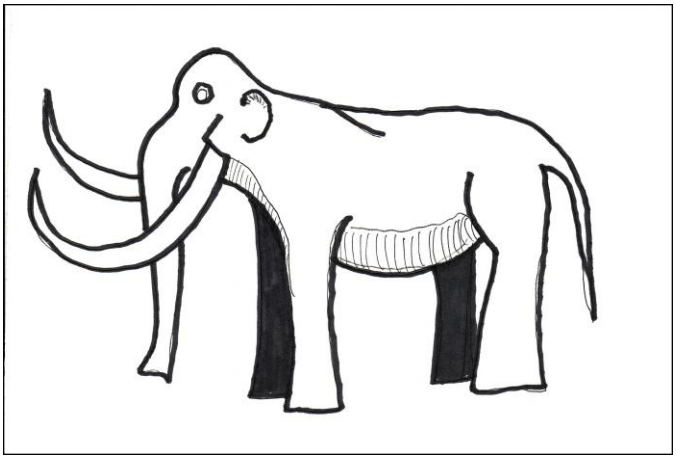
Twenty-Three

1. The Paleogene Period begat the Neogene Period, 23 million years ago. The Neogene Period, meaning "newborn"—signifying the change in the nature and number of species from the Paleogene—lasted about 20 million years, a short time compared with the previous periods, but still a very long time, and ended "only" 2.5 million years ago. [i]
2. During these 200,000 centuries, the continental plates were moving toward the arrangement we have today. Near the end of the period, North and South America connected, creating the narrow neck of land, what we call an *isthmus,* which is now the country of Panama. This event separated the flow of warm water from the Pacific to the Atlantic Oceans. [ii]
3. That event meant two things. First, the warm waters of the Pacific no longer flowed into the Atlantic Ocean.
4. Second, the divergence of evolution that had occurred on both continents could now interact. Unusual animals like armadillos, sloths, opossums, and porcupines could walk from South America to North America, and they did, expanding their habitat.
5. This "divergence of evolution" is important to understand, my child. Changes in a species that appear during evolution are hard to see. Most of the time, you wouldn't recognize them from one generation to the next. It's only over several, even hundreds of generations that these changes might be visible to one who could see the first generation and the thousandth.[iii]
6. Sometimes, the changes might appear more quickly. If a generation of humans, for example, who didn't have enough milk, were given milk to drink early on, they would tend to be much taller than the previous generation. The number of bones in their bodies would be the same, but those bones would be bigger and stronger.
7. Growing a new leg or a new flipper or losing a tail, however, would be a process that would take generations and generations, perhaps thousands or even millions of years. So when we say that there were armadillos in South America but not in North America before the two continents collided, it means that the conditions in South America encouraged the development of animals like armadillos while the conditions in North America did not. [iv]
8. And over millions of years, little changes in the children of one pair of animals led to another little change in another set of children, which begat another little change in another set of children, which begat another little change in another set of children and so on and so on and so on. Do you understand, my child?
9. "I think so. Little changes over long periods of time add up to big changes. Right?"
10. That's right! Meanwhile, as we were talking, the Earth was also evolving. We could say that the Neogene Period was also the "Age of Mountains," for during this 20 million years, many of the Earth's great mountain ranges were created or enlarged. The northward movement of the India plate continued to push up against the Asian plate, and the Himalaya Mountains continued

to grow higher and higher, eventually becoming the highest mountain range on the Earth.

11. Mount Everest is the tallest mountain on the Earth, over 29,000 feet or 8,848 meters high. [v]
12. In Europe, the plate carrying Italy moved northward pushing the Alps upward, and Spain pushed up against France raising the Pyrenees.
13. In the Western Hemisphere, the east-west collisions of tectonic plates pushed up the Rocky Mountains in North America and the Andes Mountains in South America.
14. As for the climate, my child, things gradually cooled and cooled, and this led to a series of ice ages. During the Neogene Period, though, this meant that ice caps formed more clearly on the North and South Poles. [vi]
15. During the "newborn" period, birds and mammals evolved dramatically into their modern forms while plants and marine life remained fairly stable.
16. The cooler temperatures encouraged the development of different kinds of grasses, and the grasslands spread. As a result, more and more grazing animals grew and diversified. Vast herds of bison, horses, early forms of sheep, called mouflons, and antelope roamed the plains and steppes.
17. About 6 million years ago, the first elephant-like animals appeared in what is now Africa. They roamed over the grasslands and diversified into mastodons and wooly mammoths. [vii]
18. Mastodons lived mostly in North America and grew to about 9 feet in height and could weigh 5 tons. Mastodons had a flat head but very long tusks that curved upward.

