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SANDRO PIGNATTI: A PIONEER IN THE RESEARCH ON URBAN ECOLOGY

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Abstract – Urban ecology has developed through different scientific traditions, including the Arizona school focusing on urban biotic communities, the Chinese school emphasizing urban metabolism and ecosystem services, and the Berlin school highlighting biodiversity and urban planning. Inspired by the work of Herbert Sukopp and the Berlin school, urban ecology was introduced in Rome in the 1980s by Sandro Pignatti, who initiated systematic studies of the city's flora and ecosystems. Rome represents a unique case among European cities due to its exceptionally high biodiversity, with more than 1,600 vascular plant species recorded within the municipal territory. This richness is linked to the presence of extensive natural areas within the urban matrix, a relatively loose urban fabric with many semi-natural and abandoned spaces, and an ecological network of corridors connecting urban and peri-urban habitats.

Keywords: Urban ecology; Urban biodiversity; Rome.

Introduction

The discipline of Urban ecology and the role of Sandro Pignatti in the study of Rome

Urban ecology is a discipline with multiple traditions and schools of thought: the Arizona school, emphasizing the biotic communities that arise in cities; the Chinese school, focusing on urban metabolism and ecosystem services; and the so-called "Berlin school", which emphasizes biodiversity and urban planning (Rega-Brodsky et al., 2022). The "Berlin school" emerged when the botanist Herbert Sukopp (Kowarik, 2020) was contacted by city managers in West Berlin to assist with planning the development of the city. Berlin was still devastated by World War II bombings, with large areas consisting of heaps of rubble. Moreover, the division of the city into two halves during the Cold War led to the abandonment of many sites, particularly along the Wall but also in other districts of the city (Zerbe et al., 2003). Sukopp and his collaborators, notably Ingo Kowarik (Sukopp, 1973), surveyed the biodiversity and vegetation of Berlin and discovered that in these unexploited areas ("Brachen") communities had arisen that were not found elsewhere in natural ecosystems; in other words, Berlin was full of "novel habitats" (Kowarik, 2011), habitats characterized by an original composition different from that of non-urban ecosystems. Inspired by this discovery, Sukopp's students and collaborators developed the concept of the "four natures" (Kowarik, 2013); only the first nature is represented by pristine environments, whereas the others are transformed by human activity. Rome is, in some respects, comparable to Berlin in the 1950s, with large extensions of abandoned areas; however, Rome is much more natural than the Brachen of Berlin and, most importantly, these areas are exceptionally diverse (Fratarcangeli et al., 2022). Floristic surveys initiated by Sandro Pignatti recorded the remarkable number of approximately 1300 plant species within the urban area of Rome (Celesti, 1995); this number rises to about 1600 if the entire municipal territory is considered (Celesti et al., 2013). In 1982, shortly after the publication of *Flora*

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d'Italia, his monumental lifetime work, and after years of teaching in Trieste, where he collaborated with a productive group of researchers including Nimis, Feoli, and Poldini, Pignatti was invited to Rome by Franco Bruno, then director of the Botanical Garden of Rome. Sandro Pignatti was the same age and a close friend of Herbert Sukopp. He was enthusiastic about the results produced by the Berlin school and introduced urban ecology to Rome. Valerio Giacomini had previously initiated a UNESCO project, "Man and the Biosphere", focusing on the city of Rome (Giacomini, 1978), and had established collaborations with environmental psychologists, particularly Mirilia Bonnes from the Department of Psychology at Sapienza University (Bonnes, 1987). Pignatti later took over the project and began the study of the plant component of the Roman ecosystem (Cignini et al., 1995). In 1988 he organized an IAVS congress in Rome on "Spontaneous Vegetation in Settlements" (Savoia, 1989) and encouraged his students to study the flora of Rome not using traditional floristic methods but through a square-grid approach, which was eventually published (Celesti, 1995). This work was also facilitated by a favorable political context, when a new centre-left municipal administration appeared interested in establishing a network of protected areas and supported research programs on the biodiversity of Rome, including both plants and animals (Zapparoli, 1997).

