Elephas tiliensis n. sp. from Tilos island (Dodecanese, Greece)*

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ABSTRACT: This paper summarizes the existing knowledge on the Tilos endemic dwarf elephants and proposes the new specific name *Elephas tiliensis* n. sp. The new name is geographical and is mainly based on the fact that elephants from Tilos could never be part of the *Elephas falconeri* population of Sicily or any other endemic elephant population, as it lived isolated from all other Mediterranean endemic elephants. The new species *Elephas tiliensis* n.sp. is quite larger than the small species of Sicily (*Elephas falconeri*), Crete (*Elephas creticus*) and Cyprus (*Elephas cypriotes*). According detailed comparisons by Theodorou (1983, 1986). Tilos elephants also never arrived at the larger dimensions of their bigger endemic relatives of Sicily (*Elephas mnaidriensis*) and Crete (*Elephas creutzburgi* and *Elephas chaniensis*). Comparison cannot be made with the small to middle sized elephants of Cyprus for which at the moment there is inadequate information or the middle sized elephants of Sicily which are usually attributed to their smaller or larger relatives. The morphology of the new species points to a population with numerous changes concerning the postcranial material thus describing a very agile animal well adapted to the island environment allowing movement on rough terrain. The extinction of *Elephas tiliensis* during Holocene is a combined result of environmental stress caused by climatic changes, reduction of the surface of the island due to postglacial eustatic sea level rise and the volcanism of the area.

Elephas tiliensis n.sp. is the last Mediterranean and European endemic elephant. It lived during the last 50.000 years on Tilos Island and became extinct during the second half of the Holocene. It was an endemic elephant of small-medium dimensions at least 50% or even smaller than its probable ancestor, the continental *Elephas (Palaeoloxodon) antiquus*. It is still unknown if man ever saw and hunted *Elephas tiliensis* while still living on Tilos island.
Key-words: *Island endemics, Proboscidea, Elephantidae Elephas tiliensis n.sp., Quaternary, Tilos, Dodecanese, Greece*.

ΠΕΡΙΛΗΨΗ: Στην εργασία ανακεφαλαιώνεται η υπάρχουσα μέχρι σήμερα γνώση για τους ενδημικούς ελέφαντες της Τήλου και προτείνεται το νέο όνομα *Elephas tiliensis* n. sp. Το νέο είδος είναι γεωγραφικό και βασίζεται στο γεγονός ότι οι ελέφαντες της Τήλου δεν ήταν ποτέ δυνατόν να αποτελούν μέρος του πληθυσμού του *Elephas falconeri* από την Σικελία η άλλου πληθυσμού ενδημικών ελεφάντων, δεδομένου ότι ελέφαντες της Τήλου έζησαν πλήρως απομονωμένοι από κάθε άλλο ενδημικό ελέφαντα της Μεσογείου. Το είδος *Elephas tiliensis* n. sp. είναι αρκετά πιο μεγαλόσωμο από τα μικρότερα είδη της Σικελίας (*Elephas falconeri*), της Κρήτης (*Elephas creticus*) και της Κύπρου (*Elephas cypriotes*) σύμφωνα με τις λεπτομερείς συγκρίσεις που έχουν πραγματοποιηθεί από τον Theodorou (1983, 1986). Οι ελέφαντες της Τήλου δεν απέκτησαν ποτέ τις διαστάσεις των μεγαλύτερων ενδημικών ελεφάντων της Σικελίας (*Elephas mnaidriensis*) και της Κρήτης (*Elephas creutzburgi* και *Elephas chaniensis*). Σύγκριση δεν μπορεί να γίνει με τους ελέφαντες μέσων διαστάσεων της Κύπρου για τους οποίους προς το παρόν δεν υπάρχουν επαρκή δεδομένα ή με τους ελέφαντες μέσων διαστάσεων από την Σικελία που συνήθως εντάσσονται στους πλέον μεγαλόσωμους ή μικρόσωμους συγγενείς τους. Η μορφολογική μελέτη του νέου είδους έχει αποκαλύψει ένα είδος με πολυάριθμες αλλαγές που αφορούν στο μετακρανιακό υλικό και επιτρέπουν την περιγραφή ενός πολύ ευκίνητου ζώου καλά προσαρμοσμένου στο νησιωτικό περιβάλλον με πολύ καλές δυνατότητες κίνησης στο τραχύ έδαφος. Η εξαφάνιση του *Elephas tiliensis* κατά το Ολόκαινο είναι αποτέλεσμα συνδυασμού παραγόντων περιβαλλοντικής πίεσης που προκλήθηκε από τις κλιματικές αλλαγές, τη μείωση της έκτασης του νησιού εξαιτίας της ευστατικής ανόδου της στάθμης της θάλασσας μετά το τελευταίο θερμοκρασιακό ελάχιστο αλλά και της ηφαιστειότητας στην ευρύτερη περιοχή.

Ο *Elephas tiliensis* n. sp. είναι ο τελευταίος ενδημικός ελέφαντας της Μεσογείου και της Ευρώπης. Έζησε στα τελευταία 50.000 χρόνια και εξαφανίστηκε στο δεύτερο μισό του Ολοκαίνου. Ήταν ενδημικός ελέφαντας μικρών έως μέσων διαστάσεων τουλάχιστον 50% ή ακόμη πιο μικρόσωμος από τον πιθανό πρόγονό του, τον ηπειρωτικό *Elephas* (*Palaeoloxodon*) *antiquus*. Δεν γνωρίζουμε αν ό άνθρωπος συνάντησε και κυνήγησε τον *Elephas tiliensis*.
Λέξεις Κλειδιά: *Προβοσκιδωτά, Ελέφαντες, Τεταρτογενές, Τήλος, Δωδεκάνησα, Ελλάδα, Νησιωτικά ενδημικά Θηλαστικά, Elephas tiliensis n. sp*.

INTRODUCTION AND HISTORICAL BACKGROUND

The question of the nomenclature of island endemics is an old one and the opinions usually vary (Palombo, 2001). The Tilos story started in 1972 with the first publication concerning this last European and Mediterranean dwarf elephant. In the first papers, the names *"Palaeoloxodon antiquus melitensis"* and *"Palaeoloxodon antiquus falconeri"* were used for the endemic elephants of Tilos (Symeonidis, 1972). Later on, the first excavators used the specific names *"Palaeoloxodon antiquus mnaidriensis"* and *"Palaeoloxodon antiquus falconeri"* (Bachmayer & Symeonidis, 1975; and Bachmayer *et al.,* 1976, 1984).

* *Elephas tiliensis* n. sp. από τη νήσο Τήλο (Δωδεκάνησα, Ελλάδα).

