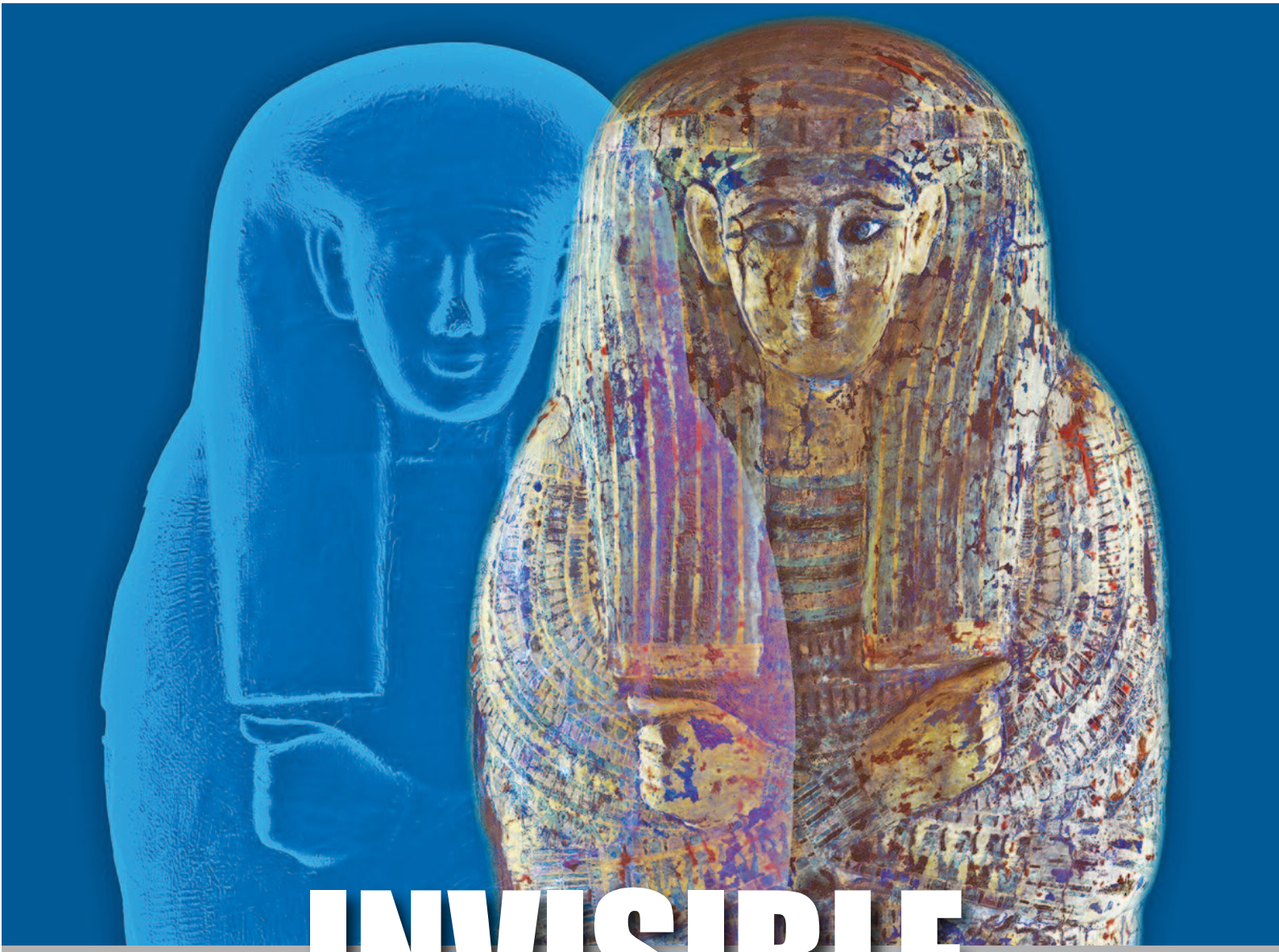


INVISIBLE ARCHAEOLOGY

BEYOND THE NAKED EYE

by Lucy Gordan-Rastelli

Photos courtesy the Museo Egizio

On display at the Museo Egizio in Turin, Italy, until January 6, 2020, is "L'Archeologia Invisibile," a magical exhibition of over fifty artifacts, ancient and non, all belonging to the Museum, curated by in-house Egyptologist Enrico Ferraris. More easily understood as "Archaeology not Visible to the Naked Eye," it is magical for its state-of-the-art technical investigation, its imaginative, innovative and

Above, Logo of the exhibition, utilizing projections of the outer coffin of 21st Dynasty necropolis scribe Butehamen.

