Birds That Go **Wild for the City**

Many animal species have made their homes in towns and cities. However, the conditions they encounter there are different than those under which they would live in a natural environment. **Henrik Brumm**, **Jesko Partecke** and **Bart Kempenaers** from the **Max Planck Institute for Ornithology** in Seewiesen and Radolfzell are studying the effects of city living on our native songbirds. In the process, they have discovered some surprising behavioral changes.

TEXT **STEFANIE REINBERGER**

It is located in a picturesque setting, the Max Planck Institute for Ornithology in Seewiesen: nestled between meadows, fields and forest, on the banks of Lake Eßsee – the lake where Konrad Lorenz once swam with his young gray geese. The subdued atmosphere of the misty November morning further enhances the idyllic atmosphere. If you had just made your way out here from the hustle and bustle of downtown Munich, you might think this was nature at its best. But wait: Isn't that the noise of traffic from the nearby highway?

"Yes, sure," says Henrik Brumm, who leads the Communication and Social Behavior research group. "And in addition to the noise of the cars, we sometimes also hear noise from the nearby Oberpfaffenhofen airfield." The problem of urbanization isn't restricted to urban areas. "Noise actually radiates a long way out into rural regions." Brumm tells of an expedition he made into the Amazon River region: "Even in the middle of the rainforest, far from any civilization, I could still hear aircraft flying over us."

Urbanization is a major issue of our time – for the United Nations, it is the most pressing issue after climate change. About half of the world's population currently lives in towns and cities, and the tendency is rising. Forecasts indicate that, by 2030, around five billion people will have settled in urban areas. Megacities are forming – and they are spreading. This brings with it massive environmental damage, including garbage and air pollution.

"Noise is a big problem, too," says Brumm, pointing out a whole array of studies that demonstrate that noise can cause illness. "And of course it also affects wild animals, whether they live in the city or in the countryside." This is exactly what the Max Planck scientist is interested in, focusing in particular on avian communication: whether and how it is impaired by noise and what consequences that has for the animals.

Henrik Brumm settled on his research area while still doing his doctorate at Freie Universität Berlin. Back then, he studied the song of the night-

Some species of birds are surprisingly resourceful when they need to adapt to the city as a habitat: Here, a fieldfare has built its nest in a set of traffic lights.

Photo: Avenue Images

ingale, a species of bird widely found in both urban areas and the countryside. In Berlin alone, there are some 1,500 breeding pairs – living wherever they can find the bushy vegetation they prefer to nest in. Brumm discovered that nightingales sing more loudly in a noise-intensive setting. This even extends to them singing more quietly on weekends than they do on working days in the hum of commuter traffic.

We humans also raise our voices in a noisy environment. This is referred to as the Lombard effect, named after the French otologist, Étienne Lombard, who first described the phenomenon. But the discovery of this effect in birds was something new. "It was a surprise because, at the time, we assumed that birds always sang at maximum volume," says Brumm. The scientist did a simple experiment to show that this wasn't the case. He kept nightingales in aviaries and exposed them to white noise – a type of background noise that encompasses all audible frequencies and is thus not perceived as a defined sound. The birds did indeed put more into their singing, even under lab conditions, if their environment was noisy.

Other scientists subsequently discovered that many bird species sing at a higher pitch in the city than they do in rural areas – the great tit, for example. And the blackbird, as Brumm – who by then had been at the Max Planck Institute for Ornithology in Seewiesen for some time – demonstrated in a study.

HIGHER TONES TO BEAT TRAFFIC NOISE?

"We wondered why birds sing not only louder, but also higher," reports Brumm. One possible reason could be that higher-pitched singing would be easier to hear against low-frequency road noise. Or perhaps it can be heard over longer distances, they thought. Or might it be able to compensate for the

Researchers working with Henrik Brumm are conducting field studies and experiments in acoustic laboratories to investigate how birds adapt their singing to the environment.

1 | Mathias Ritschard records birdsong in noise-polluted areas.

