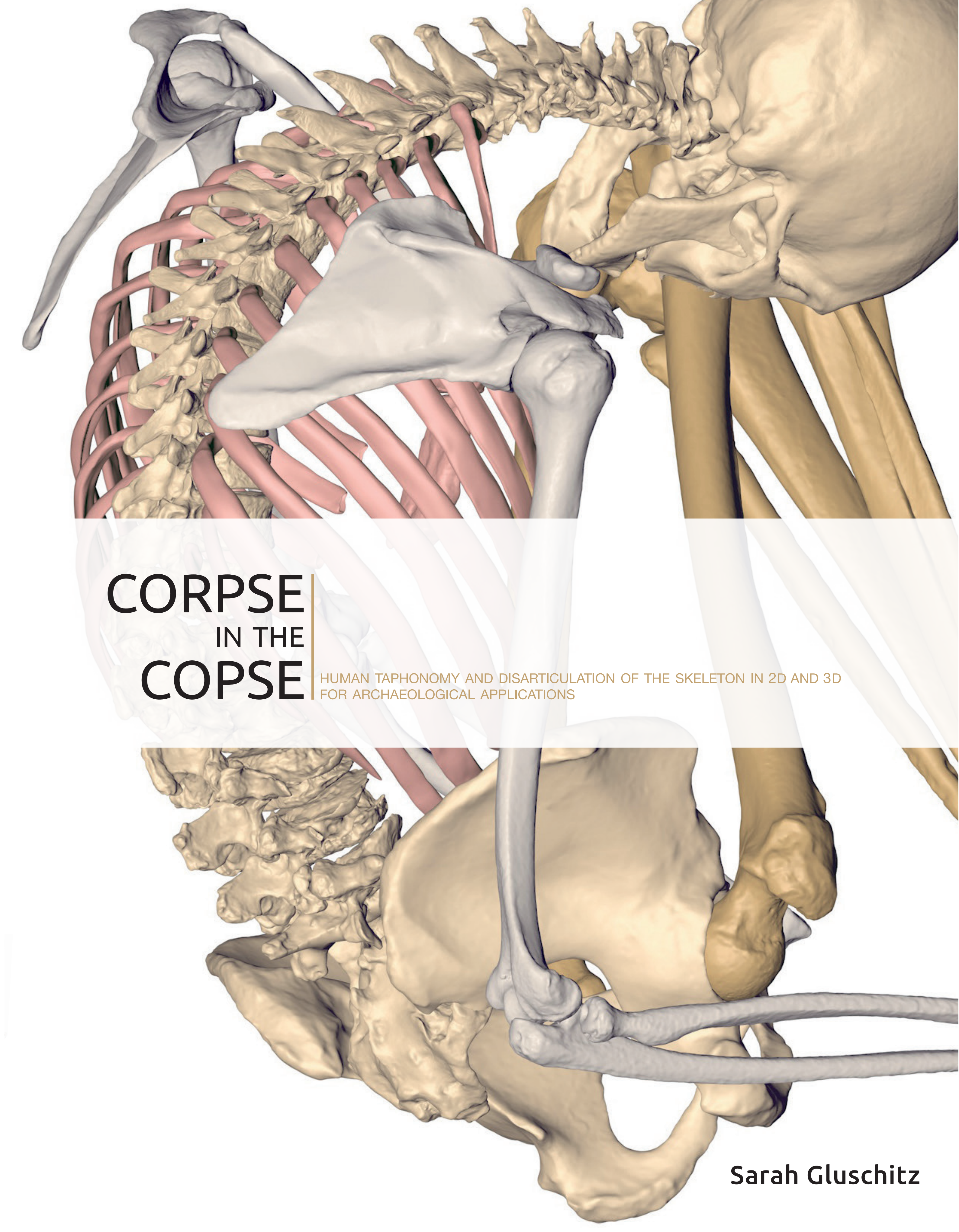


CORPSE IN THE COPSE

HUMAN TAPHONOMY AND DISARTICULATION OF THE SKELETON IN 2D AND 3D FOR ARCHAEOLOGICAL APPLICATIONS

Sarah Gluschitz

CORPSE IN THE COPSE

HUMAN TAPHONOMY AND DISARTICULATION OF THE SKELETON IN 2D AND 3D FOR ARCHAEOLOGICAL APPLICATIONS

by

SARAH GLUSCHITZ

A Thesis presented for the degree of

MASTER OF ARTS IN

SCIENTIFIC ILLUSTRATION

ZUYD University of Applied Sciences and Maastricht University

2018, MAASTRICHT, THE NETHERLANDS

Maastricht University Leading in Learning!

Academie Beeldende Kunsten Maastricht ZUYD

COLOPHON

Cover llustration	Lateral View of Skeleton on Day 1, Sarah Gluschitz
Co-editors	Rogier Trompert, Medical Illustrator/Program Director/Teacher, Master Scientific Illustration (MSI) Zuyd University of Applied Sciences, Faculty of Arts Maastricht, The Netherlands.
	Arno Lataster MSc. Vice Head of the Department of Anatomy & Embryology Maastricht University (UM), Maastricht, The Netherlands.
	Greet Mommen, Medical Illustrator at the Department of Anatomy & Embryology Maastricht University (UM), Maastricht, The Netherlands.
	Jacques Spee, former Head/ Teacher Master Scientific Illustration (MSI) Zuyd University of Applied Sciences, Faculty of Arts Maastricht, The Netherlands.
	Ilse Wielage, Fine Art Professional, Study Career Counselor, Teacher Master Scientific Illustration (MSI) Zuyd University of Applied Sciences, Faculty of Arts Maastricht, The Netherlands.
	Dirk Traufelder, Medical Illustrator, Teacher Master Scientific Illustration (MSI) Zuyd University of Applied Sciences, Faculty of Arts Maastricht, The Netherlands.
	Ruth Benschop, PhD, Lector, Research Centre for Arts, Autonomy and the Public Sphere, Faculty of Arts Maastricht, The Netherlands.
External Supervisor	Dr. Hayley L. Mickleburgh, Postdoctoral Researcher, Archaeology, Leiden University, The Netherlands
Design, Text and Illustrations	Sarah Gluschitz
Font	Adobe Garamond Pro, Helvetica Neue, Ubuntu
Printer	Walters BV, Maastricht, The Netherlands
ISBN	978-94-92741-06-6

INDEX

“A human body starts to decompose four minutes after death. Once the encapsulation of life, it now undergoes its final metamorphoses. It begins to digest itself. Cells dissolve from the inside out. Tissue turns to liquid, then to gas. No longer animate, the body becomes an immovable feast for other organisms. Bacteria first, then insects. Flies. Eggs are laid, then hatch. The larvae feed on the nutrient-rich broth, and then migrate. They leave the body in orderly fashion, following each other in a neat procession that always heads south. South-east or south-west sometimes, but never north. No-one knows why.

By now the body’s muscle protein has broken down, producing a potent chemical brew. Lethal to vegetation, it kills the grass as the larvae crawl through it, forming an umbilical of death that extends back the way they came. In the right conditions - dry and hot, say, without rain - it can extend for yards, a wavering brown conga-line of fat yellow grubs. It’s a curious sight, and for the curious what could be more natural than to follow this phenomenon back to its source?”

Chemistry of Death, Simon Beckett, 2006

Fig. 1: *FARF, Caging of fresh body donation,* Dr. Hayley L. Mickleburgh, August 2017

Fig. 2: *FARF, Excavation of body donation,* Dr. Hayley L. Mickleburgh, August 2017

Fig. 3: *ORPL, Cleaned skeleton,* Dr. Daniel J. Wescott, 2018

Fig. 4: *GEFARL, Photographing skeletal remains,* Dr. Daniel J.Wescott, 2018

PROLOGUE

And so, I did. I followed the "*wavering brown conga-line of fat yellow grubs*" (Beckett, 2006), a path cobbled with criminology novels, anatomy drawings, bones, visits to the natural history museum, photographs of Sally Mann, and a few years at the Royal Academy of Art in The Hague, until it led me South to pursue a Master's Degree in Scientific Illustration in Maastricht.

When I first read the opening paragraph of Simon Becketts book *The Chemistry of Death* I was taken by the beautiful, withal morbid image that he painted. Ever since I have become fascinated with the dead, body farms and forensics. Regardless I've never lost my interest in arts. Scientific illustration has become a way for me to combine both of my passions.

A group of vultures was circling the sky, whilst a few others would sit high up in the telephone posts and dead trees as we approached the Forensic Anthropology Research Facility (FARF), located on the Freeman Ranch, San Marcos, Texas. FARF is part of the Forensic Anthropology Center of Texas State University (FACTS) in San Marcos, Texas. It is an outdoor human decomposition facility, where scientists study the taphonomic process of the human body. During a three-week period, I visited the Freeman Ranch almost every day to help Dr. H.L. Mickleburgh gather data for her research. It gave me the opportunity to gain more insight on the origin of the data which I was going to work with during this thesis. Assisting in an excavation made me understand the difficulties archaeologists face due to the fragility of gravesites; highlighting the importance for accurate documentation. An excavation is always a destructive and irreversible process, which makes my work as an illustrator even more important. As a scientific illustrator, I have the tools to reconstruct an excavation site based upon the archaeologists data. Besides being able to reconstruct a site, my extensive knowledge of soft tissue and anatomy can help to interpret and reconstruct the taphonomic process. Hence, helping with the interpretation of burial positions and a therefore better understanding of past societies and their rituals.

Before donations reach FARF, they are being brought to and documented at the Osteology Research and Processing Laboratory (ORPL). Throughout my stay I was able to witness the arrival of the final donation of the series of experiments. I assisted Dr. H.L. Mickleburgh and forensic dentist Dr. J.P. Fletcher in the taking of tissue samples such as teeth, bone fragments and fluids. Subsequently it was transported and placed at FARF (Fig. 1). Once a donation has reached a preferred state of decomposition, depending on the research, it is carefully collected (Fig. 2) and brought back to ORPL. The human remains are then cleaned of any soft tissue (Fig. 3), numbered and eventually stored at the Grady Early Forensic Anthropology Research Laboratory (GEFARL), San Marcos, Texas (Fig. 4).

I spent half of my days at FARF and ORPL helping to collect data, and spent the other half at GEFARL, where I had access to the skeleton of donation one (D1). I used Structure from Motion (SfM), a photogrammetric imaging technique which allows the estimation of 3D structure from 2D images, to create 3D models of the individual bones for the purpose of a successful reconstruction of the process of decomposition and skeletal disarticulation.

Whilst assisting at FARF, ORPL and GEFARL I was able to observe the process of decomposition in numerous willed human body donations. I observed all stages of human decomposition from fresh to skeletonized, as well as the procedure of outdoor placement, data collection, retrieval and cleaning of skeletonized remains, and subsequent data analysis conducted at FACTS. Being in a very research oriented and professional environment, to me, the donations soon started to become less a person with a face, but rather the face of particular research.

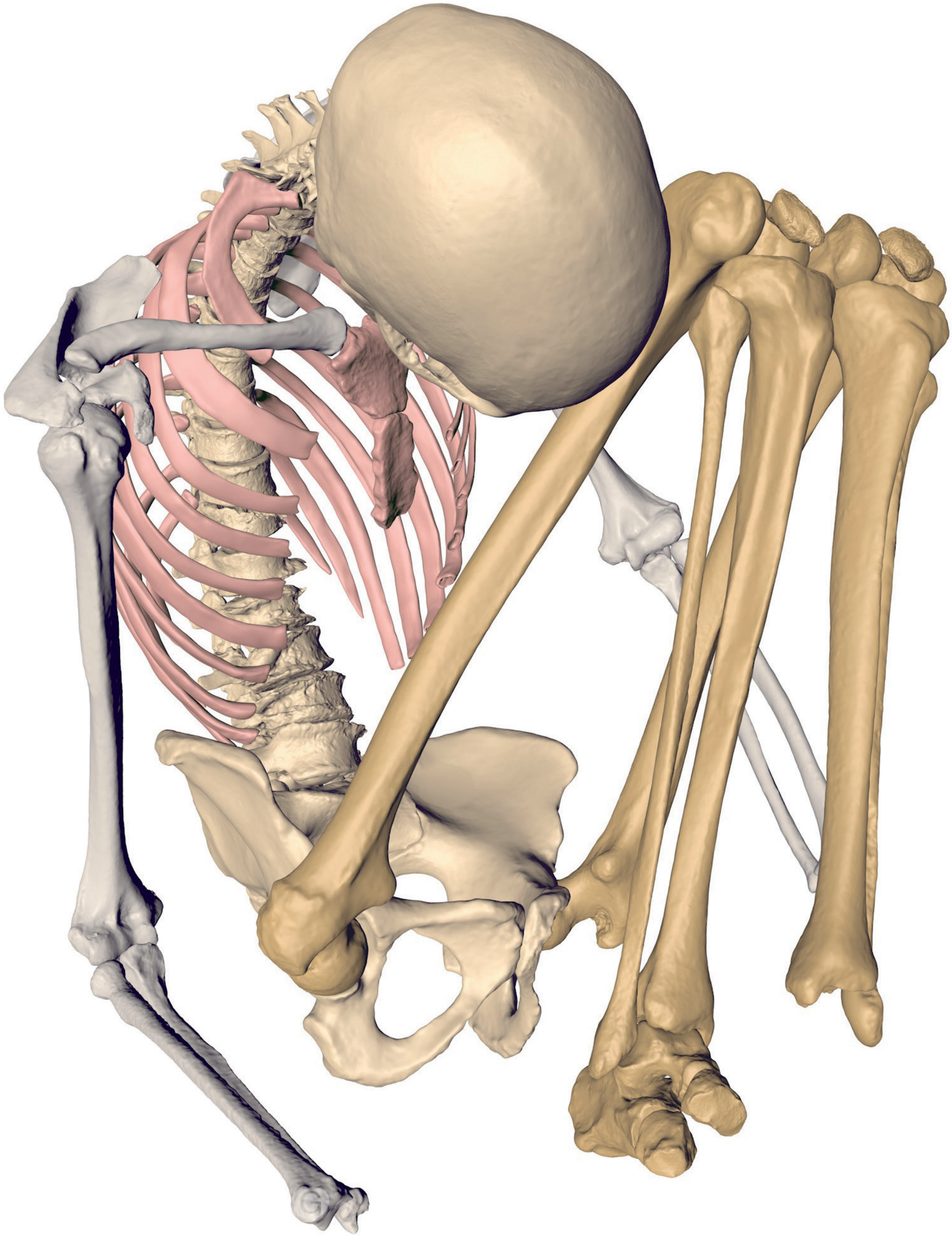


Fig. 5: *Donation 1 - Skeleton day 1*, SG
Upper extremity Axial skeleton Lower extremity Ribcage

INTRODUCTION

This thesis focuses on the role of scientific illustration in the study of the taphonomy of the human skeleton in archaeology. It collaborates with and illustrates the research of archaeologist Dr. H.L. Mickleburgh (*A forensic taphonomic study of the effects of decomposition on human remains for forensic and archaeological applications*). Within this research she is interested in the influence of the taphonomic process on the placement of the skeleton in the grave. For her research, she has conducted several case studies at a forensic decomposition facility in Texas, USA. One of those case studies, D1, will be the subject of this thesis: an open-pit placement, which has been thoroughly documented with Structure from Motion (SfM).

In this thesis I am introducing the expertise of a scientific illustrator as an investigative research tool for archaeologists; showing that scientific illustration is more than an illustrative outreach tool. I will translate this research into a stand-alone computer animated 3D model (Fig. 5) as well as visualize the sequence of disarticulation. With the help of the computer animation, a reconstruction of the original body condition and position upon placement is made. Allowing to follow the sequence of disarticulation at a stage where the view was obstructed by soft tissue in the field. The ultimate goal being to improve interpretation of archaeological human burials in future excavations. As such, it introduces 3D animation as a valuable research tool alongside the currently used quantitative analysis. In addition, the 3D animation represents an important public outreach and scientific education tool. Finally, this project has demonstrated the value of collaborative research between an archaeologist and a scientific illustrator, as well as the importance of involvement of the scientific illustrator in all stages of the research.