The biodiversity of Rome

The remarkable biodiversity of Rome can be attributed to three main factors (Capotorti et al., 2013; Fratarcangeli et al., 2022):

- the presence of large natural areas within and around the city;
- the relatively loose urban fabric, with many open and unbuilt areas colonized by grasslands and wastelands (not unlike those of Berlin), which extend across the entire urban territory and allow nature to thrive even in heavily urbanized neighbourhoods;
- the existence of several ecological corridors connecting these areas with one another and with the surrounding countryside (Figure 1).

This remarkable diversity was recognized during studies conducted in the 1990s and led to the establishment of a network of protected areas under the authority of the regional government, known as the "RomaNatura" network (Cazzola, 2005). Today RomaNatura manages a system of 14 protected natural areas (regional reserves and parks) and one marine reserve (Secche di Tor Paterno), for a total of approximately 14,000 hectares of protected territory within the municipality of Rome (Figure 2).

An important feature of this network is that it emerged largely due to pressure from grassroots movements of environmentalists and citizens who demanded green spaces for recreation and health. These movements remain highly active (Martella & Tesei, 2024) and are currently calling for the ecological network of Rome to be extended to areas that had previously received little attention but that host high biodiversity and provide important ecosystem services such as climate mitigation, buffering against extreme climatic events, carbon storage, and pollution reduction. Numerous studies have shown that the presence of green spaces is positively associated with the health of surrounding neighbourhoods (Revich, 2023), and this scientific evidence represents one of the main arguments advanced by citizens' associations. Below we present two case studies in which the interaction between citizens and researchers played a key role in protecting natural environments characterized by important ecological features: the Aguzzano Regional Park and the area of the former SNIA Viscosa factory.

Aguzzano Urban Regional Park

The Aguzzano Urban Regional Park is located in the northeastern sector of the city of Rome. Established in 1989, it covers approximately 60 hectares. The area and its surroundings were used for agriculture and livestock breeding

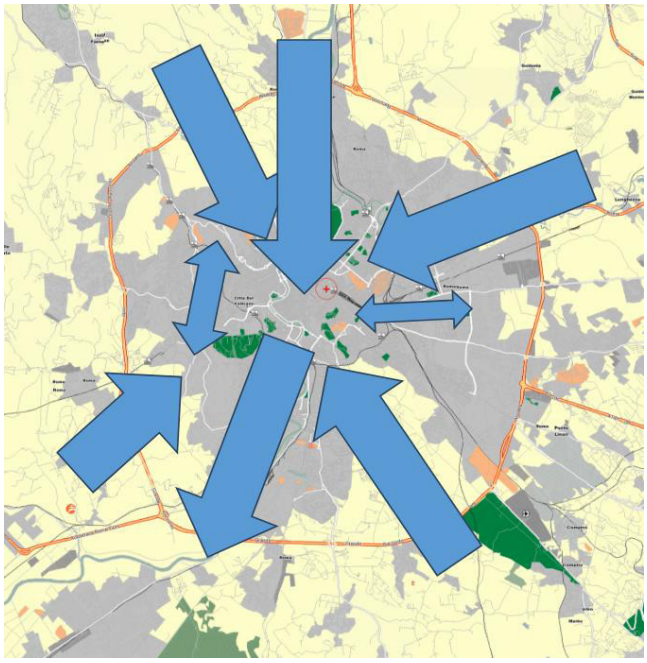


Figure 1. The biotic corridors of the city of Rome, forming a crisscross pattern across the entire urban fabric.

