Biol. on-line: Vol. 11, Núm. 2 (Juliol de 2022) *ISSN: 2339-5745 online*

Coping with novel environments: how birds have adapted to urban environments

Lucas Bogaert i Marc Chillarón

Introduction

Urbanization presents a major threat to biodiversity. However, it also represents a unique opportunity to study evolution in novel environments. As cities are constantly reshaping, birds living in these areas face continuous challenges and, as its co-dwellers, they need to adapt to these changes as they happen using different strategies. Here, we aim to identify some of the traits selected by urban habitats and explore the relationship between brain size and brood value as two forms of plasticity.

Identifying these traits may help us mitigate biotic homogenization and it could also be an effective approach for preserving ecosystem functions and services in urban areas, as well as to identify which species are more sensitive to urbanization processes.

Urban traits

Nesting Site

Urbanization favors cavity nesting species in contrast to ground-nesting species. In those nests, birds are more protected from predation and human disturbance, thus, have higher survival rates.

Plumage coloration

Urbanized areas show not only fewer species, but also species that look more similar between them. Moreover, it is an important trait for camouflage, and, as birds tend to resemble their surroundings, highly urbanized areas are dominated by grey colour.

Human Tolerance

Birds with a higher tolerance to human presence have a selective advantage in urban environments. Flight initiation index (FID) is used to measure this tolerance. Shorter FID reduces the costs associated with flight, and help birds exploit novel resources.

Generalism

Generalist species are positively associated with urbanisation. They usually lay multiple clutches, have larger niche breadths and broader diets, which allow them to cope with such novel environments.

Biol. on-line: Vol. 11, Núm. 2 (Juliol de 2022) ISSN: 2339-5745 online

A connection between behavioral plasticity (brain size) and bet-hedging (brood-value)

One of the traits that is expected to be enhanced in novel environments is behavioral plasticity, which is determined by brain size relative to body size. Birds who have a great capacity to learn and adapt to new situations should thrive in cities.

However, when we look at the species that do well in cities (known as urban exploiters), we find out that not only the species with large relative brains thrive, but also those with a small relative brain (**Figure 1**).

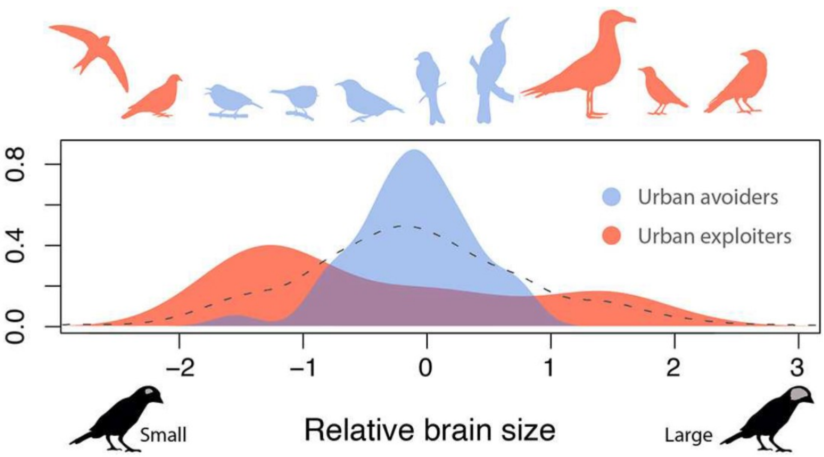

Figure 1: Relative brain size distribution among urban exploiters and avoiders. Sayol et al. 2020

This means the relation is not as simple as one would assume in the first place. Urban exploiters include examples of small-brained birds like pigeons and swifts and large brained birds like crows and gulls. This differences in brain size are correlated with two different life history strategies referring to brood value. The brood value measures the relative value of each reproductive event, that is, how important is each brood to the overall reproductive effort. For example, one reproductive event per year with a high number of eggs will have a high brood value, while three reproductive events per year with less eggs will have a lower brood value.

