RTI IMAGES FOR DOCUMENTATION IN ARCHAEOLOGY

The Case of the Iron Age Female Terracotta Figurines from Buṣayra, Jordan

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ABSTRACT

Starting from a set of figurines from Buṣayra, this article describes a project in cooperation between the universities of Basel and Strasbourg to create a virtual collection of 450 widely-scattered terracotta female figurines from Jordan. The project aims at measuring and recording the figurines and fragments of figurines using RTI/PTM techniques, and compiling them in a virtual database. The ultimate goal is to create the digital tools for visualization, virtual assembly, and interactive annotation, opening up and encouraging international cooperation, and providing a solid basis for the enhancement of World Heritage objects.

KEYWORDS: female figurines, Jordan, digital humanities, RTI images, collection building, data storage

The Iron Age Female Terracotta Figurines from Transjordan

At present, 450 female terracotta figurines from the Iron Age II (1000–600 BCE) found in Transjordan are known (Fig. 1). These figurines, representing a female figure, which is nude or (less often) dressed, sometimes holding a frame drum, pregnant or breastfeeding a baby, constitute a widespread category of artefacts in the southern Levant, to the east as well as to the west of the Jordan River. Their identification and use are still unknown. Nevertheless, because of the similarities of technique and iconography of these figurines, questions about their origin, diffusion, and reception in the different Levantine societies need to be asked. According to textual witnesses, the Old Testament included, the relations between the different kingdoms and societies in the southern Levant were often marked by border conflicts and wars; however, figurines fashioned in the same molds on both sides of the Jordan River indicate a more complex reality. In order to demonstrate cultural exchanges between the societies concerned by means of these small craft objects, archaeological, typological, ceramic, historical, religious, and anthropological analyses are necessary. One of the crucial tasks that has so far been neglected, for example, is the systematic identification and comparison of all objects found in the same square or locus of a given excavation site.

More than three-quarters of the female figurines from Transjordan are stored in difficult-to-access storerooms, and a little less than 10%, notably figurines published between 1930 and 1970, cannot be located at all anymore. It therefore appears to be of

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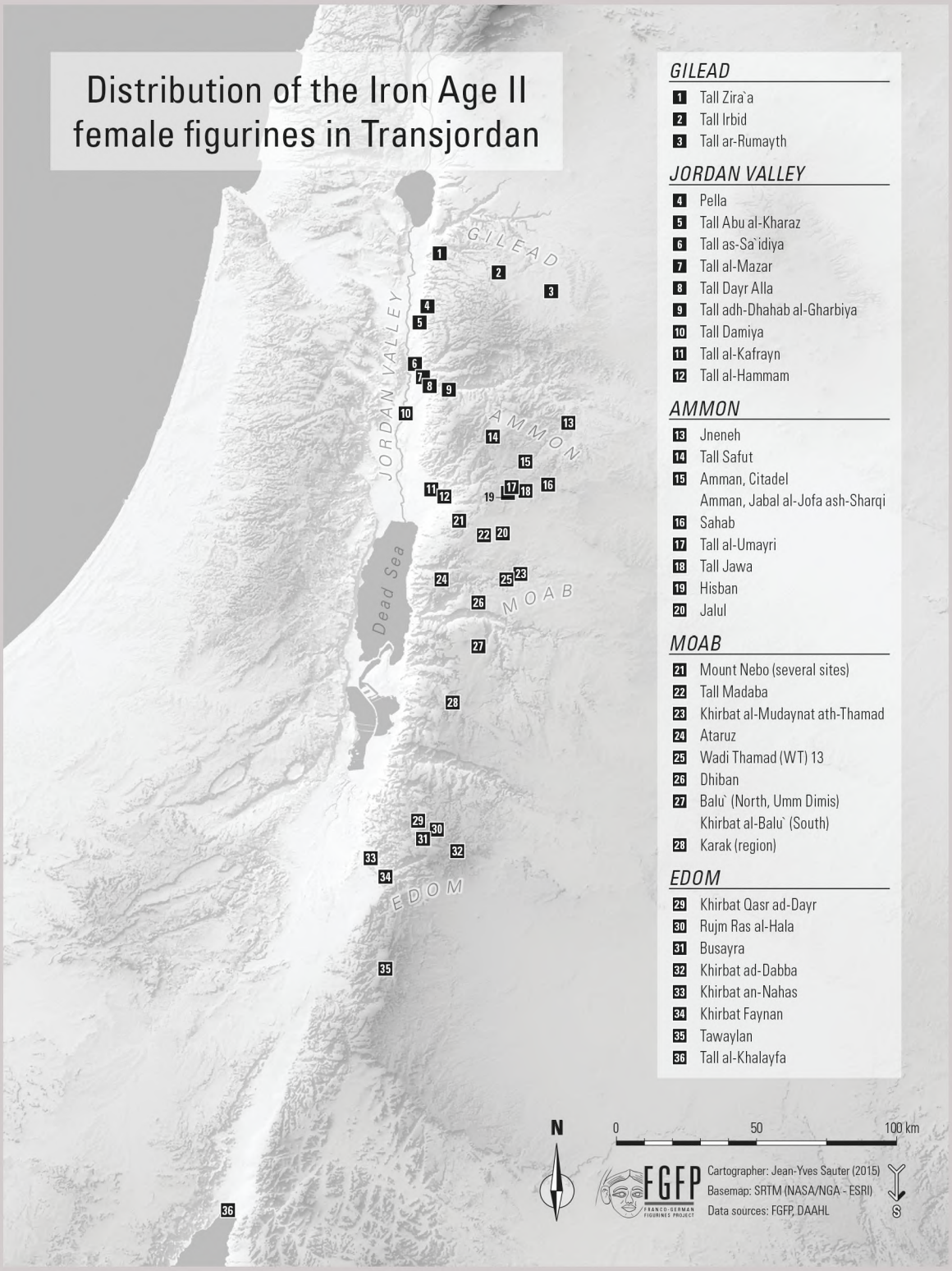

FIG. 1

Distribution of Iron Age II female figurines in Transjordan. (Map by J.-Y. Sauter; courtesy of the Franco-German Figurines Project.)

great importance to create an inventory of all known objects, especially given the political volatility of the region.[1]

The Franco-German Figurines Project (FGFP)