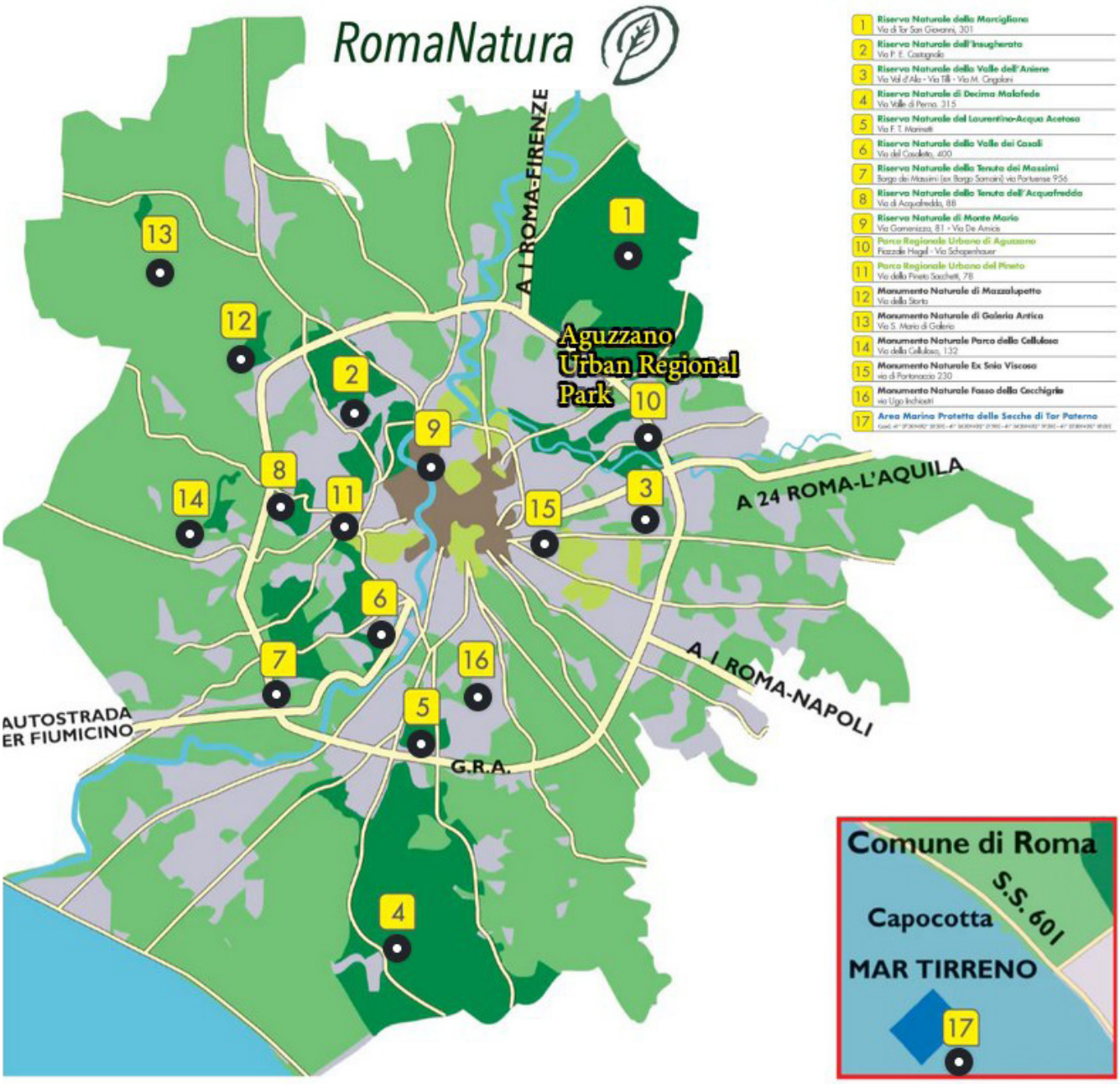


Figure 2. The parks managed by RomaNatura range from small natural monuments to large protected landscapes such as the Park of Decima in southern Rome.

