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ORIGINAL RESEARCH ARTICLE

Contribution of genetic protection to the improvement of urban green space

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ABSTRACT

Through a theoretical review, the potential application of the genetic protection concept in urban green spaces was discussed. Usually, urban green space is regarded as a part of urban real estate, and its use is often related to the aesthetics of the city. Its planning does not consider technical or scientific aspects. In addition, the study of cities ignores the genetic conditions of species in a generally hostile environment. It is suggested to carry out genetic protection research in order to improve the quality of biodiversity in urban green spaces and achieve greater functional purpose.

Keywords: genetic protection; landscape genetics; landscape ecology; urban area; urban green space; city

1. Introduction

The majority of the world's population lives, works, mobilizes, and consumes in cities[1]. By 2020, there may be more than 500 cities with a population of more than 1 million, the most important of which are Tokyo, Shanghai, Jakarta, Delhi, Seoul, Mexico City, New York, and Sao Paulo. For the first time in history, the urban population will exceed the rural population. In addition, it is expected that a large part of the natural growth of the world's population will be absorbed by the least developed urban areas in the world. As a key factor, urbanization is considered to be a major cultural process in the development of human society. Therefore, it must be dealt with as a priority in order to achieve the desired sustainable development.

In 2012, the United Nations recognized the reality of contemporary cities, so improving the sustainability of cities is one of the main objectives of sustainable development. However, uncontrolled or unplanned urbanization leads to the loss of natural habitats, resulting in the loss of species[2]. The ecosystem services provided by natural areas to cities are limited by the lack of clear guidelines and practices for sustainable urban planning.

Maurice Strong said that the battle for urban sustainability is either win or lose[3]. We can't agree with that anymore. The city is a basic logistics space, but for many people, it is considered to be a space with low biological productivity. This is an area that imports resources such as energy and food from remote areas and exports surplus products to rural areas. In other words, it is a source of pollution, but it cannot be separated from its territorial system. The

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development of urban space not only limits the development of rural space but also decreases continuously[1].

On the contrary, cities usually rarely invest in protecting, maintaining, and improving the ecological conditions of urban forests so as to maximize the many ecosystem and aesthetic benefits they provide[4]. The study will emphasize the role of public green space in urban sustainability and how to benefit from genetic protection tools and technologies.

2. Urban ecosystem

First of all, it is important to regard the city as a place incompatible with natural space. The idea was accepted by society. In the social sciences, cities are seen as a special partnership between human beings (economic, social, and cultural aspects)[5]. To a lesser extent, it regards the city as an ecosystem. In some cases, people tend to compare cities with a giant creature, which is a mistake because this analogy confuses the commandments established in human ecology and urban ecology.

Treating the city as a man-made place without nature has created a false culture of sustainability, which in many cases only seeks to protect natural areas. Worse, in the collective unconsciousness of society, the continuous degradation of the urban system is rationalized as a normal phenomenon, as long as the natural space is protected. It is negatively believed that the environmental conditions in urban areas do not need to be improved because resources can be extracted from nature.

Ecosystems are defined as networks of relationships between biological and abiotic elements that form a whole and are more complex than the sum of their parts[6]. In addition, it can be described by various material and energy flows occurring in a specific space and time. According to this definition, it can be said that cities are a complex ecosystem, and their connections are all over the world.

The urban environment has seriously changed the natural and environmental conditions of a region[7]. Because its operation depends on a lot of energy consumption, which in turn allows its maintenance and growth. Considering these characteristics, Odum defined the city as a human-dominated heterotrophic ecosystem that depends on a wide range of energy and material boundaries that are transported horizontally. The above reference framework allows the use of concepts and methods related to urban research, with just a few examples from the perspectives of conservation biology, sustainability, and ecology.

3. Urban green space

A As mentioned above, urban areas are expanding rapidly and becoming more dispersed. This has generated new interest in understanding the relationship between cities and open spaces. This growing interest is due to the fact that the urban park system is increasingly becoming the only way for urban residents to come into contact with nature.