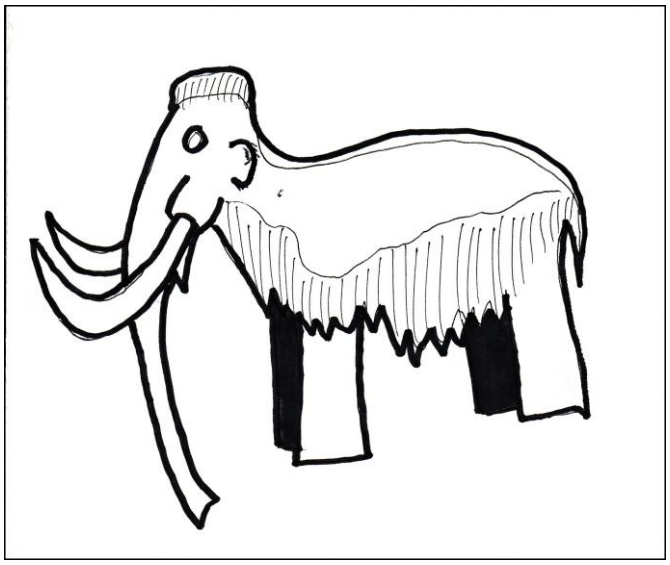


Mastodon

Hand drawn by author after viewing multiple images including [viii]

19. Mastodons lived in herds grazing on certain kinds of grasses and twigs. They lived for a long time, about 4 million years, but then went extinct. They were hunted to extinction, but more about that later.

20. In the northern areas, about 3 million years ago, another elephant family member thrived, the wooly mammoth. We have been able to track the evolution of mammoths because there were a lot of them. Their teeth, their head and jaw shape, and other aspects adapted and changed as they roamed over different *ecosystems* across what is now Europe.
21. Do you know what an "ecosystem" is, my child? An ecosystem is all of the things that allow things to live, the combination of soil, water, air, plants, chemicals, heat, seasons, other life forms, and so forth that either encourage one kind of life or discourage it. If you live in a grassy ecosystem, you have to have the kind of teeth that can grind grass and the kind of stomach that can digest grass. Otherwise, you will die.
22. Mammoths were very big. They could be 13 feet at the shoulder and weigh 12 tons. They had long, curling tusks and hairy bodies. Mammoths like mastodons lived a long time. The last ones died out about 10,000 years ago. Perhaps the warming climate contributed to their death. Perhaps they contracted a disease. Perhaps they were hunted out by hominids (people). More on that later.



Mammoth
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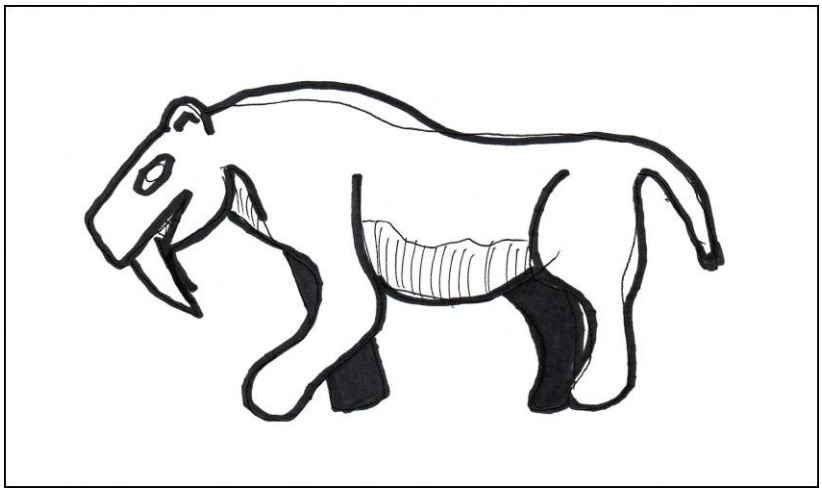
23. Even today, tiny little one-celled organisms like the very first life on the Earth can kill the largest of animals.
24. The development of grazing herds meant that those animals that ate the grazing animals had to run faster, and so the predators evolved to be thinner and faster. Cats grew bigger and faster as did dogs.
25. The cats had to eat, so they had to learn to run faster to catch the antelope as they ran away. And they evolved, or they died. Those who ran faster and caught their food lived. Those who were slower and couldn't catch their food died. And the cats became faster.

