

## CASTING TECHNOLOGIES AND CULTURAL CONNECTIONS AT AN EGYPTIAN HARBOUR TOWN

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### *Abstract*

*Lead and bronze finds dominate the statuette assemblage at Thonis-Heracleion, an Egyptian port of the Late and Ptolemaic Periods. In this article, I extrapolate the types of casting methods used for statuette production at Thonis-Heracleion based on detailed examinations of the figures in the field. The bronze statuettes and amulets provide new insights on the topic of Egyptian bronze casting, as the methods are still debated. I evaluate the possible use of the indirect lost wax method and issues of quality and mass production for bronze figures. The lead statuettes and amulets, alternatively, open a new discussion about lead casting in Egypt, as the lead statuettes have few parallels outside of Thonis-Heracleion and lead casting has never been discussed in detail with respect to Egyptian statuettes. The lead statuettes include replicated figures across several different iconographic types, and these figures were cast using open and bivalve refractory moulds. The hollow lead figures were probably created with the lead slush technique.*

*This discussion of casting techniques as a whole targets not only the methods used for lead and bronze casting in Egypt, but also the social implications behind these techniques, such as how and with whom specific technologies were exchanged. Replication of bronze and lead figures was common among other cultures in the Late Period and earlier, in Greece and in the Eastern Mediterranean, and contact with these cultures may have contributed to the development of replication methods in Egypt for bronze and lead casting.*

### INTRODUCTION

The city of Thonis-Heracleion is an Egyptian harbour town that flourished between the seventh and second centuries BC.<sup>1</sup> It has a complex topography with multiple landmasses intermeshed with canals that acted as the city's main thoroughfares.<sup>2</sup> Thonis-Heracleion met a cataclysmic end by the eighth c. AD, when much of the Canopic peninsula sank as

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<sup>1</sup> Thonis-Heracleion monographs, theses, and catalogues: Goddio 2007; Stanley and Bandelli 2007; Stolz 2007; Goddio and Fabre 2008; Robinson 2008; von Bomhard 2008; Thiers 2009; Libonati 2010; von Bomhard 2012; Heinz forthcoming; van der Wilt forthcoming. In-depth articles: Fabre and Goddio 2012; Grataloup 2012; Heinz 2011; Meadows 2011; van der Wilt 2010; and articles in Robinson and Wilson 2010, 2011.

<sup>2</sup> Goddio and Fabre 2008, 45. Depth: Stanley and Bandelli 2007, 47.

the result of heavy flooding or earthquakes; the site is now 5-6m underwater.<sup>3</sup> Intensive survey and underwater excavations by the Institut Européen d'Archéologie Sous-Marine (IEASM) began in 2000 after the team discovered Thonis-Heracleion and its neighbouring city East Canopus. The site's current position underwater and its topography in antiquity created ideal conditions for the survival of metals. Some looting may have occurred during the site's history, but much of the metal on land and anything in the canals was preserved from reuse in antiquity, and the site's current location several kilometres off the Egyptian coastline has inhibited more modern looting.<sup>4</sup>

Among its finds, Thonis-Heracleion has over three hundred statuettes and amulets; 85% of those are lead or bronze. The bronzes are mostly Egyptian style, while the lead figures encompass Egyptian, Greek, and Ptolemaic styles.<sup>5</sup> Figure 1 shows the distribution of the statuettes and amulets across the site, both in the canals and on land. Below, I first outline the casting processes that were frequently used in antiquity. I then look first at the bronzes and then the lead figures and explain the methods used for each. Finally, I place these technologies in the wider cultural context.

#### THE CASTING PROCESS<sup>6</sup>

Before evaluating the casting methods used for the Thonis-Heracleion figures, it is important to first give an overview of the casting processes in antiquity and the various choices that artisans had for creating statuettes. In Ancient Egypt, there were three common ways to make a metal statuette.<sup>7</sup> The first was to hammer sheets of metal around a wooden core. Statuettes thus created are known to Classical archaeologists as *sphyrelata*, but these are not common in Egypt and are not present at Thonis-Heracleion.<sup>8</sup> The remaining methods

<sup>3</sup> For an account of the excavated zones up to 2005, see Goddio 2007, 69-130. For an artist's rendering of the site, see Goddio and Fabre 2008, 46.

<sup>4</sup> Goddio 2007, 77; Robinson 2008, 32; Cox 2008, 264.

<sup>5</sup> For the assemblage as a whole, see Heinz forthcoming. For an overview of the lead figures, see Heinz 2011. Several of the bronzes and some lead figures were preliminarily published in Goddio and Fabre 2008, 316-323, 338-340, nos. 167-206, 208-209, 211-212, 319-333, 345. For an overview and analysis of the exhibition bronzes, see Weiß 2012, 395-397.

<sup>6</sup> The following discussion is a summary of sources for the lost wax technique and Egyptian metalworking practices: see Scheel 1989 and Ogden 2000 for Egyptian metals, including ore sources and manufacture; outdated but still comprehensive: Garland and Bannister 1927. Copper alloy casting: Garland and Bannister 1927, 34-84; Brown 1976; Mattusch 1988, 10-30; Scheel 1989, 40-43; Ogden 2000, 155-161. Secondarily: Hill 2001, 202-204; Hill 2004, 2; Mendoza 2008, 9-14. Haynes 1992 provides a detailed analysis with an emphasis on Greek figures, including production and post-production techniques; see Lahusen and Formigli 2001 for Roman bronzes. See Cavanagh 1990 for casting in general, with modern working parallels; Hunt 1980 for a comparative study spanning 5000 years of history and several continents; Goldmann 1985 for prehistoric central Europe. For ancient sources for bronze casting, see Zimmer 1985; Haynes 1992, in relation to the development of piece moulding; Lahusen and Formigli 2001, 13-16.

<sup>7</sup> For a time, sand box casting was considered an option, at least for Greek bronzes, but the idea has been largely discredited. Mattusch 1988, 22-30 provides a summary of the debate. See also Lahusen and Formigli 2001, 449-451.

<sup>8</sup> For Greek *sphyrelata*, evidence and technique, see Haynes 1992, 11-23.

are the refractory mould method and the lost wax method. In refractory mould casting, metal is directly cast into a mould capable of withstanding high temperatures.<sup>9</sup>

The lost wax technique, or *cire perdue* casting, is the third method and is a technique still used in foundries.<sup>10</sup> It was the most common technique for bronze statuettes and is the most complex method of the three available. Lost wax casting may have begun in Egypt as early as the Old Kingdom. Eventually it displaced hammering for many purposes, and hollow-cast examples arose in the Middle Kingdom.<sup>11</sup> This technique is called the lost wax technique because during the process a wax model is melted or “lost,” leaving a perfectly moulded cavity into which molten metal is poured. Two lost wax methods exist: the direct and indirect methods. With both, the sculptor can create hollow or solid-cast statuary.

