

EQUATORIAL CITIES AS NOVEL ECOSYSTEMS

Text by Prof. Richard T. Corlett, Department of Biological Sciences, National University of Singapore
Illustration by Blanca Chang

Singapore likes to see itself as unique, but to the visitor stepping out from his or her downtown hotel, first impressions are of familiarity rather than differences. Too hot to be Helsinki, too humid to be Tucson, too tidy compared to London, and not quite German enough to be Frankfurt, but “a modern city on planet Earth” captures the essence of Singapore. Glass, concrete, evenly spaced trees, close-mown grass, pigeons, sparrows and lots of people. Contrary to what tourism boards may think, this similarity is, for most of us, a good thing. This is what the human species likes, whatever language it speaks or foods it eats.

Modern cities, wherever they are, also provide very similar environments for wild plants and animals. From an ecological viewpoint, the major unifying characteristic is the replacement of surfaces covered by natural soil and vegetation by surfaces covered in impervious materials, such as concrete, stone, and asphalt. The proportion of land covered by such materials varies from less than 10 percent in some low-density suburbs to 100 percent in many city centres and industrial areas. Another habitat shared by most cities worldwide is grassland, usually kept short and free of other plants by regular mowing. In many places, these grasslands are planted with scattered trees, creating a sort of urban savanna. It is tempting to view this preference as a reflection of our own origins in the savannas of Africa, with the trees promising escape for a semi-arboreal ape from lions and other terrestrial predators. Other shared urban habitats include planted shrubberies, concrete drains and urban wastelands. Climatic differences between cities are important, but many urban-adapted wild species have remarkably wide climatic tolerances. The sparrows and pigeons in Vladivostok are the same species as in Singapore.

However, modern cities in different parts of the world differ hugely in how much they contrast with the natural ecosystems they have replaced. Cities first originated in relatively open environments in Egypt, Mesopotamia, the Indus and Yellow River valleys, Mesoamerica and the Andes. Modern desert cities, like Las Vegas, are oases, with more plant and animal species than the wild habitats they replaced, and the same was probably true of the first urban settlements. Cities constructed in natural grasslands, savannas or open woodlands offer the least contrast, since they provide structurally similar habitats to those that existed beforehand, which are then occupied by species that move in from the





surrounding countryside. The contrast increases again as we move towards densely forested regions and reaches its peak in the lowland tropics. Even today, there are few big cities in the equatorial lowlands, within 10° of the equator, and even fewer in climates that support dense forests. The equatorial African cities, Lagos, Kinshasa and Abidjan, are in areas with a savanna climate, but Singapore, Jakarta, Kuala Lumpur and Colombo in Asia, and Manaus and Belém in South America, have replaced tropical rainforests.

Wherever it is warm or wet enough—and nowhere is warmer and wetter than the equatorial lowlands—trees dominate natural ecosystems and exclude species that cannot tolerate their shade. In equatorial cities, in contrast, large areas are kept open and sun-lit by intensive management: mowing, weeding, pruning etc. It is hard to imagine a greater environmental contrast than that between the damp shade of the rainforest and the environment of a city street. Urban areas are brighter, warmer, drier, noisier and more polluted than any natural habitat in the wet tropics. The increase in temperature—known as the “urban heat island effect”—is a result of a variety of factors, including waste heat from buildings and vehicles, dark surfaces that absorb more heat from the sun, the absence of evaporative cooling from vegetation and soil, and streets lined by tall buildings that trap heat. Urban-rural temperature differences can be as much as 4 to 7°C in Singapore a few hours after sunset, although vegetated urban areas, such as parks, are several degrees cooler than their surroundings. The lower humidity of urban areas results from the rapid draining of water from impervious surfaces after rain, leaving none to evaporate.

Not surprisingly, far fewer native species have made the transition from Singapore’s natural ecosystems into the urban area than those that have done so in cities located in regions with more open vegetation. The exceptions are telling, and include epiphytic ferns and orchids, adapted to life on exposed branches high up in the rainforest canopy, and a variety of coastal plants and animals, from habitats that are similarly open and unstable. Nature abhors a vacuum and the urban habitats left vacant by the absence of natives have been filled by aliens. This is true for both the deliberately cultivated trees, shrubs, herbs and grasses, and for the numerous “naturalised” plant and animal species that have escaped from human custody or have been brought in accidentally as hitchhikers and stowaways. The commonest grasses, trees, birds and insects in urban areas are all aliens, and there are hundreds—probably thousands—of less conspicuous invaders. In most cases, these species come from drier climates within the tropics, but some of the best-adapted species come from further afield, including the urban pigeons, which originated from the rock doves of exposed coastal cliffs in Europe and western Asia.

The end result is a completely novel type of ecosystem that has not existed before on our planet. It meets the definition of an ecosystem in Webster’s Dictionary—a system made up of a community of animals, plants, and bacteria interrelated together with its physical and chemical environment. Unlike natural ecosystems, however, it is not the result of millions of years of reciprocal co-evolution between interacting species, but is instead an assemblage of species that have met for the first time within the last few decades or, at most, the last two centuries. The consequences of this recent assembly are not immediately obvious. The Javan mynahs, which arrived in Singapore in 1920, look natural enough feeding on the fruits of MacArthur’s palm, which arrived around the same time from Australia. The changeable lizards, which only arrived in the 1970s, chase down native and alien insects with equal skill. Native honeybees collect nectar and pollen from the flowers of numerous alien plant species. Native squirrels chew the sugary pods of American rain trees and native woodpeckers search for insects on their trunks.

