GIZ ASKS

What Is the Newest Animal?

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Giz Asks

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Bears. Donkeys. Fat, friendly dogs. These animals—animals, generally—have been around for an extremely long time, long enough to feel like a fixed part of the landscape. It's easy to forget that these creatures weren't always there, and didn't always look like they do now. On human—as opposed to geologic—time, forms seem more or less fixed; sexual mores and national attitudes towards fascism might change in the course of one's lifetime, but zebras stay more or less the same. Taking the long view, though, it's worth wondering—which of these animals, as we know them now, has been around for the least amount of time?

For this week's Giz Asks, we reached out to a number of evolutionary biologists for their take on what the newest animal is. As it turns out, speciation's tough to pinpoint—it's hard to tell, sometimes, whether you're dealing with a whole new species or just an old species with a weird new thing. But, as at least one of our experts pointed out, climate change is speeding evolution up at alarming rates —so who knows, maybe all kinds of new animals will be roaming (and/or terrorizing) the streets, come 2030.

Leif Andersson

Professor, Genomics, Uppsala University, and the one of world's most renowned scholars in the genomic and molecular study of domestic animals

> This is a question that has no answer for two major reasons: Speciation is a gradual process, and there is no real sharp border where two populations have diverged to the extent that they are two distinct species. For instance, earlier this year my colleagues and I published a paper on the Big bird lineage, which started when a Large cactus finch hybridized with a Medium ground finch in 1981, on the small island of Daphne major in the Galapagos archipelago. Since then the lineage has not mixed with other species, and has behaved like a species. But the lineage may break down if unfavorable environmental conditions occur.
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> That said, many any species of animals (if we include all invertebrates) are still unknown to science, so we have no idea if new species are emerging among groups of animals that are poorly studied.

Axel Meyer

Professor, Biology, University of Konstanz, best known for his work on the role of ecological and sexual selection in speciation, among other things

> In Lake Victoria, more than 500 new endemic species of fish originated in less than 15,000 years, and in some of the crater lakes in Nicaragua that are less than 2000 years old, we find endemic species that we've estimated to be only a few hundred generations old. Those are absolute world records in terms of speed of speciation.

"There are probably thousands of species that have diverged from each other in the last few hundred or few thousand years."

Kevin Omland

Professor, Biological Sciences, University of Maryland, Baltimore County

Many people think of humans as the most recent species. Or they might think humans are the most evolved species, or the species that has undergone the most rapid evolution. None of that is true. But there are several useful ways to think about human evolution that can help illustrate these concepts.

First, we know we are very closely related to chimpanzees. Perhaps we evolved from chimpanzees very recently? However, for starters, we did not evolve from chimpanzees. We shared a common ancestor with chimpanzees. Chimpanzees are our cousins not our great, great, ...great grandparents. Ok—so everyone says our genomes are something like 99% identical to chimpanzees; maybe that split happened quite recently. But the best evidence suggests our two lineages speciated from each other roughly seven million years ago, which is quite a long time ago evolutionarily.

Second, what if we ask when fossil evidence suggests we evolved our present form. Anthropologists used to argue that Homo sapiens first appear in the fossil record 200,000 years ago in East Africa. But last year researchers found human fossils in Morocco dating to 300,000 years ago. But such dating just emphasizes a small number of skeletal morphological differences. Surely we are more than just bones. Who we are as a species involves at least millions of different characteristics of our morphology, physiology and genomes. Ultimately, there is no way to say how who we are today traces back to any one point in time—different parts of our genomes have characteristics that trace back thousands of years, millions of years, and billions of years. Even if we were there on the sidelines watching exactly what happened, there would be no way to say when one species ends and another species begins.