In 1987 Dr. W.M. Bass opened the first Forensic Anthropology Center, widely known as body farm (University of Tennessee, 2017). The Forensic Anthropology Center at the University of Tennessee led the way for several institutions that devote their resources to forensic anthropological research. Most of them situated in the United States of America with first ones opened up in Australia. One of these institutes is the Forensic Anthropology Research Facility in the heart of Texas. FARF, part of Texas State University, is in existence since 2008 and measures 26 acres of outdoor space making it the largest decomposition facility so far (Texas State University, 2017). Besides educating their own anthropology students and local law enforcement, they also have the possibility for scientists from all around the world to conduct their research at FARF. Dr. H.L. Mickleburgh is one of the scientists who is able to put her hypothesis to the test. She researches the effects of decomposition on human remains for forensic and archaeological applications. Doing so, she is one of the first archaeologists taking a generally known theorem to the test. While other archaeologists have theorized the influence of taphonomy, actualistic experiments still needed to be done.

The field of archaeothanatology has been around for slightly more than 30 years. It was developed by the French archaeologist Henri Duday. Archaeothanatology, being the study of changes in bodies after death, has as its core thesis that the position of recovered remains is not representative for the initial placement upon burial (Duday, 2006; Knüsel, 2014). This field focuses on identifying primary and secondary burials and distinguishing between intentional and accidental placement of bones. It also investigates whether a grave is a mass grave with simultaneously buried bodies or a collective burial site with successively buried bodies. Other focus points of archaeothanatology are body treatment, pre-burial transportation, disturbed post-depositions and containers or wrappings.

HISTORY

Portraying the death of humans in the arts is widespread. The portrait of decay on the contrary is minimal. Finding scientific illustrations on decaying human bodies has proved itself difficult. Going back a few centuries, the depiction of the stages of decay was not uncommon in the 13th to 19th century throughout Buddhist culture. *Body of a coutesan in 9 stages* (Fig. 6) is a series of illustrations surrounding the process of dying and decaying made by Japanese artist Kobayashi Eitaku (Eitaku, 1871). They were created in the 19th century visualizing the stages of decay from dying to bloating over scavenging and eventually complete skeletonization of the body. The display of a decaying body was not intended for scientific purposes, but had religious origins (Kaminishi, 2015).

In scientific illustration visualizing the decay of e.g. whales (Fig. 7) and other animals has found a place. While a series of illustrations on the decomposition of human remains was done in the 1820's by Spanish physician M.J.B. Orfila, it is difficult to find in the present. His illustrations show exhumed bodies as seen in figure 8. (Orfila, 1831). In 1987 the topic of human taphonomy arose again with the establishing of the Anthropology Research Centers. It eventually found its way into the world of fine arts and popular media. With her controversial photography series from 2001, *Body Farm*, Sally Mann has shine a new spotlight on the mainly hidden existence of the former (Fig. 9). Every now and so often the so-called body farms are talked about in the media e.g. documentaries or television series. *National Geographic* and other programs such as *Focus* have picked up on stories revolving around the human decomposition research facilities. Repeatedly, the reporting appeals to the sensationalism of the viewer. A current documentary reported on FARF's involvement with identification of border crossers at the Southern border between Mexico and the United States of America. However, even with such a serious topic the reporter also talked a lot about the olfactory experience and graphic imagery saying that it was "*quite an impressive smell*" (Focus, 2018). Rather than translating what the reporter said, the Dutch subtitles read "*Honestly, this is quite a substantial stench/stink*." (Fig. 10; Focus, 2018); appealing to the sensationalism of the viewer.

Fig. 6: From top left to bottom right: *Body of a courtesan in 9 stages,* Kobayashi Eitaku, 1871

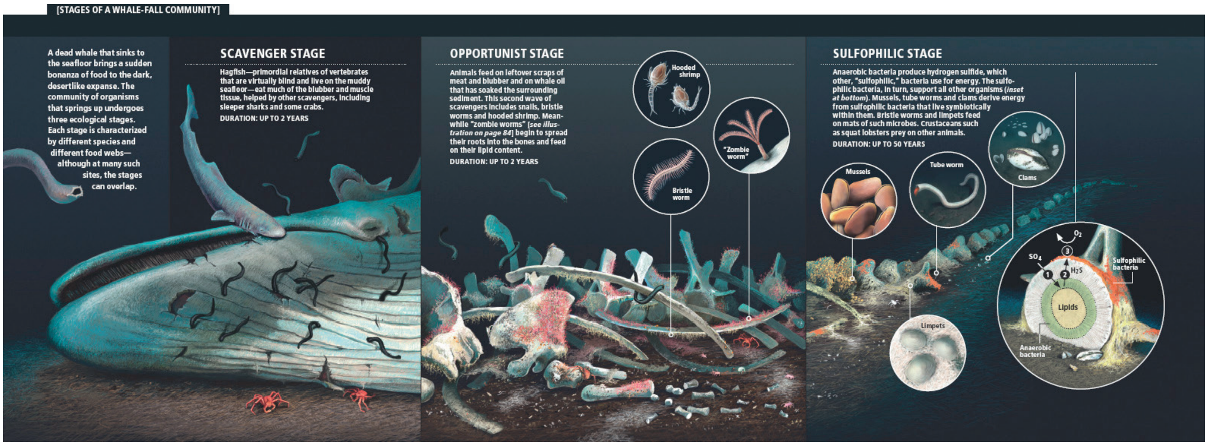


Fig. 7: *Stages of a whale-fall community*, Jen Christiansen and Catherine Wilson, 2010

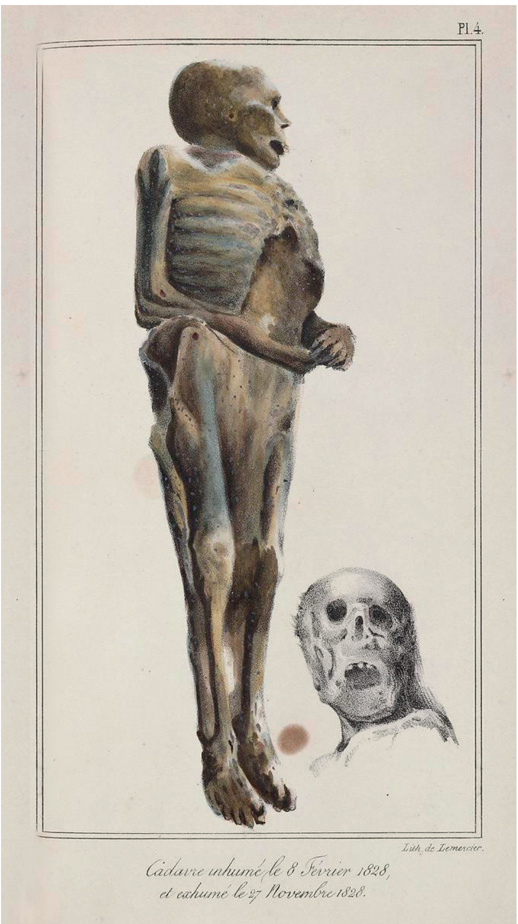


Fig. 8: *Cadavre,* Mathieu J.B. Orfila, 1828

Fig. 9: *Body Farm*, Sally Mann, 2001

Fig. 10: *Rondleiding op een bodyfarm 4:58* , Focus, NTR, 2018

RECONSTRUCTION
IN ARCHAEOLOGY

When it comes to reconstructions[1] in archaeology, there is a large variety of things to be reconstructed. Archaeological artifacts enjoy a big part of the reconstructional work effort as well as the architectural reconstruction of sites such as Forum Romanum in Italy or Stonehenge in England. The reconstruction of human remains and graves, especially reconstructions of e.g. early humans like Neanderthals can be found throughout museums. More often these reconstructions have been made by artists rather than scientific illustrators or forensic artists. This might lead to very subjective reconstructional work efforts. Dr. J. Hodgson conducted research on archaeological architectural reconstruction illustrations. For his research on the reconstruction of a Dewlish Villa, he supplied a variety of artists/ illustrators with the same information of an excavation and compared the results. He claims, that in order for reconstructions to be successful it is important for the artists/ illustrator to take the scientific aspect, meaning the opinion of the expert archaeologist, into full account; instead of imposing own interpretations on the subject (Hodgson, 2004). After receiving the illustrations he gave them to the archaeologists to evaluate them on accuracy as well as handed them to a museum audience, while he conducted a variety of other objective assessments. Figure 11 shows the most convincing illustration and figure 12 depicts the least convincing illustration. Expert knowledge as well as good communication throughout the process were crucial for the successful interpretation of figure 11. Dr. J. Hodgson analyzed not only occupation, age and experience, but also looked into the influence of more subjective factors.

To be able to reconstruct more than just the physical form of material culture, such as an iron cast sculpture, it is important to not only engage archaeologists, but also artists in the process. An archaeologist can employ 3D software to create a digital 3D reconstruction of a broken iron cast as well as eventually print it with a 3D printer. A digital 3D reconstruction bound to screen or paper stays flat. Once 3D printed it will however most likely miss out on the advanced tactile experience and structural integrity of the original material. The practicing artist, familiar with the material, technique and process can have helpful insight into the reconstruction beyond the physical appearance of material culture as researched by Dr. C. Hansen in her

1 Definition: *An impression, model, or re-enactment of a past event formed from available evidence* (Oxford Dictionaries, 2018)

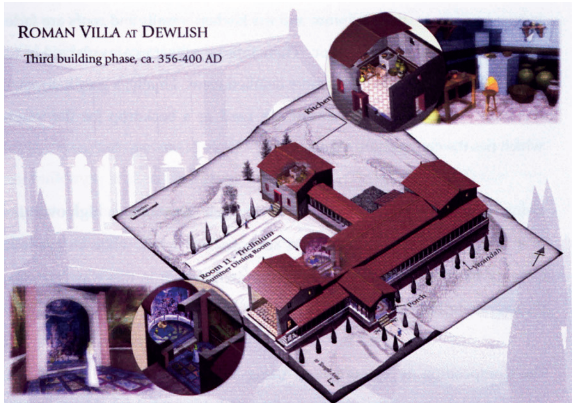


Fig. 11: *Roman Villa at Dewlish,* Unknown artist for Dr. John Hodgson, 2004

Fig. 12: *Roman Villa at Dewlish*, Unknown artist for Dr. John Hodgson, 2004

Fig. 13: *Pit Ponies*, Fiona Coffey, 2006

dissertation *The function of the Artist Interpreting Material Culture* (Hansen, 2008). While the archaeologist is able to do a theoretical and possibly imitational reconstruction, the artist can put that theory to the test (Fig. 13). Working closely together the archaeologist can use his/her expert knowledge combined with the artist's expert knowledge to create an educated and data/evidence supported interpretation of the artifact. Using artists as craftsmen to explore archaeological artifacts only works on a visual level, if there is no supervision by and collaboration with the archaeologist itself. By collaborating, the artist can assist the scientist with the development of research questions and go beyond explaining artefacts, leading to facilitating an experience.

Expert knowledge of the medium e.g. drawing/painting in Dr. J. Hodgson's experiments and iron casting in Dr. C. Hansen's experiment seems to be an important factor. It leads to believe that expert knowledge of the human body enhances the ability to create reconstructions of human burials. A good scientific illustrator is both an expert in illustrating, classically trained and a master in technique, as well as highly trained in anatomical knowledge. The anatomical knowledge gives the scientific illustrator an advantage over a fine artist. Nowadays there are fewer and fewer anatomy classes in art schools and a high emphasis on subjectivity and individuality in arts education. Whereas a scientific illustrator usually compares himself with a fine artist or illustrator, within this project it is important to compare the scientific illustrator also to animators. Animators are highly trained in the use of software as well as have a great insight into moving image creation. For a scientific illustrator guarding the objectivity of the visualization is one of the main focus points. The visualizations are intended to be as untainted as possible from personal preference and interpretation. All interpretations must be made based on hard evidence.

The book *The Archaeology of the Dead - Lectures in Archaeothanatology* by Henri Duday shows a broad spectrum of quality when it comes to illustrations of skeletal remains. In figures 14 and 15 (Duday, 2006) we see floor plans of archaeological excavations. These floor plans excel in accuracy as they are incredibly precise down to a millimeter. Floor plans are usually made during the excavation and are a direct outcome of fieldwork. They serve the purpose of documentation as well as interpretation, rather than publication. The archaeologist makes choices defined by the aims of the research design, preliminary interpretations of the past as well as interpretations of basic level observations, such as the precise shape of a stain in the soil. These choices are reflected in the chosen drawing method. Nonetheless, while they are accurate and at first suffice for the intended purpose, they are also two dimensional and confusing to fellow scientists and a less knowledgeable audience. A drawing made as a direct outcome of fieldwork is difficult to recreate at a later stage, in case the objective has changed.

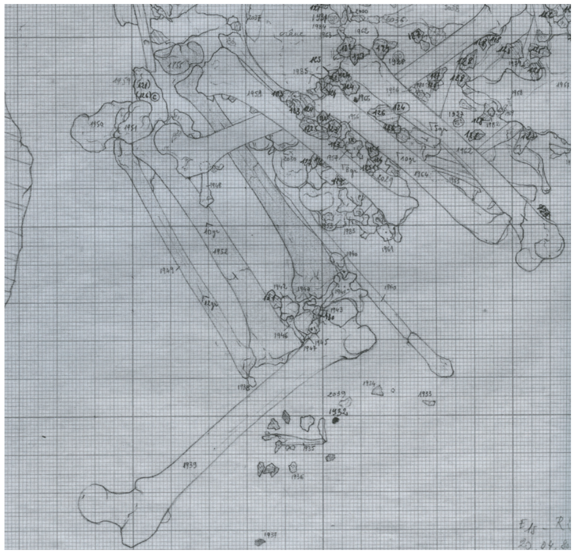


Fig. 14: *Excavationplan*, Henry Duday

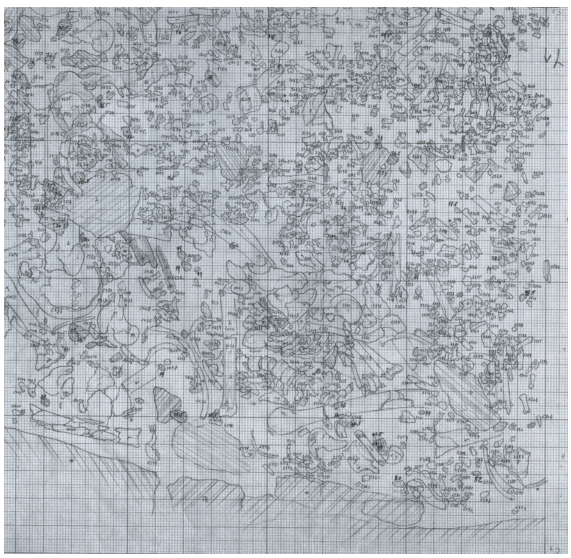


Fig. 15: *Excavationplan*, Henry Duday

In figures 14 and 15 all outlines are drawn in pencil on an equally saturated grid, while the numbering of the items is done in either pencil or pen to distinguish between bone and stone. This distinction is not as clear as one would wish for, nor does it help in identifying different individuals. A floor plan like this is great for initially registering the situation, but does not help in transmitting this information to others in a publication. Thus, this is where the importance of an illustrator comes back into play. The floor plan would ideally need to be processed by an illustrator, instructed by the archaeologist, in order to create a more comprehensible version.

Another example are figures 16 and 17 (Duday, 2006). They show excavated baby skeletons depicted in line drawings. Unfortunately, the interpretations of placement make use of a figurine with proportions attributed to a different age group (highlighted in red). It is common anatomical knowledge, that the proportion of head to body are different in babies than in adults. A baby has most commonly a proportion of 1:4, while a full grown adult measures 1:7 up to 1:8. In figure 20 the changing proportions are visually registered by Gottfried Bammes. The archaeological drawings however measure 1:6 up to 1:6,5, indicating a 7-10 year old individual according to Bammes (highlighted in red). Thus not matching the excavated bones of a stillborn baby. It seems rather obvious, that these interpretations have not been made with anatomical accuracy in mind. I have used the proportions of Bammes (Fig. 18) to reconstruct the burial position of figure 17 with correct anatomical proportions (Fig. 19).

