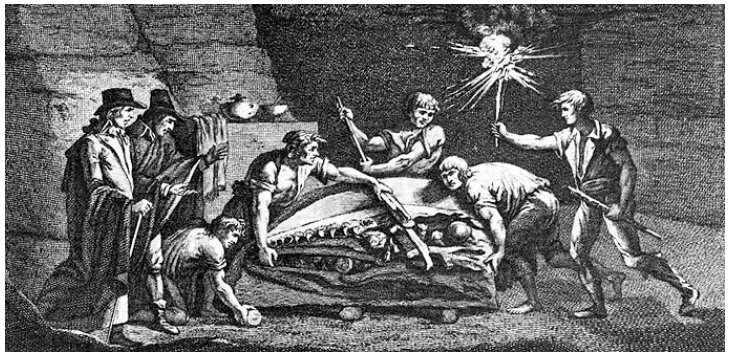
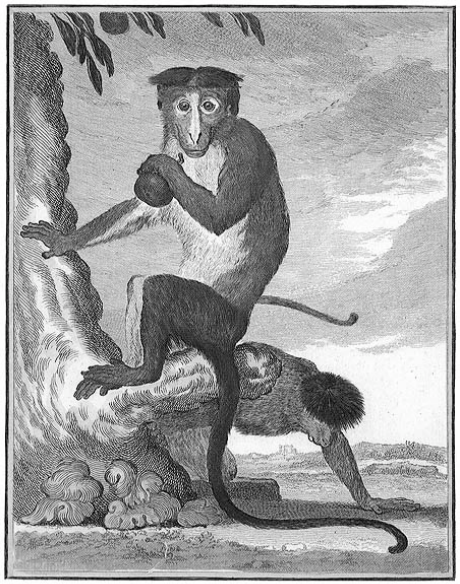
Now we switch our attention to France. . . In the early 1800s, France's conquests and explorations were bringing in the remains of strange living animals. . .



. . . and also strange fossil bones, like this giant lizard—shown being excavated near Maastricht, Holland—which Napoleon's army seized and carried off to France.



LE BONNET-CHINOIS

This illustration from *Histoire naturelle* shows a macaque (a type of Old World monkey). Buffon's encyclopedia was beautifully illustrated. It was wildly popular and was widely translated.

The reason why natural history was so sexy in France was Georges-Louis Leclerc, Comte de Buffon, a French nobleman, who wrote (among other books) a 44-volume encyclopedia, *Histoire naturelle*.

A bit more on Buffon. . .

Buffon assumed that the Earth had cooled from a formerly molten state. . .

. . . and by estimating its rate of cooling, he reckoned its age at 75,000 years, with 93,000 to go. (This got him in trouble with Church authorities.)

Kilauea, Hawaii image source: Volcano World

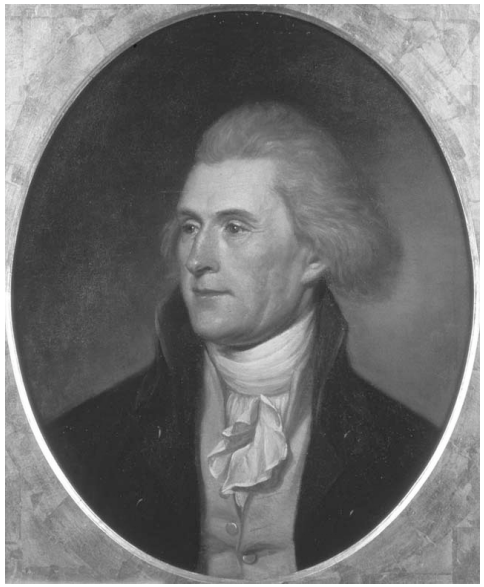
In some of his writings Buffon denied that old species could produce new ones through time. . .

"Though it cannot be demonstrated that the production of a species by degeneration from another species is an impossibility for nature, the number of probabilities against it is so enormous that even on philosophical grounds one can scarcely have any doubt upon the point."

