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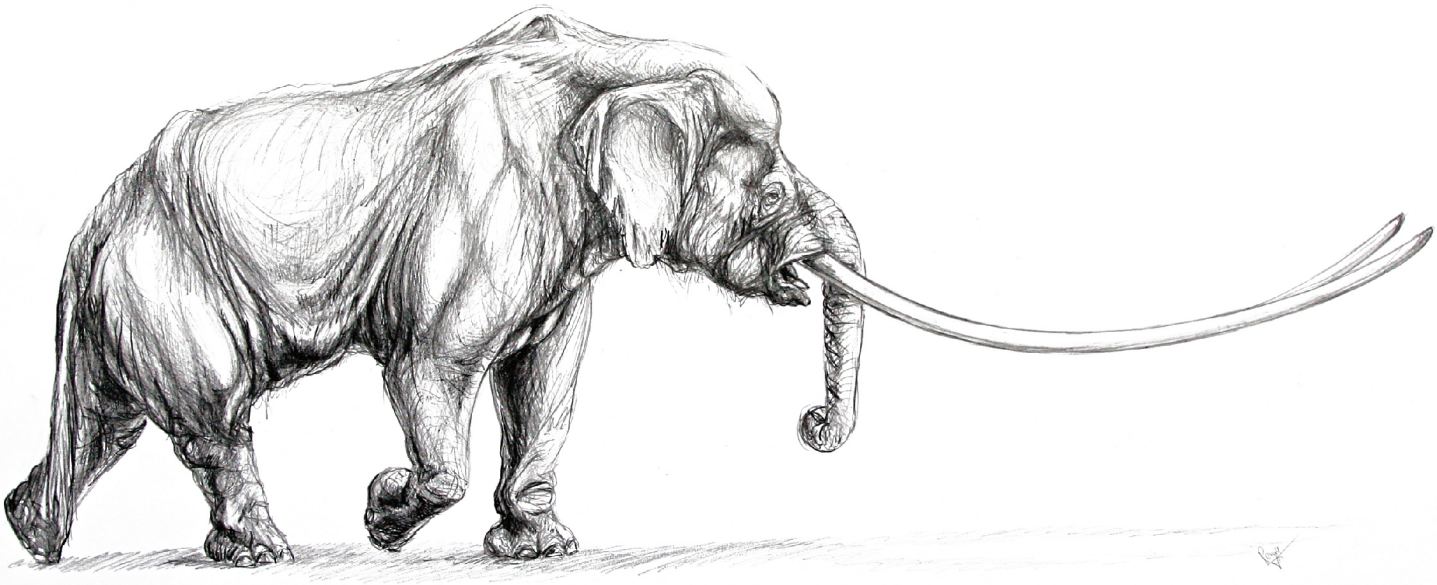

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ABSTRACT BOOK

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Functional diversity in the masticatory patterns of Proboscidea

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The mastication of fossil proboscideans was reconstructed from wear facets and striations. The jaw movement is symbolized in the "mastication compass" distinguishing the direction and inclination of phases of the power stroke. Various functions can be distinguished as food is comminuted: compression, shear-cutting, and grinding. These are defined by the interaction of enamel exposed on occlusal surfaces (Koenigswald et al., 2013; Koenigswald, 2014).

The morphology of the occlusal surface, however, changes with wear. Therefore two different stages of wear are recognized: slightly worn teeth that show the optimal condition for a full range of functions, and intensively worn teeth in which grinding predominates. In early proboscideans the entire tooth row can be evaluated; in more modern proboscideans horizontal tooth displacement has to be considered.

