Mammalian herbivore chewing anatomy

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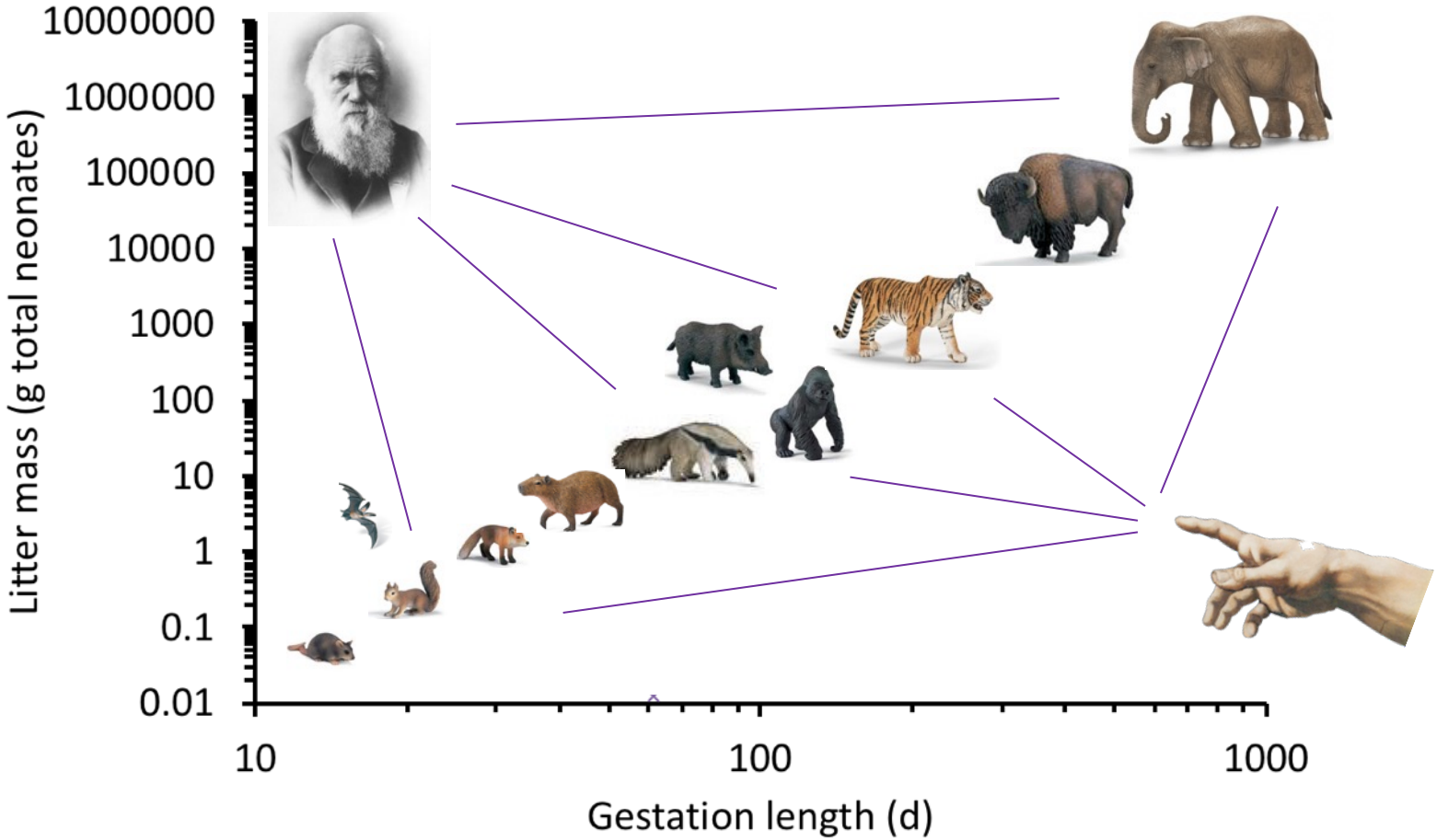
The obsession with 'perfection'

