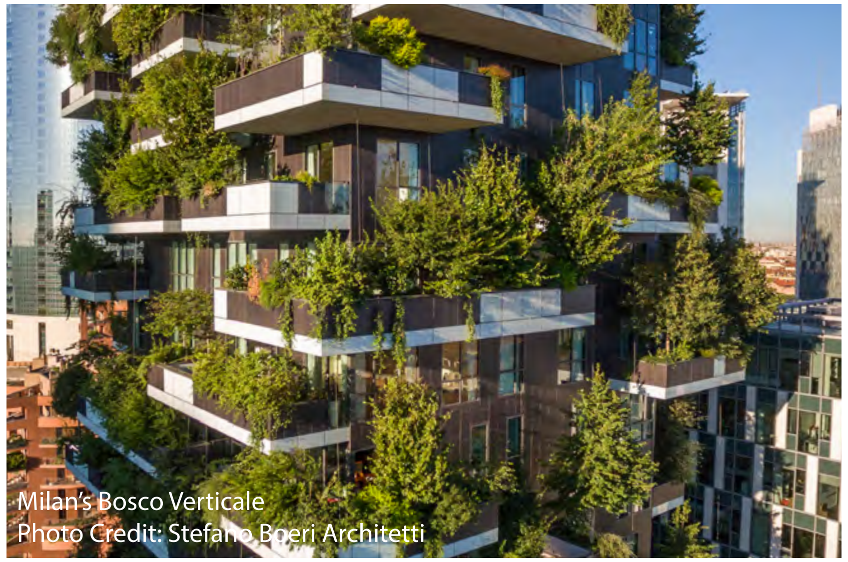
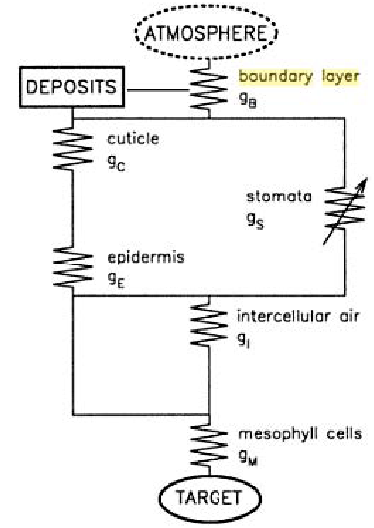


Milan's Bosco Verticale
Photo Credit: Stefano Boeri Architetti



Plant Selection and Performance in a Vertical City

By Julia Kane Africa

Dense urban centers struggle to satisfy residential demand for privacy and contact with nature. Milan's Bosco Verticale is a striking example of the trend towards distributing green space vertically, joining similar projects worldwide in a race to improve environmental health, residential well-being, and biodiversity. While this building is an exemplary project and has inspired many, it also offers opportunities to examine how elevation changes the ecological performance of the facade.

Generally speaking, increases in building height expose plants to increased wind speed and decreased temperature. Given that we seek to replicate nature in the sky, we might do well to consider the example of a mountain. In the foothills, one expects broadleaf deciduous trees and long-stemmed wildflowers whereas conifers, woody shrubs and low, hardy plants dominate the chilly peaks. Following the principle that "nature knows best," we see that leaf characteristics evolved to protect plants from the elements while enabling vital metabolic functions of photosynthesis and gas respiration. Accordingly, the plant specifications in our "Vertical Forests" may vary from the ground floor to the penthouse.

Milan has historically struggled with poor air quality stemming from both pollution and airborne dust particles. The increase in leaf surface area on the façade of the Bosco Verticale will doubtless improve occupants' perception of important sensible air quality parameters like temperature and freshness; in addition to CO_2 absorption, it may also provide objective improvement in air quality through removal of contaminants. How does plant filtration of airborne particles work, and how might that process change with elevation in an urban context?

