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Urbanization and Artificial Structure's Effect on Wild Lives and Their Adaption

Abstract: Short comics that present some creatures' adaption to urbanization and the differences between urban and non-urban individuals.

1. Evolution in Blackbirds' singing voice.

Ambient noise is an important environmental constraint impeding signal detection, and it is thought that environmental noise plays an important role in the evolution of birdsong.[2] Birds always try to avoid signal masking by background noise like the acoustic masking by low-frequency traffic noise, including adjustments in song timing, song structure and performance. Some of them, for instance, sing louder in noisy conditions. Others use particularly high frequencies well above the noise of the fast-running streams in their habitat.[3]

In urban habitats, anthropogenic noise, especially traffic noise constrains birds' communication. Recent studies have shown that birds can vary their songs with the amount of background noise in cities.[1] Blackbirds are one of such successful colonizers of urban habitats. These birds started to settle in European cities more than 150 years ago, and in urban areas the species has changed from a former shy woodland dweller to a rather tame city bird.

Blackbirds' song seems typical for forest birds because of its far-reaching motifs with a narrow bandwidth and rather long elements are well suited for long-range communication in a closed, echoing habitat. However, one research recently showed that the loudest frequencies of the motif elements in urban blackbirds' song were much higher than in the forest. And they also sang significantly shorter songs with fewer elements.[1] Shifting to higher frequencies could be an adaptation to the traffic noise in cities, as higher frequencies will suffer less masking in low-frequency noise.[1]

Such phenomenon could also be related to changes in stress physiology and to timing of gonadal development and breeding.[4] Blackbirds from the city of Munich in southern Germany develop their gonads 3 weeks earlier than birds in a forest nearby and males in the city show on average higher amounts of luteinizing hormone throughout the season and lower amounts of plasma testosterone during gonadal development.[4] A higher testosterone level possibly leads to lower song frequencies in blackbirds. A reason for higher arousal in city birds could be a higher bird density in urban areas. Higher densities could imply more intense social interaction with neighbors and therefore change the motivational state of a singer. It has been shown n in 27 species that bird density increases with household density and decreases only in extremely densely populated areas.[1]

In the first page of my short comics I present the black birds living in forest on left side and city on the right side. The drawing in the middle suggest the way how urbanization interferes their original living habitats.

In the forest, black bird can sing for a long period (the long music score coming out of the bird's mouth in the drawing) in a large open space, as like they are idylists. But after the urban noises (cars, drillers, sound boxes and so on) have got around it , its original singing style is no match for it, so it has to change. The microphone in the bird's hand is a metaphor of their even louder singing voice. Also I use the different images of idylist and pop singer to suggest the length and the amount of information contained in the song. (pop songs tends to be shorter and to contain fewer elements).

In the second line, I make a joke of differences of how a couple fall in love with each other between city and rural area. On the left side, two black birds are singing to each other from a far distance on two trees. It will take a long period and frequent song interactions(the many music notes) between them to ensure their relationship, like an old, classic country love story. On the contrary, as large amount of black birds gathering in the city, they have easier access to communicate with opposite gender. And the louder and straighter song communication makes the rate of coupling increase greatly, just like teenagers in modern city. It also suggest the earlier gonadal development and breeding of birds in the city. (human precocity)

2. Change in the size of house finches' beaks

Urbanization can also affect birds diet, and then makes them gradually turns out totally different morphological forms, in the birds' case, are the width, length and thickness of their beaks. Urban areas are often characterized by the provision of supplementary avian food, which mostly consists of seeds or other plant material coming from agriculture development.[9] In America, urban house finches rely mostly on sunflower seeds at bird feeders in cities, which is a food that is larger and harder than their natural foods in surrounding desert habitats. And in contrast, insectivorous species appear to be relatively scarce in urban areas[5]. This change in diet caused directional selection for longer and wider beaks in the urban population, traits associated with stronger bite force.[5] Even before the global urbanization, similar natural selection have taken place several times. For example, in an environment where primary food source is nut-bearing trees or bushes, some finches with the beaks better shaped for nut-cracking can survive more easily than those with beaks poorly shaped for nut-cracking. Hence, those finches with more suitably shaped beaks are more likely to leave over their gnome to the next generation. In the same way, if one habitat's food resource is predominantly insect species, the birds with narrow and long beaks will be favored to live on.

