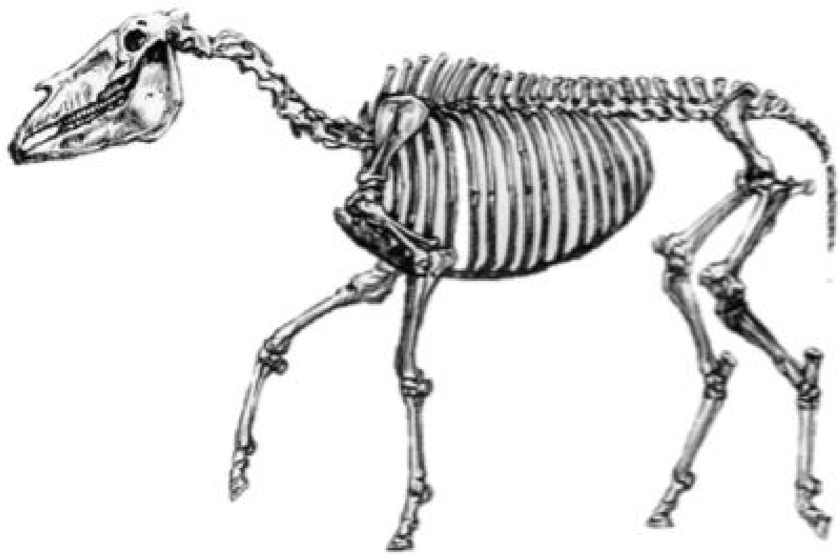
FOSSIL TEETH

A LESSON ON CHANGING CLIMATES AND EVOLUTIONARY RESPONSES PRESERVED IN THE FOSSIL RECORD



A set of lesson plans for High School Students developed at Hagerman Fossil Beds National Monument. With funding through the Geological Society of America Geo-Scientist in Park Program and the National Park Service.

Paleontology in the "Real-World": Using Recent Paleontological Literature to Engage High School Students and Encourage STEM-based Learning

Gina Roberti
Hagerman Fossil Beds National Monument

Funded by the Geological Society of America GeoCorps Program

National Park Service

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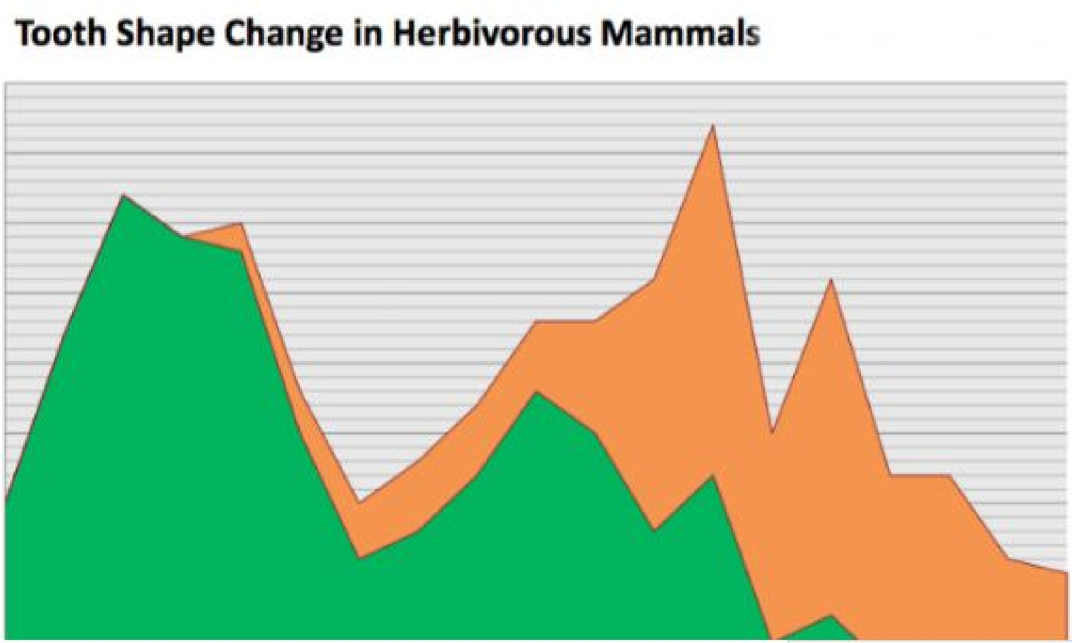
LESSON PLAN

Fossil Teeth: Changing Climates and Evolutionary Responses Preserved in the Fossil Record (Lesson Plan by Geoscientist-in-the-Park Gina Roberti)

Download Lesson Plan

6286KB

HAGERMAN FOSSIL BEDS NATIONAL MONUMENT, HAGERMAN FOSSIL BEDS NATIONAL MONUMENT



LESSON PLANS

- Climate Science in Focus: Data and Tools
- Exploring Climate Science: Climate Change
- Climate Science in Focus: Earth as a System

Multi-part lesson intended for advanced high school students. Pre-lesson, assessment and teacher background documents included.

Digitally accessible through the National Park Service "For Teachers" page.

Palaeogeography, Palaeoclimatology, Palaeoecology 365–366 (2012) 1–10

ELSEVIER

Contents lists available at SciVerse ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

PALAEO 3

Grit not grass: Concordant patterns of early origin of hypsodonty in Great Plains ungulates and Glires

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Inspiration: Primary-source scientific literature (synthesis paper).

ARTICLE INFO

Article history:
Received 22 May 2012
Received in revised form 28 August 2012
Accepted 3 September 2012
Available online 7 September 2012

Keywords:
Mammal
Hypsodonty
Adaptation
Evolution
Grasslands
Great Plains

ABSTRACT

A major step in mammalian evolution was the shift amongst many herbivorous clades from a browsing diet of leaves to a grazing diet of grasses. This was associated with (1) major cooling and increasing continentality and the enormous spread of grasslands in most continents, replacing closed and open forests, and (2) hypsodonty, the possession of high-crowned teeth. Hypsodonty is traditionally linked with eating grass because of the contained phytoliths, silica-rich granules, which are presumed to wear away mammalian dental tissues. However, we present evidence from the Great Plains of North America that the origins of hypsodonty in different clades of ungulates (hoofed mammals) and Glires (rodents and lagomorphs) were substantially out of synchrony with the great spread of grasslands, 26–22 Myr ago (latest Oligocene/earliest Miocene). Moderate hypsodonty was acquired by some Oligocene artiodactyls and several rodent families (mainly burrowers) at least 7 Myr earlier. Highly hypsodont ungulates and hypselodont (= ever-growing cheek teeth) rodents post-date the spread of grasslands by 4 to 9 Myr. Lagomorphs follow a different trend, with hypselodont forms present from near the Eocene–Oligocene boundary. These results indicate that hypsodonty was not a simple adaptation for eating grasses, and may have originated in some clades to counteract the ingestion of grit and soil.

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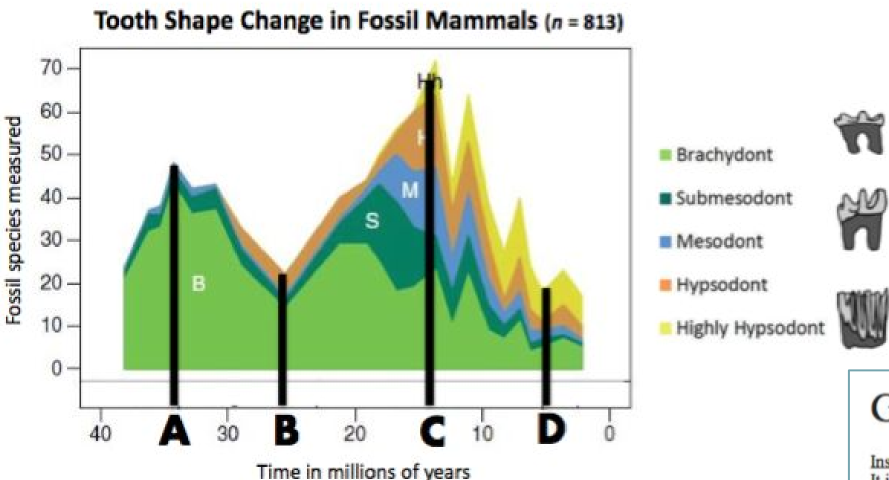
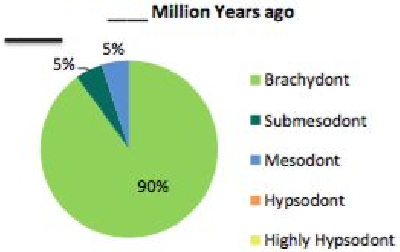
The result: A Lesson Plan with Three Goals:

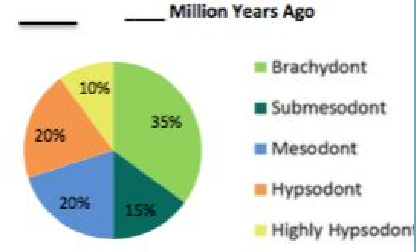
1. Graphical analysis
2. Critical reading
3. Data analysis

Student Worksheet: Analyzing 'Real-World' Data



The graph above marks the change in PROPORTION of species with different teeth over time.
Directions: Match each pie chart to the correct location on the graph.





