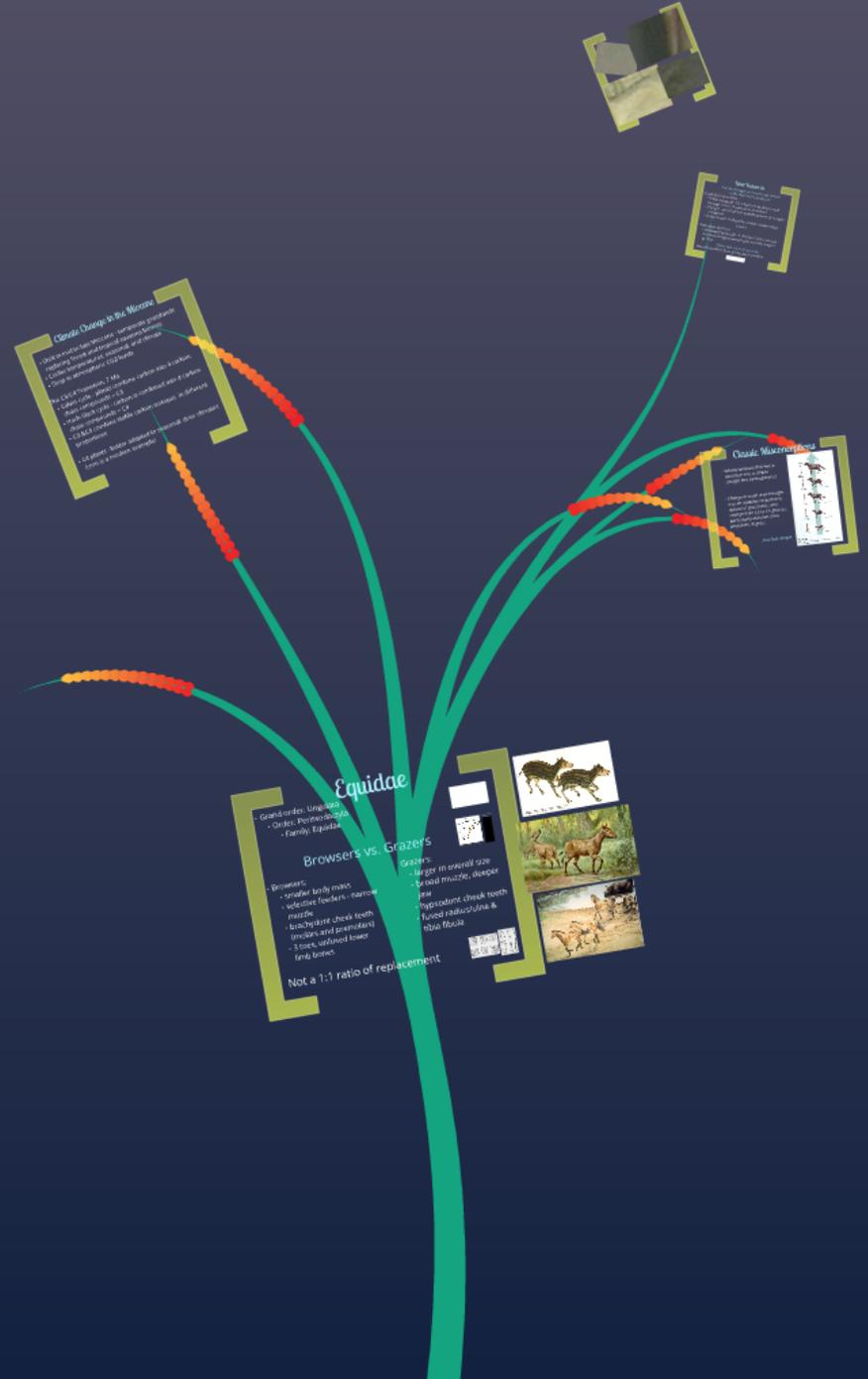


Miocene Horse Evolution and the Emergence of C4 Grasses in the North American Great Plains