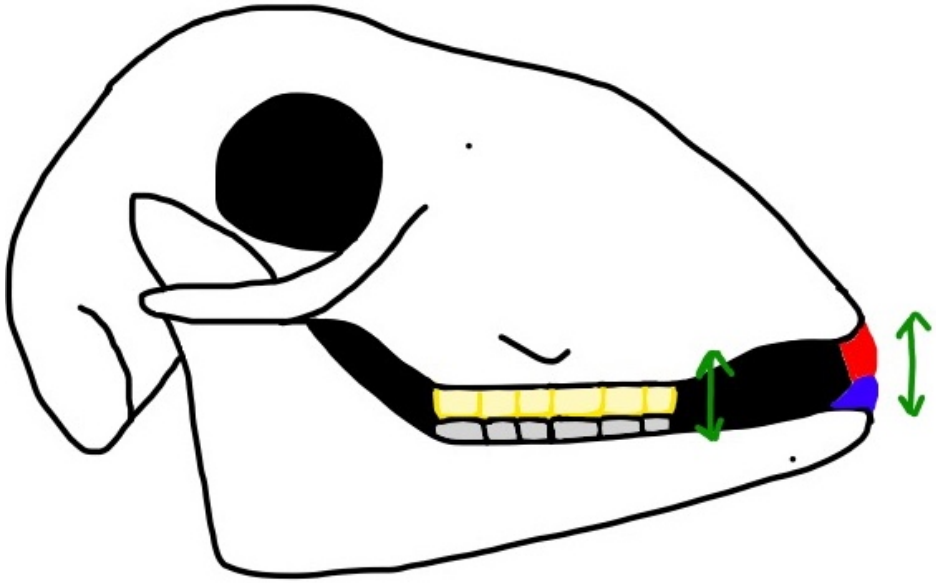
what many creationists and evolutionarists have in common

Perfect ?


10000000
1000000
100000
10000
1000
100
10
1
0.1
0.01
Litter mass (g total neonates)
10
100
1000
Gestation length (d)

The tooth example

The challenge



the mandible is a fixed link between the molars and the incisors

any movement of the mandible (for incisor bite, or for molar grinding chewing) will automatically move the other teeth

how can the mandible perform both functions without these mutually impairing each other ?

Priorities

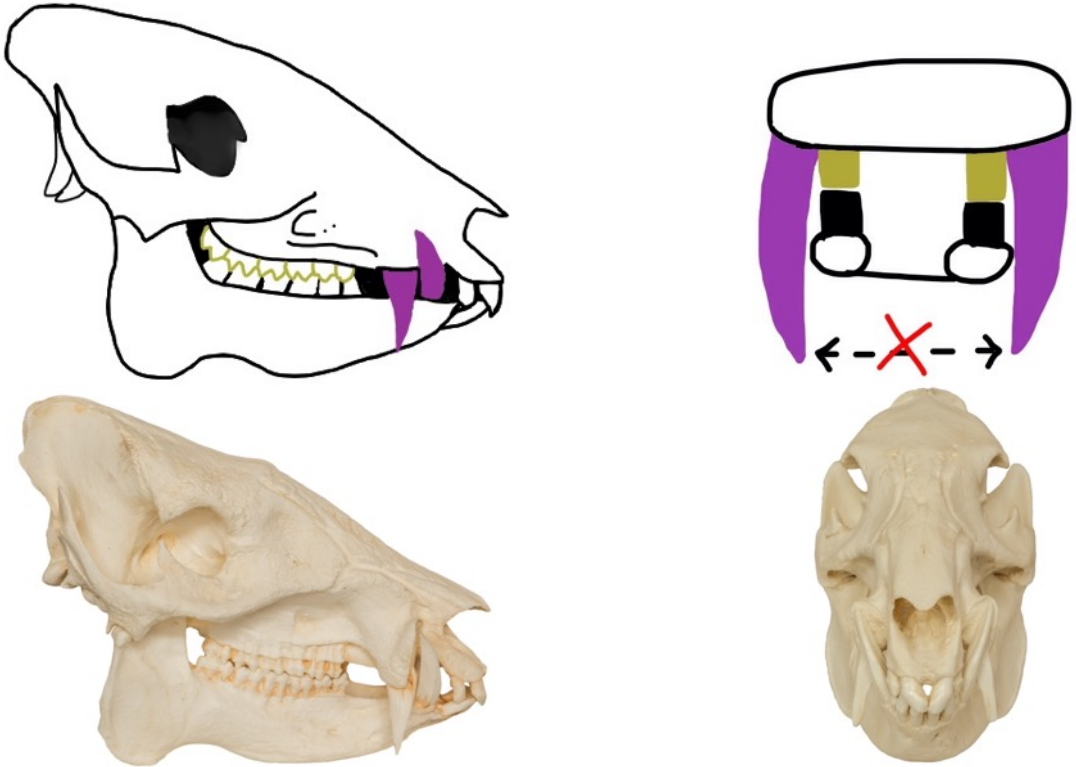
For a herbivore, grinding chewing has, in theory, the highest priority.