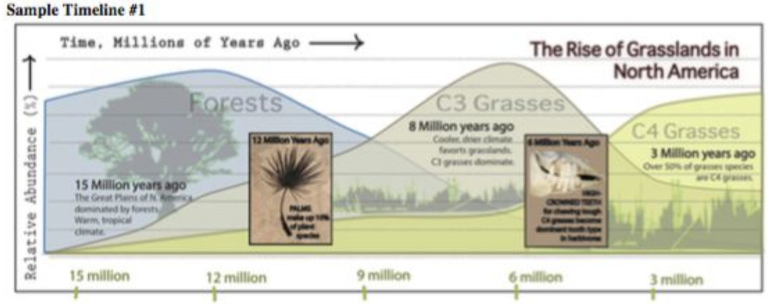
Student Timeline Activity

Instructions: Science communication is important in today's world, where it often takes 10 years for new scientific breakthroughs to reach the public.

Your task: Use the fossil evidence below to create a story about how plants and animals adapt to climate.

Creativity is encouraged! A few example timelines are shown below. Just be sure to support your design choices with data from the following pages (Lines of Evidence #1-4).

Sample Timeline #1



Design Notes: In Sample #1, the shaded background colors are actually a graph representing different types of plants and how the abundance of various plants changed over time! Each step of the y-axis (the grey horizontal lines) represent a 10% increase in the abundance of each plant type. For example, at 9 million years, 15% of plants are C4 grasses, 40% are C3 grasses and 45% are forests. This matches the graph in Line of Evidence #4 (pg. 4).

Grit Not Grass. Student Worksheet.

Instructions:
It is your job to investigate the hypothesis of 'Grit Not Grass' presented by paleontologists Philip Jardine, Christine Janis, Sarda Sahney and Michael Benton in a scientific publication in 2012. The following excerpt is taken from the introduction of their paper.

Using what you have learned about the rise of grasslands in North America, and what you know about how organisms adapt to changes in their environment, your task is to write a letter in response to the hypothesis presented in the paper below.
Your letter must address the question:

Do you support the 'grit not grass' hypothesis as a valid explanation for the early rise of hypsodonty amongst North American land mammals?

Your argument must be supported with information from your data analysis of last class.

If eligible, your letter may qualify to be sent to the National Park Service paleontologist at Hagerman Fossil Beds National Monument.

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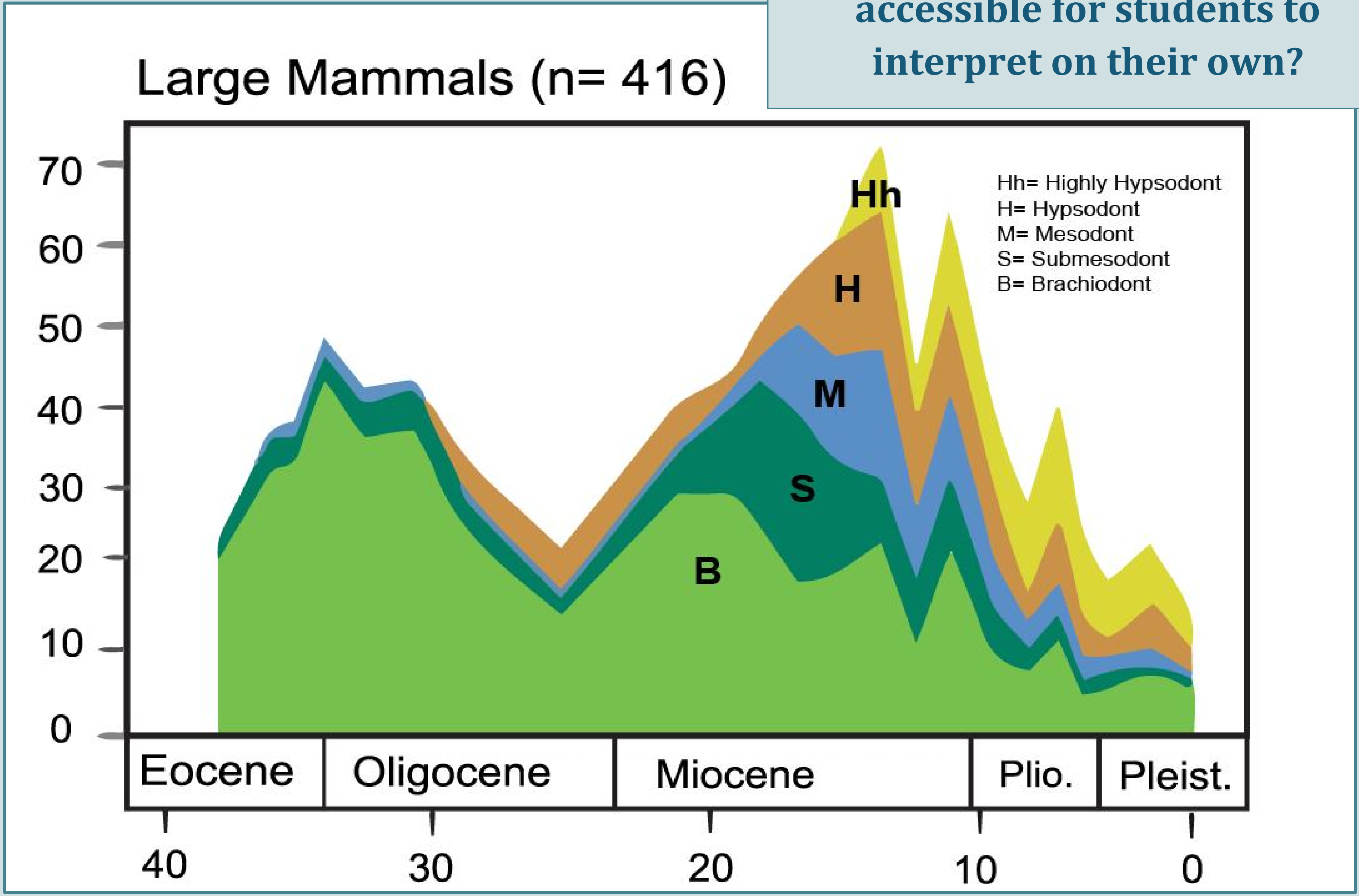
Grit not grass: Concordant patterns of early origin of hypsodonty in Great Plains ungulates and Glires

Working with primary source data.

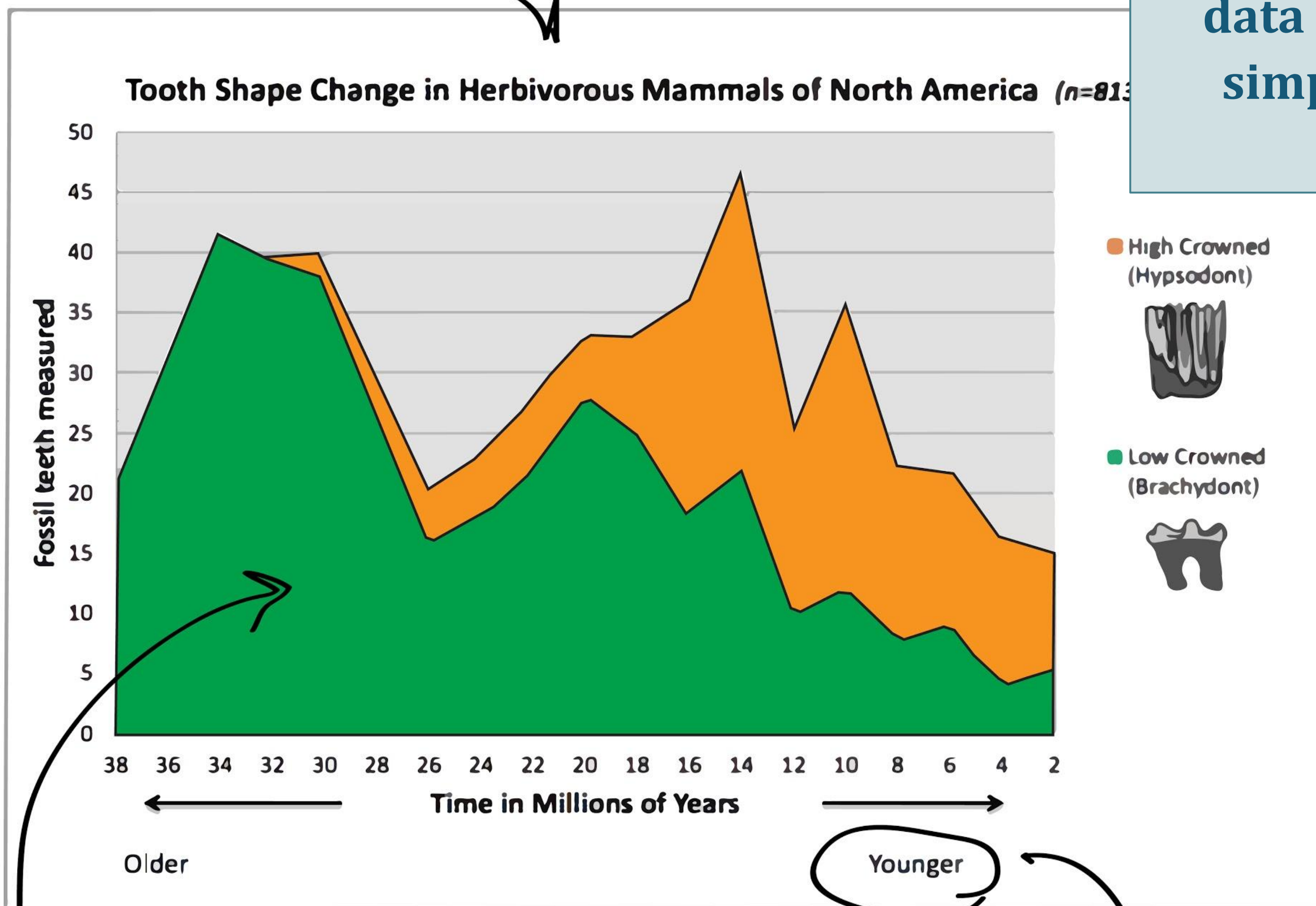
Problem: How to make data accessible for students to interpret on their own?



