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Maria Guerra

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ETRUSCAN GOLD JEWELLERY: GENUINE, RESTORED OR PASTICHE?

MARIA FILOMENA GUERRA

Centre de Recherche et de Restauration des Musées de France. UMR 171 CNRS, Palais du Louvre.
Porte des Lions. 14, quai François Mitterrand. 75001 Paris, France.

ABSTRACT

Non-destructive elemental analysis and examination provide paramount information for authentication of gold jewellery items kept in museum collections with no reference documents. A small group of Etruscan objects in the Campana's collection (assembled in the 19th century) were studied by optical microscopy, SEM, X-radiography and PIXE, in order to establish criteria for the discrimination of genuine objects, pastiches and modern restorations. We could show that: the morphology of wires and granules from ornamental patterns added to enhance the objects separate in some cases modern from ancient parts; the composition of the alloys showed in other cases the different steps of construction of an object.

Key words: gold, jewellery, Etruscan, authentication, analysis, PIXE, radiography, SEM.

INTRODUCTION

The increasing attention given in the 19th century to archaeological objects from ancient civilisations amplified the production of fakes and consequently their number in private collections and museum collections. The exhibition and trade of objects that suffered from burial conditions was not attractive. For this reason, the production of pastiches and of heavily restored objects was promoted. The absence of documents on the archaeological contexts of the finds, on the origin and acquisition of the objects, and on the restorations carried out, contributed to the loss of a large part of the information on the way the objects were made, used, and traded in the past.

Among those civilisations, the Etruscan – which were rather unknown in the 19th century to connoisseurs and scholars – quickly became very much attractive to collectors, particularly after the finds in the Cerveteri (the tomb Regolini-Galassi was found in 1836). Along with the archaeological finds from the Italian excavations, many forged and heavily restored productions, based on a partial knowledge of the art of the Etruscans, entered the collections. The most renowned objects are the Pasinati cista, attributed to Francesco Martinetti, the sarcophagus of the British Museum, made by Pietro and Enrico Pennelli (Williams, 1992), the Diana of the Art Museum of St. Louis, made by Alceo Dossena (Fleming *et al.* 1971), and the colossal warriors of Orvieto of the Metropolitan Museum of Art, made by Pio and Alfonso Riccardo and by Alfredo Adolfo Fioravanti (Duchêne, 2006).

Some of the forgers were in fact restorers: the Pennelli brothers worked in the Campana's workshops. The objects arriving in the Campana's collection were cleaned and sometimes enhanced by additions by restorers who worked "like forgers" (Reinach, 1904, 1905). The Marquis Giovanni Pietro Campana di Cavelli (1808-1880), who had an unlimited passion for archaeology and antiquities, assembled about fifteen thousand paintings, ceramics, sculptures, jewellery items, wall-paintings, etc. (Sarti, 2001) among which a large number of items attributed to the Etruscans. Found in several excavations in Etruria and in the Latium, but also purchased in the antiquities market, the objects belonging to the Campana's collection vary from genuine pieces to fantasist fakes and pastiches (Borrelli, 1992).

After the acquisition by Napoleon III in 1861 of a large part of the Campana's collection, the gold jewellery items are kept at the Louvre Museum (Gaultier & Metzger, 2006). We must however remember that the intricate elaboration and decoration techniques used by the Etruscan goldsmith (Cristofani & Martelli, 2000) fascinated craftsmen such as the Castellani, a family of Italian goldsmiths and merchants who reproduced and restored several of those items (Donati, 2004). The copies are nowadays kept in the museum of Villa Giulia (Sgubini, 2000) and were the base of the archaeological-style jewellery very much in fashion in the 19th century (Rudoe, 1986). If some pieces of the Campana's collection of jewellery are clear pastiches and fakes – the Castellani's workshop "was used on occasion either to forge or to garnish and embellish works purchased" (Bury, 1975) – others could

not till now be classified by unequivocal factors due to the rarity of the objects and the difficulties connected to the short knowledge of the Etruscan goldsmith techniques. The aim of this work is to show the contribution of scientific techniques to the authentication of Etruscan gold jewellery through the study of a few items belonging to the Campana's collection.

ETRUSCAN JEWELLERY: IS IT A FAKE?