26. In the oceans, a new algae ecosystem developed, as kelp forests attached themselves to coral and rock beds. New animals that could live in these kelp forests evolved, many of them still around today, animals such as the dugong and the manatee.
27. But the sharks were still the king of the seas. *Megalo-don*, Big Tooth, was the biggest shark of all. He grew to be up to 60 feet long and could catch, kill, and eat even large whales. Megalodon was much bigger than the great white sharks we have today. His teeth were as much as four or five times larger! As many as ten people could fit inside megalodon's mouth! Clearly, megalodon was the T-Rex of the seas! None of the fishes or animals in the seas were safe from him. [x]
28. Do you remember what I told you about the law of nature, how all living things need food to survive, and how the strong eat the weak? Megalodon had replaced the mesosaurs as the king of the seas. The big fish were eating the little fish.
29. On the land, the big cats and the big dogs were chasing the herding animals, catching the slower and older ones, killing them, and eating them.
30. One of the predators developed very long canine teeth. He looked like a cat, and we call him a saber-toothed cat or tiger. His canine teeth could grow up to 20 inches long! While we called them cats, their bodies were more like bears. [xi]



Saber-toothed Tiger
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31. The saber-toothed cats hunted large mammals such as rhinoceroses, elephants, and other large plant-eaters.
32. Nearby, on the fringes of the grasslands, by the trees, another very important development was occurring. Some of the monkeys, the primates, were beginning to walk on their hind legs. About 3.5 million years ago, in eastern Africa, a group of primates we have named *Australo-pithecus* appeared.

33. And with Australopithecus, we begin a new and important chapter in our story, my child, a more distinct part of the song of mankind. [xiii]

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[i] https://en.wikipedia.org/wiki/Neogene, May 2016
[ii] https://en.wikipedia.org/wiki/Pangaea, May 2016
[iii] Dawkins (2010)
[iv] http://evolution.about.com/od/LifeOrigins/ss/How-Earth-Changes-Affect-Evolution.htm#step2, May 2016
[v] http://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Convergent/Continental-Collision, May 2016
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[vii] https://en.wikipedia.org/wiki/Mammoth, May 2016
[viii] https://www.google.com/search?q=mastodon+images&espv=2&biw=1366&bih=653&tbm=isch&imgil=7PTUDFXxKPJE-M%253A%253BLOqFEVzr-CwMPM%253Bhttp%25253A%25252F%25252Fnews.softpedia.com%25252Fnews%25252F13-000-Year-Old-Mastodon-Bone-Found-by-Boys-in-Their-Backyard-316643.shtml&source=iu&pf=m&fir=7PTUDFXxKPJE-M%253A%252CLOqFEVzr-CwMPM%252C_&usg=__aOW6iolAew_ouUKsLJfznCkX-rE%3D&ved=0ahUKEwjLjfCM1cXMAhWKaT4KHdTlBzkQyjcIMQ&ei=06osV4vYJ4rT-QHUy5_IAw#imgrc=7PTUDFXxKPJE-M%3A, May 2016
[ix] https://www.google.com/search?q=mastodon+images&espv=2&biw=1366&bih=653&tbm=isch&imgil=7PTUDFXxKPJE-M%253A%253BLOqFEVzr-CwMPM%253Bhttp%25253A%25252F%25252Fnews.softpedia.com%25252Fnews%25252F13-000-Year-Old-Mastodon-Bone-Found-by-Boys-in-Their-Backyard-316643.shtml&source=iu&pf=m&fir=7PTUDFXxKPJE-M%253A%252CLOqFEVzr-CwMPM%252C_&usg=__aOW6iolAew_ouUKsLJfznCkX-rE%3D&ved=0ahUKEwjLjfCM1cXMAhWKaT4KHdTlBzkQyjcIMQ&ei=06osV4vYJ4rT-QHUy5_IAw#imgrc=7PTUDFXxKPJE-M%3A, May 2016
[x] http://www.sharksider.com/megalodon-shark/, May 2016
[xi] http://a-z-animals.com/animals/sabre-toothed-tiger/, May 2016
[xii] https://www.google.com/search?q=sabre-toothed-tiger+images&espv=2&biw=1366&bih=653&tbm=isch&imgil=0_D9B_zp6Kw7sM%253A%253BW8f88zAy9xFhFM%253Bhttps%25253A%25252F%25252Figs.indiana.edu%25252FFossilsAndTime%25252FSabertooth.cfm&source=iu&pf=m&fir=0_D9B_zp6Kw7sM%253A%252CW8f88zAy9xFhFM%252C_&usg=__7loAJXSAEzGVwpHyORIr24saFyY%3D&ved=0ahUKEwiR9t-M1sXMAhVJOD4KHX-uCN8QyjcILw&ei=36ssV9GKMsnw-AH_3KL4DQ#imgrc=0_D9B_zp6Kw7sM%3A, May 2016
[xiii] https://en.wikipedia.org/wiki/Australopithecus, May 2016