaeologist. Karo[22] described them as having "eine doppelt geschweifte Form, die am ehesten an ein kurzes Stück Rohr mit Knoten erinnert." There are a number of Mycenaean amber beads of the same curious shape. One is Ashmolean Museum no. AE 1515 from the Dictaean (Psychro) cave, which Boardman[23] describes as "barrel-shaped." A second, unregistered bead in the Ashmolean, from the same source, has the same shape, though in a more elongated form. Another was listed by Evans[24] among the trinkets passed with the Thisbê Treasure; the only amber piece from this source now in the Ashmolean Museum has lost all recognizable shape. Evans suggested an LM Ia date for it. The British Museum has two further examples from Tomb 13 at Ialysos on Rhodes (Strong[25] nos. 1b and 1c). The pottery from this tomb is all LH IIIc. Strong calls them "double concave."[26] The island of Kephallenia has yielded a substantial collection, both at Lekkithra[27] and especially at Metaxata.[28] A single example from Salamis, Athens National Museum no. 3589, was described by Wide[29] as a "tubular

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[21] Baltic amber is not limited to the Baltic Sea but occurs widely across northern Europe from England to deep into Russia.

[22] Karo, *supra* n.2.

[23] J. Boardman, *The Cretan Collection in Oxford* (Oxford 1961) no. 352, p.73; fig. 32, p.72; plate xxiii.

[24] A. Evans, "The Ring of Nestor," *JHS* 45 (1925) 2.

[25] D. E. Strong, *Catalogue of the Carved Amber in the Department of Greek and Roman Antiquities* (British Museum, London 1966).

[26] Strong, *supra* n.25, p.39.

[27] S. Marinatos, *ArchEph* 1932, p.42 n.2 and plate 15, A3 and A7.

[28] S. Marinatos, *ArchEph* 1933, pp.92–94 and plate 2.

[29] S. Wide, *AthMitt* 35 (1910) 31.

bead of bone(?)," but Mr Catling in Oxford has examined it and finds it to be amber.[30] Far afield there is a necklace of 18 large, more or less well-preserved beads of this shape from Tomb 31 of the necropolis of Piazza Monfalcone on Lipari, dated to the first phase of the Ausonian II period, or 1150 to 1050 B.C.[31] They have been described as "of a shape which sometimes recalls that of astragaloi."[32] Perhaps there are others. It may be significant that no beads of this shape seem to be known in any material other than amber.

It is also notable that all the beads of this type which can be dated fall within a narrow range of time near 1200 B.C. Evans LM Ia date is not well founded; the Thisbê trinkets are now considered to span the range of LH I to LH III.

There is obviously no consensus about their shape. From the published illustrations and from direct examination we have no doubt that an organic, not a geometric, representation was intended: the cross-section of the beads is almost invariably elliptical rather than circular, the ends are usually not parallel, and the central ridge is not placed by any considerations of symmetry. Though we cannot quite follow Brea and Cavalier[33] in seeing these beads as *astragaloi*, they do resemble bones more than anything else that comes readily to mind. If they are bones they might, like *astragaloi*, be good luck symbols or they might have a more specific and religious significance as the remnants of sacrificial animals.

The technique of the gold wire work of the Tiryns "wheels" is unique in Mycenaean archaeology.[34] A length of gold wire, of circular cross section and 1 mm diameter, has been doubled back upon itself and coiled ten or eleven times into a circle which thus has 20 to 22 horizontal turns of wire. These are connected by half-round gold wires which form alternately vertical lines and rhomboid patterns. The half-round wire is wrapped once around each turn of the horizontal wire in passing; in the vertical connections the direction of these turns is the reverse of that in the rhomboid ones (Figure 5). Karo[35] called the technique "in imitation of weaving (der Weberei

