Explore Urban Sustainable Ecology Construction from Bio-design Perspective

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Abstract. Industrialization and economic expansion emerged in developing countries accelerate the process of urbanization, while some ecological problems such as natural ecology system damage and transformation of urban land also showed up. In the prophase of urban ecology planning, sustainable development should be taken into consideration to reduce the further transformation of the city and ecological restoration in the later period. For the purpose, this paper applied a framework of sustainable urban ecological construction to the problems that urban areas are facing with. A Bio-related design based perspective is proposed: focusing on the relationship among biological principles, organisms and design. Given three different sustainability research aspects: urban resilience, urban environment and urban biodiversity, this paper provides some suggestions for urban ecology construction. Key research questions for urban planners, landscape ecologists and designers are posed to advance the development of urban ecology in a bio-design mode.

Keywords: Bio-design · Urban ecosystem · Symbiotic · Biomimetics · Sustainability

1 Introduction

Urbanization is a necessary path for the development of many regions around the world. It has continuously improved the quality of life of urban residents and greatly facilitated people's daily lives. However, with the advancement of urbanization, many environmental problems have also arisen. The damage to environment is of critical concern. Many factors are contributing to urban ecological transformation including cities under construction, expanding urbanization to rural areas, and wasteland of city [1]. The sustainable development of a city is closely related to the urban ecology. In order to achieve urban ecological sustainability, it is necessary to have a deep understanding of the city's local ecology and the external natural ecology.

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2 Bio-design

2.1 The Relationship Between Design and Biology

Many iterations and fusions have emerged through the evolvement of the concept: Bio-inspired Design. The problem we need to focus on is not just the change and replacement of concepts, but the analysis of the relationship between design and biology [2]. For example, Biomimicry means we imitate some special characteristics of organisms [3]. In this case, imitation is the relationship between design and organisms. We should put our attention to the depth and form of the combination of biology and design, and then figure out the role of organisms: material, content or just the inspiration of design.

2.2 From Concept to Relationship

The concept of Bio-design is sometimes blurred, and some of them may be just a variant and continuation of previous concepts. The development of bio-related design concept is given in Table 1. These concepts in the table are still in use today, and correspond to this continuation process. For the division of biological design, with the continuous expansion and improvement of concepts. Our way of thinking requires some changes. From conceptual thinking to a way of thinking about relationships.

Table 1. Glossary of bio-related design terms and concepts

Concept	Definition	References
Biomimetic	A science concerned with the application of data about the functioning of biological systems to the solution of engineering problems	Schmitt O. Third Int. Biophysics Congress. 1969. Some interesting and useful biomimetic transforms. p. 297. [4]
Biomimicry	A "new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems"	Merrill, Connie Lange (1982). "Biomimicry of the Dioxygen Active Site in the Copper Proteins Hemocyanin and Cytochrome Oxidase". Rice University. [5]
Bionics	"The science of systems which have some function copied from nature, or which represent characteristics of natural systems or their analogues"	Mary McCarty. "Life of bionics founder a fine adventure". Dayton Daily News, 29 January 2009. [6]

Based on the above concept, we have simply classified some common bio-related design concepts (Fig. 1). These concepts are divided into several relationships such as imitation, integration, utilization, transplantation, and regeneration. For each type of relationship, some similar or related concepts can be classified into one category. If the concepts related to biological design are considered using the relationship between biology and design, many concepts will become clearer. It also can be used to urban planning.

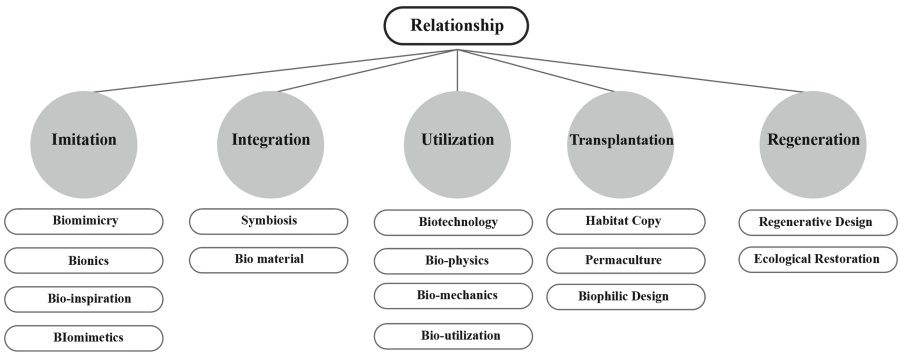

Fig. 1. The Bio-design zone

3 Discussion on the Path of Urban Bio-design

3.1 Urban Resilience

Urban resilience is also called "Flexible City". The concept of "Flexible City" was created to effectively invoke the resources that cities can use to maintain key functions [7]. This is a precautionary concept to enable cities to cope with unexpected situations that exceed their daily operating conditions. As climate change continues to intensify and the frequency of various ecological crises increases, a city's ability to resist disasters becomes particularly significant. Of course, the resilience of a region is not only about its ability to cope with natural disasters, such as emergency design for some areas prone to natural disasters. Urban resilience should also consider the complex, long-term, and sustainable development of an area to face with challenges from social, economic, and environmental aspects.

Jack Ahern proposed five strategies to enhance urban resilience and interdisciplinary cooperation: biodiversity, urban ecological networks and links, planning and designing cities for versatility, modularity, adaptive design [8]. The improvement of urban resilience includes both the system level and some specific designs for a certain area. It is necessary to consider both the urban infrastructure and various creatures living in the city [9]. Under the concept of "Flexible City", the functions of city can be expanded. The biological design for urban resilience is mainly at the level of "utilization" (Fig. 2), that is, the realization of functions is based on the direct use of organisms. In normal times, these creatures may play a decorative role. Once there are some problems in the urban environment or the city encounters some disasters, these creatures will assume certain functions.

