

Elephants and other Proboscideans: a summary of recent findings and new taxonomic suggestions

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SUMMARY: Today we recognize 165 species and subspecies of proboscideans, classified in 42 genera and 8 families. Of these, three species are extant: the forest African elephant (*Loxodonta cyclotis*), bush African elephant (*L. africana*), and the Asian elephant (*Elephas maximus*, with three subspecies). In 2000, the estimated world population of elephants was just over one half million; most are African elephants. New taxa include Mammutida and Elephantida, and one proposed here: Plesielephantiformes, as a sister taxon to Elephantiformes. Neontological research is currently under way on these areas of investigation: anatomy and physiology on eye, trunk, hyoid apparatus, brain, hearing, reproduction, ecology, behavior, and conservation. Topics for future research include: phylogenetic positions of Anthracobunids, *Moeritherium*, tetralophodont gomphotheres, *Stegolophodon* and *Stegodon*, and intra-familial relationships among *Loxodonta*, *Elephas* and *Mammuthus*, and also continuing studies on brain, reproductive biology, and conservation, emphasizing educational approaches.

1. INTRODUCTION

Henry Fairfield Osborn published his monumental two-volume *Proboscidea* in 1936 and 1942 (Osborn 1936, 1942). In 1996 the first and third authors of this contribution edited another volume by the same name that reviewed advances in our knowledge since Osborn (Shoshani & Tassy 1996). In this presentation, we build on the 1996 volume to summarize recent findings on living and extinct proboscideans and propose some taxonomic revisions and additions.

In 1942, following Osborn, 352 species and subspecies of proboscideans were recognized; they were classified in 40 genera, and 8 families. In 1996, corresponding numbers were 162, 40, and 8 (not the same genera and families). Most recently a new genus and three new species have been described: *Phosphatherium escuilliei* (by Gheerbrant, Sudre & Cappetta 1996) from Mo-

rocco, *Stegodon sondaari* (by Van den Bergh 1997) from Indonesia named in honor of Paul Y. Sondaar [Note: Van den Bergh placed *Stegodon* in the family Elephantidae, *contra* other investigators who place *Stegodon* in the family Stegodontidae (more below)], and *Zygodontodon aegyptensis* (by Sanders and Miller, in press) from Egypt. In addition, *Loxodonta cyclotis* (Matschie 1900), was elevated from subspecies to species level (Grubb *et al.* 2000). Results from Molecular findings (cytochrome b), however, indicate that of the one dozen of sequences of *L. cyclotis* not all samples clustered to form a clade (there were two exceptions: two savanna elephants had forest haplotype!) (Debruyne in preparation). Based on the work of Inuzuka (1977a, b) and our morphological observations, as well as studies of skeletons of *P. naumanni*, we suggest that *Palaeoloxodon* is a *bona fide* genus, instead of a subgenus of *Elephas*.

These descriptions and a revision bring the total of living and extinct proboscideans to 165 species (classified in 42 genera, and 8 families). Of these three species, two are monotypic and one is with three subspecies are alive today: the forest African elephant (*L. cyclotis*), the bush African elephant (*L. africana*), and the Asian elephant (*E. maximus*). The Asian elephant is believed to include three subspecies (Shoshani & Eisenberg 1982): the Sumatran Asian elephant (*E. m. sumatranus*), the mainland Asian elephant (*E. m. indicus*), and the Sri Lankan Asian elephant (*E. m. maximus*) [sequence of listing represents an evolutionary trend, Shoshani 2000].

As of the year 2000, the average estimated population of elephants in the world was just over half a million (minimum 329,663, maximum 706,090). Of these, there are 278,205 – 637,599 African elephants of both species in the wild (Marchant *et al.* 2000) and 748-808 in captivity (Shoshani, S.L. 2000), and 36,450-50,250 Asian elephants in the wild (Sukumar & Santiapillai 2000) and 14,260-17,433 in captivity (Shoshani, S.L. 2000).

