

What knowledge did the Minoans have of elephants? Phaistos graters and Zakros tusks

Sevket SEN & Martine FAURE



DIRECTEUR DE LA PUBLICATION / *PUBLICATION DIRECTOR*: Gilles Bloch
Président du Muséum national d'Histoire naturelle

RÉDACTEUR EN CHEF / *EDITOR-IN-CHIEF*: Rémi Berthon

RÉDACTRICE / *EDITOR*: Christine Lefèvre

ASSISTANTE DE RÉDACTION / *ASSISTANT EDITOR*: Emmanuelle Rocklin (anthropo@mnhn.fr)

MISE EN PAGE / *PAGE LAYOUT*: Emmanuelle Rocklin, Inist-CNRS

COMITÉ SCIENTIFIQUE / *SCIENTIFIC BOARD*:

Louis Chaix (Muséum d'Histoire naturelle, Genève, Suisse)
Jean-Pierre Digard (CNRS, Ivry-sur-Seine, France)
Allowen Evin (Muséum national d'Histoire naturelle, Paris, France)
Bernard Faye (Cirad, Montpellier, France)
Carole Ferret (Laboratoire d'Anthropologie sociale, Paris, France)
Giacomo Giacobini (Università di Torino, Turin, Italie)
Lionel Gourichon (Université de Nice, Nice, France)
Véronique Laroulandie (CNRS, Université de Bordeaux 1, France)
Stavros Lazaris (Orient & Méditerranée, Collège de France – CNRS – Sorbonne Université, Paris, France)
Nicolas Lescureux (Centre d'Écologie fonctionnelle et évolutive, Montpellier, France)
Joséphine Lesur (Muséum national d'Histoire naturelle, Paris, France)
Marco Masseti (University of Florence, Italy)
Georges Métailié (Muséum national d'Histoire naturelle, Paris, France)
Diego Moreno (Università di Genova, Gènes, Italie)
François Moutou (Boulogne-Billancourt, France)
Marcel Otte (Université de Liège, Liège, Belgique)
Joris Peters (Universität München, Munich, Allemagne)
Jean Trinquier (École normale supérieure, Paris, France)
Baudouin Van Den Abeele (Université catholique de Louvain, Louvain, Belgique)
Christophe Vendries (Université de Rennes 2, Rennes, France)
Denis Vialou (Muséum national d'Histoire naturelle, Paris, France)
Jean-Denis Vigne (Muséum national d'Histoire naturelle, Paris, France)
Arnaud Zucker (Université de Nice, Nice, France)

COUVERTURE / *COVER*:

Une coupe avec râpe du site minoen de Phaistos et une défense d'éléphant trouvée dans les ruines de Zakros en Crète (conservées au Musée archéologique d'Héraklion). Crédit: S. Sen / *A grater from the Minoan site of Phaistos, and an elephant tusk from the ruins of Zakros in Crete (both preserved at the Archaeological Museum of Heraklion). Credits: S. Sen.*

Anthropozoologica est indexé dans / *Anthropozoologica is indexed in*:

- Social Sciences Citation Index
- Arts & Humanities Citation Index
- Current Contents – Social & Behavioral Sciences
- Current Contents – Arts & Humanities
- Zoological Record
- BIOSIS Previews
- Initial list de l'European Science Foundation (ESF)
- Norwegian Social Science Data Services (NSD)
- Research Bible

Anthropozoologica est distribué en version électronique par / *Anthropozoologica is distributed electronically by*:

- BioOne® (<https://www.bioone.org>)

Anthropozoologica est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris, avec le soutien du CNRS.

Anthropozoologica is a fast track journal published by the Museum Science Press, Paris, with the support of the CNRS.

Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publish: Adansonia, Zoosystema, Geodiversitas, European Journal of Taxonomy, Naturae, Cryptogamie* sous-sections *Algologie, Bryologie, Mycologie, Comptes Rendus Palevol.*

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél.: 33 (0)1 40 79 48 05 / Fax: 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / <https://sciencepress.mnhn.fr>

© Publications scientifiques du Muséum national d'Histoire naturelle, Paris, 2025
ISSN (imprimé / *print*): 0761-3032 / ISSN (électronique / *electronic*): 2107-0881

What knowledge did the Minoans have of elephants? Phaistos graters and Zakros tusks

Sevket SEN

Centre de recherche en paléontologie – Paris (CR2P),
CNRS, MNHN, Université Pierre et Marie Curie, Sorbonne Université,
57 rue Cuvier, F-75231 Paris cedex 05 (France)
sevket.sen@mnhn.fr

Martine FAURE

Université Lumière – Lyon 2,
18 quai Claude Bernard, F-69007 Lyon (France)
fauremartine@free.fr

Submitted on 4 April 2024 | Accepted on 30 January 2025 | Published on 28 March 2025

Sen S. & Faure M. 2025. — What knowledge did the Minoans have of elephants? Phaistos graters and Zakros tusks. *Anthropozoologica* 60 (4): 35–47. <https://doi.org/10.5252/anthropozoologica2025v60a4>. <http://anthropozoologica.com/60/4>

ABSTRACT

The present study is based on two observations: the presence of a type of Minoan vessel at Phaistos and Agia Triada, and the elephant tusks found in the storeroom of the Palace of Zakros, three sites in Crete. The examination of these objects allowed us to develop two hypotheses. The first concerns the cups called “grater”, which include inside an element that served as rasp. The shape and surface of the rasp are surprisingly reminiscent of the outline and the design of the masticatory surface of elephant molars. This led us to revisit the fossil elephants of this island and to look for the degree of similarity between the elephant molars and the design of some rasps from Phaistos and Agia Triada, dating from *c.* 1800–1700 BC. The second hypothesis relates to the provenance of elephant ivory, used in Crete from *c.* 1600 BC to manufacture many precious objects (seals, plaques, figurines, statuettes, etc.), based on the raw elephant tusks found in a storeroom at Zakros, and dated to 1500–1450 BC. The morphological comparison of these tusks with those of fossil elephants from Crete and the extant species from Asia and Africa, as well as the examination of palaeontological, archaeological, iconographic and epigraphic data, allow us to suggest the attribution of the tusks of Zakros to *Elephas maximus* Linnaeus, 1758 which lived in the Levant until around 1200 BC. This affinity would deserve to be supported by microstructural and isotopic analyses.

KEY WORDS
Minoan graters,
elephant tusks,
Crete.

RÉSUMÉ

Quelle connaissance les Minoens avaient-ils des éléphants? Les râpes de Phaistos et les défenses de Zakros. La présente étude s'appuie sur deux observations: la présence d'un type de vaisselle minoenne à Phaistos et Agia Triada, et l'examen des défenses d'éléphants retrouvées dans les réserves du Palais de Zakros, trois sites en Crète. L'analyse des caractéristiques de ces objets nous a permis de développer deux hypothèses. La première concerne un type de vaisselle appelé «grater». Il s'agit de coupes comportant un élément servant de râpe. La forme et la surface de la râpe rappellent étonnamment la forme et le dessin de la surface masticatrice des molaires d'éléphant. Ceci nous a conduit à revoir les éléphants fossiles de cette île et à rechercher le degré de similitude entre les molaires d'éléphant et les râpes de Phaistos et Agia Triada, qui datent de *c.* 1800-1700 BC. La seconde hypothèse se rapporte à la provenance de l'ivoire d'éléphant, utilisée en Crète à partir d'environ 1600 BC. Les Minoens ont utilisé l'ivoire pour fabriquer de nombreux objets précieux (sceaux, plaquettes, figurines, statuettes...), mais son origine reste inconnue. Que peuvent dire à ce propos les défenses d'éléphant brutes trouvées à Zakros? La comparaison de leur morphologie avec celle des éléphants fossiles de Crète et actuels d'Asie et d'Afrique, ainsi que l'examen des données paléontologiques, archéologiques, iconographiques et épigraphiques, nous permettent de suggérer l'attribution des défenses de Zakros à *Elephas maximus* Linnaeus, 1758 qui a vécu au Levant jusque vers 1200 BC. Ce résultat mériterait d'être étayé par des analyses microstructurales et isotopiques.

MOTS CLÉS
Râpes minoennes,
défenses d'éléphant,
Crète.

INTRODUCTION

The great civilization that flourished in Crete during the Bronze Age was popularized by Evans (1921) as the Minoan civilization, after the name of the legendary king of Crete, Minos. He also first coined the Minoan chronology and subdivided it into three main periods: the Early Minoan (3100-2000 BC), the Middle Minoan (2000-1600 BC) and the Late Minoan periods (*c.* 1600-1075 BC), which are in turn subdivided in subperiods such as EM I, EM II, EM III, etc. Levi (1976) presented a comparative table of ten different proposals, including his own, which consists of a division in “Palatal” periods. Over the course of a century, archaeologists have preferred the one or the other of these chronologies, and above all considerably improved the precision of their durations and limits. Our intention is not to discuss the accuracy of this or that chronology. We take as a reference the chronology published by Knappett (2020) which seems to be the consensus today. The above dates and others mentioned in the text refer to this book.