The great diversity of Proboscidea is not discussed here in terms of systematics, but proboscideans are grouped according to their molar morphology. In the available material four functional **patterns of mastication (POM)** can be recognized that are indicated by typical genera (Fig.1):

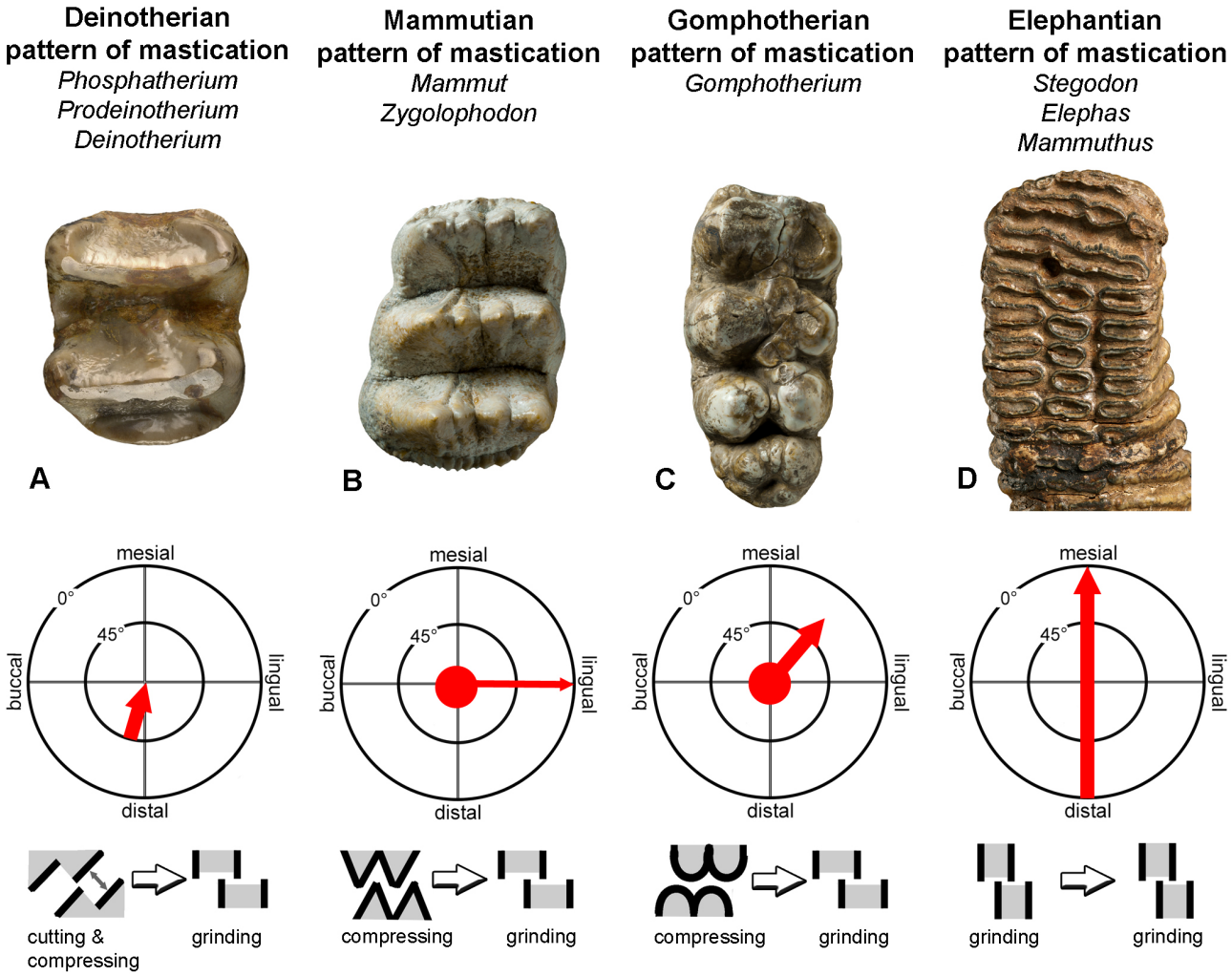

Fig. 1. Schematic characterization of the four functional patterns of mastication (POM) found in the proboscidean molar dentitions. Illustrations show typical molars of (**A**) *Deinotherium giganteum*, (**B**) *Mammut borsoni*, (**C**) *Gomphotherium angustidens*, (**D**) *Mammuthus primigenius*.