The first line on the second page of my work shows the original size comparison between house finches and their food in the forest, mostly small flower seed and soft fruits. But after the agriculture taking place in the area, these birds have to adjust to the new food resource, which is sunflower seeds and other crops in large size, the result is longer and wider beak to break and swallow the food. Also the picture on the

right also suggests that food resources are more concentrate in city.(mostly offered by human)

In the second line, the left side shows the various type of food house finches used to have in the forest, worms, flower seeds, moths, and so on. This made the many different size of house finches' beaks, some are long and narrow while others are curvy and thick. But in the city, only birds with certain type of beaks could survive, which is the straight long and wide one that can easily break the shell of large seeds and nuts. The advertisement board in the background is inspired by the one in the human society that people in city tend to chase one certain standard.

3. Changes in plants' life-history traits.

Fragmentation of land can reduces the size and increases the isolation of plant populations, pollinator services may decline, reducing seed set and causing a weak Allee effect, which will possess a reduced per capita growth rate at lower population density or size. This, in turn, could select for higher rates of self-fertilization and affect selection on dispersal, for example, by reducing populations of dispersers or limiting access to suitable habitats.[6]

A recent research on a Mediterranean annual weed, *crepis sancta* shows that fragmented and unfragmented habitats differed strongly in several life-history traits including stalk height, capitulum diameter, flowering time and the ratio of non-dispersing seeds.Fragmented populations have smaller capitulum diameter, shorter flowering stalk and flower later. [6]

Since that urban plants tend to be self-incompatible in these urban fragmented environments, scientists expected the rarity of pollinators will lead to increased attractiveness in plants via a larger capitulum or higher flowering stalks. [7]While the truth is that because of higher cost in producing larger capitula, the competitive pressures on pollination in urban fragmented habitats are relaxed.[6] The similar theory, which is high cost of dispersal because of extreme fragmentation of habitats can explain the evolution in speed dispersal. [7] Although pollinators do choose to forage on bigger capitula in the countryside, foraging behaviour within urban patches suggests more relaxing selection on reproductive traits linked to attractiveness. The study in *crepis sancta* shows that the time pollinators spend searching for capitula is much longer in urban fragmented habitats than in unfragmented urban or rural habitats. Thus, a pollinator may take longer to find a patch of flowering crepis growing alongside a tree on a street, but once such a patch is located, the pollinator may then become less selective and focus on all mature capitula while ignoring their size or height.[6]

Research have shown that soils in urban patches are drier and warmer than soils in rural populations.[8] However, urban patches are exposed to less direct sunlight because of buildings.A plausible explanation for delayed flowering is that to allow slower-growing plants to gain enough energy to reproduce.Delayed flowering might also reflect the lower diversity of flowering plants in urban fragmented habitats.[6] In rural habitats with abundant pollinators, competition for pollinator services may have

favoured early-flowering plants, but relaxed competition for pollinators in urban fragmented habitats may then have favoured the later flowering.[6]

In the last page, I present the different life traits between urban and non-urban *crepis sancta* by giving them human characteristics, like their family scale and the way they show off the size of their flowers and capitula.

In the first line, crepis in the forest always spread its seeds in a large area through wind. And thus the number of descendants from one individual flower in a certain area is large. (large family scale) And then since human build up buildings and fences to fragment areas, crepis has to be more careful to select the place to disperse seed, which means their population will a decrease. I present this phenomenon by showing a crepis directly bury seeds nearby to ensure their survival. This is an exaggeration since that in the real world urban crepis still use wind to disperse their seeds. Also, because of the gas emit in the sky and the shade blocking sun light, I depict the flowers in the city much smaller than those in the forest because of the later flowering period in city.

