OPENING SCREEN

PTEROSAURS
FLIGHT IN THE AGE OF DINOSAURS

Buttons to select chapter
• WHAT IS A PTEROSAUR?
• BIG HEAD, LONG TAIL: Dimorphodon
• COVERED IN FUZZ: Jeholopterus
• EXTREME SIZE: Pteranodon
• DRAMATIC DISPLAY: Tupuxuara
• TONS OF TEETH: Pterodaustro
• ABOUT THE EXHIBITION

FIRST CHAPTER

Page 1
What is a pterosaur?
They flew with their fingers. They walked on their wings. Neither birds nor dinosaurs, some of these flying reptiles were gigantic, while others could fit in the palm of a hand. Millions of years ago, the skies were ruled by pterosaurs, the first animals with backbones to fly under their own power.

Running head = PTEROSAURS

Page 2
What Is a Pterosaur?
Learn what pterosaurs are—and what they are not. And see how the wings of these flying reptiles are different from those of birds and bats.
THREE KINDS OF WINGS

The wing bones of pterosaurs, birds and bats correspond to the bones in our arms and hands. In flying animals, the bones evolved in different ways to build a wing.

Labels on illustrations
PTEROSAUR
BIRD
BAT
HUMAN

Buttons (some with pop-up text)
• ARM BONES

• HAND BONES
Pterosaurs had very long hand bones.

• FINGER BONES
Fourth finger
This "wing finger" is the equivalent of our ring finger. Pterosaurs had no pinky.

• PTEROID BONE
This bone is found only in pterosaurs and supported a membrane at the front of the wing.

Adapted for Flight
Discover how pterosaurs came to rule the skies as the first vertebrates to achieve powered flight.
What’s Next?
Scientists continue to unearth new pterosaur fossils. In an especially exciting discovery, fragments of an unknown species of giant pterosaur were discovered recently in Romania. Researchers now think this massive creature was just one of several enormous pterosaurs that lived in the area during the Late Cretaceous, not long before all pterosaurs became extinct.

*Photo IDs*

<table>
<thead>
<tr>
<th>Neck bone of <em>Anhanguera</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingspan: 13 feet (4 meters)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neck bone of new Romanian pterosaur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingspan: More than 33 feet (10 meters)</td>
</tr>
</tbody>
</table>
This pterosaur had a robust body, a large head and a very long tail. The name *Dimorphodon*, or “two-formed tooth,” describes the long, curved teeth at the front of its jaws and short pointed teeth at the back.

**Quick facts**

*D. macronyx*
dye-MORF-o-don ma-KRON-ix

When: Around 200 million years ago  
Where: On a coast in what is now southern England  
Wingspan: Up to 4 feet 7 inches (1.4 m)  
Food: Insects, fish and other small vertebrates

**EXAMINE THE FOSSIL**

This fossil of *Dimorphodon macronyx* was found on the southern coast of England in 1858. When this pterosaur died, its bones drifted apart as they settled into the muddy seafloor.

SLIDE

[callouts]
Skull  
Ribs  
Hand  
Foot  
Tail  
Knee
**Story of Mary Anning and the discovery of Dimorphodon**

### SHE FOUND FOSSILS

In 1829, the geologist William Buckland announced that a remarkable fossil had turned up in England. The skeleton, he said, belonged to “that most rare and curious of all reptiles,” a pterosaur. As Buckland explained, he didn’t find the fossil himself. He bought it from the sharp-eyed fossil hunter Mary Anning.

**[portrait of Mary Anning]**

Mary Anning (1799–1847) at the fossil beds of Lyme Regis, England, with her dog, Tray

Born in Lyme Regis, on the coast of Dorset, England, Anning grew up collecting fossils to sell to tourists and museums: ammonites, squid-like belemnites and ancient fishes left behind by the Jurassic sea. She made many striking discoveries, from large swimming reptiles like ichthyosaurs and plesiosaurs to tiny coprolites, which she correctly identified as fossil dung.

Scientists visited Anning’s shop and bought her fossils. She read their works and shared her expertise with them. As a woman with little formal education, she could never join their circles, but she did win fame.