The Minoans produced a great variety of ceramics of exceptional beauty. Among this abundant production our interest has focused on some clay cups known as graters. These are bowls of a certain size used in the kitchen to extract the juice from fruits and vegetables thanks to a rough oblong protuberance inside them. Pernier (1935: 394) is apparently the first author to mention the discovery of such cups at Phaistos, to describe and to interpret them as basins “used for domestic use and specifically for grating or kneading”. Later on, several other cups of that kind have been found at Phaistos in particular during the excavations led by Doro Levi in the 1950s and 1960s. Two of these graters are on display at the Archaeological Museum of Heraklion. Their label indicates that they are “Clay ‘graters’ for juicing fruits (...) Phaistos, 1800-1700 BC”. The shape and ornamentation of their rasps

bear a striking resemblance to the molars of dwarf elephants well known in Crete from many Pleistocene sites (Bate 1905, 1907; Simonelli 1908; Kotsakis 1980; Poulakakis *et al.* 2002; Van der Geer *et al.* 2010; Sen 2017; Athanassiou *et al.* 2019; Lyras *et al.* 2022). Indeed, Crete and many other Aegean islands hosted dwarf elephants during the Pleistocene, and also during the Holocene in Tilos Island near the Anatolian coasts, where dwarf elephants survived till about 3.5 thousand years BC (Theodorou *et al.* 2007; Masseti 2009; Athanassiou *et al.* 2019; Lyras *et al.* 2022).

Is this a convergence of form? The shape and the design of the rasping surface suggest that the pottery artisans of Phaistos may have been inspired by the pattern of the masticatory surface of elephant molars to make these graters. This leads us to question: did the Minoans know the last dwarf elephants of the island, or did they collect their fossils?

The Minoans also used elephant ivory to make decorative or functional items (statuettes, plaques, inlays, seals, etc.). Ivory workshops are known in several Minoan cities. The origin of elephant ivory for the manufacture of these objects in Crete has been the subject of numerous morphological, iconographic and epigraphic studies, without reaching a consensus on the question. What do the raw tusks found at Zakros tell us about this?

THE GRATERS OF PHAISTOS

Excavations carried out over the course of more than a century in the Minoan city of Phaistos have led to the discovery of several hundred pots and all kinds of clay vessels. Among them a few ceramics named “graters” are very peculiar in their shape and content. Pernier (1935: 238, fig. 114) was the first to discover and to report on these clay ceramics. Other graters were found during Levi's excavations from the 1950s onwards

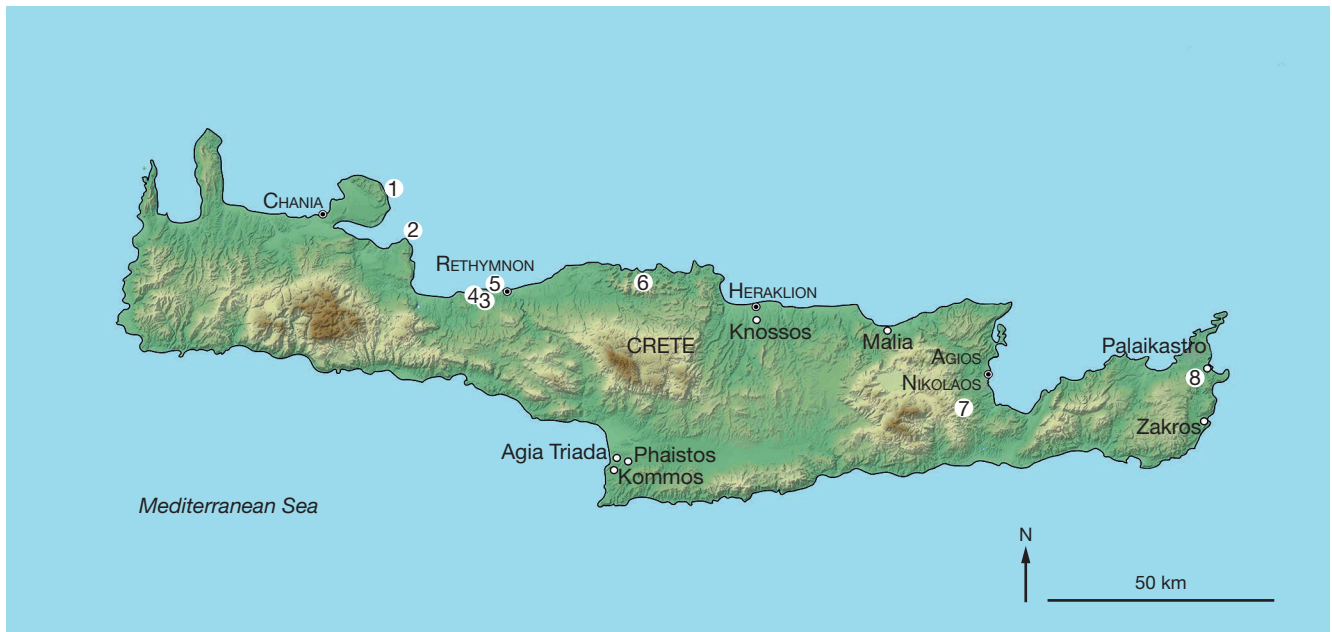


FIG. 1. – Simplified map of Crete with the main Minoan sites mentioned in the text, and main localities with elephantid remains: 1, Cape Maléka (*Mammuthus creticus* (Bate, 1907)); 2, Vámos Cave; 3, Coumbes Cave (*Palaeoloxodon chaniensis* (Symeonidis, Teodorou & Gianopoulos, 2000)); 4, Simonelli Cave; 5, Rethymnon fissures; 6, Kaló Choráphi Cave; 7, Katharó Plateau; 8, Karoumbes Cave (*Palaeoloxodon creutzburgi* (Kuss, 1965)). For a more detailed map of Minoan sites, see Driessen & Langohr 2014; Watrous 2021: p. 90; for palaeontological sites which yielded elephantid fossils, see Poulakakis et al. 2002; Iliopoulos et al. 2010; Athanassiou et al. 2019.

(Levi 1955, 1958, 1976). These pots have no decorative aspect and were apparently kitchen utensils, for grating fruits and vegetables to extract the juice. It appears that this type of graters was apparently found only at Phaistos, except for one from Agia Triada (Girella 2005), another Minoan site about two kilometers northwest of Phaistos (Fig. 1). They were all made of semifine-coarse reddish clay (Antonello 2022: 281). The graters of Phaistos are from the latest Middle Minoan period (Levi & Carinci 1988; Antonello 2022).

The clearest definition of such vessels was done by Antonello (2022: 287): “The grater is a vessel with a peculiar shape, generally made up of a basin and, inside this, a protruding element characterized by some protuberances arranged in rows, which constitute a grater. It is attested at Phaistos in deposits of MM IB and MM IIB. This type of vessel was probably used in the preparation of food; the presence of a drain on some of these basins allows us to hypothesize their use for liquid substances”. To be clear, in the following pages, the whole vessel will be called the *grater*, and the element inside with protuberances is the *rasp*. We can distinguish three types of graters depending on the form and thickness of the protuberance (Fig. 2).

The first type of graters has rasps that are unmistakably reminiscent of the molars of dwarf elephants from Crete. Two examples of this type are particularly characteristic. A bowl-shaped grater, restored and exhibited at the Archaeological Museum of Heraklion, was initially described by Pernier (1935: 293, fig. 171). Its inventory number is C 5825, its diameter 22 cm, and its depth 9.5 cm. This is a hemispherical cup, made of a soft clay, having a trapezoidal element inside, inclined from the edge towards the centre (Fig. 2A). It has a

horizontal handle close to the upper rim on the one side, and opposite to it a pouring spout. It is of a beige-pink colour with three internal bands of dark decoration. The rasp is stuck on the bottom, placed close to the handle in a slightly oblique manner. Its surface is wide on the handle side and narrows towards the centre of the basin, and it measures 12.5×6.5 cm, with a vertical thickness of about 4.5 cm. The seven rough stripes of its surface, each about 10 mm wide, are separated by flat bands as grooves. The stripes are not worn, indicating that the vessel was not used much. The shape and surface of the rasp closely recalls a molar of elephantid from Katharó Plateau in Crete (Fig. 3C).

The second example of this type is a “boat shaped” grater, initially illustrated by Levi (1976: 133, pl. 140d), Levi & Carinci (1988: 222, fig. 49), and Antonello (2022: pl. 34, fig. 653). Its inventory number is F 1412, total length 28.8 cm, length without handle 25.6 cm, width 15.8 cm, and height 6.7 cm (Levi 1976: 133; Antonello 2022: 235). It is made of dark beige and semi-fine grainy clay, it has an ellipsoidal outline with rounded rims, a vertical handle set between the rim and the external wall, opposite of which is a pouring spout, and, in the basin, a central horizontal rasp of ellipsoidal outline (Fig. 2B). The rasp measures 10.2×5.1 cm on its surface, and its height is about 4.5 cm. The surface of the rasp bears eight rough transverse stripes, each about 6 mm wide, separated by seven flat interstripe bands wider than the rough stripes, and one smooth area on each end. The rough stripes are relatively worn, demonstrating that this object was used for grating or rasping. As on the previous one, the rasp of this grater closely recalls the chewing surface of a lower molar of an elephant (Fig. 3D).