Etruscan jewellery is very much renowned by the quality of, among others, the filigree and granulation patterns, which were quite difficult to imitate by the modern mechanised techniques used in the 19th century (Hoffmann, 1969). The production of wires and granules by the Etruscans has been under discussion along with the welding techniques by scholars who often expressed divergent hypothesis. It is generally assumed that —even if some authors expressed their doubts on this (Carroll, 1972)— drawn wires, with parallel striations (certainly produced after the 5th century AD, Oddy, 1977), are modern productions whilst plain hammered and twisted wires are ancient (Formigli, 1979; Hoffmann, 1969), identified in many pieces of jewellery (Nicolini, 2000). Etruscan granulation is difficult to classify (Carroll, 1974), but accurate observation of several items produced around the 6th century BC shows that granules attain a diameter of about 120µm in the case of dust granulation, giving a “rough” aspect to the gold surface, to reach for plain and hollow granules several millimetres (Guerra, 2007). The production and welding techniques of granulation patterns gave also rise to many debates and propositions (Carroll, 1974; Parrini *et al.*, 1982). It is generally assumed that in modern joining the decorations are “flooded” with solder (Hoffmann, 1969) while Etruscan granulation and wires seem often joined by copper salts (Mello *et al.*, 1983), technique described by Pliny, Theophilus and Cellini (Wolters, 1981). Forgeries are said to have, in addition to granules “half imbedded in solder” and to the bad conception of the granulation patterns, a lack of “snap and vigour” (Curtis, 1914).

The identification of Etruscan pastiches and forgeries were in a very few cases based on the study of the wire and granulation making (Formigli, 1993) and complemented by the determination of the item construction and the alloy composition. In spite of the analytical efforts, the Praeneste “sanguisuga” type fibula remained difficult to authenticate. Identified as a fake by some authors (Gordon, 1982; Guarducci, 1980), because the history of its acquisition and its analytical and technical studies lead to a fake by Francesco Martinetti (the author of the forged Pasinati cista), this item was considered as genuine, but heavily restored and manipulated by others (Formigli, 1992). In this work, we present a few successful studies by using the combination of several scientific methods.

SCIENTIFIC METHODS

According to the queries and the type of objects, different methods of examination and analysis are available for the study of cultural heritage objects (Regert *et al.*, 2006). For jewellery items, the most important requirement is the non-destructiveness of the methods (Guerra, 2005). In order to obtain information on the construction of an object, scientific methods are coupled with goldsmith techniques knowledge and examination finds its major role (Perea, 1989; Armbruster & Guerra, 2003).

Examination of the objects under different lights and radiations was here restricted to binocular observation under direct and grazing natural light at different magnifications, X-radiography, and, for objects that can be contained in the chamber (figure 1), scanning electron microscopy (SEM). Optical microscopy shows the details and defects present on the surface of the object and gives information on the topography and texture of the surfaces, on the mounting and joining techniques, etc.; SEM supplies equivalent details but also provides information on the chemical phases. When coupled to an energy dispersive X-ray detection system, SEM-EDS provides images together with elemental analysis and chemical maps. X-radiography detects in the case of jewellery the invisible details of the constructions, some manufacture techniques, and the possible repairs made during the life of the object.

Elemental, isotopic and structural analysis of jewellery items provides information on the nature of the materials, on some manufacturing techniques, on the possible products from the deterioration of the materials, and on the provenance of the raw materials (Guerra & Calligaro, 2003). The non-destructiveness requirement usually leads to the use of elemental analysis that can be carried out by a very large number of methods from particles accelerators to small portable XRF systems or by SEM-EDS (Tsuji *et al.*, 2004, Uda *et al.*, 2005). According to the sensitivity of the method, elemental analysis provides information either on the nature of the material or, by measuring trace elements, on the provenance of the raw material (Guerra *et al.*, 2007). Elemental analysis was carried out in this work by PIXE (particle induced X-ray emission) with a 3MeV external proton beam of 30µm diameter and an intensity of 30-40nA. Two Si(Li) detectors collected the emitted X-rays, one with a 75µm filter of Cu to absorb the gold L-lines, measures minor and trace elements (Guerra, 2004).