Source of image: Jardine, Janis et al. 2012.

Step 1. Change Title
Add context.

Solution: Modify the data and re-graph to simplify. Eliminate jargon.

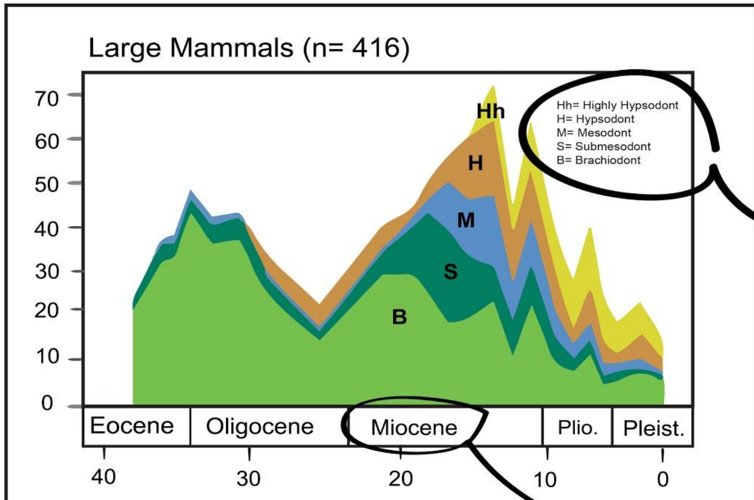


Step 4.
visual key
color-coded

Step 2.
Simplify Amount of
content displayed

Step 3.
Eliminate jargon.

Start: Multi-dimensional line graph from primary source data



Step 1. Change Title
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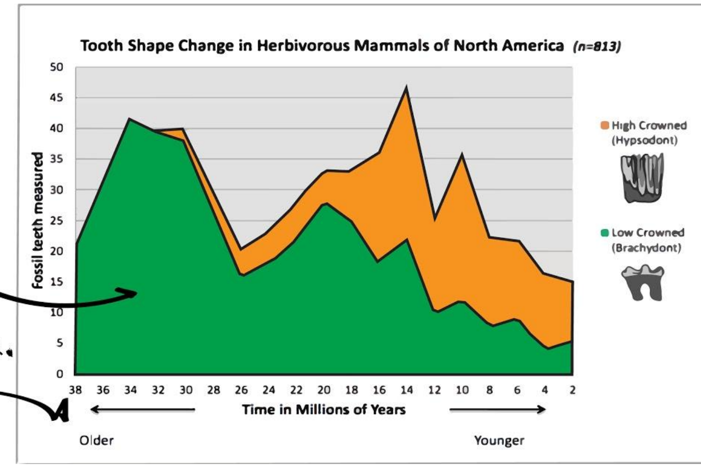
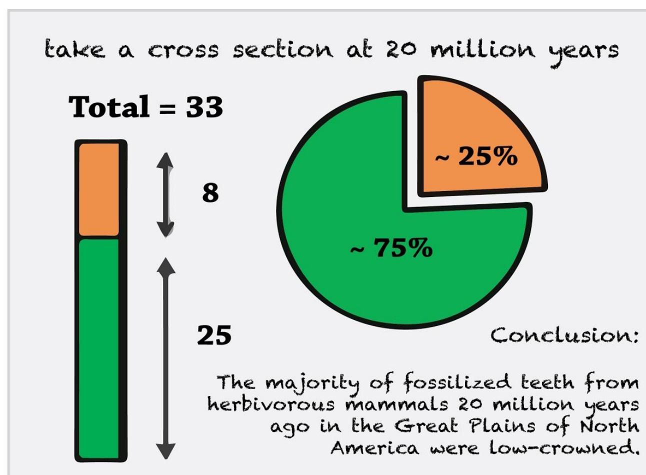


Teach: Reading the graph step by step.

Students learned to read a complex graph based on paleontological data published in 2012.



The stem of a five foot long crinoid!

The next step: How to present paleontology as an exciting field?

What does paleontology look like today?

Start with real people.

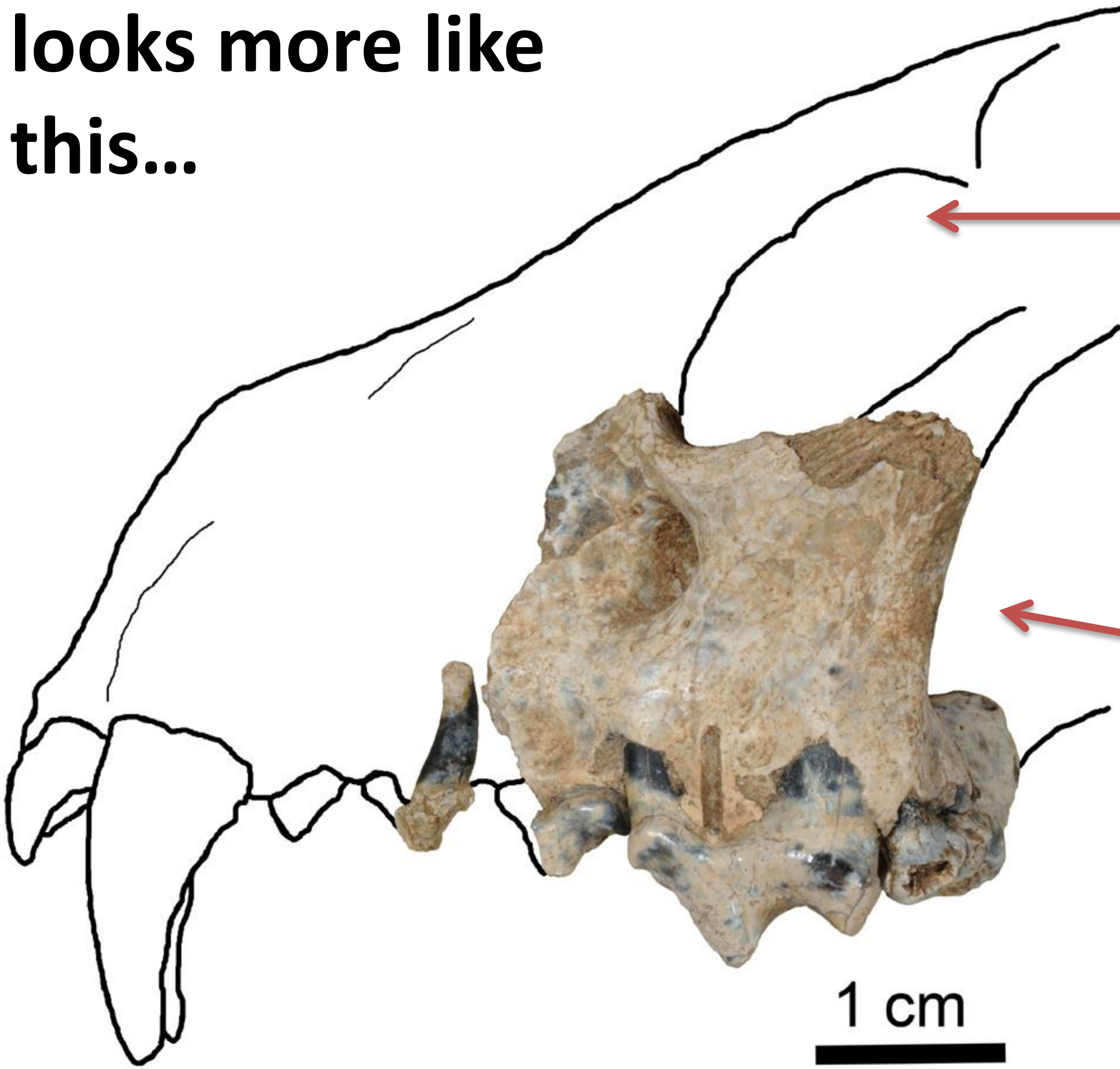
(Jurassic Park = NOT real people.)