Adaptation and speciation are ongoing processes that are happening in lineages all over the planet all the time. There are probably thousands of species that have diverged from each other in the last few hundred or few thousand years. There are some well-known examples of recent "adaptive radiations" that illustrate how rapidly these processes can occur. One of the most famous examples of recent speciation involves the cichlid fishes of Africa's Lake Malawi. Roughly 1,000 different species have evolved just in the last 1 million years or so. But there are many other similar cases including Darwin's finches on the Galapagos Islands, crickets on Hawaii and lemurs on Madagascar. My wife studies fly speciation and her work focuses on recent divergences in flies that feed on different kinds of holly trees in the eastern United States. It would be hard to parse through all these examples and come up with one species pair that one could argue represents the most recent divergence.

> The bottom line is that we are all cousins. Every single species on the planet traces back to a common ancestor that first evolved on this Earth roughly 3-4 billion years ago! Since that time, life has been evolving and diverging into millions of different species. Each one of those species has many recent adaptations in their genomes, especially adaptations to viruses and bacteria. Evolution never stops.
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> Thinking about whether cousins are older or younger than each other is not that crucial a question. All species on the planet are members of the present generation of life on Earth.
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> Every one of these "extant" species shares a very small planet. With the exception of a few astronauts on the International Space Station, as Carl Sagan elegantly pointed out, we are all on stuck on this very small rock on some nondescript arm of a very ordinary galaxy. We need to take care of our planet and all our cousins.

Matthew Knope

Associate Professor of Biology and head of the Knope Evolutionary Lab at the University of Hawaii, Hilo

> Our most well-documented example in the wild is the three-spined stickleback (Gasterosteus spp.). These are small fishes that have repeatedly and independently speciated away from their marine ancestors into lakes and rivers in North America and Europe, all since the melting of the major glaciers of the Pleistocene ice age ~18,000 years ago created these new freshwater habitats.
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> One other really amazing thing about the rapid evolution of these new species of sticklebacks is that you see the same signatures of natural selection each time they independently evolve to live in freshwater. When they colonize and adapt to these novel freshwater habitats they repeatedly converge on the same evolutionary changes in body shape, skeletal armor, feeding specializations, pigmentation, regulation of internal salt levels, life history strategies, and mating preferences. The other truly amazing thing we know is that this repeated independent evolution to adapt to these similar habitats is also seen in the evolution of their genomes. That is, we see the same changes in the same set of genetic loci (both those that code for proteins and those loci that regulate the expression of those genes) each time there is a speciation event, from the marine ancestors to the newly evolved freshwater descendant species!

> *"What animals are responding, evolutionarily, to the changes that are occurring because or rapid global changes? What animals are doing something new that they've never done before, or have a form that they've never had before?"*

Alex Gunderson

Assistant Professor of Ecology and Evolutionary Biology and Head of the Gunderson Lab, Tulane University

My field of study is how evolution and anthropogenic global change interact with one another, so when I hear a question like this, what pops into my head is: what animals are responding, evolutionarily, to the changes that are occurring because or rapid global changes? What animals are doing something new that they've never done before, or have a form that they've never had before?

And in that sense, there are a lot of new animals, and many of them look different than they did before we started rapidly changing the environment around them. When you look at, for example, ants that are living in urban environments—they often tolerate higher heat than they do in their natural environment. The idea is that urban environments, because of all the concrete and things like that, on average are warmer, and these animals have evolved—their physiologies have evolved—to tolerate these higher temperatures.

Another example from urban environments would be Anolis lizards, which is a group that I study. Some of my colleagues have found that lizards that have moved into urban environments are now living on these flat, smooth surfaces, that are very different than the trees they lived on before. They're evolving: their limb-shape is changing, they're evolving longer limbs that allow them to run faster on flat surfaces, and they're holding bigger toe-pads, which allow them to sort of stick on those smooth surfaces better. These are changes that are happening on the order of decades.