until the first half of the 1970s. Protests and mobilization by local inhabitants prevented urban development and ultimately led to the establishment of the protected area. The park is crossed in its northern section by the Fosso di San Basilio stream, which deposited the alluvial substrata present in much of the site. The Department of Environmental Biology initiated a citizen science project aimed at documenting the plant biodiversity of the park (Fanelli et al., 2025). A sampling grid composed of 100 × 100 m square sectors (Figure3) was used to record plant species through surveys conducted by both citizens and scientists. Two guided excursions and four BioBlitz events were organized in the park. Additional observations and vegetation surveys were carried out by botanists from Sapienza University. Four major vegetation groups and eleven vegetation associations were identified within the park. Multispectral high-resolution satellite images from Google Earth and Copernicus (Sentinel-2) were used to segment the park area.

Combined with classified vegetation surveys, these data were processed using object-based image analysis to produce a vegetation map of the Aguzzano Urban Regional Park. The park hosts a high and distinctive diversity of plant species and vegetation communities, making it a valuable urban biodiversity hotspot. These characteristics require careful planning and management, with particular attention to sustainable use and low-impact maintenance practices, such as late mowing. The historical use of different areas within the park strongly influences floristic composition and the structure of plant communities, demonstrating how semi-natural areas can significantly contribute to increasing species and habitat diversity in urban environments. The collaboration between citizens and researchers (Figure 4) enabled an extensive sampling effort while maintaining high data quality and achieving an unexpectedly detailed level of ecological knowledge. From this perspective, Aguzzano may represent a potential open-air laboratory for future research and environmental education initiatives.

The case of the ex SNIA natural monument

Another example is the Parco delle Energie in Rome, Italy. Urban gardeners and cultural associations transformed a derelict park into garden plots through an innovative governance process that helped create ecosystem services in the center of Rome, resulting in cleaner air, reduced urban heat island effects, green amenities, and fresh food production (Mancebo, 2018). The SNIA site is an abandoned industrial area located not far from Sapienza University. In 1992, a failed real-estate development project led to the interception of the shallow aquifer and the formation of a lake. A luxuriant vegetation subsequently developed around the lake. The presence of this ecosystem in one of the most densely populated areas of Rome prompted citizens to mobilize to protect the area. This process eventually led to the establishment of the Monumento Naturale ex SNIA in 2023, which was subsequently included in the RomaNatura network of protected areas. The unusual biotic richness of this ecosystem attracted the attention of researchers