Misconception: All paleontology ≠ dinosaurs.

Courtesy Library of Congress, Portrait Photographs 1920-1930.

Photos courtesy NPS.
Fossils from the Green River Formation.
Fossil Butte National Monument, Kemmer WY.

Often, fossils looks more like this...



Drawing **(inferred)**

Partial Skull Fragment

Photo Courtesy NPS.
Source:
John Day Fossil Beds National Monument (Oregon).

Different (dinner**) Strokes for Different Folks**

Today's focus:
One recent study in paleontology that looks at

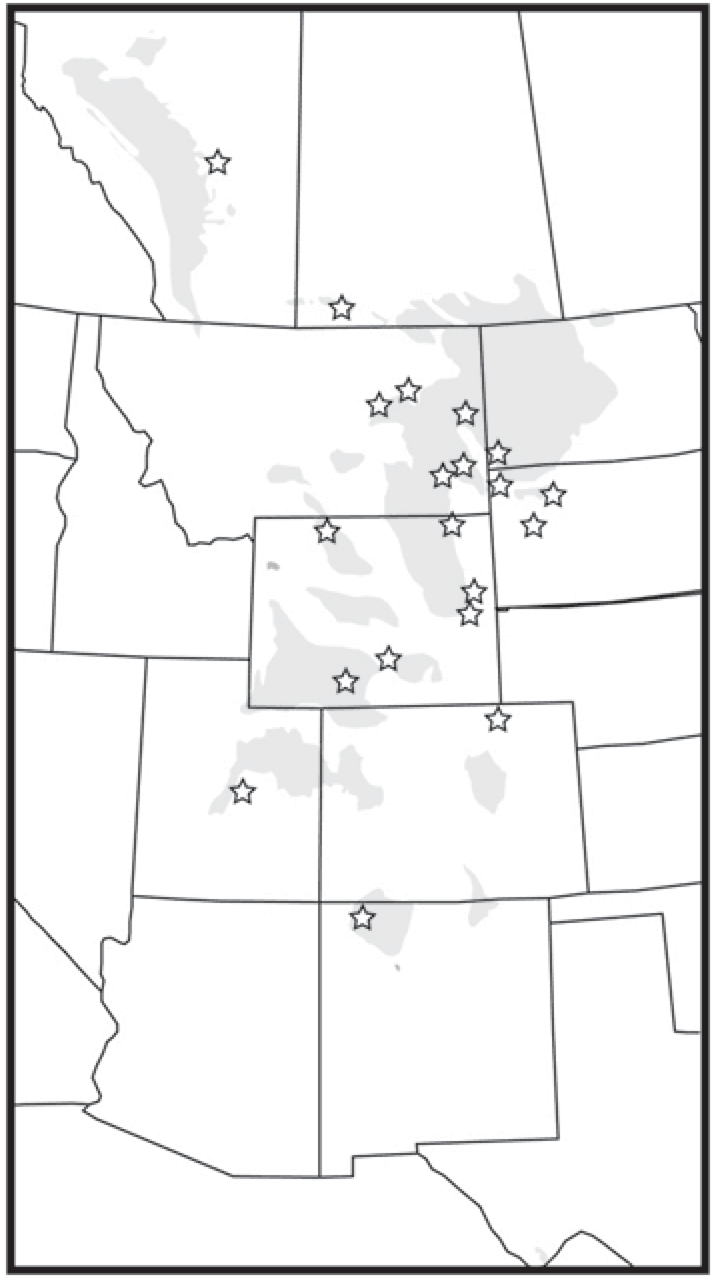
fossil teeth.

Why?

(1) Teeth are **tough and resistant to wear**.

(2) Critters have lots of teeth.

Thus teeth are **one of the most common** parts of an animal **to become fossilized.**



Study Area:

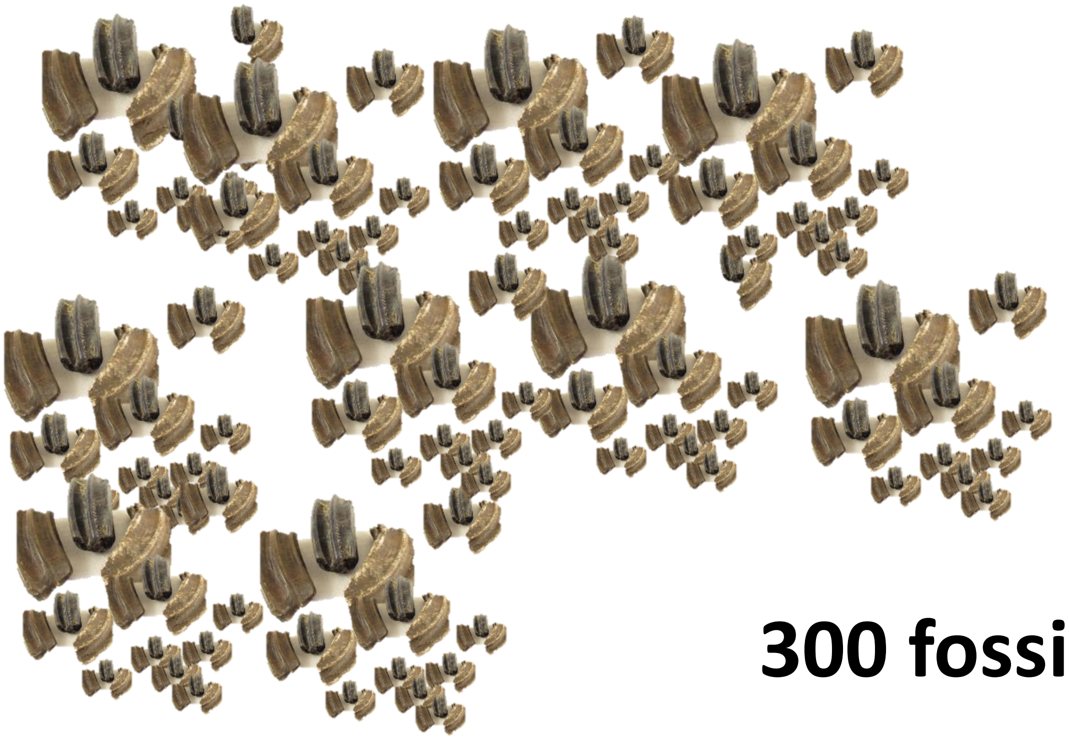
The Great Plains of North America


Step 1: finding fossils…

And more
fossils…

30 fossil teeth…

30 fossil teeth



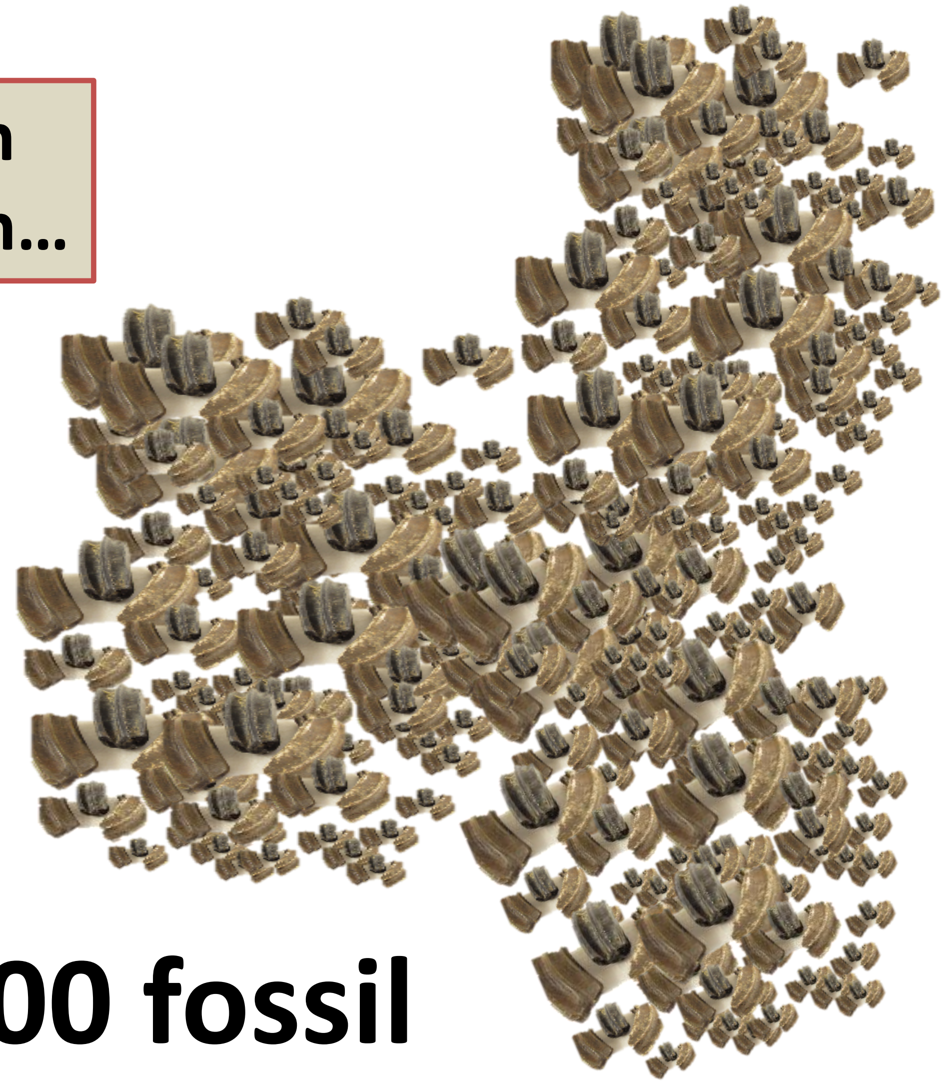
300 fossil teeth…

And more fossils …

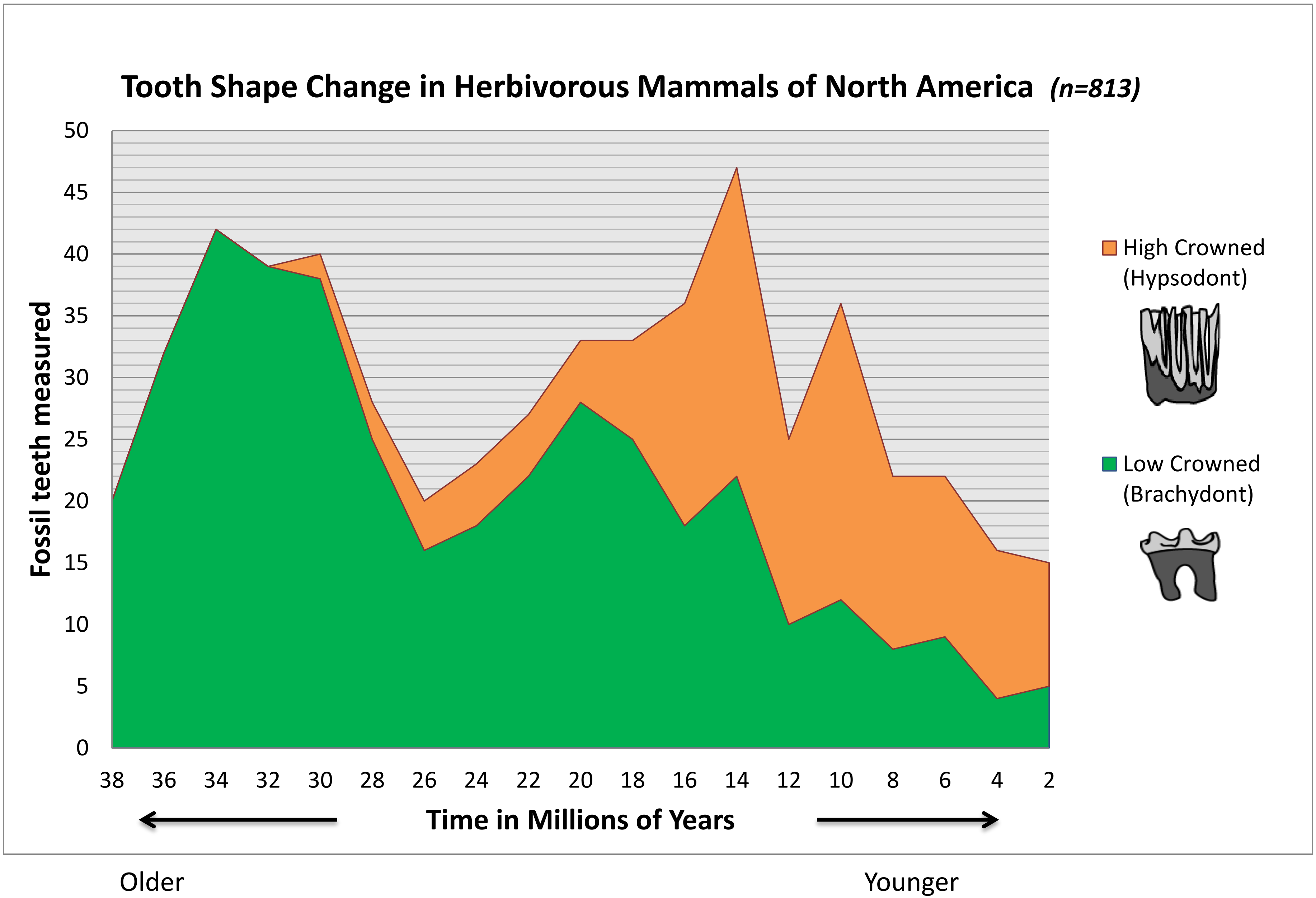
30 fossil teeth

And even more teeth…

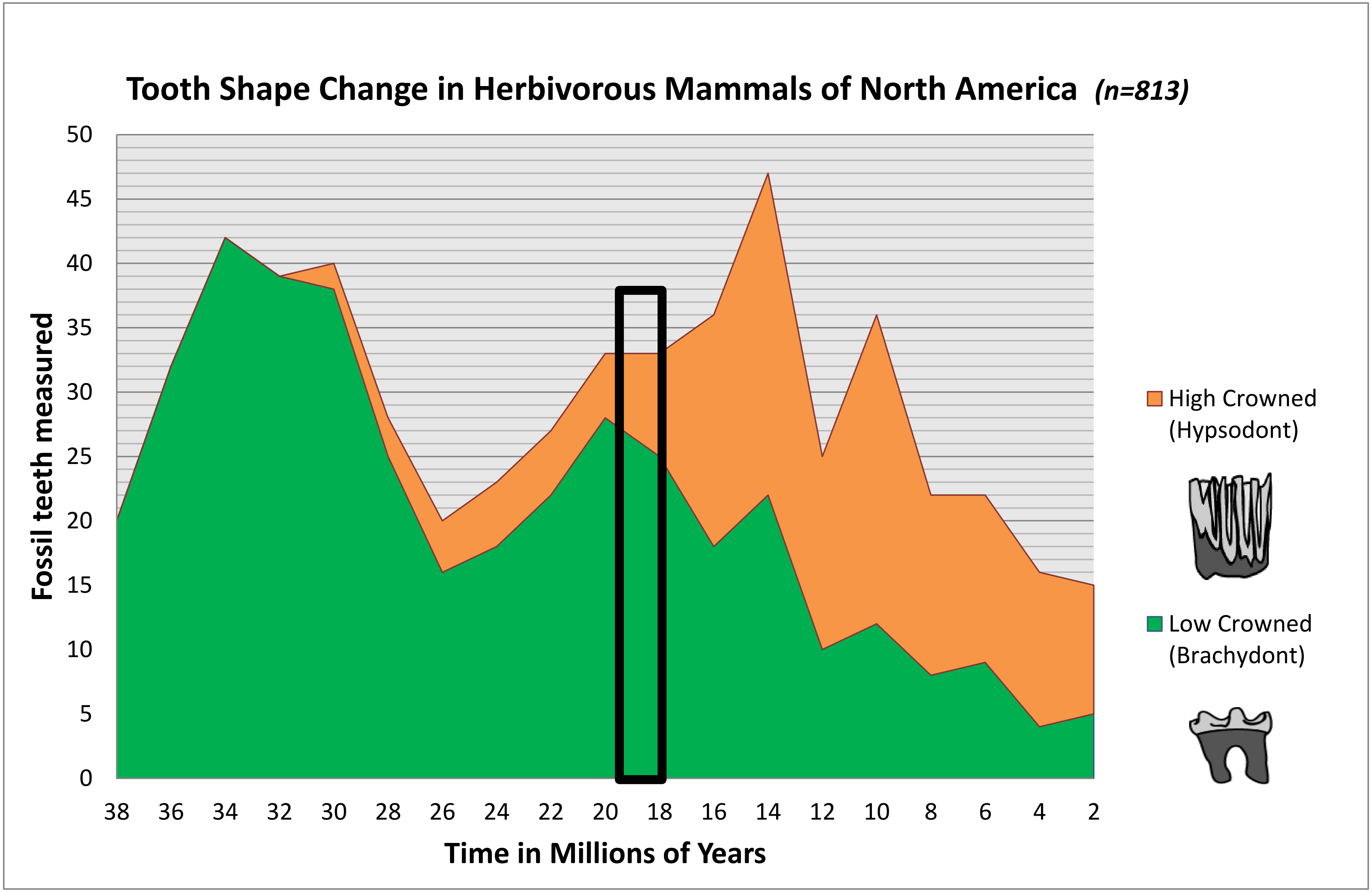
300 fossil teeth



800 fossil mammal teeth!



