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Reviewed Article:

Reconstruction of the Ancient Greek Long Jump - an Opportunity for Multidisciplinary Collaboration

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The Games of the XXXI Olympiad – the Summer Olympics in Rio de Janeiro, Brazil (5 August to 21 August, 2016) – continued the long tradition of Olympic sports, which began in ancient Greece (circa 776 BCE), and were heavily modified in their re-creation by the International Olympic Committee (starting in 1896; cf. Young 2002). An event that both Olympics hold in common, however, is the long jump – the ancient Greek halma, It was held only as part of the

ancient pentathlon (from 708 BCE onwards) but is staged in the modern Games as a separate event (since 1896) and as part of the men's decathlon (since 1912; though a similar "all-around" event was held at St. Louis in 1904) and women's heptathlon (since 1984).

> The jumpers at first found that the weights were very difficult to use. They were a distraction and changed the approach to the jump, suggesting that modern jump techniques are quite different or that much practice was necessary for ancient jumpers to use the weights effectively. Indeed, music was part of the ancient halma and we speculate that music provided a rhythm that aided ancient jumpers in their approach.

The *halma,* or long jump, consists of a jump into prepared sand pits. As part of a week of events which included a screening of *Chariots of Fire*, a public lecture, and faculty research symposium on the Classical Olympics to celebrate the Olympic year, we decided to confront an age-old problem: how was the long jump in ancient Greece conducted? Our research was prompted by two major differences between the ancient jump and today's long and triple jumps, specifically jumping weights and jumping technique. We also intended for this project to engage a broader audience than usual for research in Classics and Classical Archaeology, and to communicate with partners outside of the traditional disciplines of the Humanities.

This project emerged organically, engaging different partners from various disciplines, as discussions commenced with growing excitement and interest. We accomplished more than we expected by communication with various departments of our university, and therefore offer this narrative as an example of *multidisciplinary* research that created publicity and enhanced student interest. It must be emphasized that the main purpose of this experiment was not to recreate accurately ancient long jumps – too many variables exist between ancient Greece and contemporary Lubbock to make this possible. Instead, this project successfully supplemented the paucity of qualitative evidence that exists for athletic experience in antiquity. Moreover, the Classics program benefitted from the connections made with the School of Art and the Athletics Department, which will improve our ability to connect with a more diverse public in the future.

Aims

The creation of ancient Greek jumping weights began with the planning of the *Olympics Ancient& Modern Symposium* (5 April to 8 April, 2016) by David H.J. Larmour and Peter J. Miller. In conjunction with public and academic lectures, Larmour and Miller wished to conduct a long jump experiment that tested the ancient Greek method of jumping with weights. While the initial thought was to use modern free weights ("dumb-bells"), we observed that free weights, despite superficial similarities, were not exactly the same as ancient weights and their use might vitiate the results of the experiment.

The ancient long jump is a difficult subject, as few ancient accounts of it exist and they are subject to interpretation (Lenoir et al. 2005). While we have literary depictions of the ancient long jump, at least obliquely, beginning with the *Odyssey* (8.127), the specific details of the jump remain vague. Even something as basic as whether the jump was a standing broad jump or triple jump eludes consensus (Mouratidis 2012). One detail that is known is that jumping weights, *haltēres*, were used, so the ancient Greeks assert, to add to the distance attained and to secure the landing (Aristotle 705a; Philostratus 35). Some ancient sources discuss the weights (e.g., Pausanias 5.26.3), but, as with those for the jump itself, these are elusive descriptions that provide few concrete details (see Gardiner 1904a, 1904b; Hyde 1938); a few descriptions record lengths that are beyond belief (especially the jump of Phayllos, which was supposedly over 50 feet, see *Scholia in Aristophanem. Acharnians* 214).

Either triple jump or standing broad jump must be the ancient Greek practice; in the latter, it is believed that the competitors stood at the *batēr* (a marker near the edge of the *skamma*, or "pit"), swung their hands backwards, and then used the momentum to propel themselves forwards (see Lee 2007; Lenoir et al. 2005; Mouratidis, 2012). The total distance of the jump would be measured from the initial line of launch to the closest point of contact – usually the heel of a "perfect footprint" of the athlete (Philostratus 35).

Some previous experiments with *haltēres* have been conducted. However, the scholarship of these studies, while scientifically sound, did not answer all of the questions we wished to address. The first problem was that most of these experiments utilized computer modelling (see Papadopoulos et al. 2011; Minetti and Ardigo 2002; Provatidis 2013; Tang and Huang 2007; Ward-Smith 1995). While these simulations are far more precise because of variable control than any experiments with human participants, they lacked the ability to record qualitative findings. The other type of *haltēres* experiment has been conducted by Kinesiology departments. While actual human jumpers were used, researchers employed modern weights as a replacement for the ancient ones. These, like the computer model projects, were especially concerned with body mechanics. Indeed, no discussion of how the athletes felt were recorded. Also, as far as we could determine, none of these experiments utilized *haltēres* or even weights similar in shape. The sole example we could find that specifically discussed the weights used stated: "The chosen weights were roughly cylindrical in shape, fitting easily in the hand and made of a soft bean bag material to reduce risk of injury during the jump" (Filush 2012). The shape of a modern dumb-bell or soft hand-weight as described above is different in balance, aerodynamics, and comfort levels than an ancient weight. As we discovered, the shape of the object changed the qualitative experience of the jump significantly for the participants.

Evidence

Several extant examples of *haltēres* have survived in the archaeological record. Most of these are stone and given their unwieldy nature and the fact that some bear inscriptions, they may be dedications rather than functional weights. The marble Acmatidas jumping-weight that reads "Acmatidas of Lacedaemonia, having won the five without dust, dedicates this" is an excellent example of an object that seems to be purpose-made for dedication (*CEG no.* 372 [translation by authors]; 4.6 kg; Museum of the History of the Olympic Games in Antiquity, inv. Λ189). In contrast, a lead weightof an oblong rectangular shape survives from the sanctuary of Eleusis, and the inscription implies that this specific weight was used: "in jumping Epaenetus was victorious because of these two jumping weights" (*CEG no.* 299 [translation by authors]; 1.888kg). An early example of the "phone receiver" type in lead is in the British Museum (inv. 1837,0609.83; See Fig. 1); each of the *haltēres* weighs 1.07 kg. Other pairs of weights have also been located and in some cases the *haltēres* are of different weights (e.g., a pair of lead *haltēres* in Copenhagen [Knoepfler 1994, pp. 353-354]); some athletes, therefore, may have preferred different weights for each hand, perhaps as an aid to balance (Philostratus 55).

In some cases, ancient sources imply that *haltēres* dedicated at sanctuaries were functional athletic equipment: at Olympia, Pausanias describes the shape of *haltēres* and how they fit into the hand (5.26.3); in another passage, Pausanias obliquely refers to the change in theirstyle over time when he observes that a statue "holds jumping-weights of the old pattern" (6.3.10). The weights, sizes, and materials are different enough to suggest that different athletes preferred different *haltēres*, and that we likely have a mixture of athletic equipment and dedicatory examples from the archaeological record (See Table 1 for a selection of *haltēres* and their respective weights).

Material	Time Period	Weight	Location and Reference
Lead	5th century BCE	1.07kg	1837.0609.83; British Museum
Stone	Ca. 550 BCE	4.629kg	Λ189; National Archaeological Museum of Olympia
Lead	Ca. 6th century	1.345kg	IM 2362; Isthmia Museum (Broneer 1959)
Lead	N/A	1.572kg	Now lost; depicted in Jüthner 1965
Lead	N/A	1.48kg / 1.611kg	A, Ba 364; Nationalmuseet Copenhagen
Bronze	Ca. 5th century BCE	1.847kg	George Ortiz Collection (Knoepfler 1994)
Lead	N/A	1.888kg	MN inv. 8075; National Archaeological Museum of Athens
Stone	Ca. 6th century BCE	1.2kg (complete, over 2kg)	Nemea (Miller 2015)

TABLE 1. SELECTED *HALTERES*

The other source of evidence are ancient Greek vases that depict a variety of athletic motifs and include the *haltēres* in their depiction of the ancient long jump(The weights are shown either in an athlete's hand or hanging on walls). The shapes in the vase-paintings reflect the various shapes in the archaeological record. A neck-amphora by the Edinburgh Painter depicts the "phone receiver" type and dates to the beginning of the fifth century BCE (See Fig. 2). Other vases from the fifth century BCE show a shape with a handle integrated into the weight (*oenochoe* by the Harrow Painter, ca. 490 BCE, See Fig. 3; terracotta mug by the Group of Philadelphia 2272 Painter, ca. 460 BCE, See Fig. 4). No vase to our knowledge depicts the oblong rectangle shape, a type known from the inscribed example found at Eleusis and now in the National Archaeological Museum in Athens.