Published data could not support the theory of two elephant endemic species in one cave. BACHMAYER *et al*. (1976), p. 141 note: *"Bis zu einer Tiefe von 2,7 m findet sich die kleinste Zwergelefanten formen Palaeoloxodon antiquus falconeri BUSk vorherrschend, wahrend von 2,7 bis 4.0 m die grössere Form Palaeolloloxodon antiquus mnaidreinsis* LEITH ADAMS *dominiert"*. THEODOROU (1983 a, b,) supports the idea that the Tilos elephants from Charkadio cave should belong to a new species. Nevertheless the name *"Palaeoloxodon antiquus falconeri"* has provisionally been kept since for the Tilos elephants. The detailed description of the molars and all skeletal remains, the functional morphology of the postcranial and the taphonomy of the Tilos elephants were given by THEODOROU (1983). Remarks on the nomenclature of the Tilos elephants have also been made by SYMEONIDIS *et al*. (1973), BACHMAYER *et al*. (1976, 1984), KOTSAKIS *et al*. (1980), STATHOPOULOU & THEODOROU (2001) and many others but the question remained open. According to Theodorou (ibid) only one species was present at Charkadio cave, contrary to the initial idea that two species coexisted, *"Palaeoloxodon antiquus mnaidriensis"* in the lower part of the section and *"Palaeoloxodon antiquus falconeri"* in the uppermost strata of the Charkadio cave. The initial theory of two elephant species in one cave could no longer be supported, taking into account what a species is (WILSON, 1999). The bimodal distribution of the Tilos elephant, as seen by the various types of diagrams used for postcranial material by THEODOROU (1983a), combined with observations in the cave, proved that the two modes in histograms corresponded to females and males and that both size groups existed throughout the whole section. Since a time consuming effort had begun in order to learn more about the Tilos elephants and eventually be able to describe, support and document a new species name. Clearly it is beyond the purpose of this paper to discuss in detail the long existing problem in detail, but we are in favor of the opinion that with few exceptions, the endemic elephants of the Mediterranean Islands probably originated from the continental *Elephas (Palaeoloxodon) antiquus* (PALOMBO, 2001, p. 489). There is no indication that this is not true for the Tilos elephants.

During these last 15 years, about 250 days of excavations have been realized. In addition, a lot of work has been carried out at the laboratories of Athens University, concerning the conservation of the material (KATSIKOSTA & THEODOROU, 1994), taphonomical studies (LAMPROPOULOU 1999; STATHOPOULOU & THEODOROU, 2001; STATHOPOULOU *et al*., 2003) and the numbering and cataloging of fossils. Serious efforts have also been made to present the Tilos elephants to the public through various exhibitions (THEODOROU & SYMEONIDES, 1994). Studies on tusk microstructure fossilization (THEODOROU *et al*., 2001), and dating have been realized and presented at various international congresses (AGIADI, 2001; THEODOROU & AGIADI, 2001, 2005; STATHOPOULOU & THEODOROU, 2001; POULAKAKIS *et al*., 2002; THEODOROU & STATHOPOULOU, 2003). Remarks on the endemic elephants of Tilos have been given by SONDAAR (1976), SYMEONIDIS & MARINOS (1972), DERMITZAKIS & SONDAAR (1978), THEODOROU (1986, 1988, 2001), THEODOROU *et al*. (1986), MIXALOPOULOU & FASOULAKI (1998), PALOMBO (2001), THEODOROU & PALOMBO (2005) and many others. During the period 1990-2001 (THEODOROU & SYMEONIDES, 1994, 2001) emphasis was given to the excavation of large surfaces, in order to collect adequate taphonomical information from them.

The new answers that we finally got concerned articulated limb bones and vertebrae found in anatomical connection as well as some very important cranial findings. These allowed us to proceed. Today the long deserved new name for the elephants of Tilos is given.

MATERIAL AND METHODS

The material collected up to now from Tilos consists of more than 15.000 bones, corresponding to 45 elephants. The final number will be kown in the near future when all material will have been prepared. All significant skeletal parts present, including hyoids, ear apparatus, skull fragments, molars and tusks of all age stages have been described by the authors in detail.

The first systematic collection of taphonomical information started in the beginning of the 90s. Collecting taphonomical information is extremely time consuming since excavation has to be done by very slow methods, with the use of very small tools like needles. Since 1992, hundreds of hand made drawings regarding the taphonomy have been kept. The taphonomical drawings, the field observations of different excavation periods and the rich photographic material and videos are compared every year after every new excavation in an effort to discover pieces of useful information and associated bones. In 2000-2001 the first direct measurements of articulated bones became available for comparisons with biometrical data and are incorporated in the results.

RESULTS

The biometrical study of the Tilos elephant material has revealed the existence of a bimodal distribution documented by Theodorou since 1983 (See also Figure 2). The articulated bones collected during this decade allowed us to have a better picture of the Tilos elephants. The comparison of the ratios estimated by biometrical methods and direct measurements of the articulated bones is given bellow.

All measurements that are used in this paper were made according to THEODOROU (1983a).

ULNA P1 / MCV P1
Ratio of average values estimated by the biometrical study = 5,8
Ratio of direct measurements of bones made in anatomical connection = 6,0
ULNA P1 / MCIV P1
Ratio of average values estimated by the biometrical study = 5,3
Ratio of direct measurements of articulated bones. = 5,4
ULNA P1 / MCIII P1
Ratio of average values estimated by the biometrical study = 4,6
Ratio of direct measurements of articulated bones = 4,6
TIBIA P1 / ASTRAGALUS P1
Ratio of average values estimated by the biometrical study = 7,0
Ratio of direct measurements of articulated bones = 6,3
TIBIA P1 / MTIV P1
Ratio of average values estimated by the biometrical study = 5,1
Ratio of direct measurements of bones collected in anatomical connection = 4,9
TIBIA P1 / MTIII P1
Ratio of average values estimated by the biometrical study = 4,7
Ratio of direct measurements of articulated bones = 4,8
TIBIA P1 / CALCANEUS P1
Ratio of average values estimated by the biometrical study = 3,7
Ratio of direct measurements of articulated bones = 3,5

The statistical diagrams (Figures 1, 2, 3, 4, 5) that follow allow the reader to observe the morphometric characteristics of the bones of the Tilos elephants. Measurements of adult animals only, given by THEODOROU (1983, p. 201-217) are used for the calculation of average values. Boxes give the range using the mean value and standard deviation (s. d.) up to one or 1,96 times. The two size groups clearly presented in fig. 2 represent the females and males of the Tilos elephant population.

SYSTEMATIC

Order : Proboscidea ILLIGER, 1811
Family : Elephantidae GRAY, 1821
Genus : *Elephas* LINNE, 1758
Species : *Elephas tiliensis* n. sp.
Basic Synonym catalog

1972, *Palaeoloxodon antiquus falconeri*. Symeonidis, N. *Ann. Géol. des Pays Hellén*., p. 445-461, Athènes.

1972, *Palaeoloxodon antiquus melitensis* Symeonidis. N., *Ann. Géol. des Pays Hellén*., p. 445-461, (Taf XXXIV and page 454), Athènes.

1973, *Palaeoloxodon antiquus falconeri*. Symeonidis, N., *et al*. *Ann. Naturhist. Museum Wien*, 77, 133-139, Abb. 1, Taf. 1, Wien.

1973, *Palaeoloxodon antiquus mnaidriensis.* Symeonidis, N., *et al*. *Ann. Naturhist. Museum Wien*, 77, 133-139, Abb. 1, Taf. 1, Wien.

1976, *Palaeoloxodon antiquus falconeri*. Bachmayer *et al*. *Ann. Naturhist. Museum Wien*, 80, 113-144, Abb. 10, Taf. 5, Wien.