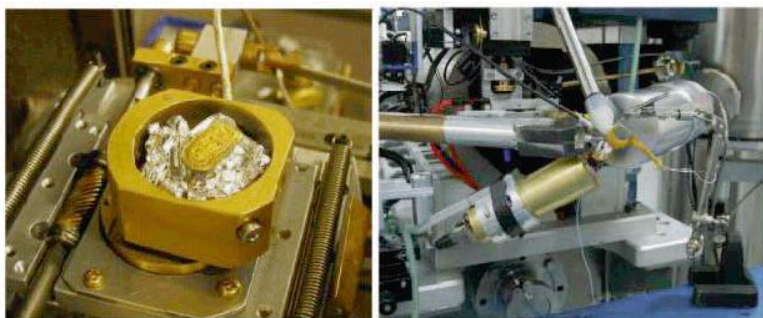


Figure 1. (a) Cartouche finger-ring in the sample-holder of the SEM; (b) fibula during PIXE analysis at AGLAE (© M.F. Guerra, C2RMF)

SMALL RESTORATIONS AND “MISAPPROPRIATIONS”

In this section we consider two types of objects present in the Campana’s collection: the first are genuine objects slightly restored but kept in their original form while the second are genuine objects whose function seems to have been modified in modern times by small additions. Figure 2 shows several details of a "sanguisuga" type fibula¹ whose head and body are maintained together by a gold plain wire. X-radiography shows the localisation of the modern holes that were made on the head of the fibula in order to let the wire pass through. This round wire, visible under the binocular and by SEM, is of about 200 µm diameter. The hole, with quite “fresh” borders, has a diameter of about 700µm and was pierced from the inside of the fibula head.

The pair of brooches named Helios’ heads² are among the most famous objects copied by Castellani in the 19th century (Soros & Walker, 2004); the punch of the sun god’s head made in 1859 by Castellani is kept in the Istituto Statale d’Arte in Rome (Donati, 2004). If nowadays these items are mounted as brooches, the X-radiography (figure 3a) shows that the clasp construction is modern, obtained by application of one pin and several gold sheets, which take the form of rectangular “patches”. Observation under the SEM of the wires that decorate the 28 rays in repoussé emanating from the sun god's heads points out a small number of modern restorations. They consist on the addition of plain wires incised with a chisel, imitating beaded wire, certainly not made by a goldsmith. Figure 3 compares the morphology of these modern wires with the ancient beaded wires. Equivalent incised wires could be found on one panel of the hinged bracelets (see below “The pastiches”) and on the scarab necklace (reference Bj521-544, Platz-Horster & Tietz 1993) from the Campana’s collection. The latter item was assembled in 1859 by the Castellani’s workshop (Gaultier & Metzger, 2006: 44), which could indicate that one restorer was enhancing Etruscan items at this workshop.

Figure 3c shows the presence of a modern hard solder to weld some of the beaded wires, their grooves corresponding to the instrument used for their fabrication by rolling (Swaddling *et al.*, 1991). All the wires are plain and their diameters vary from 250 to 300 µm. The analysis by PIXE shows that the ancient parts were fabricated with a gold alloy containing 2.1 ± 0.1 % Ag and 0.7 ± 0.1 % Cu whilst the gold alloy of the modern wires contains 7.9 ± 0.2 % Ag and 1.6 ± 0.3 % Cu. The elemental composition of the ancient parts of the brooches tends to corroborate our assumptions and shows that the rays belong to the same production of the sun god’s heads. The slight differences in the central sun god’s head motif for the two brooches seem to point out a separate production in repoussé by the same goldsmith. It is however impossible to affirm whether these objects were brooches in the past.



¹ From Vulci (?) 6th century BC, reference Bj823 (Gaultier & Metzger, 2006:128).

² From southern Italy (?) 4th -3rd century BC, references Bj962 and Bj963 (Gaultier & Metzger, 2006:162).

Figure 2. Details of a modern restoration of a "sanguisuga" type fibula: (a) X-radiography (©T. Borel, C2RMF); (b) binocular image (©D. Bagault, C2RMF); (c) SE image by SEM (©M.F. Guerra, C2RMF).