Any functions of canines and incisors have to be subordinate to the necessity to grind plant food.

Canines may act as weapons or secondary sexual characters. Incisors may serve for biting / gnawing, as weapons or as secondary sexual characters.

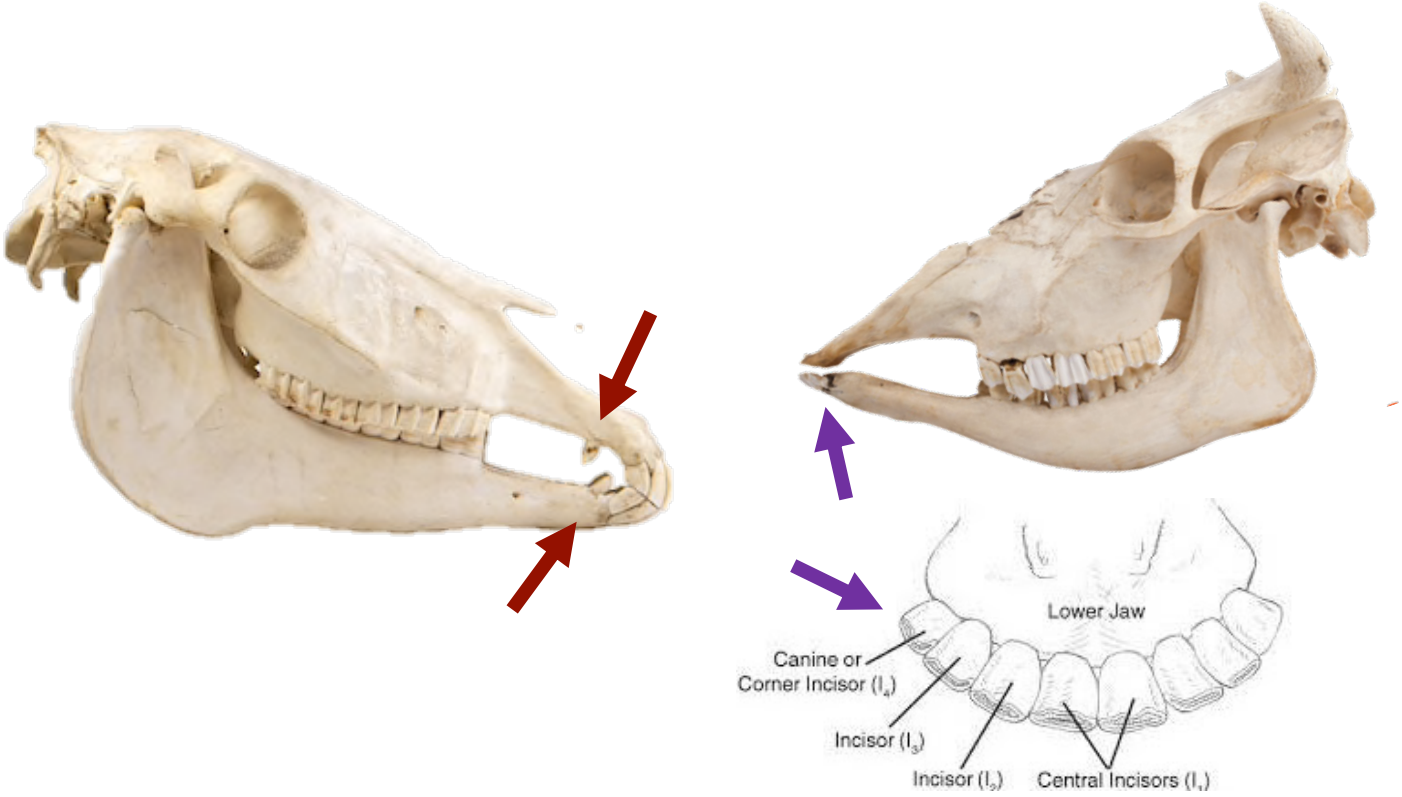
Canines

Mutual impairment I: canines



fixed canines can evidently impair lateral movement of the mandible during grinding chewing: **peccary**, tapir

