the hill. The area is continually grazed by sheep and cattle so that the soil deposit is gradually being eroded away to expose the underlying consolidated sediments. The artifacts are left resting upon the hard surface underlying the site. According to Graffham, much of the site has already eroded away although the highest section of the hilltop is still covered by the soil mantle. The soil layer varies from perhaps 6 inches to 2 feet in thickness, depending upon the slope and amount of erosion, and extends over an area approximately 50 feet wide by 150 to 200 feet long. Although the artifacts were obviously coming from the soil layer, no digging or test excavations were undertaken. Graffham reports the complete absence of pottery or animal bones at the site, although some darker colored areas may represent hearths or concentrations of occupational debris. The bones of mammoth, horse, camel, and sloth are to be found in the vicinity of Chicha canyon but no established artifact associations were found by Graffham. A number of localities, however, were not investigated.

The best specimens from the site are illustrated in Figures 1–3. Almost all of the artifacts are made of obsidian, although specimens of dark colored flint and basalt are represented. Scrapers are the most common artifact; many of the projectile points are broken. The general assemblage suggests that the site marks a camp area rather than a "kill site." The presence of different projectile point types hints that two occupations may be represented. The most interesting specimens are the fluted points, represented chiefly by bases, broken or reworked examples. Although fluted, the points differ from classic Folsom or Clovis types, suggesting a distinctive South American form. The total assemblage suggests an early paleo-Indian tradition in South America, but will require further study and excavation to properly evaluate its role in South American prehistory.

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ABORIGINAL GILDING IN PANAMA

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ABSTRACT

Lothrop places on record the original study of the "mise en coleur" gilding of Coclé objects which Bergsøe had completed in 1940. The Coclé specimens were made of a copper-gold alloy with low gold content, and were cast in molds. Because such an alloy corrodes easily, the exact composition of the Coclé alloy could not be determined. The Coclé goldsmiths did not use the hammered overlay, mercury gilding, or leaf gilding processes, but rather the "mise en coleur" process in which the copper is removed from the surface of the alloy leaving a blackish-brown, spongy gold deposit as an overlay. This spongy overlay is compressed and returned to a golden color by hammering and burnishing. The surface copper was probably dissolved by ammonium carbonate derived from urine.

IN COPENHAGEN August, 1938, I had the pleasure of meeting Paul Bergsøe who had recently published the results of his studies on the aboriginal gilding of Ecuador (Bergsøe 1938). He expressed interest in metalwork from Sitio Conte, Province of Coclé, Panama, which had been published by the Peabody Museum, Harvard University (Lothrop 1937). As a result, some time later, we sent Bergsøe 27 samples of Coclé gilding, to be examined by the technical methods he had previously developed. On January 9, 1940, Bergsøe sent us the report printed below. I immediately wrote that we would like to publish his observations as well as the detailed analyses of the individual samples. My letter probably reached Copenhagen on the day of the German occupation. After the war, Bergsøe wrote that he had received it and had mailed the analyses. They evidently did not pass the censorship or were lost at sea, for they never reached this country.

Bergsøe's manuscript recently turned up in the files. In spite of the lapse of time, his observations have not

(*continued from preceding page*)

ing along sides and base; *b*, base of fluted point, fluted on both faces, ground on both sides, slight basal grinding; *c*, base of fluted point, fluted on both faces, some secondary chipping along base after removal of flutes, slight grinding on sides and base; *d*, base of fluted point, fluted on one face only, ground along sides and base; *e*, projectile point base, not fluted, appears to have been made from flat flake, slight grinding on sides; *f*, base of fluted point, fluted on one side only, reverse face seems to be flat surface of a flake, secondary chipping across base after flute was removed, slight grinding on sides and base; *g*, base of fluted point, fluted on both faces and showing remnant of striking platform, in removal of flute on reverse, flake hinged off and spoiled specimen, obviously broken in manufacture, no grinding; *h*, base of fluted point, fluted on one side only, not ground; *i*, base of fluted point, fluted on both faces, left tang damaged, ground on sides and base; *j*, base of fluted point, fluted on both faces, but flutes not much longer than stem, ground on sides and base of stem; *k*, projectile point base, two flutes removed from one face, no grinding; *l*, projectile point base, not fluted, grinding along sides and base; *m*, projectile point with attempted fluting on both faces, appears to be a resharpened example made from a broken specimen similar to *j*, slight grinding on sides, right tang slightly broken; *n*, projectile point with flute on one face, reverse flat from original flake, blade apparently resharpened from broken specimen, sides of stem ground, black flint; *o*, projectile point base, thinned with three or four flakes, grinding on sides and base; *p*, projectile point base, not fluted, but thinned with four or five parallel flakes, slight grinding on sides; *q*, base of projectile point or knife, not fluted, not ground; *r*, projectile point base, not fluted, grinding along edges of stem; *s*, projectile point, not fluted, slight grinding on edges of stem; *t*, projectile point or knife, not fluted, not ground, point broken; *u*, base of projectile point, not fluted, slight grinding on right side of stem. Scale: 5 cm.