We chose to reconstruct the "phone receiver" type because this was the simplest design to cast in bronze and also because of its prevalence in the archaeological and vase-painting record. Nonetheless, we should note that various shapes of *haltēres* were in use throughout the fifth-century BCE. In order to furnish our participants with choice and to observe changes and difficulties associated with weight, we made three sizes of *haltēres,* two of which reflect a weight found in the extant examples (1kg and 2kg), and one that approached the weight of the heaviest example (3kg; See Fig. 5).

Given the lack of scholarly consensus about *haltēres* and ancient *halma*, the purpose of this reconstruction was not to replicate exactly the ancient methods and means. In fact, such a perfect reconstruction is impossible, given the vast array of differences between the ancient Greeks and modern humans (in physical fitness, athletic ability, diet), let alone between ancient and modern athletes. As an example, we might compare experimental work that endeavoured to compare relative stamina between modern college students and ancient hoplites: Donlan and Thompson concluded that ancient reports of hoplites' charges were at odds with the observable limits of human endurance (1976, 1979). Geof Kron has argued for broad differences in nutrition and physical health (not necessarily in favour of modernity) and his research indicates the complexity of attempting to compare health and physical fitness in antiquity and today (2005).

Moreover, a great deal has already been published on ancient Greek furnaces and bronze work, and we contend that using authentic techniques and materials would not have greatly increased our knowledge of the subject or changed – dramatically – the results of this experiment (see Craddock et al. 2007).

Steps and reflections on the process

We first approached William and Shannon Cannings of the Texas Tech University School of Art for their help in creating a concrete mould. We believed that concrete was the best option as it was an inexpensive material with high plasticity, which would hopefully allow us to overcome our lack of artistic skill. The Cannings immediately suggested casting the *haltēres* in bronze using the lost wax method for a more authentic recreation. While not a perfect reproduction, this would provide a more similar weight and material to some of the weights used in antiquity.

If the School of Art had not already scheduled a bronze pour, this experiment would have been prohibitively expensive, since heating the bronze and the furnaces for a single project was not feasible. While the materials themselves, such as wax and bronze, silicone investment, and tools were a controllable cost, the time Will and Shannon Cannings spent on the project was not. As they are featured artists, their help was vital to completion and they donated the time spent on this project. Certainly, a benefit of having trained artists familiar with the university's equipment was that the project was conducted safely and efficiently. Use of the furnace, for example, would not have been possible or safe without professionals.

The steps taken to create the *haltēres* were: first, creating the wax versions which were proportionally the same weight as the finished bronze objects; second, spruing and investment to make the shell around the wax versions; and, finally, the burnout of the wax and the metal casting (See Figures 6-10).

In between each of these steps, the Cannings were most insistent on making sure that the objects were aesthetically pleasing. We include this note because their goals for the project were to add to knowledge of the School of Art and emphasize its presence on campus. Texas Tech completed the 3D Art Annex building in 2008, but, while it is well known in their field as a technological marvel, the rest of the campus has little idea it exists. For them, therefore, exposure was a key goal. To accomplish that goal, they felt that a finished product should display the art school's talents to best effect. We might also note that this aesthetic aspect was welcome since the surviving examples of *haltēres* from the ancient world run the gamut from strictly utilitarian to beautiful objects. For example, a bronze jumping-weight in the George Ortiz Collection in Geneva is engraved with a standing cock and along its edges runs a motif similar to metopes and triglyphs (Knoepfler 1994; image available here). Other objects such as discuses were inscribed or engraved as well (an example in Berlin is etched with a picture of a jumper with *haltēres*; See Knoepfler 1994 Fig. 6). Since several of the *haltēres* found in the archaeological record are dedications to gods (as evidenced by epigrams – cited above – or simply inscribed names of deities (e.g., Pleket and Stroud 1991, Chaniotis et al. 2001), beauty would, of course, be important, because the gods take delight in *agalmata*, "beautiful things" (see Day 2010). In short, therefore, it would seem that some ancient Greek athletes *also* thought that *haltēres* – or other athletic equipment – could (and should) be beautiful.

The Event

The next question to be addressed was where the trials would take place. We turned to the Athletics Department, and specifically the Track and Field programme and Diane Wholey (Assistant Athletic Director – Track and Field Operations). Wholey has had a thirty-seven-year career in athletics, both as a competitor and as a coach. She had participated in biomechanical long jump studies before, although never from a historical perspective: "I have certainly seen the ancient drawings over the years and even have a few 'craft' items someone gave me as gifts when they returned from Greece after the 2004 Olympic Games. To be honest I had not thought very much about the objects the athletes were carrying while competing until I had this opportunity to speak with the TTU professors" (email, pers. comm. 2017). The jumping trials took place in athletic facilities with sand jumping pits that greatly enhanced the safety of the trials. Furthermore, the use of Texas Tech's state-of-the-art athletics facilities (in a temperature controlled indoor dome) removed many of the variables that would have come from outdoor experiments.

We conducted two main trial days, both of which were on weekends. We had four participants, all of whom were in good shape and had advanced athletic experience in track and field or gymnastics (See Figure 11). The group included undergraduate and graduate students and professors (ages ranged from early 20s to late 30s). The four participants were male and weighed between 72kg and 84kg.

Results – Qualitative

Participants were asked questions throughout the process and their responses produced some important observations. Participant 1 admitted he had practiced before the trials with dumbbell weights. He expressed displeasure at the dumbbell's ergonomics and claimed that the shape was difficult to use. The swing motion of the weight, skimming the thigh, was uncomfortable; he had been worried he would hit himself in the leg. In contrast, the *haltēres* were preferred, and the volunteer felt they were safer and the grip was more ideal.

The jumpers at first found that the weights were very difficult to use. They were a distraction and changed the approach to the jump, suggesting that modern jump techniques are quite different or that much practice was necessary for ancient jumpers to use the weights effectively. Indeed, music was part of the ancient *halma* and we speculate that music provided a rhythm that aided ancient jumpers in their approach (Philostratus 55). Even for the standing jump the weights changed the rhythm of motion and required some practice. Because of these potential difficulties, our initial trials concentrated on the standing jump since it required less finesse. The running jump would require a great deal more practice as the entire rhythm of the approach and the launch was off because of the weights (the running jump will be attempted in later trials).

Each participant jumped several times without being measured in order to become accustomed to the weight of the *haltēres* and to warm up for the actual trial jumps. The trial jumps themselves were standing broad jumps: participants stood at the edge of a long jump pit (filled with sand) and swung the weights backwards before leaping forwards. The distance of their jumps was measured from the leading edge of the pit to the heel of their closest footprint. Each participant jumped three times with each set of weights (and three times with no weights) so as to generate an average jump distance.

Diane Wholey observed the different jump profile as well as the changes in the landing: participants landed with their weight forward. Their imprints in the sand were flatter, which indicated a landing with body weight distributed evenly, rather than landing with the back of the heels. This has the benefit of pulling the jumper forward during landing. A wobble or misstep will more likely be taken forward rather than backward, and would therefore not decrease the length of the jump. Wholey also noted that arms were extended forward with the weights, thus increasing the follow-through motion of the arm swing. This result mirrors the findings of the computer model tests.

The jumpers felt there was a period of adjustment when they started. Wholey herself noted that there was “a bit of a learning curve for the test subjects of this particular study” (email, pers. comm. 2017). As they became more familiar with the weights, three of the four participants could jump further; however, while repeated jumping increased skill, it also caused the athletes fatigue. A second trial, currently ongoing, will allow jumpers to gain skill, but jump over multiple days to best prevent fatigue from affecting the results.

Once they became accustomed to the *halteres*, all four stated the most comfortable weight was 2kg. None of the participants felt the lightest size (1kg) was useful. The 3kg weight was too large, they claimed, and was described as “pulling” one’s arms forward in an uncomfortable way. This might be a case of the volunteers needing more practice to become comfortable with the heavier set of *haltēres*, or that they need to train their shoulders so the jarring “pull” sensation is less onerous.