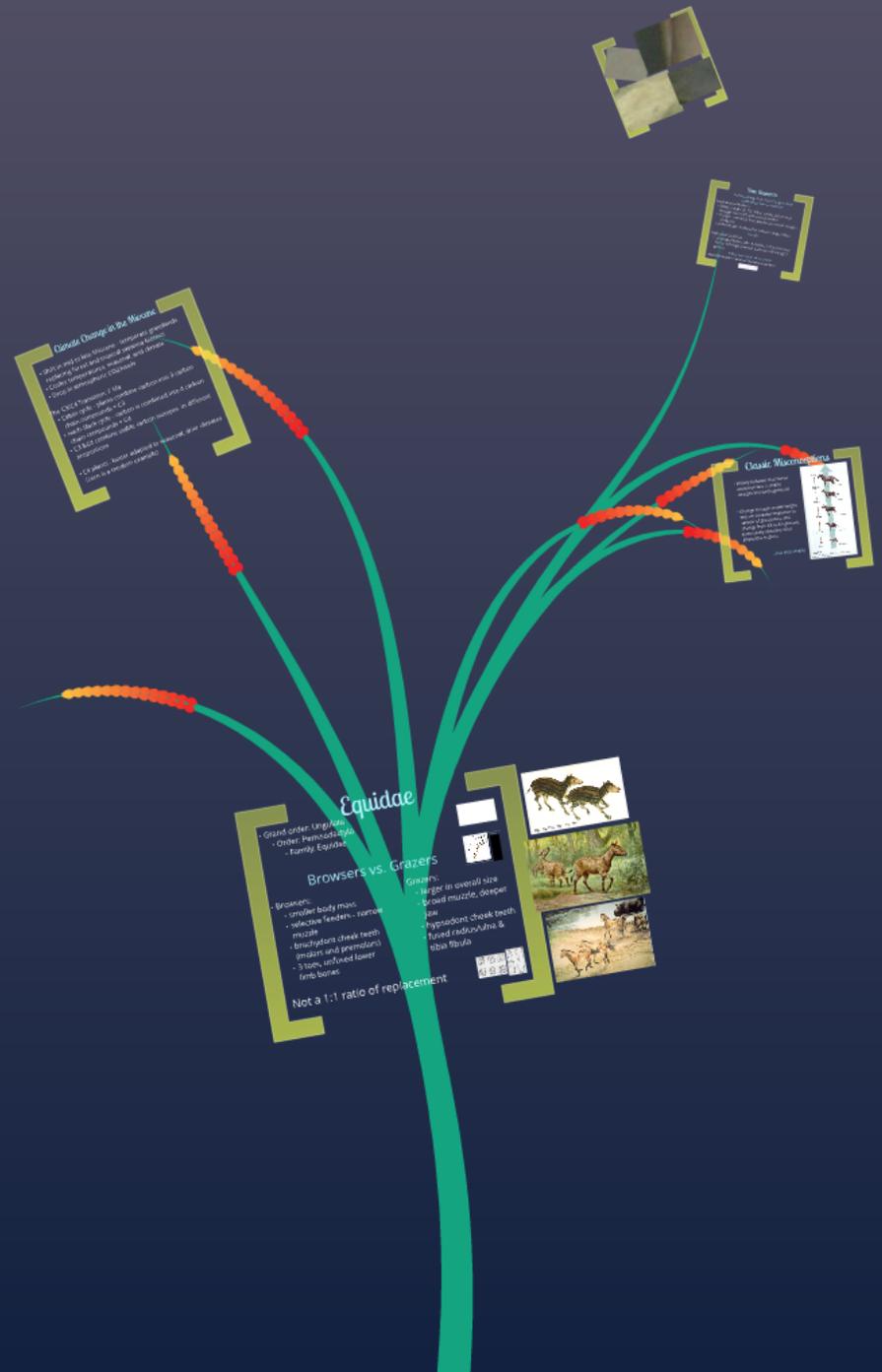
Adrienne Stroup



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Equidae

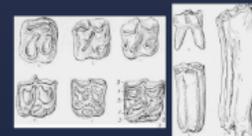
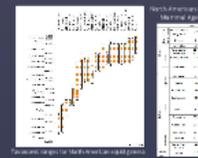
- Grand order: Ungulata
 - Order: Perissodactyla
 - Family: Equidae