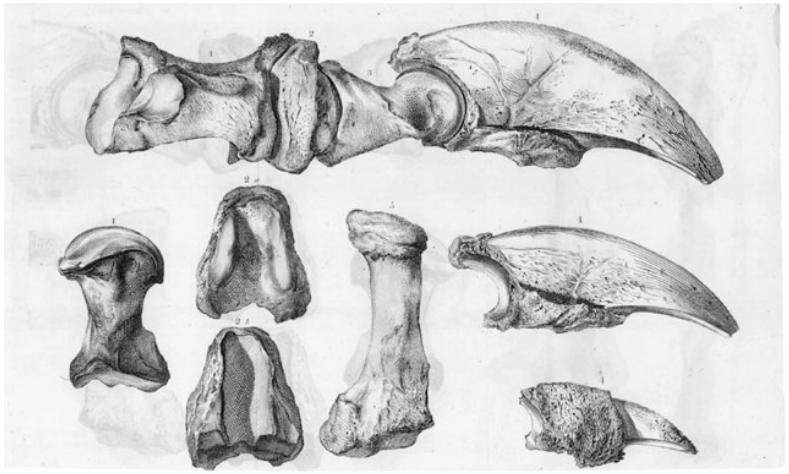
In others, he suggested that it might well be possible. (It's hard to be consistent when you spend your whole adult life writing a 44-volume encyclopedia. . .)

"It is not impossible that. . . all the animals of the New World may be at bottom the same as those of the Old—having originated from the latter in some former age. . . . This, however, should not prevent our regarding them today as different species. . . . Nature, I maintain, is in a state of continual flux and movement."

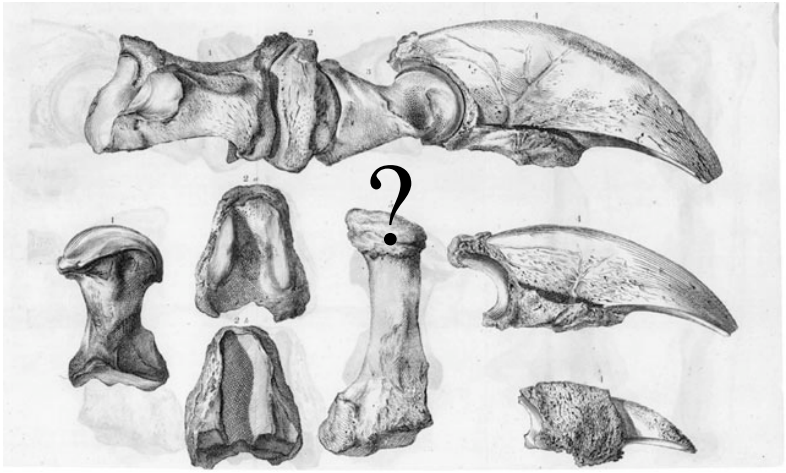
Buffon's idea that American animals were degenerated, inferior forms of European ones annoyed the heck out of one of the greatest scientists in America, who also happened to be the President. . .



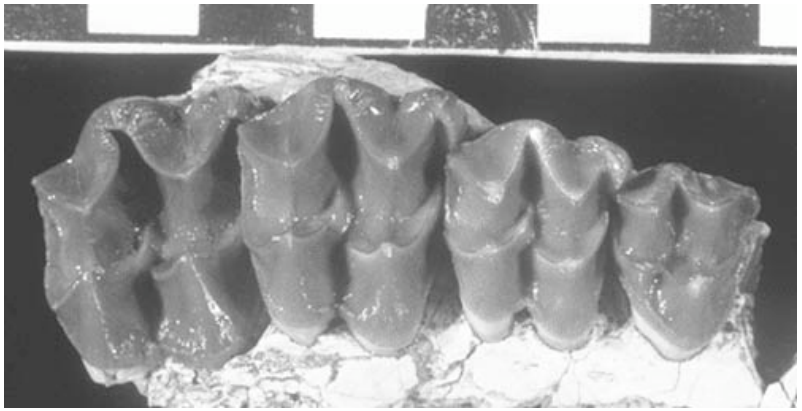
Jefferson thought that giant fossil bones, like these claws from a cave in Virginia, proved that American animals were not "degenerate" knock-offs of European ones. . .



. . . but if *that* was the case, where had the giant animals gone? Might they still be hiding in the American West? Could they be *extinct?*



(Images from the Library of Congress Thomas Jefferson exhibit)



To Cuvier, organisms were integrated. Every part (like these fossil teeth) reflected the overall structure and mode of life of the whole organism.

Georges Cuvier (1769-1832)

Even if we have only the extremity of a well-preserved bone we can, by examining it carefully, applying analogical skills, and comparing it with other materials, determine as much as if we had the whole animal.