Tooth Shape Change in Herbivorous Mammals of North America (n=813)
Fossil teeth measured
50
45
40
35
30
25
20
15
10
5
0
38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
Time in Millions of Years
High Crowned (Hypsodont)
Low Crowned (Brachydont)
Older
Younger



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4
2
Time in Millions of Years
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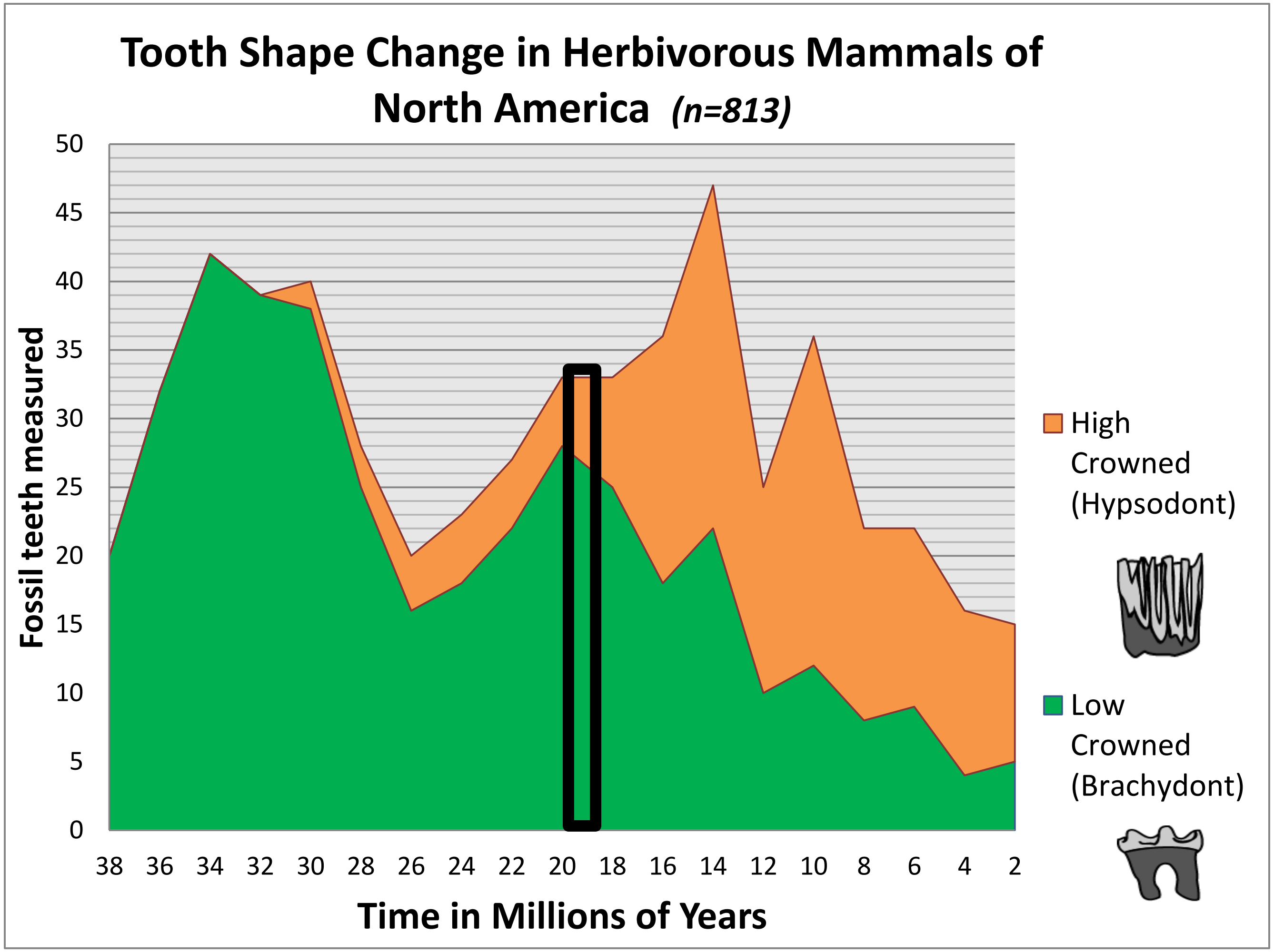
Low Crowned (Brachydont)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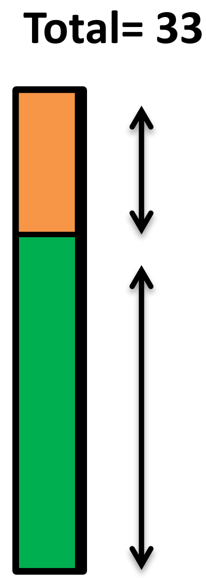
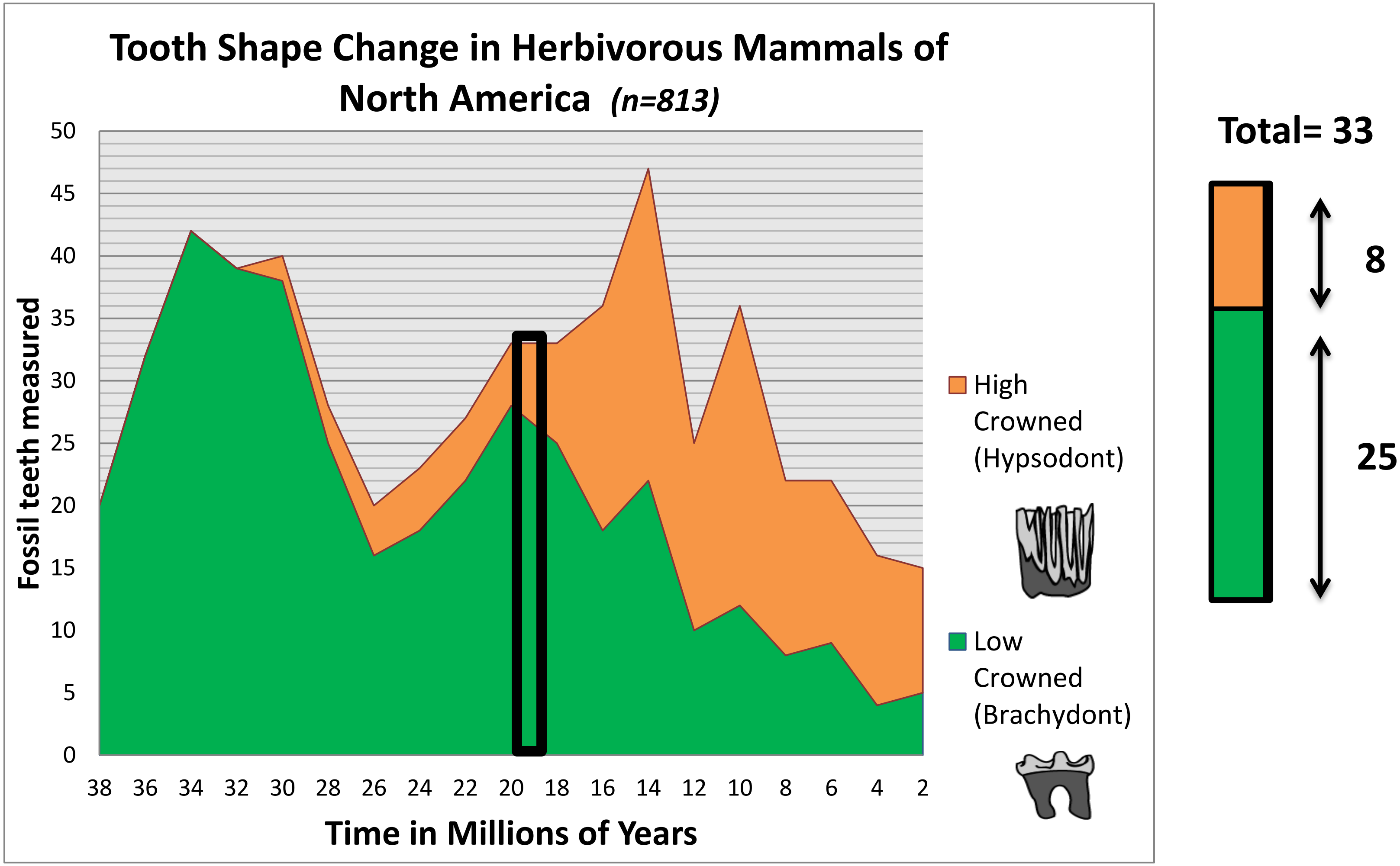