The simplest lost wax method is the direct method, which in its most basic form consists of five steps: (1) the artist makes a wax model; (2) he coats the wax figure in clay; (3) he fires the figure, the clay hardens into a solid mould, and the wax melts out; (4) he pours molten metal into the mould’s cavity and allows the metal to cool; (5) and he then removes the mould and cleans and polishes the bronze. The most important aspect of the direct method, for this discussion, is that each figure is unique. When casting is complete, the metal worker breaks the mould to retrieve the bronze within. This method is also called the investment method, because this ceramic layer is lost, or invested, in the making of the piece.<sup>12</sup> The original wax model and the clay mould are destroyed in the process, thus leaving no way to replicate the piece.

The indirect method, in contrast, allows for the production of a series of more or less identical solid or hollow-cast figures. The primary difference between the direct and indirect methods is one extra step at the beginning of the process in which the artist creates an extra mould. After creating the wax model, the artist moulds clay around it. He then removes the mould without breaking it, usually by fashioning it in two or more pieces, and fires it. He can then pour heated wax into that mould to create more identical wax figures. From there, each wax figure is casted according to the direct method, as described above. In principle the difference between the two processes is basic but important: with the indirect method, both the original mould and the original model are preserved, allowing for replication. For refractory and indirect lost wax techniques, there are three types of moulds: open moulds, bivalve moulds, and piece moulds.<sup>13</sup>

<sup>9</sup> Ogden 2000, 157. Denys Haynes (1992, 30), with reference to Greek techniques, uses the term refractory to designate specifically loam or sand/clay mixtures; here I use the term to refer to any type of durable mould material including clay, stone, plaster, or even metal.

<sup>10</sup> Foundry debris is rare; without physical examples, it is difficult to imagine what the mould and the bronzes looked like as this process progressed. Cavanagh (1990) provides useful photos of the modern process; see also Mattusch 1988, 15-22. Several online videos show the process in modern foundries; for example, for the first 3 minutes, 30 seconds: AP Casting. “How to Make Bronze Sculptures — Lost Wax Bronze Casting.” Theappgallery. <http://www.youtube.com/watch?v=gVe3VeQfyzw&feature=related> (uploaded October 13, 2008); multiple videos highlighting each stage: Expert Village <http://www.youtube.com/watch?v=-ScNxwqXkxY> (related links to the other videos on the right side). All of these videos concern the indirect method.

<sup>11</sup> Ogden 2000, 158. For a basic timeline: Ziegler 1996, 29-30, with specific pieces listed; Hill 2001, 204-207.

<sup>12</sup> For the term “investment” see Cavanagh 1990, 150-151.

<sup>13</sup> Open mould: Ogden 2000, 157. Piece mould: Haynes 1992, 42-53 (fig. 3 for an illustration).

BRONZE CASTING AT THONIS-HERACLEION<sup>14</sup>**Framing the Wider Debate**

The bronze statuettes at Thonis-Heracleion are representative of many similar votive statuettes throughout Egypt. These Egyptian bronze statuettes usually represent deities in anthropomorphic, hybrid, or theriomorphic forms.<sup>15</sup> Bronze votive statuettes were frequently buried after use, with the result that many survived looting in antiquity and in modern times.<sup>16</sup> Though thousands of bronze statuettes and figurines like those at Thonis-Heracleion stand on display in museums across the world, there is still debate over the methods by which they were produced. The material from Thonis-Heracleion, however, provides new information in this regard. In particular, the material points to the practice of replicable production; in other words, methods that allow for the production of identical figures, an idea that scholars have alternately accepted and rejected with respect to Egyptian bronze casting.

The earliest comprehensive works on Egyptian bronzes are Günther Roeder's publications from 1937 and 1956. Large portions of these, as well as earlier articles by Roeder, were dedicated to the technical processes used to make bronzes. He proposed that Egyptian bronzes were mass-produced through the indirect method, using moulds to produce wax replicas for casting.<sup>17</sup> He took this even further, stating that many wax figures were assembled from pre-moulded parts. For example, separate moulds existed for multiple portions of the figure (the head, the crown, the upper body, the lower body, the arms and the legs).<sup>18</sup> Using the moulded parts on hand, figures were assembled in wax according to the subject desired and then cast, taking mass production to the extreme.

Maarten Raven published preliminary results for his study of the 700 figured bronzes in the Leiden collection. He supports Roeder's opinions, but without providing visual confirmation through pictures or drawings, presumably because these were to be included in the final publication.<sup>19</sup> Roeder's assembly process appears evident to Raven because many of the Leiden figures have "protruding or lopsided joins between the original model parts, attributes or limbs of the wrong dimensions, protrusions resulting from superfluous wax, or casting-ducts removed incompletely or not at all." According to Raven, these were all signs of "shoddy workmanship and mass production."<sup>20</sup> Michel Wuttmann, in preliminary

<sup>14</sup> In technical studies, the term copper alloy is frequently used instead of bronze, as bronze refers to a specific combination of copper and tin (see, for example, Craddock 1977; Ogden 2000). Throughout this work, the term bronze is retained in part for its familiarity, and in part because the majority of Egyptian cast statuettes contemporary with those from Thonis-Heracleion, when tested, prove to be leaded bronzes (Riederer 1981, with bibliography).

<sup>15</sup> The most comprehensive resources on Egyptian bronze votive statuettes include Roeder 1937, 1956; Hill 2001, 2004, 2007; Aubert and Aubert 2001; Mendoza 2008; and Weiß 2012.

<sup>16</sup> Hill 2001, 203.

<sup>17</sup> Roeder 1933a; 1933b; 1937, 187-251; 1956, 515-549.

<sup>18</sup> Roeder 1933a; 1933b, 228-238; 1937, 144-187; 1956, 520-525.

<sup>19</sup> Raven 1992.

<sup>20</sup> Raven 1992, 531.

articles about several hundred bronze Osiris figures from ‘Ayn Manâwir, suggests that most were made in either mono or bivalve moulds, but he does not provide further explanation or visual proofs.<sup>21</sup>

Other scholars have expressed opposition to Roeder’s views. Deborah Schorsch has conducted detailed technical examinations of numerous Egyptian statuettes, often to determine their authenticity for museums.<sup>22</sup> In her 1988 article, she states that there are no ancient identical statuettes from Egypt because the direct lost wax method used to cast these bronzes does not allow for duplicates or copies to be made. She even notes that in cases where a piece was already considered a modern fake, the fact that a duplicate existed was considered the definitive evidence.<sup>23</sup> In 2007 Schorsch states that mould lines on a figure would prove that the indirect method was used, but that the mould lines described by Roeder were often different features that he confused with mould lines.<sup>24</sup> She does allow, however, that replicas were perhaps created in the Ptolemaic period and that this may reflect a change in foundry practices at this period, which may have included the indirect method.<sup>25</sup>