**[Mary Anning’s house]**

Anning’s home and fossil shop in Lyme Regis, England

**[sketch of Anning by de la Beche]**

Mary Anning with her fossil-hunting hammer, in a hat to protect her head from falling rocks

**[illustration of fossil]**

In 1828, Mary Anning discovered this fossil of the first English pterosaur, known today as *Dimorphodon macronyx*. Headlines celebrated Mary and her “flying dragon.”

Anning lived at a time when scientists were just beginning to piece together the story of life on Earth. This early picture of prehistoric sea animals is based on her discoveries.
PAGE 4 (animation)

OUT FOR A STROLL
Like all pterosaurs, when *Dimorphodon macronyx* went walking, it folded its flight fingers back and up toward the side. This way the wings did not obstruct progress, and the animal did not run the risk of damaging its wings while on the ground.

SLIDE

PAGE 5 (interview)

IMPORTANCE OF TAILS
Mike Habib, research associate at the Dinosaur Institute at the Natural History Museum of Los Angeles County, gives his thoughts about pterosaur tails and flight.

PAGE 6

*Long and short tails feature: guess and click to reveal*

LONG TAIL OR SHORT?

TAP a pterosaur to see its tail.

The earliest, most primitive pterosaurs had long tails that helped stabilize flight, like the tail of a kite.

Many pterosaurs that evolved later had very short tails. To keep steady when flying, they relied on specialized wings.

[callouts to pictures, after clicking]

*Preondactylus*
LONG TAIL

*Rhamphorhynchus*
LONG TAIL
<table>
<thead>
<tr>
<th>Pterosaurs iPad – FINAL– March 25, 2014 - 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimorphodon</strong></td>
</tr>
<tr>
<td>LONG TAIL</td>
</tr>
<tr>
<td><strong>Pterodactylus</strong></td>
</tr>
<tr>
<td>SHORT TAIL</td>
</tr>
<tr>
<td><strong>Tupandactylus</strong></td>
</tr>
<tr>
<td>SHORT TAIL</td>
</tr>
<tr>
<td><strong>Thalassodromeus</strong></td>
</tr>
<tr>
<td>SHORT TAIL</td>
</tr>
</tbody>
</table>
COVERED IN FUZZ

Pterosaurs, such as this one from what’s now China, were reptiles, like modern snakes and lizards. But instead of being covered in scales, pterosaurs were covered in hairlike fibers.

Quick facts

_Jeholopterus ningchengensis_

je-hol-OP-ter-us ning-cheng-EN-sis

Fast Facts

When: Around 130 million years ago
Where: A forest in what’s now northeastern China
Wingspan: 35 inches (90 cm)
Food: Probably insects

EXAMINE THE FOSSIL

This *Jeholopterus* fossil includes not just the skeleton—but also remains of the animal’s wings, skin and hairlike covering.

First slide: regular view

Labels on body parts:

- Neck
- Backbone
- Ribs
- Wing
- Hind limb

- PHOTOGRAPH

buttons:

TOGGLE BETWEEN VIEWS

- FOSSIL
- FUZZ
- SKIN
second slide: drawing

Labels on illustration:
• FUZZ
These hairlike fibers, called pycnofibers, are not the same as the hair found on mammals, but they may have helped pterosaurs keep warm.

Caption for photo:
Close-up photo of the fossil reveals fibers, which are about the thickness of horsehair.

• ILLUSTRATION

Third slide: UV light view

Labels on body parts:
• Glue used to repair specimen

• UV IMAGE

Special callout to white areas
Skin
Under ultraviolet light, remains of the pterosaur’s skin glow white. The skin appears to trace the edges of the ribs and torso.

Special callout to right wing
Wings
Ultraviolet light reveals details about the internal structure of the wings. The fossil shows layers of internal fibers that crisscrossed to strengthen the wing.
SWIFT AND DEADLY
With its broad, short wings, *Jeholopterus ningchengensis* could bob and weave through branches and reeds to chase down insects. Once this agile hunter got close enough to its prey, it could snatch an insect right out of the air with its small jaws and tiny, sharp teeth.

FUZZY PTEROSAURS
Alexander Kellner, a research associate at the American Museum of Natural History and paleontologist at the Museu Nacional in Rio De Janeiro, Brazil, explains that some pterosaurs were covered in hairlike fibers.
**A TIMELINE OF PTerosaurs**

Pterosaurs flourished during the Mesozoic Era, the chapter of Earth’s history when dinosaurs dominated the land.

