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What can fossils tell us about growing up?

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Picture credit: Maija Karala

Abstract

Did you know that some animals like crocodiles and sharks keep growing larger as they get older? Mammals are not like that. We only grow during the first part of our lives. We were curious about how this trait evolved, so we used X-rays and 3D imaging to look at two small mammal-like fossils from the Jurassic. The fossils were from a juvenile and an adult. We found they grew more slowly than mammals do today. This helps us better understand the evolution of mammals.

Introduction

Have you already lost your baby teeth? Do you ever wonder why you even have baby teeth at all? It turns out most other **mammals** have them too! From tiny mice to large rhinos, modern mammals have an amazing variety of shapes, sizes, and behaviors. Despite the differences, all mammals have a few things in common. We all need to breathe air, we all have hair or fur (though some mammals don't have very much of it), and we are **warm-blooded**. We even have similarly shaped hearts!

These things may seem like a coincidence. But to a biologist, it's a big clue that we share a **common ancestor**! We share these **traits** because all mammals descended from the same ancient animals. We adapted and changed over millions and millions of years.

Studying the evolution of species is tricky. **Paleontologists** look for **fossils** to learn more about the story of life on earth. Fossils are rare! For an organism to turn into a fossil when it dies, a lot of things have to happen just right. Usually, only the hard parts of an organism can turn into fossils, like bones, teeth, and claws.

We studied two amazing fossils of a mammal-like animal called *Krusatodon kirtlingtonensis*. *Krusatodon* lived in the Jurassic Period. They are part of a group of animals called **mammaliaforms**, which includes all mammals and their closest ancient ancestors. Our fossil finds were from a juvenile and an adult. We asked ourselves, could these fossils help us answer questions about how mammal **life cycles** evolved?

These 3D-printed *Krusatodon* skulls are three times the actual size!
Photo: Elsa Panciroli

Methods

We used a technique called **computed tomography** to analyze the fossils. This technique uses X-rays from multiple angles to make a 3D picture of the fossils – without having to scrape away all the rock surrounding it!

We made a digital model of the fossils from the 3D scans (see Figure 1). Then we looked for clues that would tell us about the age and size of the animal. We carefully labeled and measured each bone and tooth. In the juvenile, we also looked at the order the adult teeth were coming in.

Another important clue comes from the **dental cementum**. This is the hard material covering the roots of your teeth. Your body is always making more layers of cementum. The pattern of dark and light layers in cementum tracks how many years old the tooth is, like the rings in a tree. So, we counted the layers of cementum in each specimen's teeth to estimate their age.

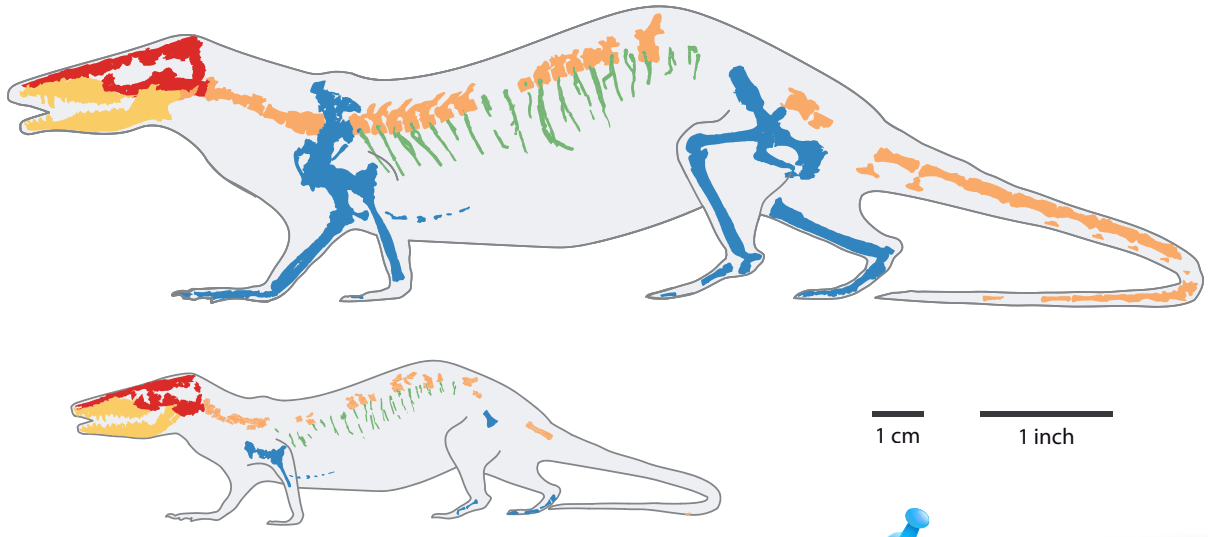

Figure 1: We investigated two fossils of *Krusatodon kirtlingtonensis*. We show an outline of what the adult and juvenile would have looked like, with all the bones we found sorted and put in place.

Results

We estimate that the juvenile *Krusatodon* was between 7 months and 2 years old, and the adult was at least 7 years old. About half of the juvenile's adult teeth had already come in. Using the sizes of the leg bones, we estimated that the adult's mass was between 54 and 156 grams. The juvenile was between 32 and 80 grams. So, we think that the juvenile was at least half its adult size. That means it was probably already past **weaning** age.

We compared the juvenile *Krusatodon*'s growth stage to modern animals of similar size (Figure 2). Most small

Please see Figure 2 on page 3

mammals today would already be at 100% of their adult weight by their first birthday. But *Krusatodon* was only a little past halfway there! That means that *Krusatodon* must have grown up at a much slower rate than mammals do today.