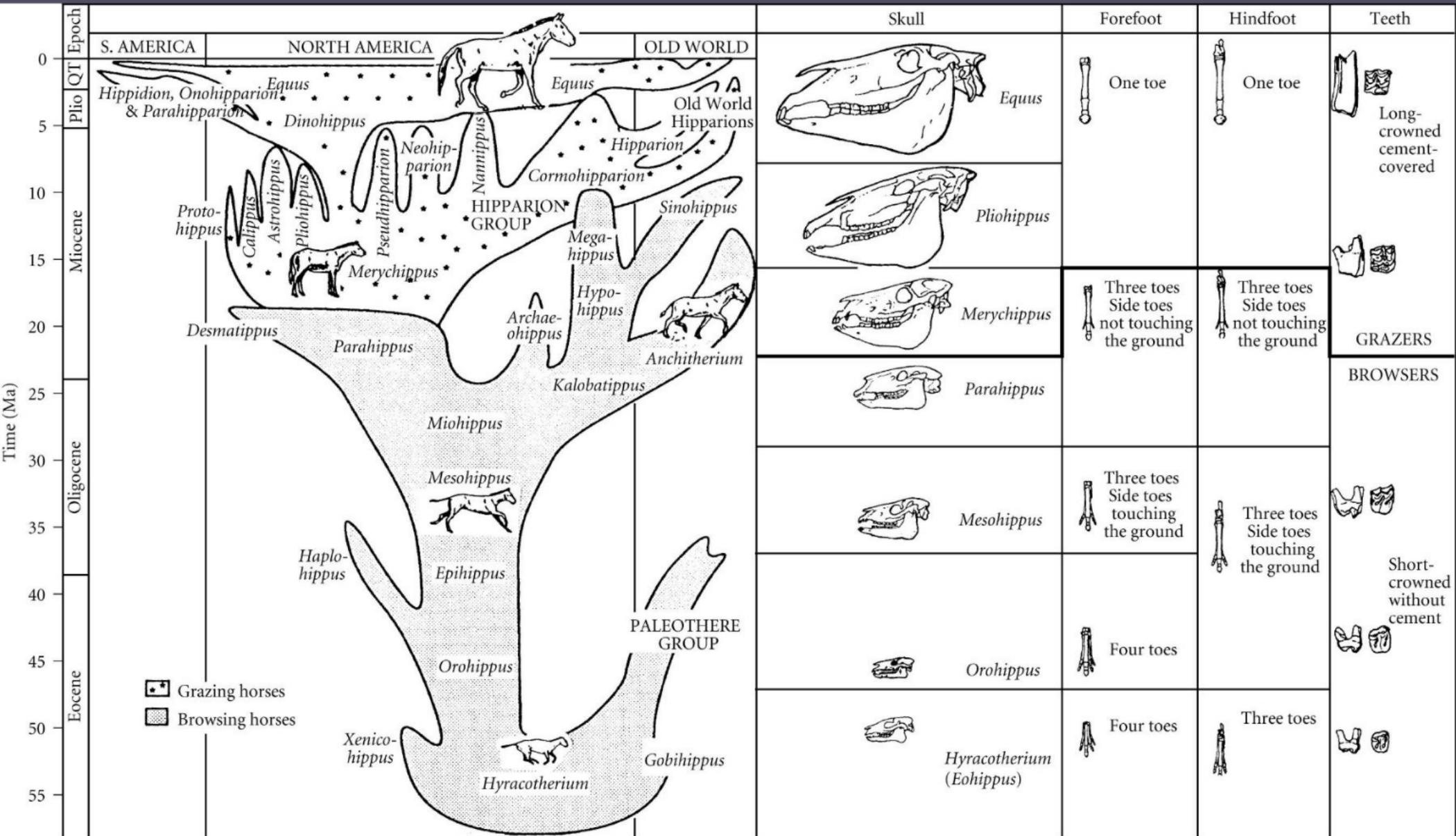
Browsers vs. Grazers

- Browsers:
 - smaller body mass
 - selective feeders - narrow muzzle
 - brachydont cheek teeth (molars and premolars)
 - 3 toes, unfused lower limb bones