In 2012, a successful networking of interdisciplinary research interests led to the creation of the Franco-German Figurines Project (FGFP) by an Old Testament scholar (Regine Hunziker-Rodewald, Strasbourg), an archaeologist of the ancient Near East (Astrid Nunn, Würzburg), and a computational archaeologist (Thomas Graichen, Mainz). The team, financed by the universities of Strasbourg (more than two-thirds) and Würzburg, as well as by private funds, began, in the course of several research periods, to catalog the female terracotta figurines from Transjordan that are kept in museums, storage facilities, and university collections in Jordan, the United States, and Canada. For the recording procedure the RTI (Reflectance Transformation Imaging) technique was chosen because it generates very dense surface data from the photographed objects and goes far beyond conventional digital photography in terms of output format versatility.[2]

At the end of 2015, the Franco-German project on Transjordan figurines was accepted as a pilot project by the leaders of the *Archives Ouvertes de la Connaissance* (AOC) project of the University of Strasbourg. Since then, computer scientists from the IT Department of the University of Strasbourg have begun to establish the structure of the relational database, which will be built by means of improved, web-adapted RTI photographs, detailed descriptions, maps, and information on the type of object, its conservation status, dimensions, provenance, production technique, archaeological context, inventory numbers and specific bibliographies. Meanwhile the previously acquired RTI data are stored on the server of the University of Strasbourg while the clarification of legal issues has been handled by specialists from the Library Service of the University of Strasbourg.

Since 2017, Peter Fornaro of the Digital Humanities Lab of the University of Basel has joined the project,[3] and an open-access Franco-German-Swiss cooperation is emerging, dedicated to the virtual documentation, restitution, and contextualization of ancient art objects. The research of Peter Fornaro, who replaced Thomas Graichen, covers modern camera technology, innovative scanning methods like improved Reflection Transformation Imaging (RTI), color science, and digital preservation. In January 2018, with financial support from the Fondation Université de Strasbourg, the Hunziker-Rodewald/Nunn/Fornaro team was able to take RTI photos of over thirty female figurines in museums in London (British Museum) and Leiden (Rijksmuseum van Oudheden). The overall objective of this cooperation is to make available to the international scientific community a corpus of ancient artifacts, using advanced visualization technologies such as RTI for the web, in the form of an interactive database with a freely accessible user interface in four languages (English, French, German, and Arabic). This database will also contain an inventory of all data associated with these figurines as well as the results of ongoing research on their interpretation and function in the ancient societies concerned.

Buṣayra in Southern Jordan

During the years 1971–1974 and 1980, C.-M. Bennett conducted excavations at a fortified hill settlement south of Wadi al-Hasa in southern Transjordan, situated between Wadi Arabah and the Syrian Desert, 4 km west of the so-called King's Highway (Bienkowski 2002: 37–38). Bennett was not the first one to identify the site north of the present-day town of Al-Buṣeirah with biblical Boṣrah, in Hebrew "the inaccessible one."[4] In the Isaiah tradition, in both the Hebrew and Greek versions, בָּצְרָה / Βοσορ is placed on a par with the land of Edom[5] which might underline the regional importance of the site. Whether Boṣrah was, at least temporarily, Edom's capital, however, cannot be decided yet.[6] Apart from that question, one of the main reasons for Bennett's choice of the site for her excavations was its proximity to the Wadi Faynan mining district (Bienkowski 1990: 101),[7] which, at this geographical point only, is connected to the Edomite Highlands by a break in the cliffs.[8]

The Site and Its Female Figurines

Henceforth we will refer to the site by its conventional designation of "Buṣayra." In its ruins, 19 female terracotta figurines were discovered. Eighteen of them were found in the lower town (Area B) situated between the southwestern perimeter wall and the stone platform that supports the large open-court structure in Area A (Bienkowski 2002: 137) (Fig. 2).[9] The architectural remains in Area A probably belong to a public installation consisting of two large buildings constructed one on top of the other in such a way that the later building from the sixth or fifth century BCE replaced the earlier, larger building from the late eighth or seventh century BCE (Reich 2011: 305). In the adjacent Area B, where the 18 female figurines were found, small rectangular structures built against the perimeter wall suggest a domestic occupation probably by the personnel—servants and/or priests—of the large buildings in Area A and C in its southwest where a residence or palace was identified (Bienkowski 2002: 199, 476).

Stratigraphy and Dating

Buṣayra is only excavated to a small extent, therefore the stratigraphic connections between Areas A–D, H, and M are uncertain; nevertheless, the editor of the final excavation report has established an absolute phasing of the excavated zone. An absolute dating relative to two identified destruction episodes has been suggested for the integrated stages throughout the site. According to these propositions, one half of the female figurines in Area B has to be assigned to a settlement phase that preceded the mid-sixth century BCE,[10] while the other half[11] of the

figurines belongs to a settlement phase which extends from the mid-sixth to, at the latest, the end of the third century BCE.[12]

Against this background, given the typological similarity of the figurines,[13] questions arise about the long-term use of these objects or the possibility of heirlooms, and about the longevity of molds or mold generations (e.g., molds taken from molded figurines in case the original mold is worn or broken). The typology of the figurines might even relativize the postulated absolute stratigraphy and its dating. In any case, detailed comparisons of typology, of potential mold-links (e.g., figurines made from the same mold), and the identification, as appropriate, of mold generations (Hunziker-Rodewald 2017: 67, 76, 91–93) will be useful and reliable only if we use high-precision, reproducible, and true-color photographic recordings, digitally sensed models of the surface and virtually reconstructed complete shapes of these image media.[14]

Issues of Context and Interpretation

The 18 female-figurine fragments excavated in Buṣayra were found in a base area of about 20 x 20 m, 11 of them accumulated in only four different trenches.[15] This (random) pattern is unusual and hardly corresponds to the distribution of figurines within residential contexts.[16] In Trench B2.7, three of the four female figurines have been found even in the same locus (B2.7.4), which, besides ashes and clay, contained fragments of burnt painted pottery. The huge amount of very fine pottery, to a fair extent without signs of usage (Bennett 1973: 11), and of luxury goods such as a part of a rim of an inscribed Egyptian chalice and an engraved *Tridacna squamosa* shell in Area B is striking—whereas the temple buildings[17] in Area A produced significantly less finds.

This fact led the excavator to the suggestion that the buildings in Area A were sacked and the pottery (and figurines) thrown against the city wall in Area B (Bennett 1973: 11; 1974: 1).[18] Should this assumption be acceptable, then we can ask: Were these figurines—some of which were painted and at least seven of them represent pregnant women about to give birth[19]—ex-votos dedicated to the temple after a safe birth?[20] The thesis becomes all the more probable as four more fragments (legs, torso, bust) possibly also represent pregnant women—apart from the seven remaining heads which to date cannot be classified as belonging to a pregnant body. In order to be able to assign these fragments, documentation of the highest photographic quality is required, using software that allows for multiple edits of the captured data and for virtual measurement, comparison, and recreation of the fragments (see below on the imaging technology).