3.2 Biological Design for Different Urban Environments

Imitate Habitat of Organisms. Urban environment are often compared with rural or wilderness areas and are typically characterized by less plant, highly polluted. Many people generally believe that plant types in urban areas are dominated by species such as weeds, because these species can better adapt to human-induced changes to the environment. In some hardened areas of the city. In fact, because of the special geological structure in urban areas, some of the dominant plants in cities are species that often live in some rocky areas, while grassland and floodplains are rare. To a certain extent, the urban built environment can reproduce the habitat templates required by plants in these rocky areas [10]. This kind of copy may sometimes be unintentional, but as a method of restoring and transforming the urban ecology, we can transform it into a deliberate way. That is, in some areas of the city, before introducing plants in nature, analyze the natural habitat of the plants first, and then imitate this habitat in the urban environment (Fig. 4). In addition to creating novel ecological habitats, urban ecological theory can also construct corresponding forms to replicate some habitat analogs.

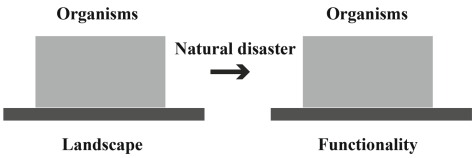

Fig. 2. Utilization

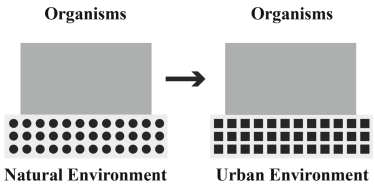

Fig. 3. Imitation. Imitate the natural environment of organisms

Fig. 4. Sanya Mangrove Ecological Park. Brown lands (*left*). After ecological restoration (*right*) [13]

Ecological Restoration Using Natural Ecology as a Template. Except for the land occupied by urban buildings and residential areas, there are many other types of land in cities, such as brown land, greenways, urban farms, urban parks, and so on. Among them, Brownfield Sit is a special land type, which mainly refers to the wasteland that was once used for development and construction [11]. The problem of ecological restoration of brown lands is more about the restoration of the ecology of this area. Because of human activities, brown lands have greatly affected the natural ecology of this area. If these old facilities and buildings cannot be reused in the later period, the ecology of the infrastructure that was used to build these infrastructures will not be restored and some of the pollution caused by brown land to its area will not be timely clean up and repair.

For large-scale ecological reconstruction, it is necessary to extract templates from nature. Sanya Mangrove Ecological Park is a typical case for this type (Fig. 4). The park is designed to restore the wetland system with the concept of mangrove root system and establish a habitat suitable for mangrove growth. Mangrove planting is combined with natural succession to restore mangroves in a healthy and stable way [12]. The mangrove ecological park imitated the native mangrove community, and the mangrove plantation is combined with natural succession to restore the mangrove forest and enrich the vegetation community.

3.3 Maintenance of Urban Biodiversity

The urban area is a highly transformed place with some complex landscape conditions. At the same time, cities are hotspots with abundant plant species, and sometimes even richer in species types than the rural areas around the cities. Thus, the protection and restoration of urban biodiversity is a very important task for city planners. Animals living in cities are often affected by human activities. Green space and open land are as equal important for humans as wild animals living in cities. The decrease of green land in city become a huge threaten for creatures in city.

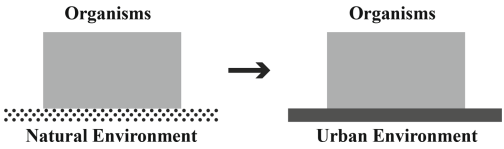

Fig. 5. Transplantation

On the issue of urban biodiversity, it does not mean that the introduction of some species that cities do not have will allow cities to restore a natural ecology. On the one hand, the introduced species may conflict with the urban indigenous species, which will have a more serious impact on the city's local ecology. On the other hand, the introduction of this species may not have played any role, but merely increased urban biodiversity in quantity. In this case, these species still exist only as a landscape and do not form a harmonious and unified relationship with the city's artificial environment, urban residents, and urban native species. It is necessary to analyze the urban original

community to ensure that the introduced species do not conflict with the original community. Aboriginal organisms, as some species that have survived in cities for a long time, have adapted to the city's artificial or semi-nature environment [14]. And living with the human group, urban species will also have some adaptability in life habits, more adapt to urban life. In addition, it is also necessary to analyze the introduced biomes, the living environment of the introduced biomes and the corresponding natural enemy threats, and the symbiotic and exclusion relationship between the introduced biomes and the urban indigenous species.

Organisms introduced into the city also can be integrated with the city's infrastructure (Fig. 6). This combination does not mean that nature exists as a landscape. Instead, nature has assumed a certain function during the entire city operation, and this part of the function that nature assumes will reduce the use of other facilities and proportion of energy supply. Biology and urban infrastructure form a unified whole, and jointly assume corresponding functions.

Fig. 6. Integration

4 Discuss

This paper mainly lists several paths and possible directions of biological design for different urban areas and environments, and analyzes how these directions can be designed through some cases. Significantly, biological design has great guidance and reference in the field of urban sustainable ecological construction. By analyzing the relationship between design and biology to discuss biological design, the design process can be more and more clear. This paper focuses on urban sustainable ecological exploration mainly in several aspects, urban resilience, urban biodiversity and urban environment. Through some conceptual explanations and case studies, some new ideas are provided for the sustainable development of the city in the future. Sustainability of a city is a very ambitious vision. It requires overall planning, coordination of resources, and long-term goals. As a tool to coordinate biology and the environment, Bio-design will play an increasingly important role in urban sustainability.

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