Results – Quantitative

Participant	Jump 1 Distance	Jump 2 Distance	Jump 3 Distance	Average
	No weights			
1	229.87 cm	252.73 cm	243.84 cm	242.15 cm
2	229.87	241.94	234.32	235.38
3	226.82	231.01	225.25	227.69
4	238.25	238.13	250.19	242.10
	3 kg			
1	232.41 cm	235.59 cm	240.03 cm	236.01 cm
2	234.32	215.90	254.64	234.95
3	217.17	226.70	219.08	220.65
4	243.84	254	243.84	247.23

	2 kg			
1	224.15 cm	237.49 cm	247.02 cm	236.55 cm
2	222.25	241.3	239.40	234.32
3	217.17	222.25	221.62	220.35
4	237.49	241.94	243.21	240.88
	*1 kg**			
2	235.59 cm	232.41 cm	236.22 cm	234.74 cm
3	217.17	210.82	212.09	213.36
4	238.76	241.3	230.51	236.86

TABLE 2. JUMP DISTANCES WITH DIFFERENT *HALTĒRES.* *PARTICIPANT 1 WAS CALLED AWAY IN THE MIDDLE OF THE EXPERIMENT AND WAS THEREFORE UNABLE TO COMPLETE HIS MEASURED JUMPS WITH A 1KG WEIGHT.

Table 2 provides full details, but some preliminary conclusions can be drawn: three of the four participants jumped farthest *on average* with no weights (participant 4 jumped farthest on average with 3kg weights). However, three of four participants jumped their farthest individual jump of the day with 2kg or 3kg weights (participant 3 jumped his farthest individual jump with no weights). The two farthest jumps of the day overall were made with 3kg weights. Although the athletes did not prefer it subjectively, the 3kg weights led to the longest jump of the day, perhaps indicating, therefore, that the heavy Acmatidas examplewas, actually, a competition piece; indeed, the farthest average series of jumps was also made with 3kg weights. These results support the ancient evidence that suggests individual pentathletes had individual preferences for the weight of their *haltēres* and whether or not they used them in competition at all. It may also be observed that the weights did not affect the overall ranking of the participants to any great degree: with 3kg, 2kg, and 1kg weights, participant 4 jumped farthest on average; with no weights, participant 1 jumped farthest (the difference between participant 1 and 4 with no weights is 0.05 cm). Athletic ability, therefore, would appear to have remained the most important criterion for jumping distance.

The jumps also indicate an adjustment period, which reflects the subjective experience of the participants. For the 3kg and 2kg weights, the average first jump was shorter than the second and third jumps in the series. With 3kg weights, the average of the third jump in the series was over 7cm farther than the first jump; with 2kg weights, the average of the third jump was over 12cm farther than the first jump. Only 1kg weights failed to indicate this trend. Indeed, 1kg weights provided neither the longest average jump for any participant nor the longest single jump overall, and therefore the data support the subjective experience of participants that the 1kg weights were of little use.

Publicity

For the first experiment, we kept audience numbers small, but a press release (in *Texas Tech Today*) was published in conjunction with the conference. After this, multiple faculty (both in and outside the department) contacted us and wished to attend despite its scheduled time of a Saturday morning.

The experiment also generated a great deal of interest within the university. The Office of the Vice President for Research asked if they could feature the experiment in their web series, "In the Field". This series is intended to create excitement about research at Texas Tech and to highlight the broad nature of study at the university. A 10-minute web report on the research was produced. "In the Field" host John Davis talked about why he chose to highlight this piece of research: "It is a perfect 'people' story illustrating interesting research at Texas Tech. For us, you can't ask for much more than that. It incorporates art and science practitioners working together to solve a question – each donating his or her expertise". He also stated, "this project is definitely a stellar example of inter-disciplinary research. One of the things I find so outstanding about this is it includes arts and sciences together. Everyone talks about STEM [science, technology, engineering, math] these days, which is important. ... For a question such as this, STEAM [science, technology, engineering, arts, math] is a much better approach. This is a shining example of a cooperative collaboration to a problem that involves both art and science to understand how the Greeks used *haltēres* for the long-jump events" (email, pers. comm. 2016).

Other comments we received were that no one expected Classics to be doing hands-on experiments. "I didn't know what to think. I assumed that Classics professors spent their time in libraries, and archaeologists spent their time in the dirt. I think I expected pith helmets. I didn't think about them being the same people moving from dirt to library," one responder answered during a survey to the public that accompanied the second trials. Shannon Cannings was very gratified to be able to display through this project that the technologies which she loves to use every day have such ancient roots.

Diane Wholey stated, "I think the premise of the study was very interesting and I am excited that I was able to be a part of it, even if in a very small way. I am more than a little bit of a "geek" when it comes to the biomechanical studies of the track and field events, particularly with the long jump as the field events have always been a part of my coaching involvement. It was very interesting to add the ancient/historical perspective as well, which I have not been involved with as much in my past" (email, pers. comm. 2017).

Conclusions

While many questions about the ancient Greek long jump and its equipment remain, we did learn many important lessons about running experiential and experimental activities. In the future, we suggest that this experiment continue with new volunteers who have time to train with the weights in order that they develop familiarity with them; a longer-term study is in the works to address this question directly. The project has also caused us to consider the differences between modern athletes trained for a specific event, and ancient athletes who had a trained skill set related to a physically arduous occupation or warfare.

This experiment also has provided us with a case-study of how to generate interest from the public and the university administration, while working with diverse faculty and staff. The results have been felt immediately; better links have been established between the Classics program, Athletics, and the School of Art. These links have led to future projects; our Ancient Technology class is now going to be taught with significant use of the Art School's 3D Annex and pottery studio. Our links with the Athletics department are continuing as we plan another set of trials. Moreover, the weights themselves are both aesthetic and functional objects. Once the trials are complete, the *haltēres* will be displayed publicly on campus. These weights will also be used as a recruiting tool during Classics day when we invite local high school students to come to campus.

Classical Archaeology, a term itself which is frequently derided by our anthropological peers in the United States, is shrinking (Davis 2001). As always, we must make new connections and conduct outreach which will continue to increase our visibility as a discipline both within our universities and the larger community. Frankly, we must change to survive; this project is one attempt by our Classics program to do so.

Keywords sport
interpretation
tools

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Bibliography

ARISTOTLE, 1937. *Parts of Animals. Movement of Animals. Progression of Animals.* Trans. A.L. Peck and E.S. Forster. Cambridge, Mass.: Harvard University Press.

BRONEER, O., 1959. Excavations at Isthmia, Fourth Campaign, 1957-1958. *Hesperia,* 28(4), pp. 298-343.

CEG: see Hansen, P.

CHANIOTIS, A., PLEKET, H.W., STROUD, R.S., STRUBBE, J.H.M., 2001. "*SEG* 48-537. Kaukania. Inscribed dedicatory jumping weight, ca. 550 B.C." In A. Chaniotis, H.W. Pleket, R.S. Stroud, J.H.M. Strubbe, *Supplementum Epigraphicum Graecum* 48.

CRADDOCK, P., MEEKS, N. and TIMBERLAKE, S., 2007. On the edge of success: the scientific examination of the products of the Early Mines Research Group smelting experiments. Iin: S.

La Niece, D. Hook and P. Craddock, eds. *Metals and mines: studies in archaeometallurgy.* London: Archetype Publications. pp. 37-45.

DAVIS, J. 2016. Personal Interview, 20 October.

DAVIS, J., 2001. Classical Archaeology and Anthropological Archaeology in North America: A Meeting of Minds at the Millennium? In: G. M. Feinman and T. D. Price eds. *Archaeology at the Millennium.*New York: Springer Verlag US. pp.415-437

DAY, J. W., 2010. *Archaic Greek Epigram and Dedication: Representation and Reperformance*. Cambridge: Cambridge University Press.

DONLAN, W. and THOMPSON, J., 1976. The Charge at Marathon: Herodotus 6.112. *The Classical Journal*, 71(4), pp. 339-343.

DONLAN, W. and THOMPSON, J., 1979. The Charge at Marathon Again. *The Classical World*, 72(7), pp. 419-420.

FILUSH, A., 2012. *Effect of Using Hand-Weights on Performance in the Standing Long Jump*. M.S.E. Grand Valley State University. Availableat: scholarworks.gvsu.edu/theses/28. [Accessed 09.08.2017].

GARDINER, E. N., 1904a. Phayllos and his record jump. *Journal of Hellenic Studies*, 24, pp. 70-80.

GARDINER, E. N., 1904b. Further notes on the Greek jump. *Journal of Hellenic Studies*, 24, pp. 179-194.

HANSEN, P. ed., 1983. *Carmina Epigraphica Graeca*. Berlin: de Gruyter.

HOMER, 1919. *The Odyssey*. Trans. A.T. Murray. Cambridge, Mass.: Harvard University Press.

HYDE, W. W., 1938. The pentathlon jump. *American Journal of Philology*, 236, pp. 405-418.

JÜTHNER, J., 1965. *Die athletischen Liebesübungen der Griechen*. Vienna: Österreichische Akademie d. Wissenschaften

KNOEPFLER, G., 1994. Haltère de bronze dédie à Apollon *Hékabolos* dans la collection G. Ortiz (Genève). *Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres*, 138(2), pp. 337-379.

