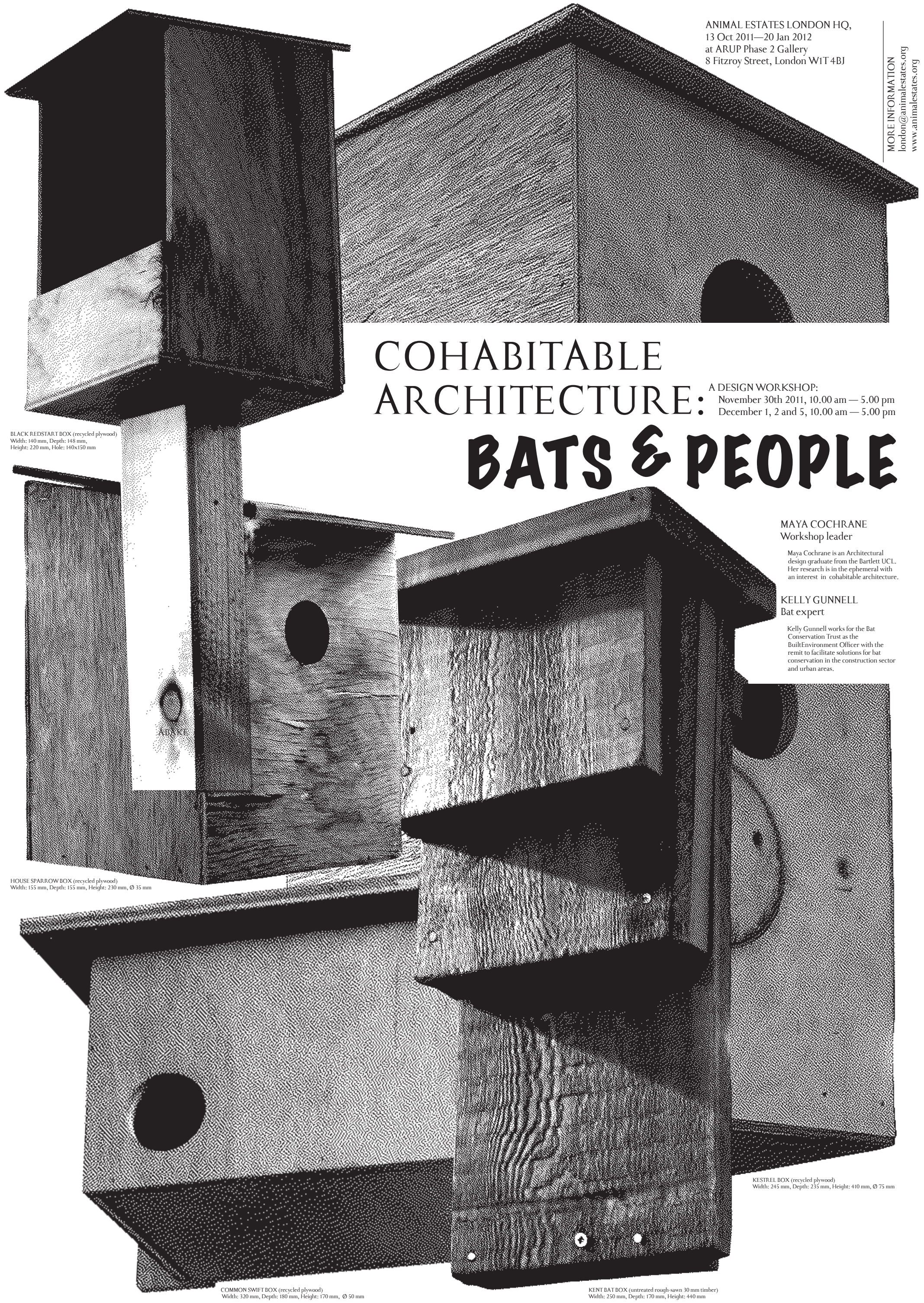

Fritz Haeg. Animal Estates London. *Cohabitable Architecture. Bats and People*. Design Workshop and Exhibition, 2021.