Scroll down to see some species that emerged and died out during this time.

<table>
<thead>
<tr>
<th><strong>Triassic Period, 252–201 million years ago</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The oldest known pterosaur fossils are about 220 million years old. The earliest pterosaurs were relatively small, with long tails, short necks and jaws lined with teeth.</td>
</tr>
<tr>
<td>Map of world: Land connected in supercontinent</td>
</tr>
<tr>
<td><em>Raeticodactylus filisurensis</em> (~220 million years ago)</td>
</tr>
<tr>
<td><em>Preondactylus buffarinii</em> (~220 million years ago)</td>
</tr>
<tr>
<td><em>Eudimorphodon ranzii</em> (~220 million years ago)</td>
</tr>
<tr>
<td><em>Dimorphodon macronyx</em> (~200 mya)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Jurassic Period, 201–145 million years ago</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>At this time, a new group of pterosaurs emerged, with shorter tails, longer hand and neck bones, and bony crests on top of their heads.</td>
</tr>
<tr>
<td>Map of world: Supercontinent was breaking up</td>
</tr>
<tr>
<td><em>Campylognathoides liasicus</em> (~170 mya)</td>
</tr>
<tr>
<td><em>Wukongopterus lii</em> (~165 mya)</td>
</tr>
<tr>
<td><em>Sordes pilosus</em> (~160 mya)</td>
</tr>
<tr>
<td><em>Pterodactylus antiquus</em> (~150 mya)</td>
</tr>
<tr>
<td><em>Rhamphorhynchus muensteri</em> (~150 mya)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Cretaceous Period, 145–66 million years ago</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A wide variety of pterosaurs evolved during the Cretaceous, including the largest pterosaurs known. Many species had long, slender skulls and very long necks. Some had no teeth and huge crests.</td>
</tr>
</tbody>
</table>
Map of world: Modern continents took shape

*Jeholopterus ningchengensis* (~130 mya)
*Sinopterus dongi* (~122 mya)
*Istiodactylus latidens* (~122 mya)
*Anhanguera blittersdorffi* (~110 mya)
*Thalassodromeus sethi* (~110 mya)
*Pterodaustro guinazui* (~100 mya)
*Nyctosaurus gracilis* (~84 mya)
*Pteranodon longiceps* (~85 mya)
*Quetzalcoatlus northropi* (~70 mya)

**Cenozoic Era, 66 million years ago–present**
After pterosaurs and large dinosaurs went extinct, the Age of Mammals began.

Map of world: Modern continents

**Other events for timeline:**

First dinosaurs (~230 million years ago)
First mammals (~200 million years ago)
Marine reptiles, including ichthyosaurs, dominated seas (~190 million years ago)
Sauropod dinosaurs roamed the land (~180 million years ago)
First birds (~150 million years ago)
First flowering plants (~125 million years ago)

K-T extinction event: Almost all large vertebrates—including pterosaurs and non-avian dinosaurs—went extinct 66 million years ago.
AT HOME IN THE FOREST
Welcome to eastern Asia, some 130 million years ago. Fossils from the region reveal the diverse species that lived alongside *Jeholopterus*.

TAP buttons to learn more.

---

**Callouts, first slide**

**PTEROSAUR**

*Sinopterus dongi*
This crested pterosaur had a wingspan of around 4 feet (1.2 meters); its name means “Chinese wing.”

**MAMMAL**

*Repenomamus giganticus*
Most mammals were relatively small 130 million years ago, but this one was about the size of a small dog. A fossil *Repenomamus* had remains of a dinosaur in its stomach; this mammal might have fed on pterosaurs, too.

**DINOSAUR**

*Psittacosaurus sinensis*
This small, plant-eating dinosaur apparently lived in flocks when young. Here, numerous young dinosaurs stay close to an adult.

---

**Callouts, second slide**

**TREE**

*Ginkgo*
The fan-shaped leaves of this ancient ginkgo tree, now extinct, are similar to modern ginkgo leaves.

**DINOSAUR**

*Sinornithosaurus millenii*
Scientists know this small dinosaur, related to *Velociraptor*, had feathers: Its fossil shows astonishingly clear imprints of them.

**BIRD**

*Liaoningornis longidigitris*
This early bird flew alongside the pterosaurs of this forest.