KRON, J. G., 2005. Anthropometry, Physical Anthropology, and the Reconstruction of Ancient Health, Nutrition, and Living Standards. *Historia*, 54, pp. 68-83.

LEE, H. M., 2007. The Halma: A Running or Standing Jump? In: G. Schaus and S. Wenn, eds. *Onward to the Olympics: Historical Perspectives on the Olympic Games*. Ontario: Wilfrid Laurier University Press. pp. 153-165

LENOIR, M., De Clercq, D. and Laporte, W., 2005. The "how" and "why" of the ancient Greek long jump with weights: A five-fold symmetric jump in a row? *Journal of Sports Sciences,* 23(10), pp. 1033-1043.

MILLER, S. G., 2015. Nemea, Sikyon, and Delphi. In: A.P. Matthaiou and N. Papazarkadas, eds. *Axon: Studies in Honor of Ronald S. Stroud*. Athens: Greek Epigraphic Society. pp. 481-493.

MINETTI, A. E. and ARDIGÓ, L. P., 2002. Halteres used in ancient Olympic long jump. *Nature*, 420(6912), pp. 141-142.

MOURATIDIS, J. 2012. *On the Jump of the Ancient Pentathlon*. Hildesheim: Weidmann.

PAUSANIAS, 1926. *Description of Greece Volume* II-III. Trans. W.H.S. Jones and H.A. Ormerod. Cambridge, Mass.: Harvard University Press.

PAPADOPOULOS, C., NOUSSIOS, G. MANOLOPOULOS, E., KIRITSI, O., NTONES, G., GANTIRAGA, E., and GISSIS, I., 2011. Standing long jump and handheld halters; is jumping performance improved? *Journal of Human Sport and Exercise*, 6(2), pp. 436-443.

PHILOSTRATUS, 2014. *Heroicus. Gymnasticus. Discourses 1 and 2.* Trans. J. Rusten and J. König. Cambridge, Mass.: Harvard University Press.

PLEKET, H.W. and Stroud, R.S., 1991. "*SEG* 38-328. Aigiai. Near Gytheion. Inscribed Stone Halter, 525-500 B.C."In: H.W. Pleket and R.S. Stroud, *Supplementum Epigraphicum Graecum* 38.

PROVATIDIS, C., 2013. Simplified Biomechanics for a Possible Explanation of the Ancient Greek Long Jump Using Halteres. *Universal Journal of Engineering Science*. 1(1), pp. 5-16.

TANG, R. H. and HUANG, C. F., 2007. Legend or history? A biomechanical analysis of extra weights on standing long jump. *Journal of Biomechanics*. 40(Supplement 2), p. S609.

WARD-SMITH, A. J., 1995. The application of modern methods of biomechanics to the evaluation of jumping performance in ancient Greece. *Journal of Sports Science*, 13(3), pp. 223-228.

WHOLEY, D. 2016. Personal Interview, 13 February.

WILSON, N.G. (ed), 1975. *Scholia in Aristophanem. Acharnians*. Groningen: Egbert Forsten.

YOUNG, D. C., 2002. *The Modern Olympics: A Struggle for Revival*. Baltimore: The Johns Hopkins University Press.

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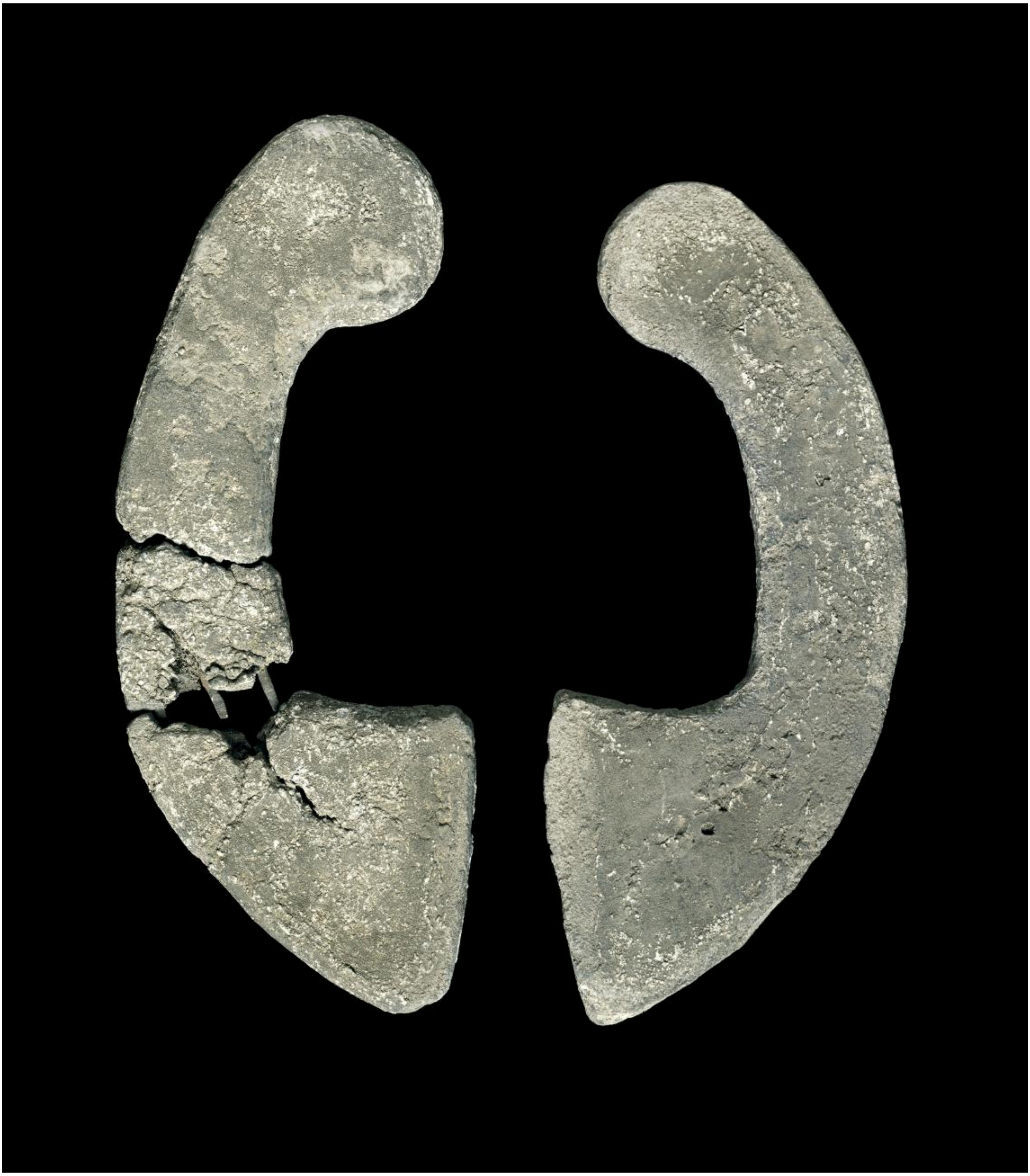