1978, *Palaeoloxodon antiquus falconeri*. Dermitzakis *et al*. *Ann. Géol. des Pays Hellén*., XXIX, p. 808-840, Athènes.

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1983 a, *Palaeoloxodon antiquus falconeri*. Theodorou G., *Phd Thesis, Offset edition*. Athens. In Greek. p. 232.

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2001, *Palaeoloxodon antiquus falconeri*. Palombo, M.R. *The world of elephants. Proceedings of the 1st International Congress*, p. 486-491. Rome.

2001, *Palaeoloxodon antiquus falconeri*. Stathopoulou E., *The world of Elephants. Proceedings of the 1st International Congress*. Rome 16/20 Oct. 2001, pp. 557 562. Rome.

2001, *Palaeoloxodon antiquus falconeri*. Theodorou G., Symeonides N., *The world of Elephants. Proceedings of the 1st International Congress*. Rome 16/20 Oct. 2001. pp 563- 567.

2001, *Palaeoloxodon antiquus falconeri.* Theodorou Symeonides N., *The world of Elephants. Proceedings of the 1st International Congress*. Rome, 16/20 Oct. 2001. pp. 514 518.

2002, *Palaeoloxodon antiquus falconeri.* Poulakakis N., *et al. J. Mol. Evol.* 55:364 374. Springer Verlag.

2003, *Palaeoloxodon antiquus falconeri.* Theodorou G., Stathopoulou E. *International Symposium Insular Vertebrate evolution. The palaeontological approach. Programme and abstracts*. Mallorca.

2003, "Tilos elephant" Theodorou G., *et al*., *International Symposium Insular Vertebrate evolution. The palaeontological approach. Programme and abstracts*. Mallorca.

2003, *"Paleoloxodon antiquus falconeri" Georgiadou Dikeoulia et al., Palaeontology : Proboscidea* pp. 172-187 (In Greek).

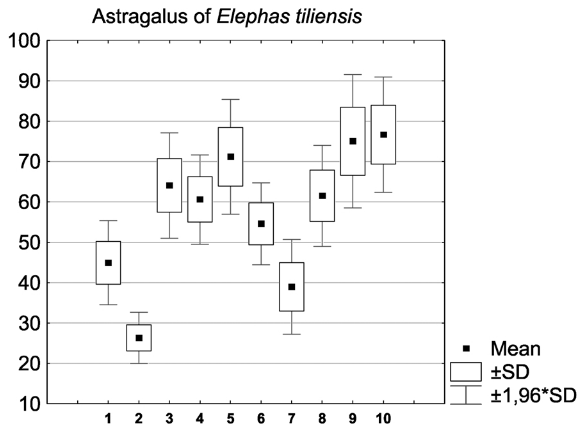

Fig. 1.

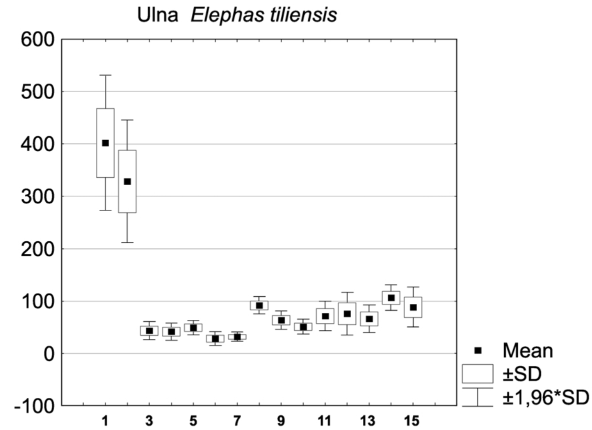

Fig. 4.

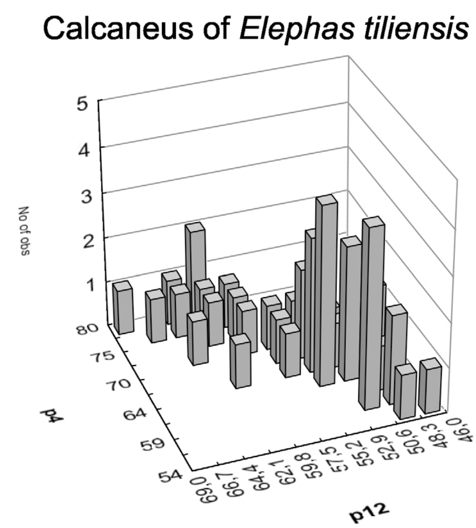

Fig. 2.

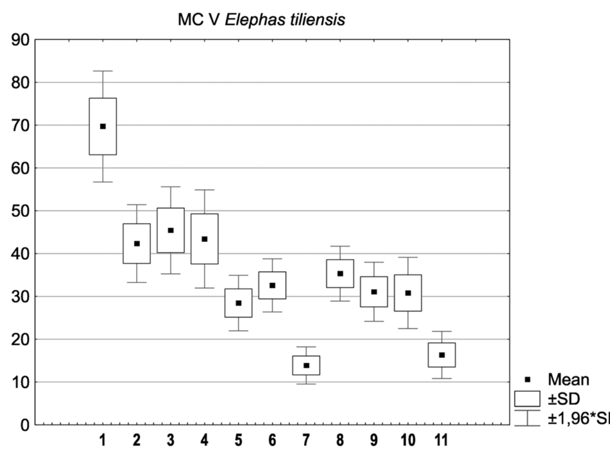

Fig. 5.

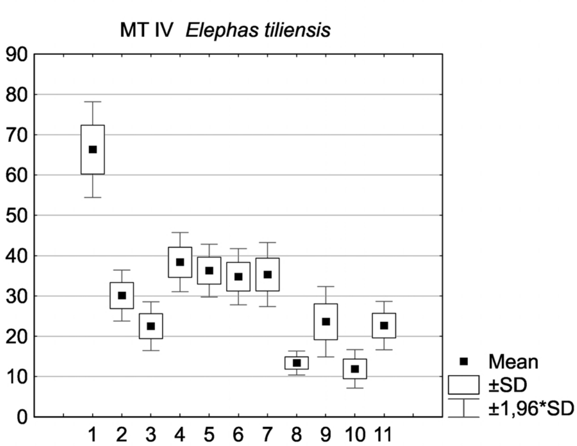

Fig.3.

Fig. 1-5

The statistical diagrams are based on the biometrical study of bones of *E. tiliensis* collected since the beginning of the excavations. The histogram, which is typical for the E. tiliensis collection, points to two size groups which according to Theodorou (1983a) must be attributed to females and males and not to two different endemic species as it was originally accepted. The available taphonomical information does not allow us to correlate any size group with any horizon. Direct observations prove that some of the larger available bones have been collected at the uppermost layers. Clearly there was no decrease in size from the lower to the upper layers in the cave.

ETYMOLOGY

Named after the small island of Tilos, where the last Mediterranean endemic elephants lived.