The left picture on the second line shows how rural crepis sanctas try every effort to attract pollinators. The one who has largest flower and capitula always gain more chance to pass their pollen. This is a common rule in the natural world. However, crepis in the city doesn’t seem to worry much about it, because of the smaller population in an area in city, urban crepis have less competitors for the pollinator. So I depict pollinators lining up to collect pollen from one crepis that doesn’t have large flower, for it is one on the only few pollen resources in this area, this sounds almost like an exclusive company, as is shown on the board in the background.

Annotated Bibliography

[1] Henrik Brumm and Erwin Nemeth. 2009. "*Blackbirds sing higher-pitched songs in cities: adaptation to habitat acoustics or side-effect of urbanization?*" https://s3.amazonaws.com/academia.edu.documents/44900381/Blackbirds_sing_higher-pitched_songs_in_20160419-21470-1novdp8.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1538363384&Signature=JM%2B5WGuGJv6KkwoOFoktCRTZ3eQ%3D&response-content-disposition=inline%3B%20filename%3DBlackbirds_sing_higher-pitched_songs_in.pdf

This resource gives an example of how blackbirds alternate their pitch of voice to adapt the urban habitat. The scientists compared the songs of blackbirds, Turdus merula, from the city centre of Vienna and the Vienna Woods and found that forest birds sang at lower frequencies and with longer intervals between songs. This difference in song pitch might reflect an adaptation to urban ambient noise. However, the song divergence could also be the result of more intense vocal interaction in the more densely populated city areas or a side-effect of physiological adaptation to urban habitats.

[2] Ryan, M. J. and Brenowitz. 1985. "*The role of body size, phylogeny, and ambient noise in the evolution of bird song.*" American Naturalist, 126, 87 – 100.

This resource is used to prove a scientific research result that ambient noise is a key factor to the evolution of birds' song voice.

[3] Brumm, H. and Slabbekoorn. 2005. "*Acoustic communication in noise. Advances in the Study of Behavior.* " 35, 151 – 209.

This resource tells several different ways that birds commonly alter their song voice to fit the local ambient noise.

[4] Partecke, J., Schwabl, I. and Gwinner. 2006. "*Stress and the city: urbanization and its effects on the stress in European blackbirds*." Ecology, 87, 1945–1952.

The resource shows that European Blackbirds born in a city have a lower stress response than their forest con-specifics. The results suggest that the difference is genetically determined, although early developmental effects cannot be excluded. Either way, the results support the idea that urbanization creates a shift in coping styles by changing the stress physiology of animals.

[5] Marc T. J. Johnson, Jason Munshi-South. "*Evolution of life in urban environments*" http://science.sciencemag.org/content/358/6363/eaam8327/tab-pdf

This article introduces a large amounts of examples of wild animals' adaption to urbanization. How early human settlements led to the evolution of human commensals, including some of the most notorious pests and disease vectors.

[6] Jonathan Dubois, Pierre-Olivier Cheptou. "*Effects of fragmentation on plant adaptation to urban environments.*"
http://rstb.royalsocietypublishing.org/content/372/1712/20160038

The resource shows the role of fragmentation for dispersal traits shift in urban environments and a more complex pattern for other traits. Writers discuss the role of pollinator scarcity and an inhospitable matrix as drivers of adaptation.

[7] P.-O. Cheptou, O. Carrue, S. Rouifed and A. Cantarel. "*Rapid evolution of seed dispersal in an urban environment in the weed Crepis sancta.*"
https://www.jstor.org/stable/25461320?seq=1#metadata_info_tab_contents