been superseded by subsequent research. Even without the analyses on which they were based, they give a new insight into aboriginal metallurgy. The Peabody Museum has a record of the catalogue numbers and grave associations of the specimens analyzed. This list is of value now only because it indicated that the metal specimens were representative and reflected the entire ceramic sequence which was later established for stratified Sitio Conte graves. Although changes in type and style of gold jewelry took place during about 1000 years, the gilding techniques apparently remained unchanged.

Report on Coclé Metallurgical Investigations

Paul Bergsøe

My first task was to investigate what technical resemblance, if any, existed between the material from the Coclé finds (Lothrop 1937) and the well-known gold objects from Esmeraldas, Ecuador, which I examined and classified (Bergsøe 1938), a large number of which have subsequently been housed in the National Museum at Copenhagen. Technically speaking, it is practically impossible to find any points of similarity.

All the gold objects from La Tolita and Atacames in Ecuador were hammered; not one single molded object was discovered. The technique consisted in the melting of native gold to form an ingot by means of charcoal and blow-pipe and subsequent hammering into shape. Coclé, on the contrary, shows us molded objects, in which the technique may be said to have attained a very high standard. In other words, the natives must have been acquainted with the use of crucibles and with the construction of molds and cores. As regards Esmeraldas, it is remarkable that all the objects should be so inconceivably small and thin; they are almost certainly the finest and smallest gold objects ever found in America, and it appears as though gold could only be procured in small quantities. To make up for this, however, the Esmeraldas natives would seem to have been endowed with great dexterity and skill, and their use of platinum for plating gold bears witness to a very highly developed technique in this respect. The Coclé natives do not appear to have been acquainted with platinum plating, if we may judge by the fact that no platinum-plated objects have been discovered among them.

Both peoples were acquainted with gilding, but the characteristic gilding method employed in Ecuador — I have called it "fusion gilding" — was not demonstrable on any single one of the many gilded objects from Coclé that I have examined. The method was undoubtedly unknown there. The gilded copper objects found in Coclé show precisely the same high degree of corrosion as the corresponding objects from Ecuador. Corrosion is due to the same cause: a gold content in the copper core. This creates a local difference in potential between the copper and gold, which becomes disintegrated in small particles. In the presence of moisture, the copper will oxidize, and in the presence of carbonic acid the usual products of oxidation will be formed which, however, are black on account of the separated gold. The process has been described (Bergsøe 1938: 10).

Gold is, as we know, a metal completely exempt from corrosion, even when the copper content is relatively high. Copper itself is also astonishingly resistent to corrosion, especially in the pure state; a number of the copper articles found in Ecuador, which are made from practically speaking pure native copper, were not even green. But in the case of alloys of gold and copper with a high copper but low gold content (0.5 to 20%) the case becomes quite different, these alloys being extremely subject to corrosion. The heavy corrosion of these alloys makes it impossible for us to determine by means of chemical or spectroscopical tests the original composition of the corroded material, especially the quantitative relations of gold and copper, for it must be regarded as a certainty that some part of the copper has been dissolved and washed away by the action of water containing carbonic acid. The gold content will thus always be too high.

In Esmeraldas, Ecuador, gilding was performed by overlaying the copper with a melted copper alloy (about 20% copper) which fuses at a temperature 200°C lower than the melting point of copper. After cooling, this overlay was smoothed out by hammering, but it was impossible to avoid the formation of tiny rifts where corrosion could set in and continue its action, because the gold was in constant intimate connection with the copper which, in addition, itself had received a slight gold content, the gold having penetrated into the core during the process of gilding. The final result was that the gilding became loosened from its base; large quantities of these gold scales have been found.

Gilding in Coclé was not carried out in the above manner. The gold overlay does not contain as much copper as it should if "fusion gilding" had been employed. Neither was gilding accomplished by means of mercury. I have expressed my doubts as regards both mercury-gilding and mercury-soldering in America (Bergsøe 1938: 51), in spite of the fact that the theory has found many adherents. I now consider myself in a position to prove that none of the objects sent to me were mercury-gilded.

Samples of the gilding were taken from every object. The test pieces were cleaned, boiled in dilute nitric acid, and then used as electrodes for the spark for a spectroscopical analysis. In no single case was it possible to demonstrate the presence of remnants of the mercury which otherwise must have been present. Even the presence of such an infinitesimal quantity as 1 to 1,000,000 parts would have been identified.

