In Cities, Wildlife Evolves Astonishingly Fast

**Animals, plants, and insects adapt to the extreme urban environment — and even to specific subway lines.**

8 MINUTE READ

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Most naturalists turn up their noses at [cities](https://news.nationalgeographic.com/2016/04/160423-best-pictures-animals-cities-urban-wildlife-photography/?beta=true), regarding them as anti-nature—sterile wastelands of concrete and steel. But [evolutionary biologist Menno Schilthuizen](https://science.naturalis.nl/en/people/scientists/menno-schilthuizen/), author of [*Darwin Comes to Town*](https://www.goodreads.com/book/show/34930832-darwin-comes-to-town), takes the opposite view: Urban environments are in fact “powerhouses of evolution,” where animals as diverse as [blackbirds and bobcats](https://news.nationalgeographic.com/2016/04/160418-animals-urban-cities-wildlife-science-coyotes/?beta=true) are adapting to their new surroundings, with startling results.

Speaking from his home in Leiden, Netherlands, Schilthuizen explains why mosquitoes on the Piccadilly Line in [London’s Underground](https://video.nationalgeographic.com/video/i-didnt-know-that/idkt-london-tube) are genetically different from those on the Bakerloo Line; why cities accelerate evolution in ways Darwin could not have imagined; and why sex in the city is helping [urban blackbirds](https://news.nationalgeographic.com/news/2014/09/140904-loss-night-birds-hormone-sing-light-winged-warning/?beta=true) evolve into a new species.

**Of all the adaptations you describe, the most extraordinary is surely the**[**London Underground mosquito**](http://www.bbc.co.uk/earth/story/20160323-the-unique-mosquito-that-lives-in-the-london-underground)**. Tell us how it evolved.**

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Despite its name, the London Underground mosquito is not restricted to London. It’s the name that has caught on for a species that lives in [human-constructed, underground spaces](https://news.nationalgeographic.com/2016/01/160116-subways-transportation-photos-gallery/?beta=true) all over the world—including the Amsterdam Metro—and cellars and basements all over the world.

It is called the London Underground mosquito because it affected people who hid there during the [Blitz in 1940](http://www.bbc.co.uk/history/events/the_blitz). What’s special about it is that it seems to be a species that has evolved very recently. Its ancestor was *culex pipiens*, a common mosquito that lives above ground, feeds only on birds, and forms large mating swarms.

This new species, *culex pipiens molestus*, is different. It feeds on human blood, mates one on one, and the female doesn’t require a blood meal before it lays eggs, as an aboveground mosquito does. On top of that is the fact that it has recently evolved: Because the mosquitoes are confined to separate subway lines, they don’t mix and so have specific genes, which may be an adaptation to conditions in that particular subway line. The only way they would become a unified species is if they all changed trains at Oxford Circus. [laughs]

**Most naturalists regard cities as sterile wastelands. How did you get interested in urban ecology and why do you call cities “evolutionary powerhouses"?**

I got interested in ecology and evolution in cities because cities are, in many ways, extreme environments. Cities have [urban heat islands](https://www.nationalgeographic.org/encyclopedia/urban-heat-island/); they are polluted and noisy; they have artificial light; and there’s concrete everywhere. Because the environment is so different, some subspecies disappear, but others adapt to the new conditions.

The evolution of species also occurs faster because new mutations, which give a species the ability to survive in that extreme environment, will spread very rapidly. This is what we call [HIREC](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3352552/), or human-induced rapid evolutionary change. We see that in cities and also in other environments where humans create a new habitat or ecological situation. In those places you see very, very fast evolutionary adaptations, which can take place in the space of decades or even years.

**That contradicts a core tenet of Darwin’s theory, doesn’t it? That evolution is a very slow process that unfolds over millions of years.**

I think Darwin underestimated the speed it can happen, particularly with species that have numerous generations in a short space of time. Generation time is the evolutionary clock speed, so if you have multiple generations per year you can accumulate evolutionary changes much more quickly than humans can, for example, which have one generation every 20 years.

An example is the [Hawk’s-Beard](https://www.nature.com/news/2008/080303/full/news.2008.639.html) plants in the French city of Montpellier. A French researcher named Pierre-Olivier Cheptou studied the seed science of these weeds that grow in little patches of soil around trees that are planted along city streets. These plants make two kinds of seeds, big seeds and small ones. The small ones have little parachutes that they use to float on the wind. In the city, we found that these small-sized seeds are disappearing. That has to do with the fact that in the city those drifting seeds will probably land on tarmac and will not be able to germinate. So the plant’s genes invest more in the heavy seeds, which fall to the floor and germinate at the foot of the parent plant. Those genes have an advantage in the city, which has resulted in a change in as little as 10 to 20 years. So, really fast!

**In recent years, studying the DNA of urban species has yielded some startling results. Explain why**[**bobcats in Hollywood**](https://www.nps.gov/samo/learn/news/genetic-change-in-la-bobcats.htm)**are different from those living north of the 101 freeway.**

Fragmentation in cities is a common theme. In urban ecology humans create all kinds of barriers, like roads and highways. North of Los Angeles, the bobcat population is divided by two very large highways, which bisect the area where they live. These barriers cause something similar to what happens to mosquitoes in the London subway lines, whereby evolution is restricted to the areas cut off from other populations.

In Los Angeles, there was a mange epidemic caused by exposure to mites, which resulted in high mortality. But high mortality also means strong natural selection and in the section of the bobcat population that is cut off by the 101 freeway, genes evolved to make these bobcats more resistant to mange. In other words, the species in that particular area evolved a change to be better able to deal with this particular disease.