**PTEROSAUR**

*Jeholopterus ningchengensis*
This fuzzy pterosaur is chasing a dragonfly.
Callouts, third slide

<table>
<thead>
<tr>
<th>Category</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DINOSAUR</strong></td>
<td><strong>Dilong paradoxus</strong></td>
<td>This cousin of <em>T. rex</em> preyed on many of the animals in this forest. It also had a thick coat of primitive feathers, which probably helped keep the animal warm.</td>
</tr>
<tr>
<td><strong>PLANT</strong></td>
<td><strong>Equisetum</strong></td>
<td>The horsetail plant may look like grass—but it’s not. Grasses are flowering plants, which were uncommon 130 million years ago. Horsetail reproduces through spores, much like ferns, and can still be found today.</td>
</tr>
<tr>
<td><strong>TURTLE</strong></td>
<td><strong>Manchurochelys liaoxiensis</strong></td>
<td>This kind of turtle is extinct.</td>
</tr>
<tr>
<td><strong>POND</strong></td>
<td><strong>Beneath the surface</strong></td>
<td>Ponds in the ancient forest were home to long-necked aquatic reptiles (<em>Hyphalosaurus lingyuanensis</em>), fish similar to modern sturgeon (<em>Peipiaosteus pani</em>) and large water striders (<em>Gerridae</em>).</td>
</tr>
<tr>
<td><strong>DINOSAUR</strong></td>
<td><strong>Sinosauropteryx prima</strong></td>
<td>The fossil remains of this dinosaur showed the animal had short, primitive feathers—the first evidence that animals other than birds had a feather-like covering.</td>
</tr>
<tr>
<td><strong>DINOSAUR</strong></td>
<td><strong>Microraptor gui</strong></td>
<td>With feathers on its legs, this dinosaur appeared to have four wings. These feathers are essentially identical to those of flying birds today.</td>
</tr>
</tbody>
</table>
FOURTH CHAPTER

PAGE 1

EXTREME SIZE
With its long, dramatic crest, the giant *Pteranodon longiceps* is one of the most recognizable pterosaurs. And for many decades, it was the largest known pterosaur, with a wingspan of up to 20 feet (6 meters).

Quick facts

*Pteranodon longiceps*
ter-AN-o-don LON-ji-seps

Fast Facts
When: Around 85 million years ago
Where: Over a large seaway covering what is now central North America
Wingspan: Up to 20 feet (6 m)
Food: Fish

PAGE 2

Navigation bar throughout: SIZE

EXAMINE THE FOSSIL
TAP to learn more about *Pteranodon*.

Popup #1: go to fleshed out illustration of head

CREST
Dramatic display
This species had a long, dagger-shaped crest jutting out of the back of the skull.

Popup #2: pix of someone hang gliding

WING
Taking flight
A full-grown adult *Pteranodon* had a wing span of up to 20 feet (6 meters)—around the size of a hang glider.
**Popup #3: close up of fossil**

**FOURTH FINGER**

**“Wing” finger**

Pterosaur wings evolved from the same body parts as our arms. The bones of one finger—the equivalent of our ring finger—were extraordinarily long to support the wing. Pterosaurs had no pinky fingers.

**Popup #4: close up of toothless jaw**

**BEAK**

**No teeth**

*Pterandon* had no teeth; its name means “winged and toothless.”

**Popup #5: close-up of pteroid bone**

**PTEROID BONE**

**Unique to pterosaurs**

The pteroid bone is found only in pterosaurs. Pointing from the wrist toward the shoulder, it stabilized the front of the wing.
WILD WEST PTEROSAURS

The men traveled by covered wagon, and told stories of drinking rainwater from their hats and fending off rattlesnakes. Military escorts guided them as they moved through territories of Sioux and other Native peoples.

But in the end, the crew led by Yale paleontologist O. C. Marsh came home from its 1870 expedition with an intriguing discovery: a single fossil from the wing of a giant pterosaur found in Kansas.

The team returned to the Kansas site in 1871 and uncovered more of the pterosaur, which Marsh named *Pteranodon*. He estimated the animal had a wingspan of 20 feet (6 meters). This was the largest pterosaur known at that time—and the first to be found in the United States.

For many years, *Pteranodon* was the largest known pterosaur—until the discovery of another fossil in the American West. In 1971, geology student Douglas Lawson discovered a giant pterosaur in Big Bend National Park, Texas. Named *Quetzalcoatlus northropi*, its wingspan was around 33 feet (10 meters).