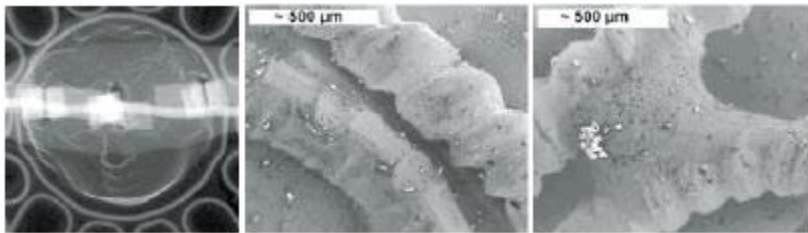


Figure 3. Details of modern restorations of the Helios' brooches: (a) clasp system by X-radiography (©T. Borel, C2RMF); SE images by SEM of the (b) plain incised wires and (c) hard solder joining (©M.F. Guerra, C2RMF).

THE PASTICHES

Among the most famous items of the Campana's collection of jewellery some are pastiches. The three hinged bracelets³, copied by Castellani, by Melillo and by other jewellers in the 19th century (Soros, 2004), were first attributed to Tarquinia (Simpson, 2004) and some years ago recognised as pastiches (Rudoe, 1984), consisting of several flattened front and rear curved panels from Etruscan "a bauletto" type earrings from the 6th century BC. The observation of these jewellery items under different lights and radiations revealed new essential details of the construction of each panel (Guerra, 2005). In general, a panel comprises a central ancient part and a modern contour (figure 4c). The latter is always produced with drawn wires of about 200µm diameter, except in one single panel where incised wire of the same diameter is also applied (equivalent to the wire of figure 3). The square patterns as expected come from the front and rear panels of "a bauletto" earrings but the circular patterns come from their side panels.

We could also reveal that a few square panels of a single pattern —particularly repeated in the longer bracelet— were produced with drawn wire, have no contour and are totally modern (figure 4a). The heterogeneous sources of the different parts of the bracelets are illustrated by the disparity of the alloys that even so corroborate in average our assumptions for each panel. For one panel we observed that the central ancient parts have in average 3.5% Ag and 1.7% Cu⁴ and the modern contour and rear plaque have in average 1.3% Ag and 0.7% Cu. We remark the dissimilarity of these and the Helios brooches alloys.

The disparity of the alloys used in the production of a single item is also observed in the case of rings. Etruscan gold rings with cartouche, produced during the 2nd half of the 6th century BC, consist of a hoop and an engraved or in *repoussé* plaque mounted on a bezel. Those belonging to the Campana's collection are occasionally ornamented with wire and granulation patterns and mounted with ribbon hoops, which is rather suspicious. In order to perceive the degree of authenticity of these rings and the complexity of the pastiches, we describe in this work the most complex piece⁵, considered as "absolutely of Etruscan origin" (Fontenay, 1887: 23), presenting in addition to a ribbon hoop and coiled patterns of wires surmounted by granules, two cervidaes mounted on the bezel. Figure 5 shows the X-radiography of the finger-ring and a detail under the binocular of one of the coiled patterns and of one beaded wire on the hoop. The granules are plain and the cervidaes, which are applied on the wire and granules patterns, are hollow. The twisted and the beaded wires are "flooded" in solder and granules, with heteroclite diameters, are not entirely round. These are the characteristics expected for modern work. The observation of the cervidaes under the SEM (figure 6) shows that they are die formed in two halves. The grooves from the joining can be observed on the heads and tails; on the heads we note a slight deviation of one of the sheets. This manufacture is ancient and usual for the epoch (Williams & Ogden, 1995). We can assume that these cervidaes were recovered from another ancient item in the restoration workshop and mounted on this finger-ring. The observation of the finger-ring under the SEM reveals the use of several types of wires, which are illustrated in figure 7. The classical beaded wire of about 250µm diameter outlining the in *repoussé* motif of the cartouche (figure 7a) does not show the presence of grooves, which means that its manufacture is different from the ornamental beaded wires of the Helios brooches. In spite of the quite regular aspect of this wire its

³ References Bj987, Bj989, and Bj989 (Gaultier & Metzger, 2006: 166), comprise respectively 9, 13 and 9 gold panels hinged together with clasps at the end.