Apart from the fragmentary state of conservation and the not secure archaeological context of the Buṣayra figurines, a further problem, which is due to find-sharing procedures between the sponsors of the Bennett excavation, is the distribution of these artifacts between eight museums located on three continents. Therefore, they can probably never again be checked and compared side by side. Whether some isolated heads match the bodies can be decided only by using an identical technology for recording these fragments for the purpose of virtual comparability, which is the main approach when dealing with typology.

Issues of Typology: The Problem

The Buṣayra female figurines differ typologically from every other figurine corpus in Transjordan for at least two reasons (this, however, can only be asserted for each fragment if conditions allow for classification): (1) they represent a heavily pregnant woman (2) whose hair is covered partly or completely by a hood or a veil which in most cases hides the ears (Sedman 2002: 369–74).[21] While the terracotta portrayal of a female exhibiting *advanced* pregnancy is rare if not unique in the southern Levant,[22] several veiled or hooded female terracotta heads are known from Ḥorvat Qitmit in the Negev desert.[23] In that respect, the female figurines from Buṣayra could typologically refer to contacts and influences along the trade route connecting Arabia with Gaza via Buṣayra, Ḥorvat Qitmit, and Beersheba.[24] The typology of the female figurines east and west of the Arabah, especially their hooded or veiled heads, with local peculiarities,[25] testify in the field of material culture to a local, Edomite, tradition

in the area, which might indicate that the actual trade was less Assyrian-controlled[26] and was more likely to be carried out by Arabian tribes themselves (Bienkowski, oral communication).

In order to be able to grasp exactly the peculiarity of the presumed Edomite local culture along a possible connection between Buṣayra, ʿEn Ḥaẓeva, Tel Malḥata, Tel ʿIra, and Beersheba based on the female figurines' typology, researchers should have available to them better data than blurred photos and simplified drawings, which, when compared, further multiply the uncertainties.[27]

In way of summary, we state that: (1) drawings are subjective interpretations, comparative studies based on drawings alone are methodologically untenable; (2) the postulation of mold-links based on personal conviction that cannot be verified by the reader through corresponding detailed photographical recordings (including digital measurements) is useless; (3) worn fragments that are not digitally documented with utmost care are lost to research; (4) fragments of the same type of objects kept in (storage facilities of) remote collections and published only as low-resolution photos and line drawings of minor quality are practically worthless for scientific evaluation within the scope of disciplines such as comparative art and cultural history; (5) in the case of the improper documentation of small-sized fragmentary artifacts made of unremarkable material, valuable information for example about non-elite practices in ancient societies is at risk of getting lost.

However, there are ways to avoid "groping in the dark" when interpreting such artifacts.

Images for Documentation

Images have a long tradition in documentation (Talbot 1844). They have always played a vital part in archaeological research, especially for the purposes of documentation while doing excavations. Such reproductions allow researchers to take artifacts virtually back to their offices, where theories can be developed and discussed with colleagues. They are also important for the documentation of the current state of an artifact, for example one that is in the process of restoration. Such documentation is particularly useful if the object is only accessible for a limited time, be it on site or while the researcher visits a museum where the artifact is kept.

A common solution is to work with photographs. They document the visual impressions of objects and can be a precise tool for capturing the state of an original, including its color, geometry, and materiality. In addition, in the digital domain, new attributes can be advantageous: digital images can be easily accessed and disseminated. Therefore digital images have become an important part not only of art-historical research but of our cultural heritage in general, and they are an essential component of our contemporary multimedia output in the social, scientific, and economic fields.

However, when it comes to special attributes of artifacts such as surface roughness or relief, static and two-dimensional photographs cannot by any means reproduce the variety of visual impressions. Therefore, new approaches, technologies, and methods are needed to translate characteristic features of archaeological artifacts into the digital domain. Our computational-photography approach promises a more comprehensive way to capture, communicate, and disseminate digital images of archaeological pieces, one that goes far beyond conventional photography. New possibilities in computer technology and digital imaging have been developed to virtually transfer most of the relevant object features into the digital domain. Furthermore, these technological advances have brought a new standard in photographic quality. Color can be captured and rendered in much better quality, geometric distortion can be minimized, and even interaction is provided in web-based environments.

Technological Approach: Reflectance Transformation Imaging

A promising method to solve the above-mentioned limitations of conventional photography is Reflectance Transformation Imaging (RTI). RTI is a set of computational photographic methods that captures an object's surface shape and color and enables subsequent interactive re-lighting of the object from any direction, based on a mathematical surface model. To gain such RTIs, first the

reflection of light is captured by multiple photographs illuminated from different angles. Then, a mathematical term that describes the physics on the surface, typically a polynomial of second order, is fitted to the measured reflection for each pixel position. This approach is convenient from several points of view: only little hardware and software are needed to acquire such image, and the stability and reproducibility of the mathematical fitting process are easy to guarantee thanks to a robust model.

The major drawback of this method is the lack of the ability to render any gloss of a surface. A second-order polynomial is able to reproduce the reflection of diffuse surfaces, also called a Lambertian surface, while the realistic reproduction of shininess is not possible. A Lambertian surface scatters the incoming light equally in each direction in such a way that the apparent brightness does not depend on the observer's point of view. Although the radiance of the surface depends on the angle between the illuminating source and the orientation of a specific point on the surface, following the Lambertian cosine law, it does not depend on the point of view of the observer—it has a uniform reflection. A glossy surface, on the other hand, has a more or less strong component of specular reflection. Specularity means that light is reflected in one specific direction defined by the law of reflection (also called Snell's Law). A mirror is a perfect example of specular reflection. Another drawback is the RTI imaging workflow and the fact that the display of conventional RTIs needs a particular stand-alone application. The most advantageous way to work with RTI renderings is certainly a web environment based on standard technology, without plugins or other add-ons. There have been basic approaches to integrate an RTI viewer in web environments. Most of those implementations are still in the prototype phase or are not maintained well.

Therefore, we have improved RTI by the following means:

- Using a data-driven approach to find a better model or actually a combination of multiple models to be able to reproduce Lambertian and glossy materials with as few parameters as possible.
- Using WebGL to render RTI images in any standard web browser, even on most mobile devices. Such a solution opens up various new applications and the possibility for collaborative work because the viewer can be embedded in a web environment.