HOSTING BIODIVERSITY

Towards an Ecocentric Architecture

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Every day in the city, we cross paths with wild species on our way, at the foot of walls or in the air. Even if we do not pay attention to them, they inhabit the city spontaneously, finding shelter in its cracks and crevices. As early as 1976, the TV show *Les Animaux du Monde* presented Notre-Dame Cathedral in Paris as an example of an "ecological pyramid" housing different bird species due to the irregularities in its architecture[1]. At the base of the monument, sparrows and passerines nest between the statues and the facade. The cavities left by scaffolding behind the gallery of the Kings become "wonderful welcome structures" for pigeons. Cornices serve as perches for jackdaws, and at the top, the structure houses kestrels[2], a species observed in Paris since 1840. The city is constantly evolving, and much like the metabolist vision[3], which includes the invisible and the forgotten, it is not independent from the rest of the territory. It is a place of interaction between species—human and non-human, wild and domestic.

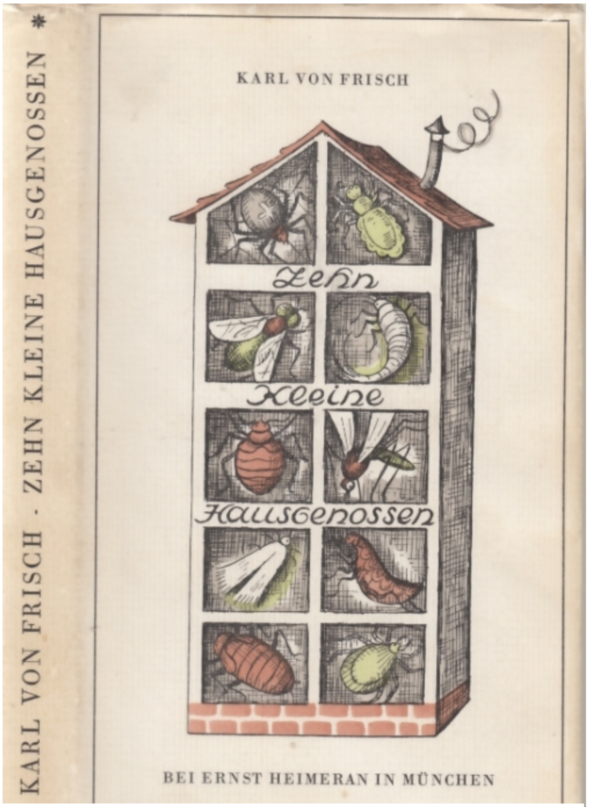
In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), known as the biodiversity equivalent of the IPCC, explicitly identified the artificialization of land and urban sprawl among the leading causes of biodiversity loss[4]. To address this crisis, urban environments must refocus and enable ecological continuities at a global scale, allowing wild fauna to find shelter and pass through them. The implementation of green and blue ecological networks – and also black, brown, and white[5] networks, is an ecological strategy to think about the movement of animals across fragmented territories. In a dense urban fabric like that of Paris, building envelopes – old and new – constitute available surfaces to create biodiversity pockets and foster these continuities. Green roofs and walls provide shelter and stepping stones for local flora and fauna. Ivy-covered walls, for example, allow small birds like wrens to build their nests between the facade and the leaves.

1. « Les animaux de Notre-Dame », TV show *Les Animaux du monde*, October 3, 1976.
2. The last pair of falcons was forced to find a new nest after the fire at the cathedral in 2019.
3. Metabolism views the city as a body that, in order to preserve its vital functions, consumes energy and material flows and produces waste. Thus, it is not independent from the rest of the territory from which, for example, it extracts resources. Green (terrestrial), blue (aquatic), brown (soil), and those potentially disturbed by artificial light (black) or noise (white) ecological corridors are considered. Website of the French Office for Biodiversity (www.ofb.gouv.fr/trame-verte-et-bleue), accessed on January 19, 2022.
4. Sandra Díaz et al. (eds.), *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services*, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), (www.ina.fr/ina-eclaire-actu/video/i19106685/les-animaux-de-notre-dame).
5. These frameworks correspond to the ecological continuities of terrestrial environments.