2 | Sue Anne Zollinger plays traffic noise to young birds in a soundproof lab and then observes how their song develops.

3 | Ana Martins, Henrik Brumm and Sue Anne Zollinger (from left) prepare to take acoustic measurements in the lab.

disadvantage faced by city birds, for whom noisy conditions mean that they can communicate over only half the distance their country cousins can? Brumm and his team of scientists developed a mathematical model to examine these possible relationships, but the result was negative. While singing higher does actually compensate a little for traffic noise, the effect is minimal. "For blackbirds, it doesn't work at all, because they sing at much lower pitches than birds like the great tit," says Brumm.

Trilling at a higher pitch may be nothing more than a side effect of the higher volume of noise the birds face. We see this in humans, too: shouting raises the pitch of the voice. So it could be that urban blackbirds vary their song to suit the noise level: more higher-pitched passages to sing more loudly. Henrik Brumm is currently testing this theory with colleague Jesko Partecke, who works at the Max Planck Institute for Ornithology's Radolfzell location. The two scientists put blackbirds in soundproof boxes, where they are away from the influence of ambient noise, and studied their song. They found that the birds actually do seem to produce higher tones at a louder volume.

GREAT TITS LEARN TO WARBLE IN THE LAB

It's also not inconceivable that birds from the city might have difficulty learning their parents' melodies correctly because they can't hear them so well due to the noise. Brumm and his team are investigating this in the lab with great tits that have been hand-reared at the institute and have picked up their chirruping skills there under a variety of acoustic conditions. What the scientists found is that the birds can learn even low-pitched passages of song when it's noisy. Thus, learning difficulties in the young don't appear to be the problem.

"While we've been able to observe such phenomena, what we don't yet know is what impact they have on the animals, on their life expectancy, their breeding behavior or their mating success," says Brumm. One of his fellow scientists, Sue Anne Zollinger, for instance, recently studied whether singing more loudly used up more energy. The effect was minimal. "In actual fact, the birds do use a little more energy, but the difference is barely measurable. So it's highly unlikely that it affects them," says Brumm.

However, behavioral changes in different habitats – in this case the city and the countryside – don't always have to be negative and to the detriment of the animals. "Observing the same species of bird in the city and in the countryside offers a fascinating opportunity to watch

Photos: Axel Griesch (3)

Open wide: In the city, male blackbirds sing louder to be heard over the traffic noise. Why they also sing at a higher pitch is not yet known. The tooth-like growths in the palate *(Papillae palatinae)* are made of horn and serve to catch prey and move them down into the gullet.

evolution in action," explains Jesko Partecke. That's because the necessary conditions for successful city living are becoming increasingly prevalent in our towns and cities.

Blackbirds are the subject of Partecke's research. Admittedly, he found the thought of them pretty boring as a young scientist, as he relates with a smile. He was just about to go off to Africa to study stonechats for his doctoral thesis when he found out there was going to be an addition to the family; suddenly Africa didn't seem quite the right place for the father-to-be. "My doctorate supervisor offered me a topic with blackbirds in the field of urban ecology," the ornithologist recalls. That turned out to be a real stroke of luck, as the field was a new one that had hardly been explored. "Blackbirds are the ideal study objects in this field: they colonized our towns and cities long ago and they are also found in the countryside. So it's easy to make comparisons."

CITY BLACKBIRDS ARE DIFFERENT

There are lots of behavioral differences between urban and rural blackbirds; their song is just one of many. For instance, urban blackbirds fly south less often than their rural cousins do. Their eggs hatch about three weeks earlier, and sometimes they even have several clutches per year. They also live in closer proximity to others of their species than blackbirds in the countryside.

Sometimes, living in the city even appears to offer the birds advantages. One thing that Partecke discovered in 2008 is that city blackbirds don't get parasites as often as others. Birds from the city also have greater stress resistance. When they find themselves in difficult situations, the animals react like people do, with an acute stress response and the release of stress hormones, known as glucocorticoids. That helps them react fast to a dangerous situation. But if their stress levels and thus the amount of stress hormones in their blood remain high over a long period – what is known as chronic stress – it can affect the birds' reproduction, immune defenses and brain function.