Roger Butlin

Professor, Evolutionary Biology, University of Sheffield

> All animals are evolving all of the time. This continuous change makes the question impossible to answer! You could rephrase it to: which species has separated most recently into two new species? But this is also difficult—there are many species where some populations have evolved to be distinct from others, and these may have gone part of the way to being new species.
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> Often this has happened recently, in the last hundreds or thousands of years. Freshwater populations of sticklebacks are a well-known example. The coastal snails that I study are another, with clearly different forms in different habitats on the Swedish coast, even though the islands they live on have only recently emerged from the sea. A new species of Darwin's finch in the Galapagos islands is said to have appeared, as a result of hybridisation, just a few generations ago. This might be the newest case we know about.

"This question illustrates a common misunderstanding about evolution. All organisms have evolved, and continue to evolve."

Charles F. Aquadro

Professor of Population Genetics and Biological Sciences and Director of the Center for Comparative and Population Genomics at Cornell University

> This question illustrates a common misunderstanding about evolution. All organisms have evolved, and continue to evolve. Some people consider humans the pinnacle of evolution, but in reality, organisms with short generation times (bacteria, many insects, etc.—typically small organisms) have actually had more opportunity to evolve than humans have because of the greater number of generations (and thus opportunities for natural selection) in short generation organisms compared to long generation organisms like humans.
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> Given that we all evolved from a distant common ancestor billions of years ago, that means the time in years back to that common ancestor is actually the same for all organisms. Some people also think that because we don't see organisms changing (for example, what they look like on the outside—facial features or whatever) that these organisms have stopped evolving (think horseshoe crabs). But in reality, the environment is always changing (not just the abiotic environment, but the biotic environment, including pathogens and parasites) and these latter biotic factors provide in many respects some of the most powerful and never ending pressures for organisms to evolve.
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> Humans are a great example. Pathogens such as influenza are a constant evolutionary pressure to which humans must respond immunologically. More obvious, but a bit more distant examples, include the evolution of lactose tolerance (selected for by the domestication of cattle etc) and the selection for sickle cell hemoglobin variants in humans living in regions of the globe with persistent malaria.

Stephen Palumbi

Professor, Marine Biology, Stanford University and co-author of The Extreme Life of the Sea, *among other books*

> A lot of species "appear" earlier to each other than they do to us—they are called cryptic species, and they are good species by the main definitions, in that they do not interbreed with even the most similar species around them. This basically means that the species themselves can tell each other apart quite well, so that they do not interbreed. But they are not easily distinguished *by us* from their sister species by any but the most detailed look. And because they are so similar in so many ways, they can't really be found in the fossil record, and their date of 'appearance' is often only estimated by genetics.
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> My favorite example right now is a group of magnificent table top corals in the Pacific. They are part of a species complex that all used to be called Acropora hyacinthus. But there are at least six cryptic species in this complex—up to four of them living together on reefs like in American Samoa, the Cook Islands, Palau, the GBR, etc. The reason this is my favorite is that one of these species has evolved traits that we are finding very useful right now: they are resistant to the heat waves caused by climate change sweeping across the tropics and killing corals wholesale.
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> This species, still only named by a letter designation He (distinguished from Ha, Hb, Hc, Hd, Hf) is the most heat resistant of the group, associates with the most heat resistant symbionts, and lives in the warmest microclimates. When we moved it to a nearby reef and grew it in coral nurseries, the nubbins performed better and survived heat waves more. This species complex is more ready for future climate change than we would know if we thought all corals with the same latin name (Acropora hyacinthus) were all the same.

Tim Barraclough

Professor, Evolutionary Biology, Imperial College London, who works on the evolution of species diversity

Humans are discovering new species all of the time, but most of those have been around for a long time. Either we only just found them or we only just realised they are different enough from related animals to justify the name of a new species. The question of which animal species formed most recently is quite hard to answer because the process of divergence into separate species—called speciation—takes place over long time periods and therefore it is hard to categorically say at what point there is a transition from "two populations of the same species" to "two species". We can, however, estimate the divergence time between separate species using molecular clock approaches: the tendency for DNA sequence differences to accumulate at a roughly constant rate over time.