FIG. 2. – Two graters from the Minoan site of Phaistos at the Archaeological Museum of Heraklion: **A**, Round grater (C 5825) with a rasp slightly inclined toward the basin center; **B**, boat-shaped grater (F 1412) carrying a rasp in the middle the surface of which bears rugged rows separated by smooth intervals. Credits: S. Sen

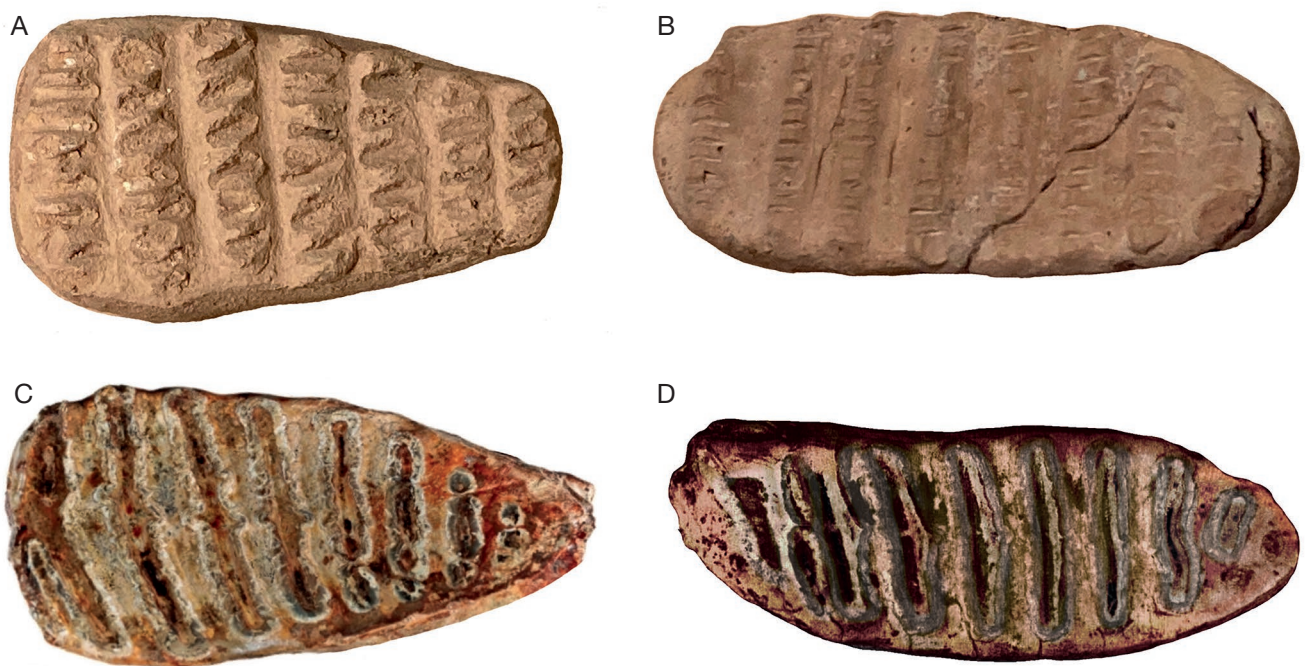


FIG. 3. – Comparison of the rasps of Minoan graters with dwarf elephant molars from Crete: **A**, The rasp of the round grater from Phaistos at the Archaeological Museum of Heraklion (C 5825); **B**, the rasp of the boat-shaped grater from Phaistos at the same museum (F 1412); **C**, occlusal view of a molar of *Palaeoloxodon creutzburgii* (Kuss, 1965) from Katharó Plateau in Crete. For Poulakakis *et al.* (2002: fig. 3), it is right second upper molar, whilst Herridge (2010: 125, fig. 4.9) identifies this specimen as “a left lower M3, based on wear and curvature”; **D**, occlusal view of a left third lower molar of *P. chaniensis* (Symeonidis, Teodorou & Gianopoulos, 2000) from Coumbes Cave in Crete. Note the resemblances of pattern between A and C, and B and D. Credits: A, B, S. Sen; C, Herridge 2010: fig. 4.9; D, Symeonidis & Theodorou 1982: plate V, coloured by L. Cazes.

The second type of graters from Phaistos, round or ellipsoid in outline, have been described and occasionally illustrated by Levi (1958: 234, figs 57d, 58; 1976: 81, 120, fig. 99, pl. 140), Levi & Carinci (1988: 222, 223, fig. 49, pl. 95), Tzedakis & Martlew (1999: 96, 97, pls 68, 69) and Antonello (2022: 158, 235, 269, 287, 346, pls 11, 34, 41). The size and shape of the bowl are as in the previous type; however, they differ in having the rasp not as a protuberance, but a thickening of the wall of the cup. The rasp element consists of an inclined extra-thick wall which extends from the edge to the bottom of the bowl, close to the handle, and it bears five bands of rugged stripes, separated by flat

bands (Fig. 4B, E-G). The pattern of the rasp calls once more elephant molars in some extant. The unique grater found at Agia Triada (Girella 2005: 399, fig. 40) is similar to the second type graters.

A third type of grater from Phaistos was reported by Pernier (1935: fig. 114) and another one by Levi (1955: 412, fig. 41; 1976: pl. 140a, c) (Inv. F 2056, height 10.5 cm, diameter 26.5 cm) from the 1953-1957 excavations. Pernier's illustration shows an incomplete cup, 9.5 cm high, while the grater illustrated by Levi (1955; 1976) is oval in shape, exactly like F 1412 described above (Fig. 4A, C). Both graters consist of a bowl containing a central or wall-displaced protuberance,



FIG. 4. – Minoan graters of Phaistos from the Protopalatial Period MM IIB illustrated by Levi (1976: pl. 140). Note the differences in the general shape of the graters, the place and the type of rugosity of the rasp surfaces.

as in the first type graters. The difference is that the surface of the protuberance is covered with cupules, not with alternating rough and smooth bands.

In summary, graters are rare among the countless pottery vessels found in the ruins of Phaistos. They were probably used as kitchenware for grating fruits and vegetables and extracting juice. Some of them have a protuberance or rough surface that are strangely reminiscent of elephant molars or at least the form and the pattern of their occlusal surface. It must be emphasized that these graters date from the Protopalatial period during which elephant ivory was unknown in Crete. This observation leads us to wonder if the Minoan potters knew of the dwarf elephants of Crete, or at least the fossils of their molars, to draw inspiration in the design of these kitchen utensils. The Minoan civilization flourished on Crete for almost two thousand years and used its resources, and in particular its soil to extract clay and to make potteries. While digging in the ground, the Minoans certainly saw the remains of fossil mammals, the most prominent and abundant of these being elephants, the remains of which are

now known from more than thirty localities (Poulakakis *et al.* 2002; Iliopoulos *et al.* 2010).

On the other hand, the Minoan art shows how Minoan artists and artisans were excellent observers of the natural world. As already noted by Evans (1921), the “Minoan naturalism” frequently used animal or plant figures in wall paintings (e.g. Immerwahr 1990), seal imprints (e.g. Krzyszkowska 2005; Karnava 2019; Panagiotopoulos 2021), barbotin ceramics (e.g. Foster 1982), in the shape and decoration of jars, jugs, bowls, and so on. The shapes of many pots are inspired of animal forms (birds, reptiles, mammals; see Betancourt 2007; Poursat 2008; Legendart 2020; Poursat & Knappett 2022; Anderson 2024) the vessel, seals or frescos are often decorated of *mise en scène* of faunal or floral elements. In summary, there is a prevalence of skeuomorphy in Minoan pottery because vessels containing models of birds, mammals or flowers are not uncommon (Knappett 2020), in addition to anthropomorphic forms (Anderson 2024). To support our hypothesis on the resemblance of the rasps with elephant molars, it is appropriate to give an overview on Cretan dwarf elephants.

ELEPHANTS IN CRETE AND NEIGHBORING ISLANDS

It was at the very beginning of the 1900s that an English palaeontologist Dorothea Bate (1878-1951) and a professor of geology at the University of Bologna, Vittorio Simonelli (1860-1929) discovered fossil bones in caves along the northern coasts of Crete, and they both described elephant remains (Bate 1905, 1907; Simonelli 1908). They noted remarkably small size of these elephants compared to their continental relatives. Some decades ago, Hugh Falconer (1868) and A. Leith Adams (1870) have reported on fossil bones of a very small elephant from Malta, *Elephas melitensis* Falconer, 1868. After these pioneer studies, the notion of dwarfism was born for mammals adapted to island conditions, and it became a subject of debate and controversy throughout the 20th century. Later on, fossils of endemic mammals have been found in many other sites in Crete, and some were the subject of detailed studies. Also, in the meantime, remains of more or less dwarf elephants have been discovered in several other islands of the Aegean realm such as Astypalaia, Delos, Kasos Kythera, Kythnos, Naxos, Rhodes, Tilos... (Lyras *et al.* 2022).

During the Pleistocene, before the introduction of other mammals by humans, Crete and several other Aegean islands were home to unbalanced faunas, composed of a limited number of species (elephants, hippopotamus, deer and murids), and lacking terrestrial carnivorans. As initially noted by Sondaar & Boekschoten (1967), Dermitzakis & Sondaar (1978), Sondaar & Dermitzakis (1982) and Dermitzakis & De Vos (1987), these mammals reached the islands, in particular Crete, by swimming or drifting.

In Crete, over thirty sites have yielded remains of dwarf elephants (Dermitzakis 1977; Dermitzakis & De Vos 1987; Poulakakis *et al.* 2002; Iliopoulos *et al.* 2010; Van der Geer *et al.* 2010; Sen 2017; Athanassiou *et al.* 2019; Lyras *et al.* 2022). Three species are recognized. The smallest and the oldest is *Mammuthus creticus* (Bate, 1907), only recorded from Cape Maléka in western Crete (Fig. 1). Herridge & Lister (2012) estimated its average body mass at about 310 kg and its shoulder height at 1.13 m. *M. creticus* apparently reached Crete during the first migration wave of land mammals during the Early Pleistocene (Mayhew 1977, 1996), i.e. c. 0.9 million years ago (Reese *et al.* 1996; Sondaar & Van der Geer 2005; Herridge 2010; Van der Geer *et al.* 2010; Van der Geer & Lyras 2011). The molars of this species have wide lamellae and in reduced number compared to the other Cretan elephantid species. For instance, its M3 has five lamellae as on the graters illustrated by Levi (1976: pl. 140b, f), reported here in Figure 4. Its tusk is unknown.