Popular anxiety regarding air quality is increasing; terms like particulate matter (PM) 10 (larger particles like dust or pet dander) and PM 2.5 (smaller byproducts of combustion) are common in popular media. Smaller size particles are considered more hazardous because they have the capacity to penetrate the lungs more deeply. The external surface of the particle determines synergies with other allergens and irritants. The absolute amount and allergenicity of ambient pollen is expected to increase as temperature increases and growing seasons lengthen globally; particulate matter bound to pollen will continue to elevate the incidence of asthma, respiratory and cardiovascular disease. With this knowledge in hand, the performance of design interventions that improve air quality takes on renewed importance for population health.

Environmental characteristics like wind, temperature, and precipitation interact with the surfaces of leaves to mediate the fate of particulates. Leaf size, thickness, surface roughness, and distribution of stomata (the pores through which gas exchange takes place) have evolved strategically to protect plants from water loss, wind shear, and predators. Stomata serve to control the gas exchange process for the plant; the goal, at a very simple level, is to accept gaseous CO_2 for energy production without losing much water vapor in the process. As a general matter, most particles are too big to be absorbed by the stomata. The physical structure of a leaf (rough, hairy, waxy, smooth) combined with the micron-thin boundary layer determines whether particles stick to the leaf surface or are sloughed off. While it is true that a leaf may remove dust and particulates from the air (think of the film you can wipe off your long-suffering houseplants), it cannot do so under all conditions. High winds disrupt the boundary layer, stripping the plant of the electrostatic and moisture properties that encourage particle deposition and retention. Waxy, water repellant leaf surfaces also shed particles easily. Choosing plants that will thrive in their built environment habitat – and, in the process, reliably improve our habitat – is both a science and art.

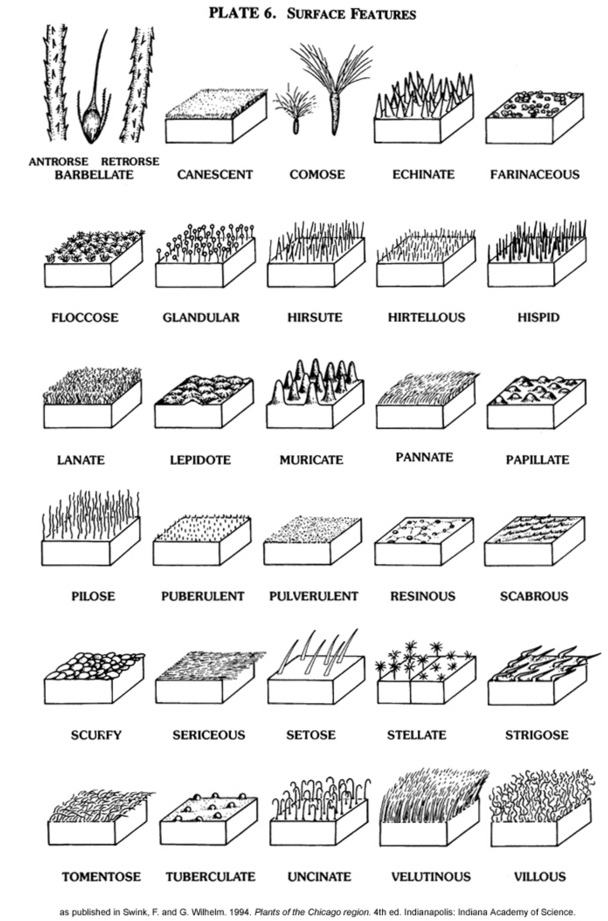


Diagram: Plants of the Chicago Region
Credit: Indiana Academy of Science, vplants.org

While it is true that the addition of plants to our facades improves building performance through cooling and physical barriers to airborne contaminants, their most important contribution may also be their most ephemeral. The perception of cool, clean air or shelter conferred by a balcony that resembles a sylvan grotto is less trendy amenity than critical habitat to support health and wellbeing. And yet while we recognize how extraordinary these spaces are, we must remain sanguine about our expectations of the plants we have chosen to sheath our buildings.

Phytofiltration of airborne contaminants is still a relatively new field with footings in botany, forestry science, meteorology, physics and environmental health; in order to fulfill the promise of green facades, we must continue to rigorously evaluate our designs to ensure optimal performance.

Julia Kane Africa is a Biophilic Design and Wellness consultant and researcher formerly with the Harvard T.H. Chan School of Public Health.