Total= 33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Fossil teeth measured
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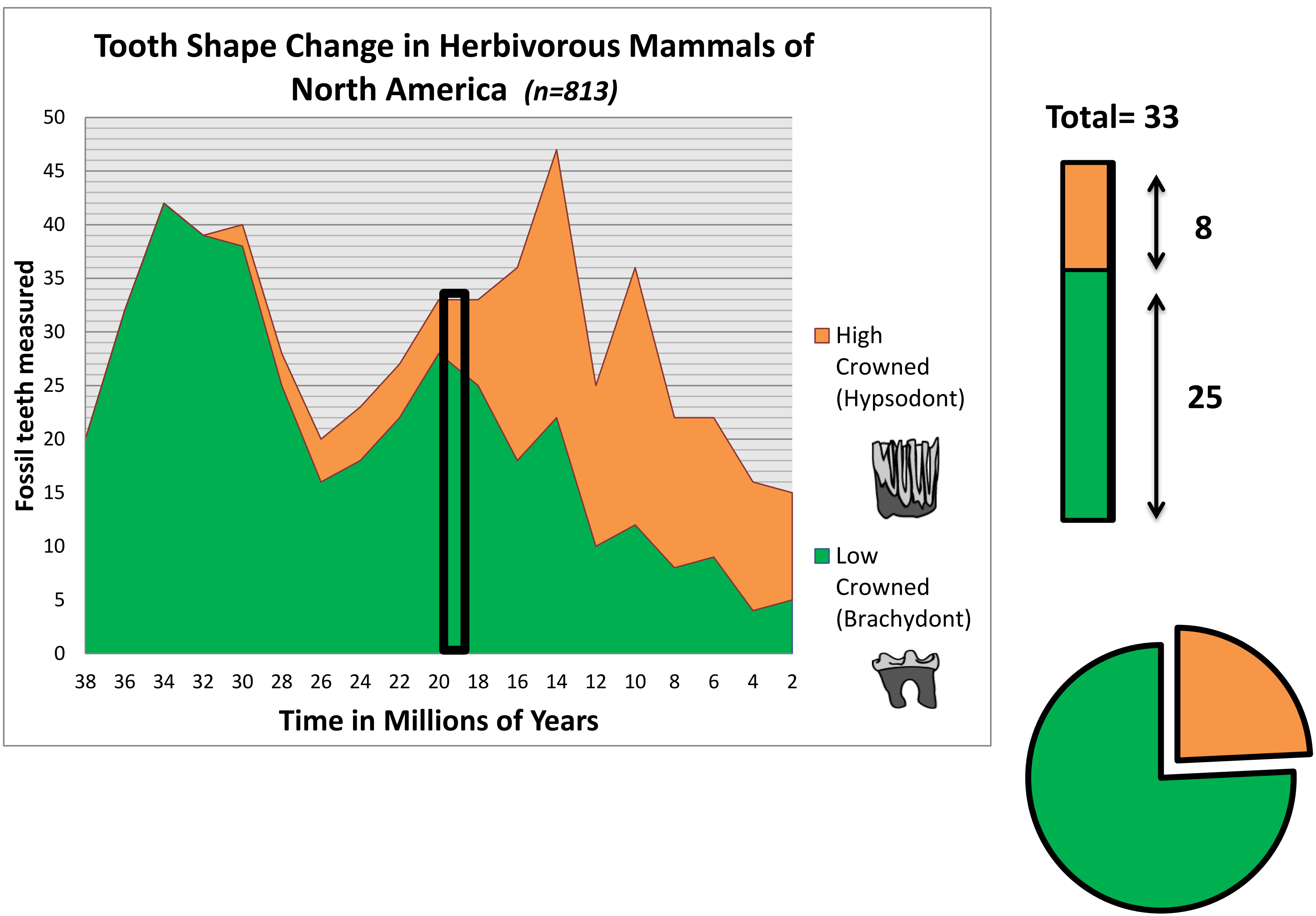
Time in Millions of Years
High Crowned (Hypsodont)
Low Crowned (Brachydont)
Total= 33
8
25



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Low Crowned (Brachydont)
Total= 33
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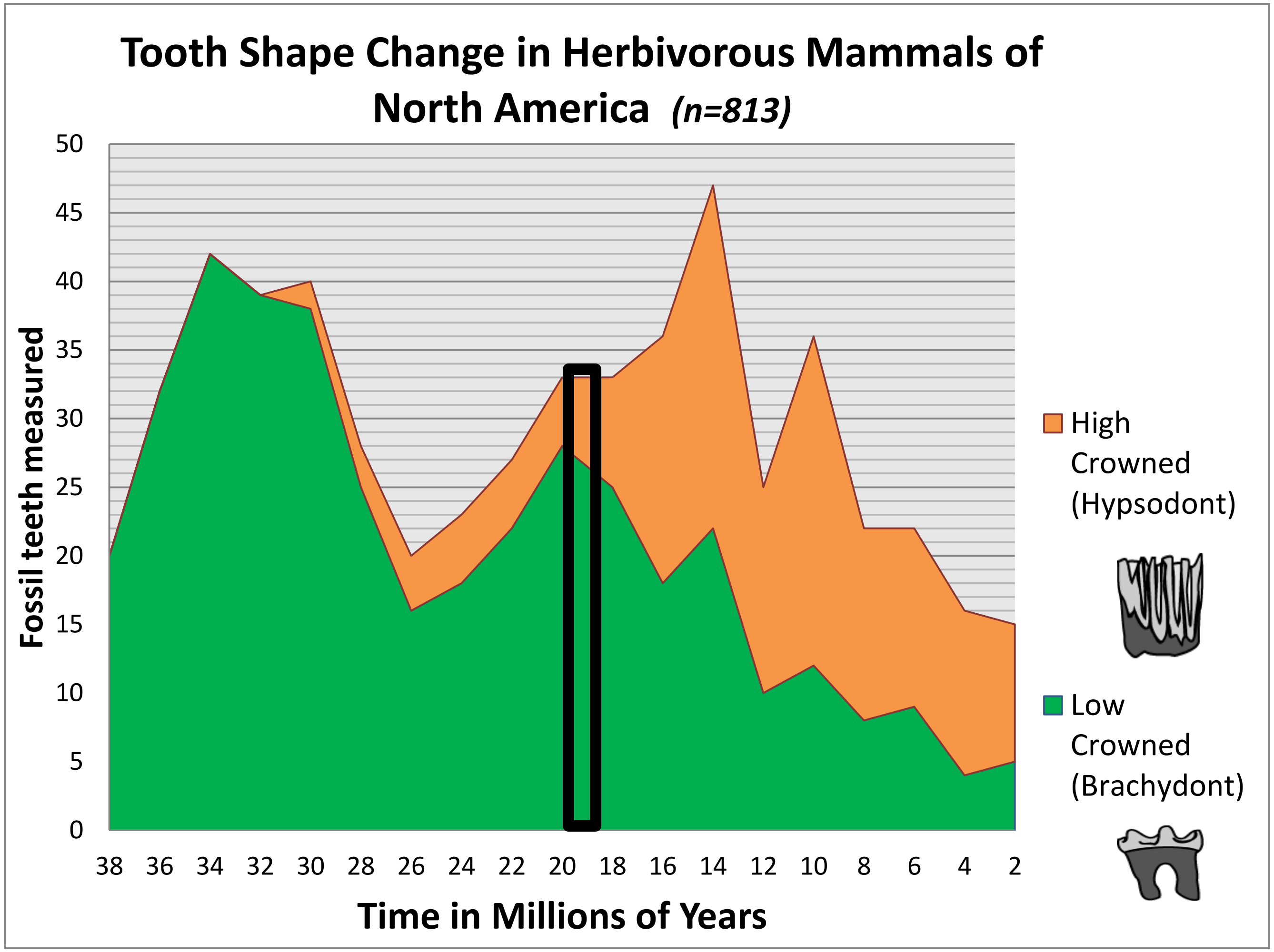
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Time in Millions of Years
High Crowned (Hypsodont)
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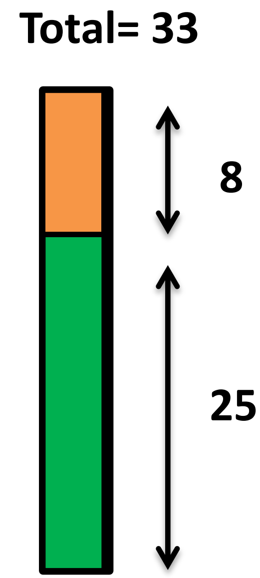
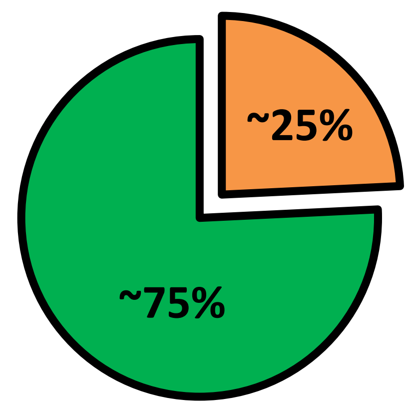
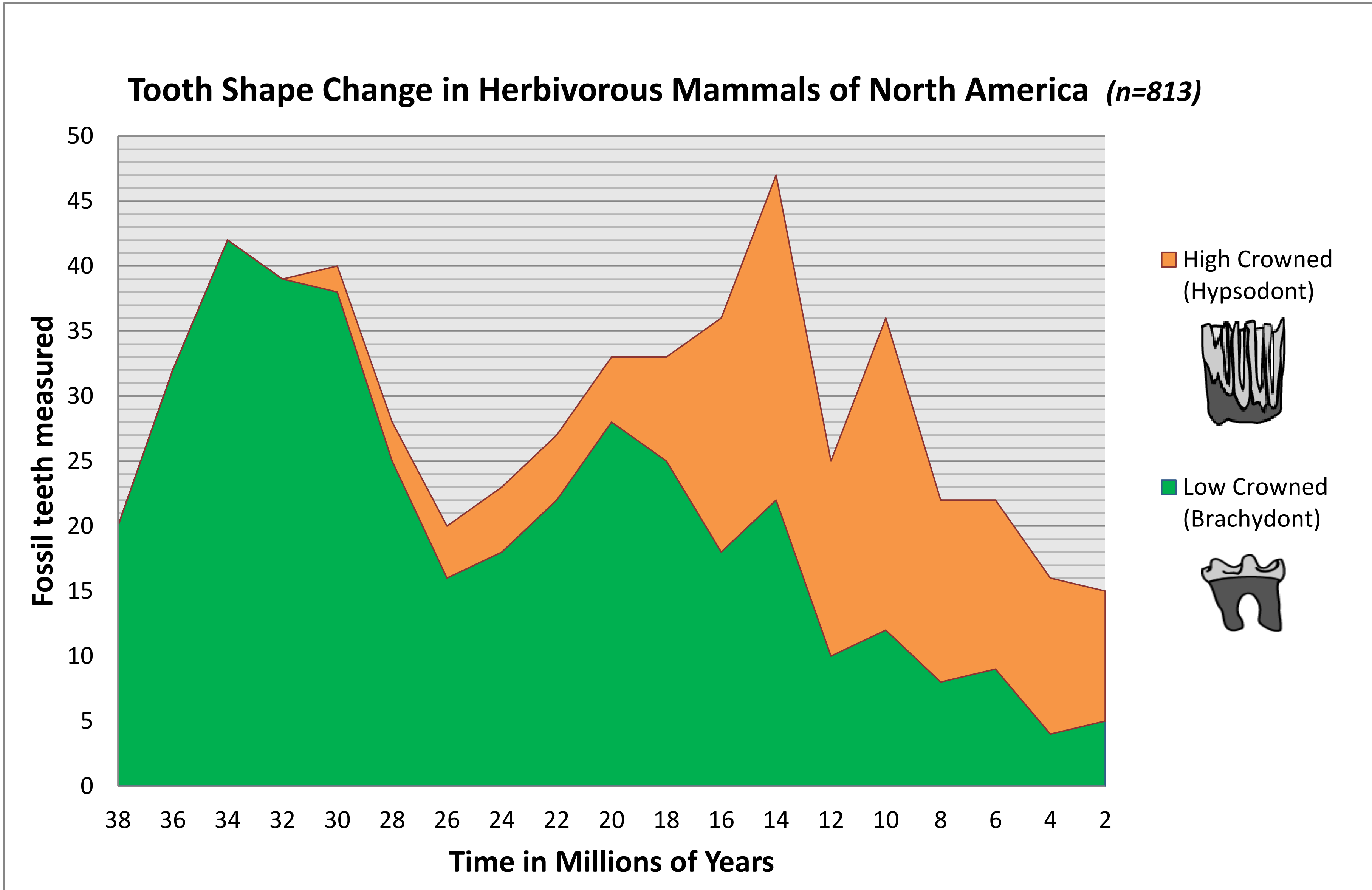