**HARDY CREW**

Yale University paleontologist O. C. Marsh (*back row, center*) led expeditions to the American West between 1870 and 1873. Team members had military escorts when traveling through dangerous areas and sometimes carried guns.

**BUFFALO BILL**

In 1870, Marsh and his crew of fossil hunters were briefly escorted by William Cody—also known as Buffalo Bill. Cody was a famous buffalo hunter, Army scout and, later, actor in Buffalo Bill’s Wild West show. Marsh and Cody became longtime friends.
TAKING FLIGHT
This large pterosaur likely spent its days flying over the ocean, rarely returning to land. But after taking a break from flying to eat a fish, *Pteranodon* would be airborne again. Taking off from the water is no easy feat: the pterosaur probably pushed off the water with massive force, and then hopped and flapped along the water until it could fly again. Next stop, more fish!

DISTANCE FLIERS
Mike Habib, research associate at the Dinosaur Institute at the Natural History Museum of Los Angeles County, discusses how well large pterosaurs could fly.

How big were pterosaurs?

SLIDE

Labels for pterosaurs:
*Quetzalcoatlus*
Wingspan = ~33 feet (10 m)

*Tropeognathus*
Wingspan = ~27 feet (8.2 m)

*Pteranodon*
Wingspan = ~20 feet (6 m)

*Anhanguera*
Wingspan = ~13 feet (4 m)

*Dsungaripterus*
Wingspan = ~11 feet (3.4 m)

*Rhamphorhynchus*
Wingspan = ~6 feet (1.8 m)

*Pterodaustro*
Wingspan = ~8 feet (2.4 m)
Nemicolopterus
Wingspan ~10 inches (25 cm)

Labels for size comparisons:
Pigeon
Wingspan = ~22 inches (56 cm)

Albatross
Wingspan = 10 feet (3 m)

Skydiver
BRINGING PTEROSAURS TO LIFE
In the 1940s, the American Museum of Natural History installed this large-scale painting of pterosaurs. Now on view on the fourth floor of the Museum, the mural reflects what scientists thought about pterosaurs at that time.

TAP buttons to explore the mural.

Popup #1: #1 on key

**PTERANODON**
The older painting shows *Pteranodon* with its wing membrane attached to its crest; scientists no longer think this is accurate.

Current depiction of *Pteranodon*

Popup #2: #2 on key

**NYCTOSAURUS**
In the mural, *Nyctosaurus* is shown with no crest. Now, however, scientists know the species had a large crest.

Current depiction of *Nyctosaurus*

Popup #3: #10 on key

“**PTENODRACON**”
Once thought to be a separate species, this pterosaur is now considered a juvenile *Pteranodon*.

Popup #4: roosting on rocks

**ROOSTING**
The artist showed the animals building nests and roosting on the rocks of this cliff. No cliffs existed where these animals lived and no evidence for climbing behavior exists.
Popup #5: walking on all fours

**WALKING**

This *Dimorphodon* is shown accurately walking on all four limbs. This posture was controversial for many years, but trackway evidence now indicates this painting is correct: Pterosaurs walked on their hands and feet.

Popup #6: key

This historic mural on display at the American Museum of Natural History shows a variety of species from different locations and time periods.

1. *Pteranodon*
2. *Nyctosaurus*
3. *Dimorphodon*
4. *Campylognathus*
5. *Dorygnathus*
6. *Scaphognathus*
7. *Rhamphorhynchus*
8. *Cycnorhamphus*
9. *Pterodactylus*
10. “*Ptenodracon*”
Dramatic Displays
An eye-catching crest was the most dramatic feature of many pterosaurs—and *Tupuxuara* had one of the most spectacular crests ever found.

Quick facts

**Tupuxuara Leonardii**
\[\text{too-pu-SHWA-ra lay-o-NAR-dee-eye}\]

Fast Facts

When: Around 110 million years ago
Where: Lagoon in what is now northeastern Brazil
Wingspan: 15 feet (4.5 meters)
Food: Probably fish

Examine the fossil
This large, crested pterosaur had no teeth—but its sharp beak was a fine weapon for capturing its prey, probably fish.

Tap the buttons to see more special features.