FIG 1. “JUMPING-WEIGHT” CA. 500 BCE, BRITISH MUSEUM (1837, 0609, 83) © TRUSTEES OF THE BRITISH MUSEUM

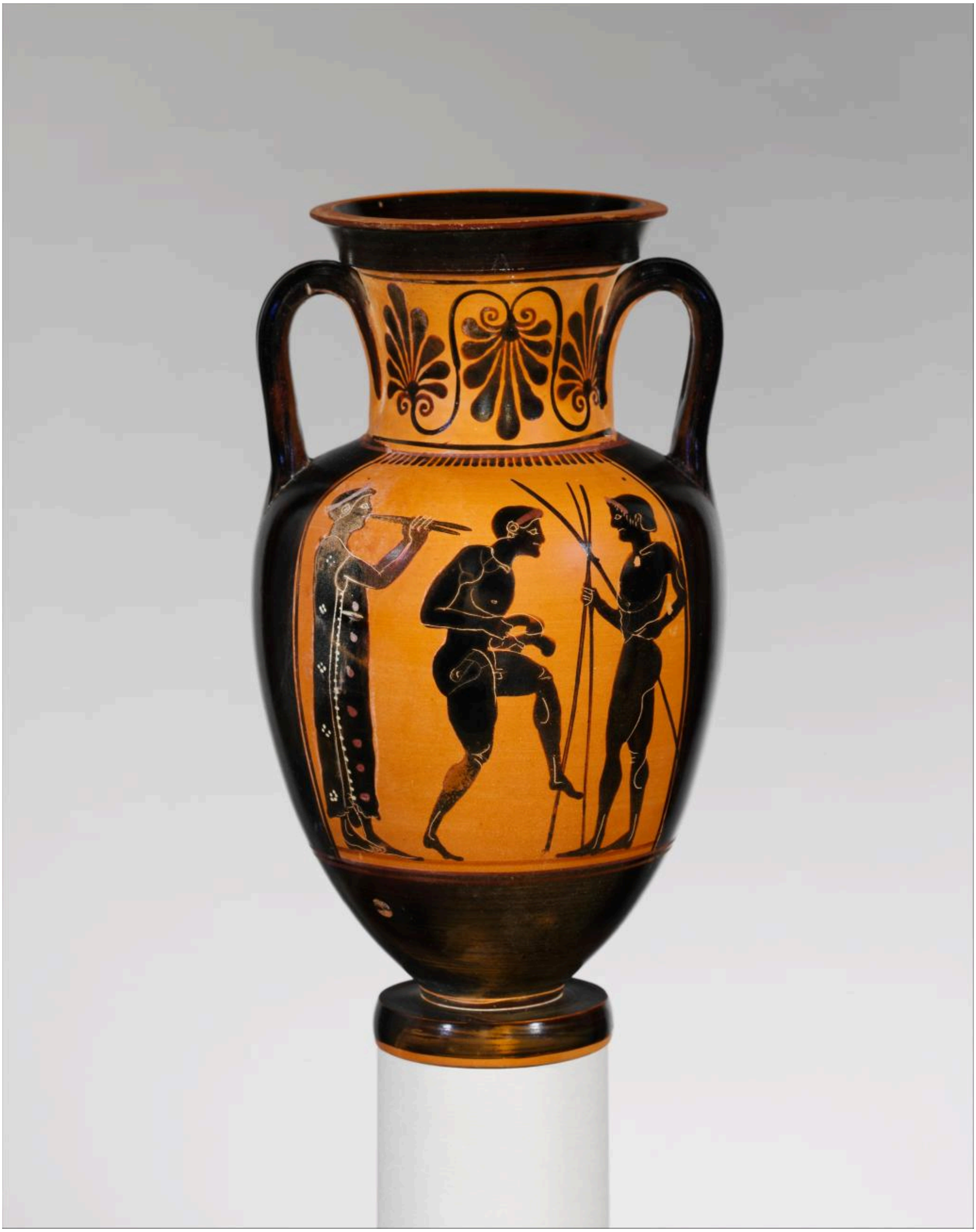

FIG 2. NECK-AMPHORA BY THE EDINBURGH PAINTER CA. 500 BCE, METROPOLITAN MUSEUM OF ART (56.49.1)

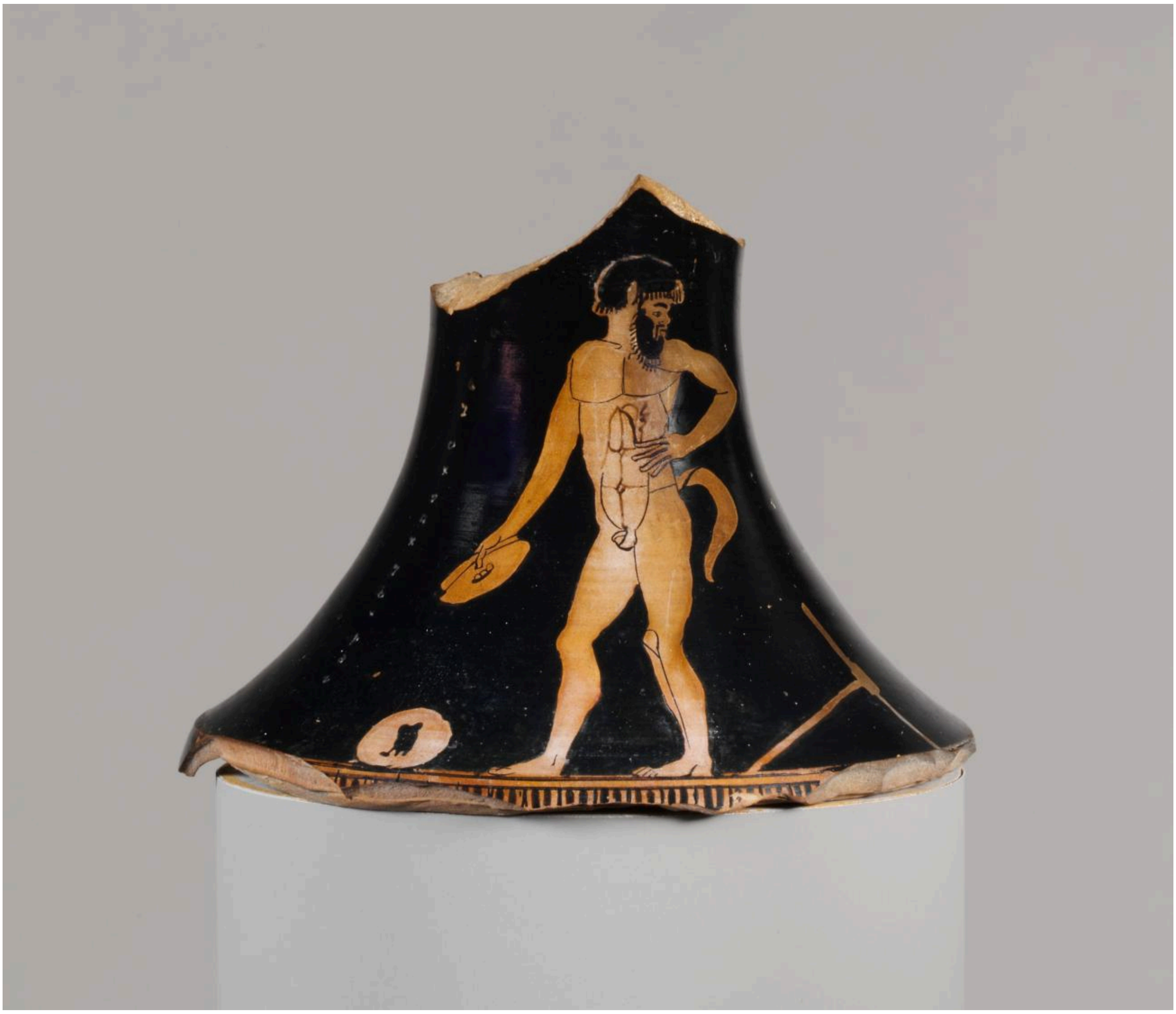

FIG 3. OENOCHOE BY THE HARROW PAINTER CA. 490 BCE, METROPOLITAN MUSEUM OF ART (12.229.13)