Left, Introduction gallery of the Museo Egizio's "L'Archeologica Invisible" exhibition.

thought-provoking presentation, for its explanations in both Italian and English on wall panels, on artifact captions and on the audio guide included in the entrance fee of €15, available in Italian, English, French, German, Spanish, German, Chinese and Arabic. The explanations are clear to a first-time visitor and intriguing for Egyptologists. Not to mention that artifacts are seen and facts learned in a brand-new way, thanks to modern science: x-rays, CT-scans, photometry, 3-D photography, materials engineering, earth sciences, biology, botany and chemistry. Almost certainly there has never been an exhibition quite like this one.

Its ten sections — Introduction, Map of Contributors, Traditional Archeology and its Tools, Colors, Kha and Merit's Mummies, Animal Mummies, Wall Paintings, Papyrus, Textiles and the Coffin of Butehamen — are grouped as excavation phases, diagnostic analyses, and state-of the-art restoration and reconstruction; or, more formally, Traditional Archeology and its Tools; Colors; Human Mummies; Animal Mummies; and State-of-the-Art Restoration and Reconstruction.

The Introduction and the Coffin of Butehamen offer Museum visitors some unexpected surprises. For an exhibition about archaeology in one of Italy's most famous archaeology museums, and the only one outside Egypt to be devoted entirely to ancient Egypt, I would have expected any such exhibition there to open with ancient Egyptian artifacts. Instead, the introductory room has several vitrines with everyday household objects which recently have been discarded as out-of-date: toy cars, a paint box, a paint brush, light fixtures, a light bulb, a pocket watch, an ink blotter, a small tape-recorder's miniature tape, a vinyl record, a Walkman and an athlete's shoe, to name a selection.

The reason for this is explained in the exhibit's first wall-panel: *"Each object, whether ancient or contemporary, has its own unique and unrepeatable biography. This does not end with the age or civilization from which it originated, but continues to silently record fragments of new memories, as the object passes through time and the changes of history.*

"By recounting how they have been used, altered, abandoned, forgotten, rediscovered and then handed down, perhaps rescuing them from new oblivion, objects resist and bear witness to our lives and those of the people who lived before us. Whether they are artistic creations or everyday things, ancient finds, or items from our childhood, objects act as a bridge connecting those who produced them with those who observe them and question them today.

"In an attempt to make the world and the people who created these objects ever clear, a museum fulfills its fundamental task of continuously refining that

Above, The "Excavation & Conservation" gallery of the exhibition focuses on traditional archaeology of the 19th & 20th centuries, one vitrine (right, top & middle) displaying field equipment used by Ernesto Schiaparelli during his digs in Egypt. Right, Presentation of the various minerials from which the ancient Egyptians produced paint colors.

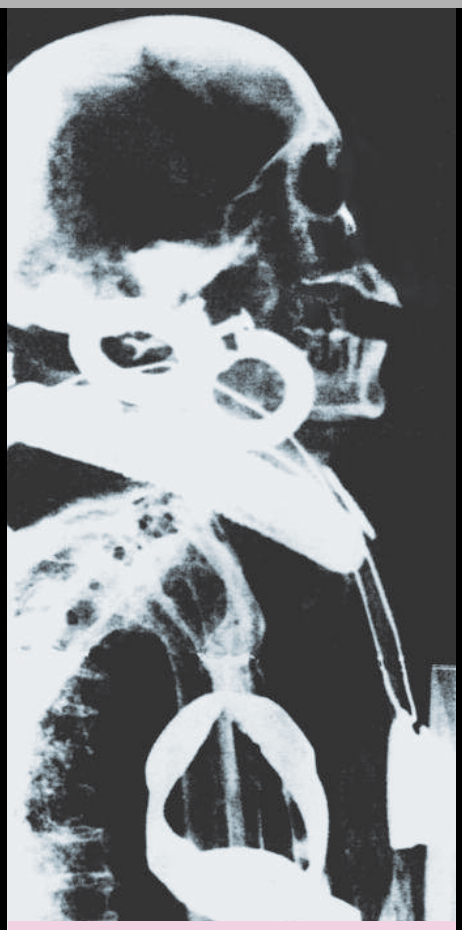
contact between people and experiences of every age.

"In order to study objects, and grasp the biographical fragments they preserve in the material and techniques used to produce them, the damage they have suffered, the repairs and alterations they have undergone in time, a museum uses its most profound and refined form of study: Research.

"The exhibition 'Invisible Archeology' therefore arises from a dialogue between the Historical Sciences and the Natural Sciences (physics, chemistry, botany) and the resources offered by Archaeometry. This is the use of advanced instruments of analysis and technologies that make visible the information that has always been present in the items but was previously beyond our ability to measure and understand.