The second elephant species is *Palaeoloxodon creutzburgi* (Kuss, 1965). It is the most common elephant since it has been recognized in about twenty localities in every part of the island. Several jaw fragments, cheek teeth, tusks and postcranial bones were referred to this species (see synthesis in Lyras *et al.* 2022). Lomolino *et al.* (2013) estimated its body mass as 38 % of its ancestor *Palaeoloxodon antiquus*

(Falconer & Cautley, 1847), i.e., about 2600 kg, while for Burness *et al.* (2001) the body mass of this species was about 3200 kg. Amino Acid Racemization and Electron Spin Resonance methods applied on hippopotamus and deer bones and teeth from Katharó Plain, Simonelli Cave and Bate Cave, and on a femur of *P. creutzburgi* from Simonelli Cave yielded ages with very wide range, from c. 24 000 to 951 000 years (Reese *et al.* 1996), this showing the need to carry out new dating to define the time interval of this species. Its dental and skeletal features recall the European straight-tusked elephant *P. antiquus*, which inhabited Europe and Western Asia during the Pleistocene, c. between 900 and 33 000 years ago (Sousa & Figueiredo 2001; Mol *et al.* 2007; Stuart & Lister 2012; Palombo 2017). The first and second molars of *P. creutzburgi* have six to eight lamellae, eight to 12 lamellae in lower third molar and eight to nine lamellae in the upper third molar (Sen 2017). The surface of the Phaistos rasps closely resembles the occlusal pattern of the molars of this species (Figs 2, 3). Its tusks are known from the Simonelli Cave near Rethymnon (Kotsakis 1980), and an unpublished almost complete tusk from the same area is on display at the Palaeontological Museum of Rethymnon. They are thin (maximum diameter about 50 mm), hardly curved and slightly flattened. The size and shape of these tusks are different from those of Zakros (see below).

The third and largest elephant species from Crete is *Palaeoloxodon chaniensis* (Symeonidis, Theodorou & Gianopoulos, 2000). Its type locality is the submerged Cave of Vámos, near Chania. The authors also included in this species a mandible from the Coumbes Cave near Rethymnon (Symeonidis & Theodorou 1982; Symeonidis *et al.* 2000: 106) diagnosed this species as “Endemic elephant of relatively large dimensions about 20 % smaller than continental *P. antiquus*”, and they estimated its size close to the extant Asian elephant, with a shoulder height of about 3-3.5 m and a body mass about 3200 kg. Symeonidis *et al.* (2001) calculated its age as about 18 000 years because the entrance of the Vámos Cave is 10 m below present sea level, but this age should be taken with caution.

We are aware that several authors (Poulakakis *et al.* 2002; Van der Geer *et al.* 2010; Athanassiou *et al.* 2019; Lyras *et al.* 2022) considered *P. chaniensis* a junior synonym of *P. creutzburgi*, arguing that there is a large overlap in size as in many other modern and fossil Proboscideans, and the size and morphological differences may be due to intra-specific diversity.

The Palaeontological Museum of Rethymnon exhibits a partial composite skeleton bearing complete tusks, and other cranial and postcranial remains, from several localities near Rethymnon, including the Coumbes Cave. These specimens were not studied. The illustrations in Symeonidis *et al.* (2000, 2001) and our observations on the material preserved at the Rethymnon Museum show that all these remains belonged to an elephant larger than *P. creutzburgi* and its molars have a larger number of lamellae than those of *P. creutzburgi*. As shown in Figure 5, the tusks of this ele-



FIG. 5. – A partial composite skeleton of *Palaeoloxodon chaniensis* (Symeonidis, Teodorou & Gianopoulos, 2000) from the fossiliferous sites near Rethymnon, Crete, as exhibited at the Palaeontological Museum of Rethymnon (bottom left) and its tusks. The second tusk is displayed in a showcase and pasted to the original photo. Credits: S. Sen.

phant are almost rectilinear, slightly curved upwards, and their thickness does not change much along the tusk, except at their tips, and they are larger (maximum diameter about 100 mm) than those of *P. creutzburgi*, of which two tusk fragments from Simonelli Cave were described by Kotsakis (1980) and other tusks are in display at the Rethymnon Museum. The published data and our preliminary observations on the material exhibited at the Rethymnon Museum lead us to suggest that the fossils referred to *P. chaniensis* are larger than those of *P. creutzburgi*, and the morphology of the tusks and molars differs from that of the latter species. The systematics of Cretan elephants are out of the scope of the present study, but it is important to emphasize that this question deserves a detailed analysis of the remains already available for both species before concluding on the status of these taxa.

The contemporaneity of the last elephants of Crete with the Minoans is not documented. Neither the Holocene sediments of Crete nor the archaeological sites have yielded any remains that could be attributed to dwarf elephants. Also, the elephant is totally absent in Minoan art, with the

exception of ivory used to make utilitarian or decorative objects. No statuette, seal imprint or painting represent elephants, and no text mentions them (Vanschoonwinkel 1996; Legendart 2020). In the Aegean realm, one exception comes from the island of Kos: Brown (1926: 535) reported a “small elephant tooth, identified as a milk molar of *Elephas antiquus* (...) found among the pieces of statuary and figurines in the ruins of the famous Asklepieion”. This is the only fossil elephant remain found in an archaeological context in the Aegean region. Once more the question arises: what did the Minoans know about fossil and modern elephants?

Since the Paleolithic, people from various cultures have been interested in fossil vertebrates and invertebrates, that were formerly called *curiosa*, and have collected them and sometimes transported them over great distances (Tassignon 2005). It is very likely that the Minoans recorded the remains of fossil elephants and were particularly interested in their molars and their tusks for inspiration and why not possibly for carving. Unfortunately, in the literature that we have been able to consult, no archaeologist mentions the discovery of fossil elephant remains in the Minoan sites.

Some archaeologists have questioned the possibility of working fossil ivory to make objects. Bégouen (1932) showed that replicas of Upper Paleolithic statuettes from Dolní Věstonice in the Czech Republic are done of fossil ivory, thus demonstrating the possibility of its carving. Also, many small Campaniform ornaments such as beads or buttons from Bell Beaker tombs in Spain indicate that they were manufactured from the tusks of *Palaeoloxodon antiquus* (Liesau von Lettow-Vorbeck 2016, and references therein). *A priori*, we cannot exclude the use of fossil ivory, even occasionally, for the manufacture of some objects.

ORIGIN OF THE ELEPHANT TUSKS OF ZAKROS

Minoan craftsmen used elephant ivory for the manufacture of precious objects such as seals, plaques, amulets, figurines or statuettes (Krzyszkowska 1981, 1990; Hemingway 2000; Krzyszkowska & Morkot 2000; Poursat 2008, 2018). The origin of the elephant ivory (both zoological and geographical) has been discussed by several authors (Krzyszkowska 1981, 1983, 1988; Barnett 1982; De Hoff 1988; Hayward 1990; Krzyszkowska & Morkot 2000; Kelder *et al.* 2018; Poursat 2018). The possibility that elephant ivory was imported from Asia or Africa is often mentioned. However, in the Minoan iconography and epigraphy elephants are totally absent. What is clear is that elephant ivory begins to appear in Minoan art with the Neopalatial Period, i.e., c. 1600 BC or a little earlier (Poursat 2018). Where does this ivory come from? Could a comparison of Zakros' tusks with those of African and Asian elephants help us to suggest a hypothesis?

The Minoan site of Zakros, in the far east of Crete (Fig. 1), yielded four elephant tusks during the 1963 excavation season in the storeroom XI next to the palace (Platon 1971, 1985: fig. p. 61). They are dated to the Neopalatial Period, c. 1500-1450 BC (Platon 1988). Two of the Zakros tusks are restored and are on display at the Heraklion Museum (Fig. 6). The one is preserved on 45 cm, and its maximum diameter is about 10 cm (catalog F-I-GI, no. 7; Platon 1988). The second tusk is almost complete (catalog F-I-GI, no. 6; Platon 1988), its length on the external face is approximately 113 cm and its maximum diameter at the base 14.5 cm. These tusks are well curved, their diameter refines from the base towards the tip, and their section is rather round. More detailed descriptions of the Zakros tusks and illustrations can be found in Platon (1971, 1985: fig. p. 61; 1988: pl. 19), Krzyszkowska (1981: pls 23, 24), and Masseti (2012: fig. 21). Platon (1988: 69) notes that "Their pointed ends are blunt and they are strongly curved, but are not very long (...) This particular type of curved and short tusk probably comes from Syria. This view is suggested by the discovery of copper ingots in the same place, perhaps coming from Cyprus. It is probable that these unworked materials were simultaneously imported to Zakros during one commercial journey in the area of the SE Mediterranean coasts".

These tusks cannot belong to any of the fossil elephants of Crete, because their size, curvature and the shape of their section are different. They only may belong to the African or Asian elephants, and consequently imported from North Africa or the Levant. We have to note that the tusks of African and Asian elephants cannot be securely distinguished based on their apparent morphology (Hooijer 1978). The African elephant *Loxodonta africana* (Blumenbach, 1797) occupied territories in North Africa until historical times. As for Egypt, its remains have been found both in natural sites (Kasr Es Saga-Fayum, Dakhla Oasis, El Nabta Basin, or Jebel Ouenat in the Western Desert) and in the tombs of Hierakonpolis, all older than 3000 BC (Friedman 2004; Van Neer *et al.* 2004; Manlius 2008). They are also abundantly represented in engravings in many sites north of the Sahara. Le Quellec (2021) presented a synthesis of ancient and recent discoveries of rock art in North Africa, and as for elephants, he concluded that the number of elephant engravings decreases from 4000 BC to disappear completely around 2000 BC. These observations do not support an African origin for the Zakros tusks.