Furthermore, scholars may want to integrate information coming from other types of scientific photographs, such as infrared or ultraviolet illuminated or induced fluorescence photography to enrich the visual impressions of the artifact renderings with usually non-visual aspects. The combination of such scientific photographs with RTI images is especially advantageous because multiple visual impressions can be combined in a way that would not be possible in reality (Fornaro et al. 2017).

Hardware

The developed mobile custom-made hardware consists of a dome structure made of a composition of aluminum and acrylic glass. The device is equipped with 48 high-luminance, white-light LEDs powered by integrated electronics for automated capture with high reproducibility. The structure is approximately 50 cm in diameter and 35 cm in height. A standard high-resolution digital camera can be mounted on top of the structure. The full setup is calibrated before operation. Calibration includes the adjustment of intensity, white point of the LEDs and color correction of the capture. The LEDs can be synchronized with the camera by standard TTL flash-trigger signals. Besides LEDs in the visible range, UV or IR LEDs can also be controlled and therefore integrated in the measurement process to create an extended acquisition.

The setup is mobile, battery-driven, highly flexible, and especially designed for the purpose of RTI capturing on site (Fig. 3). The system can be configured to control the LED intensity by software. In addition, continuous light with all LEDs activated is possible for a very homogeneous illumination of the object in conventional digital photographs. The continuous full-light mode is optimal for various reproduction setups. The advantage of our approach is its compatibility with standard off-the-shelf camera equipment. It can be easily configured to automatically do sequential interval capture with any standard digital camera. The main advantages of this setup are its simplicity and robustness that lead to reproducible and calibrated results of high quality. Calibration is very important for RTI

FIG. 3
Light dome with 48 white-light LEDs for capturing reproducible RTIs. Ez-Zantur (Petra, Jordan). (Photo by P. Fornaro.)

image data because of the relevance of knowing exactly the position of the light source. By calibrating, larger collections of objects can be captured in a standardized, reproducible way without any additional error-prone human interaction. As a consequence, it allows for the study of light reflection on numerous types of surfaces and materials. Because of the identical capture of all images, results from various objects can be compared and conclusions can be drawn on the basis of precise and valid data. In addition, a well-documented and calibrated system is the key element for data sustainability. Only a reproducible, well-documented physical measurement process can lead to RTI image data files of sustainable scientific value.

Software

The strength of RTI is the possibility for the user to interactively change light direction. Therefore, a set of tools for rendering and interacting with RTI/PTM data in a web browser has been developed (Fig. 4).[28] The viewer implements controls that allow the user to change the magnitude of the specular and diffuse part of the digital representation. The web-based approach opens up many new possibilities, for example the dissemination of digital reproductions and the collaborative work between researchers. A specific binary executable stand-alone application limits any scientific discussion to a workstation. The software infrastructure required to support

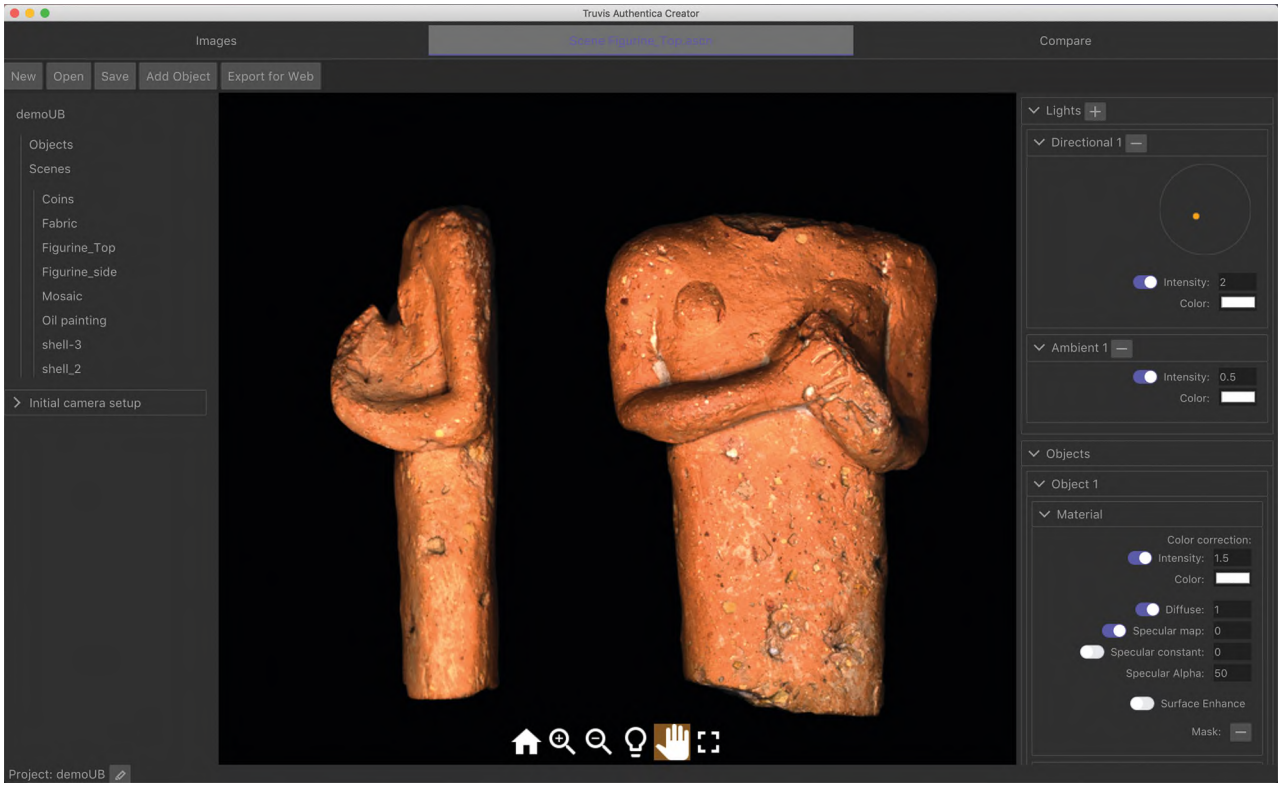

FIG. 4
Authentica RTI Software in comparison mode, simultaneously looking at two sides of the same object. Female figurine N874 from Tall Abu al-Kharaz (Jordan), early eighth century BCE. Current location: Gothenburg University collection (Sweden). (Photo by P. Fornaro; courtesy of P. Fischer.)

such collaborative work goes beyond a standard web-server solution. Besides Regions of Interest (ROIs) and linked comments and annotations, the full set of viewing parameters must be stored as technical metadata within the system. Furthermore, any time-dependent changes of those viewing parameters must be tracked for reproducibility and traceability purposes as a reference for any future discussion. Such traceability is also necessary to be able to cite a specific situation a scholar may want to highlight.