Having a low brood value means dedicating less energy in one reproductive event, which represents an advantage in changing environments, such as cities. We could say that this first strategy is a type of reproductive plasticity, known as bet-hedging. Bet-hedging allows birds to place the chances of the descendant's survival in different moments.

Birds with high brood values don't have this reproductive plasticity and invest more energy in a single reproductive event. That means that reproduction plasticity is not an option for adapting to cities. That is why they use a second strategy: behavioral plasticity. Larger brains allow birds to learn and to change their behavior giving them the chance to innovate and cope with new situations. These new skills represent a major advantage in cities, which are continuously changing and offering new opportunities.

Biol. on-line: Vol. 11, Núm. 2 (Juliol de 2022) ISSN: 2339-5745 online

One could ask if those strategies could be complementary. That is not the case, because there is an energy trade-off. Both having many reproductive events per year and a large brain need a high energy investment, which make the presence of both traits in the same bird incompatible. Trying to implement both strategies would represent a cost in fitness.

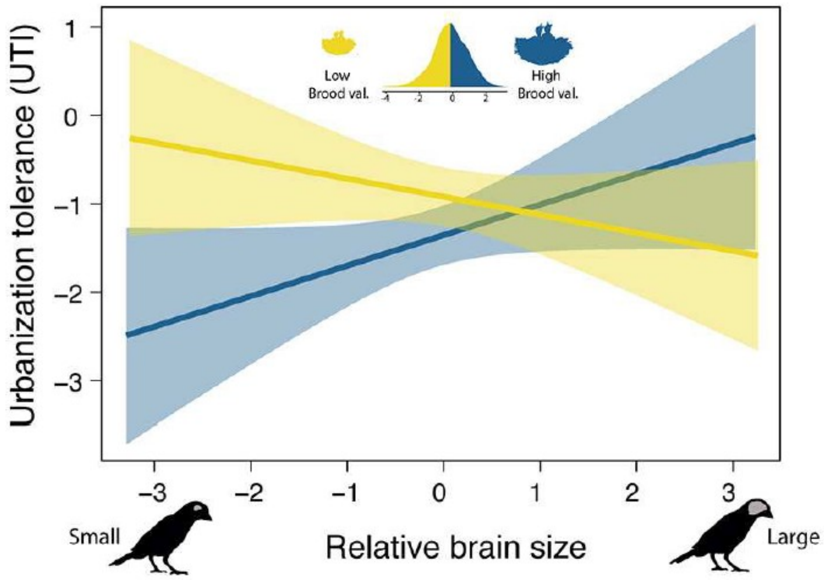

Figure 2: Brain size interacts with brood value to predict urban tolerance. Sayol et al. 2020

To sum up, we have two completely different strategies to deal with changing environments, but both enhance the ability of birds to react rapidly to changes. When we compare both strategies with urbanization tolerance (which is calculated comparing the presence of species in and out of the city), we observe that there are two trait combinations to tolerate urban environments: larger brains with high brood values and small brains with low brood values (**Figure 2**). Thus, we can say that what is important in cities is plasticity, both reproductive and behavioral.

Conclusions

This work confirms the importance of brain size in determining the responses to novel environments, but also highlights the need to consider behavioral flexibility in the context of life history. We must study these two factors together to fully comprehend how organisms respond to anthropogenic impact. Moreover, there are many other traits that provide a selective advantage to birds in urban habitats and more studies are needed to fully understand which are the most significant ones.

The understanding of urban evolution will also help identifying which are the weakest points for world's biodiversity conservation in urban areas and therefore what should be the focus on future actions.

Biol. on-line: Vol. 11, Núm. 2 (Juliol de 2022) *ISSN: 2339-5745 online*

Bibliografia:

Sayol F, Sol D and Pigot AL (2020). Brain Size and Life History Interact to Predict Urban Tolerance in Birds. Front. Ecol. Evol. 8, 58, 1-9.

Patankar S, Jambhekar R, Suryawanshi KR and Nagendra H (2021) Which Traits Influence Bird Survival in the City? A Review. Land 10, 92, 1-22.