**In Japan,**[**crows in the city of Sendai**](https://www.bbc.co.uk/programmes/p007xvww)**have found a very clever way of cracking walnuts. Explain how this works and why urban creatures tend to be what you call “fearless problem solvers.”**

The crows are a good example of an animal that is a fearless problem solver. I spent some time in the city of Sendai and have seen those crows with my own eyes. They have been feeding on walnuts for a long time, which they drop from a great height. At some point in the 1980s, the crows discovered that it’s easier to take a walnut and put it in front of the wheel of a slowly moving vehicle, like the cars at this driving school. The habit of putting walnuts in front of car wheels then spread to other crows in the city.

This is an example of the cleverness we see in many urban birds. It is not evolution, in the sense that there is not a gene for putting walnuts in front of car wheels. But there are genes for personality traits, which have to do with problem solving, curiosity, and being tolerant of people. Urban birds and mammals all over the world constantly find new ways of making use of the human inhabitants of the city. There are new foods, resources, and nesting opportunities. Wild animals are shyer, because curiosity kills the cat. But in cities, you do see that mammals and birds are evolving different personalities.

**You compare**[**the urban blackbird**](https://www.irishtimes.com/news/environment/another-life-sex-the-city-and-blackbirds-singing-in-the-dead-of-night-1.2934382)**to Darwin’s finches, in terms of its importance to the study of city ecology. Unpack the parallels for us.**

Many examples I’ve given up to now are of evolution within a species. There’s a change, but you don’t see a new species. The blackbird is one of the few cases where it seems there is in fact a new species evolving. Blackbirds started colonizing cities about two hundred years ago, in Germany and Italy. The urban streak then spread throughout Europe and into Asia. Before that time they were shy forest birds.

City blackbirds have changed in so many different ways that you can say, like Darwin’s finches, that they have adapted to a new ecological niche. City blackbirds have shorter beaks; don’t migrate anymore; have different stress responses; start breeding much earlier in the year; and sing at a different pitch.

All these things prevent them from crossbreeding with forest blackbirds, which is also a crucial step in producing a new species. So the blackbird is a good example of a real urban species that is in the process of evolving, similar to the Darwin finches evolving in the Galapagos Islands.

**Toward the end of the book, you describe some fascinating new attempts to harness urban ecology in our cities. Tell us about some of these, including Japan’s *[satoyama](https://unu.edu/publications/articles/as-japan-rebuilds-it-should-look-to-satoyama-and-satoumi-for-inspiration.html)*[revival.](https://unu.edu/publications/articles/as-japan-rebuilds-it-should-look-to-satoyama-and-satoumi-for-inspiration.html)**

S*atoyama*is a term for the traditional Japanese natural landscape around villages, this mosaic of rice fields and bits of forest, managed by local populations. That concept is now being revived in the mega-cities of Japan as local communities begin to set up urban farms, or build little vegetable plots and orchards right in the heart of the city. That’s one way to become aware of the fact that an urban ecosystem exists in the first place and that we are *a part*of it.

Urbanites can also become part of studying the evolution of city ecosystems. Here in Holland, we have introduced an app called [Snail Snap,](https://www.knnv.nl/afdeling-walcheren/help) which allows people to take pictures of the garden snail. We’re studying the colors of the shells they photograph, and we’re seeing that, inside the city, snail shells are lighter in color. This probably has to do with the fact that in the city you have this urban heat island and snails may have a higher chance of overheating in the summer. By having a lighter shell, they can reflect more of the sun’s heat and survive better. We’re hoping that this kind of citizen science project will expand all over the world to help study urban evolution.

There is also a big trend in urban planning and architecture to include ecology in buildings or city design, by having green roofs or green walls, and pockets of vegetation in or between buildings. It’s a good idea, although I think it could be improved by having a better understanding of urban evolution. Many of the plants planted on green walls and roofs are simply picked out of the catalogue of a garden center. But in the city, there are many wild plants that are in the process of adapting to urban conditions. So I would argue it would be better to simply provide the space or soil and let these areas be colonized naturally by the plants that are already growing in the city.

**What about us? Are humans evolving in cities as well?**

We also are living in an extreme environment, even though we’ve created it ourselves. Our ancestors never lived as we do now, in dense, artificial mega-villages. We *could*adapt to that evolutionarily, but for evolution you need what are called differential survivals. Some people with certain genetic characteristics would need to survive better or have more offspring than other people. But that is one way we differ from wild animals and plants that die in large numbers in cities, whereas we tend to survive, as there’s not so much death as in the past, fortunately. But that also means our evolution is slowed down, even though it could be good for us to adapt.

There is some evidence from the study of the genes of skeletons in graveyards in very early cities that people’s immune systems were already adapting to deal better with infectious diseases, which spread much more easily in cities than among sparse populations in the countryside. That will still be going on in cities today. But for the rest, we’ll just have to wait and see.

**Are you optimistic about our future on Earth?**

I’m optimistic in the short run. In the long run, I’m not sure if we can maintain this *huge*population. It’s a completely unprecedented situation that the Earth is in nowadays, with one species dominating the ecosystem in such a dramatic way. This has never happened before. So we don’t have any examples from paleontology to predict what’s going to happen. If you look at smaller ecosystems, where one species dominates, that’s usually not a stable situation. So, in the long run, I think we might become less dominant. [laughs] But how that’s going to happen, I don’t know.

*This interview was edited for length and clarity.*

*Simon Worrall curates*[*Book Talk*](http://news.nationalgeographic.com/news/book-talk/)*. Follow him on*[*Twitter*](https://twitter.com/simonworrall)*or at*[*simonworrallauthor.com*](http://www.simonworrallauthor.com/)*.*