Green areas and open spaces are very important and can be used for many purposes. They are essential to the ecological health of the urban environment because they help regulate temperature. They also reduce pollution and help control and clean stormwater runoff[8]. Urban parks jointly provide amusement parks, ecological classrooms, sports trails, flood control, leisure space, and entertainment activities such as concerts and dramas. They protect wildlife, provide space for gardens, and free people from the impact and rapid changes of urban life[9,10].

In addition to the leisure opportunities provided by green spaces, recent studies have shown that contact with the natural world improves people's physical and mental health[8,11]. According to Calthorpe[12], the main goal of the future park should be to help the metropolis establish a sustainable relationship with its water, atmosphere, and plant systems. The second compatible goal should be to encourage the metropolis to become a more suitable place for its residents.

In turn, economic and social benefits can be determined. When they are close to such facilities, their value tends to increase. They also often attract business enterprises and nearby residents. In other cases, they are part of the city's tourist attractions. In the social field, they are places of assembly where major events in the history of a country can be associated. They are a space that allows the development of cultural expressions and even a space for the development of social and political expressions.

Therefore, the advantage of urban forests is a function of the plant composition of the forest itself. The specific benefits come from the precise mixing of vegetation and forest structure. Structure is also a function of several factors, including the number of plants, whether arbors, shrubs, or herbs, species distribution, age, and physiology[5]. Under this concept, it is important to determine an urban green space sequence that almost conforms to the ecological succession process in terms of services provided. Therefore, green space can be described as:

(1) Private residential gardens
(2) Walking in a straight line
(3) Small square
(4) Large urban park
(5) Urban forest

The formation of each "green" sequence has an explanatory process. Attention and conditions need to be paid in the management process. These attention and conditions can be minimal and general, or specific and complex. Due to the dynamic nature of cities, large open spaces in the periphery of cities are usually assimilated by urban growth, just as in more natural areas. In addition, although not common, it is possible to find degraded urban areas that are slowly restored by nature. However, through the study of history and time, it is possible to determine the process of development there, and it is possible to apply ecological restoration methods according to the theory of landscape ecology. Especially under the principle of fragmentation of natural patches, it is applicable to urban areas.

In terms of generality, consideration, and application of landscape ecology, this paper lists the objects and variables of land attribute analysis, which may be the key factors of human intelligent control; land as a whole is created and influenced by different elements; and the development and dynamics of spatial heterogeneity; land ecosystem. The spatiotemporal interaction and exchange between heterogeneous landscapes, the impact of spatial heterogeneity on biological and abiotic processes, and the management of spatial heterogeneity.

To sum up, the theme axis of landscape composition that is of great significance to landscape ecology is structure, function, and change[13,14]. Cited by Garener[15,16] is defined as follows:

Structure refers to the spatial relationship between different ecosystems or elements. More specifically, it refers to the distribution of energy, matter, and species related to the size, shape, quantity, type, and configuration of ecosystems.

Function is the interaction between spatial elements, that is, the flow of energy, matter, and species among the components of the ecosystem.

Change is the change of ecological mosaic structure and function over time.

These axes can be interconnected to introduce the principles of genetic protection and apply their methods and tools.

4. Green space restoration

The main change in urban pattern is caused by accidents, because the resulting order is not the result of design but the expression of human trend or behavior. People want to maintain unsustainable consumption patterns, which often affect the increasingly car-, building-, and paving-oriented urban design. Although there is increasing evidence that society benefits from ecosystem services provided within and outside urban boundaries, Empirical data, specific tools, and guidelines are often lacking to plan and manage urban landscapes to optimize the provision of services and resources[17,18].

In this context, municipalities are using the ecological restoration of green spaces, in particular urban forests, as a measure to improve the sustainability of cities and provide public health and welfare to the public[19,20]. By applying succession theory to urban ecological restoration and the adaptive succession stage, it can provide a new method for urban natural environment planning with high disturbance and heterogeneity.

By predicting urban turbulence and ecological succession, management can become a goal in the development of ecological processes. The ecological restoration model developed in a more primitive environment can be modified to be used in cities. Urban ecological restoration methods should pay attention to existing habitats in order to protect and improve urban biodiversity, which has both short-term benefits and long-term sustainability.