SYNTYPES

For the presentation of a new species name it is necessary to decide on the use of the name bearing type or type series. The articulated limb bones could clearly be the holotype, but this would leave out of the name bearing types important skeletal elements including dental material of different individuals, femur, humerus etc. To our opinion, a unique bone or even an articulated limb is not adequate for the description of a new vertebrate species. Paratypes can help but they are not regarded as the "name bearing type" since in this case only the holotype is the "name bearing type". This is why for the description of the new species we use the Syntype method according to ICZN Article 72.1.2 and 73.2. Syntypes are specimens of a type series that collectively constitute the name bearing types, give a good idea of the size variation of the postcranial material and allow to include articulated front and hind limbs, molars, and non articulated skeletal material in the type species. The material included in the syntypes belongs to the collections of the Museum of Geology and Palaeontology of Athens University and are included in TABLE 1, TABLE 2 and TABLE 3.

TYPE LOCALITY

The type locality is Charkadio cave, located at Messaria Valley on Tilos Island (Dodecanese, Greece).

STRATUM TYPICUM

Cave deposits of Charkadio cave. Depth of 0-4 meters from zero point. Sediment rich in volcanic tuff partly redeposited into the cave.

DIAGNOSIS

Elephas tiliensis lived isolated on Tilos Island and did not colonize other islands. Even if its dimensions and morphology were equal to other endemic Mediterranean elephants its isolation is more than adequate for the description of a new endemic species. In addition, E. tiliensis n.sp. is quite different from E. falconeri and E. mnaidriensis. These differences are well known and adequately described in numerous extended previous papers all mentioned in the synonym list. Summarizing from previous papers, we can say that Elephas tiliensis n.sp. is an endemic elephant of small to medium dimensions about 50% or more smaller than continental Elephas (Palaeoloxodon) antiquus. Observed values show that it was quite larger than E. falconeri and slightly shorter than E. mnaidriensis (THEODOROU, 1983a; THEODOROU, 1986). The height of adult animals must have reached values up to 180-190 cm according to the observed values of the long bones. Using the values and the indices given by THEODOROU (1983a, 1986) and the fact that femurs with a maximum height of 70 cm have been excavated, the Tilos elephants reached 190 cm.

Clearly the size and morphological differences with the other endemic elephants of the Mediterranean elephants are a basic parameter for accepting a new species for Tilos, but in no way are these the basic reason for describing a new species. The critical parameter is the isolation of the species for a long period of time and the impossibility for exchange of genetical material with populations of the nearby mainland or other Mediterranean islands. When isolation leads to size differences and morphological changes is more than adequate for presenting a new species for an island fauna.

The Tilos new species Elephas tiliensis is quite larger than the small species of Sicily (E. falconeri), Crete (E. creticus) and Cyprus (E. Cypriotes) presented based on detailed comparisons by THEODOROU (1983a & 1986). In addition, Tilos elephants never reached at the larger dimensions of their bigger endemic relatives of Sicily (E. mnaidriensis) and Crete (E. creutzburgi and E. chaniensis). Comparison cannot be made to the small to middle size elephants of Cyprus for which at the moment there is no adequate information or the middle size elephants of Sicily which are usually attributed to their smaller or larger relatives.

Information on molars dimensions, lamellar frequency, enamel thickness and total number of lamellae is given in details in THEODOROU (1983) from page 40 to page 54.

DESCRIPTION

Agile, small to middle size elephants with numerous post cranial adaptions allowing movement on rough terrain. These adaptations have been described by THEODOROU, (1983a). Due to the morphology of carpal and tarsal bones the metacarpals and metatarsals move forward, while the leg morphology is less pillar like when compared to their normal sized relatives. The combined proximal surface of all Mt. and all Mc. is less stretched than that of their normal size relatives or other large elephants. This combined surface makes up a cycle (THEODOROU & PALOMBO, 2005). These changes on carpal and tarsal bones have caused an increased agility of the new species when compared to large elephants.

Carpal and tarsal. *Morphology denotes increased mobility when compared to Elephas antiquus or recent elephants. Proximal side edges of Mc III have an angle of 35-45o (THEODOROU, 1983a, Page 122, Fig. 23).*

Cuneiformes. *Partly ossified. The ossification is obvious in the larger cuneiforms (THEODOROU, 1983a, p. 167, Fig. 45).*

Ulna and radius. *99 % not co-ossified.*

Tibia and fibula. *100 % not co-ossified*

Sacrum. *Usually made up of 5 sacral vertebrae. One specimen had one more (Lumbar) vertebra attached to the sacral ones.*

TABLE 1

Syntypes of articulated lower anterior limb bones of *Elephas tiliensis* n.sp. (Fig. 1). The material included in the following table has been collected from square Q9 at a depth of 196 cm bellow zero point, and was found in anatomical connection. It belongs to the right (dext) side. Detailed description, methods of measurements and biometric information on bones of the anterior limbs and information on parameters is given by THEODOROU (1983).

30.06.01	CODE	PARAMETER	mm	FIGURE
ULNA	T.01.198.u	P1	413	6
ULNA	T.01.198.u	P2	328	6
ULNA	T.01.198.u	P6	66	6
ULNA	T.01.198.u	P10	58	6
ULNA	T.01.198.u	P14	119	6
RADIUS	T.01.198 r	P1	365	6
ULNARE	T.01.198.3	P1	92	6
ULNARE	T.01.198.3	P2	59	6
ULNARE	T.01.198.3	P3	26	6
ULNARE	T.01.198.3	P4	69,5	6
ULNARE	T.01.198.3	P5	53	6
ULNARE	T.01.198.3	P6	86	6
ULNARE	T.01.198.3	P7	57	6
UNCIFORME	T.01.198.1	P1	68,5	6
UNCIFORME	T.01.198.1	P2	68	6
UNCIFORME	T.01.198.1	P3	43,8	6
UNCIFORME	T.01.198.1	P4	29,5	6
UNCIFORME	T.01.198.1	P8	66	6
INTERMEDIUM	T.01.198.2	P1	71,5	6
INTERMEDIUM	T.01.198.2	P3	34,5	6
INTERMEDIUM	T.01.198.2	P5	62	6
INTERMEDIUM	T.01.198.2	P7	61,5	6
MC III	T.01.198.5	P1	89,8	6
MC III	T.01.198.5	P4	35,3	6
MC III	T.01.198.5	P5	23	6
MC IV	T.01.198.4	P1	76,5	6
MC IV	T.01.198.4	P2	46,3	6
MC IV	T.01.198.4	P4	40	6
MC IV	T.01.198.4	P5	22,5	6
MC V	T.01.198.6	P1	68,5	6
MC V	T.01.198.6	P4	40	6
MC V	T.01.198.6	P5	29,5	6

TABLE 2

Syntypes of articulated hind leg bones (Fig. 8, Fig. 9). The material included in the following table has been collected from square Q10 at a depth of 143-173 cm bellow zero point in anatomical connection. It is mentioned in drawing DR 9. It belongs to the left (sin) side. Detailed description methods of measurements and biometric information on bones of the anterior limbs and information on parameters are given by THEODOROU (1983).