The Figurine Buṣayra Reg. 637

The deep-molded bust Reg. 637, which is preserved from the head to the thighs, is the most complete female-figurine fragment of the Buṣayra corpus (Fig. 5). Already broken twice in antiquity, at the neck and waist, it was mended after excavation and is now kept in the storage facilities of the Karak Archaeological Museum in Jordan. With the generous permission of the Department of Antiquities in Amman, R. Hunziker-Rodewald and her team were able to take RTI images of this figurine in November 2012.

The fragment may serve as an example of the urgent need for the high-precision photographical recording of this kind of artifacts. It was presented the first time, with a line illustration (Fig. 6), in an unpublished doctoral thesis submitted to the University of Oxford in 1975 (Holland 1975: 2:86, fig. 72:1). The explanations of the author, T. A. Holland, include: nude female plaque holding both breasts; single-molded without a clay "tablet" background; thick, squarish *headdress which at present has no specific parallels* elsewhere.

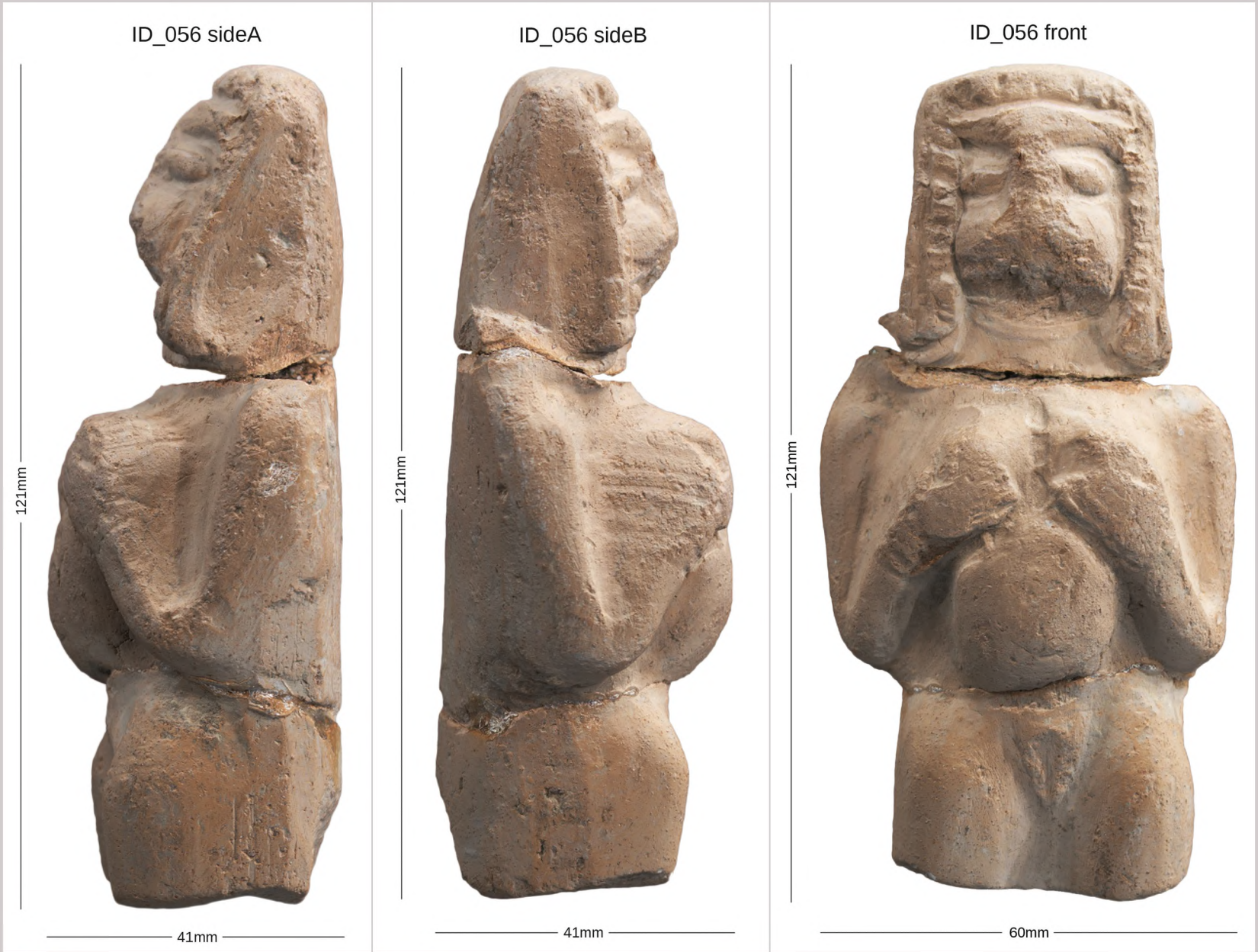

FIG. 5

Female-figurine fragment from Buṣayra (Reg. 637), now in the Karak Archaeological Museum. Terracotta, ca. seventh century BCE, 121 x 60 x 41 mm. (Photos by T. Graichen; courtesy of the Department of Antiquities via FGFP.)