A subspecies of the Asian elephant, *Elephas maximus asurus* Deraniyagala, 1950 (see Deraniyagala 1955; here below Syrian elephant) was roaming in the Middle East during the Bronze Age, at least until 1200 BC (Lenormant 1873; Hooijer 1978; Bökönyi 1985; Caubet & Poplin 1987, 2010; Becker 2005; Lister *et al.* 2013; Vila 2015; Yar *et al.* 2016) or until the 8th or 7th century BC (Pfälzner 2013, 2016; Çakırlar & İkrām 2016). Its remains are found in natural and archaeological sites, and it is also documented with the pictorial and textual evidence. For instance, its remains are abundantly unearthed from the sediments of an ancient lake named Gavur Gölü in southeastern Turkey (Albayrak & Lister 2012; Yar *et al.* 2016). Although three skeletons from this site are exhibited at the museums of Maraş, Ankara and İzmir, its tusks are unknown, the tusks on the mounted skeletons being fake resin tusks (Ebru Albayrak and Fabio Parenti, pers comm., February 2024). The rather complete tusks are only found at Alalakh-Tell Atchana (Hatay Province, Turkey; Woolley 1955), while other sites have only yielded tusk fragments, molars and bones. The two complete Alalakh tusks have a length of 160 and 140 cm, respectively (Woolley 1955: 404). Their size, upward curvature and progressive tapering toward the apical end recall that of the Zakros tusks. Woolley (1955: 288) noted that "Niya [the capital of Niya Kingdom on the Orontes River], which formed part of the territories of the king of Alalakh, was the elephant-reserve of north Syria and the source of commercial ivory (...) destined for export to Anatolia, the Aegean, Phoenicia, or Egypt to pass through the Amuq plain".

A fresco from the tomb of Rekhmire, grand vizier of Thutmose III (1481-1425 BC), has caused much ink to flow, in particular because there is a "small" elephant held on a leash by the Syrian emissaries (Davies 1944). This fresco bears five bands, the upper four represent, from top to bottom, the emissaries of Punt (approximately modern Somalia and Djibouti), Crete and/or the Aegean Islands, Nubia and Syria, the last band depicting the slaves. A Syrian emissary

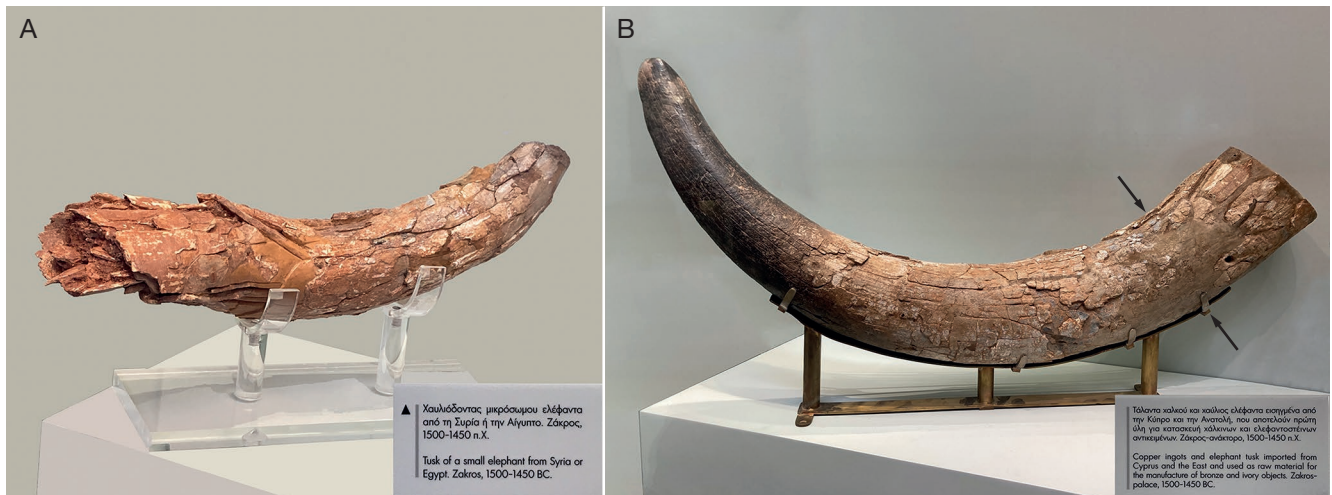


Fig. 6. – Two elephant tusks from Zakros, eastern Crete, on exhibit at the Archaeology Museum of Heraklion. Their labels indicate that they were imported from Syria or Egypt, and dated to between 1500-1450 BC. The arrows indicate the part of the tusk restored to remove the deformation of the basal part. Credits: S. Sen

pulls an elephant, and another carries two tusks to offer to the Pharaoh, in addition to other goods carried by other emissaries. This elephant is apparently adult, depicted in a reduced model for the needs of stylistic convention, but it does not mean that it was dwarf as some scholar seem to believe (Rosen 1994; Masseti 2001). In the same fresco one or more emissaries of all these peoples carry elephant tusks on their shoulders, including an emissary from Crete, to offer to the pharaoh of Egypt. In other words, this fresco does not faithfully represent the goods offered to the pharaoh coming from each of these regions, but an idealized representation of the prestigious goods offered to the pharaoh to solicit his benevolence towards these peoples.

Let us also recall the accounts of the hunting expeditions of Thutmosis III and Tiglath-Pileser I (1115-1077 BC) in Syria where the one has killed 120 elephants and the other slaughtered ten mighty male elephants and took four alive at the Khabur and Haran regions (Scullard 1974). All these data confirm Platon's (1971, 1985, 1988) opinion on the origin of the Zakros tusks: Syria or the Levant as a whole. Indeed, the Minoans traded with several port cities in the Levant and this is proven by the reciprocal exchange of objects and influences (Massa & Palmisano 2018; Poursat 2018).

However, this morphological and historical approach must be confirmed by microscopic examination of the microstructure of dentine, the shape of concentric growth lines (Lines of Owen), and X-Rays analysis to obtain evidence about absolute elemental concentrations, DNA analyses for phylogenetic relationships, or even stable isotope analyses that may reveal if they originated in Syria or Africa (Bass 1997; Trapani & Fisher 2003; Agiadi & Theodorou 2005; Nganvongpanit *et al.* 2016; Baker *et al.* 2020). All these characters differ more or less from one species to another, or even they vary from one population to another within the same species. Concerning the Zakros' tusks, and any other elephant ivory items found in Minoan sites, the application of these destructive methods cannot be currently envisaged.

CONCLUSIONS

In this study, we aimed to shed light on some Minoan pots from Phaistos and raw elephant tusks found at Zakros in the light of palaeontological and archaeological knowledge. Among the thousands of ceramics found in the buildings from the Middle Minoan Period at Phaistos, there are a few kitchen vessels called graters. Most of them have inside the bowl a protuberant rasp the surface of which forms rugged bands separated by smooth lower bands or grooves, reminiscent of the pattern of elephant molars. The strong resemblance between these rasps and the molars of dwarfed fossil elephants of Crete leads us to hypothesis that the Minoans of this period could have discovered fossil elephant molars, and that the potters of Phaistos may have taken inspiration from them for the shape and the surface design of their rasps. This hypothesis is also supported by the fact that elephant ivory was not known in Crete during the Middle Minoan Period, and the importation and use of elephant ivory only began at the end of this period, around 1600 BC (Poursat 2018). Let us remember that elephant bones and teeth were never been found in Minoan settlements, and as noted by Krzyszkowska (1981) elephant molars are unsuitable for making objects.

Four elephant tusks were found in the ruins of Zakros Palace dating from the Late Minoan IB Period. In size, curvature and thinning towards the tip, they do not resemble tusks of any fossil elephants from Crete. Most archaeologists, based on the recovery of elephant remains in Levantine archaeological and natural sites, as well as iconographic and textual documents, argued for a Levantine origin of the Zakros tusks, consequently referred to *Elephas maximus asurus*, a subspecies of the Asian elephant that survived in this region until at least 1200 BC. Other archaeologists have suggested provenance via trade with Egypt by capitalizing on the regular commercial exchanges with the country of the pharaohs. The morphological similarities of these tusks rather support affinity with the Syrian elephant, complemented by iconographic and textual data, although this result must be confirmed by microstructural and isotopic studies.

Acknowledgements

We are grateful to Pascal Tassy (MNHN, Paris) for his advice on extant elephants. Ebru Albayrak (MTA, Ankara) and Fabio Parenti (Universidade Federal do Parana, Curitiba), provided information about the fossil elephants of Gavur Gölü (Maraş) in SE Turkey. Lilian Cazes (MNHN, Paris) coloured some photographs to homogenise illustrations, and Lady Stella Kristoulaki (Armenoi, Crete) kindly housed us during our journey in Crete. Martin Pickford (CR2P-MNHN) put his professional skill to make our English compatible with Shakespeare's language. The comments of three anonymous referees were helpful to improve this study. We also acknowledge the contribution of the Desk editor Emmanuelle Rocklin and Editor-in-Chief Rémi Berthon.