30.06.2001	CODE	PARAMETER	mm	FIGURE
TIBIA	T.O1.135	P1	293	8
TIBIA	T.O1.135	P3	47	8
TIBIA	T.O1.135	P4	46	8
TIBIA	T.O1.135	P6	86	8
TIBIA	T.O1.135	P9	94	8
TIBIA	T.O1.135	P8	72	8
TIBIA	T.O1.135	P14	67	8
TIBIA	T.O1.135	P13	63	8
FIBULA	T.01.136	P1	293	3
FIBULA	T.01.136	P10	51	8
FIBULA	T.01.136	P11	34	8
CALCANEUS	T.01.137-1	P1	84	8,9
CALCANEUS	T.01.137-1	P2	94	8,9
CALCANEUS	T.01.137-1	P3	66	8,9
CALCANEUS	T.01.137-1	P8	118	8,9
CALCANEUS	T.01.137-1	P9	29	8,9
ASTRAGALUS	T.01.137-2	P1	47	8,9
ASTRAGALUS	T.01.137-2	P2	23	8.9
ASTRAGALUS	T.01.137-2	P3	66	8,9
ASTRAGALUS	T.01.137-2	P4	64	8,9
ASTRAGALUS	T.01.137-2	P5	81	8,9
ASTRAGALUS	T.01.137-2	P9	76	8,9
ESO CUNEIFORME	T.01.137-4	P3	39	8,9
ESO CUNEIFORME	T.01.137-4	P7	28	8,9
ESO CUNEIFORME	T.01.137-4	P1	63	8,9
ECTOCUNEIFORME	T.01.137-5	P2	62	8,9
ECTOCUNEIFORME	T.01.137-5	P4	15	8,9
ECTOCUNEIFORME	T.01.137-5	P6	41	8,9
ECTOCUNEIFORME	T.01.137-5	P5	14	8,9
CUBOID	T.137-3	P1	65	8,9
CUBOID	T.137-3	P2	54	8,9
CUBOID	T.137-3	P3	21	8,9
CUBOID	T.137-3	P5	64	8,9
MT III	T.O1.137-7	P1	61	8,9
MT III	T.O1.137-7	P4	36	8,9
MT III	T.O1.137-7	P5	35	8,9
MT IV	T.01.137-8	P1	60	8,9
MT V	T.01.137-9	P1	39	8,9
MT V	T.01.137-9	P4	38	8,9
MT V	T.01.137-9	P5	33	8,9
MT V	T.01.137-9	P6	43	8,9
MT V	T.01.137-9	P7	34	8,9

TABLE 3
Syntypes of *Elephas tiliensis* n.sp. Bones and molars were collected at different excavations and different layers of Charkadio cave. Non articulated materiall. Measurements and description of all skeletal and dental material included in Table 3 are given in THEODOROU 1983a or SYMEONIDIS 1972.

BONE	CODE	FIGURE
Femur sin.	T.3	(Fig. 10)
Tibia dext.	T.339	(Fig. 15)
Patella dext.	T.3356	(Fig. 15)
Humerus sin.	T.01 /239	(Fig 7)
Humerus dext.	T.41	(Fig. 11, Fig. 12)
Radius dext.	T.2265	(Fig. 12)
Trapezoid sin.	T.1099	(Fig. 13)
Lunare sin.	T.3358	(Fig. 13)
Ulnare sin.	T.53/82	(Fig. 13)
Magnum sin.	T.3355	(Fig. 13)
Unciforme sin.	T.491	(Fig. 13)
Pisiforme sin.	T.10447	(Fig. 13)
Radiale sin.	T.10448	(Fig. 13)
Mc I sin.	T.1104	(Fig. 14)
Mc II sin.	T.257	(Fig. 14)
Mc III sin.	T.230	(Fig. 14)
Mc IV sin	T.275	(Fig. 14)
Mc V sin	T.104	(Fig. 14)
Calcaneus sin.	T.1049	(Fig. 16)
Astragalus sin.	T.2206	(Fig. 16)
Naviculare sin.	T.2012	(Fig. 16)
Cuneiforme (Co-ossified) sin.	T.2031	(Fig. 16)
Ectocuneiforme sin.	T.2258	(Fig. 16)
Cuboid sin.	T.2032	(Fig. 16)
Mt II sin.	T.10473	(Fig. 17)
MT III sin.	T.183	(Fig. 17)
MT IV sin.	T.189	(Fig. 17)
MT V sin.	T.1418	(Fig. 17)
Lower Mandible Symeonidis, 1972. *Ann. Géol. des Pays Hellén*. Vol.24, Taf. XXXVI (IV)		
M_3	Theodorou, 1983, Table III, T. 3272	
Atlas	Symeonidis, 1972, *Ann. Géol. des Pays Hellén*. Vol.24, Taf. XLIII (XI) No. 16/1972.	
Epistropheus	Symeonidis, 1972, *Ann. Géol. des Pays Hellén*. Vol.24, Taf. XLIII (XI) No 17/ 1972	

Vertebral column. *There is no complete series of vertebrae of E. tiliensis up to now.*

Skull. *The angle of the long axis of the upper M3 is 32-34º. This angle is quite smaller in younger animals. When the first and second milk molars (from a series of six) are present this angle is 18-20º. Adult skull length, from the anterior part of alveoli fan to the distal part of the occipital condyles can reach 51 cm or slightly more.*

Tusks. *Curved on a single surface as usual in Palaeoloxodon antiquus. Never exceeding in length 95-100 cm.*

Tusk alveoli : Fan shaped

STRATIGRAPHY

The Upper Pleistocene of Tilos Island and part of the Holocene.

Absolute age range for *Elephas tiliensis* from 45.000 to 3.500 years BP.

ASSOCIATED FAUNA

Sub endemic deers (*Dama dama*) are present in the Charkadio cave but about 90.000 years earlier than the elephants. The absolute age of the Tilos deers is about 140.000 years BP

Skeletar remains of *Testudo marginata* were found in the same layers as the elephants. Strangely only long bones have been found. No carapax material.

Birds. Articulated bird bones, have been found in the layer containing the articulated elephant remains but they have not yet been prepared and studied. Bird bones also occur in the partly disturbed sediment mass, very close to the cave walls.

Associated flora. No available data. Sediment samples studied, did not give any pollen.

ARRIVAL TIME ON THE ISLAND AND MIGRATIONS

Elephas tiliensis is arrived on the island of Tilos long after (about 90.000 later) the extinction of the Tilos deers and after the last high sea level episode. Possible invasion time around 50.000 years before present.

Migration routes:

Most possible migration routes according to Theodorou 1983 are:

A- Kos – Nisyros – Tilos. Up to now there are no known endemic elephants from Kos, although Plio-pleistocene elephants have been mentioned but not well studied.

B- Rhodos – Tilos. Rhodos has provided us with endemic elephants from Ladiko cave (SYMEONIDIS *et al.* 1973). Their size is close to the upper size limit of *Elephas tiliensis* n.sp. The material is scarce and up to this moment there is no way of comparing data based on mean values of the two populations. No absolute date is known for Rhodos.

First occurrence in the cave.

Slightly before 45.000 years BP. Maximum occurrence in the cave sediments during the last 30.000 years BP.

Extinction time:

Around 4.000 to 3.500 BP.

Extinction causes:

The extinction of *Elephas tiliensis* n.sp. was caused by a combination of the following factors (mainly according to Theodorou, 1988).