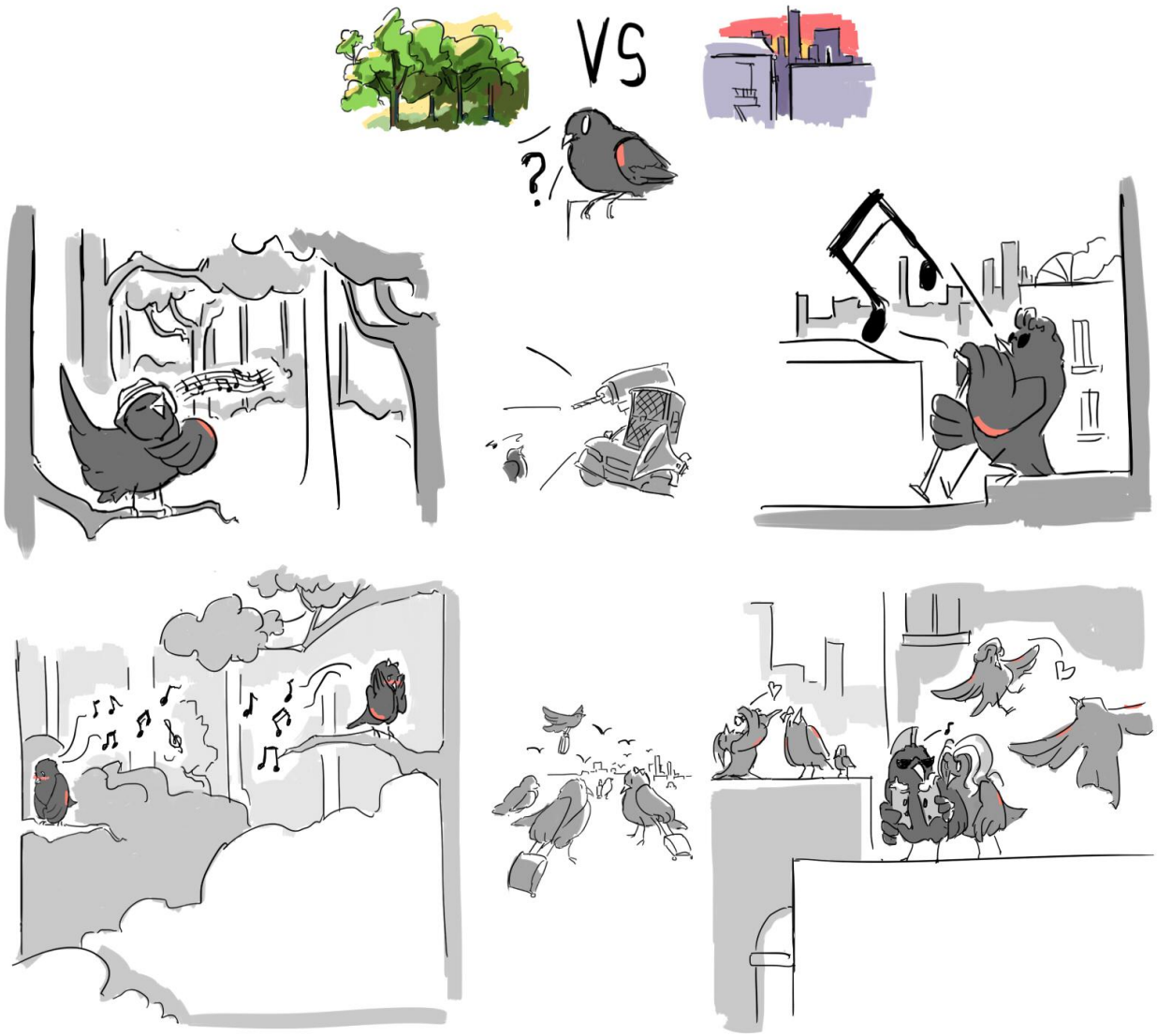
This resource introduce a study that shows that a high cost of dispersal after recent fragmentation causes rapid evolution toward lower dispersal. Demonstrating that, faced with changes in land use that cause fragmentation and the loss of habitats in human-altered ecosystems,species may respond quickly by reducing dispersal among remnant habitats.

[8] Lambrecht SC, Mahieu S and Cheptou P-O. 2016. "*Natural selection on plant physiological traits in an urban environment.*" Acta Oecol. 77, 67 – 74.

This resource talks about the studying result of elements that cause the late flowering in city area including dry soil and insufficient direct sunlight.

[9] Davies ZG, Fuller RA, Loram A, Irvine KN, Sims V, Gaston KJ. 2009. "*Urban domestic gardens (XV): the extent of the resource at a national scale.*" Biological Conservation, 142, 761-771.