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[30] H. W. Catling, by personal communication.
[31] L. Bernabò Brea and M. Cavalier, *Meligunis-Lipára* I (Palermo 1960) 119 and plate XLIII-1.
[32] Brea and Cavalier, *supra* n.27, p.149.
[33] Brea and Cavalier, *supra* n.27, p.149.
[34] Karo, *supra* n.2.
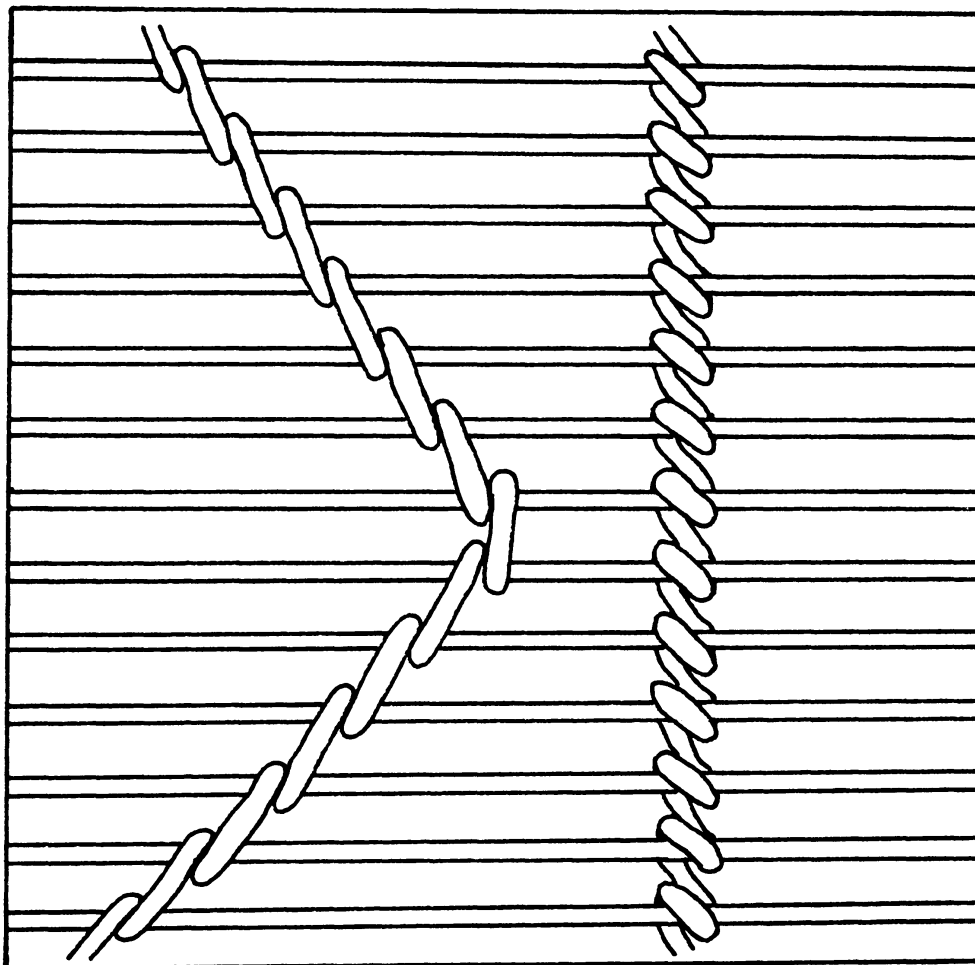[35] Karo, *supra* n.2.

Figure 5. WRAPPING OF RHOMBOID AND VERTICAL CROSS-WIRES IN THE GOLD-
AND-AMBER ORNAMENTS OF THE TIRYNS HOARD

nachgebildet)"; Marinatos[36] refers to it as "plaited (geflochten)." In weaving it is known as the wrapped or Soumak pattern;[37] in basketry it is one of the coiled-work methods called bee skep.[38] That the objects imitate basketry is also suggested by the combination of rounds (called rods or sticks in basket weaving) with half-rounds for cross-ties (called skeins in basket weaving and made by splitting young growths longitudinally). Surely the goldsmith had a reason for going

[36] S. Marinatos, "Lausitzer Goldschmuck in Tiryns," *Deutsche Beiträge zur Altertums-wissenschaft* 12/13 (1960) 151–157.

[37] H. Hodges, *Artifacts* (New York and London 1964) 143, fig. 36-3.

