Fossil Sharks

Catalina Pimiento
the isthmus that changed the world
the isthmus that changed the world
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the isthmus that changed the world
Miocene fossil shark localities

- upper late Miocene Chagres Fm
- lower late Miocene Gatun Fm
- early Miocene Culebra Fm
- late Miocene Chucunaque Fm

Map showing locations in Panama, Caribbean Sea, and Pacific Ocean.
Miocene fossil shark localities
early Miocene Culebra Formation
early Miocene Culebra Formation
early Miocene Culebra Formation
early Miocene Culebra Formation
early Miocene Culebra Formation
The late Miocene Gatun Formation

Pimiento et al. In press
late Miocene Gatun Formation

Pimienta et al. In press
late Miocene Gatun Formation

Pimiento et al. In press
late Miocene Gatun Formation

Pimiento et al. In press
late Miocene Chucunaque Formation

Coates et al. 2004
late Miocene Chucunaque Formation

Coates et al. 2004
late Miocene Chucunaque Formation
late Miocene Chucunaque Formation

Coates et al. 2004
Miocene shark faunas: Biodiversity

At least 32 taxa so far...
Only 4 are extinct
Miocene shark faunas: Biodiversity

At least 32 taxa so far...
Only 4 are extinct
Miocene shark faunas: Environment

Depth

**Chucunaque Fm.**
- Pacific side
- Strait-Isthmus

**Gatun Fm.**
- Caribbean side
- Peninsula-Isthmus

**Culebra Fm.**
- Pacific side
- Strait-Peninsula
Miocene shark faunas: Environment

Depth

Chucunaque Fm.
Pacific side
Strait-Isthmus

# Taxa

Neritic
Bathyal

Gatun Fm.
Caribbean side
Peninsula-Isthmus

# Taxa

Neritic
Bathyal

Culebra Fm.
Pacific side
Strait-Peninsula

# Taxa

Neritic
Bathyal

REEs Concentrations
MacFadden et al., in prep

Cucaracha Fm.

Seawater

La Ce Nd Sm Eu Gd Dy Er Yb
Miocene shark faunas: Biogeography

Chucunaque Fm.
Pacific side
Strait-Isthmus

Gatun Fm.
Caribbean side
Peninsula-Isthmus

Culebra Fm.
Pacific side
Strait-Peninsula
Miocene shark faunas: Biogeography

Miocene

Today

late

early
Largest marine predator of all time
Megalodon
nursery area for Megalodon

Pimiento et al. 2010
Nursery Habitats

- Essential habitats for sharks survival
- Juveniles and neonates
- Food + Protection = Productive + Shallow waters
nursery area for Megalodon

Pimiento et al., 2010
future plans

body size

Geologic Time
### future plans

<table>
<thead>
<tr>
<th>Ocean</th>
<th>Lat.</th>
<th>Country</th>
<th>Formation</th>
<th>Age</th>
<th>Collection</th>
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<tr>
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<td>Venezuela</td>
<td>Paraguaná</td>
<td>L. Pliocene (3.5Ma)</td>
<td>Various</td>
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</tr>
</tbody>
</table>

| Pacific |       |         |           |     |                  |
| North  | USA (CA) | Rosarito | E. Miocene (18Ma) | SDNHM |
| North  | USA (CA) | Temblor | M. Miocene (14Ma) | UCMP, SDNHM |
| South  | Peru | Pisco (Ica) | M. Miocene (12Ma) | NHM Lima |
| South  | Peru | Pisco (El Jahuay) | L. Miocene (10Ma) | NHM Lima |
| North  | USA (CA) | St.Margarita, St.Mateo | L. Miocene (10Ma) | UCMP, SDNHM |
| South  | Peru | Pisco (Sud Sacaco) | L. Miocene (7Ma) | NHM Lima |
| South  | Chile | Bahía Inglesa | L. Miocene (7Ma) | NHM Santiago |
| South  | Chile | Bahía Inglesa | E. Pliocene (4Ma) | NHM Santiago |
| Central | Ecuador | Onzole | E. Pliocene (4Ma) | British Mus. |