"The exhibition's layout offers a path towards the invisible and back, which shows how we study objects at the Museo Egizio and take care of them through conservation work, so that they can be subjected to the new questions that future generations will be able to ask them." It aims to demonstrate the symbiosis between archaeology and science.

From the introductory room — where visitors learn that archaeology is not limited to ancient artifacts and that each artifact, no matter its age, has several stories to recount — they pass into the corridor of contributors, almost all of which are scientific departments and laboratories at Italian universities, especially in Turin, and not museums, as almost all the ancient artifacts belong to the Museo Egizio. The exceptions are the Federal Institute for Materials Research and Testing in Berlin; The Centre for the Study of Manuscript Cultures at — *continues p. 48*



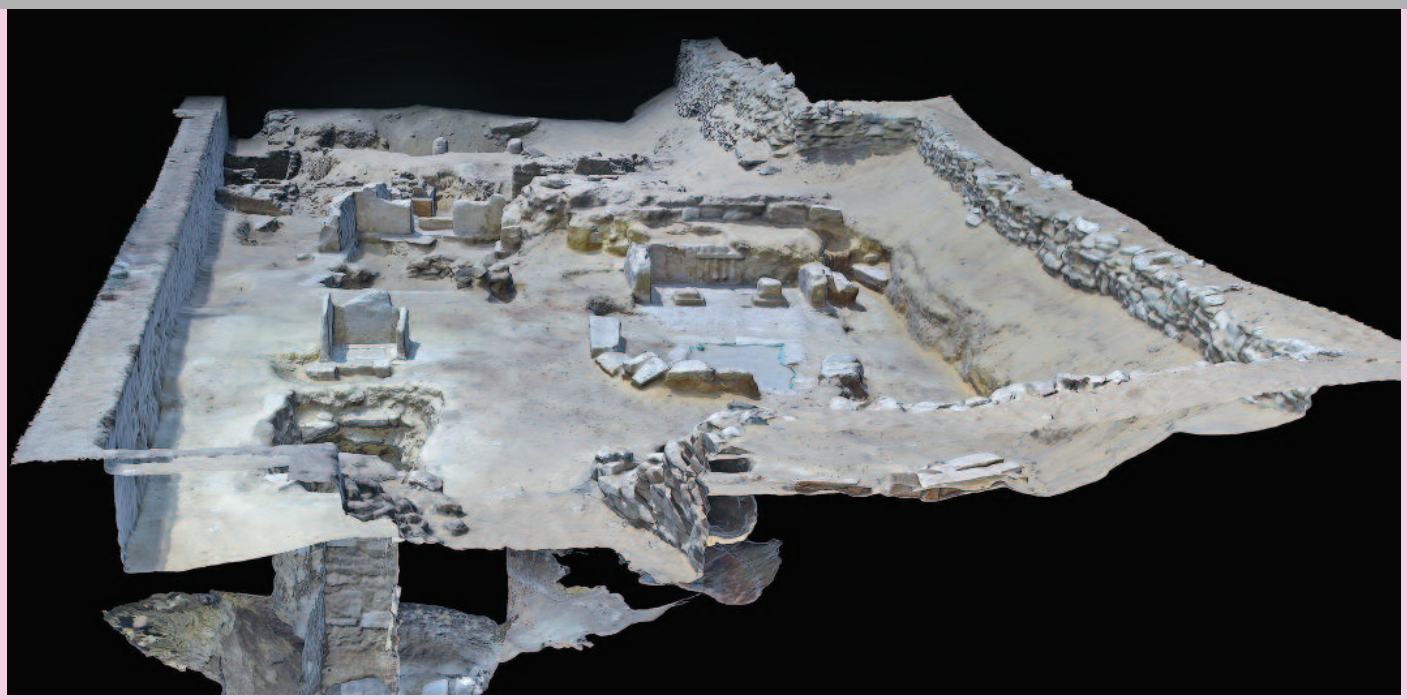
Profile & frontal x-rays taken of Kha's wrapped mummy in 1966, revealing that the tomb architect was wearing-jewelry, also that he was missing all of his upper teeth at the time of his death, at an advanced age.

For the Museo Egizio's "L'Archeologia Invisibile" exhibition, resident 18th Dynasty wrapped mummy of Kha was CT-scanned (above & opposite), to fully reveal the nature of his jewelry adornments, especially the Gold of Honor collar, large loop-earrings, sheet-gold arm bands and a gold-mounted stone heart-scarab suspended from a gold wire. Small amulets are also present, one on his forehead.