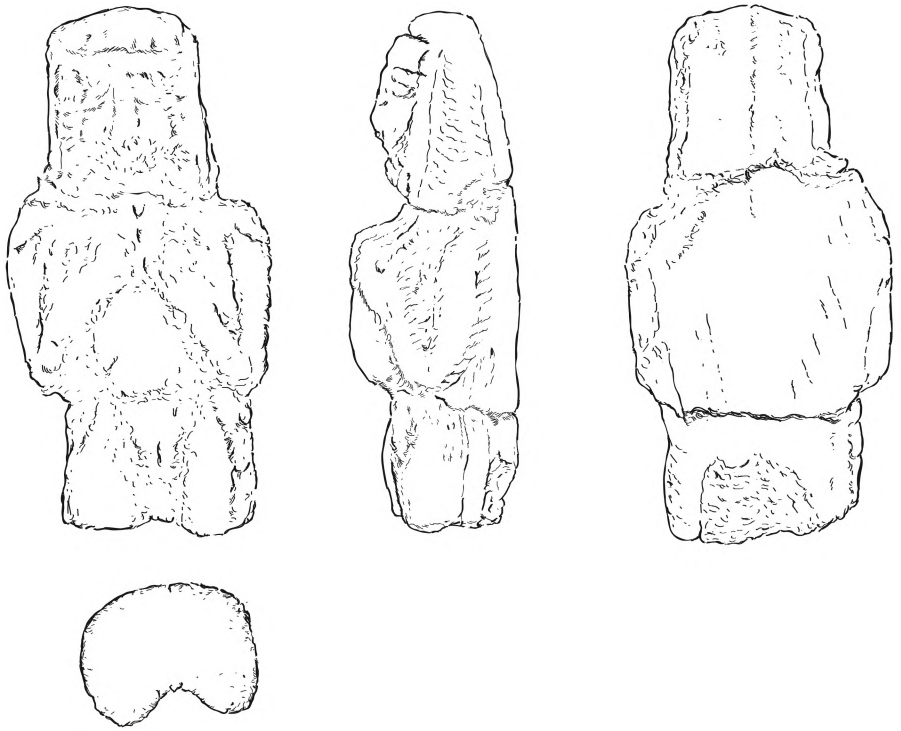

FIG. 6
Line drawing of the female figurine Buṣayra Reg. 637 after Holland 1975, vol. 2, p. 86. (Redrawn by J.-Y. Sauter.)

In 1980, the figurine was again presented, with another line drawing (Fig. 7), in an unpublished PhD thesis submitted to the University of London ('Amr 1980: 350 fig. 24). The comments by the author A.-J. 'Amr include: figurine holding its breasts; traces of *black paint* on the back of the headdress, on the shoulders, and thighs.

The drawing from 'Amr's dissertation was reproduced by R. Kletter in a publication from 1996 (p. 92 fig. 10:10; Appendix 4, p. 243: 4.VIII.1). The comments of Kletter on type 4.VIII.1 include: plaque figurine of a pregnant woman; type very different from the Late Bronze and early Iron Age plaque figurines; hands grasping the breasts, with the *thumb separated* from the other fingers; faces quite crude, with *sidelocks* reaching the shoulders.

The comments of these specialists in Iron Age figurines from the ancient Levant demonstrate how individual their perception is of details regarding the headdress/sidelocks, paint, or finger position of the object they study. Due to the poor quality of the line drawings, no reader can verify or otherwise evaluate the information provided by the authors.

In 2002, the figurine Reg. 637 was reproduced again in a photo of a drawing with sharper contrast and outlines (Fig. 8).[29] The author, L. Sedman, had access to the piece in the Karak Archaeological Museum in 1995, as well as to Bennett's excavation records in the National Museums Liverpool. Her comments include: traces of *black paint* in vertical stripes around the figure; holding breasts; eyes shown by *heavy incision*; hair or headdress?; genital area *exaggerated;* obviously pregnant; *necklace*.

The drawings in Sedman have been reused in at least one master's thesis submitted to the University of Liverpool (2010) and one PhD thesis submitted to the University College London (2017).[30] As these authors only relied on the drawing published in 2002, they could not provide new information about the represented details (headdress/sidelocks, paint, finger position, jewelry) of this figurine, but doubts about the represented pregnancy ("just . . . slightly plumper bellies," Trow 2010: 35) demonstrate very well the problems that arise when comparing drawings without having access to the original or, in its stead, high-precision photographs.

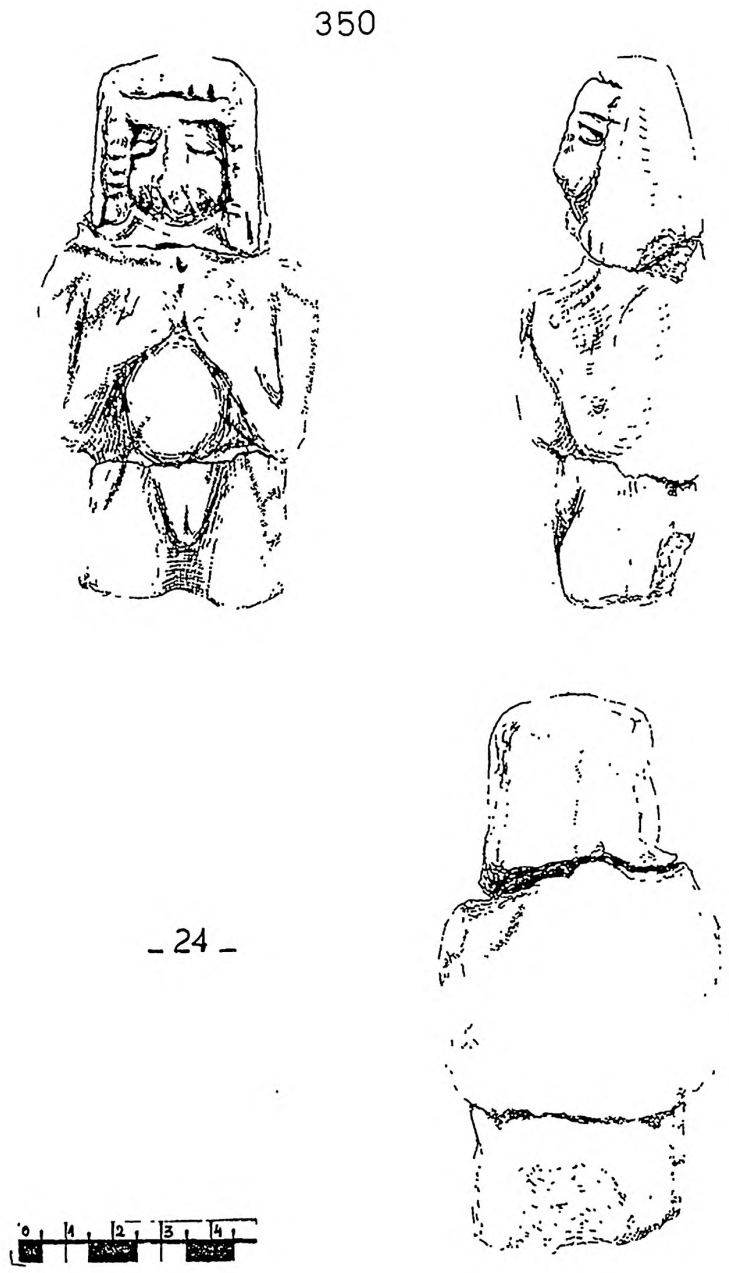

FIG. 7
Line drawing of the female figurine Buṣayra Reg. 637 in ʿAmr 1980, p. 350 fig. 24. (Courtesy of the University College London Libraries.)