In 1998, John Taylor, Paul Craddock, and Fleur Shearman wrote about the production of hollow-cast bronzes from Karnak at the beginning of the first millennium BC.<sup>26</sup> Based upon their examinations, they also concluded that the Egyptians never used the indirect method and that all Egyptian statuettes are essentially unique.<sup>27</sup> They examined six figures at the British Museum: three female figures, two Osiris figures, and one male figure.<sup>28</sup> Both Schorsch’s study and Taylor, Craddock, and Shearman’s study rule out the use of refractory moulds as well as the indirect lost wax method for bronze statuette production, as both methods are capable of producing identical statuettes. Other scholars either accept Roeder’s or Schorsch’s positions, or hesitate to commit to either without more definitive proof.<sup>29</sup>

### **The Bronze Statuettes: Production Methods**

Pinpointing a location for lead and bronze production at Thonis-Heracleion is difficult. Some bronze waste and lead slag have been discovered, but the chunks are scattered across the site with no particular concentrations in any one area. Small fragments of lead are ubiquitous, particularly in the canals and waterways, but significant casting-related concentrations have not been firmly identified. A few statuettes, bronze and lead, are heavily damaged and may be casting wasters, but again they do not indicate any particular

<sup>21</sup> Wuttman *et al.* 1996, 433; Wuttman, Coulon, and Gombert 2007, 168.

<sup>22</sup> Schorsch 1988; Schorsch and Frantz 1998.

<sup>23</sup> Schorsch 1988, 42.

<sup>24</sup> Schorsch 2007, 192.

<sup>25</sup> Schorsch 2007, 192, referring to four Ptolemaic statuettes (nos. 52-55; figs. 82-85).

<sup>26</sup> Taylor, Craddock, and Shearman 1998.

<sup>27</sup> Taylor, Craddock, and Shearman 1998, 12.

<sup>28</sup> Taylor, Craddock, and Shearman 1998, 9.

<sup>29</sup> Ogden makes little mention of the idea of assembling figures from several wax pieces, but he does lend credence to the overall idea of indirect casting (2000, 157). Weiß (2012, 15) cites Schorsch’s arguments. Hill (2001, 204) and Mendoza (2008, 12) reserve judgment.

zone on site that may have housed production.<sup>30</sup> Nevertheless, the statuettes themselves provide useful information about production techniques, whether that production occurred in Thonis-Heracleion or in a nearby city.

Thus far, the excavators have not discovered any bronze figures that are identical. Nevertheless, it does seem that the indirect lost wax method was in use at the site and some figures were replicated. The most compelling evidence for this hypothesis is a casting mould that was discovered in 2004. The mould is a flat, ovular piece of lead, 1.3cm thick and 11.9cm wide (H9099, Figures 2-3). It was found near the entrance of the North Canal, east of the rectangular island in the East Passage. The stratigraphy near the island is complex and the excavation director has proposed that the general area may reflect erosional activity, possibly a landslide, from the island. This area has potential as a production centre; the mould was not far from a bronze cubic coin die, which also may have originated from the island, although few other signs of production are apparent. This particular archaeological context is pictured and discussed in more detail in an article about the coin die and its significance.<sup>31</sup> Ceramic finds in the zone place the coin die and the lead mould in the fifth-fourth centuries BC, although finds from more recent excavations suggest that the area may have supported a less dominant Ptolemaic phase as well.<sup>32</sup>

Several indentations are on the front and back of the mould. Impressions were taken from all of the indentations and were recorded in sketches and photographs. Five indentations are on the front, one of which is easily identifiable; three indentations are on the back, two of which are identifiable. The three identifiable indentations represent spiral ram horns that would have decorated the lower portion of an *atef* or *hemhem* crown. Although the front horn is obscured to some degree by marine matter, all three preserve diagonal striations comparable to other cast spiral ram horns. Similar, but not identical, bronze cast pieces have been found at Thonis-Heracleion.<sup>33</sup>

The designs on the mould are particularly important for understanding its function. The ram horns are typical attachments for crowns of bronze figures, particularly Osiris with the *atef* crown, or child deities when they wear *hemhem* crowns.<sup>34</sup> Since the mould is a lead mould, however, the pieces could not have been cast using the refractory method; if bronze were poured directly on the mould, the molten bronze, with its higher melting point, would melt and destroy the lead mould. The most probable scenario is that the mould produced wax ram horns. These wax horns could be replicated and attached to the main figure in wax before casting, as Roeder suggests. Alternatively, they could be replicated, cast individually, and then attached mechanically to a figure after casting. In either case,

<sup>30</sup> H3163, H8167, H8187.

<sup>31</sup> Meadows 2011, 97-99.

<sup>32</sup> Goddio in Meadows 2011, 98, fn. 5. Grataloup 2010, area C, 153-154, for the ceramic dating of the East Passage.

<sup>33</sup> Published examples include Goddio and Fabre 2008, 322, nos. 202, 204, 205 for an individually cast example and examples on crown attachments. See also Heinz forthcoming for H8126, which is the most appropriate comparison in terms of size and casting method.

<sup>34</sup> *Atef*: Weiß 2012, types 85-86, 175-177. *Hemhem*: Weiß 2012, types 57-60, 145-148.

the mould produced replicable wax figures intended for bronze lost wax casting according to the indirect method.

Even if this lead mould could be used to cast lead attachments instead of waxes, as some bronze moulds may have casted bronze items, these horns do not match the iconographic types for which lead was generally used at Thonis-Heracleion. No lead examples of spiral ram horns are known, while bronze examples are abundant. None of the Osiris figures from the site are made of lead and none of the lead child deities represent a type that wears a Pharaonic style *hemhem* crown.<sup>35</sup> The horns are also large for the lead figures at Thonis-Heracleion, which are small-scale, portable, and are cast in one piece without attachments. For similar reasons (incorrect size and iconographic type), the impressions on the mould would not be used for faience manufacture. The most viable conclusion is that the mould produced waxes for bronze figures.

Other expressions of the indirect lost wax method at Thonis-Heracleion may be visible among the bronze Osiris statuettes. After child deities, Osiris is the most popular iconographic type at Thonis-Heracleion with twenty examples, not including crown fragments. Several of these figures group around a similar height range, between 7.5-9.5cm (see Figure 4). Wuttmann noted a similar size range in a sample of the bronze Osiris statuettes at ‘Ayn Manâwir; those figures ranged between 7-9cm, with the smallest at 6cm.<sup>36</sup> Carol Mattusch cites examples of Greek statuettes and statuary that were casted with the indirect method. She notes that the indirect lost wax method could be used to create basic wax models for statues, statuettes, fittings, and other bronze items. From there the artisan could carve and individualise the figures as needed.<sup>37</sup> The indirect method, if used in this manner, might explain why Osiris statuettes at Thonis-Heracleion, and elsewhere in Egypt, are so frequently similar in size but are not uniform in appearance. This method would produce statuettes that represent a balance between Roeder’s and Schorsch’s views – ones that are created efficiently from pre-formed wax models, but which are still crafted with care and are not identical.