Jesko Partecke was keen to find out whether urban and rural blackbirds have different ways of dealing with stressful situations. So he and his team went out to Munich and the surrounding areas to collect nestlings, which they then reared together by hand. All of the young birds thus had the same starting conditions – at least environmentally. The scientists then exposed the animals to acute stress and took blood samples. Young city blackbirds did, in fact, remain much cooler than those from the countryside, exhibiting less of a reaction to stressful

Photo: MPI for Ornithology

1 Urban blackbirds are better at dealing with stress than blackbirds from the country. Jesko Partecke hand-reared the nestlings of urban and woodland blackbirds for these experiments and measured their hormone levels in stressful situations.

2 The latest radiotelemetry technology enables the scientists to locate a bird and make a continuous recording of its activity pattern. Tiny data storage devices fitted with light sensors also quantify the level of light the bird is exposed to at night.

3 Davide Dominoni locates city-dwelling blackbirds in Munich.

situations. Yet in a stress-free environment, the hormone levels of the two groups were similar.

UNDER THE LIGHTS

Bart Kempenaers is studying a different type of environmental change in our cities. The Director of the Department of Behavioral Ecology and Evolutionary Genetics in Seewiesen focuses on the ever-present artificial light on the city's streets and open spaces. The scientist discovered that male blue tits mate more successfully if they live in the vicinity of street lights. "We discovered that by complete accident," admits the behavioral researcher, a Belgian by birth (MaxPlanckResearch 2/2004, page 64 ff.). A few years ago, he studied the mating behavior of blue tits in a major field study.

"There's a huge amount of variation between the animals: some of them are monogamous while others live with several partners, and yet others have one permanent partner, but they also go with other birds at the same time," recounts Bart Kempenaers. One of the things the study was attempting to find out was which males successfully two-time their partners and sire the most offspring. The scientists took DNA samples and did paternity tests to ascertain this. The surprising result was that the animals were most successful if they lived near street lamps.

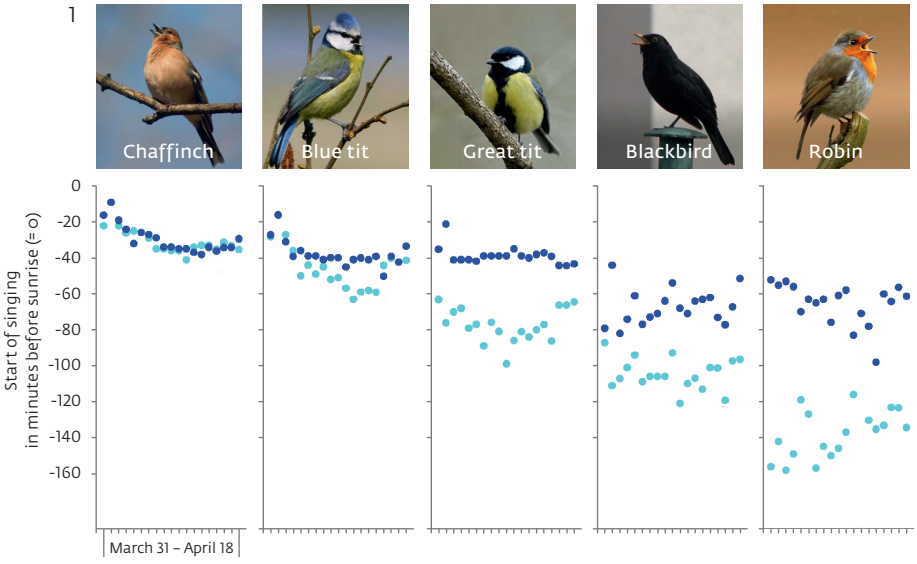
"This might have something to do with the fact that the artificial light makes them start twittering earlier in the morning and attracts the attention

Photos: MPI for Ornithology (3)

1 A song before sunrise: In the vicinity of street lamps (light blue circles) some species of birds begin to sing earlier than they do if there is no artificial light (dark blue). The difference is more marked in species that naturally being to sing earlier, such as blackbirds and robins. With chaffinches, however, artificial light has absolutely no influence on when they start to sing. For this study, birds were observed for 19 days in woodland near Vienna, where light levels varied.