With the development of digital applications, pen and paper are now often replaced with photographs, 3D scans of the site or video. Commonly used techniques are Geographical Information System (GIS), Ground Penetrating Radar (GPR), Structure from Motion (SfM) and Total Station Theodolite (TST). All of these techniques register different features of the environment, but have overlapping components. They register anything from surface mapping over subsurface mapping up to precise geographical coordinates. The availability of digital devices, which can be operated by the archaeologist itself, seems to make illustration gradually less relevant. Some of those techniques are low in cost, while others require big amounts of funding. SfM is an easily accessible and affordable technique with high quality outcome as one can see throughout this thesis; shifting the incentive

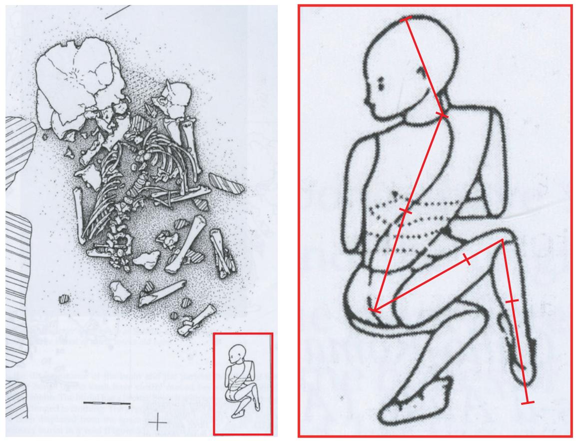


Fig. 16: *Excavationplan of baby*, Henry Duday, legend by SG
⟼ Head length

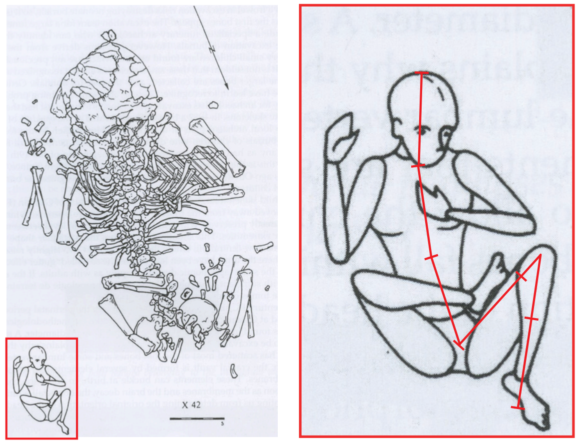


Fig. 17: *Excavationplan of baby*, Henry Duday, legend by SG
⟼ Head length

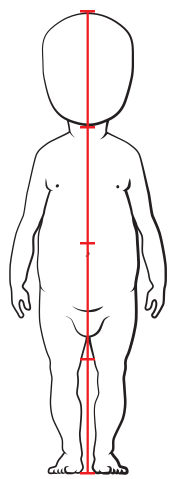


Fig. 18: SG after Gottfried Bammes
⟼ Head length

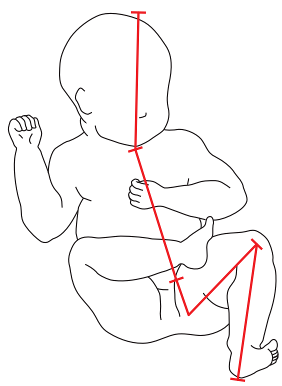


Fig. 19: *Improvement of fig. 17*, SG
⟼ Head length

of the scientific illustrator from depicting what one can register to visualizing the interpretation of the architecture of past structures or events, adding life to the excavation. It offers a different perspective of the gathered data, possibly leading to new methods as has happened in this thesis. Being a craftsman, visualizing the scientific aspect of research as well as translating it for a less knowledgeable audience is the main focus point; figuratively building a bridge between the world of archaeology and the public as well as other research disciplines. Illustrations cannot and should not replace the data collected through any of those techniques, though they can present an extra dimension to the acquired data.

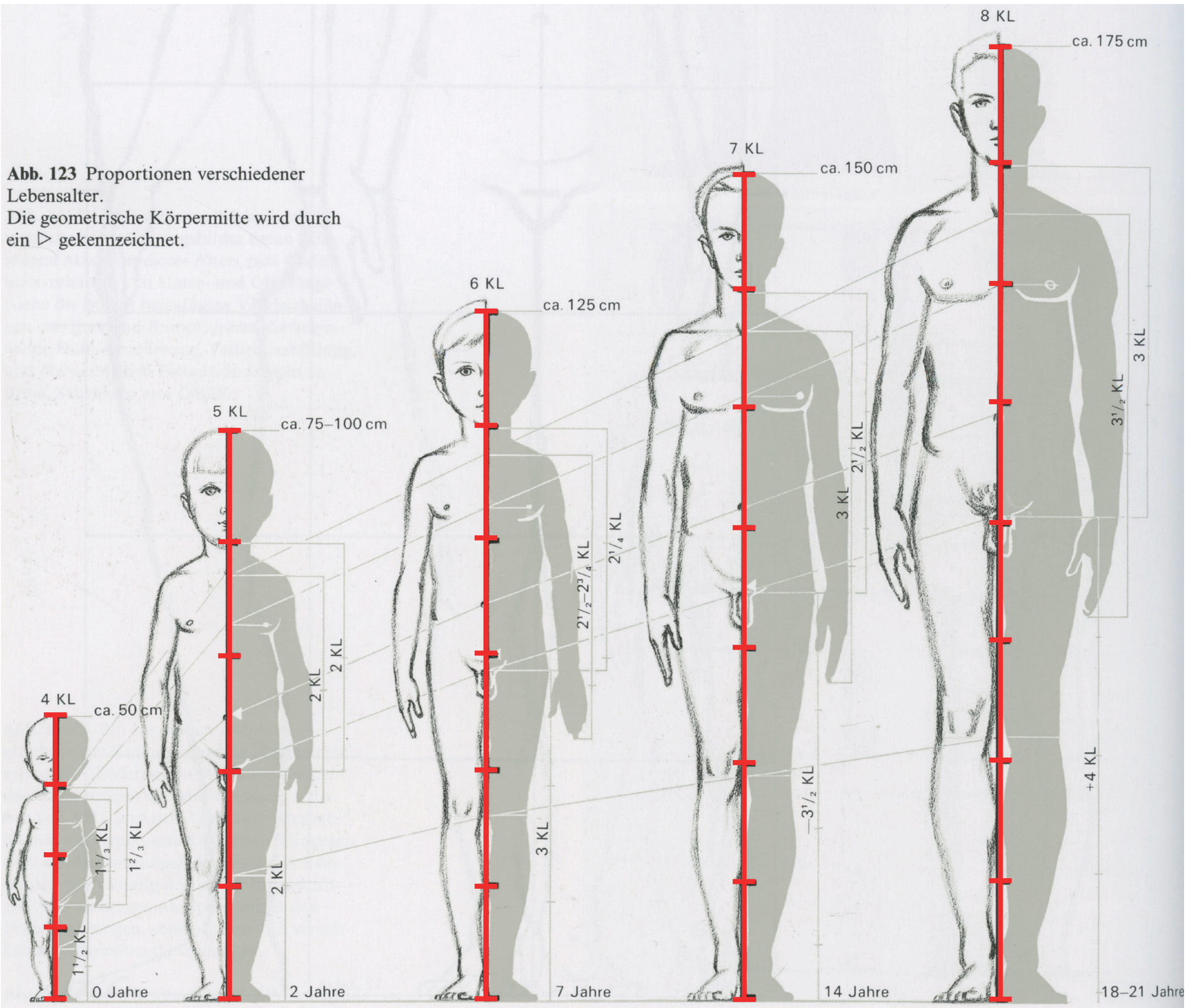


Fig. 20: *Proportions of different age groups*, Gottfried Bammes, legend by SG
Head length

RECONSTRUCTION
OF AN ARCHAEOLOGICAL EXPERIMENT

At FARF researchers work with willed donated human bodies. Donation one (D1) is one of them. D1 is subject to the research *A forensic taphonomic study of the effects of decomposition on human remains for forensic and archaeological applications* conducted by bioarchaeologist Dr. H.L. Mickleburgh. For the purpose of this research Dr. H.L. Mickleburgh set up five experiments, D1-D5, at FARF in order to monitor the entire process of decomposition and sequence of skeletal disarticulation of the bodies and the effects of different variables such as burial type and body. D2-D5 are variations of flexed body position deposits, including an upright seated burial in a small pit and a naturally mummified body buried in dorsal flexed position in a small pit (Mickleburgh and Wescott, 2018).

D1 was placed in an upright seated position with the legs flexed at both the knees and the hip in a small open pit in 2015. The process from date of placement until retrieving the bones took a total of 219 days. During the first weeks there were daily observations and photographs taken, while later on those observations and photographs were done in greater steps. Besides the taking of photographs, there were also several time lapses made with a GoPro camera. Both, photographs and videos were used for SfM. Observations during that period include the movement of the body, insect activity, weather conditions and disarticulation of joints of the skeleton (Mickleburgh and Wescott, 2018). In figures 21 and 22 the order of joint expansion, disarticulation, rearticulation and second disarticulation is mapped out. An emaciated silhouette, representing the bodily proportions of D1, gives perspective of the positioning of the donation in the pit. If the donation would have had a higher BMI, it would have resulted in a different position and influenced the order of joint disarticulation. Partially because of the emaciated posture and extreme weather conditions it only took about one month until the almost complete skeletonization of the body. While the experiment aimed to collect data on decomposition in an open pit, some excavation was needed at the end of the experiment as soil had accumulated in the bottom of the pit due to rainfall and erosion of the walls of the pit, as well as decomposition of a large maggot mass. During the excavation, the bones were recorded in two layers, removing the first layer of bones to expose underlying bones in order to document their position. Subsequently the bones were cleaned at ORPL and brought to GEFARL, where they were photographed for the creation of the 3D models using SfM for the purpose of this thesis project.

Dr. H.L. Mickleburgh required drawings, 3D models and an animation of D1 for the sake of digital and print publishing as well as educational purposes. Showing the process of displacement of the bones, disarticulation order and potentially rearticulation is important for displaying the movement influenced by the taphonomic process. The use of photographs of this research is restricted due to privacy issues and confidentiality agreements signed with FARF. Hence her research is difficult to display to others. Whilst she can write about the order of disarticulation and describe the movement of the bones, for many people it stays hard to visualize without concrete imagery.

The drawings and 3D model pose a didactical way of knowledge transfer without the graphic imagery distracting researchers from the needed information; creating imagery, that can stand by itself and does not need to be supported by long amounts of texts. It might help archaeologists to show spatial relationships more defined in imagery, rather than text and make them subsequently more didactic for future archaeologists as well as open up archaeological research for scientists from other fields. During the process of 3D modeling and animation, animation itself emerged as a potential research tool helping in analysis.

In the case of the non-existence of a confidentiality agreement or privacy issues alike, the use of photographs would counteract the intended goal of transferring knowledge. Although showing graphic images to a scientific audience within the confinement of a teaching institution might not pose a problem, showing the same images of a decomposing body to a less informed audience will most likely appeal to spectatorism and lead to misuse of the images. The triggering of spectatorism while seeing a decomposing body, would stand in the way of actually talking about the effects of decomposition on the skeleton. The attention span of an uninformed audience could easily drop to a point, where there is no discourse possible and talking about the graphic nature of the image becomes the main focus. Furthermore, illustrations are less confronting than photographs. Many people might experience the photographs as horrific. Illustrations or abstractions through 3D renders are more pleasant to look at; reaching a broader audience. More importantly scientific illustration gives the possibility to leave out confidential information (such as age, ethnicity, facial traits) and let previously hidden information appear. A scientific Illustrator

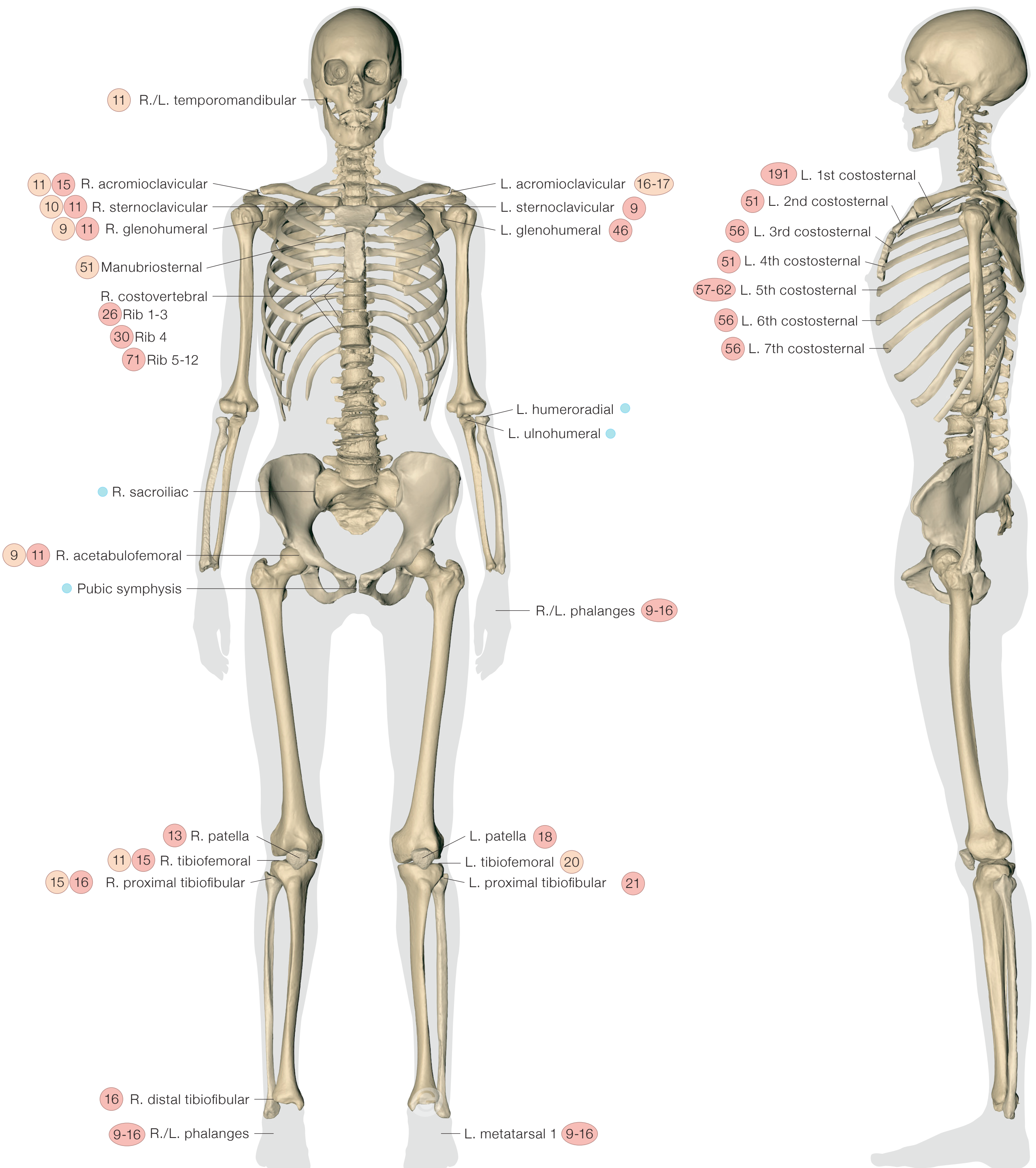


Fig. 21: *Ventral and lateral view of joint expansion and joint disarticulation*, SG