This integration of life into the built environment is increasingly desired and standardized, though it often exhausts itself in monopolizing "desirable" forms of nature, reduced to their ornamental quality—what historian David Gissen identifies as the sun, wind, and vegetation. These "desirable" forms are opposed to what he terms "Subnature," which includes animals[6]. However, many plants that represent desirable vegetation form interdependent couples[7] with insects, meaning that greened buildings can also host animal species.

Since prehistoric times, architecture has been greened. Often decorative and allegorical, such as in the Hanging Gardens of Nineveh or Babylon (6th century BC), vegetation has also served as insulation—for example, the grass roofs of traditional Scandinavian houses—from prehistory until the beginning of the 18th century. These qualities, now labeled "ecosystem services" provided by nature to humans, have been at the origin of modern green architecture associated with ecological architecture. This type of architecture is embodied both in projects like the cultural center designed by Emilio Ambasz in Fukuoka, Japan (1995), with 5,400 m² of green roofs, and in more frugal and radical underground buildings, such as those designed by architect Malcolm Wells (1926-2009). Biodiversity has only recently been considered in modern greening[8].

Welcoming animal species other than humans thus represents an unprecedented architectural program with new specifications, offering the opportunity to question our relationship with non-humans, both theoretically and practically. By anticipating the needs of other species, we challenge our personal limits regarding what we consider "harmful" or "useful." The fact of welcoming living beings, a source of new interactions between the building and its environment, allows us to imagine architectural forms that answer the following questions: What species do we want to welcome? What types of cohabitation with non-humans do we desire? And consequently, what are the needs in terms of morphology, materials, shelter, and food? To design such forms and rethink these relationships at the level of building envelopes, it is essential to draw knowledge and references from related fields, ranging from environmental ethics to natural sciences.



Karl von Frisch. *Zehn Kleine Hausgenossen* (Ten Little Housemates). 1955.

6. La Subnature de Gissen fait référence notamment aux insectes et aux pigeons. David Gissen, Subnature. Architecture's Other Environments, New York, Princeton Architectural Press, 2009.
7. Les insectes sont responsables de la pollinisation de plus de 80 % des plantes à fleurs. Voir le site de l'Office pour les insectes et leur environnement (www.insectes.org/content/37-ils-pollinisent, consulté le 29 septembre 2021).
8. Philippe Clergeau, *Manifeste pour la ville biodiversitaire*, Rennes, Éditions Apogée, 2015.
9. Nathalie Blanc, « Des blattes dans un quartier d'habitat social de Rennes » (19921993), in Élisabeth Motte-Florac et Jacqueline M.C. Thomas (dir.), *Les « Insectes » dans la tradition orale*, Louvain, Peeters, 2004.

BEYOND THE "HARMFUL/USEFUL" DICHOTOMY

Humans view animals differently depending on the context in which they encounter them. The presence of animals in cities does not have the same effect as in rural areas, just as their presence inside a building[9] is perceived differently than outside. Moreover, our perception is flexible, evolving as our knowledge of different species grows.

One of the earliest forms of coexistence between humans and animals takes place within buildings, in an uncontrolled manner. The phenomenon of synanthropy—the ability of certain wild animals to adapt to human environments—brings species such as cockroaches, flies, and termites into buildings. Their presence breaks with the notion of architecture as inert and sterile. In 2015, a scientific team created a journal dedicated to studying the indoor biome[10]—the set of ecosystems within buildings. Despite its scale, estimated to cover between 1.3 and 6% of the Earth's total surface, this biome remains largely unexplored today. Architecture, by its very nature, offers a new field of exploration as an indoor biome, which could also be described as "Subarchitecture[11]." Subarchitecture refers to the interior spaces of a building that serve as spontaneous and uncontrolled habitats for wild species. Animals, described as early as 1955 by Karl von Frisch in Zehn kleine Hausgenossen [Ten Little Housemates], traverse these often invisible and neglected spaces, which are primarily mentioned in pest control documents[12]: utility shafts, inside walls, false ceilings, etc. From a public health perspective, a sterile environment achieved through the systematic use of extermination products is not desirable[13]. Prevention guides[14] aimed at architects exist to mitigate infestations at the design stage, thus avoiding the need for extermination. At the scale of the building envelope, integrating species becomes a way of anticipating their presence in architecture. This is done through a selection process that creates a list of "desired" species, often deemed "useful," based on multiple criteria. While the presence of small animals like common birds is increasingly welcomed in façades, the line between pests and beneficial species remains blurred: should we accept spiders and bats, which are often the subject of phobias? This leads us to question our relationship with all animals and, potentially, to move beyond the pest/useful divide.