Total= 33
8
25


~25%
~75%



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Fossil teeth measured
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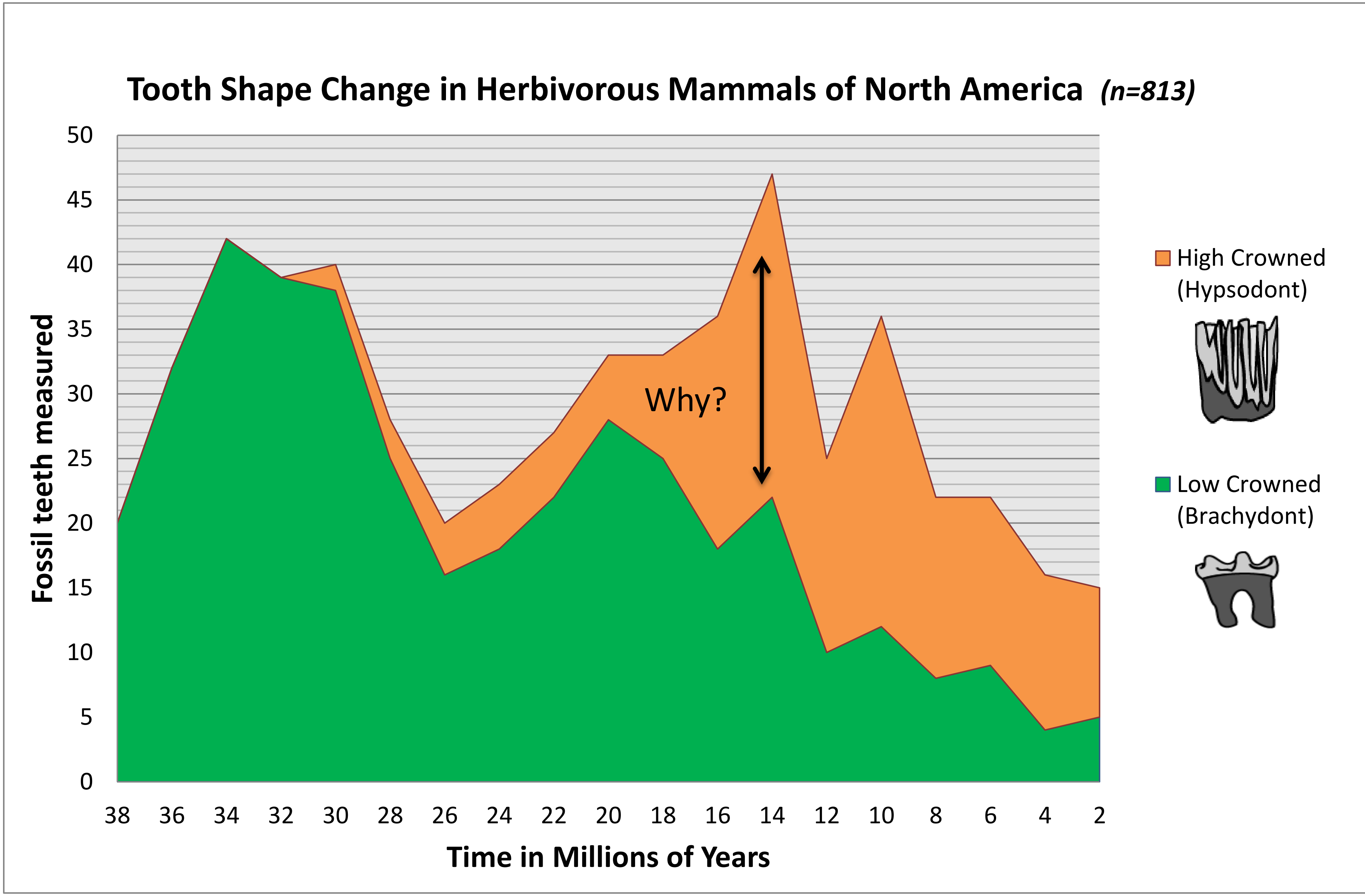
Time in Millions of Years
High Crowned (Hypsodont)
Low Crowned (Brachydont)


Tooth Shape Change in Herbivorous Mammals of North America (n=813)
50
45
40
35
30
25
20
15
10
5
0
Fossil teeth measured
Why?
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Time in Millions of Years
High Crowned (Hypsodont)
Low Crowned (Brachydont)

Perhaps the change in tooth shape was a result of new habitats.