⁴ We could measure for the genuine "a bauletto" earring with reference Bj262 (Gaultier & Metzger, 2006: 166) a gold alloy with 2.1±0.3% Cu and 4.4±0.1% Ag.

⁵ Reference Bj1073 (Gaultier & Metzger, 2006: 60).

fabrication seems ancient. The twisted wires used to form the coil motifs and decorate the edges of the bezel are modern drawn wires of about 200 μ m diameter; the beaded conical wire of about 500 μ m diameter on the edges of the ribbon hoop, with a morphology close to those outlining the “S” motifs of the cartouche, can also be assumed as modern.

In order to check our assumptions on the genuine and modern parts of the finger-ring, the different base elements and ornaments were analysed by PIXE. The table of figure 8 reveals the use of four different alloys for making: (1) the elements of the cartouche (plaque, “S” wires, and granules); (2) the cervidaes; (3) the hoop and its decoration wires and granules; (4) all the elements of the bezel (plaque, coil wire patterns and granules). The relation between colour and composition (Rapson, 1996) shows that all the alloys are red-yellow except the latter, which is yellow. However, if the first three are of about 23 carats —high quality expected for ancient alloys— the fourth alloy is of only about 18-20 carats. None of these alloys are similar to the alloys used in the ancient or modern parts of the Helios brooches.

Why use such unequal alloys? The alloy of the cartouche elements is close to the alloys of other finger-rings with no restorations or enhancements kept in the Campana’s collection. We can assume that all the parts are ancient. The two cervidaes are also ancient. The ribbon hoop and its ornaments are of modern manufacture. One fibula and one decorated gold sheet in the set of copies made by Castellani showed a similar composition (Cesareo & Von Hase, 1976). Either the assumption that the Castellani’s workshop used very high purity gold alloys (Ogden, 2004) is not confirmed or the finger-rings were enhanced in another workshop. The bezel and its ornaments are also modern, made with an alloy close to the 18-carat gold of the 19th century goldwork. We remind that the Etruscan alloys of lower quality have in general higher contents of silver; those showing contents of silver closer to our fourth alloy have lower contents of copper (Cesareo & Von Hase, 1976; Paternoster *et al.*, 1996). Other finger-rings from the Campana’s collection with ornaments and ribbon hoops are decorated with drawn wires and heteroclite granules, which are “flooded” in solder. Those elements are made with an alloy similar to our fourth alloy (Guerra, 2007). These facts tend to indicate that the finger-rings in the Campana’s collection form one independent group and were manipulated by one single goldsmith or workshop, but, if we consider the changes and enhancements of other jewellery items in the collection (the Helios brooches and the hinged bracelets), probably not the Castellani’s workshop. We can at last denote that signs of electroplating and presence of I and Hg (Ogden, 2004) are absent as well as grain boundaries expected for etching (Meeks, 1998) in 19th century productions.

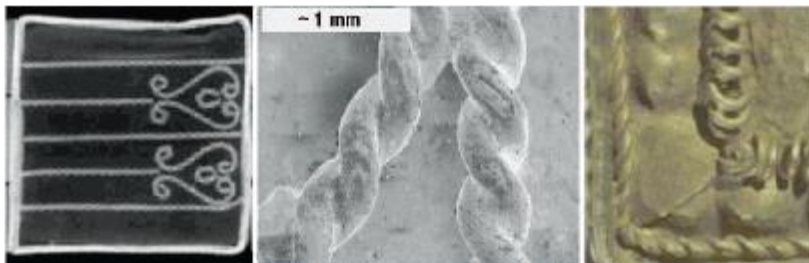


Figure 4. (a) X-ray radiography modern gold panel from the longest hinged bracelet (©T. Borel, C2RMF); (b) SE image by SEM of the drawn wires (©M.F. Guerra, C2RMF); (c) assembling region of a panel consisting on a central ancient part and a modern contour (©D. Bagault, C2RMF).