DAY Joint expansion DAY Joint disarticulation Adjustment of data needed

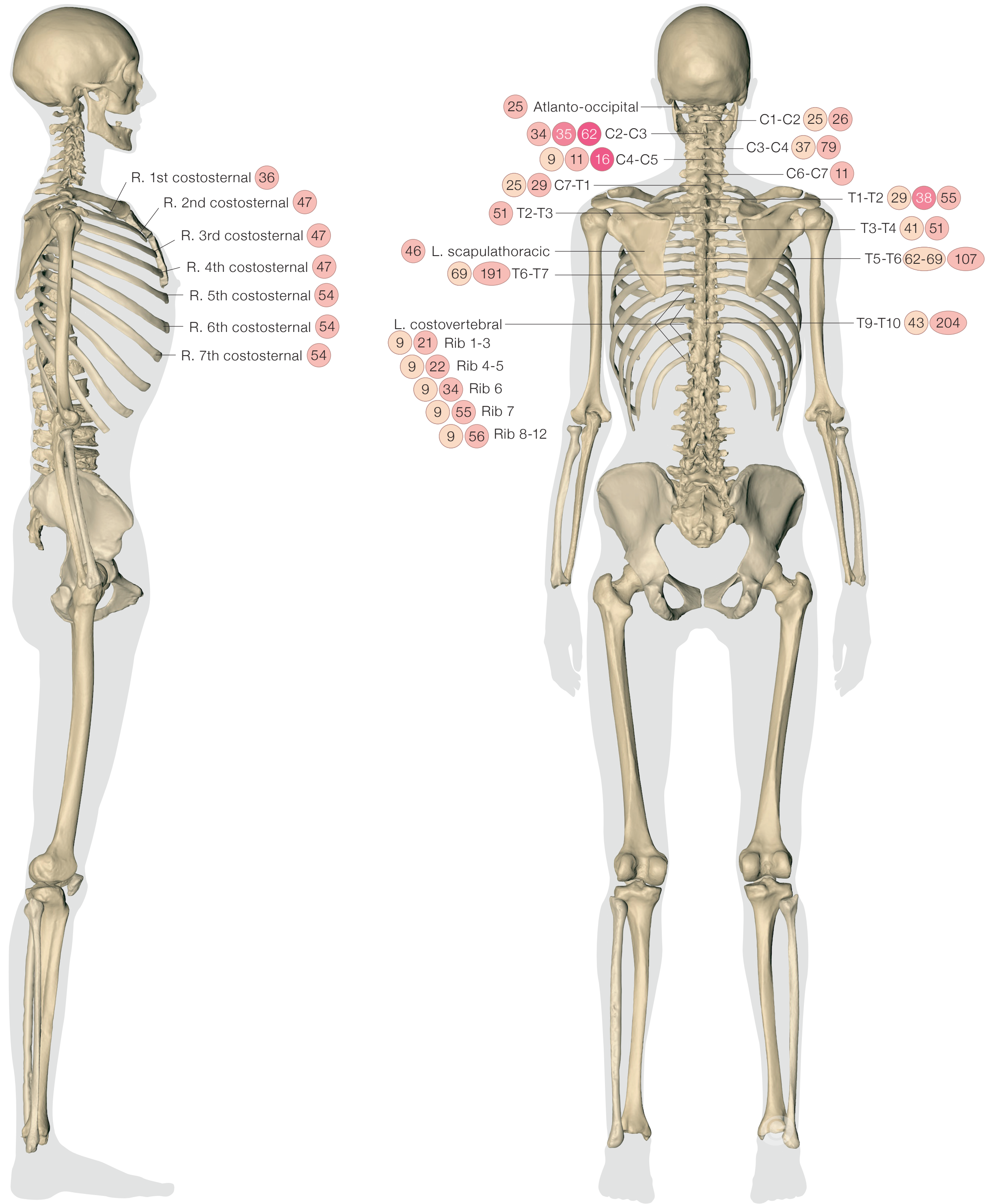


Fig. 22: *Lateral and dorsal view of joint expansion, joint disarticulation and joint rearticulation*, SG

DAY Joint expansion DAY Joint disarticulation DAY Joint rearticulation DAY 2nd Joint disarticulation is able to reconstruct different points of view, which were inaccessible with a camera, and use transparency to display the skeleton.

Using 3D imagery and the positive fascination attached to this medium will more likely intensify the attention span of the public. Even though 3D models are limited in their ways of presentation as they require a digital medium for viewing, they spark the 'Zeitgeist' of this generation. Online publishing, its use on smartphones, tablets and computers, along with museums employing large screens and lecturers almost always using projections, the public is easily engaged with the medium. A printed journal however lays out of reach, when it comes to a purely computer based 3D model. Therefore a set of line drawings is needed to assist. Together with still image renders of the 3D models the line drawings give a clear view on the subject for print publishing. Moreover the creation of line drawings benefits from the 3D models for accuracy and shows that both media are interwoven with each other.

RECONSTRUCTION IN 2D

During the Master program of Scientific Illustration one assignment of the curriculum is an anatomical elaboration of the human body. This means to reconstruct the skeleton and different muscle layers into a previously made drawing of a nude model (Fig. 23). It trains the eye to identify bony points and other visible underlying structures. This falls in line with positioning the skeleton inside the recently placed donation. In the case of the deceased body it is important to take note of the dead tissue. Dead tissue, particularly muscles, work differently than alive ones. Alive muscles always extend over the shortest way from A to B and therefore create relatively straight structures. At the same time, inanimate muscles lose their tension and do not always form direct paths. The absence of muscle tension leads to collapsing of the bodily structure, thus to unnatural positioning of body parts. Learning how to reconstruct the skeletal placement into the image of a body gives one a skill set, that easily translates to other bodies and in particular other BMI's.

In order to show the ability of a scientific illustrator being able to make an educated interpretation of a burial site, it is essential to put his/her ability to a test. Therefore, before starting on the 3D illustration it was important to make a start interpreting the data only using an untextured 3D model of D1 in initial placement. Taking photographs of a life model (Fig. 24) as well as reconstructing the situation with an articulated skeleton (Fig. 25) in order to get a better understanding of the initial placement. However, the positioning turned out to be quite difficult, as the animate model was not able to manipulate her body as extreme as the donation was manipulated before and the skeleton needed to be held in place with several supporting structures. Nonetheless, both the photographs of the model and the skeleton helped to put the bony points into perspective.

The skeleton was subsequently drawn inside the illustration of initial placement (Fig. 26, 27, 29). The articulated skeleton was partially used as a reference as well as disarticulated bones from the programs collection. The main purpose being the comparison of the drawings with the final illustrations, proving that even with a minimum amount of information a scientific illustrator is still able to make a scientific interpretation close to reality (Fig. 28).

Fig. 23: *Anatomical elaboration of a nude model; Left to right: skin, superficial muscle layer, deep muscle layer, skeleton*, SG

Fig. 24: *Life model in flexed seated position*, SG

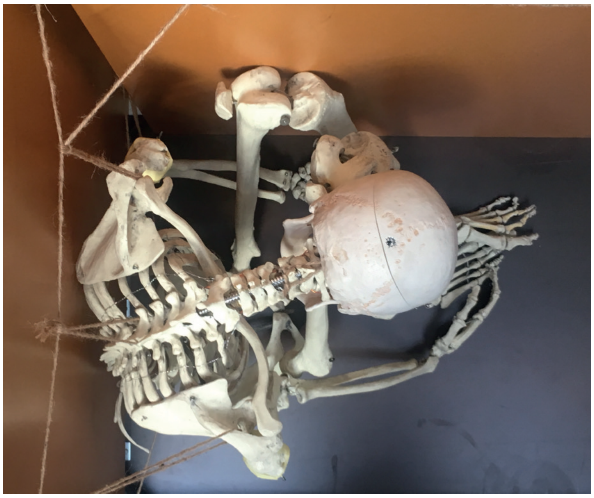


Fig. 25: *Articulated skeleton in flexed seated position*, SG

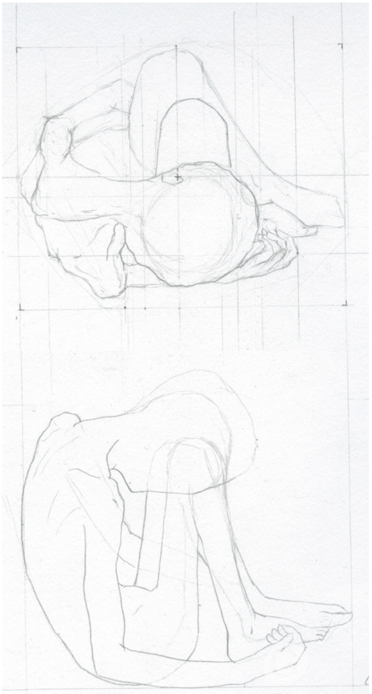


Fig. 26: *Sketch position D1*, SG

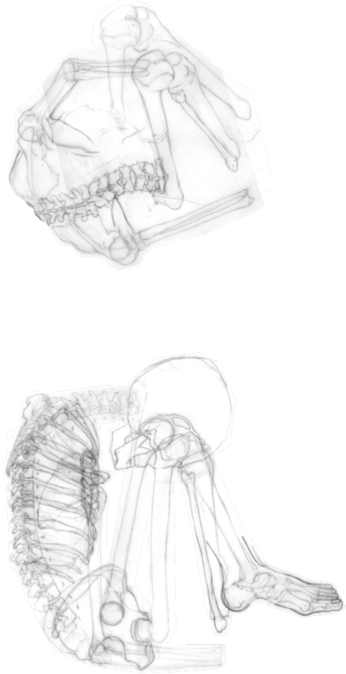


Fig. 27: *Sketch skeleton D1*, SG

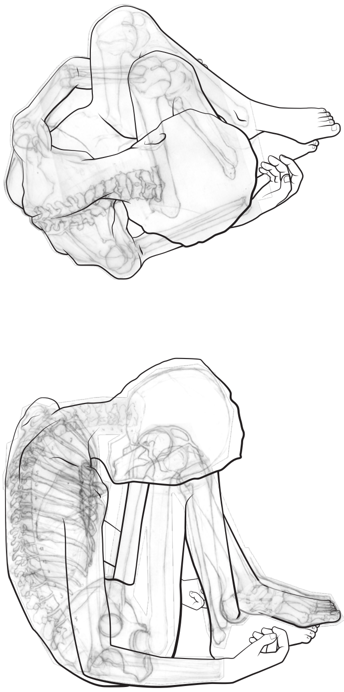


Fig. 28: *Initial drawing of placement D1*, SG

Fig. 29: *Stages of line drawing of initial placement D1*, SG

Hidden structures

RECONSTRUCTION
IN 3D

For the 3D reconstruction we used Structure from Motion (SfM). SfM is also commonly known as photogrammetry. It is an imaging technique using 2D photographs from an object or site to subsequently create 3D models. In order to capture an entire site, one needs to take photographs in several tiers around the site with no greater distance than 10-30 degrees and a minimum amount of 4-5 tiers; creating a dome like structure around the point of interest. Eventually the images are then imported into Agisoft Photoscan to convert them into 3D models. Photographing objects rather than sites asks for a slightly different technique. For the fastest modeling of the photographs a black background is required as Photoscan is able to automatically cut out the background (Fig. 30, 31). Therefore a black, light absorbing cloth was used to create a backdrop for the photographs. A spinning plateau was placed on top of it, covered in the same type of cloth and equipped with a mapping disc (Fig. 32). The setup and disc were originally created by Dr. S.T. Porter (Porter, 2017). The individual bones were placed in the center of the mapping disc and a camera on a tripod was pointed at it. It is important to take scans of both sides of the object, meaning flipping around the object in order to also register the bottom. Dr. H.L. Mickleburgh used Photoscan to create 3D models using these photographs. Subsequently she merged them in either Photoscan or Meshlab to create stand-alone 3D models. Those models were exported into the animation and modeling software Cinema4D. Due to the limited amount of time available during field work for taking the photographs, the decision was made that some bones needed to be skipped. The decision to take as many photographs as possible was made, prioritizing all long bones, hip, skull and shoulder blades. Through this, eventually all the ribs R2-R12 (left and right) and the thoracic vertebrae T1-T10 as well as the bones of the hands and feet, could not be photographed.

The vertebral column (Fig. 33) consists of 33 vertebrae; seven cervical, twelve thoracic, five lumbar, five fused sacral vertebrae and finally four fused coccyx vertebrae. No Coccyx vertebrae were found during the excavation on D1. Each vertebra has a similar morphological structure to its neighboring vertebrae; gradually morphing from one form to the next. Due to the complexity of the vertebrae and their coherent change in form, it seemed plausible to start merging the missing vertebrae from the forms of the photographed vertebrae. C7 and T11 were used as points of origin (Fig. 34, 35). T11 was scaled down, its spinous