AN ETHICS OF NATURE IN ARCHITECTURE

To design habitats for them, it is necessary to understand the needs of the species by putting oneself in the place of each one. By subjectivizing the species we are designing for, we partly escape the useful/pest perception.

10. NESCent Working Group on the Evolutionary Biology of the Built Environment, « Evolution of the indoor biome », *Trends in Ecology and Evolution*, n° 30, Cambridge (Mass.), Cell Press, 2015.
11. The use of the prefix "sub" is a reference to David Gissen's *Subnature.*
12. San Francisco Department of the Environment, *Pest prevention by design. Authoritative guidelines for designing pests out of structures*, 2012 (https://sfenvironment.org/sites/default/files/fliers/files/final_ppbd_guidelines_12-5-12.pdf).
13. In 1978, Robert Van Den Bosch raised concerns about the health risks of pesticides and insecticides in his book *The Pesticide Conspiracy*, which led to the development of the Integrated Pest Management (IPM) method.
14. The San Francisco Department of the Environment and the London Chartered Institute of Environmental Health published design prevention guides aimed at architects in 2012 and 2016, respectively.
15. Aldo Leopold, *A Sand County Almanac* (1949), reed. *With Essays on Conservation from Round River* (1953), New York, Ballantine Books, 1970 ; trad. fr. : *Almanach d'un comté des sables*, Paris, Aubier, 1995.
16. John Baird Callicott, « Bio-Empathy », in *In Defense of the Land Ethic. Essays in Environmental Philosophy*, Albany, State university of New York Press, 1989, p. 147-153.
17. Jakob von uexküll, *Milieu animal et milieu humain* (1956), Paris, Payot & Rivages, 2010.

In a similar way, American ecologist Aldo Leopold, in the face of a wolf's death, encouraged us to "think like a mountain," giving rise to an ecocentric vision of the environment that influenced the development of modern environmental ethics. *"Think like a mountain"*[15] implies a nearly emotional empathy, rooted in a respect for living organisms free from utilitarianism. It may represent a form of "bio-empathy," defined by John Baird Callicott as the intrinsic existence value of non-human species[16]. Bio-empathy moves beyond emotion when explored through biomimicry—biological analogy of systems and principles of living organisms—or through the experimental creation of spaces that give access to animal perception through augmented virtual reality. For example, we can cite the projects "Heart City, The White Suite" by architects Coop Himmelb(l)au (1967) and "Theriomorphous Cyborg" (2011) by architect Simone Ferracina, inspired by the work of biologist Jakob von Uexküll[17].

Integrating habitats for species other than humans could partially move architecture beyond anthropocentrism. However, it cannot fully embrace "biocentrism," as every construction radically transforms the natural environment in which it is built. The philosophical concepts of anthropocentrism and biocentrism represent an individualistic approach to beings, typical of naturalist classification. Architecture faces this limitation in understanding the world, which identifies beings as subjects rather than as relations. Yet biodiversity is established at the level of supra-individual entities, such as ecosystems. An excerpt from Aldo Leopold's *A Sand County Almanac* (1949), highlighted by Catherine Larrère, provides a possible definition of ecocentrism as an environmental ethic: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." This idea is accompanied by the philosopher's reflection on the connection between nature conservation and landscape aesthetics[18]. Ecocentrism would thus represent a new lens through which to think about architecture, including the balance of interactions between species and the built environment. For example, the research conducted by architects from non-profit organizations such as The Expanded Environment in the UK, or Studio Animal-Aided Design in Germany, as well as the "Animal Estates" project by artist Fritz Haeg, fall within what could be called an ecocentric approach.

Subarchitecture. Personal drawing. 2016.