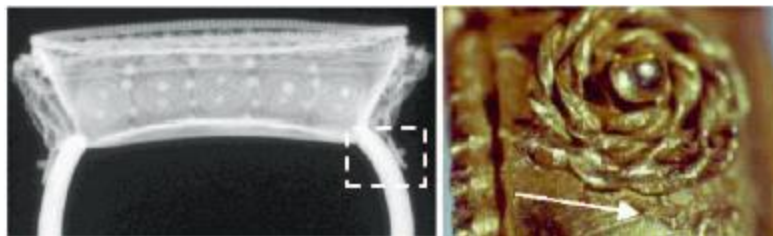


Figure 5. (a) X-ray radiography of the cartouche finger-ring on the left (©T. Borel, C2RMF); (b) coil pattern with granule on the hoop under the binocular “flooded” in solder on the right (©D. Bagault, C2RMF).

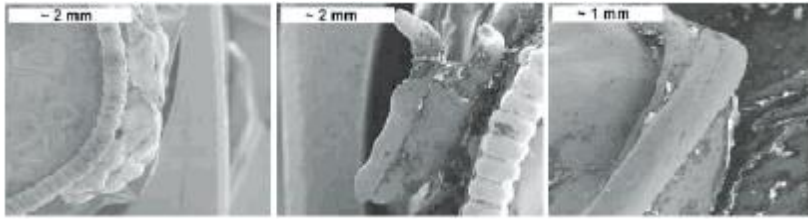


Figure 6. SE images by SEM of the cervidaes mounted on the finger-ring. (©M.F. Guerra, C2RMF).

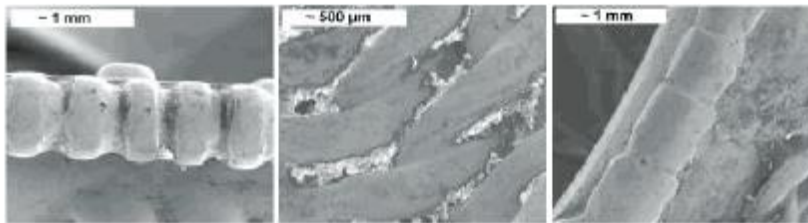


Figure 7. SE images by SEM of the wires applied to the finger-ring. (©M.F. Guerra, C2RMF).



Figure 8. Wire and granulation patterns on the bezel and alloys measured by PIXE for the different parts of the finger-ring.

CONCLUSION

The study of a few jewellery items attributed to the Etruscans and belonging to the Campana's collection showed the important contribution of scientific methods to authentication (exam and elemental analysis) particularly in the case of complex pastiches. If exam of slightly restored objects or "misappropriations" is adequate to separate ancient from modern parts, elemental analysis gives criteria on the reliability of our assumptions. The exam of the Helios brooches, which certainly had another function in ancient times, showed that they are genuine, made by one goldsmith, and slightly restored in the 19th century. Their restoration was achieved by addition of incised wires of similar morphology to wires perceived in the hinged bracelets and in the scarab necklace belonging both to the Campana's collection. The latter was assembled in 1859 at the Castellani's workshop and Castellani made a punch, copy of the sun god's head of the Helios brooches, the same year. Did one restorer make the restorations? We remind that most of the modern parts of the hinged bracelets were made with drawn wire, which could indicate a mounting by a goldsmith.

Elemental analysis has a major role in the case of intricate pastiches, corroborating the assumptions on the modern and ancient parts such as for the Helios brooches. If for the hinged bracelets the separation was less obvious, the analysis of the finger-ring with cartouche, a complex pastiche, evidenced the use of four alloys and confirmed its construction by assemblage of modern with ancient parts of different origins.

The presence of an 18-20 carats gold alloy only detected in the Campana's collection until today in base or ornamental elements of finger-rings of this type seems to indicate the work of an unique workshop or restorer (at least for the basic mountings). As far, other jewellery items of this collection present restorations and enhancements made with alloys of higher quality.

By assembling exam with elemental analysis and by increasing the number of studied pastiches and genuine objects we expect in the future to list criteria that can be used to distinguish the mountings and enhancements made at the Castellani's workshop from those made by other workshops.