Before proposing some genetic conservation strategies that can be used to improve green space, it must be noted that regulations and actions to destroy urban biodiversity have been introduced from the conceptual stage of urban parks and tree planting programs. With the formation of urban green space, what people pursue is improving urban environmental conditions. Nevertheless, when selecting plant species, aesthetic and timeliness standards override functional standards, which makes little or no contribution to the ecological restoration of human settlements. Even in the vast majority of cases, municipalities tend to allocate the maintenance of public parks and green spaces to decoration and toilet departments, which engage in more horticultural activities and have limited links with environmental management and human settlement improvement services.

5. Genetic protection of urban green space

After searching the literature in the index database on this specific subject, it can be said that this is a subject that has not been deeply developed by researchers. Most publications on green space study the structural components, that is, the composition, layout, and location of forest individuals or species in cities (**Figure 1**). According to the plant physiology, leaf, and canopy shapes of tree species and their age and spatial distribution, a list of tree species is generated and managed to assign an urban function to each tree species. However, these indicators have not been translated into a viable strategic forest succession plan that includes components for adapting to degraded environments or considering climate change scenarios. In the case of landscape genetics studies, these studies involve the effects of landscape composition, shape, and quality of the landscape matrix on gene flow and spatial genetic variation but have a strong interest in diagnosing habitat loss, spatial isolation, or fragmented natural space[21,22].

Turning the research work of landscape ecology and genetic protection to urban planning and design will provide a new perspective for studying or understanding the spatio-temporal processes occurring in these spaces, which may be the key to conservation and ecological restoration efforts in other areas with low or more natural degradation. The combination of population genetic indicators and spatial statistics will make it possible to reassess the landscape design strategy, positioning, and selection mode of forest species improvement in urban green space design.

For example, Millward and Sabir report that 40% of newly planted trees in urban areas die in the first 10 years, and their growth rate is much lower than the average compared with species in the natural environment[4]. Considering the type of time and resources invested in the maintenance of green space and the huge benefits brought to the urban system, it seems normal to consider how to improve the performance of the expected function of the green space system.

Therefore, when designing and implementing the ecological suggestions required by urban green space, it is necessary to clarify which characteristics are the most important protections or improvements. Then they can understand the role of genetic patterns in their relationships. Even landscape genomics can help to understand the nature of genes involved in local adaptation to environmental heterogeneity. However, landscape genomics must also shift from identifying selected genomic sites or regions to dissecting and characterizing potential genes, genomic structure, molecular mechanisms, and ecological functions[23].