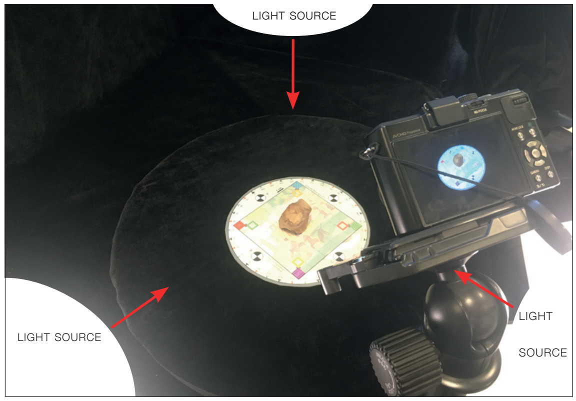


Fig. 30: *Photogrammetry set-up after Dr. Samantha T. Porter*, SG, 2017

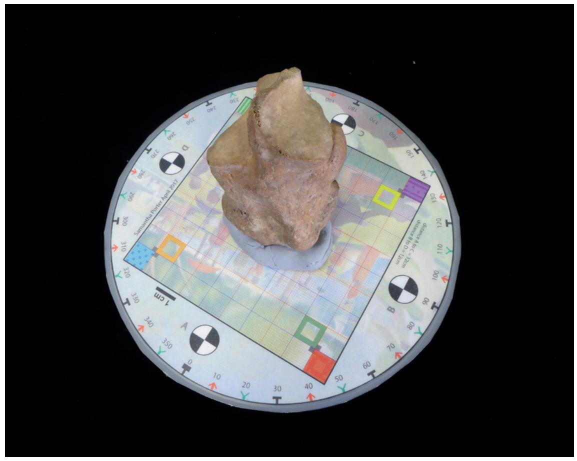


Fig. 31: *Example photograph, R. Calcaneus on scale*, SG, 2017

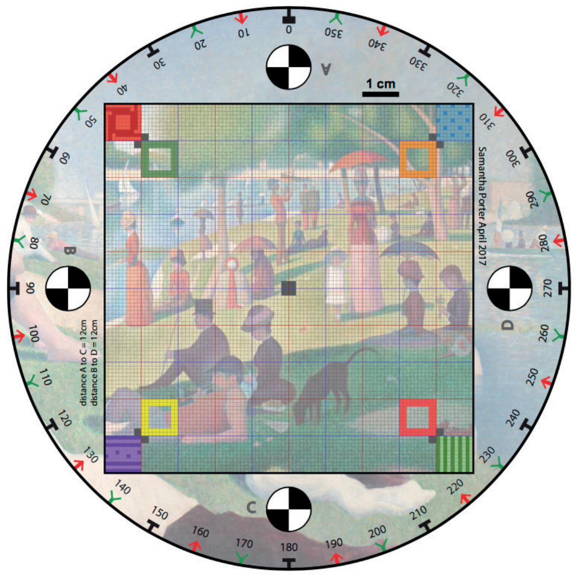


Fig. 32: *Photogrammetric scale*, Dr. Samantha T. Porter, Spring 2017

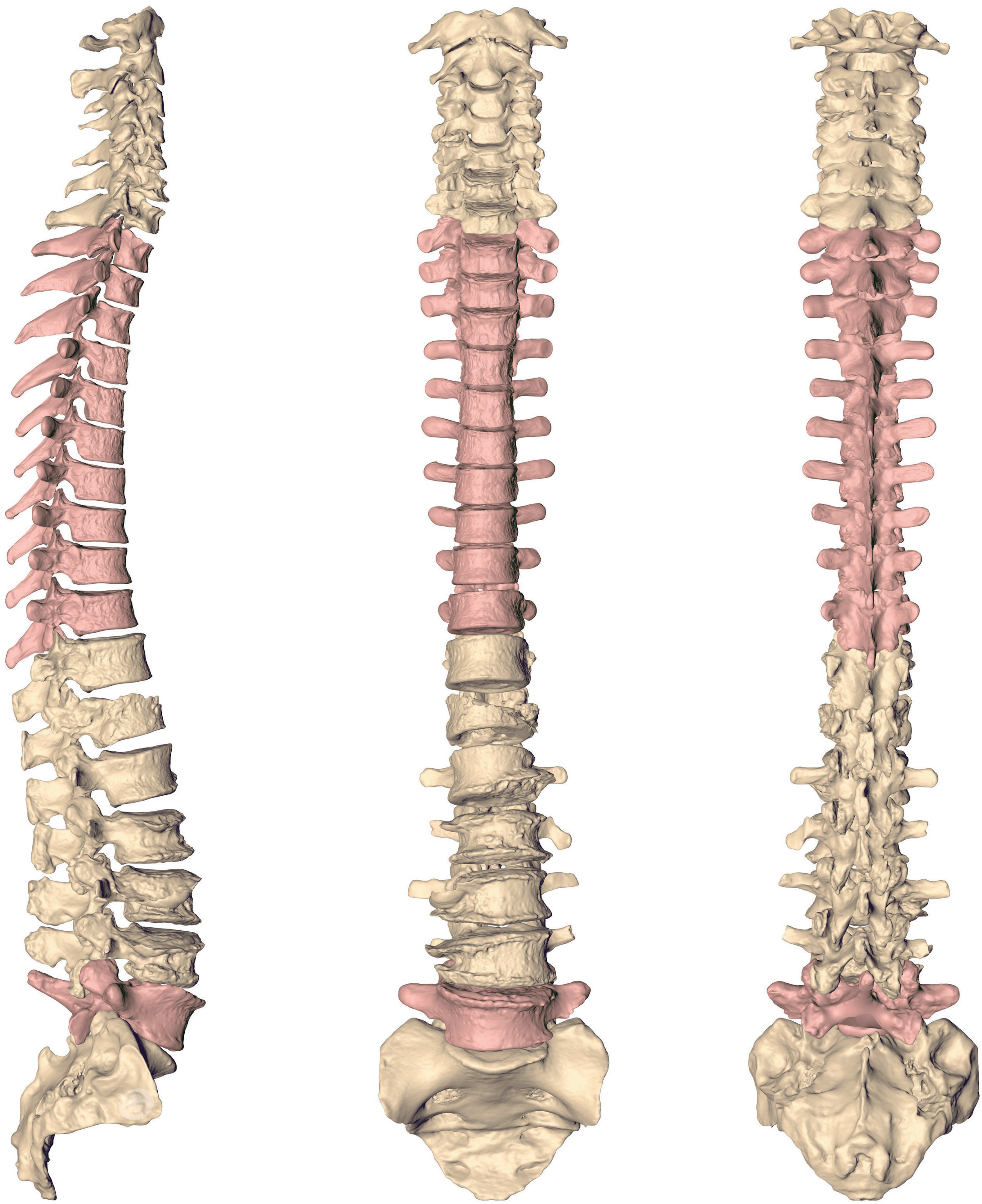


Fig. 33: *Lateral, ventral and dorsal view of vertebral column,* SG
Original models Modified models

process as well as the transverse process and other structures were morphed to look like the typical representation of a T10 vertebra. Using a real vertebra and anatomical literature for reference, while still taking into account that T10 had to fit together with T11. This workflow was repeated until T4 was reached. In order to create T1-T3, C7 was used as a base, as it more closely resembles the form of T1-T3. It also ensured the smooth transition and fitting of the vertebral column as a whole.

A different approach was taken for the ribs. Using frontal and lateral illustrations of the ribcage (Gilroy, 2016) as a base to outline the form of R5, I then modelled it entirely from scratch in Cinema4D. As for the vertebrae, real ribs were used as reference material to create a generic, but convincing rib. Starting from R5 (Fig. 36) I used each rib to merge it into its closest neighbors R4 and R6. They were merged on their turn into their neighbors, eventually creating R2-R12. Besides having to resemble a rib by itself, every rib had to match in space as a whole to create the ribcage. This led to several adjustments throughout as each rib was convincing by itself, but did not always work well in the total appearance. The scan of R1 was crucial as a size indicator for the creation of R2-R12. It provided the outlines and reference for the fitting of R2-R12 into the skeleton. Eventually I mirrored R1-R12 to form a left and right side of the rib cage (Fig. 37).

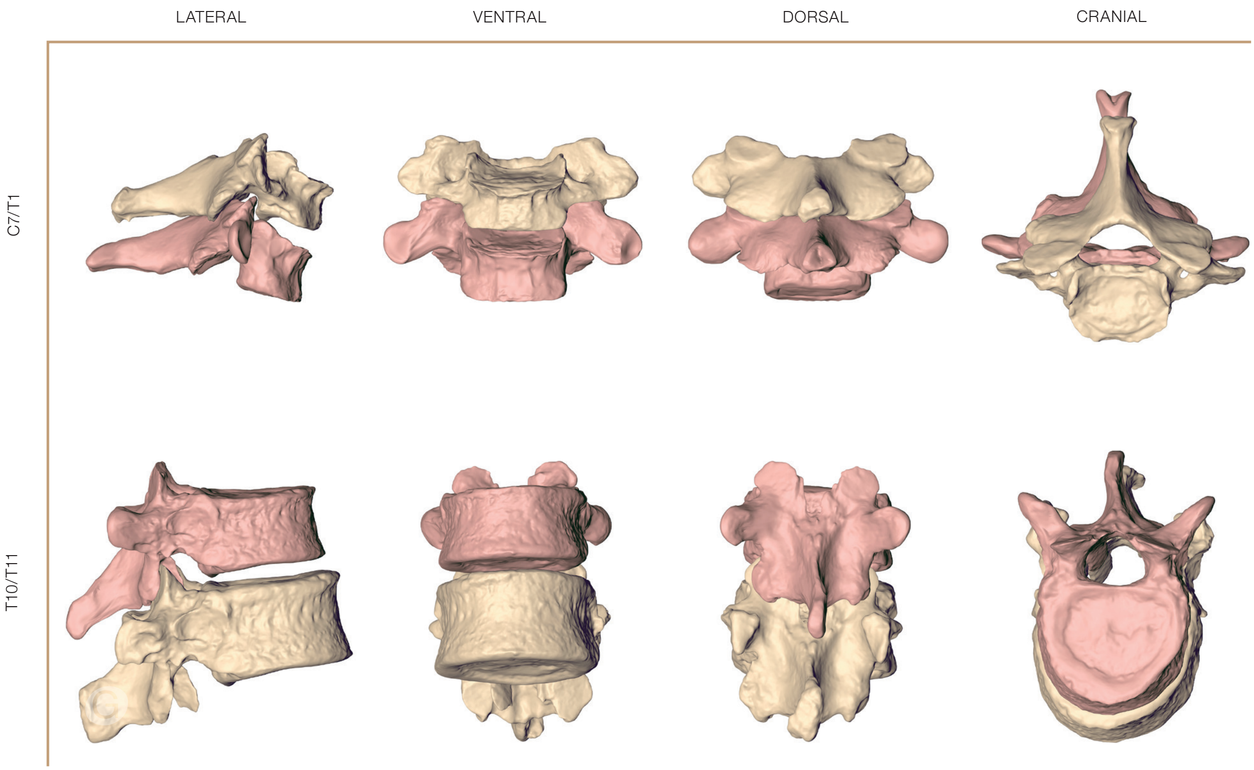


Fig. 34: *Comparison of neighboring vertebrae*, SG
Original models
Modified models