Canine solution I: canine reduction

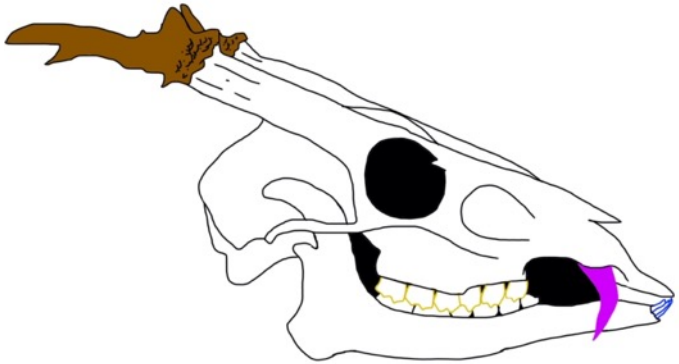


canines become so small that they cannot impair lateral movement any more (**horses**) or become so small that they become functional incisors (most **ruminants**)

Canine solution II: diastema elevation

the shape of the diastema ensures canines are so elevated that they do not impair lateral movement (camelids – typical camelid skull form)

Canine solution III: ‘hinged canines’



canines are not fixed but loose so they can ‘give’ laterally
(ruminants with long upper canines: muntjac, Chinese water deer)

Canine solution IV: canine arrangement

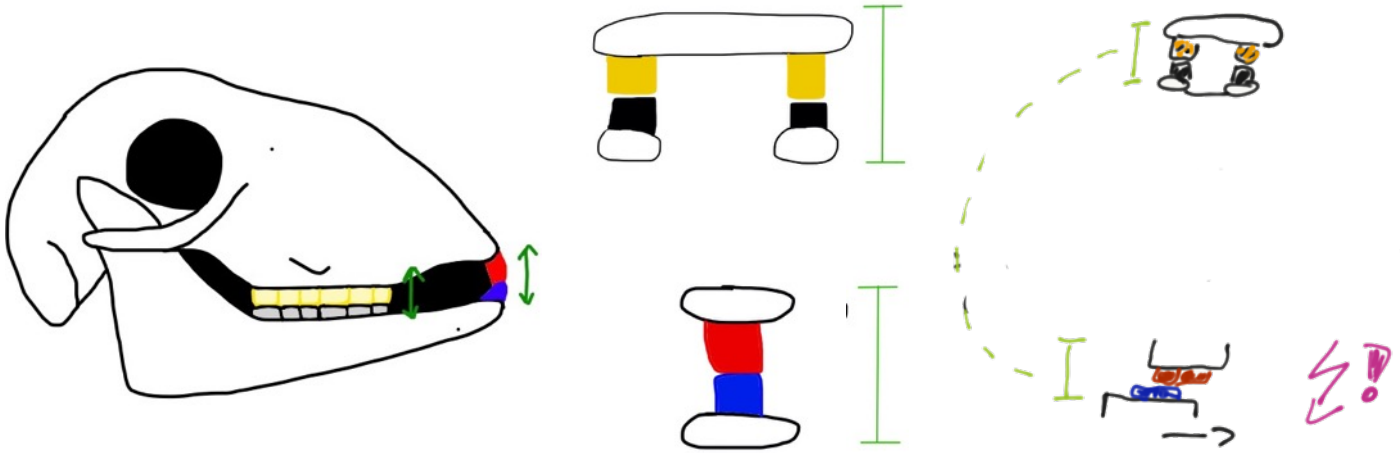
canines are arranged in such a way that they can slide laterally past each other (and sharpen each other in doing so):