Thus, the Thonis-Heracleion material requires that we at least consider the possibility that the indirect method was used for bronze casting in Egypt. But if it was used with any frequency to create identical pieces, why are duplicates so rare in museum settings, as Schorsch and others have noted? First, signs of duplication, such as mould lines, were probably rare on bronzes even in antiquity, as these signs could be easily erased in wax models. Past museum purchasing patterns may also be partly to blame. Dealers regularly split statuette groups to sell the constituent parts separately for increased profit. Few votive groups survive intact, even though many figures were designed as part of votive groups rather than as single figures.<sup>38</sup> For example, in Karnak in 1902-1903 an enormous

<sup>35</sup> Heinz 2011.

<sup>36</sup> Wuttmann *et al.* 1996, 431.

<sup>37</sup> Mattusch 1990.

<sup>38</sup> Groups: Roeder 1956, 487-515, §659-690; Hill 2004, 113. Many groups were probably dismantled in antiquity for ritual reasons as Hill suggests (2004, 130-131), as few intact groups have been found even in excavated settings, but some may also have been separated after they were discovered for profit.

cache of 17,000 bronzes was uncovered in the great court between the southern wall of the Hypostyle Hall and the seventh pylon.<sup>39</sup> The Cairo Museum, because of the glut of material, sold the ‘duplicates’.<sup>40</sup> Whether these were actual duplicates or just objects of the same iconographic type, or both, is unclear but the situation illustrates the general principle.

The subject matter of more recent major studies also reduces the chances that duplicate objects will be found and studied. For example, Marsha Hill and Barbara Mendoza examined statuettes of pharaohs and priests, respectively.<sup>41</sup> While both of these studies included generic representations of kings and priests, these are categories that represent prestigious members of society and the statuettes are often of exceptionally high quality. Taylor, Craddock, and Shearman examined six figures and although these figures may be from one site (Karnak), they are a minute fraction of the bronzes from Karnak.<sup>42</sup> They are also some of the largest and earliest extant hollow-cast pieces and they represent very prestigious members of society or prestigious gifts. Other studies have focused on the Third Intermediate Period, which represents the peak of quality for bronze statuettes, when figures were inlaid with costly materials and were even specially patinated.<sup>43</sup> In other words, even if replication was regularly practiced when these figures were crafted, the subjects of these studies are some of the statuettes least likely to be mass-produced or replicated.

The best potential sources for replicated figures are large, well-provenanced, excavated collections, like those at Saqqara and ‘Ayn Manâwir, where the assemblages include dozens or hundreds of similar iconographic types (far more than Thonis-Heracleion may claim).<sup>44</sup> Within those collections, the figures most likely to have mould lines or otherwise display signs of indirect casting would be the more generic, cheaper, smaller figures – precisely those that generally hold less interest for museums and scholars.

The question still remains, however, how much the indirect lost wax method was used and to what extent that method contributed to mass production. Several of the statuettes from Thonis-Heracleion have been pieced together from multiple components. Such piecing is an important aspect of the mass production model that Roeder envisioned. At Thonis-Heracleion, however, the piecing does not appear as extensive as Roeder proposed and was not done so quickly or in such a rote manner that it promoted sloppy workmanship, as Raven suggests for the Leiden figures.

The piecing instead seems most common between two major components, for instance between a figure and its base or between a primary figure (like Isis) and a secondary figure (*Har-pa-khered*). On two Isis *lactans* (H6901 and H10145), the join between Isis’

<sup>39</sup> For an account of the find: Legrain 1906, 12; Young 1967, 274-275, 282; Taylor, Craddock, and Shearman 1998, 14. A recent online cataloguing project has also been initiated for the Karnak material, although thus far the focus is on large statuary: <http://www.ifao.egnet.net/bases/cachette>.

<sup>40</sup> Young 1967, 275.

<sup>41</sup> Hill 2004; Mendoza 2008.

<sup>42</sup> Taylor, Craddock, and Shearman 1998.

<sup>43</sup> Ziegler 1987; Vassilika 1997; Bianchi 1990.

<sup>44</sup> Davies 2007 (Saqqara); Wuttman, Coulon, and Gombert 2007 (‘Ayn Manâwir).



lap and the child deity is clearly visible.<sup>45</sup> In both cases, *Har-pa-khered* is not mechanically joined post-casting with a tenon but is sealed into place. On a statuette of a striding ibis on a standard (H8557, Figure 5), the ovular plinth that supports the ibis was slotted into the top of the standard. The plinth and standard are now completely fused. It is probable that when the ovular support for the ibis figure was still a wax model, it was slotted into the wax standard. The two constituent parts fused during casting.

An alternative possibility is that the constituent parts of the Isis *lactans* and the ibis were ‘casted on’ rather than joined in wax.<sup>46</sup> In this method, the Isis would be cast in bronze first, then a wax *Har-pa-khered* would be attached to Isis, and the area would then be invested with clay and cast, thus fusing the metal of both figures. As Ogden notes, it is very difficult to determine on appearance alone whether something was casted on or whether two components were joined in wax, so it is an alternative possibility.<sup>47</sup> For at least one figure at Thonis-Heracleion, however, it seems more likely that its body and base were joined in wax and were not casted on. A seated cat (H11026, Figure 6) has a buffering layer of metal between the paws and the base. If the cat and base were cast separately and then joined, the cat would sit directly on the base, attached by a tenon below its rump.<sup>48</sup> The buffering layer makes more sense if the figures were joined first in wax and then cast. To attach the wax cat to the wax base, an intermediate layer of heated or roughened wax would help the two pieces stick together, much as the surface of a bronze is roughened before it is gilded so that the gypsum and gold are better retained.<sup>49</sup> Once the piece was cast, the intermediate wax layer was preserved as metal. Casting on would leave a tighter seam.

Other items that commonly were modelled separately were bronze crown attachments; many were also cast separately and were mechanically attached to the statuette post-casting, rather than being added in wax before casting.<sup>50</sup> For instance, Isis H6901 had a separately cast crown; the crown is not extant, but the hole at the top of the modius shows where it would have been inserted. Numerous crown fragments with tenons at Thonis-Heracleion have also survived; these would have been attached either to bronze statuettes or wood-and-bronze mixed media figures.<sup>51</sup>

Piecing does not presuppose indirect casting and replication. Roeder combined the two concepts by suggesting different parts of statuettes were replicated and then combined in an assembly line fashion in wax, but a figure does not need to be replicated before it can be pieced together; original carved models (of the body and crown, for instance) can also be pieced together in wax, casted on, or added mechanically after casting. What piecing does

<sup>45</sup> These figures are more fully described and presented in Heinz forthcoming, as are other previously unpublished bronze and lead statuettes and amulets mentioned in this article.

<sup>46</sup> ‘Casting on’ for Egyptian figures: Ogden 2000, 159.

<sup>47</sup> Ogden 2000, 159.