REFERENCES

- ADAMS A. L. 1870. — *Notes of a Naturalist in the Nile Valley and Malta: A Narrative of Exploration and Research in Connection with the Natural History, Geology, and Archaeology of the Lower Nile and Maltese Islands*. Edmonston and Douglas, Edinburgh, 295 p.
- AGIADI K. & THEODOROU G. 2005. — Tusk palaeohistology as a tool in the discrimination of fossil tusks from Greece, in ALCOVER J. A. & BOVER P. (eds), *Proceedings of the International Symposium "Insular Vertebrate Evolution: The Palaeontological Approach"*. *Monografies de la Societat d'Història Natural de les Balears* 12: 1-8.
- ALBAYRAK E. & LISTER A. M. 2012. — Dental remains of fossil elephants from Turkey. *Quaternary International* 276: 198-211. <https://doi.org/10.1016/j.quaint.2011.05.042>
- ANDERSON E. S. K. 2024. — *Minoan Zoomorphic Culture. Between Bodies and Things*. Cambridge University Press, New York, xii + 418 p.
- ANTONELLO S. 2022. — *Un database dei depositi de MMIB del Primo Palazzo di Festòs (Creta). Per una revisione della cronologia dell'ultima fase propalaziale*. PhD Thesis, Università Ca' Foscari Venezia, 466 p., 43 p. of figs, 24 pl.
- ATHANASSIOU A., VAN DER GEER A. A. E. & LYRAS G. A. 2019. — Pleistocene insular Proboscidea of the Eastern Mediterranean: a review and update. *Quaternary Science Reviews* 218: 306-321. <https://doi.org/10.1016/j.quascirev.2019.06.028>
- BAKER B. W., JACOBS R. L., MANN M. J., ESPINOZA E. O. & GREIN G. 2020. — Identification guide for ivory and ivory substitutes (4th edition), in ALLAN C. (ed.), *CITES, World Wildlife Fund Inc. Washington DC*. Commissioned by CITES Secretariat, Geneva, 98 p.
- BARNETT R. D. 1982. — Ancient ivories in the Middle East. *Qedem, Monographs of the Institute of Archaeology, Hebrew University of Jerusalem* 14: 1-99.
- BASS G. F. 1997. — Prolegomena to a study of maritime traffic in raw materials to the Aegean during the fourteenth and thirteenth centuries B.C., in LAFFINEUR R. & BETANCOURT P. P. (eds), *TEXNH: Craftsmen, Craftswomen and Craftsmanship in the Aegean Bronze Age. Proceedings of the 6th International Aegean Conference, Philadelphia, Temple University, 18-21 April 1996*. Université de Liège (Aegaeum; 16); University of Texas, Austin: 153-170.
- BATE D. M. A. 1905. — Four and half months in Crete in search of Pleistocene mammalian remains. *The Geological Magazine N.S.* 5 (2): 193-202.
- BATE D. M. A. 1907. — On elephant remains from Crete, with description of *Elephas creticus*, sp. n. *Proceedings of the Zoological Society of London* March and April: 238-250. <https://www.biodiversitylibrary.org/page/31209213>, last consultation on 5 March 2025.
- BECKER C. 2005. — Small numbers, large potential – new prehistoric finds of elephant and beaver from the Khabur river/Syria. *Munibe (Antropologia-Arkeologia)* 57: 445-456.
- BÉGOUEN H. 1932. — Des dendrites comme preuve d'authenticité et de la possibilité de travailler l'ivoire fossile, à propos de la Vénus II de Vistonitzé. *Bulletin de la Société préhistorique française* 29 (6): 279-291. <https://doi.org/10.3406/bspf.1932.5621>
- BETANCOURT P. P. 2007. — *Introduction to Aegean Art*. INSTAP Academic Press, Philadelphia, 212 p. <https://archive.org/details/INTRODUCTIONTOHAEAGEANART.2007ByPHILIPBETANCOURT/mode/2up>, last consultation on 27 February 2025.
- BÖKÖNYI S. 1985. — Subfossil elephant remains from Southwestern Syria, in Actes du séminaire CNRS/NSF de Bellevaux (24-29 juin 1985): L'évolution des sociétés complexes du sud-ouest de l'Iran. *Paléorient* 11 (2): 161-163. <https://doi.org/10.3406/paleo.1985.4380>
- BROWN B. 1926. — Is this the earliest known fossil collected by Man? *Natural History, The Journal of the American Museum* 26 (5): 535.
- BURNES G. P., DIAMOND J. & FLANNERY T. 2001. — Dinosaurs, dragons, and dwarfs: the evolution of maximal body size. *Proceedings of the National Academy of Sciences* 98 (25): 14518-14523. <https://doi.org/10.1073/pnas.251548698>
- ÇAKIRLAR C. & IKRAM S. 2016. — 'When elephants battle, the grass suffers.' Power, ivory and the Syrian elephant. *Levant* 48 (2): 167-183. <https://doi.org/10.1080/00758914.2016.1198068>
- CAUBET A. & POPLIN F. 1987. — Les objets de matière dure animale: étude du matériau, in YON M. (ed.), *Ras Shamra-Ougarit III, le centre de la ville, 38^e-44^e campagnes (1978-1984)*. Éditions Recherche sur les Civilisations, Paris (Mémoire; 72): 273-306.
- CAUBET A. & POPLIN F. 2010. — Réflexions sur la question de l'éléphant syrien, in KÜHNE H. (ed.), *Dur-Katlimmu 2008 and Beyond*. Harrassowitz Verlag, Wiesbaden (Studia Chaburensia; 1): 1-9.
- DAVIES N. DE G. 1944. — *The Metropolitan Museum of art, Egyptian Expedition – Paintings from the tomb of Rekh-mi-ré at Thebes, 1835*. Metropolitan Museum of Art, New York, vol. 1: ix + 118 p.; vol. 2: viii + 122 pl.
- DE HOFF S. 1988. — *The Ivory Trade in the Eastern Mediterranean Bronze Age: Background and Preliminary Investigation*. U. M. I., Ann Arbor MI, 269 p.
- DERANIYAGALA P. E. P. 1955. — *Some Extinct Elephants, Their Relatives and the Two Living Species*. Ceylon National Museums Publication, Ceylon, 161 p.
- DERMITZAKIS M. D. 1977. — The Quaternary fossil mammals in the caves and karstic holes of Crete Island and their significance. *Bulletin de la Société spéléologique de Grèce* 14: 152-190 [in Greek].
- DERMITZAKIS M. D. & DE VOS J. 1987. — Faunal succession and the evolution of mammals in Crete during the Pleistocene. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 173 (3): 377-408. <https://doi.org/10.1127/njgpa/173/1987/377>
- DERMITZAKIS M. D. & SONDAAR P. Y. 1978. — The importance of fossil mammals in reconstructing paleogeography, with special reference to the Pleistocene Aegean Archipelago. *Annales géologiques des Pays helléniques* 29: 808-840.
- DRIESSEN J. & LANGOHR C. 2014. — Recent developments in the archaeology of Minoan Crete. *Pharos* 20 (1): 75-115. <https://doi.org/10.2143/PHA.20.1.3064537>
- EVANS A. 1921. — *The Palace of Minos: A Comparative Account of the Successive Stages of the Early Cretan Civilization as Illustrated by the Discoveries at Knossos*. I, *The Neolithic and Early and Middle Minoan Ages*. Macmillan, London, 721 p., 542 figs.
- FALCONER H. 1868. — On the fossil remains of *Elephas melitensis*, an extinct pygmy species of elephant; and of other Mammalia, from the ossiferous caves of Malta. *Palaeontological Memoirs and Notes* 2: 292-308.
- FALCONER H. & CAUTLEY P. T. 1847. — *Fauna Antiqua Sivalensis, Being the Fossil Zoology of the Sewalik Hills, in the North of India. Proboscidea*. Smith, Elder and Co., London, 136 p. <https://doi.org/10.5962/bhl.title.61447>