pigs, hippos

Incisors

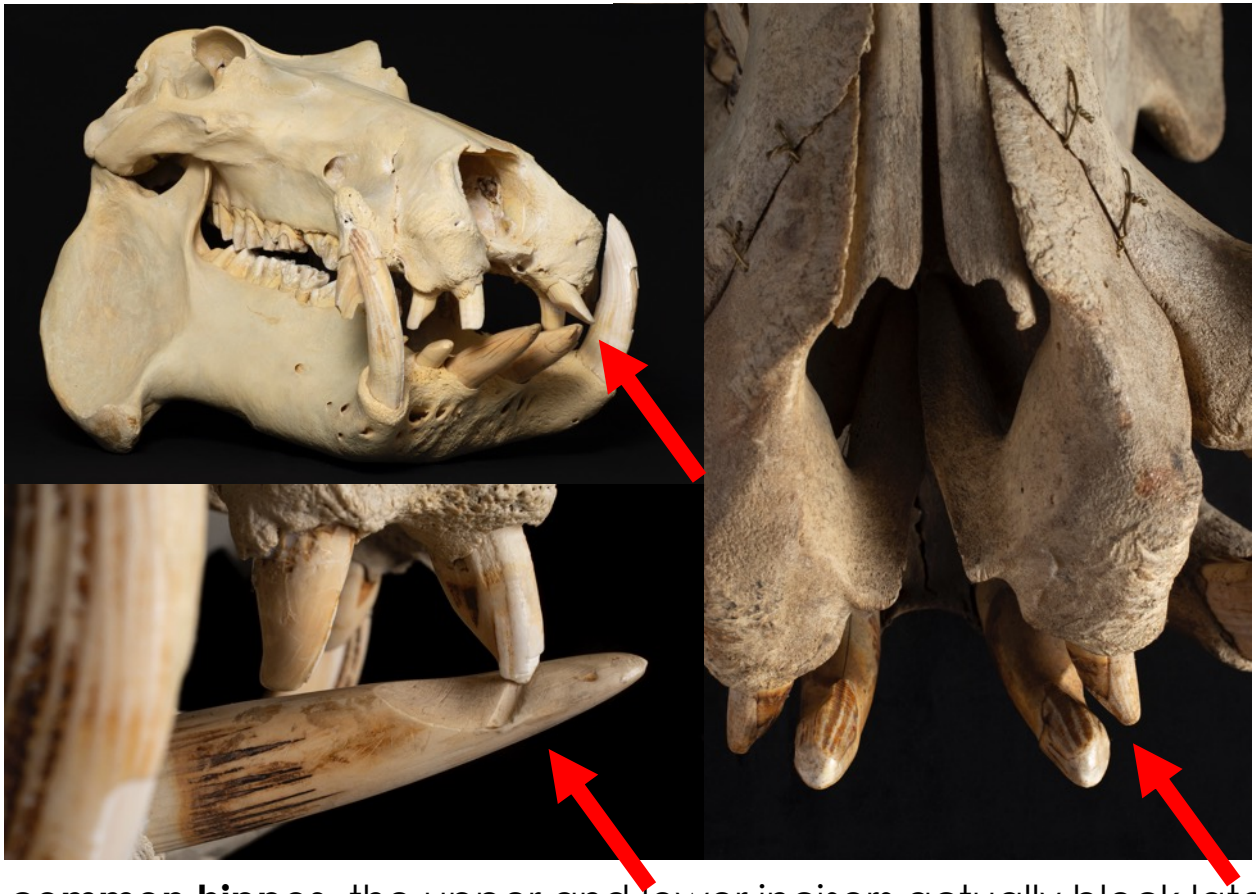
note: the cropping function of the incisors can be taken over by the lips in many herbivores

Mutual impairment II: incisors



If all teeth are in occlusion at the same position, grinding chewing will wear down the incisors …

Mutual impairment II: incisors



In **common hippos**, the upper and lower incisors actually block lateral movement. They show traces indicating lateral movement is ‘tried’ but hardly achieved. Having impressive incisors is more important for them than having a grinding chewing motion.

Mutual impairment II: incisors

If all teeth are in occlusion at the same position, grinding chewing will wear down the incisors … ***like in pygmy hippos***

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Mutual impairment II: incisors

In greater one-horned rhinos (aka ‘Indian rhinos’), one can see on the front teeth the abrasion caused by the lateral mandible movement required for molar grinding.

Mutual impairment II: incisors

The canines/incisors of a camel slide past each other during lateral chewing, causing visible abrasion on each other.

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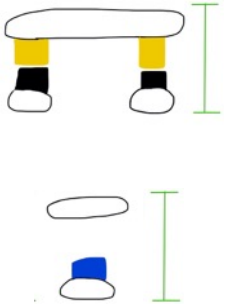
Incisor solution I: losing incisors