[38] R. J. Forbes, *Studies in Ancient Technology* IV (Leiden 1956) 174 fig. 18; 186 fig. 26. Both the word (which means bee hive) and the technique are held to be of Scottish origin.
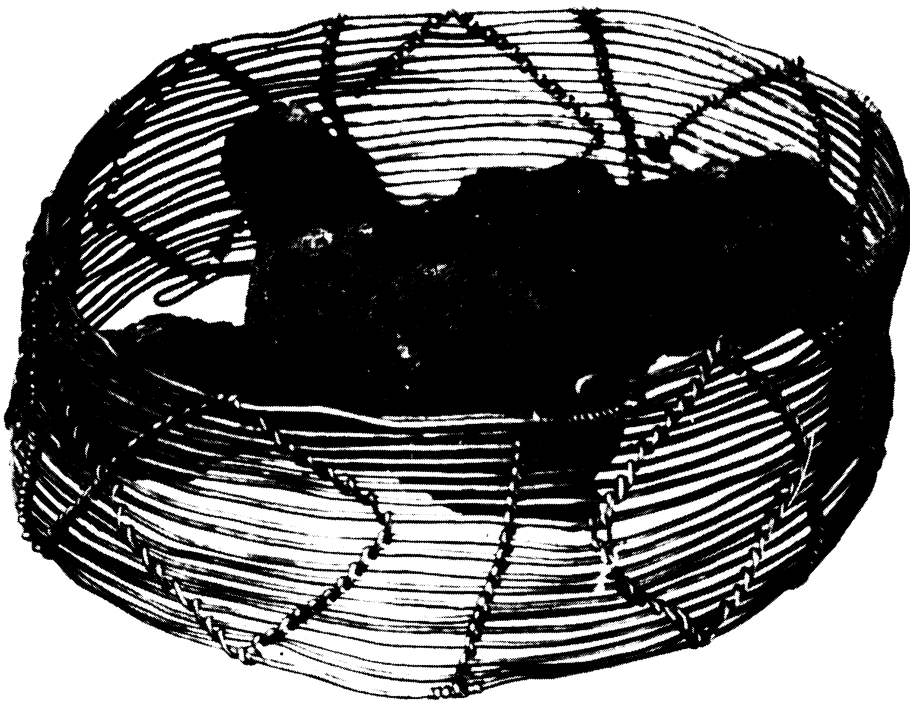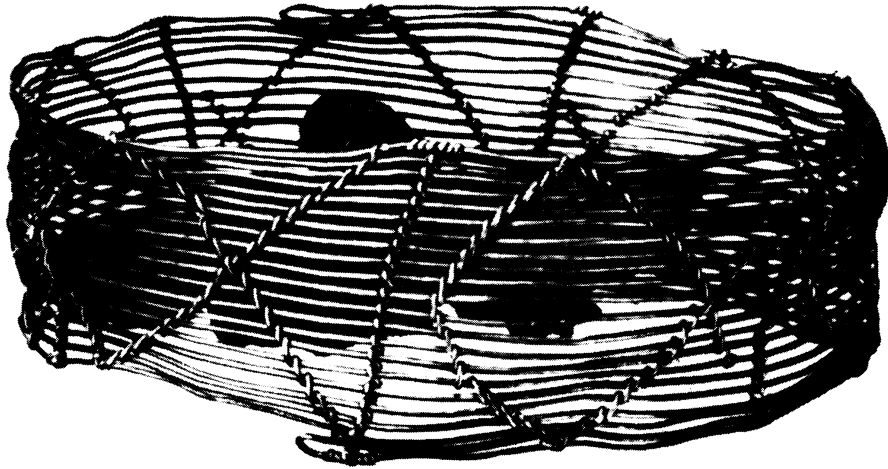
Gold-and-Amber Ornaments from the Tiryns Hoard
Athens National Museum nos. 6217A (*upper*) and 6217B (*lower*)

to the considerable trouble of shaping the gold wire for the vertical connections into a semi-circular cross section.

Philadelpheus' appellation "crowns"[39] never sat well with the Tiryns ornaments. Karo's[40] name "wheels" was obviously suggested by the cross rods which he thought of as spokes, but the fragility of the "wheels" and the absence of any hub or other means to connect them to an axle speak against the idea. Were they, then, perhaps baskets? They have of course no bottoms, and therefore anything represented as resting in them would have to be held in place in some inconspicuous manner, as the slender metal rods do hold the large amber pieces. But why amber in baskets? The amber, as we now know with certainty, is an import from the north; amber is not only sacred to Apollo, the Celts held it to be the tears which Apollo wept when he was banished to the land of the Hyperboreans.[41] That amber was among the gifts sent by the Hyperboreans to Delian Apollo was first suggested by Welcker,[42] and after reviewing the evidence in some detail, Cook[43] has concluded not only that both the Western[44] and the Eastern[45] routes of the Hyperboreans coincide with established amber routes, but that "the cult of Apollon came into Greece along the older (*i.e.* Western) Amber Route from the lands of the Hyperboreans, which is best located near the source of the Danube."