Closer inspection, though, reveals numerous broken links. Very few of the cultivated plant species can complete their life-cycles here without human intervention. They may fail to flower because a climatic cue is missing; they may flower but not be pollinated because no suitable pollinator is present; they may bear fruit but their seeds are not dispersed; or their seeds may be dispersed but fail to germinate, and so on. More subtle mismatches can also be found, such as the native sunbirds struggling to find somewhere to perch while visiting flowers of South American heliconias that have evolved with hovering hummingbirds. Native butterflies will often visit the flowers of alien plants, but most still lay their eggs on the leaves of the same native species that their ancestors used.

A common analogy for natural ecosystems is that of exquisitely complex jigsaw puzzles, in which each piece has its place. These novel urban ecosystems, in contrast, are like a collection of randomly selected pieces from many different jigsaws: some pieces more or less fit, some can be forced to fit if there is no other suitable piece, but the final assemblage is inevitably full of gaps and distortions. The few ecologists who study novel ecosystems have usually excluded cultivated species—the jigsaw pieces that are forced to fit—from their studies and looked only at native species and those aliens that have escaped from human control and become naturalised. This exclusion is illogical, however, since the cultivated aliens are often at least as abundant as any naturalised species and have been around for at least as long. In modern Singapore, the most abundant plant foods available for herbivores are the leaves of cow grass and rain trees: both cultivated American aliens that have been here for more than a century. Urban ecologists should study what is there, rather than pick and choose among the species on the basis of their origins.

“ THE DEPARTMENT OF BIOLOGICAL SCIENCES AT THE NATIONAL UNIVERSITY OF SINGAPORE IS CURRENTLY COLLABORATING WITH CUGE AND THE NATIONAL PARKS BOARD TO SCREEN NATIVE PLANT SPECIES FOR THEIR POSSIBLE USE IN URBAN PLANTINGS AND TO ASSESS THE BENEFITS OF PLANTING NATIVE SPECIES FOR URBAN WILDLIFE. ”

Alien species are the stuff of ecologists' nightmares. They fear that these species will invade the remaining natural ecosystems and replace the existing hyperdiverse tapestry—which has resulted from tens of millions of years of independent evolution in different parts of the world—by a uniform blanket of the same few aliens. The environmental contrast between equatorial cities and the natural ecosystems they replace cuts both way, however. It is as difficult for an alien species to break out of the city as it is for a native species to break in. Life among the urban cliffs and meadows is no preparation for the rainforest. A few species have moved in each direction, but—at least so far—ecological disasters in the tropics have been confined to oceanic islands, such as Hawaii, where species-poor native ecosystems lack resistance to invasion by continental aliens. Moreover, the similarities between urban floras across the tropics are not the result of collective human negligence, but a consequence of intelligent responses to similar problems. Vegetation is not a luxury in tropical cities, but a necessity for shade, climatic amelioration, reduction in noise and particulate pollution, and, of course, aesthetic pleasure. The hundreds of millions of dollars spent every year on maintaining tropical urban vegetation is a payment for ecological services, not biodiversity conservation.

Is a compromise possible? Can we have liveable cities in the equatorial lowlands that not only do not threaten native biodiversity, but actually help sustain it? The simple answer is that we do not know. Indeed, we probably know more about the ecology of tropical rainforests than we do about tropical urban ecosystems. Urban horticulturalists the world over source new species for planting from other cities in similar climates, not from nature, so we do not know if it is possible to make more use of native species. If we did plant more native trees, shrubs and grasses, would this help attract more native animals into urban areas? Again, we do not know. Could the human population of equatorial cities learn to live in an environment that reduces the contrast with native ecosystems: an environment with less sunlight and air movement, higher humidity, and lower temperatures? We do not know.

In Australian cities, the older suburbs are planted with alien species from Europe and North America, but in the newer suburbs both public and private plantings are mostly native. This was not an easy transition, since it involved both horticultural challenges—native species required very different growing conditions from the familiar exotics—and a new aesthetic appreciation of the colours and shapes of Australian plants. It was pushed by droughts and aided by the fading influence of Australia's colonial past. Could the same happen in Singapore and other equatorial cities? The Department of Biological Sciences at the National University of Singapore is currently collaborating with CUGE and the National Parks

Board to screen native plant species for their possible use in urban plantings and to assess the benefits of planting native species for urban wildlife. Even if this project is successful, it is hard to imagine Singapore giving up cow grass and rain trees for rainforest dipterocarps, and it may indeed be impossible. More likely is a compromise that involves denser urban plantings in some areas and a wider use of native plant species, coupled with an effort to re-establish the more tolerant native animal species in urban areas. Cities are built for people—the savanna ape—and this limits the extent to which they can mimic equatorial rainforests, but we are probably nowhere near that limit yet.

Further reading:

- Corlett, R.T. 2009. *The Ecology of Tropical East Asia*. Oxford University Press, Oxford, UK.
- Hahs, A.K., McDonnell, M.J., McCarthy, M.A. and others. 2009. A global synthesis of plant extinction rates in urban areas. *Ecology Letters* 12: 1165-1173.
- Teo, D.H.L., Tan, H.T.W., Corlett, R.T. and others. 2003. Continental rain forest fragments in Singapore resist invasion by exotic plants. *Journal of Biogeography* 30: 305-310.
- Williams, N.S.G., Schwartz, M.W., Vesik, P.A. and others. 2009. Future directions. A conceptual framework for predicting the effects of urban environments on floras. *Journal of Ecology* 97: 4-9