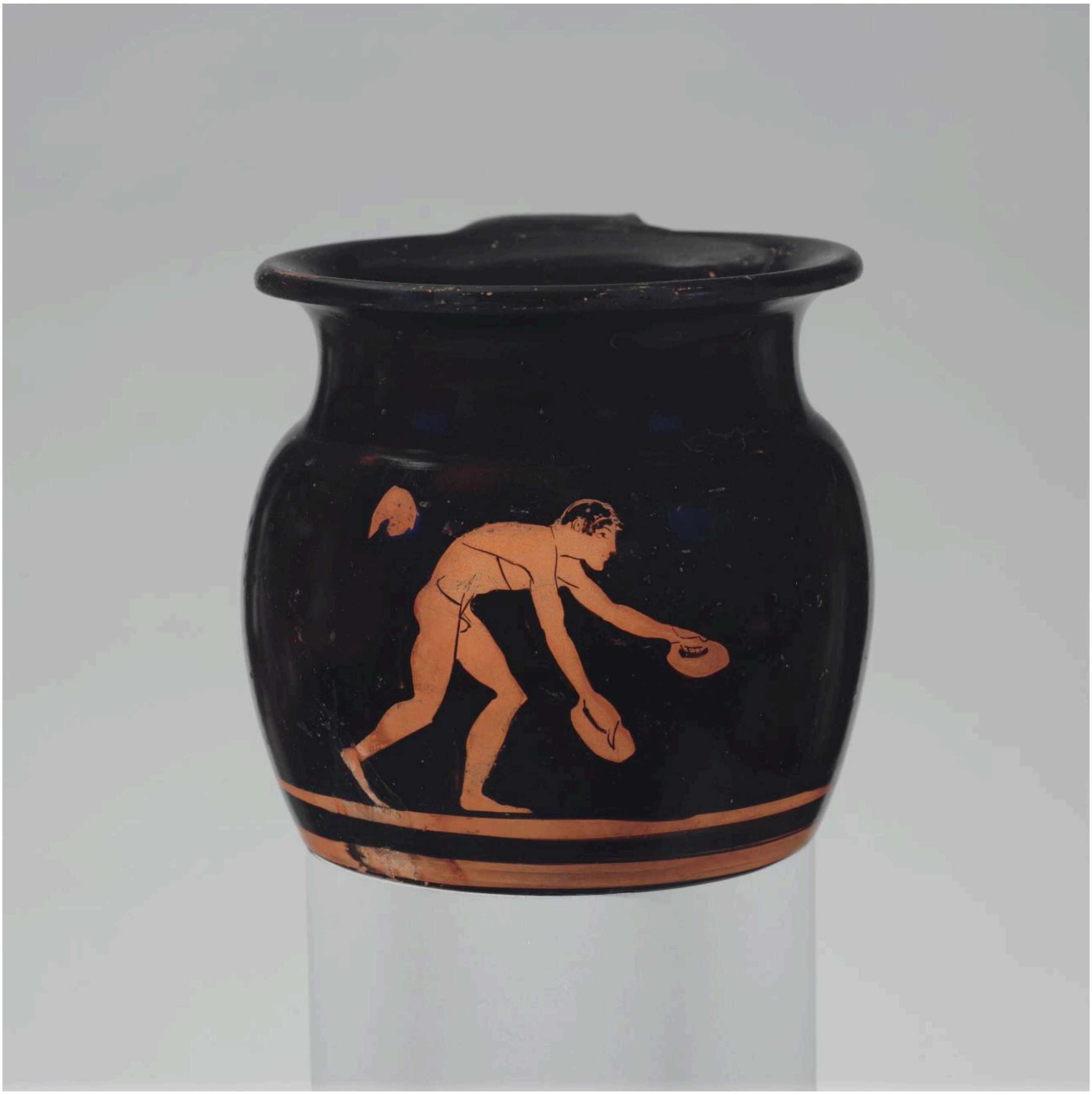

FIG 4. TERRACOTTA MUG ATTRIBUTED TO THE GROUP OF PHILADELPHIA 2272 CA. 460 BCE, METROPOLITAN MUSEUM OF ART (41.162.154)

FIG 5. BRONZE HALTERES PRODUCED BY TEXAS TECH SCHOOL OF ART

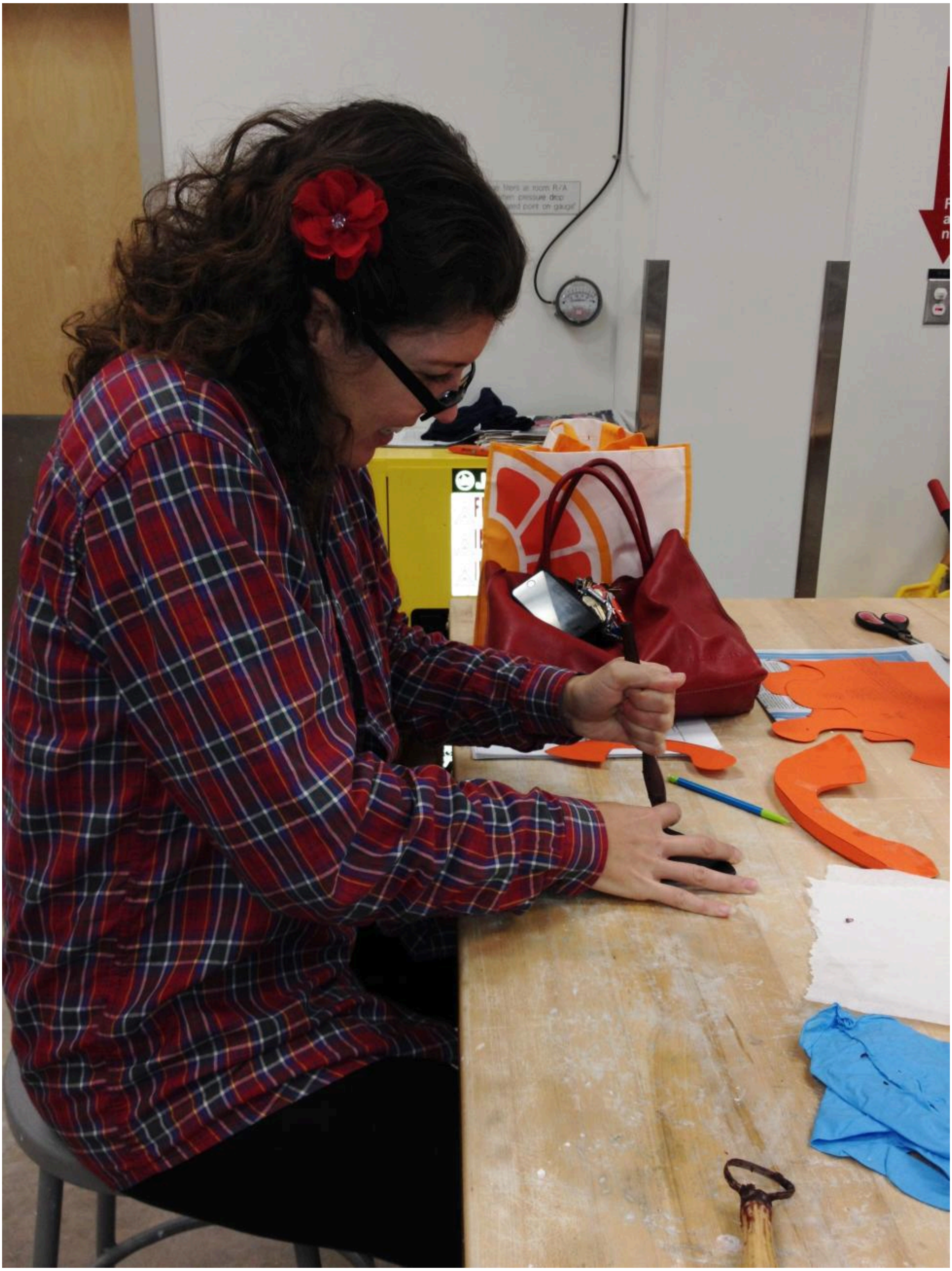

FIG 6. SHANNON CANNING CREATING THE PROTOTYPE.