- Climatic changes during the upper Quaternary and reduction of the total available surface after the last climatic minimum.
- Severe reduction of flat coastal areas. The low fertile areas of the island were drastically reduced after the last climatic minimum,
- Pollution of water by volcanic tuff. The last major volcanic eruption of Santorini corresponds to the extinction time of the Tilos elephants. The volcanic tuff which covered the island would have destroyed all the grass on the island for at least one year and would have polluted all ground water.
- Possible human presence and possible hunting by man. Hunting and competition with introduced animals cannot be documented at this moment.

TAPHONOMY

During the first decade emphasis was given to the stratigraphy in the cave. After 1990 emphasis was given at the collection of taphonomical information. Significant difficulties for the collection of taphonomical information were due to the fact that the sidewalls of the old central excavation pit made during the 70's are cracking year after year possibly, due to the drying and slight creeping of the cave sediment. This cracking has caused severe damages in the bones of the layers including articulated skeletal remains and has resulted in an increase (!) of the dimensions of certain excavation squares. Marks on the excavation surface move slowly in relation to the roof marks, making it very difficult to combine taphonomical drawings of more than two years apart. It is not seldom, that ribs, or long bones are found fractured and displaced inside the sediment. This kind of damage is severe in flat bones - pelvic bones, scapulae and skull parts which are fragmented sometimes beyond repair in numerous splitters. This fact did not allow us to use in this study, some of the bones found articulated to those attributed to the type series of the new species. Most bones are scattered in the sediment. Close to the walls of the cave the bones are more fragmented. Sometimes the long bones were found in vertical position especially close to cave walls. Most important skull remains were found close to the cave walls in areas where the fossil bones were close to the roof.

Articulated front limb bones, hind limb bones and vertebrae were found. Ribs of juveniles have been observed in anatomical connection in the same layer with the findings of long bones in anatomical connection. They were located for the first time during the excavations of 2000-2001. Bones in anatomical connection follow the two phosphate layers described by Bachmayer *et al*. (1974, (Abb. 3).

Tusks are almost always separated from alveoli. Up to now there was only one exception, where a tusk was found in the alveoli.

Concentrations of tusk fragments are mentioned by Bachmayer *et al*. (1975). It is still unclear if they are connected to human activity or not.

Burned bones: Not observed up to now.

Human artifacts and ceramics exist in the post elephant layers. There is no indication documented by taphonomic information and drawings (up to June 2001) of bones found together with ceramics in undisturbed layers. Human activity is observed only in the uppermost layers but never in relation to the elephants. In a large part of the cave, the sedimentation stopped when a large mass of roof rocks fell and covered the sediment surface. The exact moment of this event has not been dated with absolute methods, but according to all observations at the site it coincides with the last occurrence of elephants in the cave. Fractures in this stone layer allow younger elements to be transferred bellow the rocks making the dating of the falling event very difficult.

CONCLUSIONS

Excavated material includes bones from 45 animals belonging to *E. tiliensis* n.sp. This number increases after every excavation period. All available data, point out more or less to the existence of two size groups. The two modes correspond to females and males now, attributed to a single geographically isolated new endemic species. It is not possible to document that Tilos elephants ever had the opportunity to exchange genetic material with endemic elephants of other Aegean Islands and especially with Sicily, Cyprus, or Crete. Exchange of genetic material can possibly be discussed, only for the adjacent island of Rhodos. Juveniles or sub adults are present at a significant percentage and show clearly that the site is not a grave yard of exhausted old animals, which could not survive due to their old age.

The presentation of the stratigraphy of a cave deposit is very difficult. The dated crust, mentioned by Bachmayer *et al*. (1976, Abb. 3) seems to be stratigraphically younger than numerous bones of *E. tiliensis* that have been collected during the first 5 years bellow this crust. Some of the largest leg bones have been discovered at the uppermost layers. Absolute dating of Charkadio material correlated with elephants date back up to about 45.000 years BP. According to the field data and observations, taphonomical information and recent dating (Mixalopoulou & Fasoulaki, 1998) it seems that the richest layer is dated close to 17.000 – 18.000 BP, that is close to a period of a very low sea level. At this time, Tilos had the largest area ever and according to all available information man was not yet on the island. Some of the questions that have not yet been answered concern the extinction of the *E. tiliensis* and the possible role of man. To find the answers we followed an ecostratigraphical approach (THEODOROU, 1988). It is still very difficult to answer the question about the extinction causes and the possible role of man and answers will be controversial.

What started the process of the extinction? Climatic changes and sea level fluctuation? Island surface decrease? Volcanism which had a strong influence on all areas of the world where islands endemics have been extinct during the Upper Quaternary? Tsunami? Which mechanism started the extinction process and which gave the final shot ? Nature or Man?

The problematic "tusk fragments" from Tilos have been given with a question mark by the authors that presented them as human tools. Studying the extinction of Tilos deer about 140.000 years BP, we can express no logical doubt that it may be attributed to the area volcanism that turned Tilos into an inhabitable island that remained so for several thousands years. This happened well before the ancestors of *Elephas tiliensis* or man stepped on Tilos Island (THEODOROU, 1988). The new site with fossil mammals on Tilos (Tilos 2 in THEODOROU *in prep.*) will possibly shed some more light on this.

The bone catalogue from Tilos, clearly shows that all skeletal parts that are present belong to juveniles, sub adults (up to 31%) both females and males. If man had transported animal parts to the cave for eating purposes, then it would not be possible to have such a complete catalogue or find bones of complete articulated legs. No matter what we propose concerning man and elephants on Tilos island there will be always questions.

We do not know what happened at the very last moment. The last frame of the story is still missing. Or we have it but we cannot see it.

ACKNOWLEDGMENTS

The authors would like to thank all those who have financed the excavations: the Greek Ministry of the Aegean (U.O.A. Project 70/3/699 and 70/3/4407), the General Secretariat of Research and Technology of the Greek Ministry of Development (E.U. financed Project 96 ΣΥΝ 106 = Project of UOA 70/3/4407) and the Special Account for Research Grants of the University of Athens (Research project 70/4/3370). The Tilos excavation and the study of the Tilos findings have been supported by the Natural History Museum of Vienna and the Directors FR. BACHMAYER(+), R. SEEMAN, H. KOLLMAN, and M. HARZHAUSER and Univ. Prof. H. ZAPFE (+). Special thanks are owed to the Mayor of Tilos, ANASTASIOS ALIFERIS, for his continuous help to overcome the bureaucratic barriers, in order to continue working at the site and for his efforts to build a new museum. Special thanks are owed to our numerous students and colleagues that have followed us to Tilos in the last decade and which, with their enthusiasm and courage helped us to approach our goals, Dr. S. ROUSIAKIS, Dr. A. ATHANASIOU, Dr. G. ILIOPOULOS, G. LAMROPOULOU, K. AGIADI e.t.c. just to mention only few that have followed us there, continuously for many years. The syntypes in anatomical connection have been prepared with extra care by K. TSESMETZI, student of TEIA. The authors would also like to thank Dr. G. HOECK for her extremely useful remarks and Prof. ADRIAN LISTER for his invaluable help in answering some critical questions regarding the nomenclature in collaboration with ICZN committee, at London. Special thanks are also owed to Prof. G. KOUFOS and Prof. MARIARITA PALOMBO for critically reading this paper and for their valuable suggestions for improving it.