This resource shows the most apparent alternations that urbanization brings to house finches' diet. It greatly reduce the variation of the food types, since agriculture take the place of most native fruit plants and the using of pesticide take the worms and other insect species out of the menu.



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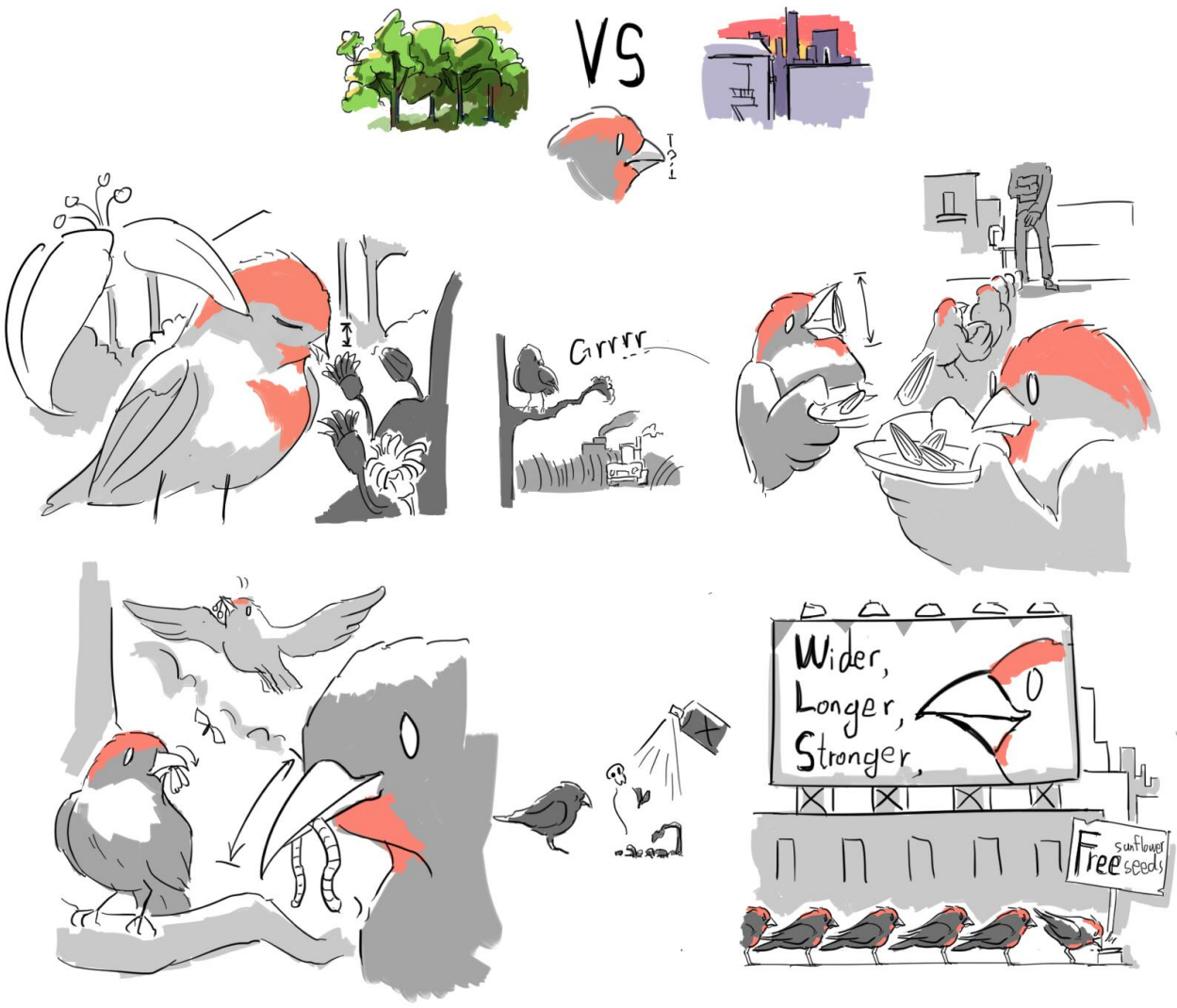