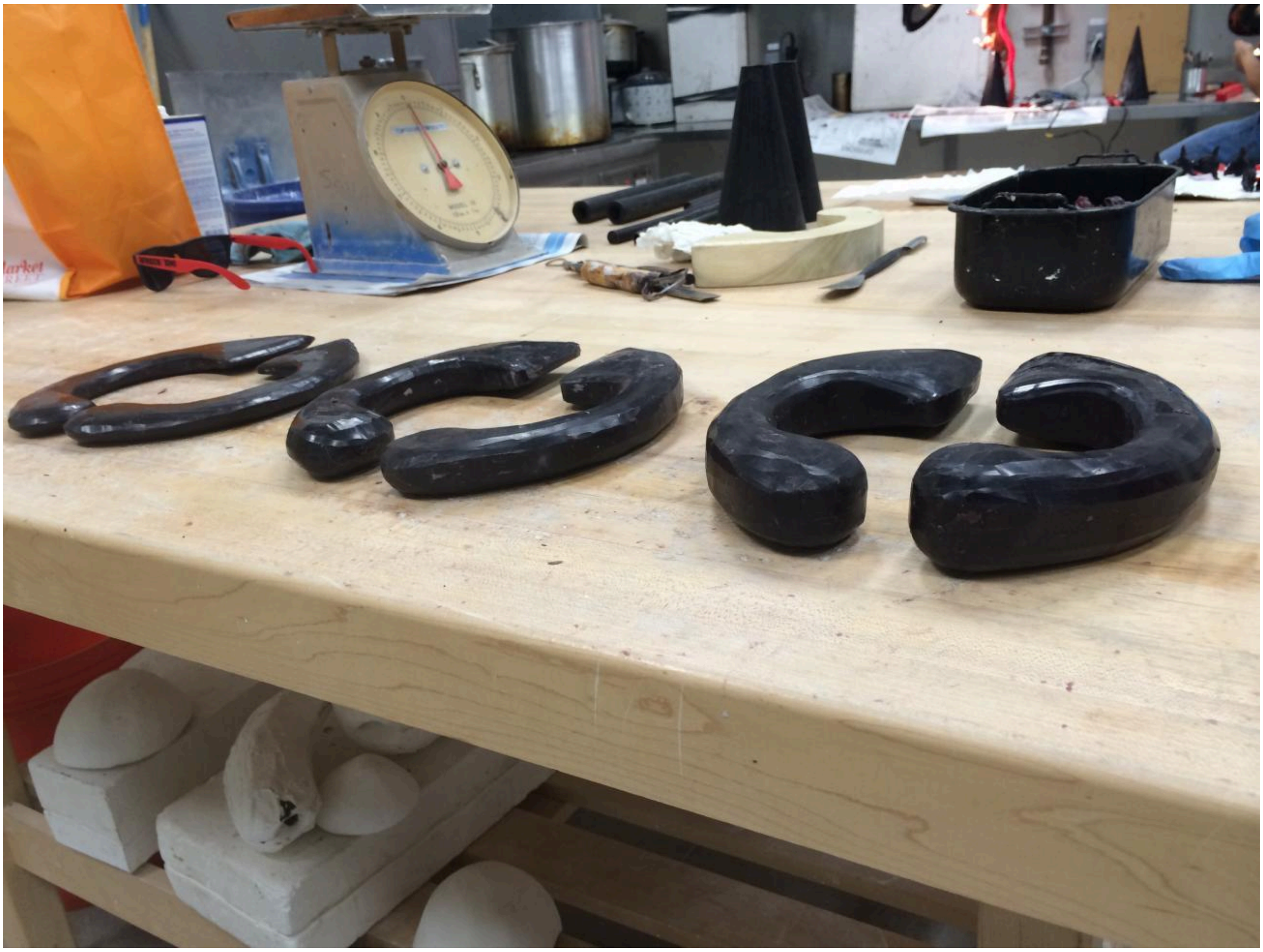

FIG 7. FINISHED WAX VERSIONS WHICH WERE PROPORTIONALLY THE SAME WEIGHT AS THE FINISHED BRONZE.

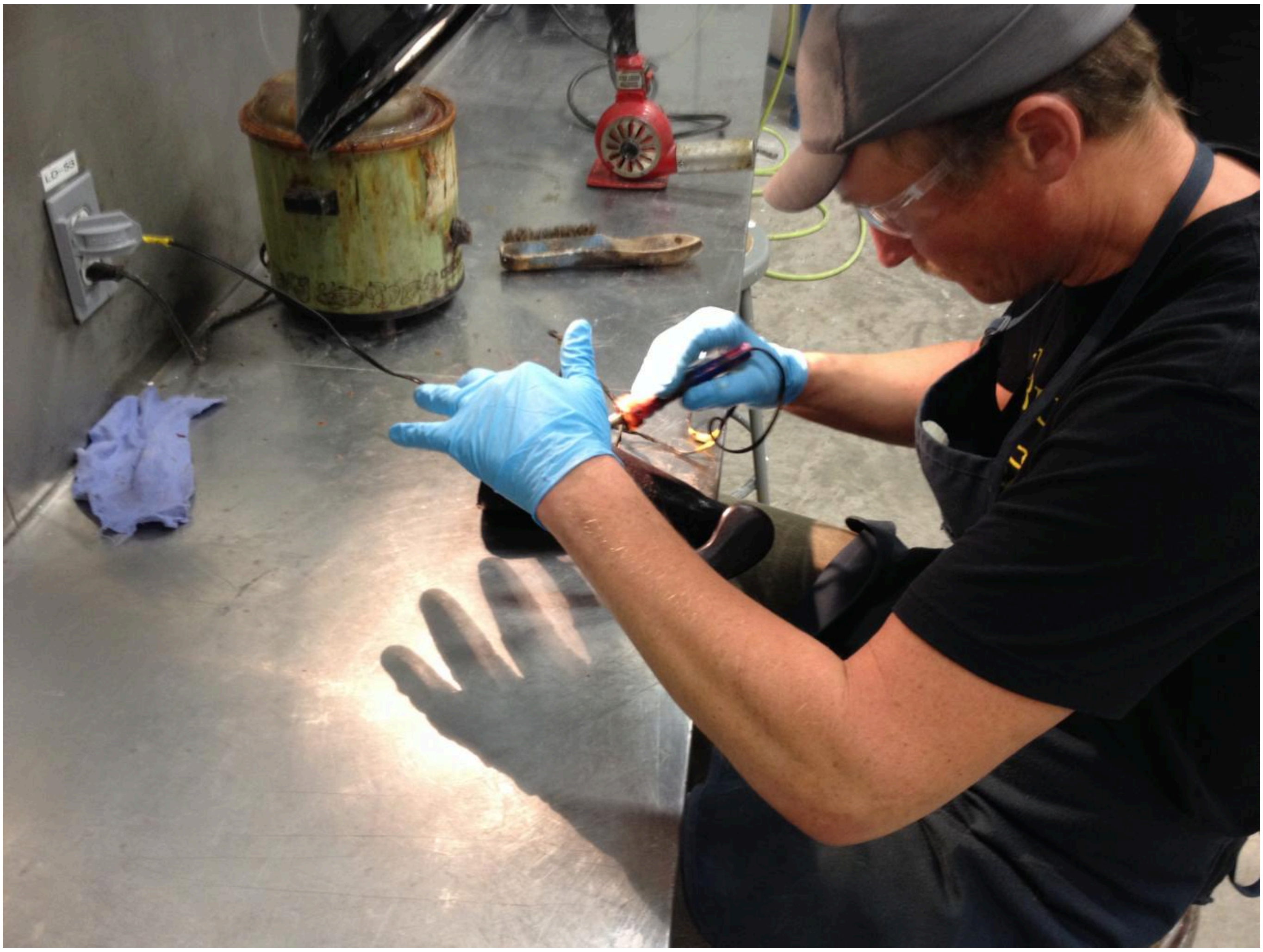

FIG 8. WILL CANNING MAKING THE WAX SPRUCES TO CREATE THE MOULD.

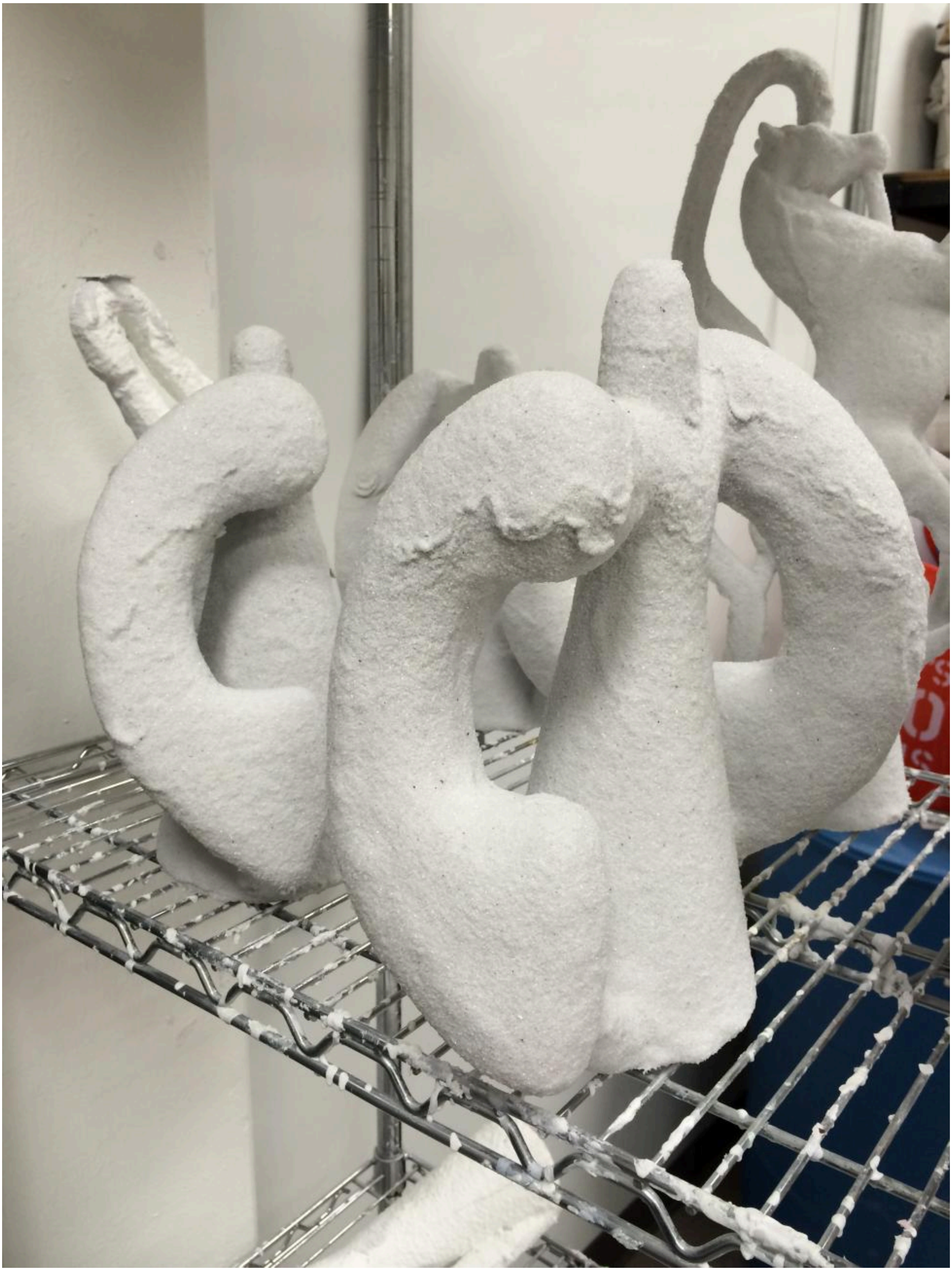

FIG 9. THE SULLRY HARDENS TO FORM THE SHELL FOR THE LOST WAX PROCESS.