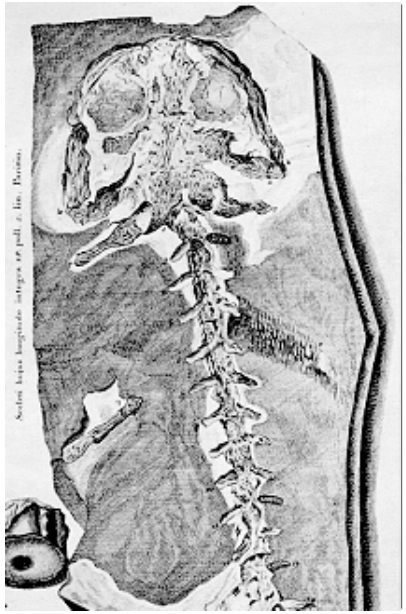
A WWW bio of Cuvier

This "Law of the Correlation of Parts" led to Cuvier's claim that he could reconstruct any fossil animal from just fragments of the skeleton. . .

I have often experimented with portions of known animals before applying this method to fossils. This has always led to such infallible success that I no longer doubt the accuracy of the results that will be obtained.

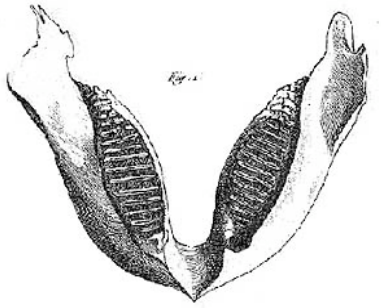
. . . but in reality, Cuvier's skill at reconstruction came mostly from careful comparative work. He is still known as the *Father of Comparative Anatomy*.

For instance. . . in 1735, this fossil from Oeningen, Germany, was interpreted as the skeleton of a man drowned in the Biblical Flood, and named *Homo diluvii testis* ["Man, a witness to the flood"].

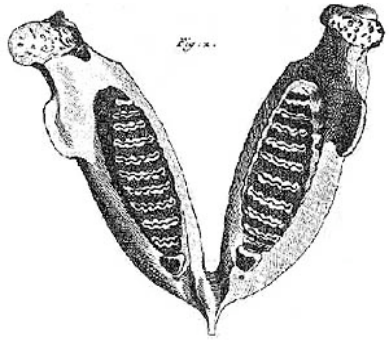


Unfortunately for some. . . In 1802, Cuvier studied the specimen and realized that it was the fossil skeleton of an unusually large salamander.

And there were other problems for the traditional worldview posed by these ancient bones! Take this giant jawbone, for instance. . .

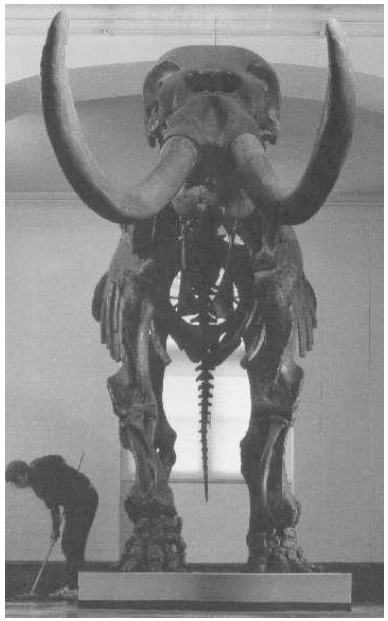


Cuvier compared this jaw of an ancient elephant-like beast called a **mammoth. . .**



. . . with the bones of living elephants, such as the Indian elephant shown here. . .

. . . and showed that they weren't identical! *Similar*, yes. . . but with consistent differences!



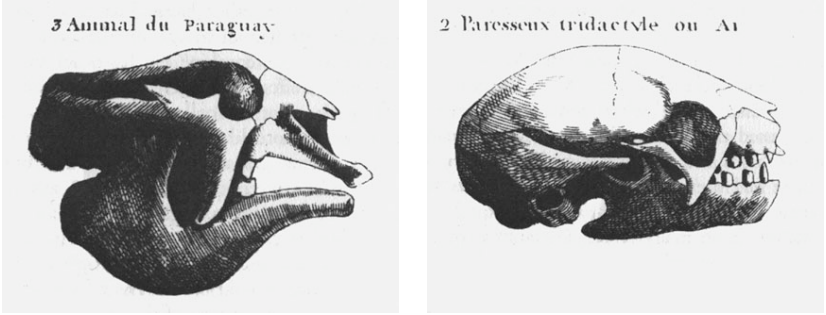
But mammoths were gigantic— the size of elephants! If they were still alive, we'd have found them by now.

Conclusion: The mammoth must have

GONE EXTINCT!