Images not to scale

Top & above, The 1966 x-rays of Merit's mummy, revealing her large earrings & beaded broad-collar adornments; also that her spinal column is broken in two places, the central portion greatly offset, probably the result of extremely rough handling during mummification. Above, center, Merit's wrapped mummy wearing her gilded-&-inlaid cartonnage funerary mask. Right, Recent CT-scan of Merit's still-wrapped mummy Opposite, Detail of the CT-scan of the Merit mummy, revealing that it is adorned with a plaited wig, the frontal lappets of which have been cut off neatly just above the large circular earrings & rest on the torso, just below the beaded broad-collar.

Below, Another CT-scan of the Merit mummy within its wrappings. Left, A new high-resolution x-ray of Merit reveals the displacement of her spinal column & rib cage, undoubtedly post-mortum damage occurring during the mummification process. Opposite, bottom right, CT-scan of Merit's loop earrings & elaborate beaded broad-collar. Opposite, bottom left, A computer-generated 3-D printout of the same collar & earrings, displayed in the "L' Archeologia Invisible" exhibition.



Photogrammetrically-generated digital model of a site at Sakkara, demonstrating what can be revealed without actual digging.

— *continued from p. 41* the University of Hamburg; ISIS Spallation Neutron Source in Oxfordshire; the Massachusets Institute of Technology; the University of Leiden; the British Museum; the Rijksmuseum; and the Vatican Museums.

From there visitors enter the first room concerning ancient Egyptian archaeology called "Excavation and Conservation" at the time of famous early Twentieth Century Italian Egyptologist Ernesto Schiaparelli. The background of the wall panels are photographs of his excavations at Deir el Medina, Gebelein and Valley of the Queens; and the vitrines display his camera (the most modern technology of Schiaparelli's time); other photographic equipment, like his tripod, lenses, stereoscopic plates (the Museum's archives preserve over 100); his notebooks and drawing materials.

The captions explain that early archaeologists —actually archaeologists up to fairly recently — used photography, drawing and writing to record their finds. The archaeologist in the Nineteenth and most of the Twentieth centuries was like a detective, the relics found being the suspects or the evidence of life in the past, and the site the scene of the crime.

Until recently, when archaeologists excavated the ground level of a site, that was inevitably damaged. As the wall panel "Documenting Excavations" explains: *"archeology was a form of destruction, and, in order to carry out its investigations, it had to clear away objects and contexts to gradually uncover the underlying levels. Now, thanks to photogrammetry, it is possible to see below ground without doing damage, to observe life at the site over long periods of time not just its last phase. Now it is possible,"* continues the wall panel, *"to follow the thread of history backwards."*

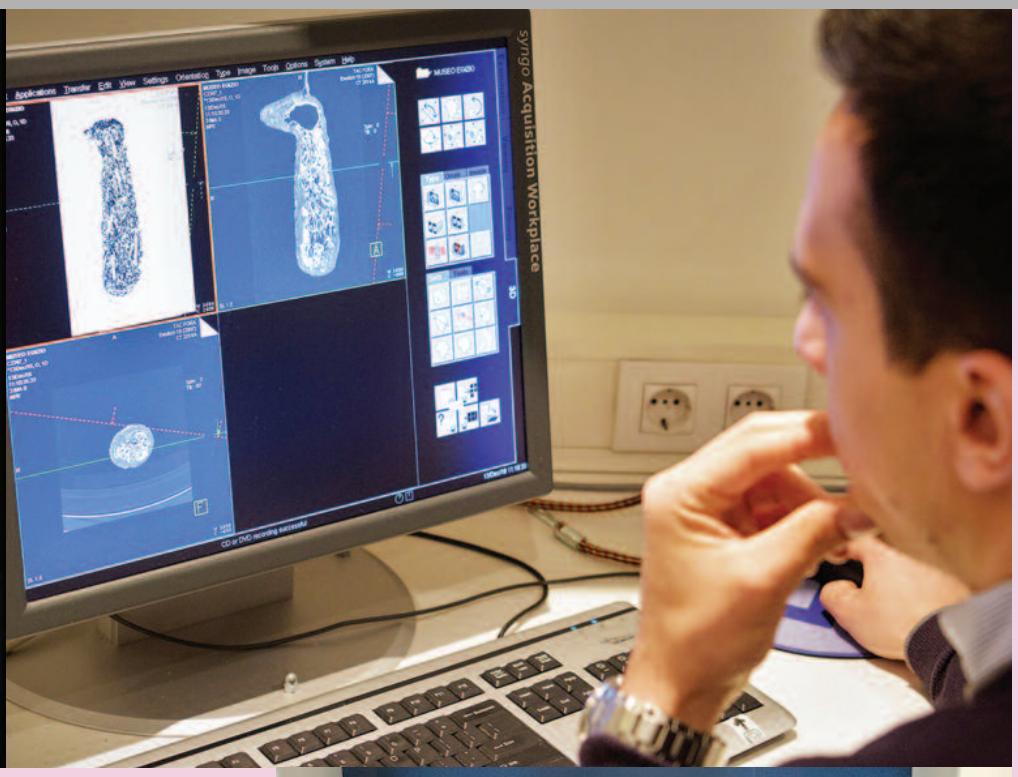
Thus it is also possible to see the extent of the site, where it has not yet been excavated. Moreover, *"the archeological contexts that physically no longer exist can be brought back to life and explored again in a digital environment."*