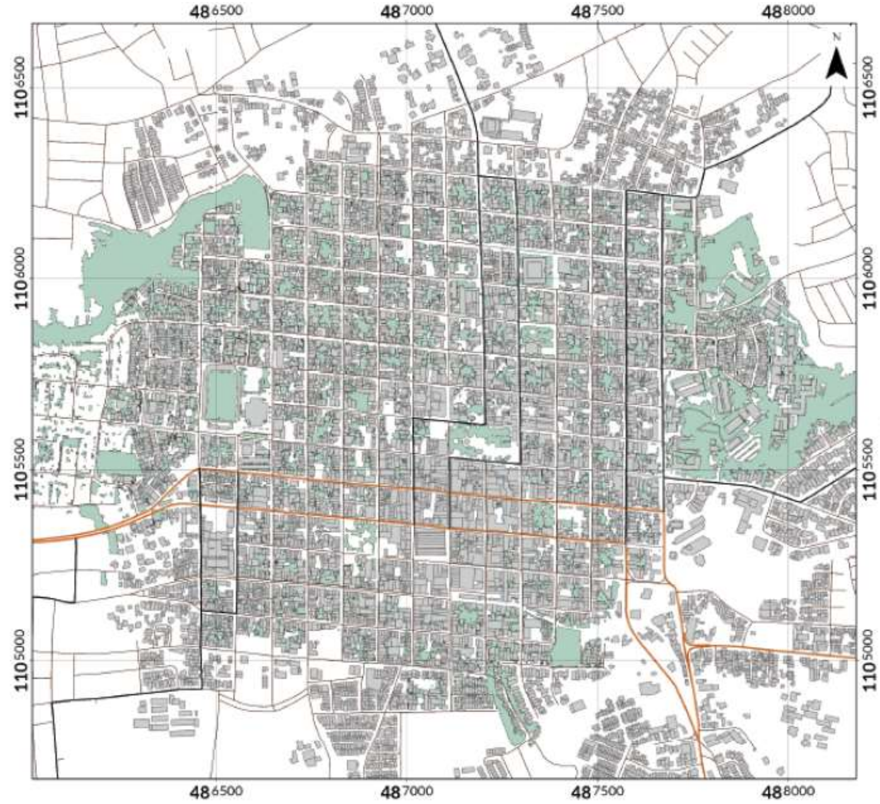

Figure 1. Eredia: green area identification (2017).

Some desirable ecological functions that can guide the selection of species characteristics are ensuring genetic diversity in order to maintain healthy populations and improve the resilience of pests to adapt to the future by maintaining sufficient variability, rapid growth of species with a view to establishing or restoring green space in the shortest possible time, and improving crown development (vertical or horizontal) as needed. For example, in order to shade and reduce noise, larger cork leaves are recommended, while for areas with high exposure to wind, leaflets and crowns are selected with low elongation. Some species are more likely to filter dust and particles, while others are more vulnerable to photochemical pollutants prevalent in cities. According to its soil yield, 75% to 80% of green space problems are caused by soil, so some species can be selected according to their response to the main soil conditions. These examples show that the number of options to be considered is as wide as existing biodiversity and can be combined as much as necessary.

Some considerations in this regard relate to the limitations of studying the genetic diversity of trees because the genetic diversity of trees cannot be observed directly, and even the phenotypic differences between local provenances or varieties of forest trees are not as obvious as many agricultural or animal crops[24]. Although the public demand for genetic variation in vertebrate species is obvious, it is much more difficult to raise public awareness of forest genetic resources. This lack of interest may be due to the concept of forests as self-sufficient entities. Therefore, professionals and the public must play a more active role in this field. Another limitation is the associated costs.

In addition, many analysis methods commonly used in landscape genetics assume equilibrium conditions, such as migration drift equilibrium. This assumption is due to the limited development of the consolidated theoretical basis. For example, the theory predicts the loss of genetic diversity caused by tree drift and inbreeding affected by habitat fragmentation. In urban areas, this proposition must be handled very carefully. The theory of population genetics may be misunderstood as plant species, which is related to ecological reality in the process of ecosystems. In other words, in cities, fragments cannot describe populations, so the genetic theory of small populations is not applicable. Even in spatially isolated populations, genetic theory can eventually be applied, and the argument of evolution assumes that samples of fragmented populations represent trees that have had enough time to experience drift, inbreeding, and final inbreeding inhibition. An unfounded assumption is that individuals in fragments are living relics of unrelated populations before possible interference[25].

In this case, the potential research directions that can be used to improve green space and general forests are inbreeding analysis, genetic enhancement to enhance resistance to the most extreme environmental conditions, and the selection of genetic resources (forest areas or endangered species), preservation for practical purposes only (e.g., traditional methods of selecting high-quality trees or trees, planting in protected areas). That is, whether a resource is protected because of its high variability or genetic uniqueness. These two goals are often compatible. The protection of common and economic species is achieved through "utilitarian" methods, while the protection of rare and endangered species is achieved through "ecological" methods. Similarly, it is necessary to address the lack of markers showing adaptive changes and begin to document the use and transfer of forest germplasm, not just plant species of economic interest. Although the current high economic cost of such research is understandable, it is expected that these technologies will be substantially improved and their costs will decrease in the next few years.

6. Conclusions

In order to move towards more sustainable cities, the challenge for policymakers is to develop strategies to improve environmental quality through the use of ecosystem approaches, in which public space and green space must play a leading role. Green areas not only provide leisure experiences, but also play other roles such as oxygen production, cooling, runoff, and biodiversity protection.

In addition, the evolutionary and ecological potential of tree species must be maintained. However, the ecological approach should be the foundation, as it is consistent with conservation and economic objectives. This must be supported by tools developed from biological conservation and landscape genetics methods. Therefore, we should encourage the protection of forest genetic resources and start the process of urban ecological restoration.