- FOSTER K. P. 1982. — Minoan ceramic relief. *Studies in Mediterranean Archaeology* 64: 1-196.
- FRIEDMAN R. F. 2004. — Elephants at Hierakonpolis, in HENDRICKX S., FRIEDLMAN R. F., CIALOWICZ K. M. & CHLODNICKI M. (eds), *Egypt at its Origins. Studies in Memory of Barbara Adams. Orientalia Lovaniensis Analecta* 138: 131-168.
- GIRELLA L. 2005. — Ceramica da cucina dal sito di Haghia Triada. Rapporto preliminare da un deposito ceramico del MM III. *Annuario della Scuola Archeologica di Atene e delle Missioni Italiane in Oriente* 83: 371-409.
- HAYWARD L. G. 1990. — The origin of the raw elephant ivory used in Greece and the Aegean during the Late Bronze Age. *Antiquity* 64 (242): 103-109. <https://doi.org/10.1017/S0003598X00077334>
- HEMINGWAY S. 2000. — The place of the Palaikastro Kouros in Minoan bone and ivory sculpture, in MACGILLIVRAY J. A., DRIESSEN J. M. & SACKETT L. H. (eds), *The Palaikastro Kouros: A Minoan Chryselephantine Statuette and its Aegean Bronze Age Context. British School at Athens Studies* 6: 113-122.
- HERRIDGE V. L. 2010. — *Dwarf Elephants on Mediterranean Islands: A Natural Experiment in Parallel Evolution*. PhD thesis, University College London, Department of Genetics, Evolution and Environment, 480 p.
- HERRIDGE V. L. & LISTER A. M. 2012. — Extreme insular dwarfism evolved in a mammoth. *Proceeding of the Royal Society B* 279: 3193-3200. <https://doi.org/10.1098/rspb.2012.0671>
- HOOIJER D. A. 1978. — The Indian elephant at the Bronze Age Ras Shamra, Ugarit. *Ugaritica* 7: 226-227.
- ILIOPOULOS G., EIKAMP H. & FASSOULAS C. 2010. — A new Late Pleistocene mammal locality from western Crete. *Bulletin of the Geological Society of Greece* 43 (2): 918-925. <https://doi.org/10.12681/bgsg.11257>
- IMMERWAHR S. A. 1990. — *Aegean Painting in the Bronze Age*. The Pennsylvania State University Press, xxiv + 240 p., 23 color pl., 89 pl.
- KARNAVA A. 2019. — Minoan archives: a case for the preservation of institutional memory, in BORGNA E., CALOI I., CARINCI F. M. & LAFFINEUR R. (eds), *Past and Memory in the Aegean Bronze Age. Proceedings of the 17th International Aegean Conference, University of Udine, Department of Humanities and Cultural Heritage, Ca' Foscari University of Venice, Department of Humanities, 17-21 April 2018. Aegaeum* 43: 579-589.
- KELDER J. M., COLE S. E. & CLINE E. H. 2018. — Memphis, Minos and Mycenae: Bronze Age contact between Egypt and the Aegean, in SPIER J., POTTS T. & COLE S. E. (eds), *Beyond the Nile: Egypt and the Classical World*. Getty Publications, Los Angeles: 9-17.
- KNAPPETT C. 2020. — *Aegean Bronze Age Art. Meaning in the Making*. Cambridge University Press, Cambridge, New York, xv + 248 p.
- KOTSAKIS T. 1980. — Short account on the elephant remains of the Simonelli Cave. *Accademia Nazionale dei Lincei, Quaderno* 249: 115-120.
- KRZYSZKOWSKA O. H. 1981. — *The Bone and Ivory Industries of the Aegean Bronze Age: A Technological Study*. PhD Thesis, University of Bristol, vol. 1, xvi + 367 p.; vol. 2, xx + 399 p.; vol. 3, 125 figs, 130 pl.
- KRZYSZKOWSKA O. H. 1983. — Wealth and prosperity in pre-palatial Crete, the case of ivory, in KRZYSZKOWSKA O. H. & NIXON L. (eds), *Minoan Society, Proceedings of the Cambridge Colloquium 1981*. Bristol Classical Press, Bristol: 163-170.
- KRZYSZKOWSKA O. H. 1988. — Ivory in the Aegean Bronze Age: elephant tusk or hippopotamus ivory? *The Annual of the British School at Athens* 83: 209-234. <https://doi.org/10.1017/S0068245400020736>
- KRZYSZKOWSKA O. H. 1990. — *Ivory and Related Materials: An Illustrated Guide*. University of London, Institute of Classical Studies (Bulletin Supplement; 59), 109 p.
- KRZYSZKOWSKA O. H. 2005. — *Aegean Seals: An Introduction*. Institute of Classical Studies, School of Advanced Study, University of London, xxx + 425 p.
- KRZYSZKOWSKA O. & MORKOT R. 2000. — Ivory and related materials, in NICHOLSON P. T. & SHAW I. (eds), *Ancient Egyptian Materials and Technology*. Cambridge University Press, Cambridge: 320-331.
- KUSS S. E. 1965. — Eine Pleistozäne Säugetierfauna der Insel Kreta. *Berichte der Naturforschenden Gesellschaft zu Freiburg im Breisgau* 55: 271-348.
- LE QUELLEC J. L. 2021. — What's new in the Sahara? (2015-2019), in BAHN P., FRANKLIN N. & STRECKER M. (eds), *Rock Art Studies: News of the Old World VI*. Archaeopress, Oxford: 63-78. <https://doi.org/10.2307/j.ctv1zm2tkx.9>
- LEGENDART A. 2020. — Une classification animale crétoise à l'âge du bronze? Le point de vue des Minoens par le prisme de l'iconographie, in BRÉMONT A., BOUDES Y., THUAULT S. & BEN SAAD M. (éds), *Appréhender les catégories zoologiques dans les sociétés du passé. Anthropozoologica* 55 (17): 247-255. <https://doi.org/10.5252/anthropozoologica2020v55a17>
- LENORMANT F. 1873. — Sur l'existence de l'éléphant dans la Mésopotamie au XII^e siècle avant l'ère chrétienne. *Comptes rendus des Séances de l'Académie des Inscriptions et Belles-Lettres* 17 (1): 178-183. <https://doi.org/10.3406/crai.1873.68030>
- LEVI D. 1955. — Scuola Archeologica italiana di Atene. La campagna di scavi a Festòs nel 1953. *Annuario della Scuola Archeologica di Atene e delle missioni Italiane in Oriente* 30-32: 389-469.
- LEVI D. 1958. — Gli scavi a Festòs nel 1956 et 1957. *Annuario della Scuola Archeologica di Atene e delle missioni Italiane in Oriente* 35-36: 193-361.
- LEVI D. 1976. — *Festòs e la civiltà minoica*. Edizione dell'Ateneo, Rome (Incunabula graeca; 60), 864 p., 248 pl.
- LEVI D. & CARINCI F. 1988. — *Festòs e la civiltà minoica*. Vol. 2, Fasc. 2, *L'arte festia nell'età protopalaziale: ceramica ed altri materiali*. Edizione dell'Ateneo, Rome (Incunabula graeca; 77), xvi + 379 p., 118 pl.
- LIESAU VON LETTOW-VORBECK C. 2016. — Some prestige goods as evidence of interregional interactions in the funerary practices of the Bell Beaker groups of Central Iberia, in GUERRA DOCE E. & LIESAU VON LETTOW-VORBECK C. (eds), *Analysis of the Economic Foundations Supporting the Social Supremacy of the Beaker Groups. Proceedings of the XVII UISPP World Congress (1-7 September, Burgos, Spain)* Vol. 6, Session B36: 69-93.
- LISTER A. M., DIRKS W., ASSAF A., CHAZAN M., GOLDBERG P., APPLBAUM Y. H., GREENBAUM N. & HORWITZ L. K. 2013. — New fossil remains of *Elephas* from the southern Levant: implications for the evolutionary history of the Asian elephant. *Palaeogeography Palaeoclimatology Palaeoecology* 386: 119-130. <https://doi.org/10.1016/j.palaeo.2013.05.013>
- LOMOLINO M. V., VAN DER GEER A. A., LYRAS G. A., PALOMBO M. R., SAX D. F. & ROZZI R. 2013. — Of mice and mammoths: generality and antiquity of the island rule. *Journal of Biogeography* 40 (8): 1427-1439. <https://doi.org/10.1111/jbi.12096>
- LYRAS G. A., ATHANASSIOU A. & VAN DER GEER A. A. 2022. — The fossil record of insular endemic mammals from Greece, in Vlachos E. (ed.), *Fossil Vertebrates of Greece 2*. Springer, Cham: 661-701. https://doi.org/10.1007/978-3-030-68442-6_25
- MANLIUS N. 2008. — L'éléphant égyptien. *Toutankhamon magazine* 39: 48-53.
- MASSA M. & PALMISANO A. 2018. — Change and continuity in the long-distance exchange networks between western/central Anatolia, northern Levant and northern Mesopotamia, c. 3200-1600 BCE. *Journal of Anthropological Archaeology* 49: 65-87. <https://doi.org/10.1016/j.jaa.2017.12.003>
- MASSETI M. 2001. — Did endemic dwarf elephants survive on Mediterranean islands up to protohistorical times? in CAVARRETTA G., GIOIA P., MUSSI M. & PALOMBO M. R. (eds), *Proceedings of the 1st International Congress "The World of Elephants"*. Università degli Studi di Roma "La Sapienza", Roma: 402-406.
- MASSETI M. 2009. — Mammals of the Mediterranean islands: homogenisation and the loss of biodiversity. *Mammalia* 73: 169-202. <https://doi.org/10.1515/MAMM.2009.029>