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FIGURES of SYNTYPES

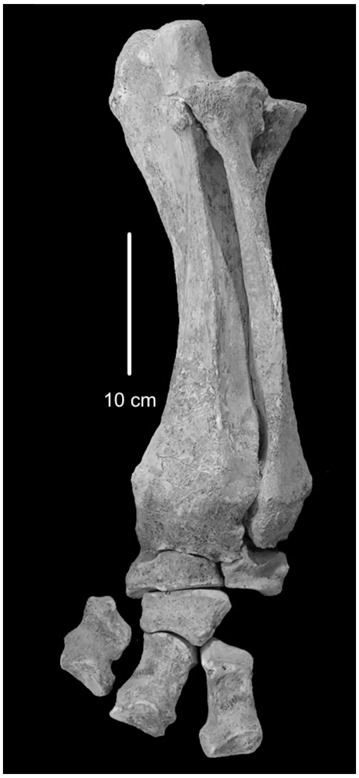

Fig. 6. *Elephas tiliensis* n.sp.
Syntypes of the lower anterior leg. The material included in the following table has been collected at square: Q9 at depth 196 cm bellow zero point in anatomical connection. It belongs to the right (dext) side. The measurements are given in Table 1. (Ulna T.01.198.u, Radius T.01.198.r, Ulnare T.01.198.3, Unciforme T.01.198.1, Intermedium T.01.198.2, McIII T.01.198.5, Mc IV T.01.198.4, Mc V T.01.198.6).
Scale 10 cm.

Fig. 7. *Elephas tiliensis* n.sp. (T.01 /239)
Humerus sin. Syntype. Collected isolated, not articulated with other bones.
Scale 10 cm.

Fig. 8. *Elephas tiliensis* n.sp.
Syntypes of the hind leg. The articulated material included in the following table has been collected at square : Q10 at depth 143-173 cm bellow zero point in anatomical connection. It belongs to the left (sin) side. The measurements are given in Table 2).
(Tibia T.01.135, Fibula T.01.136, Calcaneus T.01.137.1, Astragalus T.01. 137-2, Cuboid T.01.137-3, Esocuneiforme T.01.137-4, Mt III T.01.137-7, Mt IV T.01.137-8, Mt V T.01.137-9).
Scale 10 cm.

Fig. 9. *Elephas tiliensis* n.sp.
Anterior close view of the syntypes of the articulated tarsal and metatarsals. The material included in the following table has been collected at square : Q10 at depth 143-173 cm bellow zero point in anatomical connection. It belongs to the left (sin) side. Measurements are given in Table 2. (Astragalus T.01. 137-2, Cuboid T.01.137-3, Esocuneiforme T.01.137-4, Mt III T.01.137-7, Mt IV T.01.137-8, Mt V T.01.137-9).
Scale 10 cm.

Fig. 10. *Elephas tiliensis* n.sp.
Syntype of Femur sin. (T.3). Measurements are given are given by THEODOROU, (1983).
Scale 10 cm.

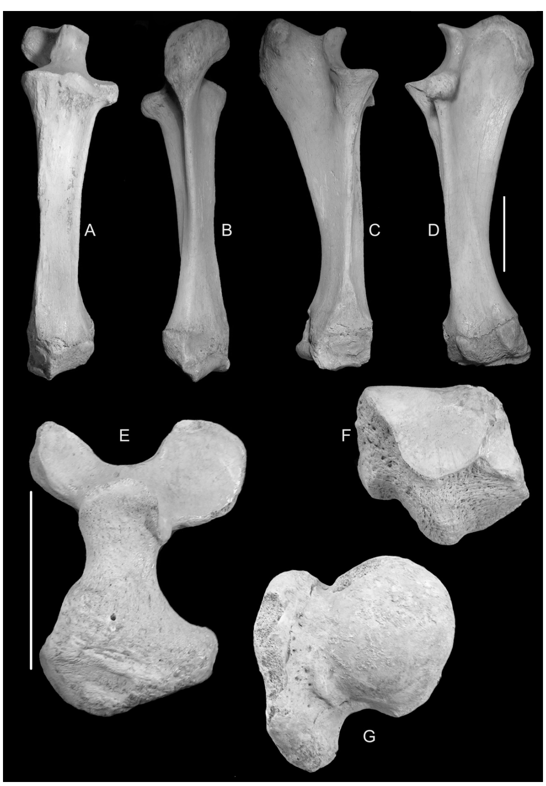

Fig. 11. *Elephas tiliensis* n.sp.
Syntype of Ulna. (T.1), (A= Anterior View, B= Posterior View, C,D Internal and external views, E= Proximal view, F= Distal view).
Syntype of Humerus dext T.41, (G= Proximal view).
Scales = 10 cm.

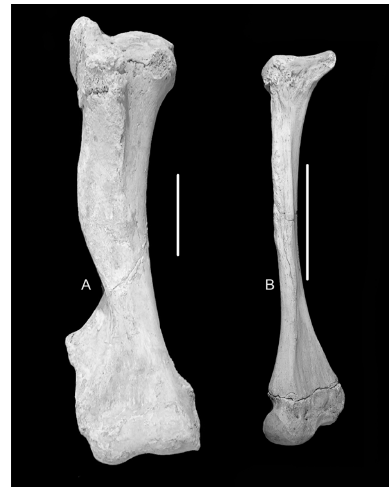

Fig. 12. *Elephas tiliensis* n.sp.
Syntype of Humerus dext T.41.
B= Syntype of Radius dext T.2265
Scale = 10 cm

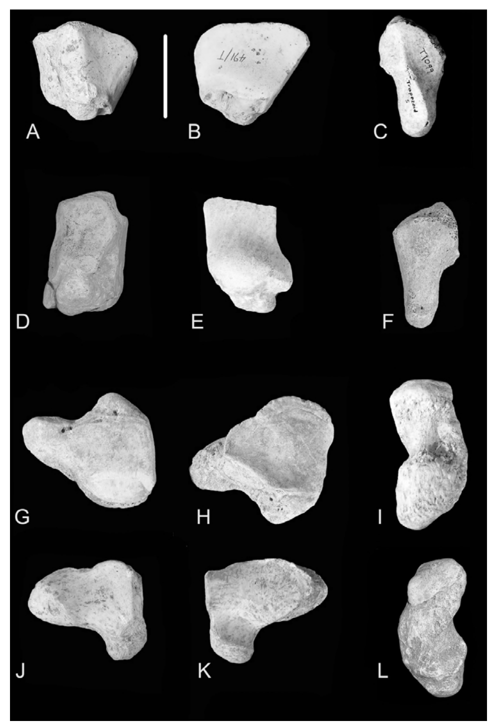

Fig. 13. *Elephas tiliensis* n.sp. Syntypes of non articulated Carpals

A=	Unciforme sin. distal.	T.491
B=	Unciforme sin. proximal	T.491
C=	Trapezoid sin. distal.	T.1099
F=	Trapezoid sin. proximal.	T.1099
D=	Magnum sin. distal.	T.3355
E=	Magnum sin. proximal.	T.3355
G=	Ulnare sin. distal	T.53/82
H=	Ulnare sin. proximal.	T.53/82
J=	Lunare sin. distal.	T.3358
K=	Lunare sin. proximal.	T.3358
I=	Pisiforme sin. external view.	T.10447
L=	Pisiforme sin. internal view.	T.10447