Crest

**CHECK ME OUT!**
A big, dramatic crest was supported by lightweight bone.

Beak

**Birdlike Beak**
A long, toothless beak, like this modern sea bird’s, was probably used for grabbing fish.
Eye socket

Eye socket
MY EYES ARE BACK HERE!
The eye socket can be hard to see on a skull—it’s not the large opening, but the much smaller one right behind it.

SKULL OPENING

Skull opening 1
HOW MANY HOLEs?
Most pterosaurs have two large open spaces in the skull. In *Tupuxuara* these holes combined into one over millions of years of evolution.

1 2
*Dimorphodon* skull

SHOWING OFF

How did some pterosaurs compete for mates? One idea is that males of species like *Tupuxuara leonardii* showed off their stunning headgear in order to impress females. Here, a male pterosaur moves its head up and down, making sure every female gets a good look.

WHY CRESTs?
Alexander Kellner, a research associate at the American Museum of Natural History and paleontologist at the Museu Nacional in Rio De Janeiro, Brazil, discussed some possible functions of pterosaur crests.
Pterosaurs once lived all over the globe. Today their remains can be found on every continent.

TAP to visit some of the world’s most exciting fossil sites.

Map callouts:

1. Germany
2. England
3. United States
4. Brazil
5. Argentina
6. China
7. Kazakhstan
8. Morocco
1. GERMANY
The flat, flaky layers of limestone from Solnhofen, Germany, have produced many of the most exquisitely detailed fossils of pterosaurs and other organisms ever found.

[fossil photo]
When the flat slabs are split, they sometimes reveal perfectly preserved fossils, such as this pristine crustacean.

2. ENGLAND
Several historic specimens were discovered by famous fossil-hunter Mary Anning in the early 1800s at Lyme Regis. Here, steep seaside cliffs slice through layers of rock, exposing fossils. Many more pterosaur fossils were unearthed from the Cambridge Greensand Formation.

3. UNITED STATES
The Niobrara Chalk Formation in Kansas—once an inland sea—has provided a trove of treasured pterosaurs, including the crested giants *Pteranodon*, *Dawndraco* and *Nyctosaurus*.

[second US site photo of Big Bend]
Just a few hundred miles away, in Texas, the gigantic *Quetzalcoatlus* was discovered in Big Bend National Park.

*Dawndraco kanzai*

4. BRAZIL
The Romualdo Formation in Brazil, a former lagoon, has produced some of the world’s most important pterosaur discoveries, including several remarkable crested species.

Some specimens from Brazil’s Romualdo Formation are perfectly preserved in three dimensions, like these fossilized *Anhanguera* bones.
5. ARGENTINA
The red rocks of the Lagarcito Formation in Argentina have produced many amazing finds, including the spectacular, comb-toothed *Pterodaustro*.

6. CHINA
Fossils from northeastern China have rewritten pterosaur history. Quarries provide an endless supply of fossil dinosaurs and pterosaurs, pressed between layers of limestone like flowers in a book.

7. KAZAKHSTAN
The remains of this *Sordes pilosus*—or “hairy devil” for its fuzzy covering—were found in the Karatau Mountains in Kazakhstan, along with several other pterosaurs.

8. MOROCCO
The arid deserts of Africa have so far produced few pterosaur fossils—but the search has just begun. Several specimens were recently found in the Kem Kem region of Morocco.

The first pterosaur found in Morocco, *Siroccopteryx moroccensis*, was named for the famous Sirocco winds; this tooth comes from a similar species.
BEST CRESTS EVER!
Pterosaur crests came in all shapes and sizes.

SELECT AN IMAGE to see some of the most fabulous headgear that ever evolved.

**Tupuxuara**
*Tupuxwuara leonardi* had a huge, fan-shaped crest sweeping back from its snout.

**Pteranodon**
*Pteranodon longiceps* had a long, dagger-like crest jutting from the back of its head.

**Dsungaripterus**
*Dsungaripterus weii* had a long, low ridge running down the middle of its head.

**Tupandactylus**
*Tupandactylus imperator* had a giant, sail-like crest several times bigger than the rest of its head, made of part bone, part soft tissue.