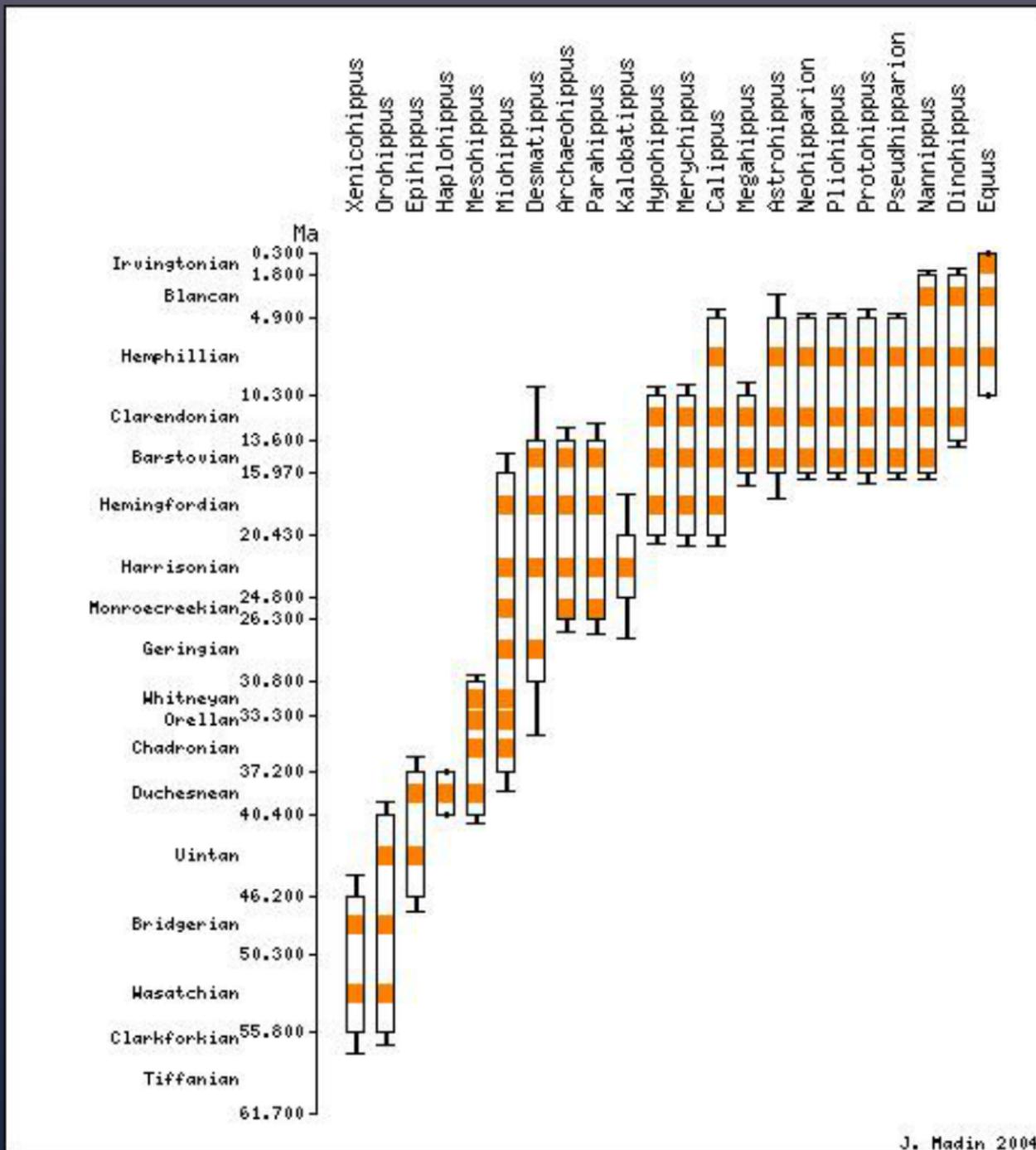
- Grazers:
 - larger in overall size
 - broad muzzle, deeper jaw
 - hypsodont cheek teeth
 - fused radius/ulna & tibia fibula

Not a 1:1 ratio of replacement





North American Land Mammal Ages



Taxonomic ranges for North American equid genera

		Mammal Age	
Pleistocene	Rancholabrean	2.00	
	Irvingtonian		
Pliocene	Blancan	5	
Neogene	Miocene	Hemphillian	8.3
		Clarendonian	11.8
		Barstovian	17.5
		Hemingfordian	20.0
Oligocene	Arikareean	29.5	
	Whitneyan	32.2	
Paleogene	Eocene	Orellan	34
		Chadronian	37
		Duchesnean	42
		Uintan	48.2
		Bridgerian	50.8
		Wasatchian	57.4
Paleocene	Clarkforkian	58.8	
	Tiffanian	62.3	
	Torrejonian	65	
	Puercan	66.4	
Cretaceous	Lancian		