A subsequent wall panel, "Digital Models of Finds/A 3D Image of the Present" explains: *"Photogrammetry also presents digital models of individual objects found during excavations. Not unlike a photograph, these models increase the ability of an object to be understood, appreciated and studied by several people, even simultaneously, although they are located a long way from the storage spaces containing the real object.*

"This knowledge is not limited to the image of the object but also can be converted into a tangible experience, as with this flask, found during a 2018 excavation mission. From the digital model it was possible to produce a 3D print that repeats the precise dimensions of the original, now in Egypt, and the roughness of its surface."

The next section concerns colors and the pigments the ancient Egyptians used to make their paints, especially "Egyptian blue," the first artificially produced pigment explained there in a video. The wall panel, called "The Pigments of Colors/Egyptian Pigments," reports: *"In ancient Egypt, pigments were extracted from minerals… such as malachite (green), and pyrolusite (black), or from earths such as ochre (yellow and red). Craftsmen crushed the pigments and then mixed them with a binder, such as egg white and gum Arabic, so they could use them as pigments.*

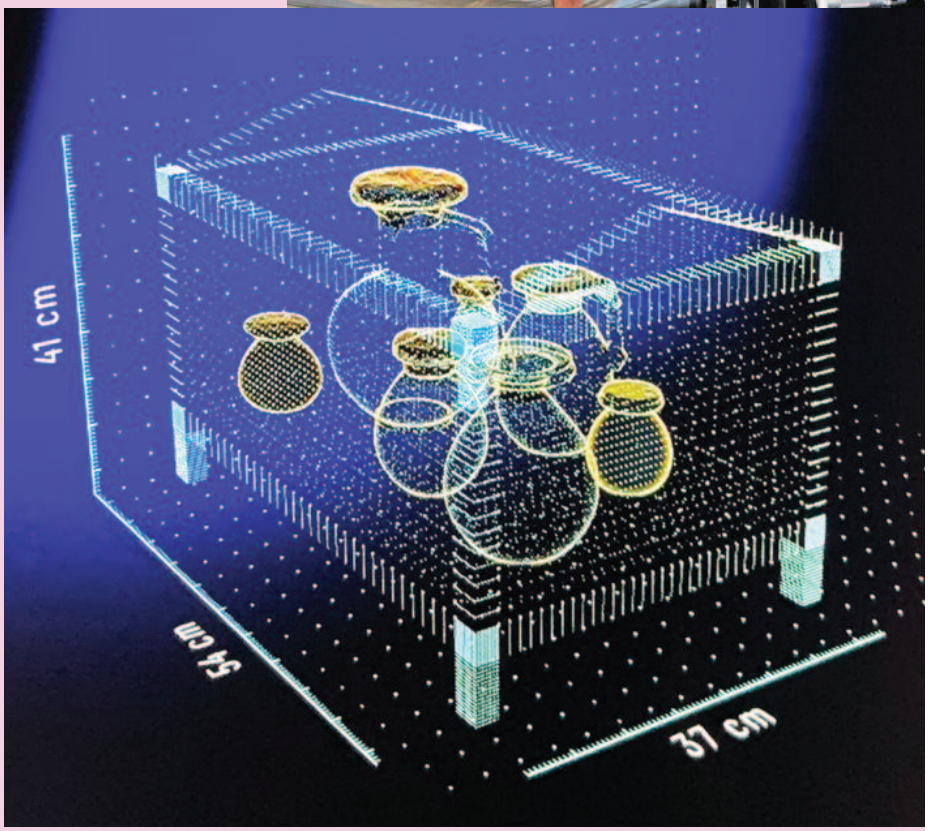
"But they did not just extract colors that existed in nature. Almost 5,000 years ago, they actually produced the first known artificial color, the famous Egyptian Blue. Recently this color has been the subject of renewed interest in the field of the science of materials, due to its unexpected qualities and appli-



The Museo Egizio collection includes some 200 animal mummies & the "L'Archeologia Invisible" exhibition demonstrates how these may be studied today by non-intrusive electronic technology. Right, The mummy of a bird wrapped as a human fetus with a miniature coffin is probably a 19th Century fake made for sale to tourists. Author's photo

Right, One of six painted-wood storage chests elevated on four legs found in the Tomb of Kha & Merit (TT8), decorated on one side panel with a scene of the deceased couple seated at an offering table & attended by their son & daughter.