<sup>48</sup> H9726 is an example of a seated cat that would have sat directly upon the base, attached by tenons.

<sup>49</sup> Intermediary wax layers: Ogden 2000, 159. Roughening the surface for gilding: Oddy *et al.* 1990, 103-104.

<sup>50</sup> Mechanical joins for Egyptian figures: Ogden 2000, 158-159.

<sup>51</sup> See ‘crown elements’ in Heinz forthcoming. For similar types of attachments for the *atef* crown, see Roeder 1956, taf. 25d, e, g.

show is that the process of casting was broken down into multiple components that would make mass manufacture easier. But it does not seem that the process was broken down as minutely as Roeder described – that for every statuette, the head, torso, arms, crowns, and legs were all initially moulded as separate pieces.<sup>52</sup> One arm fragment at Thonis-Heracleion has a tenon at the shoulder joint, which shows that it was mechanically added to a statuette post-casting, but at this site, added features are generally crown elements, bases, and secondary figures.<sup>53</sup> Moulds, if figures were regularly cast using the indirect method, probably would have represented the figure's full form. In other words, there might have been a Sekhmet mould, an Osiris mould, a child deity mould, and so on, rather than, for example, a female torso mould, a male *shendyt* kilt mould, a leg mould, and an arm mould.<sup>54</sup>

Quality is a difficult issue to assess at Thonis-Heracleion because so many of the statuettes are heavily corroded from underwater exposure to marine concretions. What can be said is that the Thonis-Heracleion figures are not of the same quality as some Third Intermediate bronzes, the types that are well known for exquisite inlay, gilding, and even special patination.<sup>55</sup> While some of the figures at Thonis-Heracleion do retain signs of inlay and gilding, these enhancements do not characterize the group.<sup>56</sup> At the same time, unlike the Leiden pieces, the Thonis-Heracleion figures are not characterized by lopsided joins or mis-proportioned limbs. Some casting mistakes are notable on the lead figures from the site,<sup>57</sup> but there are few mistakes on the bronzes that could be attributed to sloppy craftsmanship as a result of intensive mass manufacture and replication.

Overall, the evidence from Thonis-Heracleion mediates between Roeder's intensive mass-manufacture model and Schorsch's more reductionist model where each figure is a unique product. The lead mould demonstrates that the indirect lost wax method likely was used in Egypt for the some production, possibly as early as the fourth or fifth centuries BC, although the extent to which this method was used is unknown and unbounded. The practice of piecing at Thonis-Heracleion demonstrates that the casting process was broken down into multiple steps that could make mass manufacture easier, but probably not to the extent Roeder proposed and not, at this site, to the extent that craftsmanship became sloppy and unreliable.

<sup>52</sup> Roeder 1933a; 1933b, 228-238; 1937, 144-187; 1956, 520-525.

<sup>53</sup> Arm piecing for Classical figures: Kent Hill 1982.

<sup>54</sup> See, for example, moulds from Memphis from the Ptolemaic and Roman Periods: Roeder 1933b, 230; Roeder 1937, pls. 43-44; see Edgar 1903, xi, xvi for further moulds. Dating: Roeder 1933b, 230; Edgar 1903, vii-viii. Roeder dismisses these as unrepresentative of the Pharaonic Period, because they date to the Ptolemaic and Roman periods, and because they do not show evidence for extensive piecing. Neither are reasons to exclude them here, if we can posit a more fluid transition between the Late and Ptolemaic Periods.

<sup>55</sup> Inlay on Third Intermediate Figures: Taylor, Craddock, and Shearman 1998, 10; Hill 2007. Patination: Haynes 1992, 114-116; La Niece and Craddock 1993; Hill and Schorsch 1997, 13-14; Ogden 2000, 160; La Niece *et al.* 2002; Delange 2008.

<sup>56</sup> For bronzes with traces of inlay at Thonis-Heracleion, see Goddio and Fabre 2008, 322-323, no. 201, 204, 212.

<sup>57</sup> Several of the lead falcons have chips, or holes, in their wings, on the right and left sides. They occur on different figures, not just mould siblings, and thus the flaw probably cannot be attributed to the mould itself. The feature is so frequent, however, that it is likely attributable to the casting process in some way. See Heinz forthcoming for further information on this feature and other lead casting flaws.

## THE LEAD STATUETTES AND AMULETS: PRODUCTION METHODS

Unlike the bronze figures, the lead statuettes and amulets have few parallels. Lead finds from Egypt are rare, or are not published or displayed; for that reason, lead casting processes are not much discussed.<sup>58</sup> Before 2011, only one article, by Marie-Françoise Boussac and Merwate Seif el-Din, records and discusses Egyptian lead figurines from Egypt in detail; the article presents the lead figurines from the Graeco-Roman Museum and it is the main source of parallels for several of the Thonis-Heracleion figures discussed below.<sup>59</sup> The greatest amount of literature regarding lead use and lead casting in antiquity, aside from the separate issue of lead isotope analysis, revolves around artefacts from the Roman Period, and most of it concentrates on more utilitarian items such as piping or ingots.<sup>60</sup> Thonis-Heracleion, however, has over 1,000 lead objects and around one hundred of those are lead statuettes and amulets. Thus the Thonis-Heracleion material presents the opportunity to open a new discussion on lead casting in Egypt in the Late and Ptolemaic Periods. This article focuses on the statuettes and amulets, but some other categories of material are mentioned where appropriate.

Signs of casting processes are more readily identifiable for the lead figures than the bronze figures. Replication, for instance, is common and two types of evidence confirm the use of replication processes: mould lines and identical figures (mould siblings).<sup>61</sup> Several different lead iconographic types at Thonis-Heracleion have mould lines and mould siblings: falcon amulets, elephant figurines, horse figurines, and Ptolemaic-style child deities.<sup>62</sup> The elephants, horses, and child deities all date to the early Ptolemaic Period, while the falcon amulets derive from fifth-second century zones, with at least one in a sixth-fourth century context.<sup>63</sup> The mould lines are raised lines that bisect the figures, running up the chest over the crest of the head, and down the spine.

The amulets represent falcons wearing the double crown of Egypt; they are all very small, solid cast, and under 3cm. Eight of the eighteen falcons have mould lines, and in the group there are two sets of identical figures, with three examples each.<sup>64</sup> The horses, elephants and child deities are also small-scale, ranging in height from 2.8 to 4.2cm. They

<sup>58</sup> Recent work has been done by van der Wilt for the lead objects from Thonis-Heracleion, with the exception of the figurines: van der Wilt 2010; this volume; and forthcoming. See van der Wilt forthcoming for an in-depth discussion on lead finds in Egypt and possible reasons for their scarcity outside of Thonis-Heracleion. For the scarcity of lead ore in Egypt, see Ogden 2000, 168-9. For a compilation of known lead artifacts from Egypt, see Lucas and Harris 1962, 244.