REFERENCES

- ARMBRUSTER, B.; GUERRA, M.F. 2003: "L'or archéologique, une approche interdisciplinaire". *Technè* 18: 57-62.
- BORRELLI, L.V. 1992: "Faux, pastiches, imitations". In M. Pallotino (ed.): *Les Étrusques et l'Europe*. R.M.N. Paris: 432-439.
- BURY, S. 1975: "Alessandro Castellani and the revival of granulation". *The Burlington Magazine* 117(871): 664-668.
- CARROLL, D.L. 1972: "Wire drawing in Antiquity". *Am. J. Archaeology* 3: 321-323.
- CARROLL, D.L. 1974: "A Classification for Granulation in Ancient Metalwork". *Am. J. Archaeology* 78(1): 33-39.
- CESAREO, R.; VON HASE, F.W. 1976: "Analisi di ori etruschi del VII sec. a.C. con uno strumento portatile che impiega la tecnica fluorescenza X eccitata da radioisotopo". *Atti dei Convegni Lincei* 11: 259-296.
- CRISTOFANI, M.; MARTELLI, M. 2000: *L'oro degli Etruschi*. Istituto Geografico de Agostini. Roma.
- CURTIS, C.D. 1914: "An early Graeco-Etruscan fibula". *J. Roman Studies* 4 (1): 17-25.
- DONATI, M. 2004: "The Workshop: Models, Tools, and Newly Discovered Designs". In Soros and Walker 2004: 129-152.
- DUCHÊNE, H. 2006: "La guerre du faux n'aura pas lieu". *Dossiers d'Archéologie* 312: 2-7.
- FLEMING, S.J.; JUCKER, H.; RIEDERER, J. 1971: "Etruscan wall paintings on terracotta: a study in authenticity". *Archaeometry* 13(2): 143-167.
- FONTENAY, E. 1887: *Les bijoux anciens et modernes*. Maison Quentin. Paris.
- FORMIGLI, E. 1979: "Modi di fabbricazione di filo metallico nell'oreficeria etrusca". *St. Etr.* 47: 281-292.
- FORMIGLI, E. 1992: "Indagini archeometriche sull'autenticità della fibula Praenestina". *Mitteilungen DAI(RA)* 99: 329-343.
- FORMIGLI, E. 1993: "Einige fälschungen antiken Goldschmucks im 19. Jahrhundert". *Archäologischer Anzeiger* 3: 299-332.
- GAULTIER, F.; METZGER, C. (eds) 2006: *Trésors antiques. Bijoux de la collection Campana*. Musée du Louvre-5 Continents. Paris.
- GORDON, A.E. 1982: "On la cosiddetta fibula Prenestina by Margherita Guarducci". *The Classical Journal* 78 (1): 64-70.
- GUARDUCCI, M. 1980: *La cosiddetta fibula Prenestina. Antiquari, eruditi e falsari nella Roma dell'Ottocento*, Accademia Nazionale dei Lincei, ser. 8, vol. 24, Rome.
- GUERRA, M.F. 2004: "Fingerprinting ancient gold with proton beams of different energy". *Nucl. Instrum. and Methods B* 226: 185-198.
- GUERRA, M.F. 2005: "Etruscan gold jewellery pastiches of the Campana's collection revealed by scientific analysis". In M.Cavallini and G.E. Gigante (eds.): *De Re Metallica: dalla produzione antica alla copia moderna*. L'Erma Di Bretschneider. Rome: 103-128
- GUERRA, M.F. 2007: "Examen et analyse élémentaire de bijoux étrusques de la collection Campana". In Ecole du Louvre (eds.): *Les bijoux de la collection Campana : de l'antique au pastiche*. Paris: 145-177.
- GUERRA, M.F.; CALLIGARO, T. 2003: "The analysis of gold: manufacture technologies and provenance of the metal". *Measurement in Science and Technology* 14: 1527-1537.
- GUERRA, M.F.; CALLIGARO, T.; PEREA, A. 2007: "The treasure of Guarrazar: tracing the gold supplies in Visigothic Iberian peninsula". *Archaeometry* 49(1): 53-74.
- HOFFMANN, H. 1969: "Greek gold reconsidered". *Am. J. Archaeology* 4: 447-451.
- MEEKS, N. 1998: "A Greek gold necklace: a case of dual identity". In D. Williams (ed.): *The Art of the Greek Goldsmith*. The British Museum Press. London: 127-138.
- MELLO, E.; PARRINI, P.; FORMIGLI, E. 1983: "Etruscan Filigree: Welding Techniques of Two Gold Bracelets from Vetulonia". *Am. J. Archaeology* 87(4): 548-551.
- NICOLINI, G. 2000: *Techniques des ors anciens*. Picard ed. Paris.
- OGDEN, J. 2004: "Revivers of the lost Art: Alessandro Castellani and the quest for classical precision". In Soros and Walker 2004: 181-200.
- ODDY, A. 1977: "The production of gold wire in Antiquity". *Gold Bull.* 10 (3): 79-87.
- PARRINI, P.; FORMIGLI, E.; MELLO, E. 1982: "Etruscan granulation analysis of orientaling jewelry from Marsiliana d'Albergua". *Am. J. Archaeol.* 86, 118-121.
- PATERNOSTER, G.; RINZIVILLO, R.; SCHEICH, C. 1996: "Analyses par la méthode non destructive FX de bijoux campaniens en or datant du VIIe au IVe s av. J-C" *Supplem. Rev. Archéométrie*: 147-152.
- PEREA, A. 1989: "Tecnología y Metodos de studio". En *El oro en la España Preromana, Revista de Arqueología*. Zugarto eds. Madrid: 24-31.
- PLATZ-HORSTER, G.; TIETZ, H.U. 1993: "Etruskische Skaraben Kolliers". *Jahrbuch der Berliner Museen* 35: 7-45.