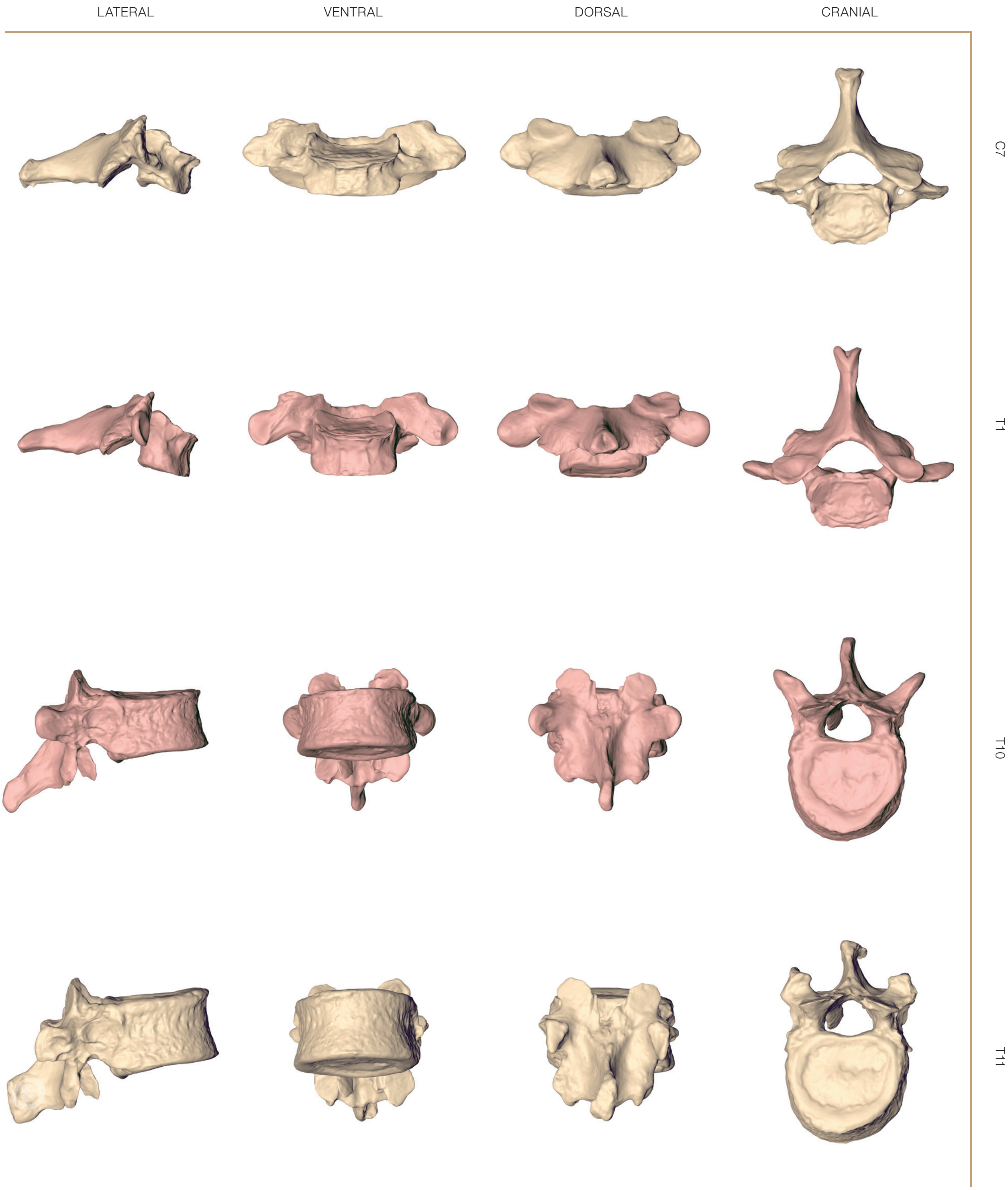


Fig. 35: *Vertebrae*, SG
Original models
Modified models

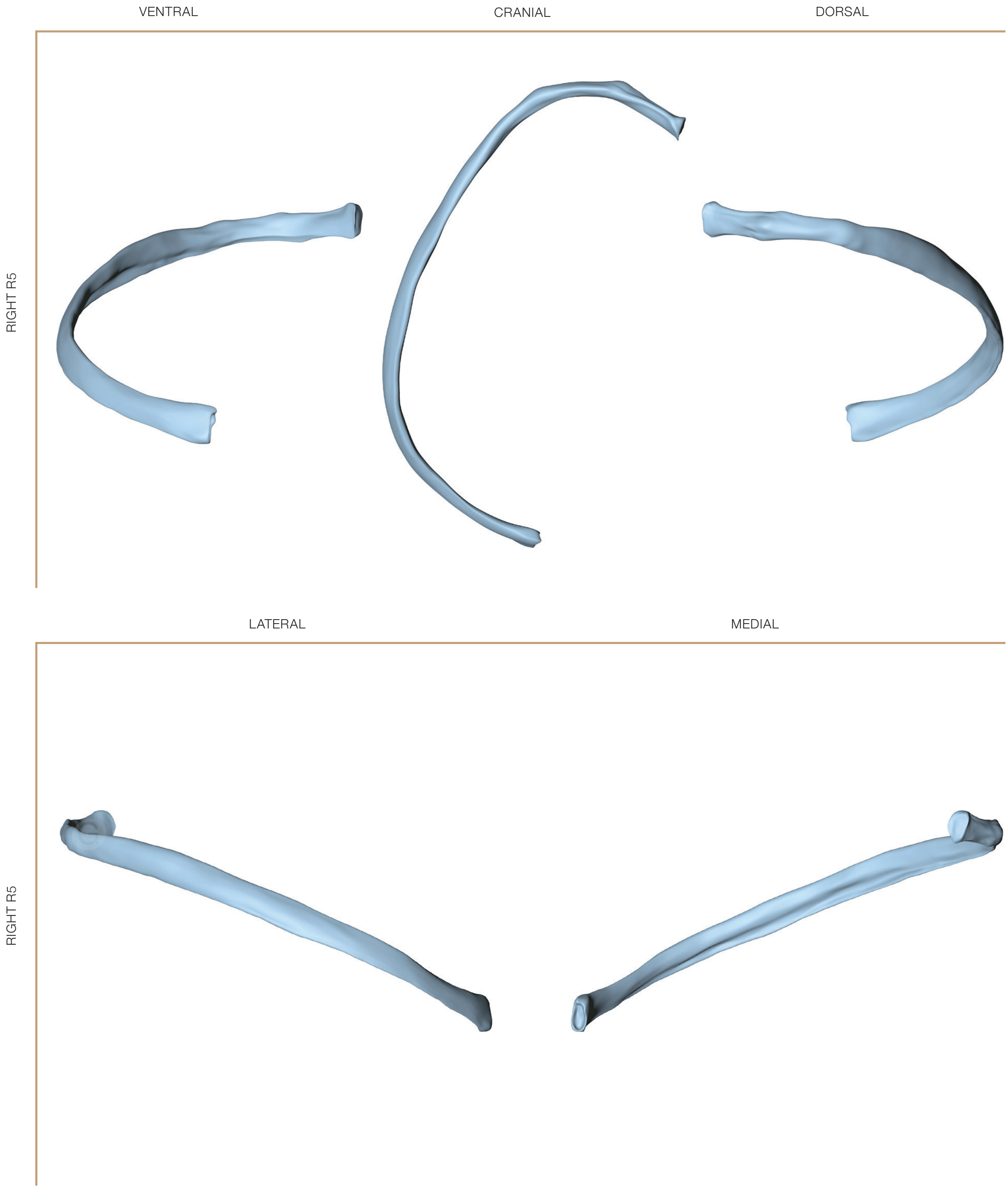


Fig. 36: *Right 5th rib*, SG
Handsculpted models

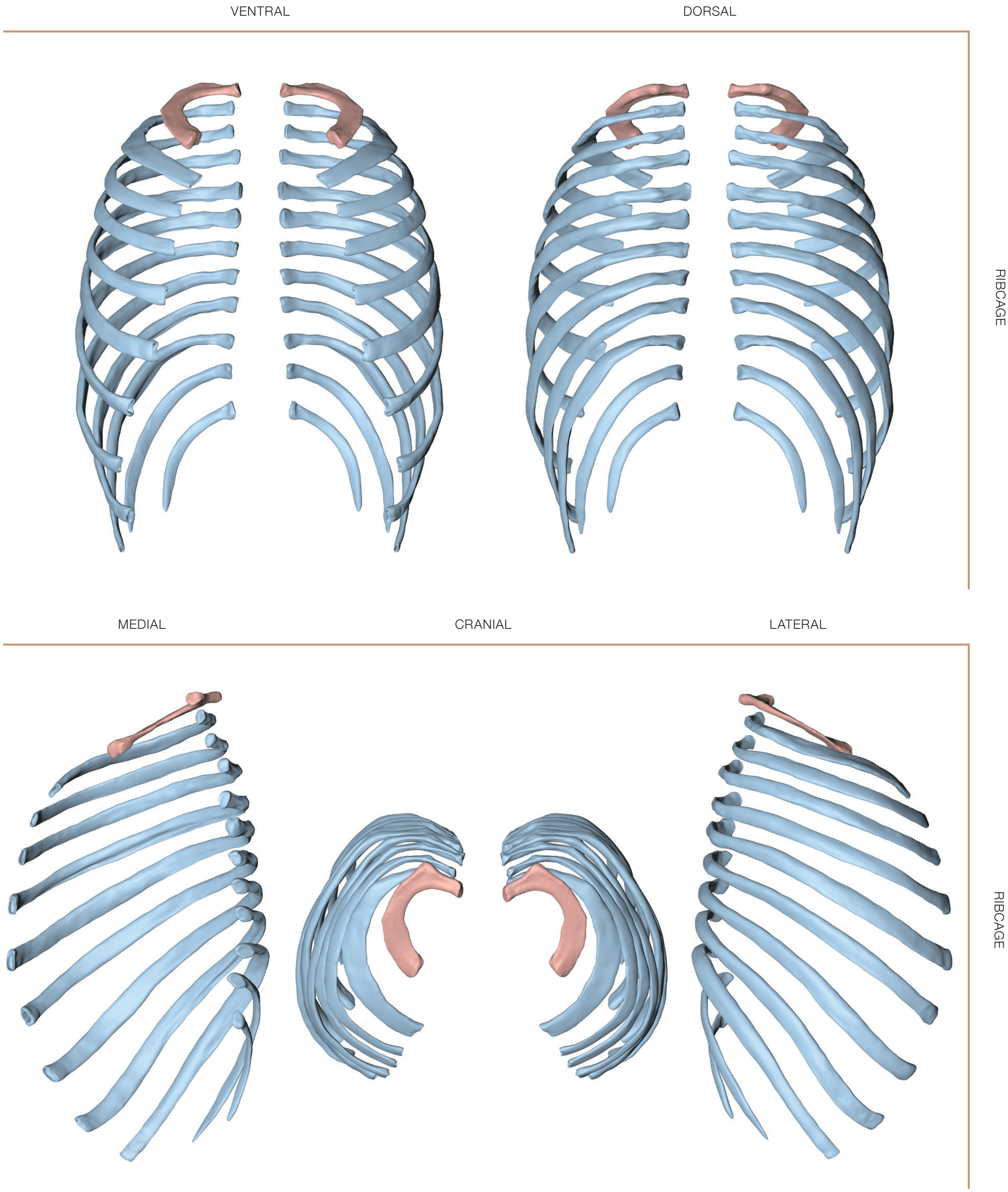


Fig. 37: *Ribcage*, SG

Modified models Handsculpted models

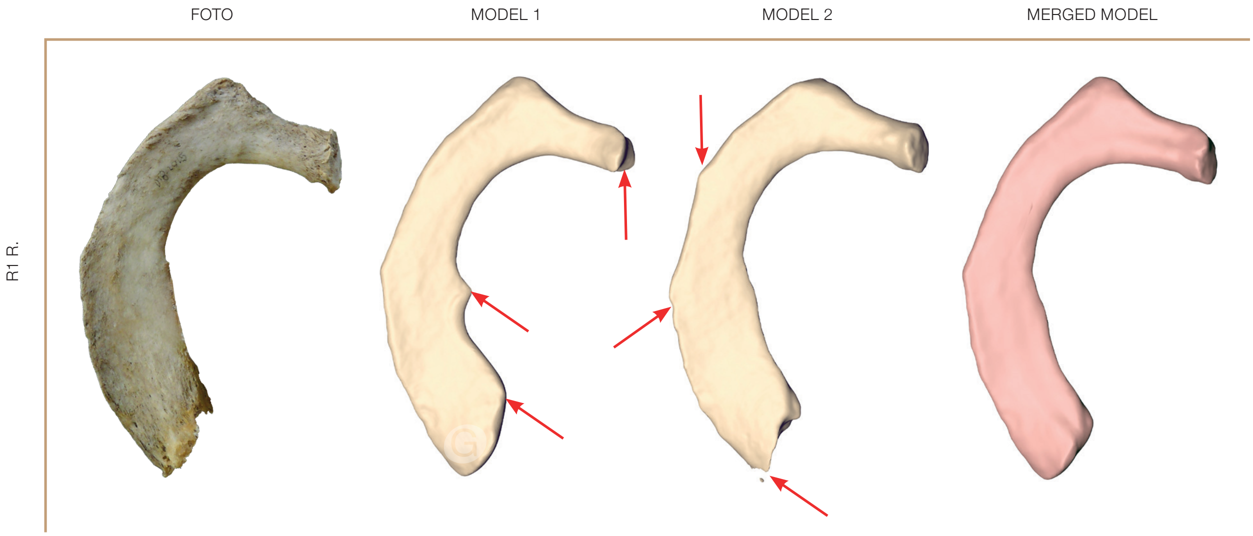


Fig. 38: *Cranial view of right 1st rib*, SG
Original models   Modified models   Errors

Utilizing R1 was tainted by malfunction of the SfM process. The two halves of the model wouldn't merge correctly and had to be merged manually. Comparing the photographs of R1 with the initial models, one can see mayor discreprancies (Fig. 38). Taking both well-modeled sides and merging them by hand resulted in a convincing 3D model. The merging problem did not only arise in R1, but also in several other bones, such as the navicular bone.

The bones in hands and feet were neither from D1 nor were they created from scratch. Due to the amount of inherently different bones and their complexity it appeared to me that the best decision, taking time and precision into account, was to create SfM models of another individual's boneset after the fieldwork period had ended. For this purpose the osteology laboratory of the archaeology department of Leiden University provided a set of bones from an excavation in the Netherlands (Fig. 39). The bonesets of hand and foot are eventually intended to be mirrored in order to create a left and a right boneset. I had to scale the bones in order to fit D1 and adjusted, if needed, articulation surfaces.

The merging of the navicular bone gives a good insight of the problems that occured. The smooth surfaces with holes in them, were not correctly calculated by the computer. Using the precise calculated sides of each modeling attempt, it was possible to merge them by hand into a precise model of the navicular bone (Fig. 40).

Fig. 39: *Right foot*, SG, 2017
Navicular bone

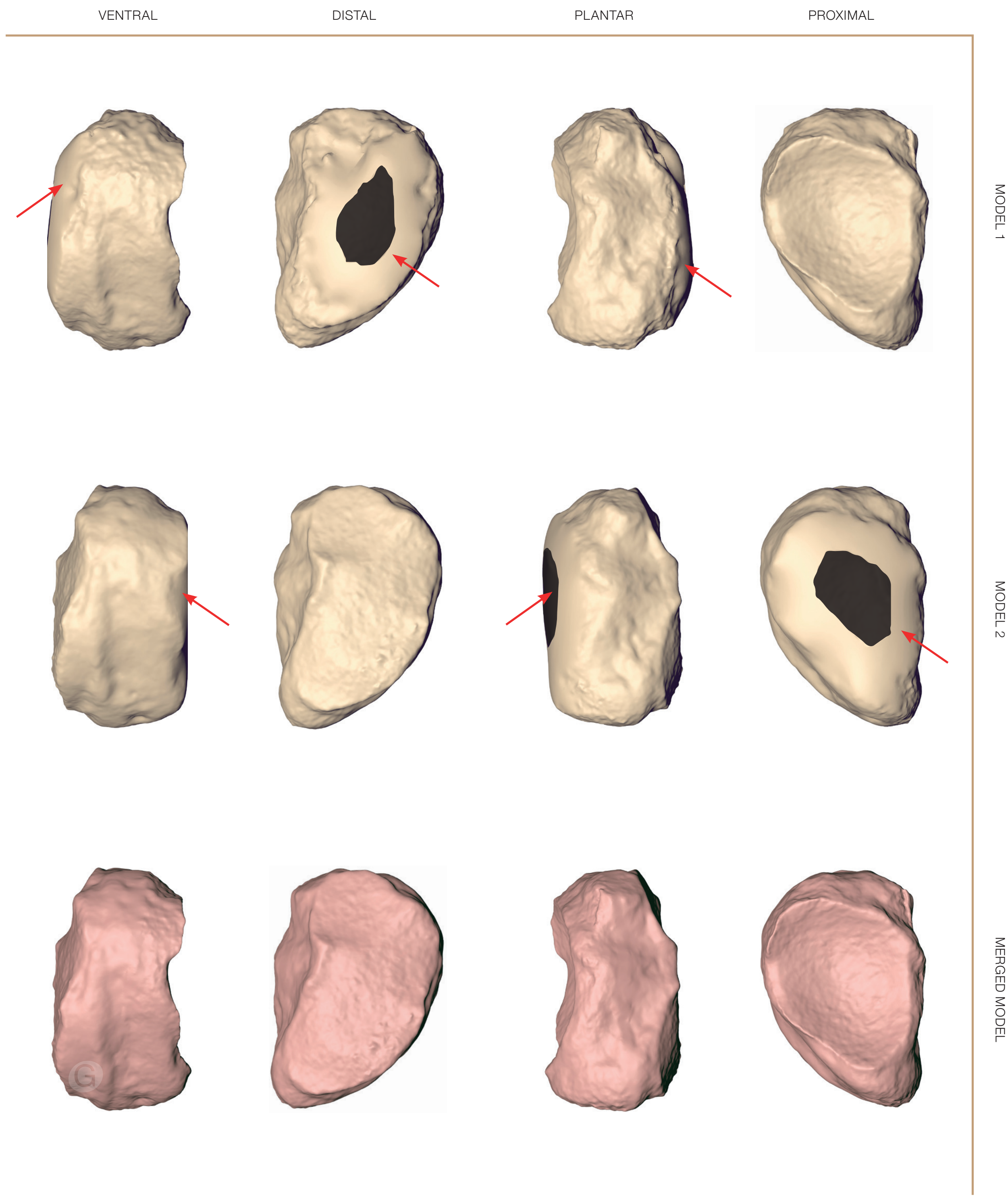


Fig. 40: *Right navicular bone*, SG
Original models   Modified models   Hole   Errors

RECONSTRUCTION
AND ANIMATION

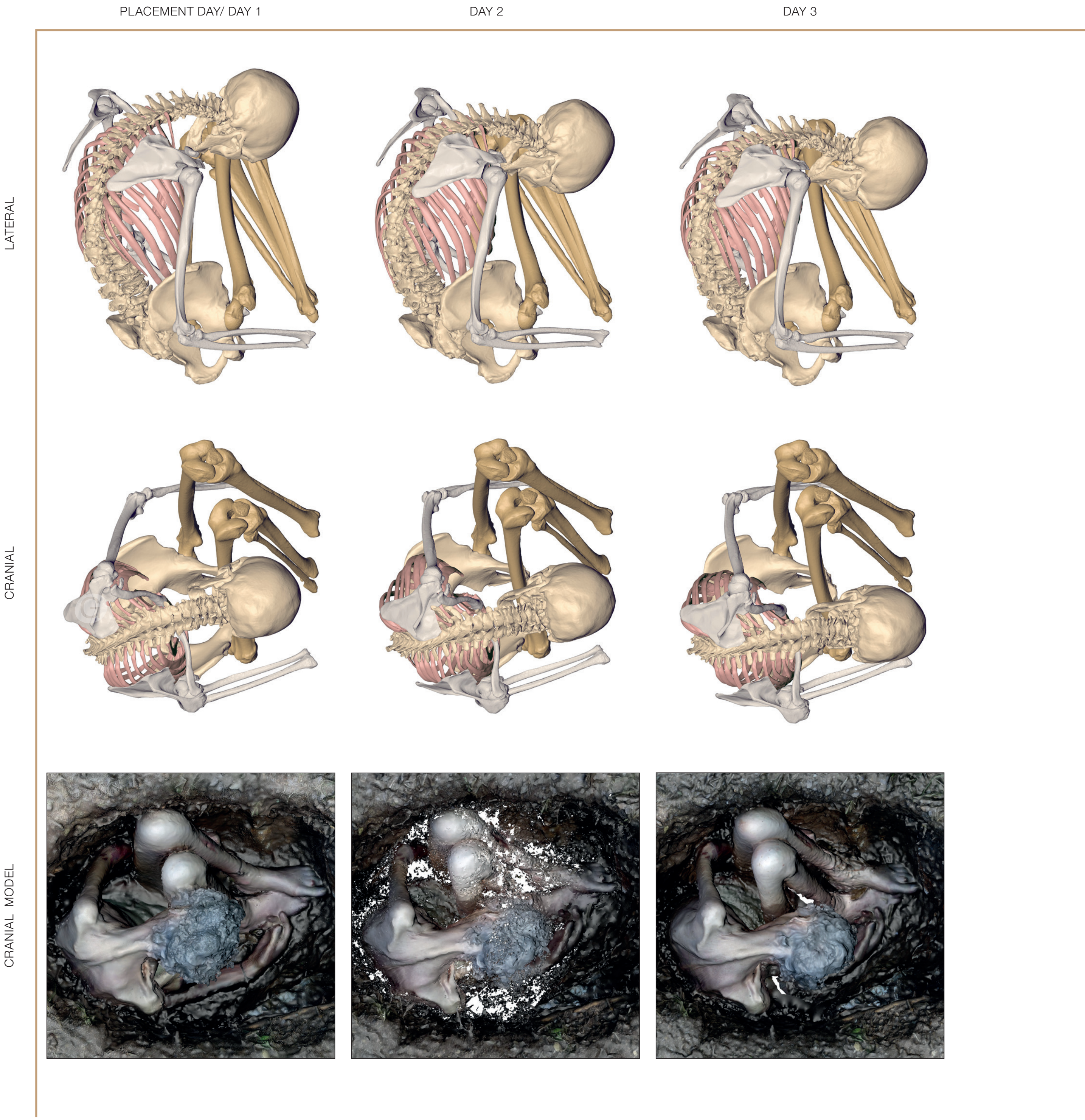
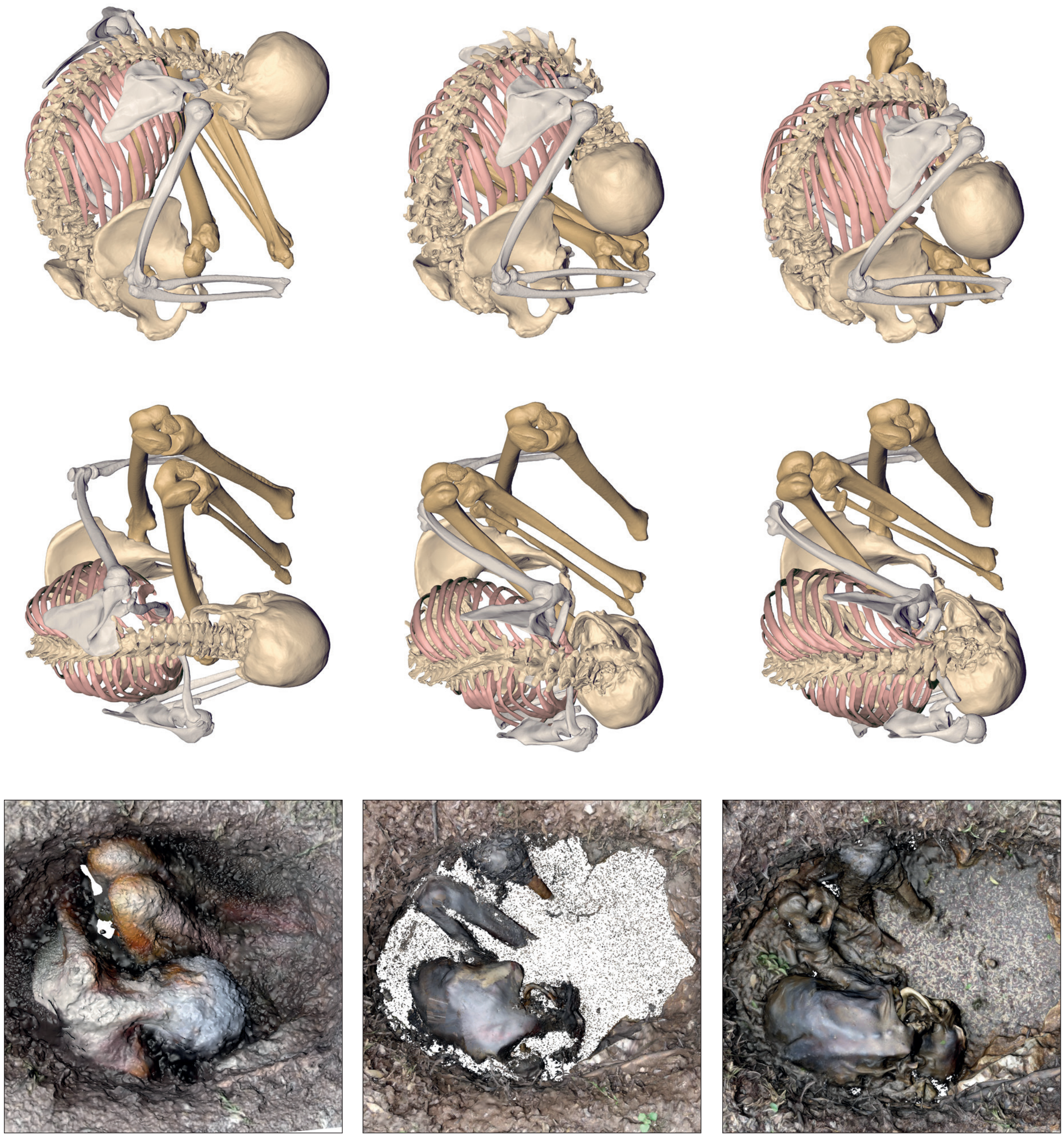


Fig. 41: *Lateral and cranial view skeletal position and cranial view of field model*, SG
Upper extremity   Axial skeleton   Lower extremity   Ribcage   Gaps in field model

DAY 7 | DAY 11 | DAY 16



The animation has been made in Cinema4D. In order to create an animation, Cinema4D uses keyframes in between which the computer calculates pathways. The 3D field model of the placement day was used as the starting point for the placement of the skeleton. By identifying the bony points in the 3D field model, the bones were subsequently placed and adjusted throughout. Figure 41 shows the step by step placement of the bones including a cranial view of the 3D field model. The 3D field models were overlaid and the bones manipulated into the new positions. Scapulae, skull and long bones were relatively easy to place, while pelvis, vertebral column and ribs were more difficult as the 3D field model missed quite a bit of information, due to obstruction by the pit walls, the upper body and moving maggots (Fig. 42). Some of the 3D field models were created not with photographs as source material, but GoPro footage. The proportions of these 3D field models were only cranially the same, but lacked depth of the pit. This increased the level of difficulty for the placement of bones. One example for this is the cranial view of the field model of day 7 as seen in figure 41. However being able to rely on the information of the 3D field models from the day before and on anatomical knowledge it was possible to manipulate the bones into a logical position.