Equidae

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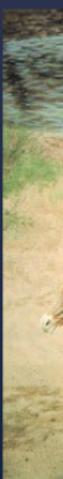
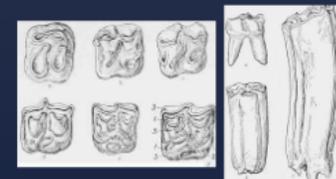
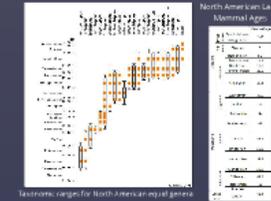
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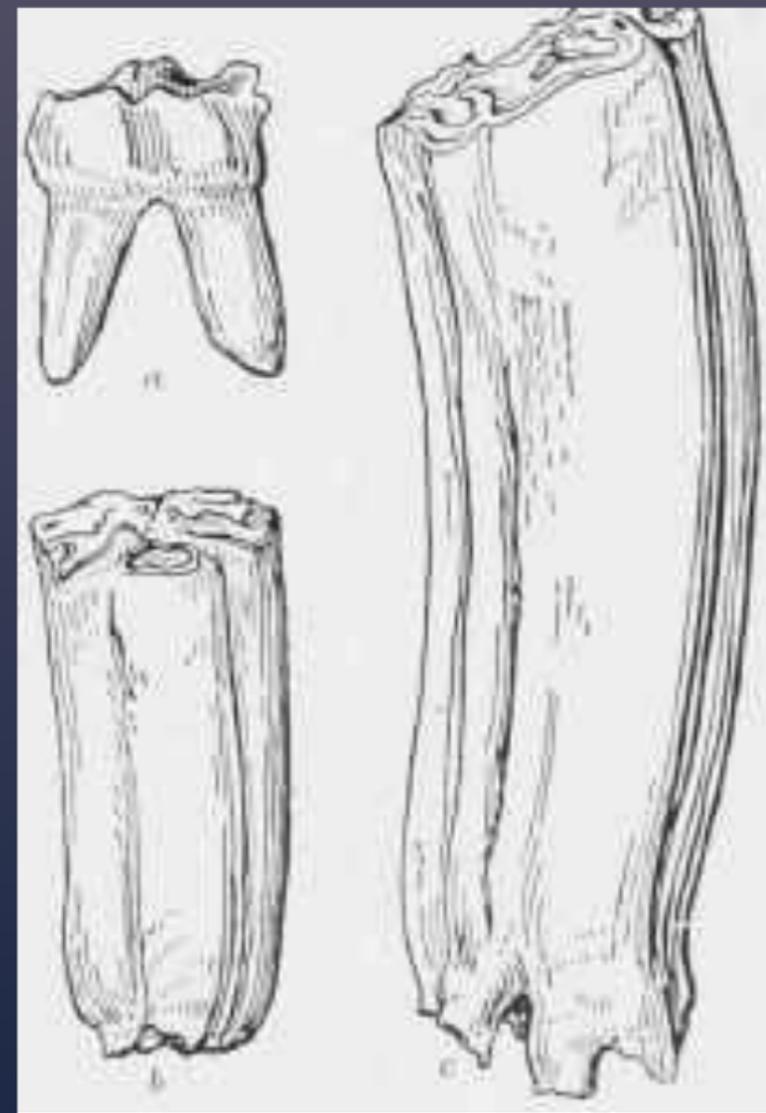
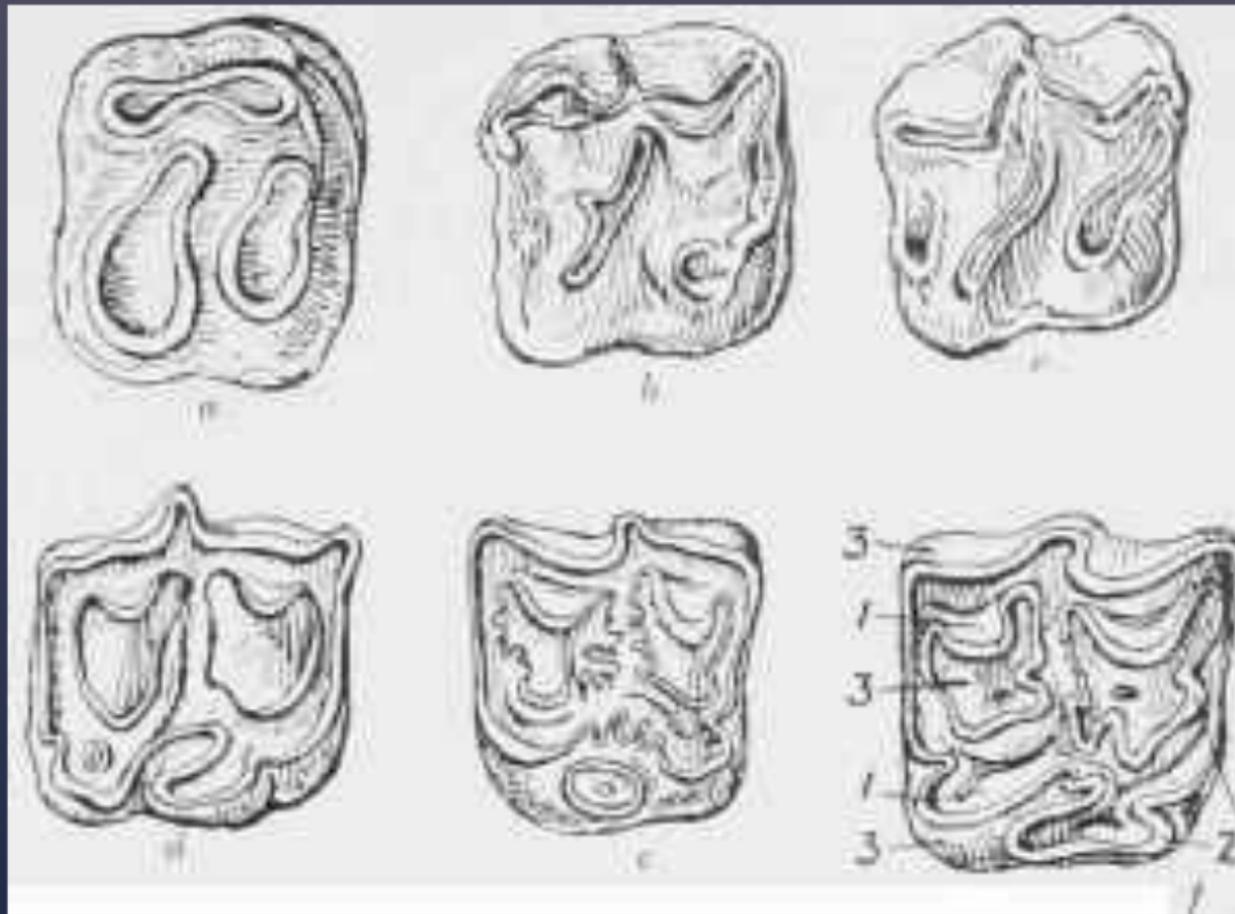
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Climate Change in the Miocene