The same was true for the "Irish elk", a giant European deer (not really an elk, and not restricted to Ireland) whose bones had been known for centuries. . .

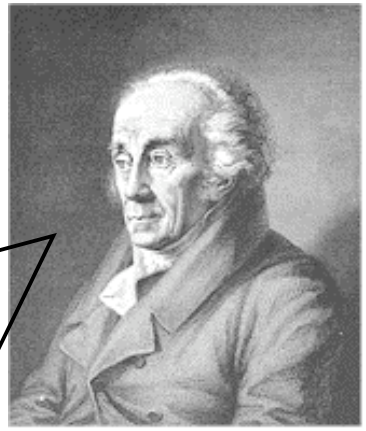
And the same was true for countless other animals, including the extinct giant sloth on the left (compared with a living South American tree sloth on the right).



This bothered people: Why would God create something, only to let it vanish forever? And how could you accommodate that many extinct species in a young Earth?

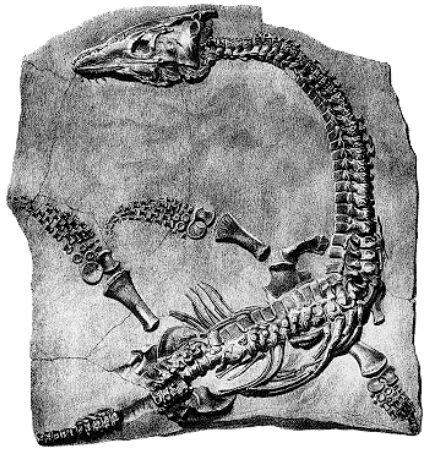
Cuvier's German colleague Johann Friedrich Blumenbach (1752-1840) came to the same conclusion for fossil invertebrates—and countered religious and moral objections to the idea of extinction:

> Nature. . . will not go to pieces even if one species of creature dies out, or another is newly created,—and it is more than merely probable, that both cases have happened before now,—and all this without the slightest danger to order, either in the physical or the moral world, or for religion in general.
>
> —*Anthropological Treatises,* 1806-11



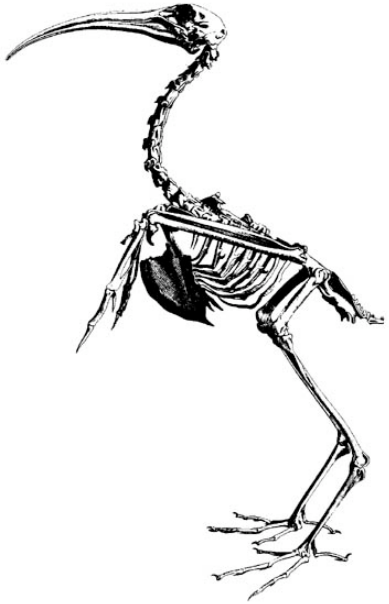
What was more: the older the fossils were, the *less* likely they were to resemble living organisms.

- The youngest fossils included relatively familiar forms, like the long-horned bison at the top.
- Older fossils included less familiar beasts, such as the vaguely rhino-like *titanothere*. . .
- And if you went back far enough in time, you found bizarre reptile-like animals with no living counterparts at all.



Fossil plesiosaur, discovered in the 1820s by Mary Anning at Lyme Regis, England

The idea of an incalculably ancient Earth, which had once housed strange extinct beasts, was increasingly accepted — especially as things like *this* turned up in the rocks. How could the huge and growing diversity of bizarre extinct lifeforms be crammed into 6000 years?



Squelette d'Ibis, tiré d'une momie de Thèbes en Egypte?.

But Cuvier showed that this skeleton of an ibis, recovered from an ancient Egyptian tomb—the oldest animal remains that could be dated reliably—was identical to the skeletons of the ibises that live there to this day. There had been no gradual evolutionary change, at least within the last several thousand years.

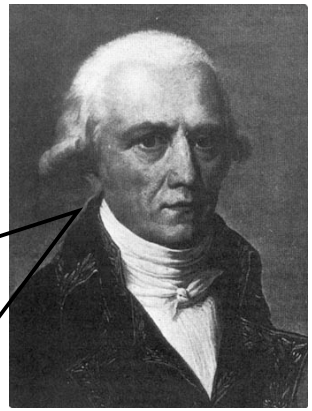
Cuvier explained all this with his theory of *serial catastrophism*.