"L'Archeologie Invisible" demonstrates how, using ultraviolet Macro XRF fluorescence technology (right), the stages of the painting of the chest & its present-day conservation can be analyzed. Below, An exhibition display shows positioning of the chest's contents (seven calcite vases) when found. Author's photo



cations in the fields of medicine, energy and diagnostics."

Egyptian blue is also known as calcium copper silicate or cuprorivaite. It is made up of a mixture of silica, lime, copper and alkali, first synthesized in Egypt during the Fourth Dynasty. The earliest evidence of its use is on an alabaster bowl excavated at Hierakonpolis and now in Boston's Museum of Fine Arts. It continued to be used extensively until the fall of the Roman Empire. It owes its color to its copper content. In antiquity it was used to color a wide variety of media: stone, wood, plaster, papyrus and canvas; and in the production of numerous objects: cylinder seals, beads, scarabs, inlays, pots and statuettes. In spite of its popularity, no written information exists in ancient Egyptian texts. Vitruvius, the famous Roman architect and engineer, is the first writer to mention it in his First Century AD treatise, *De architectura*.

On display are a scribe's palette from Kha and Merit's tomb (TT8), some unmixed pigments (red dating to the Middle Kingdom and excavated by Schiaparelli at Deir el Medina in 1909; Egyptian blue, New Kingdom (also excavated by Schiaparelli in 1909 at Deir el Medina); and a wooden polychrome coffer painted with an offering scene, again from the Tomb of Kha and Merit, which has undergone several analyses: ultraviolet (which reveal earlier restorations and how well the painting we see today is conserved); visible induced luminesce (which reveals the Egyptian blue); infrared (which reveal earlier paintings no longer visible to the naked eye); and MA-XRF (Macro X-Ray Fluorescence), which maps the chemistry of the colors used in the decoration). These analyses are "photographic" so in no way damaging to the coffer.

The next two sections are devoted to mummies, both human and animal. It begins with a timeline about mummification. The first entry, 1st Century AD, (1161-1231) reports: *"Bitumen from the Black Sea and Persia is praised for its medical properties by the Roman naturalist Pliny the Elder (23-79 AD) and the*

Greek physician Pedanius Dioscorides (40-90 AD).” Around 900 AD *“In the treatise Kitab Al-Mansuri, the Persian doctor al-Razi (854-925) is among the first to use the term mûmîa for mineral bitumen.”* Two hundred years later *“in the Latin translation of Kitab Al-Mansuri Gerard of Cremona (1184-1187) erroneously explains the term ‘mummy’ as the substance that preserves Egyptian mummies.”* Not long afterwards *“Ibn al-Baytar (1197-1248) uses the term ‘al mûmîia al quburi’ (‘the mummy of the tombs’) to differentiate it from the analogous substance of mineral origin, but the Arab doctor Abd al-Latif (1161-1231) suggests that the two substances are similar and that mummies can be a valid substitute for mineral bitumen.”* Around 1400 *“the demand for mummies increases in Europe and, given the scarcity of supplies of natural bitumen from Persia and the Dead Sea, they are sought in tombs in Egypt.”* A century later *“smuggling mummies to Europe becomes a big business: Egyptian mummies, in pieces or powder form, are among the products sold in European pharmacies. The merchants produce and sell false mummies made from the bodies of criminals sentenced to death.”* Another century later, around 1600, *“mummies become a sought-after collector’s item for the Wunderkammer of nobles and intellectuals. Doctors and pharmacists unwrap mummies to study embalming.”* Gradually although *“doctors grow more skeptical about the curative powers of the ‘mummy’, it continues to be used but to a limited extent until the early 20th century. In 1790 the anthropologist Blumenboch unwraps some mummies in the British Museum to define the Egyptians’ ethnic features.”* Sixty years later *“the director of the Cairo Museum G. Maspero oversees the unwrapping of mummies of priests and pharaohs found in the Theban Necropolis. In England the adventurer G.B. Belzoni and the surgeon R. Pettigrew are among the first to perform public unwrappings as a form of paid entertainment. Egyptologists begin to practice isolated unwrappings to study mummies.”* X-rays (invented 1896) *“are first used on Egyptian mummies by the British Egyptologist W.F. Petrie in 1897. Unwrappings are still the method of scientific study of the commoner mummies. In Cairo G.E. Smith performs an X-ray on the head of Pharaoh Thutmose IV (1903).”* However, it isn’t until the 1950s that museums systematically use x-rays to study their mummies. *“The mummies of Kha and Merit were first x-rayed in 1966 and the ‘Manchester Mummy Project’ began its interdisciplinary research in 1972.”* The time chart’s last image is a photograph of the Museum’s then director Silvio Curto, looking at the Museum’s first x-rays of mummies.