Caveats out of the way, we can attempt to answer the question. One of the most spectacularly rapid radiations of animal species is cichlid fish of Lake Victoria, in which over 500 species have originated from a single common ancestor between about 100,000 to 400,000 years ago. We cannot easily date the origin of each species because there has not been enough time to accumulate DNA sequence differences, but with a few assumptions it can be calculated that around 5% of the species would be less than 2000 years old and the youngest species would be around 150 years old. Unfortunately, which cichlid species that is, no-one knows.

An alternative place to look is for species associated with human habitats. For example, the body louse (Pediculus humanus humanus) diverged from the head louse (Pediculus humanus capitis) around 100,000 years ago into a lifestyle associated with the origin of clothing. They are currently classified as sub-species, rather than a full species. Species are also adapting to human-modified habitats, such as cities or farmland. For example, two forms of the malaria-transmitting mosquito Anopheles gambiae have adapted to rice paddy fields versus puddles in West Africa, and both of them are strongly associated with humans. These have recently been reclassified as Anopholes coluzzii and Anopholes gambiae. Their dependency on high densities of humans would argue for divergence perhaps 5000 years ago, but the divergence time estimated from DNA sequence data is around 60,000 years. Either way, this divergence is very recent compared to most other species. Other cases such as the proposed new species of Culex mosquitos adapted to life in the London Underground system remain ambiguous as these may be older and have colonized from other habitats (e.g. caves).

Speciation is ongoing, and species that are in the process of forming will only become unambiguously separate after longer time has elapsed than we can observe directly. There are many cases of animal species adapting to the impact of humans on global habitats and environment. Whether these populations persist and diverge into full species will depend in part on how long our own footprint lasts on the planet.

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"Organisms evolve gradually, and so it might not be so easy to find when an animal species reached its 'present form.'"

Nick Barton

Professor of Evolutionary Biology and Dean of the Graduate School at the Institute of Science and Technology in Austria

Well, this is not so easy to answer: organisms evolve gradually, and so it might not be so easy to find when an animal species reached its "present form." Also, evidence could only come from fossils, which are patchily distributed. For example, though there is a consensus that "anatomically modern humans" emerged roughly 200,000 years ago, this term is hard to define—traits such as large brains, tool use, and bipedalism evolved at different times across multiple taxa. Perhaps the clearest example would be domesticated animals, such as dogs: morphologically, dogs show as much diversity as typical mammal genera (related groups of species), and most of this diversity arose from organized selection of pedigree breeds in the 19th century.

Sean Mullen

Associate Professor, Biology, Boston University, whose research is aimed at understanding the origin and maintenance of diversity at all levels of biological organization

This is a pretty difficult question to answer for several reasons. First of all, animal species are constantly evolving, including humans. Second, our knowledge of biodiversity is highly incomplete, so it would be impossible to say for certain whether one species is "the youngest" or "newest". Third, definitions of what species are vary considerable among scientists and across different groups of organisms… further mudding the waters.

What we do know, as evolutionary biologists, is that there are intrinsic features of organisms that increase their likelihood of rapid speciation. These include things like fast generation times, high mutation rates, etc. In addition, we often see the highest rates of speciation and divergence among groups of organisms that have evolved key evolutionary innovations that allow them to colonize previously unexploited ecological niches. For example, African rift lake cichlid fishes, Darwin's finches, or neotropical Adelpha butterflies.

The one thing I do really like about this question, however, is that if you asked 100 evolutionary biologists, you'd likely get 100 different and equally wonderful answers!

> *"There are many cases of animal species adapting to the impact of humans on global habitats and environment. Whether these populations persist and diverge into full species will depend in part on how long our own footprint lasts on the planet."*

Do you have a question for Giz Asks? Email us at tipbox@gizmodo.com.

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