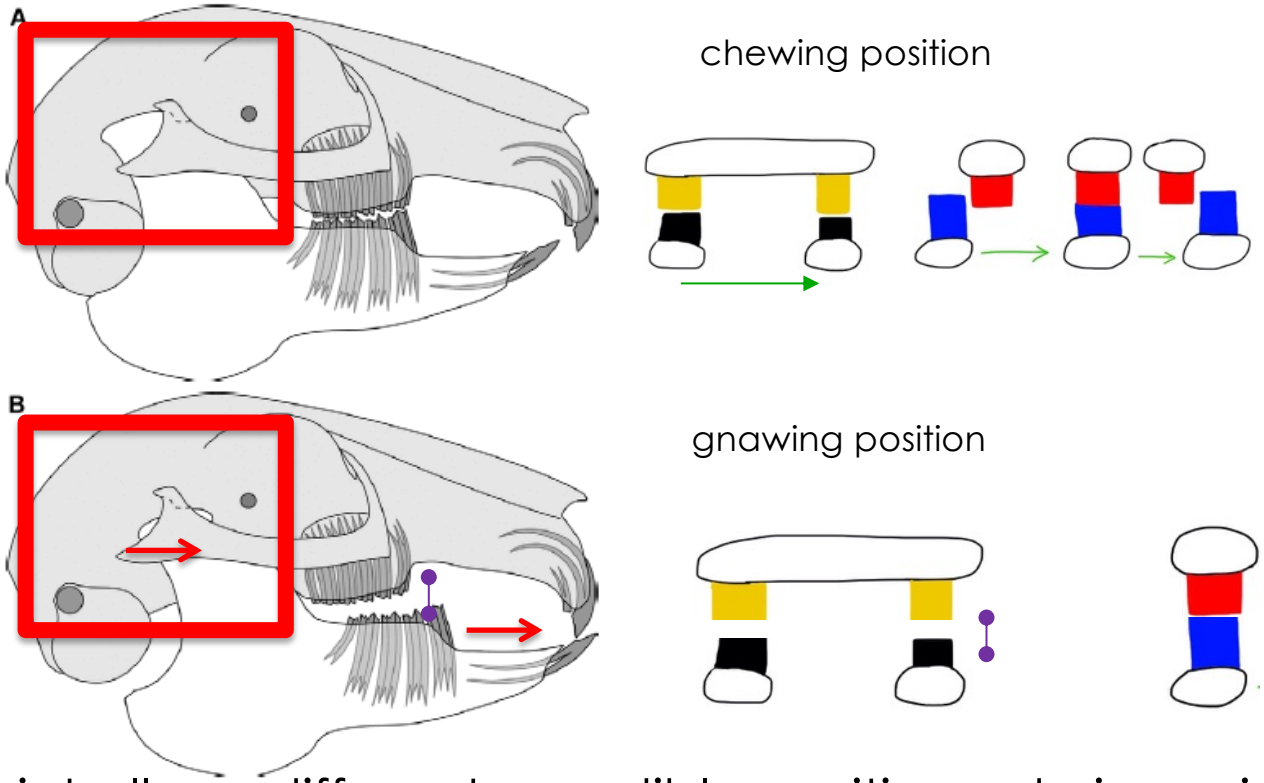


getting rid of incisors: either in only one jaw (the maxilla): ruminating herbivores – camelids and ruminants

Incisor solution I: losing incisors

African rhinoceros species have lost all incisors. They crop with their pointed or broad lips.

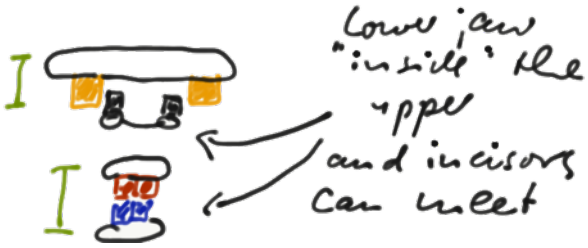
Incisor solution II: shifting mandible

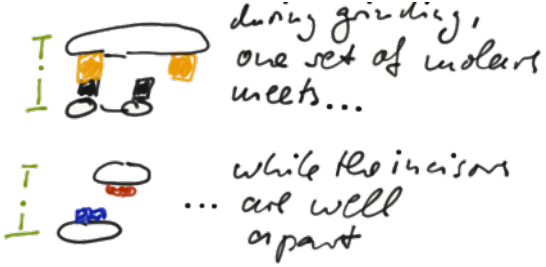


Crossley (2003)

the jaw joint allows different mandible positions: during grinding, the incisors slide past each other; for incisor action, the whole mandible is shifted forwards and during gnawing, the molars are apart – e.g. **rabbits**, humans