Did *Krusatodon* grow up faster or slower than other mammals of similar size? How can you tell?

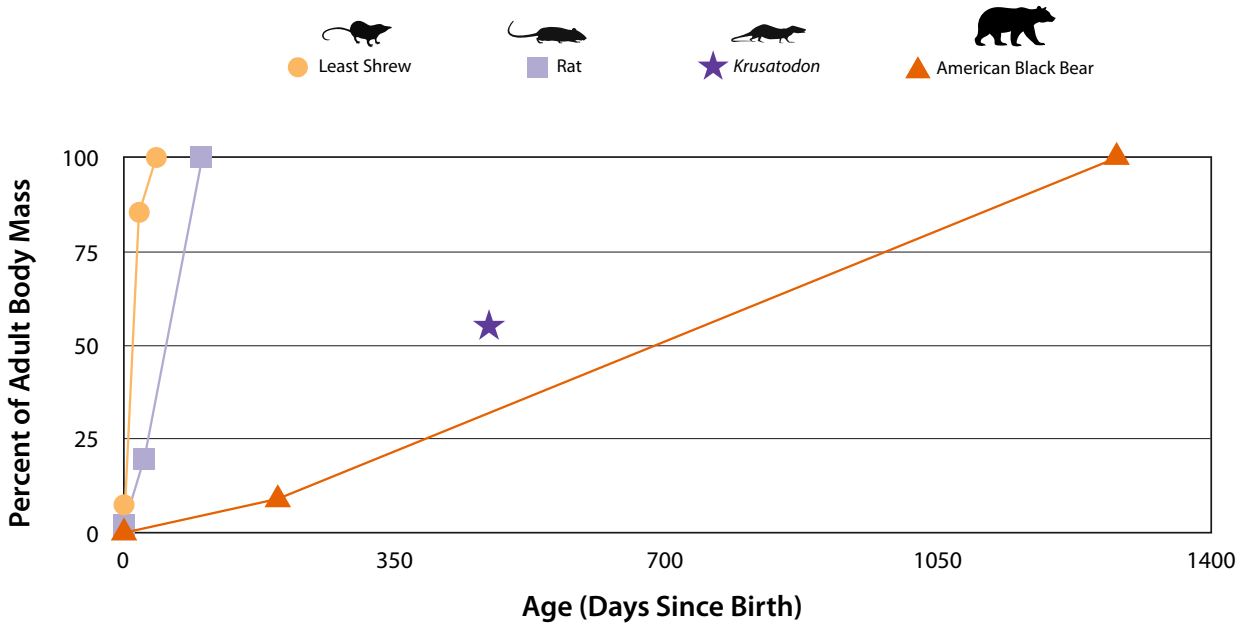

Figure 2: We compared the growth rate of *Krusatodon* to mammals that exist today. Each line tracks the growth of an animal from birth, to weaning, to the time it reaches its full adult size. The star shows the estimated age and size of the juvenile *Krusatodon*. You can see it grew much more slowly than modern mammals of a similar size!

Discussion

It's lucky to find a fossil of even one bone. It's luckier to find a nearly complete skeleton. But to study the life cycle, you need to find fossils from animals of different ages. That's why we were excited to find *Krusatodon* fossils from both a juvenile and an adult!

When we find fossils with the same traits as an animal alive today, it's a good sign that that trait evolved even earlier. When a dentist looks at your teeth, they look to see if your teeth are growing in the right order. The juvenile *Krusatodon*'s adult teeth were emerging in a similar way to modern mammals, so we can tell that this pattern appeared much earlier. But when we looked at *Krusatodon*'s teeth

compared to its age, we could tell that it was growing up at a much slower rate. We also know animals like *Krusatodon* kept growing when they were adults.

Little clues like this help us piece together the big picture of **evolution**. Our study tells us that there must have been a big change in the life cycle of mammals sometime after *Krusatodon* to make them grow up more quickly – and then stop growing when they were adults.

Conclusion

Humans and other mammals go through major changes as we grow up. Think about the differences between babies, elementary school kids, teens, and adults. What do you think are the biggest milestones along the way? It might seem strange, but you share many of these milestones with other animals! We are more closely related than it sometimes appears. If you can, visit a zoo, natural history museum, or wildlife preserve in your area. What similarities can you find between yourself and the animals you see?

Glossary of Key Terms

Common ancestor - two species share a common ancestor if they are both descended from the same ancient species.

Computed tomography - a method of scanning that uses X-rays from multiple angles to make a 3D picture of an object.

Dental cementum - the hard material covering the roots of your teeth.

Evolution - the slow series of changes in species over hundreds of thousands of years.

Fossils - the mineralized remains or imprint of an ancient animal or plant.

Life cycle - the series of changes in an organism over its lifespan.

Mammals - a group of animals that share features including feeding their young with milk and growing hair or fur.

Mammaliaforms - a group of species that includes all the modern mammals and their closest extinct relatives. They share many of the traits of modern mammals, as well as some older ones from their common ancestors.

Paleontologists - scientists who study extinct life and fossils.

Trait - a feature or characteristic of an organism.

Warm-blooded - when an animal's body is able to keep itself at a specific temperature.

Weaning - when an animal stops needing its mother's milk and starts eating other foods.

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Check your understanding

1. Why were we excited to find two fossils of the same animal?

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2. What clue did we use to figure out how old the animal was when it died?

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3. We looked at how fast *Krusatodon* grew up compared to other mammals. When we study modern mammals, we often think about the environment they live in. What kind of clues could paleontologists look for to learn about the *Krusatodon*'s habitat?

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4. Think of a favorite mammal. What similarities can you find between yourself and that animal?

REFERENCES

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