<sup>59</sup> Boussac and Seif el-Din 2009.

<sup>60</sup> For example, Tylecote 1962; 2002, 72-73; Boulakia 1972.

<sup>61</sup> See Schorsch 2007, 192 for the significance of mould lines, as noted above in 'Framing the Wider Debate.'

<sup>62</sup> For stylistic dating and further iconographic information for these figures, see Heinz 2011, 214-217.

<sup>63</sup> Many of the falcons derive from the main temple area and one particular area in the Grand Canal; see Grataloup 2010, areas D-F, 154-156, for ceramic dating for the temple and Grand Canal. The last falcon comes from a sanctuary zone in the north of the site (G1). See Goddio 2007, 120 for G1. The child deities, elephants, and horses are concentrated on the central landmass to the east of the main temple, and also in parts of the Central Port. For the chronology of the zone east of the temple, see Grataloup 2010, area G, 156.

<sup>64</sup> Falcons with mould lines: H5578, H10718, H1461, H4587, H1465, H10734, H12212, H12132. Identical falcons: group 1 – H10734, H5578, H10718; group 2 – H1465, H3545, H1493. Figure H3470, may also belong to the second group, although it is heavily damaged.

are hollow-cast with a rectangular open bottom edge. Three of the fourteen elephants have mould lines, as do three of the eight leaping horse and one child deity.<sup>65</sup> Some other figurines from the site that do not belong to these particular groups also have mould lines: a lead figure of Bes with raised lines running vertically down its sides (H9646) and several lead miniature vessels.<sup>66</sup>

At least three horses have enough detail preserved to show that the figures are identical and are from the same mould, although the state of preservation varies: H11402, (3.7×3.2cm, 24.9g), H11485 (3.7×3.4cm, 23.4g), and H11644 (3.5×3.0cm, 19.6g). The remaining figures that represent horses with riders are also remarkably similar to one another. At least two of the best-preserved elephant statuettes at Thonis-Heracleion exhibit identical detail, down to the design of the saddle blanket: H8578 (4.2×3.7cm, 23.2g) and H11788 (3.55×3.6cm, 9.7g).<sup>67</sup> Two others have traces of this detail but are less well preserved (H8578 and H9602). Of the nine lead child deities, four are probably mould siblings: H8811 (4.4×3.4cm, 39.1g), H6945 (4.0×3.2cm, 41.9g), H9940 (4.8×3.7cm, 40.1g), and H9481 (4.9×3.2cm, 41.38g). Figures 7-9 provide examples of identical falcons, elephants, and horses.

These figures were probably cast using refractory moulds. Lost wax casting would have been cost-prohibitive as the beeswax was relatively expensive, and with lead's lower melting point refractory methods were sufficient for small figures such as these.<sup>68</sup> Edgar, in his study of the Greek moulds from Memphis, noted that the plaster moulds might not have withstood the heat of bronze casting over multiple uses and suggested that they would have been used to produce waxes.<sup>69</sup> Because the melting point of lead is lower than bronze, 327 °C versus 960-1,083 °C, a refractory bivalve mould would have lasted longer with lead than with bronze figures.<sup>70</sup> Haynes noted that one of the main differences between pieces cast with refractory methods and those cast in the indirect lost wax method is that figures cast directly into moulds without the intermediary wax step would be more likely to have mould lines, like the figures described above.<sup>71</sup> On wax figures, mould lines are easily removed. The use of the refractory method explains why so many of the lead falcons, elephants, and horses retain mould lines.

Although the Thonis-Heracleion finds have few parallels in Egypt, two regions in the Mediterranean, Laconia and Anatolia, have produced large, pre-Roman assemblages of lead figurines. These assemblages are iconographically different than the Thonis-Heracleion figures, but provide valuable comparisons for the use of lead and for casting techniques.

<sup>65</sup> Elephants with mould lines: H9630, 9602, 11726; horses with mould lines: H9695, H11402, H11644. Child deity with mould line: H6302. Further examples have faint lines that may be mould lines; only those that are secure are provided.

<sup>66</sup> For the miniature vessels, see van der Wilt forthcoming.

<sup>67</sup> A similar blanket detail is described on three of the Graeco-Roman Museum pieces, but whether the blanket is identical is not possible to determine from the photos: Boussac and Seif el-Din 2009, 226, nos. 20-22; 251, figs. 19-21. Nearly the entire left side of H11788, and most of the solid rider, are missing, which account for the weight difference between it and H8578.

<sup>68</sup> Beeswax: Serpico and White 2000, 409-411.

<sup>69</sup> Edgar 1903, viii. The Memphis moulds also retain no traces of metal.

<sup>70</sup> Melting points: Mattusch 1988, 13-14.

<sup>71</sup> Haynes 1992, 55.

The figures from Laconia are best known from the Sanctuary of Artemis Orthia and from the Menelaion in Sparta.<sup>72</sup> Several thousand have been found and range in date from the seventh-sixth centuries BC. The Anatolian material is older, from last quarter of the second millennium, and is best known from Alishar and Kültepe.<sup>73</sup> In both regions, the figures were cast in open moulds; they had flat backs and decorated fronts; several moulds have also been found.<sup>74</sup> Like the figures from Laconia and Anatolia, a few statuettes at Thonis-Heracleion were cast in open moulds: for example, a lead offering bearer (H3043) and one unidentified lead anthropomorphic figure (H9976). Three lead ingots also retain layered lines on their side that show the metal was poured into an open mould (H5944, H9137, and H10000).<sup>75</sup>

The majority of the Thonis-Heracleion figures, however, were moulded in a bivalve mould, as noted previously. The falcons are solid cast and the lead would have been poured directly into the mould to cool and set. The horses, elephants, and child deities, however are slightly more complex. I propose that these figures were made according to a technique called the 'slush' technique. This is a technique that (for antiquity studies) is more frequently discussed in relation to hollow cast bronzes from the indirect lost wax method.

With the wax slush technique, the artist fills a mould with wax and then 'slushes' the wax around to make sure it coats all parts of the mould. As the wax cools, the wax in direct contact with the mould solidifies first and builds up. Before all of the wax cools, the artists up-ends the mould and pours out the molten wax. When the mould is removed, the result is a wax figure with thin, even edges and a hollow interior.<sup>76</sup> The process could be repeated to create multiple, identical hollow waxes. The best evidence for the use of the slush technique comes from the interior of large-scale statuary. Haynes pointed to the interior of a Greek large-scale hollow bronze that preserves a drip mark that was originally on the wax. He suggested that the wax shell was made using the slush method and the drip mark occurred when the molten wax was thrown out of the mould; the drip-mark was then preserved in the bronze during casting.<sup>77</sup> This type of evidence indicates that the slush technique was in use in antiquity.