Incisor solution III: molar resting position





upper molars overlap lower ones in side view

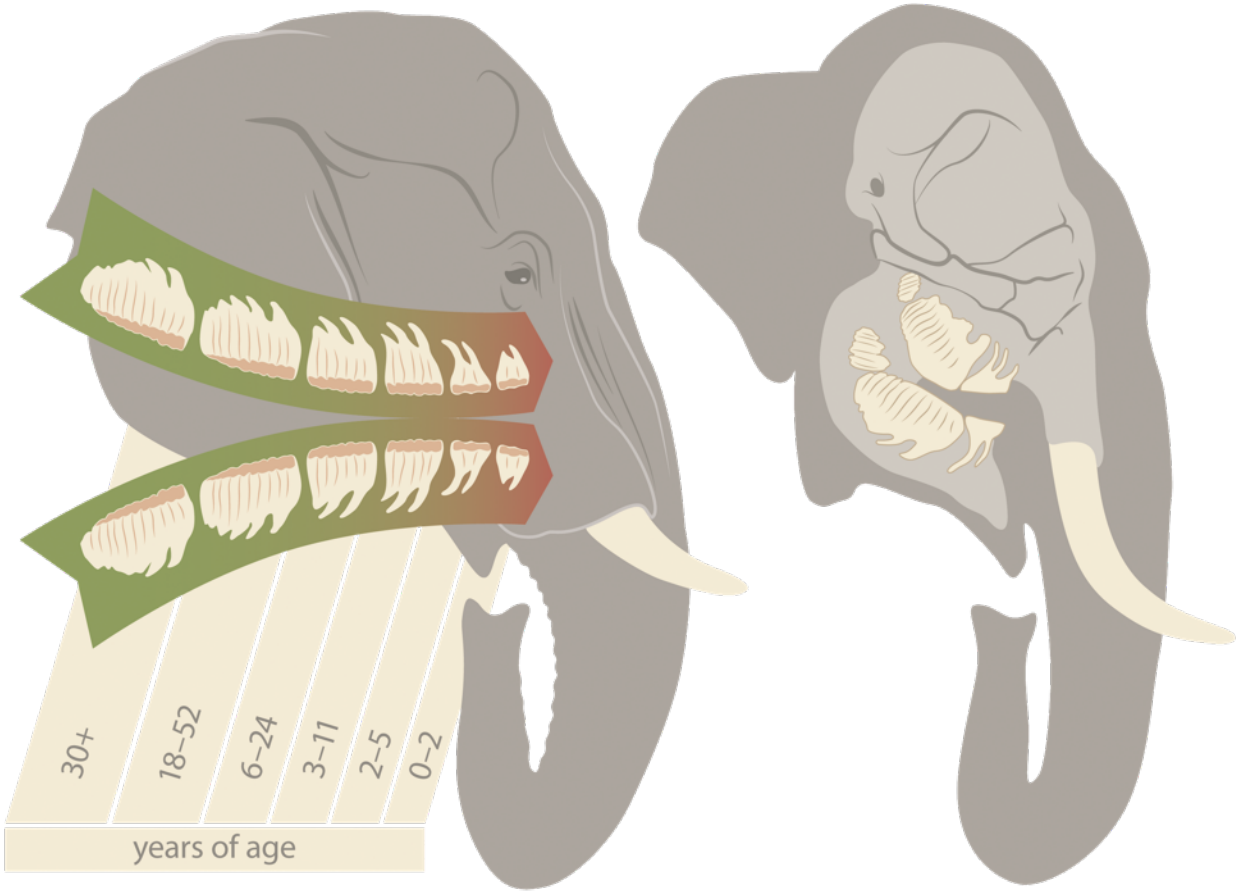
put mandibular molars 'inside' the maxillary molars at rest when incisors meet – by having a narrow mandible, oblique occlusal surface, or both – best examples: ***horses*** (although ruminants etc. also have this)

Incisor solution III: molar resting position

If the lower cheek teeth rest ‘inside’ of the upper ones, due to a narrow mandible and/or oblique chewing surface, incisors can meet when the mandible is straight, but will be ‘out of reach’ during a lateral chewing stroke. Seen in horses (but also others).