- Long periods of an unchanging, steady-state Earth had been interrupted by violent upheavals that had largely wiped out the life of the preceding period.
- New life forms had appeared after each upheaval. (Cuvier refused to speculate *how* that had happened.)
- Cuvier himself wasn't especially religious. . . but many people who were supported serial catastrophism. In their view, the Great Flood described in the Bible was simply the most recent catastrophe in a long series.

"But what then was this primitive earth where all the beings differed from those that have succeeded them? What nature was this that was not subject to man's dominion? And what revolution was capable of destroying it, to the point of leaving as trace of it only some half-decomposed bones?"
—Georges Cuvier, 1796

Jean-Baptiste Lamarck (1769-1832)

. . . the structure of the individuals and of their parts. . . their organs, their faculties, etc. etc. are entirely the result of the circumstances to which the race of each species has found itself subjected by nature.

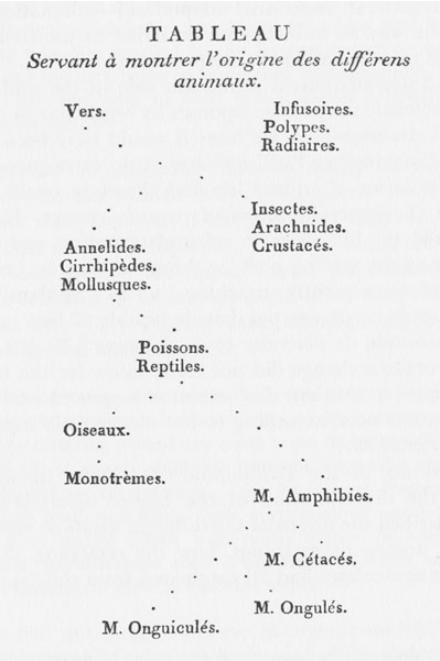


More on Lamarck. . .

"Lamarckian evolution"

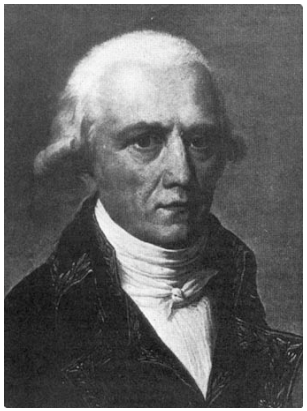
- Lamarck was the first to propose a *theory of evolution*.
  - Other authors had toyed with the idea of some kind of natural process producing new species—that idea goes back to some of the earliest Greek philosophers
  - Lamarck gets the credit, not just for arguing that new life forms could be produced from old ones, but for working out a theory of the process that did this.
  - Though not accepted today, his ideas were influential for long after his death. . .

An organism's environment would cause it to behave in certain ways. Behavior affected form. . . and changes in form could be inherited. Or so said Lamarck.



Over time, this would give rise to diverse and complex life forms from simple ancestors such as protozoans and worms. Note how Lamarck diagrammed this process with a branching drawing. (The worms, "Vers", and protists, "Infusoires", are at the top; various mammal groups are at the bottom.)

Why is this man not smiling?



Lamarck's contemporaries considered his evolutionary work too speculative and far-fetched—Cuvier made sarcastic jokes about it but otherwise ignored it. Whereas Cuvier went on to wealth, fame, and nobility, Lamarck died poor and blind. However. . . .

Erasmus Darwin (1731-1802)

More on Erasmus Darwin's thought

. . . Lamarck may have inspired this English physician and thinker, Erasmus Darwin. At any rate, Dr. Darwin had some very similar ideas to Lamarck's, suggesting that all life formed "one living filament" as it had evolved from a common ancestor.

Could it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine, that all warm-blooded animals have arisen from one living filament which the Great First Cause endued with animality. . . and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity. . . world without end!

- *Zoonomia, or, the Laws of Organic Life* (1794)

Dr. Darwin might have been taken a bit more seriously if he hadn't presented many of his ideas in the form of epic poems.

"Organic life beneath the shoreless waves
Was born and nurs'd in ocean's pearly caves;
First forms minute, unseen by spheric glass,
Move on the mud, or pierce the watery mass;
These, as successive generations bloom,
New powers acquire and larger limbs assume;
Whence countless groups of vegetation spring,
And breathing realms of fin and feet and wing."

- *The Temple of Nature* (1802)

He might also have been taken a bit more seriously if he hadn't been more enthusiastic about sex than many of his readers were prepared to deal with. . .