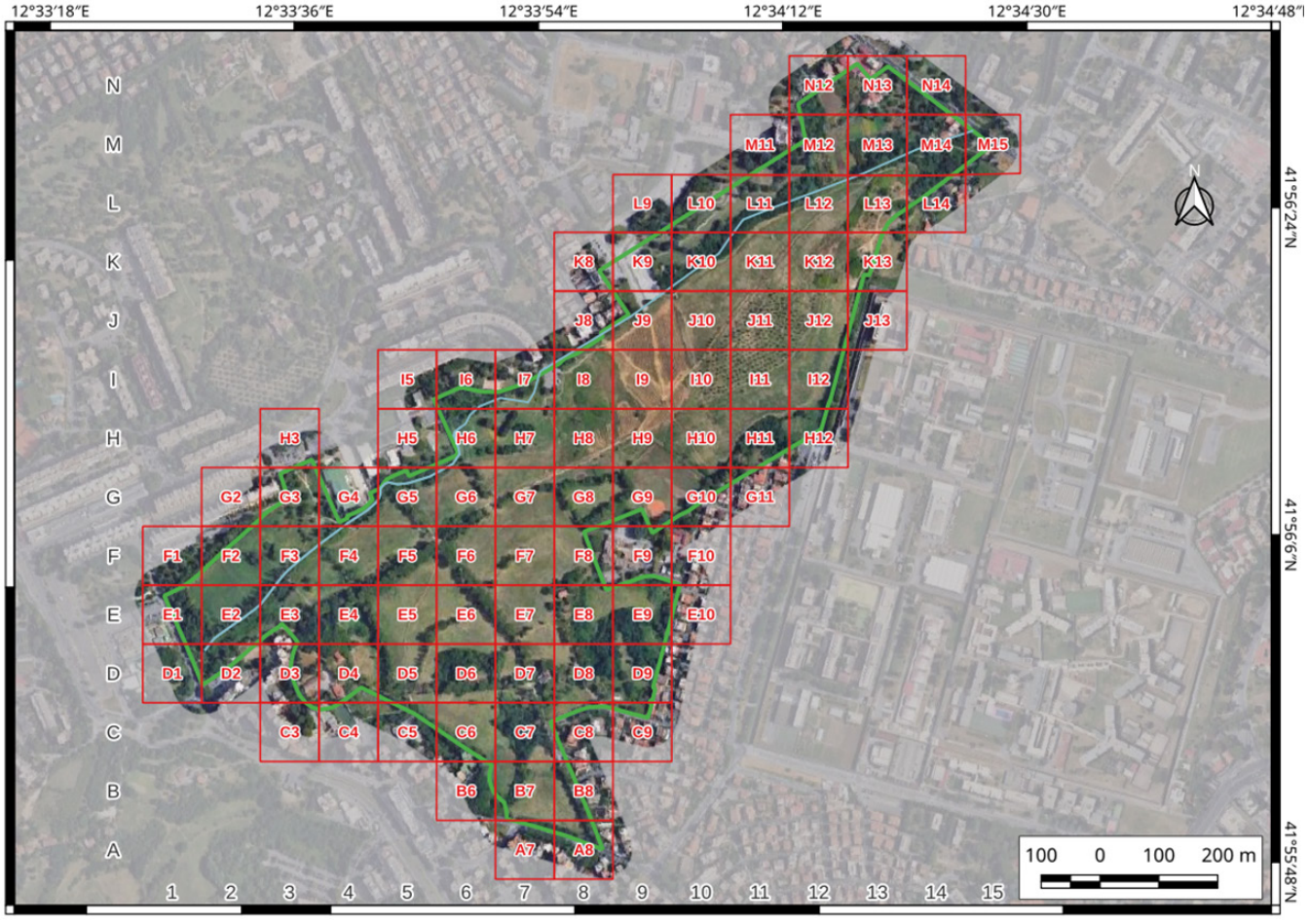


Figure 3. The Parco di Aguzzano and the grid map used for floristic sampling.



Figure 4. A researcher (left) and an engaged citizen (right) resting in the Parco di Aguzzano after a day of fieldwork.

from different disciplines who began to investigate the site (Battisti et al., 2017; Kowarik, 2021). Sociologists, architects, planners, botanists, and zoologists studied this habitat and documented both unexpected biodiversity and a thriving ecosystem providing important ecosystem services (Mancebo, 2018). One particularly surprising result of these studies was the presence of at least five Natura 2000 habitats within the park. This finding was not only scientifically significant but also provided a strong scientific basis for the official designation of the site as a natural monument.

Conclusions

Pignatti was not deeply involved in politics, at least in the traditional sense of the term. He was a committed environmentalist but was more interested in the cultural and philosophical dimensions of environmentalism than in political power dynamics or direct opposition to speculative development (Pignatti & Trezza, 2000). Although he was not an activist, many of his students and collaborators were. Through his work, he encouraged them to direct their attention away from traditional pristine landscapes toward cities, where the most profound contradictions of contemporary society emerge between nature and social organization. Moreover, his emphasis on complex systems—one of the central leitmotifs of his scientific thinking—provided those who worked with him with conceptual tools to manage the inherent complexity of socio-economic-environmental systems and to make significant contributions to the field of urban ecology and to its broader implications for society (Trentanovi et al., 2021).

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