The ultraviolet Macro XRF fluoresence camera being used to analyze the footboard of the lid of the outer coffin of the 21st Dynasty necropolis scribe Butehamen.

Facing the entrance door is the still-wrapped (reportedly because Schiaparelli rightly predicted that unwrapping destroyed the evidence and that future scientific discoveries would not make it necessary) mummy of Kha, and across the room that of his wife Merit. The 1966 x-rays (“TT8 Project”) showed that they are both wearing jewelry and amulets under their wrappings and that Merit is wearing a wig. A wall panel tells us that *“the CAT-scan performed on both mummies in 2016 added information about the materials and the technique used to produce these jewels. The new digital*

Opposite, The 21st Dynasty painted-wood outer coffin of Butehamen (center), as displayed in a main-floor gallery of the Museo Egizio. Reportedly found reused in TT291 (Tomb of Nakhtmin), it arrived at the Museo Egizio as part of the Drovetti Collection.

Above, Sequential images of a plexiform full-scale model onto which images of Butehamen's outer coffin are projected to show the stages of its construction & decoration. Images of the coffin are also projected onto the walls of this final gallery of the "L'Archeologia Invisible" exhibtion at Turin's Museo Egizio. Author's photos

models developed from that data were given a material form by 3D printing, which finally made it possible to extract the jewels virtually and display them in the nearby showcase next to real objects that help to clarify their meaning and forms."

As for animal mummies, the room's wall panel states: *"The Museo Egizio preserves over two hundred animal mummies, some of them still in their coffins. Although isolated cases of domestic animals mummified by their masters are known, perhaps to keep them at their side in the afterlife, most animal mummies had a votive function. Pilgrims visiting the temples offered the deities examples of the mummified animals associated with them (Thoth/ibis or baboons, Bastet/cats, Anubis/dogs, Sobek/crocodiles, Horus/hawks). Animal mummies would often be buried in necropolises specially dedicated to them.*

"The practice spread from the Late Period (8th-4th centuries BC) and was then abandoned in the 4th century AD, when the Edict of Theodosius (380) suppressed pagan cults.

"Recently, vast necropolises of mummified animals have been discovered. Tomographic scans offer new opportunities to study the methods used to embalm and preserve these relics, as well as providing important information for a map of Egyptian fauna."

Thus this room opens appropriately with such a wall-panel map, while another wall-panel explains the mummifying process. The first vitrine contains two mummified crocodiles. One is still bandaged and encased in reed matting; the other has only traces of its bandages and embalming oils. A CT-scan revealed the still wrapped crocodile to be much smaller than its bandages make it seem. The exhibition's catalogue (€16, sadly only in Italian) hypothesizes that this was done intentionally on the part of the embalmers, who could sell a large mummy for much more than a small one.

The next vitrines contain the skittle-shaped mummy of a female dog; several mummies of birds in their coffins; and the wrappings decorated as the head of a bull. Its caption relates: *"The CAT-scan reveals that the bandages do not always cover the whole body of the animal. Sometimes, perhaps due to lack of time and resources, or even with fraudulent intent, only a part of the animal was mummified by adding clay, textiles, or plant material to complete the mummy; such is the case for the bull pseudo-mummy containing only the skull, the ribs, and some scattered bones."*

Another embalmers' trick, one also on display here, is the coffin of a small child. Its caption reads: *"Don't be fooled by appearances!"* and explains: *"Sometimes the container fails to match the content. Some mummies shaped like a human fetus actually contain birds or parts of them. They may be artifacts produced for the 19th-century antique market. A human mummy, even a child, would probably be more valuable than an animal so, by wrapping it in a cartonnage and faking a small coffin with reused wooden boards, the real contents were camouflaged."*

Still another vitrine contains the skittle-shaped mummy of a cat; a cat-shaped coffin containing its mummified occupant; and two ibis mummies in their coffins.