More research is needed to identify important areas of diversity, describe population structure and phylogeographic patterns, especially endangered species, and develop conservation strategies to improve the natural and urban environment.

Conflict of interest

The author declares no conflict of interest.

References

1. Tello E. Ciudades sostenibles: Un cambio de rumbo (Spanish) [Sustainable cities: A change of course]. Mientras Tanto 1996; (64): 35–61.
2. Pellissier V, Cohen M, Boulay A, et al. Birds are also sensitive to landscape composition and configuration within the city centre. Landscape and Urban Planning 2012; 104(2): 181–188.
3. Wackernagel M. ¿Ciudades sostenibles? (Spanish) [Sustainable cities?]. Ecología Política 1996; (12): 43–50.
4. Millward AA, Sabir S. Structure of a forested urban

park: Implications for strategic management. Journal of Environmental Management 2010; 91(11): 2215–2224.
5. Bettini V. Elementos de una ecología urbana (Spanish) [Elements of an urban ecology]. 1st ed. Madrid: Trotta, S.A; 1998.
6. Higueras E. Urbanismo bioclimático (Spanish) [Bioclimatic urban planning]. 1st ed. Barcelona: Editorial Gustavo Gill; 2006.
7. Fernández IC. Planning for urban ecosystem services: Generating actionable knowledge for reducing environmental inequities. Santiago de Chile: Arizona State University; 2017.
8. Johnson LR. Long-term outcomes of ecological restoration and management in urban forest patches. The U.S.: The State University of New Jersey; 2013.
9. Harnik P. Inside city parks. Washington, D.C.: Urban Land Institute; 2000.
10. Harnik P. The excellent city park system: What makes it great how to get there. San Francisco, California: The Trust for Public Land; 2003.
11. Arnberger A. Urban densification and recreational quality of public urban green spaces—A viennese case study. Sustainability 2012; 4(4): 703–720.
12. Calthorpe P, Van der Ryn S. Sustainable communities: A new design synthesis for cities, suburbs and towns. San Francisco: Sierra Club Books; 1986.
13. Forman RT, Godron M. Landscape ecology. New York: John Wiley & Sons; 1986.
14. McGarical K, Marks BJ. Fragstats: Spatial pattern analysis program for quantifying landscape structure. General Technical Report 1994; 97331(503): 134.
15. Carpenter SR, Turner MG. A decade of ecosystems. Ecosystems 2007; 10(4): 519–522.
16. Carreiro MM, Song YC, Wu J. Ecology, planning, and management of urban forests. New York: Springer New York; 2008.
17. Burguillos L, Parra L, Wagner E. Human, ecologican, and biophysical dimensions of tropical dry forests. Venezuela: Manual of Methods; 2008.
18. Wagner JL. Evolution of a sustainable park: Forest Park. St. Louis, Missouri: Saint Louis University; 2013.
19. Kramer AT, Ison JL, Ashley MV, et al. The paradox of forest fragmentation genetics. Conservation Biology 2008; 22(4): 878–885.
20. Shanahan DF, Lin BB, Gaston KJ, et al. What is the role of trees and remnant vegetation in attracting people to urban parks? Landscape Ecology 2015; 30(1): 153–165.
21. Fahrig L. Relative effects of habitat loss and fragmentation on population extinction. The Journal of Wildlife Management 1997; 61(3): 603–610.
22. Fahrig L. Effects of habitat fragmentation on biodiversity. Annual Review of Ecology, Evolution and Systematics 2003; 34(1): 487–515.
23. Manel S, Holderegger R. Ten years of landscape genetics. Trends in Ecology & Evolution 2013; 28(10): 614–621.
24. Geburek T, Konrad H. Why the conservation of forest genetic resources has not worked. Conservation Biology 2008; 22(2): 267–274.
25. Gazmararian J, Kripalani S, Miller M, et al. Factors associated with medication refill adherence in cardiovascular related diseases: A focus on health literacy. The Journal of General Internal Medicine 2006; 21(4): 1215–1221.