Since very few researchers have the time and funding to look for the original figurines, from Buṣayra or elsewhere, in collections all over the world, an open-access database with interactive RTI images, which can be enlarged and lightened by each individual scholar from all the angles needed for their study, is an invaluable tool to foster research on these small objects of ancient art and cultural expression.

The RTIs taken in 2012 of the figurine Reg. 637 (Figs. 9 and 10) can finally provide details that have never been discerned from the drawings: (1) the hair (fringe, sidelocks) coming out from under the headgear on the front is covered at the sides and back by a shoulder-length veil or hood (see Fig. 7); (2) the figurine exhibits a neckband or choker; (3) it has almond-shaped, slanting eyes; (4) the hands are "cupping" the breasts; parallel lines mark bracelets on the

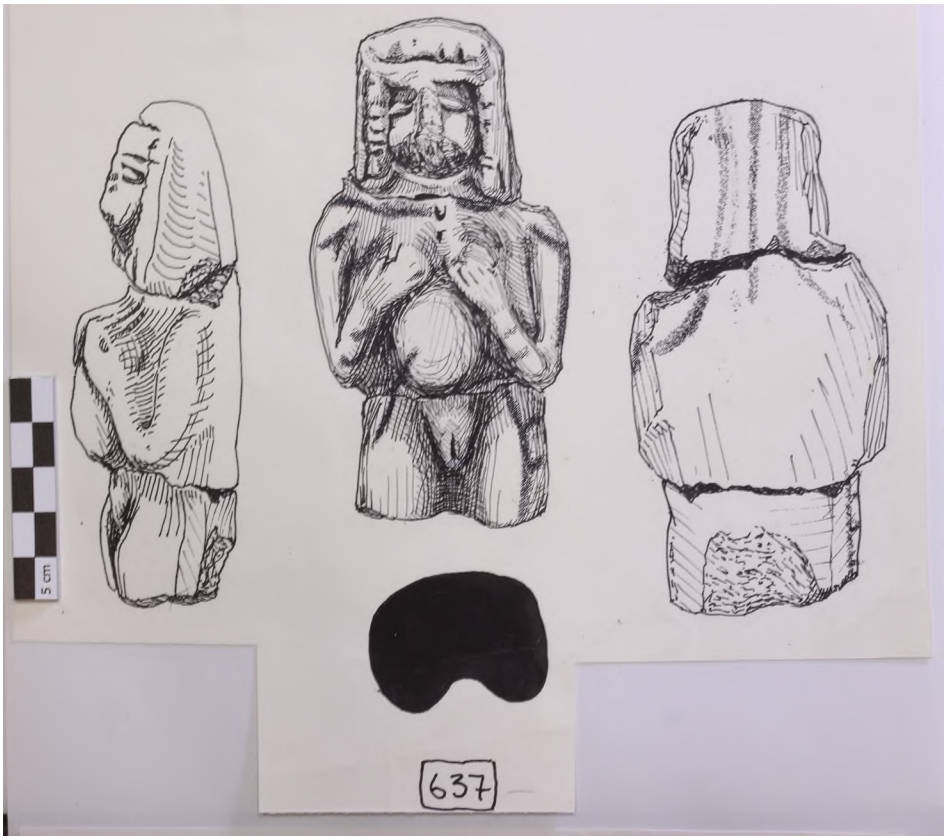

FIG. 8
Line drawing of the figurine Reg. 637 by the Bennett excavation team, reproduced in Sedman 2002. (Photo of the original drawing by A. Cooke; courtesy of National Museums Liverpool [World Museum].)

right wrist (see Fig. 8); (5) there may be traces of paint on the back (head, shoulders) and above the eyes.[31]

The interpretation of the observed details cannot be developed in the present article,[32] but the richness of details revealed by RTI photography is obvious. Nevertheless, documenting one isolated figurine can only be a first step in building up web-based collections or databases that can be searched, interactively annotated, and discussed among specialists.

Collection Building

The female figurines from Buṣayra are a very good example to show how important it is to build collections so as to be able to compare and correlate the images. A collection in the digital domain is a set of equally captured and represented image files comparable by means of perspective, illumination, color, magnification, and background. If those attributes are provided, digital image files can be compared to some extent as if the original artifacts were available on the same site. A nice example of this approach is the Fragmentarium project.[33] The Fragmentarium's primary objective is to develop a digital library specialized in medieval manuscript fragment research. Fragments can be virtually combined and analyzed in a web-based environment. In this way, it is possible to digitally recreate medieval manuscripts by combining fragments that are physically located in different places.

The same approach can be implemented for various types of artifacts, especially figurines or fragments of figurines. The basic idea behind this is defined in the International Image Interoperability Framework (IIIF; see Rosenthaler et al. 2017),[34] a standard initiated at Stanford University that allows for standardized access to image resources and their metadata via the Internet.

Outlook: Collaborative Work

Single objects and collections can be viewed and analyzed by individual researchers or collaboratively. Collaboration in the digital domain needs an appropriate infrastructure,

FIG. 9
Bușayra figurine Reg. 637, Normals Visualization, RTI HSH, 1540 x 2738, RTIViewer 1.1.0., snapshots: head, front and side. (Photos by T. Graichen; courtesy of the Department of Antiquities via FGFP.)

FIG. 10
Bușayra figurine Reg. 637, Normals Visualization, RTI HSH, 1540 x 2738, RTIViewer 1.1.0., snapshot: hands "cupping" the breasts, fingers indicated, parallel lines incised on the right wrist, aligned impressions between the breasts. (Photo by T. Graichen; courtesy of the Department of Antiquities via FGFP.)

typically, a database that offers simultaneous multiuser access. If such an infrastructure has built-in tools for the analysis of digital objects and their attributes, it is called a virtual research environment (VRE). A VRE typically offers tools for annotating and adding comments to digital objects. It also might allow selecting regions or marking specific spots on a virtual representation. If RTI images are embedded in such a VRE, this would open up for collaborative work. Virtually represented artifacts can be discussed in detail in ways that would not be possible with the physical artifacts. Additionally, such a solution can be used as a sustainable publication platform that allows for digital citation. The Digital Humanities Labs of the University of Basel and the University of Strasbourg are planning, in close cooperation with the Swiss National Data and Service Center for the Humanities (DaSCH),[35] to merge RTI visualization and VRE in the new project called figurine21—Creation of a standard model for the digital documentation, virtual reconstruction, and sustainable archiving of ancient art objects in open access by 2019.