Counter tests were made in the following way. A copper strip was mercury-gilded and then heated until not only had the mercury evaporated, but even the gold had diffused into the copper. Nevertheless, a spectroscopical examination of the copper revealed an amount of mercury present corresponding roughly to 1000 times more than the demonstrable minimum.

Residues of mercury cannot disappear in the course of years. From the National Museum in Copenhagen I received two pieces of gilded copper, the one dating undoubtedly from A.D. 1138, the other dating about A.D. 1200. The first was leaf-gilded, and after the removal of the overlay, it was seen that the copper had been completely protected from corrosion. The other piece was assumed to have been mercury-gilded, for the gold was inseparable from the core; neither were there any signs of corrosion in this case. It was spectroscoped and showed such evident traces of mercury as to leave no doubt that mercury residues cannot "evaporate" from the gold, even after the lapse of thousands of years. Consequently I consider that the objects from Coclé were not mercury-gilded, and I am still of the opinion that, if mercury-gilding or silvering has been employed anywhere in America, mercury must be demonstrable in the overlay to an extent of 0.01%.

How, then, was the gilding of the Coclé material carried out? There seems to be no doubt that some of the objects were leaf-gilded, as the investigations previously carried out in America also showed. It might be appropriate to point out that this manner of leaf-gilding must not be compared with modern leaf-gilding, where gold-leaf, which the finest technique enables us to hammer out into inconceivably thin sheets, is caused to adhere by means of some adhesive. In those days it was quite impossible to hammer out gold sheets of such extreme thinness.

There are also found in the Old World specimens of gold-leaf gilding where the gold-leaf was applied by means of heat to the carefully cleansed copper core. Gilding of this kind may serve as an excellent protection to the underlying copper if it adheres firmly and closely enough to prevent the ingress of atmosphere and moisture between the leaf and the underlying surface. This, however, does not clear up the problem of how the Coclé objects were gilded. In the case of many of them it is obvious that leaf-gilding has not or simply could not have been the method employed.

"Mise en coleur" is not gilding in the true sense of the word, but is rather a coloration produced by removing the copper from the surface. The gold overlay which thus appears is derived from the gold content of the object itself. It appears probable to me that the quite thin gold overlay found on several of the Coclé objects was derived from treatment of this kind.

I carried out certain experiments which showed me that it was possible to "collect" the gold to form an overlay even in cases where the copper did not contain more than a small percentage of gold. This cannot be accomplished by oxidizing the copper by means of heat and then dissolving the copper oxide in an acid. If the attempt is made, the result is negative, for, even supposing that one can procure a gold overlay from a copper-gold alloy so poor in gold, the overlay will not adhere firmly. If, on the other hand, copper with a gold content of 5 to 20% be laid in a solution of ammonium carbonate and allowed to stand for a few days where air can reach it, the copper will be dissolved superficially and the gold will appear as a blackish brown, spongy overlay, which adheres fairly firmly to the copper. This gold sponge can be compressed by careful hammering and burnishing. In this way it is possible to produce a thin gold overlay on copper containing but a very small percentage of gold. It is quite thinkable that such a method was used, in which case urine was employed as a source of ammonium carbonate.

All primitive people used urine, especially for cleansing purposes. It is this very content of acid ammonium carbonate which determines its use. The use of urine in the treatment of gold has been suggested again and again in olden times, probably owing to the color. The most recent "recipe" known to me containing urine dates from 1804. Whether or not the gilding upon the Coclé objects was produced in this way it is, of course, impossible to prove. Nothing definite can be said regarding material so heavily attacked by corrosion, and the answer to the problem will probably never be given. But this method of gilding is perfectly conceivable. Possibility assumes the aspect of probability when we consider that the underlying metal really consists of a gold-copper alloy made up of a great deal of copper and very little gold, and that the gold overlay is as thin as it really is.

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Peabody Museum
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EXPERIMENTS IN THE USE OF ATLATL WEIGHTS

Orville H. Peets

Abstract

Evidence is supplied that the weights often attached to atlatls do not add to the force of the dart. An experiment was made with a copy of the atlatl with stone weight from Baylor Rock Shelter and cast with and without the weight showed no significant difference. It is proposed that the purpose of the weights was to secure balance on the hand of the atlatl-dart combination. The superiority of the harpoon over the arrow in carrying a line is given as explanation of overlapping of relics of bow and atlatl along water courses.

THE ASSUMPTION is commonly made that the stone weight on the atlatl adds force to the cast of the dart. No actual experiments have been published that prove this to be true. The experiment described here seems to prove that it is not true and that the search for the real