| Indian |       |         |           |     |                  |
| Central | Australia | Batesford, Gippsland | E. Miocene (18Ma) | Victoria Mus. |
| Central | Australia | Port Campbell | M. Miocene (11Ma) | Victoria Mus. |
| Central | Australia | Black Rock | L. Miocene (8Ma) | Victoria Mus. |
| Central | Australia | Whaler’s Bluff, Loxton Sand | E. Pliocene (4Ma) | Victoria Mus. |
| Central | Australia | Grange Burn, Cameron Inlet | L. Pliocene (3.5Ma) | Victoria Mus. |
geographic distribution size in deep time
What are the patterns of Megalodon extinction?

- Distribution

Why Megalodon became extinct?

- Climate
  - Oceanography
- Preys
- Competitors
why is this important?
Implications: Conservation

Approximately 17% of sharks and their relatives are threatened, an additional 13% are considered Near Threatened, and a high proportion (47%) are Data Deficient. IUCN 2010

Trophic Downgrading of Planet Earth

Until recently, large apex consumers were ubiquitous across the globe and had been for millions of years. The loss of these animals may be humankind's most pervasive influence on nature. Although such losses are widely viewed as an ethical and aesthetic problem, recent research reveals extensive cascading effects of their disappearance in marine, terrestrial, and freshwater ecosystems worldwide. This empirical work supports long-standing theory about the role of top-down forcing in ecosystems but also highlights the unanticipated impacts of trophic cascades on processes as diverse as the dynamics of disease, wildfire, carbon sequestration, invasive species, and biogeochemical cycles. These findings emphasize the urgent need for interdisciplinary research to forecast the effects of trophic downgrading on process, function, and resilience in global ecosystems.

Science (2011)

Conservation paleobiology: putting the dead to work

... the geohistorical record is a natural laboratory from which we can address the responses of species to environmental changes, helping us to understand which species will be most sensitive and what kinds of responses will be most common.

TREE (2010)
Training the next generation of scientist: Education and Outreach
website for kids

TIBURONES FÓSILES EN PANAMÁ
FOSSIL SHARKS IN PANAMA

Pimiento 2010
Fossil sharks: Learning from and about the past

by Catalina Pimiento and Rose M. Pringle

Have you ever felt the excitement of school-aged children as they observe fossils in a museum? Children are usually enthusiastic to learn about prehistoric remains or fossils of both plants and animals. Recent studies on preferences in museums have revealed that children are fascinated by fossil sharks—the remains of sharks that inhabited the oceans of the past (MacFadden 2006). This has created new opportunities to connect informal science learning at museums to public school science curricula.

Recent studies on preferences in museums have revealed that children are fascinated by fossil sharks—the remains of sharks that inhabited the oceans of the past (MacFadden 2006). This has created new opportunities to connect informal science learning at museums to public school science curricula. By studying fossil sharks, children learn about the composition of ancient faunas and the geologic changes that have occurred in the Earth's history. A study of fossil sharks can be tied to numerous important areas of natural (Earth) sciences such as geology, geography, and paleontology. Studies of fossil sharks can also be connected to science, technology, engineering, and mathematics (STEM) topics, such as evidence for evolution and climate change in the past.

In this article, we describe a series of science activities for middle school students that focuses on the study of fossil sharks through an examination of their morphological characteristics.

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In this section, students will conclude that fossil sharks can be found on land, even though sharks are marine animals. Experiences in Section 2 will allow students to discover for themselves that the Earth is dynamic and continents are in constant dynamic movement. This will help students to understand how it is possible to find the remains of sharks on land. Finally, in the last section, students will explore the dimension of geologic time and will integrate the knowledge and skills learned in the first two sections.

FIGURE 1 Sample of fossil shark teeth collected in Panama and Florida

Sample of fossil shark teeth collected in Panama and Florida

Pimiento and Pringle 2011

Oviedo and Pimiento 2011
undergraduate course

Introduction to the Paleontology of Panama, Class 2012
undergraduate course
undergraduate course

Blended course