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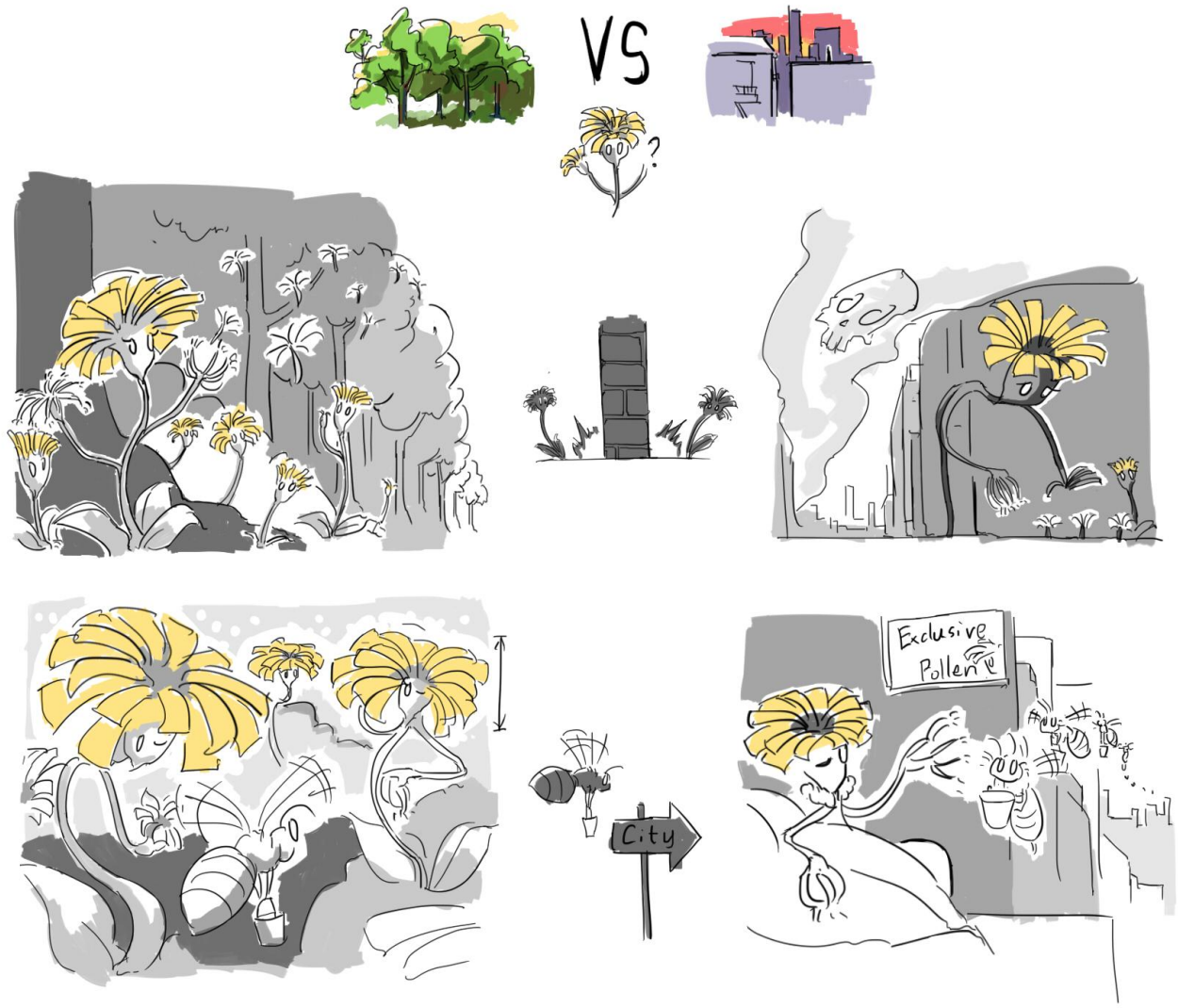

3.