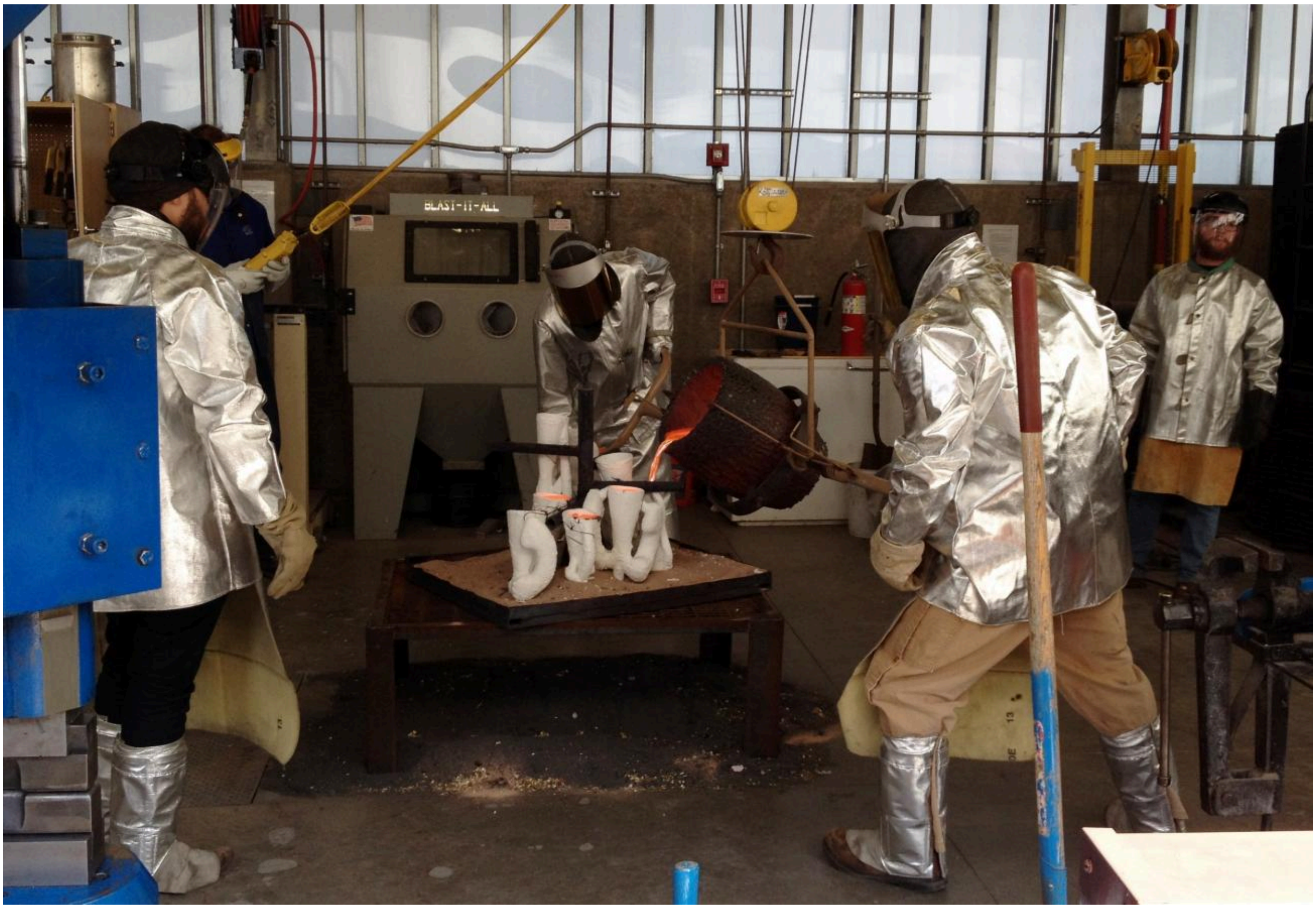

FIG 10. POURING OF THE BRONZE.

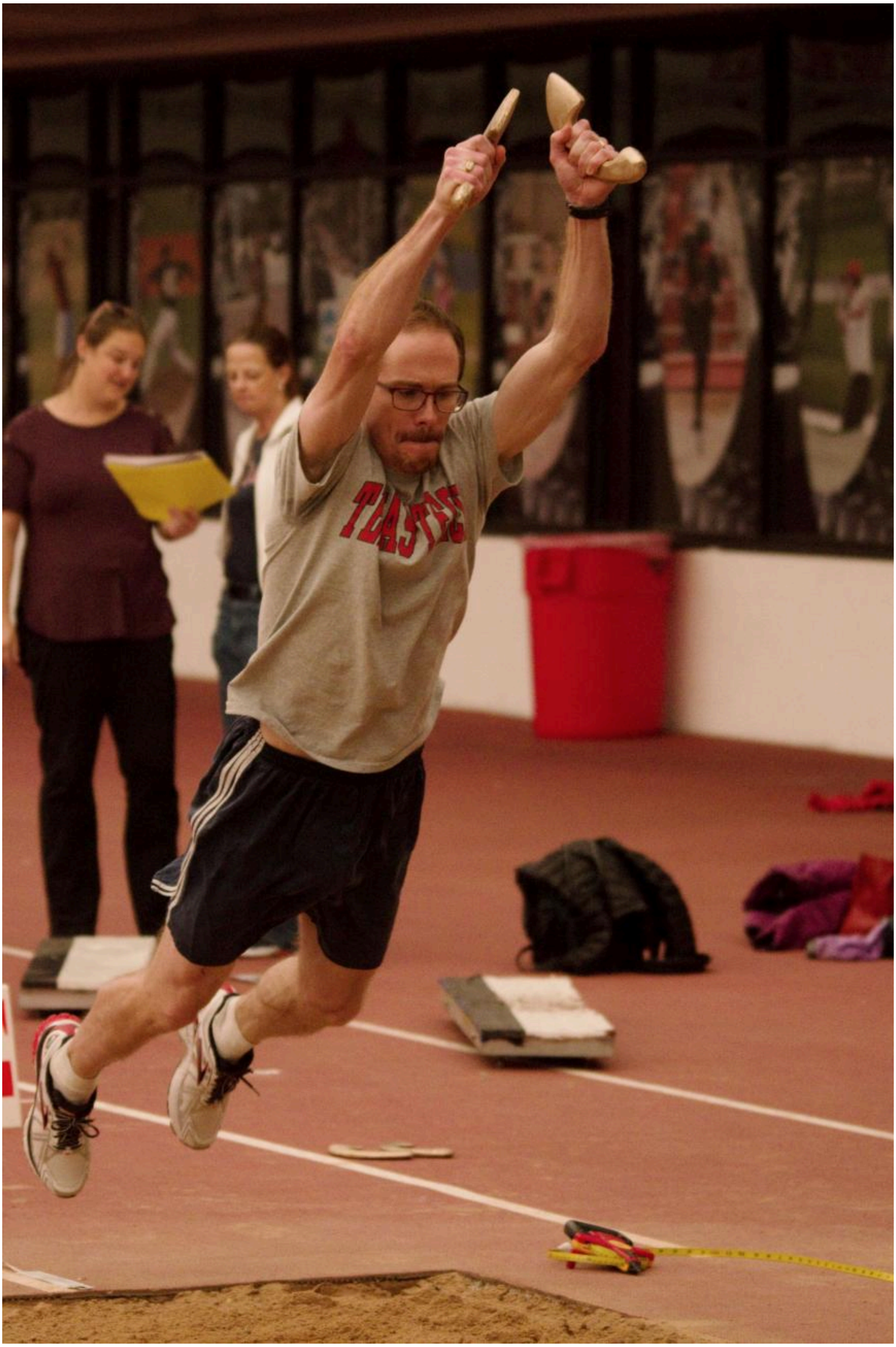

FIG 11. A PARTICIPANT ENACTING A STANDING BROAD JUMP.