For the Thonis-Heracleion figures, lead was used instead of wax. Lead was poured into a prefabricated mould, it was allowed to cool until the desired amount of metal solidified around the edges, and then the remaining lead was thrown out of the mould. This was a relatively easy method of casting lead statuettes, one that was common among amateur lead casters in the early twentieth century and that is still in use today.<sup>78</sup>

<sup>72</sup> See, for example, Dawkins 1929; Cavanagh and Laxton 1984; Gill and Vickers 2001.

<sup>73</sup> See, for example, Emre 1971; Mitchell 1983; Marchetti 2003; and Moorey 1994, with a summary and further bibliography.

<sup>74</sup> See Cavanagh and Laxton 1984, in particular, for discussions on moulds and seriation.

<sup>75</sup> Ingots and layered lines: Whittick 1961. For ingots at Thonis-Heracleion, see van der Wilt 2010, 161-163.

<sup>76</sup> Cavanagh 1990, 148.

<sup>77</sup> Haynes 1992, 27, 35, pl. 4.

<sup>78</sup> For modern lead production of small figures: Rhead 1948; Horton 1976.

Overall, evidence from Thonis-Heracleion suggests that the lead figures were made in refractory moulds; both open and bivalve moulds were used, but bivalve moulds were preferred. The hollow figures were cast using the lead slush technique in a bivalve refractory mould. Replication was frequent and was not limited to one stylistic or cultural type; Egyptian, Greek, and Ptolemaic style figures alike were all serially produced. The dates for these figures, based on archaeological context and artistic style, range between the sixth and second centuries BC.

#### CASTING AND CULTURAL CONNECTIONS

The description and evaluation of production techniques above are important, not just to know what the techniques were for the sake of knowing, but also because these details help us see how connected the Egyptians were within their own craft centres and with other cultures. Production techniques contribute to a wider narrative.

The mould at Thonis-Heracleion, and possibly the Osiris figures, suggest that the indirect lost wax method was in use in Egypt some time between the seventh and second centuries BC, which was the main period of Thonis-Heracleion's occupation; if the archaeological zones are considered, replication among the lead and bronze figures was somewhere between the fifth and second centuries BC. Schorsch contends that if replication among bronzes occurred, it was only during the Ptolemaic Period. If, however, Greek contact is seen as the necessary factor in initiating the creation of Egyptian style replication, this technology could have been introduced much earlier.

Comparisons with Greece are particularly instructive because of the close connections between Greece and Egypt and the vast amount of scholarship concerning Greek bronzes.<sup>79</sup> There is, however, little crossover in the scholarship when it comes to bronze production.<sup>80</sup> Scholars of Greek bronze production assert that statuettes were generally produced using the indirect lost wax method from the Archaic period onwards. Although Mattusch points towards a mixture of techniques (direct and indirect), the idea of replicable methods is fully accepted and necessary to her view of the importance of repetition and duplication.<sup>81</sup> Duplicates among Greek statuettes are also known, dating as early as the Archaic period.<sup>82</sup>

A direct connection between Egypt and Greece is evident in the seventh century BC at Samos, where a large number of Egyptian and Egyptian-style statuettes have been found. Samos has often been pointed out as a key meeting point between Greek and Egyptian cultures.<sup>83</sup> Coincidentally, this is also the location of the earliest bronze figure from Greece

<sup>79</sup> For comprehensive reviews with bibliography, see Mattusch 1988; Haynes 1992.

<sup>80</sup> In one of his articles, Roeder attempted to reconcile the stylistic effects of his assembly method with the perceived differences between the style of Greek and Egyptian bronzes (Roeder 1933b, 226-227, 243-245, 262-263).

<sup>81</sup> Mattusch 1990.

<sup>82</sup> Mattusch 1990, 132. Five identical seventh-century statuettes from Delphi: Haynes 1992, 43.

<sup>83</sup> For Samos: Jantzen 1972; Bianchi 1990. Egyptian statuettes abroad: Weiß 2012, 493-511. See Leahy 1988, 302-304 for the distribution of Egyptian bronzes outside Egypt, including but not restricted to Samos.

that shows clear evidence of refractory mould use. A bronze griffin protome that was a waster has three clearly delineated mould lines along the back of its neck.<sup>84</sup> Taylor, Craddock, and Shearman also cite the story reported by Pausanias that the first large-scale bronze casters, Rhoikos and Theodoros, were Samians who learned their craft in Egypt.<sup>85</sup> This literary passage does not refer to casting methods specifically, but it does suggest strongly that technological exchange with respect to bronze production occurred between Greece and Egypt as early as the Archaic Period.<sup>86</sup> And Samos was not the only point of contact, but rather a leading representative of a wider phenomenon.<sup>87</sup>

Nor is Greece the only possible source for this type of production. Early use of the indirect lost wax method is also attributed to Mesopotamia, although scholars have not debated the issue there as much as they have for Greek material.<sup>88</sup> One particularly complex bronze mould from Mesopotamia allows for the simultaneous casting of three arrowheads and dates to around 700 BC.<sup>89</sup> Early on, casting methods of other geographic regions and cultures, and mould technology in particular, were advanced. Moulds were used to create copper objects as early as the fourth millennium, though these were mostly for weapons and tools.<sup>90</sup> Whether craftsmen poured metal directly into these moulds or used them to produce waxes is a matter of debate, and possibly dependent on each mould.<sup>91</sup> The Eastern Mediterranean in general is a great potential source for mould and casting technologies. Thonis-Heracleion, the port of entry for Egypt, had intensive and wide-ranging contacts in the Eastern Mediterranean throughout its history, even from its earliest periods.<sup>92</sup> As noted previously, one of the best parallels for the lead figures, in terms of manufacture and quantity, were the figures from Anatolia, which were made as early as the late second millennium BC.

We must also look at other craft technologies in Egypt itself. In parallel technologies such as faience manufacture, moulds were used to replicate figures as early as the Old Kingdom.<sup>93</sup> By the Late Period, faience was mass-produced using these moulds.<sup>94</sup> It would be a mistake, I think, to see different craft technologies in Egypt as entirely separate. The evidence at Thonis-Heracleion, for instance, demonstrates irrefutably that refractory moulds

<sup>84</sup> Haynes 1992, 44, pl. 5.

<sup>85</sup> Taylor, Craddock, and Shearman 1998, 9; Pausanias 10.38.6.

<sup>86</sup> Such an exchange is often discussed in relation to other crafts and art forms, particularly Archaic Greek *kouroi*: (in the context of bronzes) Mattusch 1988, 45. *Kouroi* in general: Richter 1970.

<sup>87</sup> Winter 1971, 154-155.

<sup>88</sup> For Mesopotamian bronze casting, with bibliography, see Moorey 1994, 269-273; for lead in Mesopotamia, Moorey 1994, 292, 297.

<sup>89</sup> Coghlan 1952; Moorey 1994, 270.

<sup>90</sup> Bivalve casting: Hunt 1980, 72-73 (moulds and waxes in general); Garland and Bannister 1927, 55, figure 2; Ogden 2000, 157 (for Egypt); Moorey 1994, 269-270 (Mesopotamia); Garland and Bannister 1927, 55, figure 3 (Assyria); Scheel 1989, 40 (Sumerians); Hunt 1980, 70 (Iran).