2. PALEONTOLOGY, INCLUDING TAXONOMY

The classification of the 165 proboscidean taxa into 42 genera and 8 families is slightly different from the 1996 publication. Subfamilies and tribes and higher categories were added to elucidate cladistic findings. In addition, we now include *Choerolophodon* (subfamily Choerolophodontinae) in the family Gomphotheriidae (*contra* Tassy 1985). New taxa include Mammutida and Elephantida (Shoshani *et al.* 1998), and one we propose here, Plesielephantiformes as a sister taxon to Elephantiformes [Plesielephantiformes includes: Numidotheriidae, Barytheriidae, and Deinotheriidae; Elephantiformes includes: Palaeomastodontidae, Phiomiidae, Mammutidae, Gomphotheriidae, tetralophodont gomphotheres, Stegodontidae, and Elephantidae]. The suggested synapomorphy for Plesielephantiformes is bilophodonty. Problem may arise since it is possible that the lophodonty of deinotheres, for example, may not be homologous with lophodonty of *Phosphatherium* and

numidotheres. Other hypotheses to be tested include whether *Palaeomastodon* is a/the common ancestor of Mammutida (or a sister-taxon to it), and also whether *Phiomia* is a/the common ancestor of Elephantida (or a sister-taxon to it). Presentations during this ITC-8 meeting (Sun City South Africa) and those to be presented in Rome (Italy) will include these topics: new finding of proboscidean remains in Ethiopia, Eritrea; Schreger pattern on tusks; frozen mammoths (finding of the Jarkov mammoth); relationships within the family Elephantidae, and subjects on anatomy, physiology, ecology, and conservation.

3. NEONTOLOGY

3.1 Topics investigated

Current investigations are being carried out on the eye (do elephants see colors?); on trunk anatomy and physiology (ongoing research; recently a team of investigators from Kansas State University has been investigating the proboscis from a respiratory perspective); on the hyoid apparatus (anatomy and physiology; two papers are published in this volume, i.e. Shoshani *et al.* 2001; Shoshani & Marchant 2001), summarizing its functions as tongue support, resonating chamber, and for water storage); and on the brain (gross anatomy and histological investigations one paper has been presented at the 8th Theriological Congress, Sun City, South Africa, and one again is in this volume, i.e. Kupsky *et al.* 2001). In addition, research is being conducted on reproduction in the wild and in captivity (immunological techniques to prevent pregnancy, and artificial insemination), on behavior (infrasonic communication aspects investigated in the field and laboratory observations, e.g. Meng *et al.* 1997). Other topics include Thailand elephants “play music” in an orchestra, and adult elephants “mentor” young unrelated elephants.

3.2 Conservation

After the 2000 CITES (Convention on International Trade in Endangered Species of Wild

Fauna and Flora) meeting in Nairobi, South Africa's elephant population was transferred to Appendix II but no further permission was granted to any party to export ivory for commercial purposes. All other African populations are listed in Appendix I CITES. *Elephas maximus* is placed in Appendix I of CITES.

4. FUTURE RESEARCH

Future research topics might include whether anthracobunids should be included in the Proboscidea or as a sister group in the Tethytheria, whether *Moeritherium* should be placed in Pleisiephantiformes (a new taxon proposed here), or as an earlier offshoot of Proboscidea, what is the taxonomic position tetralophodont gomphotheres (i.e. those with four ridges on 4th premolars, the 1st and 2nd molars), should *Stegolophodon* and *Stegodon* be placed in the family Stegodontidae or in the family Elephantidae, and what are the intra-familial relationships among *Loxodonta*, *Elephas* and *Mammuthus* — is it (*Loxodonta* (*Mammuthus* + *Elephas*)) as suggested by the classical morphological data (e.g. Maglio 1973), or (*Elephas* (*Mammuthus* + *Loxodonta*)) based on some molecular data (Debruyne, in preparation)? In addition, it is suggested that studies should be continued on the form and function of the brain, and to find effective method for birth control in the wild, and on ways to reduce culling operations. In the field of conservation, we suggest that educational approaches to co-existence of humans and wildlife should be emphasized, especially as the larger animals are ecological keystone, or super-keystone species. Some of these ideas were discussed in Shoshani and Tassy (1996), and other in Shoshani (2000).

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