Scale = 5 cm

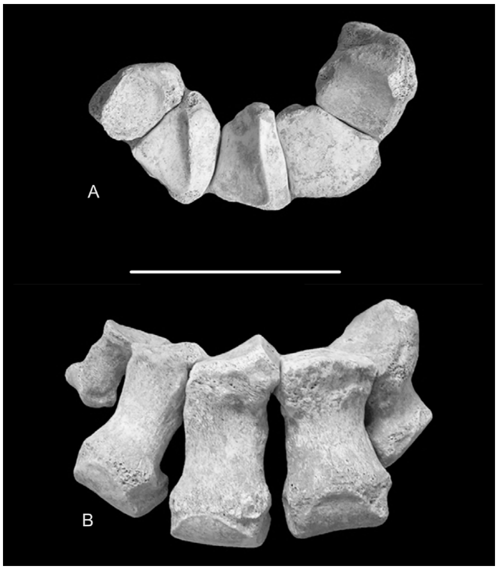

Fig. 14. *Elephas tiliensis* n.sp.
Syntypes of non articulated Metacarpals (A = proximal view, B = Anterior view). From left to right
Mc I sin = T.1104
Mc II sin = T.257
Mc III sin = T.230
Mc IV sin = T.275
Mc V sin = T.104
Scale = 10 cm.

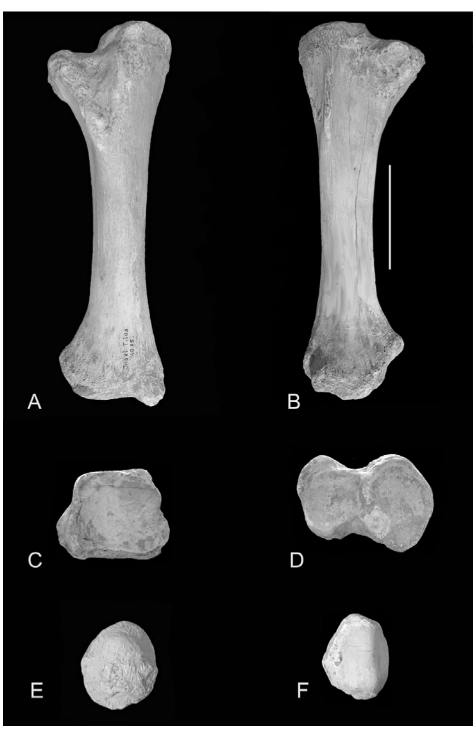

Fig. 15. *Elephas tiliensis* n.sp.
Syntype of Tibia dext. (T.339). (A = Anterior view, B = Posterior view, C= Distal view, D = Proximal view).
Syntype of Patella dext. (T.3356). (E = Anterior view, F = Posterior view).
Scale = 10 cm.

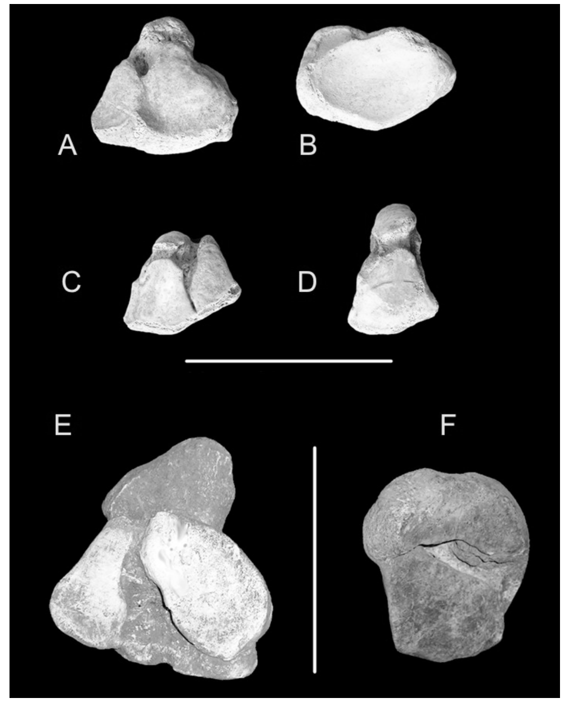

Fig. 16. *Elephas tiliensis* n.sp.
Syntypes of non articulated tarsal bones.
A = Cuboid sin. (Distal view) T.2032
B = Naviculare sin. (Facet to atsragalus) T.2012
C = Ecto-mesocuneiforme Co-ossified) sin. (Distal view) T.2031
D = Ectocuneiforme sin. (Distal view) T.2258
E = Calcaneus sin. (Facets to astragalus) T.1049
F = Astragalus sin. (Facets to calcaneus) T.2206
Scale = 10 cm

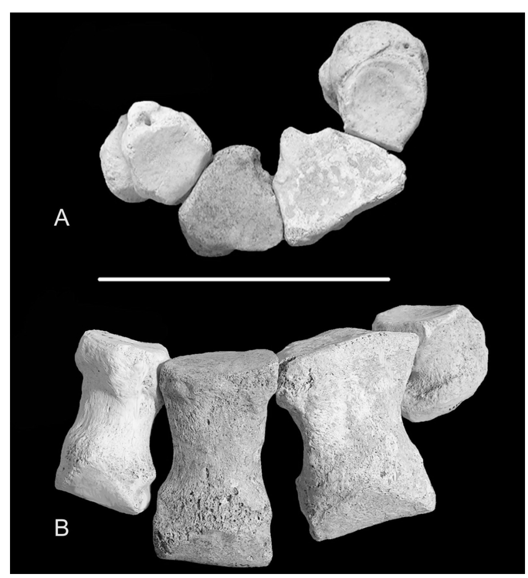

Fig. 17. *Elephas tiliensis* n.sp.
Syntypes of metatarsal bones.
Mt II sin. T.10473
MT III sin. T.183
MT IV sin. T.189
MT V sin. T.1418
Mt I are very scarce and are not include in this figure.
Scale = 10 cm.

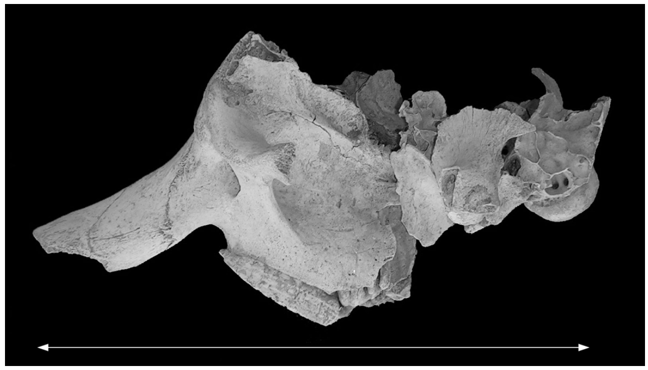

Fig. 18. *Elephas tiliensis* n.sp.
Skull No C. (Excavation 1982-83). One of the most complete skulls fragments from Charkadio. From the anterior part of the alveoli to the posterior part of occipitals it is 52 cm. The M^2 is in use and the M^3 is erupting. Scale 50 cm. It is very fragmentary to be included in name bearing types.