18. Catherine Larrère, « Y a-t-il une esthétique de la protection de la nature ? », *Nouvelle revue d'esthétique*, n° 22, 2018/2, p. 97-106.
19. Architecture makes use of biological analogies, which can be formal, structural, or based on organizational principles: Jean-Pierre Chupin, *Analogies et théorie en architecture*, Gollion, InFolio, 2010. Nous pensons notamment à ce que la ruche a apporté à l'imaginaire architectural : voir Juan Antonio Ramírez, *The Beehive Metaphor. From Gaudi to Le Corbusier*, Londres, Reaktion, 2000.
20. The observed presence of a species in a given location does not indicate its permanent settlement: is it nesting there, finding food by hunting, or simply in transit?
21. Natureparif, *Bâtir en favorisant la biodiversité. Un guide collectif à l'usage des professionnels publics et privés de la filière du bâtiment*, Paris, Victoires Éditions, 2012.
22. Statements collected from ecologist Aurélien Huguet in January 2022.

DESIGNING WITH NATURAL SCIENCES

In continuation of these philosophical considerations, architecture can be conceived as an environment informed by natural sciences, beyond the sources of inspiration they offer to architects[19]. In practice, the available resources do not always provide definitive morphological solutions. Indeed, the establishment and maintenance[20] of living species cannot be controlled in the same way as an inert material or construction system. Nevertheless, this data helps inform decisions, such as the choice of species, whether they are local, indigenous, endemic, or not, and offers examples of simple measures that can be implemented in architecture[21]. It is also important to understand the complexity of the specific needs of each species. For example, it is known that songbirds prefer southeast-facing locations protected from prevailing winds. The custom-made birdhouses integrated into the cladding of the Maison du Val in Courbevoie (K architectures and AHE environment, 2013) take this into account. Bats, on the other hand, need three to four different roosts throughout the year, depending on the seasons and their life cycle, a requirement partially addressed by the various cavities of the Bat Bridge in Poelzone Park, the Netherlands (NEXT Architects, 2015). For birdhouses, the installation and survival of animals depend precisely on height, the orientation of the entrance hole, exposure to prevailing winds, predators, and disturbances, as well as the availability of food nearby. As ecologist Aurélien Huguet explains, a poorly insulated birdhouse that overheats in summer can become a death trap for young birds[22]. The integration of birdhouses into building facades is therefore not solely an aesthetic matter but also concerns the comfort of the species. Detachable pieces to be integrated into facades are increasingly being marketed, such as birdhouses and passages for squirrels or hedgehogs by Cohab, wood-concrete birdhouses from Nature-Harmonie, or the "Bee Brick" by Green&Blue for solitary bees in England. Additionally, it is difficult to quantify the contribution of a built device in terms of biodiversity, although more and more scientific studies are addressing this. For three years, the Regional Biodiversity Agency in Île-de-France conducted a study on green roofs[23] to better understand their contribution to biodiversity through taxonomic inventories of flora, fauna (including pollinators), as well as mycorrhizae (fungi) and soil bacteria. This study provided a list of recommendations for designers. To promote biodiversity, it is recommended to design low-tech systems with few artificial components, create additional habitats on roofs with deadwood or ponds, prioritize local species, and vary substrate thicknesses. Regarding facades, researchers from the National Museum of Natural History studied and compared the biodiversity of different types of green walls, focusing on spiders and beetles[24]. After nearly three hundred samplings on thirty-three sites using a leaf blower, the study shows the ability of these green walls to house arthropods compared to a bare wall. On the contrary, other analyses now reveal that the presence of rooftop beehives, although often highlighted, is harmful to urban biodiversity, as it leads to strong competition for pollen between wild and domestic bees.

23. « Écologie des toitures végétalisées », Study GROOVES (Green ROOfs Verified Ecosystem Services) by Agence régionale de la biodiversité en Île-de-France, 2021.
24. Frédéric Madre, Philippe Clergeau, Nathalie Machon et Alan Vergnes, « Building biodiversity : Vegetated façades as habitats for spider and beetle assemblages », *Global Ecology and Conservation*, vol. 3, janvier 2015, p. 222-233.
25. Observations led by the group Eco-LOGIE and AH Ecologie.
26. In *Choses vues* (1846), Victor Hugo had already observed the swallows at the Arc de Triomphe du Carrousel du Louvre.