If amber was among the Hyperborean gifts, then it was wrapped in wheaten straw,[46] and if the Tiryns ornaments are cult representations of these sacred gifts to Apollo, then the gold wire baskets will be imitations of straw baskets of Celtic design. And the amber pieces which seem to resemble bones? Who would not think of the "famous hecatombs of asses" which Perseus found the Hyperboreans sacrificing to Apollo?[47]

Seltman's argument[48] that the Hyperboreans were not Barbarians but early Greek colonists in the upper Danube region is not relevant to Welcker's hypothesis concerning the congruence of the route of the

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[39] Philadelpheus, *supra* n.7.
[40] Karo, *supra* n.2.
[41] Apollonius Rhodius, *Argonautica* 4.609–610.
[42] F. G. Welcker, *Griechische Götterlehre* II (Göttingen 1860) 353ff.
[43] A. B. Cook, *Zeus* II (Cambridge 1925) 497–499 and plate xxvi.
[44] Hdt. 4.33.
[45] Paus. 1.31.2.
[46] Hdt., *supra* n.44.
[47] Pindar, *Pyth.* 10.32–34.
[48] C. T. Seltman, *CQ* 22 (1928) 155–159.

Hyperborean offerings with the amber routes, and his claim that "this hypothesis receives no support from the exhaustive researches of J. M. de Navarro" is unfounded. First, as far as the route described by Herodotus can be fixed geographically, it is as compatible with the "western" amber route of Cook[49] as it is with the "eastern" amber route of de Navarro,[50] since both approach the head of the Adriatic from a northeasterly direction. Second, de Navarro does not deal with later amber routes which may have connected the Vistula with the Dniester to the Black Sea; hence he has nothing to say about the reality of the Pausanian route for the Hyperborean offerings.

The fact that the Tiryns crowns can now be dated, from the shape of the amber beads, close to 1100 B.C. adds further support to the congruence of the Hyperborean route with de Navarro's Adriatic amber route which opened in the Early Iron Age. De Navarro's contribution to our knowledge of this route lies not only in having fixed its *terminus post quem* but in having shown that it emanated from the Eastern Baltic rather than from Jutland as had been thought before.

At the same time it is now clear that this route cannot have been responsible for the earlier Mycenaean amber artifacts which will form the subject of subsequent reports in this series.

Our interpretation will quickly find its critics. They must take into account another bit of evidence which points to the north: Marinatos[51] has pointed out the close similarity of the plaiting technique of the Tiryns objects with the "eight-shaped" gold wire ornaments which were found at Cernilov near Hradec Králové in Bohemia and which are now in the National Museum in Prague.[52] The Czech ornaments belong to the Lusatian culture, which is assigned to the transition from the second to the first millennium B.C. Neither a stylistic relationship to Celtic basketry nor to Lusatian jewelry need imply that the Tiryns ornaments were made outside Greece. That might best be decided by a technical study of the gold itself, for which Marinatos[53] has rightly called. We have been fortunate enough to obtain an analysis of the gold of the Tiryns objects from Dr Axel Hartmann of the Arbeitsgemeinschaft für Metallurgie am Württembergischen Landesmuseum, Stuttgart, who is engaged in a comprehensive study of the

[49] A. B. Cook, *supra* n.43.
[50] J. M. de Navarro, *GeogrJ* 66 (1925) 481–507.
[51] Marinatos, *supra* n.36.
[52] Anon., *The Prehistory of Czechoslovakia* (Prague 1958) plate XVII.
[53] Marinatos, *supra* n.36.

impurity patterns of archaeological gold. By kind permission of Dr Hartmann,[54] we append his analysis of the Tiryns gold in Table 3.

TABLE 3. ANALYSIS OF THE GOLD WIRE FROM THE TIRYNS GOLD-AND-AMBER OBJECTS[55]

Element	Per cent
Silver	11.0
Copper	2.9
Platinum	.043
Lead	less than 0.03
Tin	0.024
Nickel	less than 0.01
Bismuth	less than 0.01

The German group has not yet analyzed a sufficient number of gold objects from the Lusatian or from the Mediterranean areas to place the Tiryns gold firmly. Dr Hartmann points to the high platinum content as an unusual feature which may permit assignment of the provenience of this gold when enough comparative material is available. Thus there is hope that another aspect of archaeological chemistry will soon contribute to the solution of the enigma of these unique objects.

VASSAR COLLEGE
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[54] A. Hartmann, by private communication.
[55] The silver content is given in weight per cent of the alloy; all other values are weight per cent relative to gold = 100.