- RAPSON, RW. 1990: "The metallurgy of the coloured carat gold alloys". *Gold Bull.* 23 (4): 128-133. REGERT, M.; GUERRA, M.F.; REICHE, I. 2006: "Physico-chimie des matériaux du patrimoine culturel". *Techniques de l'Ingénieur* P 3780: 1-21 ; P 3781: 1-11 ; P 3782: 1-3.
- REINACH, S. 1904. "Esquisse d'une histoire de la collection Campana". *Revue Archéologique* 4e sér., t. IV: 179-200 and 363-384 ; t. V: 57-92, 208-249 and 343-364.
- RUDOE, J. 1984: "The archaeological style in 19 th century Jewellery". In C. Gere, J. Rudoe, H. Tait and T. Wilson (eds.): *Art of the Jeweller: A Catalogue of the Hull Grundy Gift to the British Museum*. The British Museum Press. London: 149-151.
- RUDOE, J. 1986: "Elizabeth Barrett Browning and the taste for archaeological style jewelry". *Philadelphia Museum of Art Bulletin* 83 (353): 22-23.
- SARTI, S. 2001: *Giovanni Pietro di Campana (1808-1880). The man and his collection*. BAR S971.
- SGUBINI, A. (ed.) 2000: *La collezione Augusto Castellani*. L'Erma di Bretschneider. Roma.
- SIMPSON, E. 2004: "A perfect imitation of the ancient work: ancient jewellery and Castellani's adaptations". In Soros and Walker 2004: 201-228.
- SOROS, S.W. 2004: "Under the great canopies of civilization: Castellani jewellery and metalwork at international exhibitions". In Soros and Walker 2004: 229-284.
- SOROS, S.W.; WALKER, S. (eds.) 2004: *Castellani and Italian Archaeological Jewelry*. Bard Graduate Centre. New York.
- SWADDLING, J.; ODDY, A.; MEEKS, N. 1991: "Etruscan and Other Early Gold Wire from Italy, in Classical Gold Jewellery and the Classical Tradition", *Society of Jewellery Historians* 5: 7-21.
- TSUJI, K.; INJUK, J.; VAN GRIEKEN, R. (eds.) 2004: *X-Ray spectrometry: recent technological advances*. John Wiley and Sons. New York.
- UDA, M.; DEMORTIER, G.; NAKAI, I. (eds). 2005: *X-rays for Archaeology*. Springer. The Netherlands.
- WILLIAMS, D. 1992: "The Brygos tomb reassembled and 19th-century commerce in Capuan antiquities". *Am. J. Archaeology* 96 (4): 617-636.
- WILLIAMS, D.; OGDEN, J. 1995: *Greek Gold: Jewelry of the Classical World*. The British Museum Press. London.
- WOLTERS, J. 1981: "The ancient craft of granulation". *Gold Bull.* 14 (3): 119-129.