- MASSETI M. 2012. — *Atlas of Terrestrial Mammals of the Ionian and Aegean Islands*. De Gruyter, Berlin, 302 p. <https://doi.org/10.1515/9783110254587>
- MAYHEW D. F. 1977. — The endemic Pleistocene murids of Crete. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* B80: 182-214.
- MAYHEW D. F. 1996. — The extinct murids of Crete, in REESE D. S. (ed.), *Pleistocene and Holocene Fauna of Crete and its First Settlers. Monographs in World Archaeology* 28: 167-171.
- MOL D., DE VOS J. & VAN DER PLICHT J. 2007. — The presence and extinction of *Elephas antiquus* Falconer and Cautley, 1847, in Europe. *Quaternary International* 169-170: 149-153. <https://doi.org/10.1016/j.quaint.2006.06.002>
- NGANVONGPANIT K., BROWN J. L., BUDDHACHAT K., SOMGIRD C. & THITARAM C. 2016. — Elemental analysis of Asian elephant (*Elephas maximus*) teeth using X-ray fluorescence and a comparison to other species. *Biological Trace Element Research* 170: 94-105. <https://doi.org/10.1007/s12011-015-0445-x>
- PALOMBO M. R. 2017. — Discrete dispersal bioevents of large mammals in Southern Europe in the post-Olduvai Early Pleistocene: a critical overview. *Quaternary International* 431B: 3-19. <https://doi.org/10.1016/j.quaint.2015.08.034>
- PANAGIOTOPOULOS D. 2021. — Keftiu in context: Theban tomb-paintings as a historical source. *Oxford Journal of Archaeology* 20 (3): 263-283. <https://doi.org/10.1111/1468-0092.00134>
- PERNIER L. 1935. — *Il palazzo Minoico di Festòs: scavi e studi della missione archeologica italiana a Creta dal 1900 al 1950*. Vol. I, *Gli strati più antichi e il primo palazzo*. Libreria dello Stato (Anno 13) Roma, xxiii + 475 p.
- PFÄLZNER P. 2013. — The elephant hunters of Bronze Age Syria, in ARUZ J., GRAFF S. B. & RAKIC Y. (eds), *Cultures in Contact: From Mesopotamia to the Mediterranean in the 2nd Millennium B.C. The Metropolitan Museum of Art, Symposia*. Yale University Press, London, New Haven: 112-131.
- PFÄLZNER P. 2016. — The elephants of the Orontes, in PARAYRE D. (ed.), *Le fleuve rebelle. Géographie historique du moyen Oronte d'Ebla à l'époque médiévale*. *Syria* HS 4: 159-182. <https://doi.org/10.4000/syria.5002>
- PLATON N. 1971. — *Zakros: The Discovery of a Lost Palace of Ancient Crete*. Charles Scribner's Sons, New York, 345 p.
- PLATON N. 1985. — *Zakros: The Discovery of a Lost Palace of Ancient Crete*. Adolf M. Hakkert Publisher, Amsterdam, 345 p.
- PLATON N. 1988. — *The Workshops and Working Areas of Minoan Crete. The Evidence of the Palace and Town of Zakros for a Comparative Study*. PhD Thesis, University of Bristol, Faculty of Arts, Department of Classics and Archaeology, vol. I, 488 p.; vol. II, 228 p.; vol. III, 173 fig., 64 pl.
- POULAKAKIS N., MYLONAS M., LYMBERAKIS P. & FASSOULAS C. 2002. — Origin and taxonomy of the fossil elephants of the island of Crete (Greece): problems and perspectives. *Palaeogeography, Palaeoclimatology, Palaeoecology* 186: 163-183. [https://doi.org/10.1016/S0031-0182\(02\)00451-0](https://doi.org/10.1016/S0031-0182(02)00451-0)
- POURSAT J. C. 2008. — *L'art égéen*. Vol. 1, *Grèce, Cyclades, Crète jusqu'au milieu du I^{er} millénaire av. J.-C.* Picard, Paris (Collection des Manuels d'art et d'archéologie antiques), 304 p.
- POURSAT J. C. 2018. — Exotica et commerce à longue distance en Égée à l'âge du bronze: le cas de l'ivoire. *Pasiphae: Rivista di Filologia e Antichità Eggea* 12: 175-181. <https://doi.org/10.19272/201833301012>
- POURSAT J. C. & KNAPPETT C. 2022. — *The Art and Archaeology of the Aegean Bronze Age*. Cambridge University Press, New York, xii + 572 p.
- REESE D. S., BELLUOMINI G. & IKEYA M. 1996. — Absolute dates for the Pleistocene fauna of Crete, in REESE D. S. (ed.), *Pleistocene and Holocene Fauna of Crete and its First Settlers. Monographs in World Archaeology* 28: 47-51.
- ROSEN B. 1994. — Mammoths in ancient Egypt? *Nature* 369: 364-365. <https://doi.org/10.1038/369364b0>
- SCULLARD H. H. 1974. — *The Elephant in the Greek and Roman World*. Thames and Hudson, London, xxiv + 288 p.
- SEN S. 2017. — A review of the Pleistocene dwarfed elephants from the Aegean islands, and their paleogeographic context. *Fossil Imprint* 73 (1-2): 76-92. <https://doi.org/10.2478/if-2017-0004>
- SIMONELLI V. 1908. — Mammiferi quaternari dell'isola di Candia. Memoria seconda. *Memorie della R. Accademia delle Scienze dell'Istituto di Bologna* 6 (5): 397-405.
- SONDAAR P. Y. & BOEKSCHOTEN G. J. 1967. — Quaternary mammals in the south Aegean island arc with note on other fossil mammals from the coastal regions of the Mediterranean. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* B7: 556-576.
- SONDAAR P. Y. & DERMITZAKIS D. M. 1982. — Relation migration landvertebrates, paleogeography and tectonics, in LE PICHON X., AUGUSTIDIS S. S. & MASCLE J. (eds), *International Symposium on the Hellenic Arc and Trench (H. E. A. T.), April 8-10, 1981, Athens*. Vol. 2. Ethnikó Metsóvio Polytechnéio (National Technical University), Athens: 283-308.
- SONDAAR P. Y. & VAN DER GEER A. A. E. 2005. — Evolution and extinction of Plio-Pleistocene island ungulates, in CRÉGUT-BONNOURE E. (ed.), *Les ongulés holarctiques du Pliocène et du Pléistocène*. Actes du colloque international, Avignon, septembre 2000. *Quaternaire Hors-Série* (2): 241-256.
- SOUSA M. F. & FIGUEIREDO S. M. 2001. — The Pleistocene elephants of Portugal, in CAVARRETTA G., GIOIA P., MUSSI M. & PALOMBO M. R. (eds), *The World of Elephants. Proceedings of the 1st International Congress*. Università degli Studi di Roma "La Sapienza", Roma: 611-616.
- STUART A. J. & LISTER A. 2012. — Extinction chronology of the woolly rhinoceros *Coelodonta antiquitatis* in the context of late Quaternary faunal extinctions in northern Eurasia. *Quaternary Science Reviews* 51: 1-17. <https://doi.org/10.1016/j.quascirev.2012.06.007>
- SYMEONIDIS N. K. & THEODOROU G. 1982. — New findings of fossil elephants on Crete Island. *Annales géologiques des Pays helléniques* 31: 113-129 [in Greek].
- SYMEONIDIS N. K., THEODOROU G. & GIANNOPOULOS B. 2000. — The new species *Elephas chaniensis* from the submerged Pleistocene deposits of Vámos Cave at Chania, Crete. *Bulletin de la Société spéléologique de Grèce* 22: 95-108 [in Greek].
- SYMEONIDIS N. K., THEODOROU G. & GIANNOPOULOS B. 2001. — New data on *Elephas chaniensis* (Vámos Cave, Chania, Crete), in CAVARRETTA G., GIOIA P., MUSSI M. & PALOMBO M. R. (eds), *The World of Elephants. Proceedings of the 1st International Congress*. Università degli Studi di Roma "La Sapienza", Roma: 510-513.
- TASSIGNON I. 2005. — *Naturalia et curiosa* dans les sanctuaires grecs, in DASEN V. & PIERART M. (eds), *Idia kai dêmosia. Les cadres «privés» et «publics» de la religion grecque antique*. Presses universitaires de Liège: 289-303.
- THEODOROU G., SYMEONIDIS N. & STATHOPOULOU E. 2007. — *Elephas tiliensis* n. sp. from Tilos island (Dodecanese, Greece). *Hellenic Journal of Geosciences* 42 (1): 19-32.
- TRAPANI J. & FISHER D. C. 2003. — Discriminating Proboscidean taxa using features of the Schreger Pattern in tusk dentin. *Journal of Archaeological Science* 30 (4): 429-438. <https://doi.org/10.1006/jasc.2002.0852>
- TZEDAKIS Y. & MARTLEW H. 1999. — *Minoans and Mycenaeans: Flavours of their Time*. Kapon Editions, Athens, 287 p.
- VAN DER GEER A. & LYRAS G. 2011. — *Field Trip Guidebook. European Association of Vertebrate Palaeontologists 9th Annual Meeting, Heraklion, Crete, Greece, June 14th-19th 2011*. European Association of Vertebrate Palaeontologists, Berlin, 31 p.
- VAN DER GEER A., LYRAS G., DE VOS J. & DERMITZAKIS M. 2010. — *Evolution of Island Mammals: Adaptation and Extinction of Placental Mammals on Islands*. Wiley-Blackwell, Oxford, xi + 479 p., 26 pl.

- VAN NEER W., LINSEEE V. & FRIEDMAN R. F. 2004. — Burials and food offerings at the elite cemetery HK6 of Hierakonpolis, in HENDRICKX S., FRIEDMAN R. F., CIALOWICZ K. M. & CHLODNICKI M. (eds), *Egypt at its Origins. Studies in Memory of Barbara Adams. Orientalia Lovaniensia Analecta* 138: 67-130.
- VANSCHOONWINKEL J. 1996. — Les animaux dans l'art minoen, in REESE D. S. (ed.), *Pleistocene and Holocene Fauna of Crete and Its First Settlers. Monographs in World Archaeology* 28: 351-412.
- VILA E. 2015. — The 'Syrian Elephant' revisited – Preliminary analysis of the elephant bones at Mishrife/Qatna in Late Bronze Age Syria, in PFÄLZNER P. (ed.), *Qatna and the Networks of Bronze Age Globalism, Qatna Studien* 2: 37-46.
- WATROUS L. V. 2021. — *Minoan Crete. An Introduction*. Cambridge University Press, New York, xvi + 231 p.
- WOOLLEY L. 1955. — *Alalakh. An account of the Excavations at Tell Atchana in the Hatay, 1937-1949*. Oxford University Press, Oxford (Reports of the Research Committee of the Society of Antiquaries of London; 18), xi + 411 p., 81 figs, 131 pl.
- YAR N. M., PARENTI F., ALBAYRAK E. & KÖYSU C. 2016. — The elephant remains from Gavur Lake (South-Eastern Turkey). Restoration and display. *Origini* 39: 243-273.

*Submitted on 4 April 2024;
accepted on 30 January 2025;
published on 28 March 2025.*