Notes

1. See http://figurines21.di.unistra.fr/ (accessed April 2, 2019).
2. http://www.tgraichen.de/?otw_pm_portfolio_category=rti; http://culturalheritageimaging.org/Technologies/RTI/ (accessed January 7, 2019); see also Hunziker-Rodewald, Nunn, and Graichen 2018: 524–28.
3. http://dhlab.unibas.ch (accessed January 7, 2019).
4. From Hebrew *bṣr*, "cut off, separate." The site is surrounded by steep ravines and connected to the high plateau only in the southeast.
5. Isa 34:6; 63:1; see also Gen 36:33 // 1 Chr 1:44. On Edom see Weippert 1982; Bartlett 1989.
6. Additional settlement structures within the perimeter wall were identified in 2014–2015 by a team from the University of California, Berkeley during a geophysical survey (Brown et al. 2016).
7. Radiocarbon dates demonstrate continuous smelting activities in Wadi Faynan since the tenth century BCE (Levy et al. 2008: 16465).
8. On the relationship between the mining district (500 km², about 250 mining sites; Kafafi 2014: 263) and the Edomite plateau, see Finkelstein and Singer-Avitz 2009.
9. One figurine head (Reg. no. 457; see Sedman 2002: 370) was found about 100 m east of the other eighteen figurines, within the northeastern walls of the earlier Building B in Area A (A1.10), in the topsoil layer (Bienkowski 2002: 58–59, 96).

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10. Integrated Stage 2 (seventh century to 553 BCE); see Bienkowski 2002: 476.
11. Except one of the figurines in B6 (Reg. 969), which was found in the topsoil layer (Sedman 2002: 371).
12. Integrated Stage 3 (553–300/200 BCE); see Bienkowski 2002: 476.
13. The corpus of female figurines from Area B consists of seven heads, three busts, six torsos, and two pairs of legs. All these fragments were made in deep single molds so that the front and the sides are represented in high relief. Especially the legs, torsos, and busts show that the back was flattened, so these figurines were neither made in the round nor were they freestanding. They should not be called "(low-relief) plaques" as in the vast majority of cases there is no excess of clay around the represented figurine. These high-relief figurines were not produced by pressing a mold on a clay plaque, but by filling clay into a deep mold, removing the protruding clay, finishing the figurine taken from the mold on three sides and flattening the back. In the Buṣayra corpus, due to poor documentation, it is impossible to say if some heads and torsos or legs and torsos/busts can be joined.
14. See below on the imaging technology. Identified mold-links are a methodologically important "tool" for revealing the local and (trans-)regional network of tradition and innovation as well as the migration of people and ideas, see Hunziker-Rodewald 2017. Drawings alone—which often are simplified and always represent a subjective approach to shape and iconography—by no means suffice to draw far-reaching conclusions regarding cultural dependency and exchange (see, e.g., Bienkowski and Sedman 2001: 312; Sedman 2002: 374–75).
15. Trenches B1.2 and B6.3: two figurines each; trench B3.2: three figurines; trench B2.7: four figurines (Sedman 2002: 369–74).
16. See Kletter 1996: 107–13 (maps showing the location of Judean pillar figurines in seven occupation structures in Cisjordan).
17. For the possible interpretation of Area A as a temple area see Bienkowski 2002: 94–95.
18. But see the critique of this idea in Bienkowski 2002: 126.
19. The swollen vulva of Reg. 637, see below, is not "exaggerated" or "grotesque" (Sedman 2002: 370). On the position of the vulva on Iron Age female figurines from Transjordan see Hunziker-Rodewald, forthcoming b.
20. One of the figurine heads was found in the building in Area A (see above, n. 9). Concerning the interpretation of the Iron Age female figurines from Jordan as representing the reproduction phases of women see Hunziker-Rodewald 2017, 2018, forthcoming a, forthcoming b. The paint was probably applied after firing; that is why it is often faded or at least no longer visible to the naked eye.
21. On figurine Reg. 656 ears are visible, contra Sedman 2002: 368 (the photo [pl. 10.40] on p. 370 is blurred, that is why the ears are not recognizable).
22. See Bienkowski 1995: 80, 292 fig. 9.3:1 (from Tawaylan), and Beck 1995: 99–103 fig. 107 (from Ḥorvat Qitmit). These figurines probably depict (early) pregnancy, compare the call for caution by Sedman 2002: 375. See especially the Late Bronze Age molded glass pendants from several Levantine sites exhibiting advanced pregnancy (Tufnell 1958: 2 pl. 27:2; Barag 1985: vol. 1, p. 45 and pl. 2:15; Spaer 2001: 152 fig. 65, 153 no. 281, 356 pl. 23:281). As the pendants are pierced once or twice (at shoulder and knee level), they may have served as amulets (worn, e.g., on a necklace), an issue that must be considered when interpreting "pregnant figurines," see Hunziker-Rodewald 2018, forthcoming a.
23. Beck 1995: 106-107 (Ḥorvat Qitmit); see also Kletter 2014: 548 fig. 9.2:5 (Tel Malḥata).
24. See the identification of Edomite pottery in the eighth-century BCE "way station" of Beersheba by Singer-Avitz 2004, 1999: 30–39.
25. Five figurines of the Buṣayra corpus (Reg. 98, 190, 298, 457, 747, maybe also 285, 637, 656) show on the forehead the rim of an additional headband (or is it a two-piece veil?).
26. Contra Finkelstein and Singer-Avitz 2009.
27. Kletter 2014: 569–70, 572–73; see Bienkowski and Sedman 2001: 312; Sedman 2002: 374–75.
28. https://truvis.ch/examples/chiExamples.html (accessed January 7, 2019).
29. Drawing done by C.-M. Bennett's team. This original drawing was reproduced in Sedman 2002: 372 pl. 10.45.
30. Trow 2010: 35 fig. 16: #58; Briffa 2017: 311 fig. 10.1:4, both to date unpublished.
31. As part of the figurine21 project (see above) analyses by X-Ray Absorption Fine Structure/X-Ray Fluorescence (XAFS/XRF) Spectroscopy are scheduled of the elemental composition of the clay and the pigments applied as slip and/or paint on the figurines' surface.
32. But see Hunziker-Rodewald 2018, forthcoming a, forthcoming b.
33. https://fragmentarium.ms/ (accessed January 7, 2019).
34. https://iiif.io/ (accessed January 7, 2019).
35. Rosenthaler, Fornaro, and Clivaz 2015.

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