<sup>91</sup> Ogden 2000, 157.

<sup>92</sup> For in-depth articles on early interactions between Thonis-Heracleion and the Eastern Mediterranean, see Grataloup 2012 and Fabre and Goddio 2012.

<sup>93</sup> Nicholson 1993, 19-21.

<sup>94</sup> Nicholson 1993, 39-41.

were used for lead casting and duplicates were common, even among Egyptian style figures like the falcon amulets. While the elephants, horses, and child deities are firmly Ptolemaic in date, the falcons have a wider potential date range that extends into the Late Period. At Thonis-Heracleion, Egyptian-style lead amulets were frequently found in the same context as many bronze figures, and it is probable that the same people who made the bronzes made the Egyptian-style lead amulets. While the methods of manufacture were not the same (lost wax and refractory), the same ability that allowed artisans to create moulds for lead casting would have been used to create open, bivalve, and piece moulds for indirect lost wax casting for bronze.

In all, the evidence from Thonis-Heracleion demonstrates that replicative processes were common for lead and at least minimally used for bronze as early as the Late Period. Egypt also had sustained, dynamic contact with other cultures that exhibited advanced mould technology. With these considerations in mind, we must at least accept the possibility that the indirect method was used in Egypt for bronze casting. From there, with larger excavated collections, we may investigate further the frequency of the technique, and the specifics regarding its origin and its mode of transfer between cultures.

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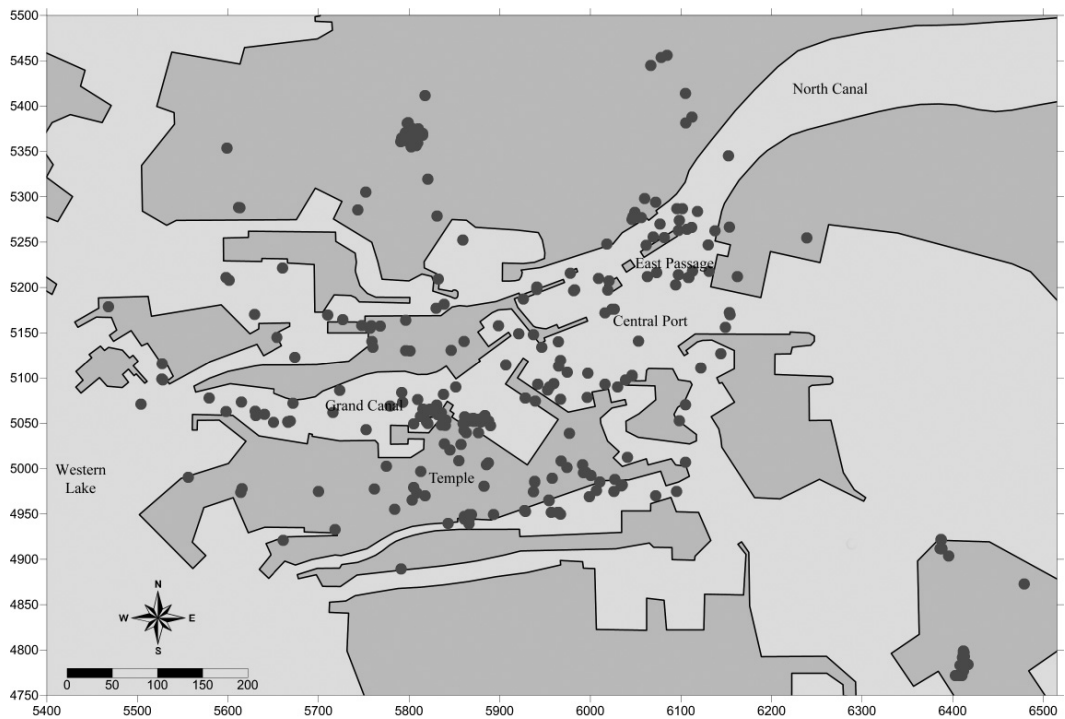


Fig. 1. Distribution of the statuettes and amulets at Thonis-Heracleion.  
Base map courtesy of Franck Goddio ©Franck Goddio/Hilti Foundation. Modified by author.



Fig. 2. Mould with impressions, H9099, front. Lead, solid cast, 11.9x8.4x1.3cm, 879g. Maritime Museum, Alexandria. Photo courtesy of Elsbeth van der Wilt.



Fig. 3. Mould with impressions, H9099, back. Lead, solid cast, 11.9x8.4x1.3cm, 879g. Maritime Museum, Alexandria. Photo courtesy of Elsbeth van der Wilt.



Fig. 4. A selection of Osiris statuettes of similar size from Thonis-Heracleion. Bronze, solid cast, 7.5-9.5cm, various widths and weights. Maritime Museum, Alexandria. Author's photo.



Fig. 5. Ibis standard, H8557, multiple views from left to right: back edge (top left), top view (bottom left), and full view from the right side (right). Bronze, hollow cast. 13.7x7.9, 299g. Maritime Museum, Alexandria. Author's photo.



Fig. 6. A seated cat with the underlying 'wax' layer indicated by the arrow, H11026. Bronze, solid cast figure, hollow cast base, 8.7x5.1, 116.1g. Maritime Museum. Author's photo.



Fig. 7. Identical falcon pendants, H5578, H10718, H10734 (left to right). Lead, solid cast, 2.4x1.7 and 4.2g, 2.3x1.4 and 4.0g, 2.2x1.2 and 4.4g. Maritime Museum. Author's photo.



Fig. 8. Identical elephant statuettes, H11788 (left) and H8578 (right). Lead, hollow cast, 3.55x3.6cm and 9.7g (left) and 4.2x3.7cm and 23.2g (right). Maritime Museum. Author's photo.

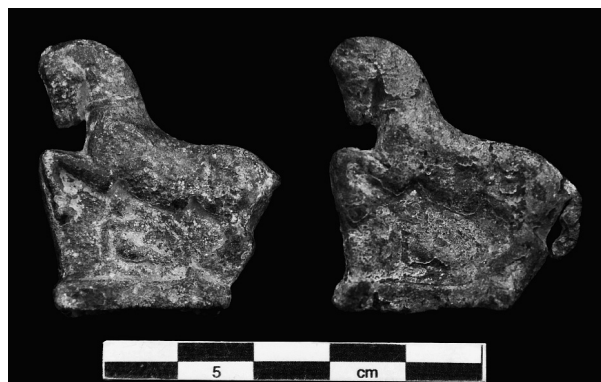


Fig. 9. Identical horse statuettes. H11402 (left) and H11485 (right). Lead, hollow cast, 3.7x3.2cm and 24.9g (left) and 3.7x3.4cm and 23.4g (right). Maritime Museum. Author's photo.