Considering a building as a analog habitat for certain species allows for a more precise response to their needs: movement, reproduction, feeding, and resting. For instance, the School of Science and Biodiversity, designed by ChartierDalix architects in Boulogne-Billancourt and completed in 2014, features an envelope composed of a multitude of blocks that incorporate birdhouses and asperities to spontaneously accommodate various species, such as common birds, bats, and wild bees. Inspired by old dry stone walls, which often provide shelter to lizards, these blocks were entirely designed and dimensioned based on naturalist data and with the assistance of ecologists. Between 2015 and 2021, three hundred and fifty animal and plant species were observed on the façade and roof of the building, including eighteen species of birds[25]. Four species of bats were identified in transit, including the common pipistrelle, which hunts on the site. The birdhouses integrated into the façade, or nearby, are used by various bird and insect species, such as the blue tit, the great tit, the black redstart, the house sparrow, and the osmia (solitary bee). In addition to morphological constraints, accommodating species also depends on adapting construction timelines to their life cycles. In Paris, the common house martin builds its nests out of clay in the overhangs of buildings, beneath cornices, eaves, or windows. The vault of the Arc de Triomphe du Carrousel and the Grande Halle de La Villette house the two largest colonies of this protected species in Paris[26]. During their respective restoration and renovation projects, substitute nests were installed near the natural nests before the martins' return from Africa in the spring.

FROM BIODETERIORATION TO THE BIORECEPTIVITY OF MATERIALS

Beyond the available data, theoretical concepts from ecology allow for a deeper understanding of the challenges related to accommodating living organisms. For example, a habitat refers to all living beings and their interactions, as well as the physical and chemical elements that constitute it, while a niche refers to the position of a species within an ecosystem, defined by physico-chemical and biological parameters. These considerations immerse us at the scale of material properties and their interactions with the environment, a territory still largely unexplored. For a long time, we have understood what biodeterioration of building materials entails, particularly in historical monuments: it refers to the capacity of materials to be degraded by microbial activity. Over the past two decades, a new field of study has emerged, called bioreceptivity[27], which refers to the ability of construction materials to host living species. These materials are also analyzed based on their agronomic properties. Though not entirely different from biodeterioration, this field approaches living organisms from a more positive perspective. Considering the physico-chemical characteristics of buildings and their influence on the environment in light of interactions with living organisms leads us to a different approach to materiality. The aging of materials, which can be favorable to the accommodation of certain species when it does not harm the structure of the building, challenges our relationship with the aesthetics of façades. Nowadays, façades are regularly cleaned and stripped of "weeds."

CONCLUSION

The awareness of the global erosion of biodiversity has changed the way urban dwellers perceive the city, a vast and nearly impassable infrastructure for wild species. In dense urban contexts, buildings can serve as analogous habitat pockets for flora and fauna. Architectural forms that attempt to address this are still relatively few, often limited to ornamental vegetation or high-tech solutions[28]. The accommodation of living species constitutes an architectural program that requires new knowledge in fields beyond architecture. Informed by both environmental ethics and natural sciences, architectural practice could take an "ecocentric" turn, which considers design based on the interactions it produces, beyond aesthetics and ecosystem services. Given the complexity of the challenge, architects are led to educate themselves and collaborate with new experts and institutions to guide their decisions. We can imagine closer relationships with naturalist associations such as the Office for Insects and their Environment or the League for the Protection of Birds. Thus, the design process would no longer rely solely on data provided by experts but also on shared field experiences. For buildings, it involves thinking about the impact of noise, light, the presence of food, and physico-chemical interactions on species. In return, these considerations offer an opportunity to explore new architectural aesthetics, materialities, and morphologies, guided by the pursuit of roughness, asperities, and porosity, in contrast to modern, inert, and smooth façades. ■

27. Guillitte, "Bioreceptivity: a new concept for building ecology studies," *Science of the Total Environment*, vol. 167, 1995, pp. 215-220.
28. High-tech here refers to solutions that rely on complex technology, often inaccessible due to cost and high consumption of materials and energy, in contrast to low-tech. *The Total Environment*, vol. 167, nos. 1-3, 1995, pp. 215-220.