- Shift in mid to late Miocene - temperate grasslands replacing forest and tropical savanna biomes
- Cooler temperatures, seasonal, arid climate
- Drop in atmospheric CO₂ levels

The C₃/C₄ Transition: 7 Ma

- Calvin cycle - plants combine carbon into 3 carbon chain compounds = C₃
- Hatch-Slack cycle - carbon is combined into 4 carbon chain compounds = C₄
- C₃ & C₄ combine stable carbon isotopes in different proportions
- C₄ plants - better adapted to seasonal, drier climates (corn is a modern example)

Classic Misconceptions

- Widely believed that horse evolution was a simple straight line (orthogenesis)
- Change in tooth crown height was an adaptive response to spread of grasslands, and change from C3 to C4 grasses, particularly abrasive silica phytoliths in grass

...not that simple



New Research

Did the change from forest to grassland really affect horse evolution?

Tooth Enamel Analysis:

- Stable isotope ($\delta^{13}\text{C}$) values can be determined through mammal tooth enamel analysis
- CO₂ gas - extracted from powdered enamel samples - cryogenics
- carbonate gas analyzed for carbon isotope values

Results:

Hypsodont dentition:

- developed before (20-15 Ma) the C₃/C₄ transition - horses with high crowned teeth are still eating C₃ grasses

Other new areas of research:

Phytolith Analysis, Enamel Microwear Analysis



amel Microw