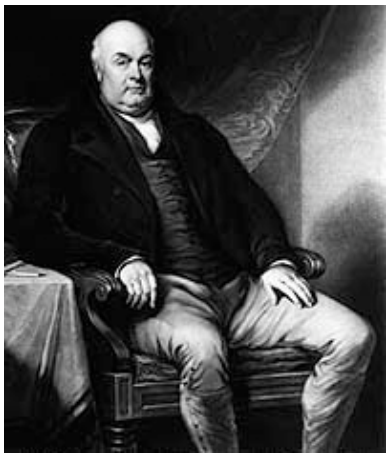
Behold, he cries, Earth! Ocean! Air above,
And hail the DEITIES of SEXUAL LOVE!
All forms of Life shall this fond Pair delight,
And sex to sex the willing world unite. . . .

- *The Temple of Nature* (1802)

The Darwin Family

Erasmus Darwin's second son Robert, a much more conventional fellow, followed in his father's footsteps, studying medicine at the University of Edinburgh in Scotland.

The Darwin Family, continued. . .



Dr. Robert Darwin became quite wealthy from his medical practice, from his marriage to a rich wife, and from various investments. . .

The Darwin Family, continued. . .

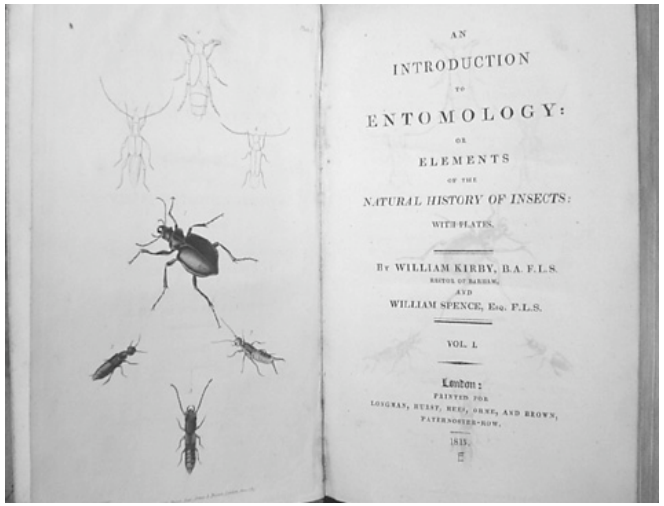
. . . and so his six children grew up quite well-off, including his second son, Charles Robert Darwin, born in 1809.

We fast-forward through a more or less uneventful childhood. . .

. . . to 1824, when Charles Darwin enrolled in the University of Edinburgh, in Scotland, to study medicine. Unfortunately, he disliked most of the professors, many of whom were awful bores, and he couldn't stand the sight of blood. He dropped out after two years. . .

His father, rather annoyed with him, sent him to Cambridge University in 1828, to study for the Anglican priesthood. Although the curriculum consisted mostly of math, Latin, Greek, and theology, Charles did find time to study natural history, with the botany professor John Henslow and geologist Adam Sedgwick.

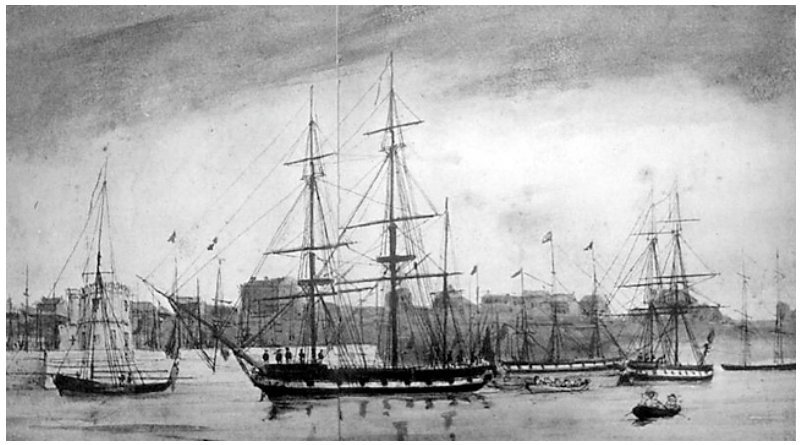
He also found plenty of time to indulge his hobbies of hunting, and of collecting beetles. . .



Capt. Robert FitzRoy

Darwin graduated in 1831, and would probably have gone right into the Church of England, except that his old professor Henslow recommended him to a British Navy captain, Capt. Robert FitzRoy, who was looking for a naturalist and companion for a surveying voyage to South America.

Despite some trouble getting his father's approval, Darwin was finally allowed to go. . .



and *HMS Beagle* left England on December 27, 1831.