The placement of the vertebral column was the most challenging. The missing wall of the pit left room for the interpretation of the curvature. A spline (3D line) was employed as a guide to help position the vertebral column in space (Fig. 43). More splines were used throughout the process to create artificial borders and guides for the positioning of the vertebrae and ribs. The combination of splines and the position of the vertebrae during the excavation helped in interpreting the curvature and movement of the vertebral column.

In order to view the full animation please use a mobile device to scan the QR-code or visit the website. The animation is subject to continous updates and improvements of the process as well as the replenishment of additional days over the course of time. Please feel free to revisit the animation on a regular basis.

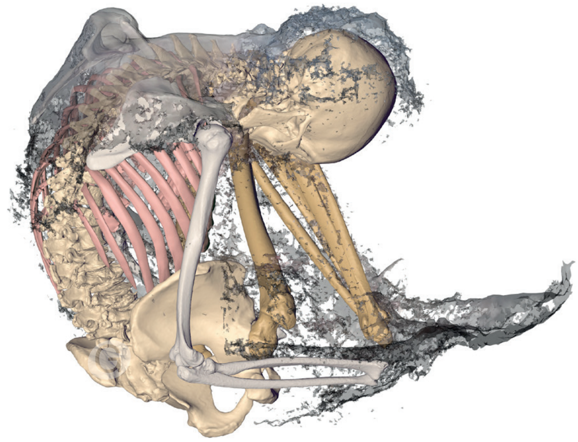


Fig. 42: *Lateral view of placement of bones in 3D field model day 2*, SG

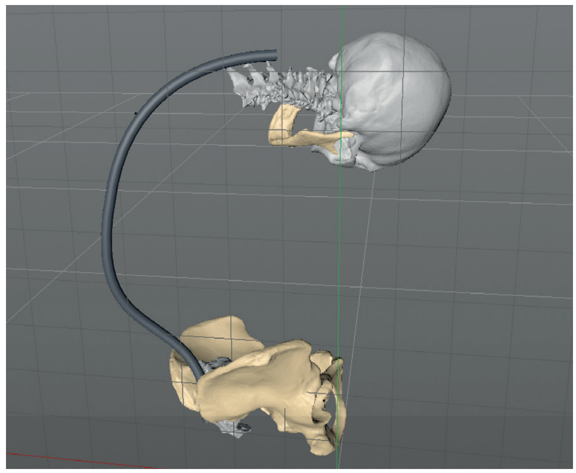


Fig. 43: *Spline guide for vetebral column placement*, SG

Scan the QR-Code for the animation
or visit www.sarahgluschitz.com/3d-illustration

DISCUSSION

The project was a challenging one. Challenging not only for its grand and unusual topic with little information about it in the field of scientific illustration, but also software-wise, time-wise and finally due to its confidentiality restrictions. There was plenty to be learned from handling the 3D-data over to the use of software up until the way of animation.

When I started on this project, I came in about two years after Dr. H.L. Mickleburgh started with the first experiment, meaning that most of the data were already collected. Working with decomposing human remains resulted in irreversible situations. Anything that was not recorded back then, was not able to be recollected now. As a scientific illustrator I'm looking at objects differently than an archaeologist, which came apparent in the capturing of photographs. Nevertheless, the previously collected data by Dr. H.L. Mickleburgh were of great quality and plentitude, I sometimes had trouble identifying situations due to the angle of the photograph. I noticed, that sometimes I would've taken other angles, different close-ups or additional pictures of complicated structures. This made the project more of a challenge, but was not in itself obstructing the work eventually. It does show however, the value of the involvement of a scientific illustrator in early stages of the research. The scientist can anticipate the angles and photographic observations possibly needed by the scientific illustrator, but finally only the scientific illustrator him-/herself can asses the situation and make the decisions based on each individual structure.

In order to prepare for the three weeks of field work, both Dr. H.L. Mickleburgh and I followed a SfM workshop by Dr. S.T. Porter at the Faculty of Archaeology, Leiden University to learn more about the technique, teamwork and preparations that needed to be done. Despite practicing and preparing all necessary material, field work did not go according to plan. Adjusting the SfM setup and managing to take consistent photographs took much longer than anticipated. Creating the necessary light conditions to capture good images was very complex and time consuming. This did cost valuable time within the tight schedule and eventually led to having to compromise on the number of models. In retrospective the decision making on which bones were prioritized, could have been optimized. As the aim was to photograph all the bones, the decision to prioritize was made late in the process, leading to all long bones from both sides being registered, rather than all vertebrae. While long bones would've been suitable for mirroring, the missing vertebrae added another difficult and time consuming section to the reconstructional aspect.

Reconstructing the vertebrae and ribs, was eventually well executed. Nonetheless, it would have helped to have overview pictures from top, front and lateral view of the missing bones. This would have cost little time, but would have led to 3D models more closely resembling D1's bones specifically, rather than resembling a universal bone. These photographs were ultimately provided, though too late in the process of the master thesis in order to make use of these data. Of course, adjustments can be made in the future. Having generic ribs made the animation slightly more difficult as they were less angled than D1's ribs. The origin and terminus of the hand sculpted ribs are the same as those of the ribs in the field model. Figure 44 shows the distance between the ribs of the field model and the hand sculpted ribs (highlighted in red). Even though the outcome and displacement of the ribs in the animation is correct in itself, there are slight discrepancies when it comes to overlaying model and reconstruction.

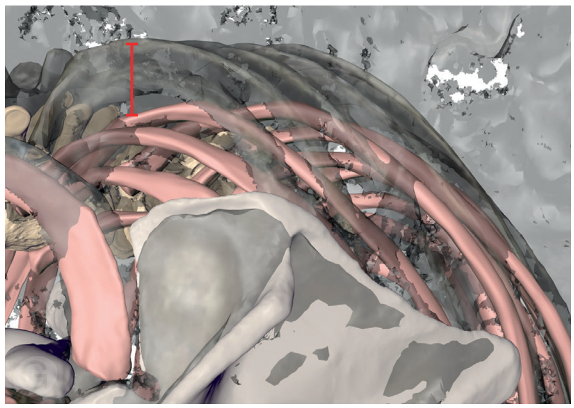


Fig. 44: *Comparison of field model with handsculpted ribs in situ*, SG
⟼ Distance

Unfamiliarity with the program Cinema4D led to a longer learning period on forehand, scraping off valuable time. Cinema4D is a complex software with many possibilities from sculpting to gravity animation, which all ask for a substantial learning period. Instead of being able to immediately start visualizing, workshops and learning-by-doing led the path for this thesis. Not being a master of the software also gave rise to problems that only became apparent much later in the process. One example for this is hierarchy of objects in the file. While grouping,

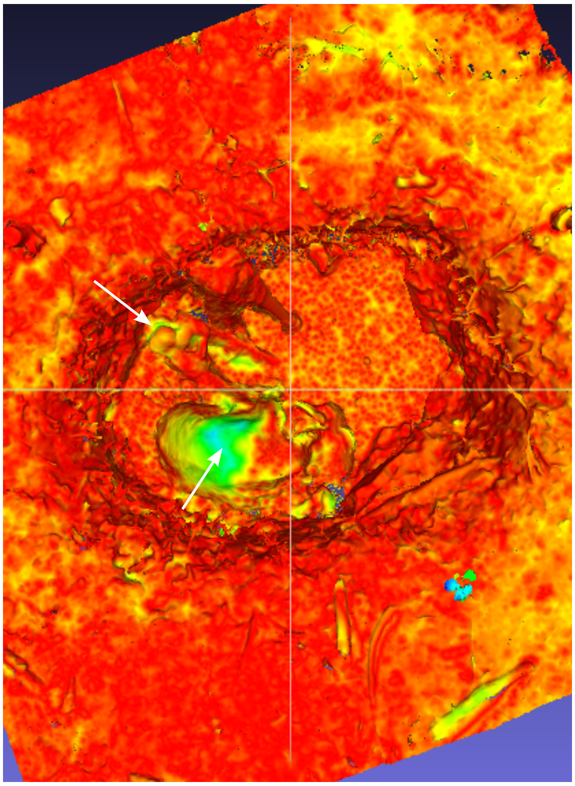


Fig. 45: *Quantitative analysis D1,* Dr. Mickleburgh
0% 100% Movement Displacement

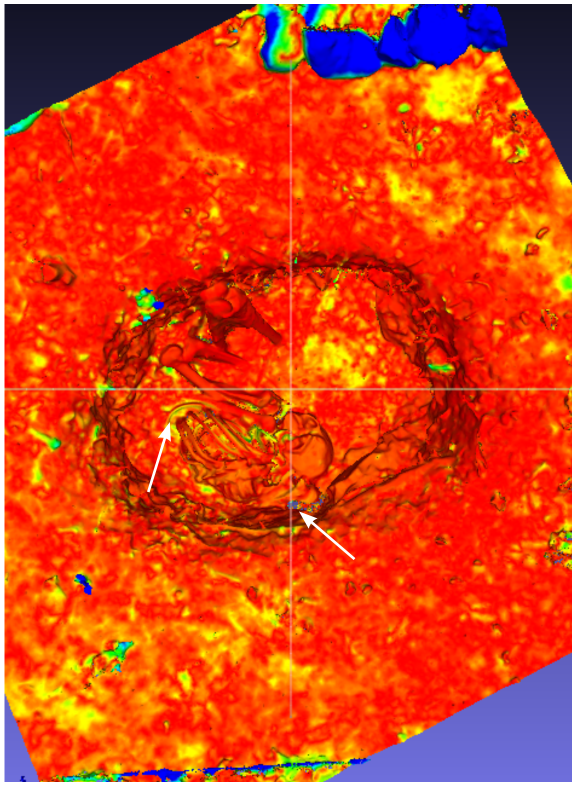


Fig. 46: *Quantitative analysis D1,* Dr. Mickleburgh
0% 100% Movement Displacement

thus making bones dependent on each other early on in the animation, things started out smooth. Yet, the same groupings became troublesome once the bones started to disarticulate, as ungrouping the hierarchy of the objects turned out to be impossible. High polygon models slowed down the computer immensely, prompting thoughts on whether high polygon models are needed to show the reconstructional aspect of the experiment. Low polygon models could have been used to show the same movement, while the high polygon models could have been reserved for close up analysis and zoom ins.

Dr. H.L. Mickleburgh conducted quantitative analysis using overlaying SfM models to highlight displacement of the body and later on the individual bones. Early on in the process large displacements of e.g. the upper body due to forward falling of the torso was clearly visible (Fig. 45). Once the donation was skeletonized, the movements of the bones were just as evident. The movement of single bones such as a rib and vertebra as seen in figure 46 is traceable. In spite of the quantitative analysis working well for the later stages of the experiment, it turned out to be not as clear for the early stages. During the early stages of decomposition the view of the bones is obstructed by soft tissue and insects. Additionally the pelvic area was obstructed from viewing almost the entire time due to the torso, the accumulated maggot mass and intermittently a pool of rainwater. While some disarticulation such as that of the right acetabulofemoral joint was observable at the date of the event, others were only observable at the date of excavation. After removing the ribs and vertebrae the positioning of the pelvis showed a joint disarticulation of the sacroiliac joint and at the pubic symphysis. It was suspected that joint expansion and later on disarticulation had taken place early on in the experiment and was possibly connected to the event of the acetabulofemoral disarticulation. Thanks to the 3D animation, I was able to connect the two events. As it turned out the joint disarticulation of the acetabulofemoral joint had to go hand in hand with a joint expansion in the sacroiliac joint and the pubic symphysis. The right innominate made a lateral outward movement towards the pitwall. Archaeothanatology assumes that movement can only happen if enough space around the body part is created, thus meaning that the movement can only be explained by decomposing soft tissue. A connection between the disarticulation and the acetabulofemoral joint and the movement of the right innominate has been established and the collected data can be adjusted. Without the employment of a scientific illustrator for the creation of the animation, Dr. H.L. Mickleburgh would have not been able to pinpoint the disarticulation to an earlier time frame.

Comparing the initial illustration with the final illustration (Fig. 47) one can see how close the resemblance of both interpretations is. The largest difference being seen in the placement of the pelvis. In the initial drawing the pelvis was assumed to be situated parallel to the sides of the pit, while in reality it was slightly positioned counterclockwise. The misplacement of the pelvis also resulted in the misplacement of the lower part of the vertebral column. The head of the initial drawing seems rather large compared to the final drawing. It is important to know, that for the purpose of a comprehensible drawing, it was decided to leave out the volume of the hair in the final drawing. While the hair has a role in the decomposition, it is not important for the understanding of the skeletal placement. Taking into account the discrepancies of both drawings it still validates the expertise of the scientific illustrator as the overall form and position of the initial drawing reflects in the final drawing. It gives confidence for the accuracy of possible future reconstructions which provide only little information due to being burials, which do not offer the opportunity to observe the body on a daily basis.