The mastication compass symbolises the movement of the left lower jaw. The direction of phase I and II of the power stroke are indicated by the compass rose, the inclination by the length of the arrow(s). Phase I ends in centric occlusion. An orthal movement of phase I is indicated by a dot in the center. When phase I and II cannot be discerned the arrow crosses the middle of the rose. - The symbols at the bottom indicate the changing functions from fresh to worn teeth. They demonstrate that fresh teeth of the four groups differ distinctly in their function, but become more similar as the teeth are worn down. Note that molars of the elephantian pattern are mostly hypsodont.

Deinotherium, *Mammut*, *Gomphotherium*, and *Elephas*.

The deinotherian POM shows a broad planar facet on the trailing side of the lophs. They are situated on the distal sides of lower lophs and mesial sides of upper lophs. The upper rim of these planar facet is formed by the sharp crest of enamel from the leading side of the loph. In most genera the unworn lophs are crenulated, which facilitates initiation of the facet in the most appropriate direction. Striations show movement of the lower jaw to have been mesio-lingual in direction, and steeply inclined. Movement representing phase I ends in centric occlusion.

Two different functions are fulfilled during phase I. When the sharp crests pass each other, their function is shear-cutting. Following this, the lophs interdigitate, and squeeze the bolus in a chamber of compression between the leading sides of antagonistic lophs. The lophs are strongly abraded from this compression and finally collapse, as in other bilophodont dentitions. In heavily worn teeth, the remaining enamel band surrounding the large dentine field functions as grinding tool. Besides of *Deinotherium* this POM was found e.g., in *Phosphatherium*, *Daouitherium*, *Numidotherium* and *Barytherium*. The deinotherian POM is found in several unrelated mammalian dentitions too, e.g., in *Lophiodon* and *Macropus*.

The mammutian POM has molars with sharp and multicuspid transverse lophs as in *Mammut*, but here lophs never bear attritional facets with a shear-cutting crest. Abrasional facets indicate an orthal jaw movement, by which the lophs interdigitate, with compression as the primary function. The jaw movement is not nearly as well controlled as in *Deinotherium*. In some fresh teeth of young individuals of *Mammut americanum* an additional movement is documented by horizontal striations, indicating the presence of a phase II, with movement in a lingual direction. With intensive wear the lophs collapse and the surrounding enamel band functions as a grinding tool until the tooth is shed. *Zygolophodon turicensis* shares the same functional pattern.

The gomphotherian POM is represented by the bunodont gomphotheres (sensu lato). The teeth do not show well defined facets, meaning that movement of the mandible is not as rigidly controlled. In fresh molars of *Gomphotherium angustidens* the mastication starts with an orthal interdigitation of the cusps (phase I). The blunt cusps break down a bolus of food mainly by compression. Following this, in phase II the lower jaw moves with low inclination in mesio-lingual direction. This movement causes the intensive wear on the pretrite side. If the dentine core is exposed, the surrounding enamel band forms a grinding surface. The movement during phase II is reflected in some teeth by striations. The pattern found in *Gomphotherium angustidens* is somewhat intermediate between that of the Oligocene *Phiomia* where compression is dominating and the more modern gomphotheres, e.g., *Cuvieronius* where horizontal grinding of phase II dominates.

The elephantian POM occurs in Stegodontidae and Elephantidae. They share polylophodont molars, with increasing hypsodonty. A flat occlusal surface indicates horizontal jaw movement, in which phases I and phase II are not discernable because there is no centric occlusion. Assuming that the elephantian POM derived from the gomphotherian pattern, a predominance of phase II can be postulated. The lophs on molars of stegodontids and the narrow lamellae on molars of elephantids are transversely oriented and suggest a mesial direction of jaw movement. Some molars show tooth wear striations directed mesial. The enamel bands that surround the lamellae then form a serial grinding tool. Since the spaces between the lamellae are filled with cementum, the occlusal surface of an entire tooth (or even two successive teeth) forms a continuous grinding surface.

The four functional patterns of mastication recognized within Proboscidea differ distinctly in the function of fresh or slightly worn teeth. Differences decrease with increasing wear, and all converge in a grinding function. Thus the grinding function that occurred in more primitive proboscideans only at a late stage of wear comes early in ontogeny in elephantids.

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