**Raeticodactylus**
*Raeticodactylus filisurensis* had a pointed, bladelike crest on its snout.

**Nyctosaurus**
*Nyctosaurus gracilis* had two long, bony prongs on its skull, likely connected by soft tissue in life.

**Thalassodromeus**
*Thalassodromeus sethi* had a huge, dramatic crest—the largest ever discovered.

**Tapejara**
*Tapejara wellnhoferi* had a crest that stuck up highest on the front of its head, possibly helping it part branches in search of fruit and seeds.
SIXTH CHAPTER

PAGE 1

**Tons of Teeth**
This pterosaur had about 1,000 teeth in its bill. But fossils tell us that the teeth weren’t for biting. Instead this species used the bristle-like teeth to feed by filtering small animals out of the water—much like flamingos do today.

---

**Pterodaustro guinazui**
tair-o-DOW-stro gee-NA-zoo-eye

When: Around 100 million years ago.
Where: Along the shores of lakes in what is now central Argentina
Wingspan: 8 feet (2.5 meters)
Food: Small arthropods, crustaceans and mollusks

---

PAGE 2

**Examine the Fossil**
TAP to explore different parts of *Pterodaustro guinazui*

---

**Callouts on fossil**
Teeth
Stomach
Thigh Bone
Fourth Finger

---

**Teeth**

**A Mouthful**
This pterosaur had two different types of teeth in its bill. The lower bill housed extremely long teeth, while the upper bill had short, nubby teeth.

---

**Stomach**

**Stomach Stones**
Stones in part of the stomach (known as the gizzard) may have helped *Pterodaustro* grind up food. Some birds today swallow stones to help them digest food.
Fourth finger
The Fourth Finger
A pterosaur’s wing membrane attached to its extremely long fourth finger, the equivalent of a person’s ring finger. This adaptation is unique to pterosaurs.

Thigh bone
To Lay an Egg
The thigh bones, or femurs, of females in this species contain special bone tissue. This trait is seen in modern female birds while the egg is being formed. The extra tissue in birds is used to produce hard eggshells.

Why Pink?
Fossils of Pterodaustro guinazui tell us this species probably had a diet similar to that of flamingos, which get their pink color from what they eat. Perhaps this species of pterosaur had a pinkish hue, too.

SCROLL DOWN through this food chain to find out where the pink color comes from.

Flamingo
Flamingos are “filter feeders,” which means they scoop up water and as the liquid flows through their comb-like beak, they filter out and swallow tiny organisms. We think several pterosaurs ate the same way.

Some flamingos feed on brine shrimp...
...while others feed directly on a type of cyanobacteria called Spirulina.

Brine shrimp
Brine shrimp dine directly on Spirulina.

Spirulina
Spirulina make carotenoids—organic pigments that create many of the colorful colors we see in birds, including the pinks of flamingos.
**Carotenoids**
These organic pigments make their way up the food chain—from cyanobacteria to brine shrimp to flamingos—and end up producing pink feathers.

One well-known carotenoid, called **carotene**, is found in carrots and gives them their bright colors.

---

**Filter Feeder**
To feed, *Pterodaustro guinazui* dipped its bill into the water and shook its head back and forth. As water flowed over the pterosaur’s bill and through its hundreds of thin teeth, it probably used its tongue to push the water out, trapping prey like brine shrimp inside. The result? A tasty meal.

---

**Straining for Food**
Mark Norell, curator and chairman in the Division of Paleontology at the American Museum of Natural History, compares the feeding style of *Pterodaustro* to a modern animal.

---

**What’s for Dinner?**
Depending on the pterosaur, a meal could be anything from fruit to fish.

TAP to learn what each pterosaur ate.

---

**Pterodaustro**
The strain game
*Pterodaustro guinazui*
This pterosaur’s many fine teeth may have allowed it to filter feed, much like flamingos do today.

---

**Rhamphorhynchus**
A little fishy
*Rhamphorhynchus muensteri*
The slender, pointed teeth of this pterosaur were ideal for snatching fish while on the wing.
| **Dsungaripterus** | **Crushing clams** | *Dsungaripterus weii*  
This pterosaur’s robust jaw and tough back teeth probably helped it crack open prey such as clams. |
|-------------------|-------------------|
| **Tapejara**      | **Something sweet** | *Tapejara wellnhoferi*  
This pterosaur’s shortened face and downturned bill may have helped it move through branches and leaves to find hidden fruit and seeds. |
About the Exhibition

*Pterosaurs: Flight in the Age of Dinosaurs* celebrates the great diversity of these prehistoric flying reptiles. The exhibition highlights the latest research by scientists at the American Museum of Natural History and leading paleontologists around the world into how these animals walked, flew, ate and more.