The next three sections, Tempera Wall Paintings, Papyri and Textiles, concern their restoration and conservation. In 1906 Schiaparelli excavated the Middle Kingdom Tomb of Henib at Qaw el Kebir; and in 1911 at Gebelein Schiaparelli discovered and cleared the half rock-cut tomb of Iti and Neferu, Pharoah's Chancellor and Commander of Troops during the First Intermediate Period. As was customary at the time, the Italian Archaeological Mission detached the paintings and brought them to Turin. Two examples on display here, the wall panel explains, *"show how diagnostic analyses conducted to develop a restoration plan have succeeded in correcting earlier reconstructions."*

The Museum's website reports: *"The Museo Egizio holds one of the world's most significant papyrus collections. It comprises nearly 700 whole or reassembled manuscripts and over 17,000 papyrus fragments. About half of these texts are written in Egyptian (in the cursive-hieroglyphic or hieratic script), while the rest were written in Demotic, Greek, Coptic, or Arabic. Their content is also very varied: administrative, legal, literary, ritual, religious, magical and funerary texts (such as the Book of the Dead). The Egyptian Museum is currently developing a website where users can learn about the history and content of the Papyrus Collection, ongoing restoration work, research conducted by scholars on our papyri, but also collaborative research projects such as 'Crossing Boundaries: Understanding Complex Scribal Practices in Ancient Egypt,' where the Egyptian Museum collaborates with the Universities of Basel and Liège."*

On display here are two papyri. One comes from the town of Thinis or This, in the south of Egypt, from a library dating to Byzantine times and now lost, thus later than this journal's timeframe. Nonetheless, scientific analyses of the inks used for the papyri from this lost library reveal many details about their provenance.

The second papyrus is ancient. Unfortunately, during the Nineteenth Century restorers in Turin "patched" this Third Intermediate funerary papyrus with fragments of papyri from the Ramesside period. Thanks to modern science this unfixable mistake would not occur today.

The ancient fabrics on display are Coptic so, like the first papyrus, later than the artifacts of interest to Journal readers, but nonetheless it can be said that when it comes to ancient textiles their fragility and the complexity of their patterns make it impossible to reweave them. Moreover, as the wall panel says, *"the specific nature of the material and its fabrication also exclude the use of synthetic products (paints, resins, nanotechnologies and chemical products in general) because they would be too invasive for the fabric."* When it comes to the conservation of textiles, each case is different and must be worked out case by case. Wall panels explain the different colorants extracted from plants and animals: indigo wood, madder, kermes/cochineals, weld plant, turmeric and salt flower, and the different dyeing methods in antiquity: using a mordant, in a vat or directly.

The most important single ancient artifact "on display," except it's not, is the coffin of the royal scribe of Butehamen, a key figure in Egyptian history, who was active during the overlap between the end of the New Kingdom and beginning of the Third Intermediate Period (reigns of Rameses XI through Smendes). He was responsible for rescuing and restoring the plundered royal and other mummified remains from the Valley of the Kings tombs, and their re-interments in TT320 and KV-35, the Royal Mummies Caches.

Butehamen's coffin set (two) arrived in Turin in 1824 with the Drovetti Collection. It is presumed to have been found reused in the tomb of a Deir el Medina craftsman named Nakhtmin (TT291). In 2014 the coffins left Turin for the Vatican Museums, where they were restored over six months as part of the Vatican Coffin Project. Butehamen's outer coffin is today on display on the ground floor of the Museo Egizio, but not in "Archeologia Invisibile," where, in the empty last room, it is magically reconstructed on a full-scale white plexiform model onto which various stages of the coffin's construction are projected. This is accompanied by an approximately five-minute 3-D video.

Captions there report about the scribe's life and career, but also additionl information: 1) Butehamen's job as "scribe of the necropolis" was to protect graves from thieves; 2) His coffin is made of thirty pieces of wood joined together with pegs; 3) High radiopacity along the perimeter shows extensive use of silt to model some elements; 4) The x-rays also highlight the reuse of other parts; in this case the hole for a false beard has been plugged; 5) The hands have been altered, as well; they perhaps had extended fingers, like on female coffins, then were reshaped for a masculine one; 6) The reuses are more evident on the basin than on the lid, because older layers of decoration are visible through its fractures; 7) The basin's left side comes from a "black varnish" coffin, in vogue about 300 years before Butehamen's time. After it was assembled, the case received an initial decoration later covered by what is evident today; 8) A lot of silt was used to connect the head to the right flank, which comes from another coffin; 9) The lid was made from scratch, then modified as reported in 4) and 5); the basin has parts from four different coffins.

The video has a romantic ending: the text of a letter written on an ostracon, now in the Louvre (N 698) and not displayed in "Archeologia Invisibile," from Butehamen to the coffin of his already dead wife. It reads: *"Oh noble coffin of the singer of Amen Ikhtay, who rests inside you! Listen to me so that you can convey my message. As you are near, tell her: "How are you? How are things?"*

Thus, "Archeologia Invisible" comes full-circle. First visitors are shown the equipment early archaeologists used; then what modern technology has allowed us to see which is not visible to the naked eye; and, lastly, recreates by video-mapping an artifact that is not otherwise physically displayed. Instead "Archeologia Invisibile" presents it virtually.

About the Author Lucy Gordan-Rastelli is an independent journalist based in Rome and the Journal's European correspondent.