Measuring Megalodon: Classroom Driven Research Made Possible with 3D Technology

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Project Origin

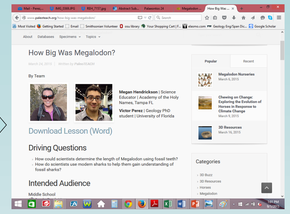
Amateur paleontologist, Gordon Hubbell, donates an associated dentition

Collaboration between Florida Museum of Natural History and Duke University results in 3D printed dentition

Middle school teacher, Megan Hendrickson, expresses an interest in creating a Megalodon lesson

Geology PhD student, Victor Perez, visits Megan's class

Students experience photographed, 3D printed, and real fossils; while contributing to research



Megan and Victor co-create a lesson on estimating body length, now available on www.paleoteach.org

Carcharocles megalodon

Evolution:

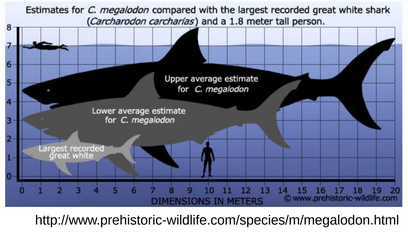
- Predominant theory is that *C. megalodon* is the end of a lineage stemming from the extinct mackeral shark, *Otodus obliquus* [1, 2, 3]
- Alternatively, it was thought that Megalodon evolved into the modern Great White Shark [4, 5]

Dentition:

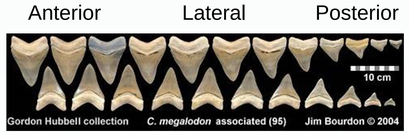
- Dignathic heterodonty: tooth form differs between positions in the upper and lower jaws
- Lots of information can be inferred from teeth, from diet to body size

Body Length:

- All body length estimates are based off relationships observed in the modern Great White Shark [4, 6, 7, 8]

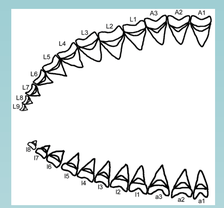


http://www.prehistoric-wildlife.com/species/m/megalodon.html



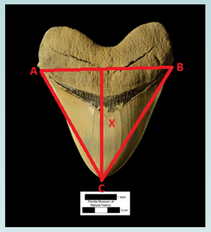
Classroom Lesson

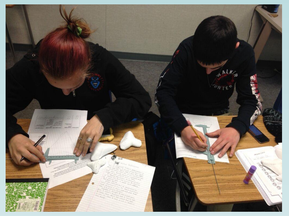
1. Identify Tooth Position



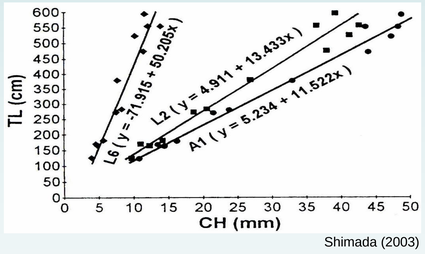
Pimiento et al. (2010)

2. Measure Crown Dimensions

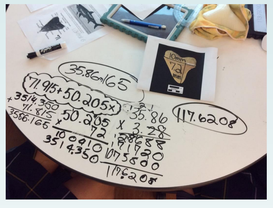




3. Estimate Body Length



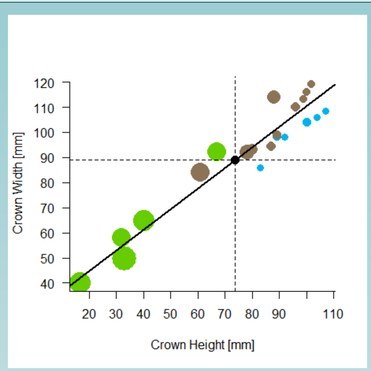
Shimada (2003)



Broader Impacts & Intellectual Merit

- Contribution to scientific research
- Increased motivation toward science learning
- Middle and high school students take on the role of researchers
- Synergy between the scientific community and the public
- Comprehension of fundamental concepts in paleontology, geology, and biology
- Real world application of geometry and algebra
- Inquiry driven learning
- Exposure to science literacy

Results & Outcomes



Students found that body length estimates vary significantly depending on the tooth position. Circle size reflects magnitude of total length estimate (blue=anterior, grey=lateral, green=posterior)

Avg. Anterior Estimate	Avg. Lateral Estimate	Avg. Posterior Estimate	Lowest Estimate	Highest Estimate
44 ft	64 ft	110 ft	40 ft	148 ft

Estimates are based on Shimada (2003)

Students garnered an appreciation for research, which stimulates interest in science education

Student, Sage McGraw, attended a workshop on 3D technology, passionately describing how it influenced his outlook toward science education

What's Next?

- Formal evaluation of the impact that 3D technology and actual research has on student outlook toward science learning, careers in science, and content retention
- Publication of new findings regarding body length estimates of *C. megalodon*, done in collaboration between paleontologists (professional an amateur), K-12 teachers, and middle and high school students
- New lesson development!

Check out www.paleoteach.org for more lesson plans that incorporate 3D printing technology and timely scientific research!

References

[1] Kent, 1994. Fossil Sharks of the Chesapeake Bay Region. Egan Rees and Boyer, Inc., Columbia, Maryland, 146 p.
[2] Nyberg et al., 2006. Tracing the ancestry of the great white shark, *Journal of Vertebrate Paleontology* 26(4): 806–814.
[3] Ehret et al., 2012. Origin of the white shark *Carcharodon* (Lamniformes: Lamnidae) based on recalibration of the upper Neogene Pisco Formation of Peru. Paleontology, 55(6): 1139-1153.
[4] Gottfried et al., 1996. Size and skeletal anatomy of the giant megatooth shark *Carcharodon megalodon*, *in* Klimley, A. and Ainley, D., eds., Great White Sharks: The Biology of *Carcharodon carcharias*. Academic Press, San Diego, California, p. 55–89.
[5] Purdy, 1996. Paleoecology of fossil white sharks, *in* Klimley, A. and Ainley, D., eds., Great White Sharks: The Biology of *Carcharodon carcharias*. Academic Press, San Diego, California. p. 67–78.
[6] Shimada, 2003. The relationship between the tooth size and total body length in the white shark, *Carcharodon carcharias* (Lamniformes: Lamnidae). Journal of Fossil Research, 35: 28–33.
[7] Pimiento et al., 2010. Ancient nursery area for the extinct giant shark Megalodon from the Miocene of Panama. Plos One, 5(5): e10552.
[8] Pimiento & Balk, 2015. Body-size trends of the extinct giant shark *Carcharocles megalodon*: a deep-time perspective on marine apex predators. Paleobiology, 41(03): p. 479–490.