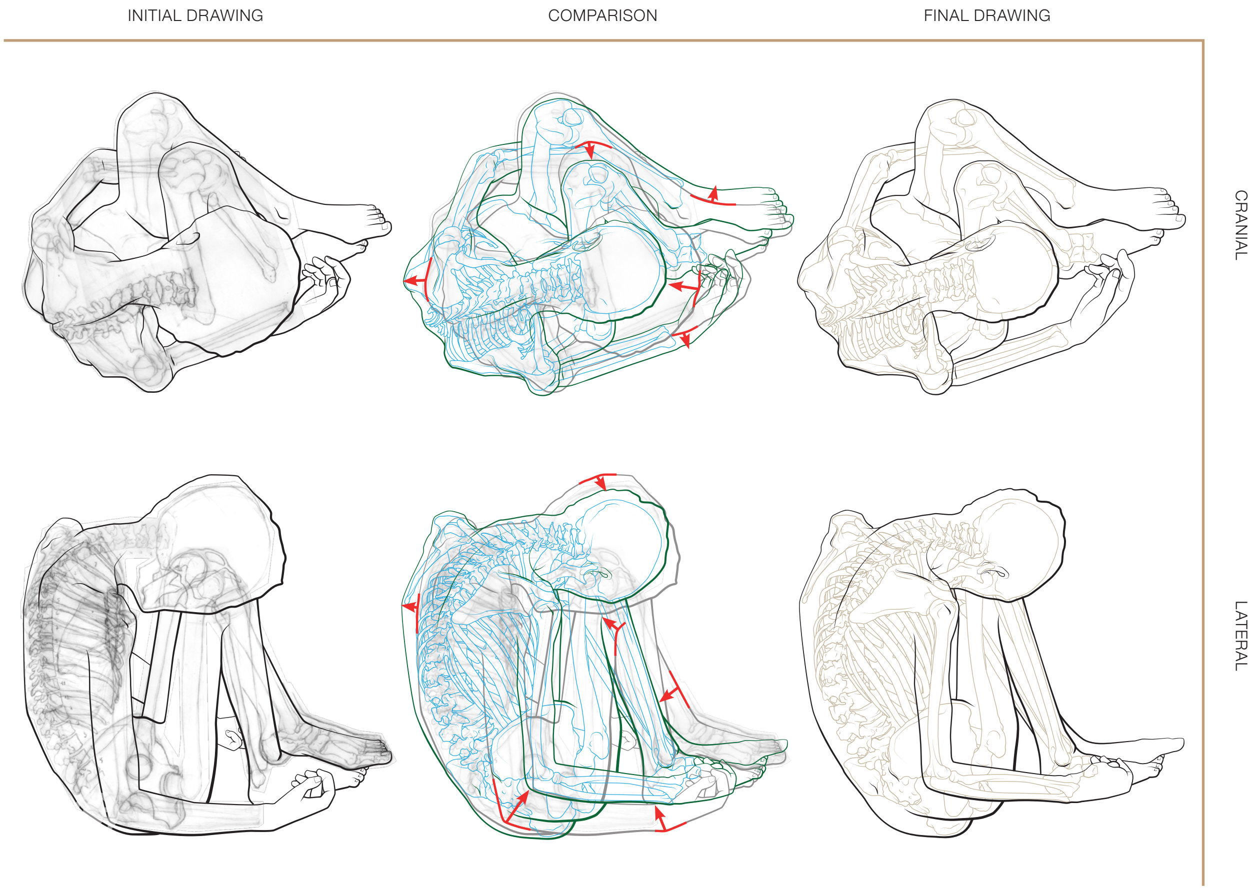


Fig. 47: *Comparison of initial drawing and final drawing,* SG
Outline overlay   Skeleton overlay   Displacement

Focusing on the difference between 3D models and traditional illustration techniques, it appears that each of the techniques has its advantages over one another. While 3D models give one the opportunity to turn an object around and view it from every angle, the traditional illustrations techniques can utilize line thickness and sharpness to create images that are easy to read. Comparing the ventral and dorsal rendering of the 3D model of R5 with a drawing made of the same projections (Fig. 48), shows that it is more difficult for the eye to figure out which way the curvature goes. The use of simple illustrative rules makes the drawing easier to read. 2D illustrations work well on screen and paper, however they are limited to that one perspective. 3D illustrations on the other hand work well on screen, but loose readability when flattened. Ideally both, 2D and 3D illustrations, are used in a symbiotic way; strengthening each other.

During the CAA 2018 conference (Computer Applications and Quantitative Methods in Archaeology), this project was presented to a vast number of brilliant minds in the field of archaeology. The conference turned into a helpful session with lots of input; unfortunately rather late in the process. One of the suggestions that came up was the employment of a different software, Blender, for future projects. Tackling the issue of continuation of this project after finishing university. Cinema4D is a paid software program, only available for free to students and teachers. Per contra Blender is an open source program with the possibility to create your own tools and is easily connected to Unity, a game engine, for future possibilities.

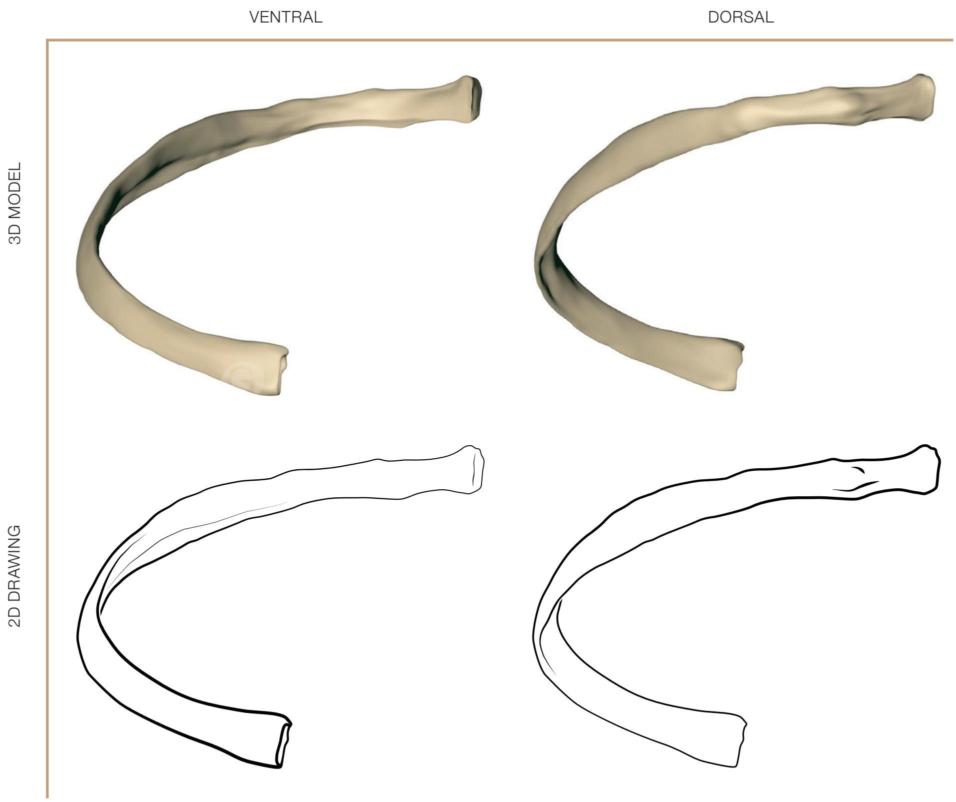


Fig. 48: *Comparison of 3D model and 2D drawing,* SG

CONCLUSIONS AND FUTURE APPLICATIONS

As mentioned earlier the ability of a scientific illustrator is often compared to fine artists/illustrators. In this case it also should be compared to the ability of an animator as it uses a medium, which crosses path with this field of work. Considering all the difficulties that arose from the process, many of them were software related. More specifically software user related. This project would have benefitted from a more profound pre-knowledge of computer animation software, although the handling of the software can be learned, given more time. In light of the fact that there was no knowledge of the medium at the beginning of this research, the result of the animation is acceptable. This shows that a good scientific illustrator is able to learn new techniques to transfer his knowledge onto. Meaning that given more time, the scientific illustrator can become not only a craftsman in illustration and highly trained in anatomical knowledge, but embody 3D modeling and animation into his skillset.

Before Dr. H.L. Mickleburgh started her investigation the question arose, how this research could be best introduced to fellow scientists and a less knowledgeable audience. 3D modeling presented itself as an excellent way of displaying the project, the use as an outreach tool and for education of students. Therefore she used SfM for data collection, but soon realised that in order to visualize the complex process, a 3D animation over time would be necessary. Unexpectedly, the outcome of the animation presented itself as research tool with far greater analytical value than originally expected. Continuing on the path of 3D illustration and animation it is desired to improve upon the existing skill set and keep growing with the projects ambition. During the development of the 3D animation it became apparent, that scientific illustration is more than just an illustrative outreach tool and can be used for investigative objectives. Undoubtedly the reconstruction of just one experiment is not representative and needs to be repeated and put to the test extensively. Along these lines it would be preferred to continue this investigation on a larger scale. Firstly completing the series of the initial five experiments set up by Dr. H.L. Mickleburgh and possibly joining her during continued research in this field. Eventually it would be desired to apply the method of archaeothanatology to archaeological cases. The experience gathered during the reconstructions of controlled decomposition of several individuals might help to make educated guesses of archaeological cases. Prompting research which leads to a better understanding of ritualistic behavior in past societies and help differentiate between what happens naturally and what is the result of (intentional) human manipulation of the body and grave.

The Dutch television program *Focus* has interviewed both Dr. H.L. Mickleburgh and me about our research. During this interview I was able to explain and show the process that went into the creation of this thesis. The final animation will now be shown on Dutch national television; reaching a broad audience — from the general public to scientists.

GERMAN ABSTRACT

Diese These behandelt den Zerfall des menschlichen Skelettes im Rahmen archäologischer Funde. In Zusammenarbeit mit Dr. H.L. Mickleburgh illustriert sie einige Forschungsergebnisse des Projektes *An integrated forensic taphonomic, biomolecular and isotopic study of the effects of decomposition on human remains for forensic and archaeological applications,* in 2D und 3D. Eines der Augenmerke dieses Forschungsprojektes liegt auf dem Einfluss des Verwesungsprozesses auf das Skelett und dessen daraus resultierender Position im Grabe. Zu diesem Zweck führte Dr. H.L. Mickleburgh verschiedene Experimente auf einer forensischen Forschungsanlage in den USA durch. Eines dieser Experimente (D1) ist Gegenstand dieser These; eine offene Grabgrube, welche mittels Photogrammetrie ausführlich dokumentiert wurde. Darauffolgend wurde es in ein freistehendes Computer animiertes 3D Modell umgesetzt und mit Zeichnungen der Grabanlage über den Zeitraum des Experimentes ergänzt. Unterstützt durch das 3D Modell, liegt der Schwerpunkt dieser These auf dem rekonstruktiven Aspekt von archäologischen, menschlichen Überresten und bildet somit einen Ansatz zur Herleitung ursprünglicher Bestattungspositionen für zukünftige Ausgrabungen. Darüber hinaus hat sich herausgestellt, dass die Ergebnisse dieser These andere quantitative Analysemethoden ergänzen.

ACKNOWLEGEMENTS

I would like to thank Hayley for all her trust, support, great advice and guidance she has given me throughout the process. I would've never dreamed of doing any of the things I did, that she made possible for me. Dirk, for being a fantastic and supportive mentor; Rogier, for pushing me towards this project and continuously believing in me; Jacques, for challenging me in anatomy; Kyra, for being a great graphic design mentor; J. for being patient life model; and of course the rest of the teaching staff as well as my classmates for always motivating me to thrive for better. I would also like to thank the Dutch television program *Focus* for letting me tell my story. My gratitude goes to the staff and students of the Forensic Anthropology Research Center Texas State University in San Marcos, Texas; particularly Daniel J. Wescott and Sophia Mavroudas for providing a great learning environment and material to work with. I would also like to thank the families of the human body donations for giving me the greatest learning opportunity I could have ever wished for.

A special thanks goes out to my family and friends for supporting me during my studies and throughout life, all while putting up with my busy schedule.

Autumn

Heat ascending from the ground,
Leaves were falling.
Orange and red
Turning yellow.

Sweetness filled the air like mist,
Softly merging into mushy soil.
Brown and wet
Becoming mellow.

Silence was finally striking root,
Sucking it dry.
Gloomy and drab
Draining marrow.

The misty-eyed creature,
Curling up into a coil.
Massive and yet
Sounding hollow.

The corpse in the copse.

Sarah Gluschitz, March 2014

BIBLIOGRAPHY

Bammes, G. (1991). Die Gestalt des Menschen: Lehr- und Handbuch der Anatomie für Künstler (4th ed.). Ravensburg: Maier.

Beckett, S. (2007). The chemistry of death. London: Bantam Books.

Kaminishi, I. (2015). Dead Beautiful: Visualizing the Decaying Corpse in Nine Stages as Skillful Means of Buddhism. In R. M. Brown (Author), A companion to Asian art and architecture. Chichester: Wiley.

Christiansen, J., and C. Christiansen (2010). Stages of whale-fall community [Digital image]. Retrieved March 29, 2018, from https://www.nature.com/scientificamerican/journal/v302/n2/box/scientificamerican0210-78_BX1.html

Duday, H. (2006). The archaeology of the dead: Lectures in archaeothanatology. Oxford: Conn.

Eitaku, K. (1871). Body of a courtesan in nine stages [Painting found in Collection online, The British museum, London]. Retrieved November 24, 2017, from http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?assetId=603867001&objectId=3168105&partId=1

Focus. (2018, April 05). Rondleiding op een Body Farm. Retrieved April 16, 2018, from https://www.youtube.com/watch?v=6WA8zFMV7fM

Gilroy, A. M., MacPherson, B. R., Voll, M., Wesker, K., and M. Schünke (2016). Atlas of anatomy (3rd ed.). New York (NY): Thieme.

Hansen, C. (2008). Art and Archaeology: The Function of the Artist in Interpreting Material Culture. Waterford Institute of Technology.

Hodgson, J. (2004). Archaeological Reconstruction Illustrations: An analysis of the history, development, motivations and current practice of reconstruction illustration, with recommendations for its future development. Bournemouth University.

Knüsel, C. J. (2014). Crouching in fear: Terms of engagement for funerary remains The recording example can be found at http://jsa.sagepub.com/. Journal of Social Archaeology, 14(1), 26-58. doi:10.1177/1469605313518869

Kooijmans, L. (2008). De doodskunstenaar: De anatomische lessen van Frederik Ruysch. Leiden: DBNL.

Mann, S. (n.d.). Body Farm. Retrieved March 29, 2018, from http://sallymann.com/selected-works/body-far (Originally photographed 2000-2001)

Mickleburgh, H. L., and S. Gluschitz (2018, March 22). Untapping the Potential of 3D Quantitative Analysis. Lecture presented at CAA, Tuebingen.

Mickleburgh, H.L., and D.J. Wescott, 2018. Controlled experimental observations on joint disarticulation and bone displacement of a human body in an open pit: Implications for funerary archaeology. Journal of Archaeological Science: Reports. Accepted for publication 26 April 2018.

Orfila, M. J. (1831). Studies of the effects of decomposition on exhumed bodies [Painting]. U.S. National Library of Medicine, Bethesda.

Reconstruction [Def. 1.2]. (n.d.). In Oxford Dictionaries. Retrieved March 29, 2018, from https://en.oxforddictionaries.com/definition/reconstruction

Porter, S. T., (2017). Photogrammetric Scale [Digital image]. Retrieved March 28, 2018, from http://www.stporter.com/wp-content/uploads/2016/03/Photogrammetric_scale_noncoded_markers_plus_2017.pdf

Texas State University. (2016, September 28). Forensic Anthropology Research Facility. Retrieved November 23, 2017, from http://www.txstate.edu/anthropology/facts/labs/farf.html

University of Tennessee. (n.d.). Forensic Anthropology Center. Retrieved November 23, 2017, from http://fac.utk.ed

Scan the QR-Code for the animation

Sarah Gluschitz | Scientific Illustrator and Artist
Sarah@Gluschitz.de | SarahGluschitz.com

Corpse in the Copse focuses on the role of scientific illustration in the study of the human taphonomy and disarticulation of skeleton in 2D and 3D for archaeological applications. It collaborates with and illustrates the research of bioarchaeologist Dr. H.L. Mickleburgh. The research was conducted at the Forensic Anthropology Research Facility at Texas State University in San Marcos, Texas, USA. This provided the subject of this thesis: an open-pit placement, which has been thoroughly documented using Structure from Motion.

This thesis introduces the expertise of a scientific illustrator and the use of 3D animation as a visualization and investigative research tool for archaeologists alongside the currently used quantitative analyses. Showing that scientific illustration is more than an illustrative tool. The process of disarticulation has been visualized in a 3D animation, allowing viewers to follow the disarticulation at a stage where the view was obstructed by soft tissue, insects and environmental conditions in the field. The ultimate goal being to improve interpretation of archaeological human burials in future excavations. In addition, the 3D animation represents an important public outreach and scientific education tool. Finally, this project has demonstrated the value of collaborative research between an archaeologist and a scientific illustrator, as well as the importance of involvement of the scientific illustrator in all stages of the research.

Published by the Master Scientific Illustration, Maastricht, The Netherlands, 2018

Maastricht University Leading in Learning!

Academie Beeldende Kunsten Maastricht ZUYD