The *Pterosaurs* app is based on an interactive in the exhibition *Pterosaurs: Flight in the Age of Dinosaurs*, organized by the American Museum of Natural History and on view from April 5, 2014, through January 5, 2015.

About the Curators

*Pterosaurs: Flight in the Age of Dinosaurs* is co-curated by Mark Norell, curator and chair of the Division of Paleontology at the American Museum of Natural History, and Alexander Kellner, a Museum research associate and paleontologist at the Museu Nacional in Rio de Janeiro, Brazil.

*Photo IDs*
Mark Norell
Alexander Kellner
Introducing Pterosaurs
Hear from three pterosaur experts who explain how new techniques are helping scientists learn more about these fascinating creatures.

FROM BONE TO STONE
Find out how fossils are formed, and learn what some pterosaur fossils can tell us about how pterosaurs lived and behaved.

About this App
The Pterosaurs app is based on an interactive in the Pterosaurs: Flight in the Age of Dinosaurs exhibition, curated by Dr. Mark Norell and Dr. Alexander Kellner. It was created by the Exhibition Department at the American Museum of Natural History, under the direction of David Harvey, Senior Vice President of Exhibition.

Creative Direction/Project Lead: Hélène Alonso, Sasha Nemecek, Catharine Weese
Art Direction: Catharine Weese, Dan Ownbey
Editorial Direction: Lauri Halderman, Sasha Nemecek
Interaction & Media Direction: Hélène Alonso
UX Design: Hélène Alonso
Graphic Design: Kelvin Chiang
Interface Design: Kelvin Chiang
Writing & Research: Margaret Dornfeld, Joe Levit, Sasha Nemecek, Martin Schwabacher
Animation: Harry Borrelli, Camila Engelbert, Joshua Krause, Roopa Vasudevan
Video: Sarah Galloway, Joe Levit, Ariel Nevarez, Ben Tudhope
Camera: David Seligman, Scott Unger
Scientific Advisor: Mike Habib
Programming & Analytics: Nick Bartzokas, Harry Borrelli
Licensing: José Ramos, Rosemary Rotondi
Operations: Melissa Posen

Special Thanks
AMNH Communications Department
AMNH Education Department
CREDITS

_Pterosaur: Flight in the Age of Dinosaurs_ produced by the Exhibition Department at the American Museum of Natural History.

Image and video credits by section

**What is a Pterosaur?**
Raul Martin; Footage/Stills Courtesy of AMNH Photo Studio/Craig Chesek; Holger Babinsky, Department of Engineering, University of Cambridge; Footage Bank HD; Audio Network; Nature Footage; Pond5; Shutterstock

**Big Head, Long Tail**
Raul Martin; Dr. Peter Wellnhofer; AMNH Library; National Museum Cardiff; UNESCO; Denis Finnin/AMNH

**Covered in Fuzz**
Raul Martin; Alexander Kellner; Denis Finnin/AMNH; Photograph courtesy of Helmut Tischlinger; Roderick Mickens/AMNH; Craig Chesek/AMNH

**Extreme Size**
Raul Martin; The Granger Collection, New York; Shutterstock; University of California at Berkeley, Bancroft Library; photographer Dennis Galloway. Courtesy D. Lawson.; Library of Congress; Courtesy of the Peabody Museum of Natural History, Yale University, New Haven CT; AMNH Library

**Dramatic Display**
Raul Martin; Blaine Harrington/AGE Fotostock; Mint Frans Lanting/AGE Fotostock; Kevmin/Wikimedia Commons; The Natural History Museum/The Image Works; Interfoto/Alamy; Shutterstock; Victor Lavrentev; Paleontological Museum Moscow; John Conway; China Ocean Press; China Ocean Press; Mick Ellison/AMNH

**Tons of Teeth**
Raul Martin; Christian Harf; Bayerische Staatssammlung für Paläontologie und Geologie (Photo by Frank Höck); Shutterstock; Kabacchi/Wikimedia Commons, Mark Wildman

**About the Exhibition**
AMNH Photo Studio/Craig Chesek; AMNH Microscopy and Imaging Facility/Henry Towbin; Audio Network