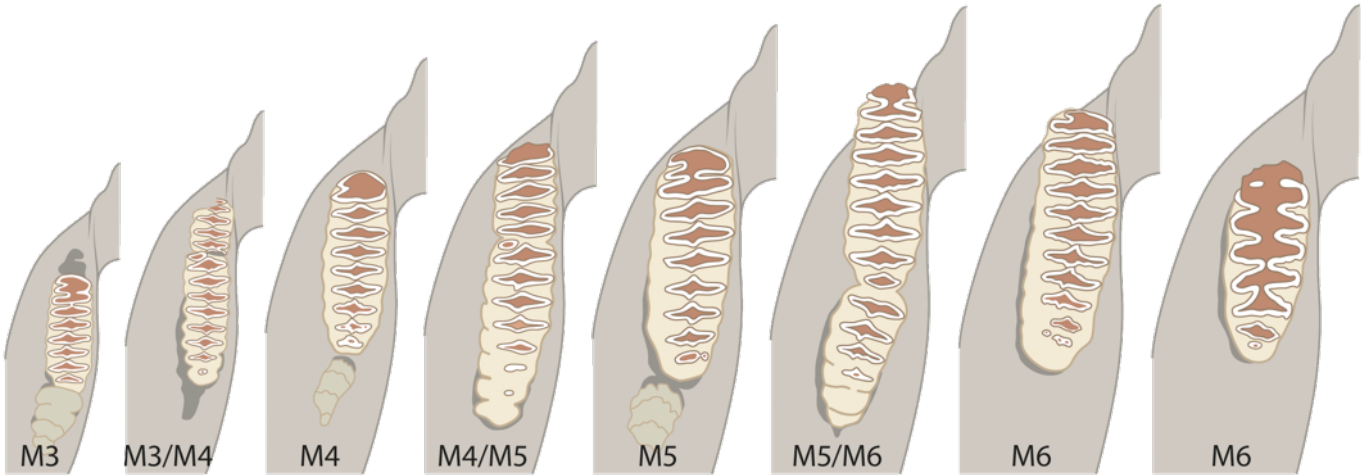
Elephants

Elephant ‘rolling carpet‘



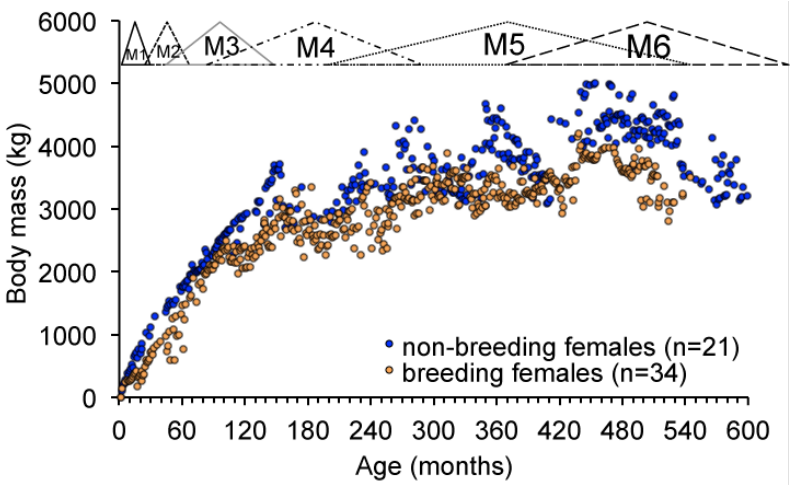
Schiffmann et al. (2019)

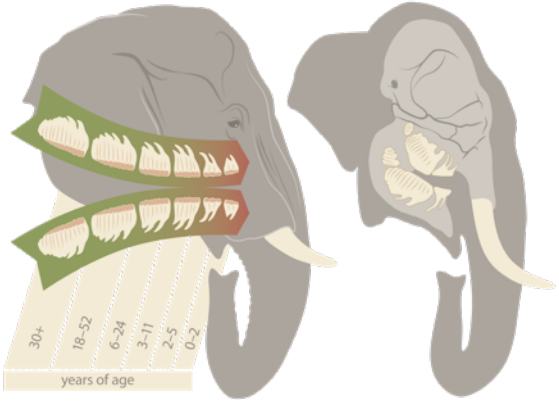
Elephant ‘rolling carpet‘

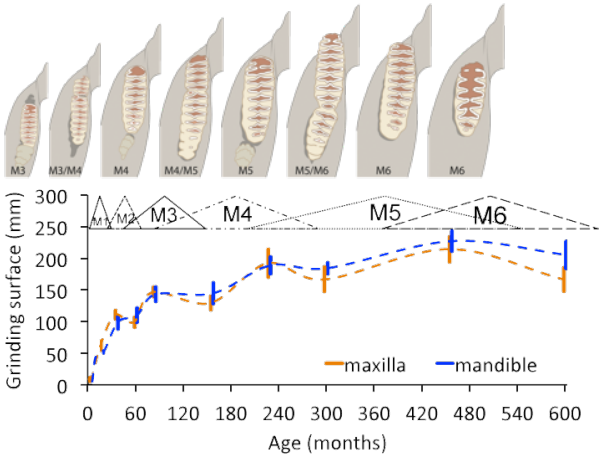


Schiffmann et al. (2019)

Elephant teeth … and body mass







Schiffmann et al. (2019)

thank you for your attention