2 An industrial park near Geel, in Belgium. Night-flying bird species are often attracted by such brightly lit spaces, whereupon they lose their orientation. Many animals die in collision with the light sources. Other impacts on the birds are still virtually unstudied and may depend on things like the color of the light.

3 Midnight sun: Niels Rattenborg, Mihai Valcu and Bart Kempenaers (from left) study the behavior of pectoral sandpipers near Barrow, Alaska. When this species reproduces, it's light 24/7. The animals have adapted to the special light conditions in the Arctic tundra: the most active males get by on very little sleep during this time and sire the most offspring.



of the females," explains Kempenaers. The early bird catches the wife, so to speak. As it happens, male blue tits really do start singing about fifteen to twenty minutes earlier because of the artificial light. The effect is even greater in blackbirds. Moreover, female birds begin laying eggs a few days earlier under artificial light. So light not only affects what happens during the course of the day, it also has an impact on seasonal processes, such as the start of reproduction.

What other effects light pollution has on the animals – whether it impairs their metabolism or their life expectancy – is still completely unknown. "When I began looking into the subject of light pollution two years ago, I was surprised at how little was known about it," says Bart Kempenaers. But he is convinced that the different day-night rhythm need not necessarily have negative consequences.

SLEEPLESS IN ALASKA

In Alaska, the Max Planck scientist is studying bird species that live with constant light in the summer months. Many of them hardly let it affect them, and carry on in their normal rhythm, apparently getting their orientation from other time signals. Yet others, like the pectoral sandpiper, just can't seem to find rest for days on end – and mate with extremely high levels of success in these very phases.

"Of course, this is not transferrable to our blue tits, given that the animals in Alaska have adapted to these extreme light conditions over a long period," emphasizes Kempenaers. But it

Graphic: 2010 Current Biology 20: 1735-1739, Elsevier Ltd.

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shows how little we know about the rhythm of life of our native bird species. Kempenaers wants to address the subject in a large-scale study in conjunction with Dutch colleagues. To this end, the scientists are observing birds in a woodland setting where various artificial sources of light have been installed at random.

Jesko Partecke is also interested in the effect of artificial light on birds, which is why he and his team have attached light-sensitive transmitters to a number of blackbirds. Not only can the scientists now record where the birds are and what they're doing, they can also see how much light the birds are actually exposed to and when. "We are now able to measure the direct impact of light pollution for the first time," says Partecke. A few researchers from his team are currently analyzing the data from the experiment. Hopefully, they will soon be able to tell us more about what role artificial light plays.

So are the behavioral differences between urban and rural birds really a consequence of microevolution – in other words, a direct adaptation to a new environment and the prevailing evolutionary pressure? Jesko Partecke has a different idea: "I think it's like with us humans: many individuals would become ill faced with the hustle and bustle of the city, so they prefer the quiet country life, while others need exactly that kind of rush." Thus, it may well be that there are different types of characters in the bird world, too, that bring a different set of attributes with them. And that might explain why some make the move to the big city, while others stay in the peace and quiet of the country. ◀

TO THE POINT

- **Birds adapt to the different living conditions in the city and the country. This is evolution in action.**
- **The noise and light conditions in cities influence the animals' behavior and physiology. Nightingales and blackbirds sing more loudly and at a higher pitch than they do in the country, for instance, and street lamps affect the reproductive success of blue tits.**

Photo: Jan Kempenaers (left), Peter Mombaerts (right)