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Eco-vegetation Construction of the Community Gardens in US and Its Implications

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Abstract Community garden is a popular vegetation landscape mode with production, ecology and life functions. On the basis of eco-service functions of community garden, this paper selected 14 such gardens in Los Angeles and studies them by field survey. It researched the response of diversity of urban vegetation varieties and distribution pattern to planters' ethnic background and construction mode, then it analyzed its implications for China's urban green space construction and leisure agriculture. A total of 439 varieties of plant were studied, indicating that community garden is an important species pool of urban ecosystem; it can maintain rich native taxa resources; plant function is mainly edible plant, which plays a great role in protecting ethnic traditional culture and regional native culture; landscape structure and function of vegetation are influenced by ethnic background and construction mode. Researches show that the community garden, as the intersection landscape of ecological diversity and cultural diversity, is a feasible construction mode for realizing urban green infrastructure construction and leisure agricultural development. China should learn from this experience, take into consideration interested parties when making green space planning and conducting eco-vegetation construction. This is of great significance to launching urban eco-vegetation construction and developing leisure agriculture in China.

Key words Community garden, Leisure agriculture, Plant diversity, Cultural diversity

1 Introduction

With remarkable development of China's urbanization, the number of people living in cities exceeds that in rural areas[1] and numerous people will move to cities. How to satisfy demands of these migrants' living habits and establish livable green landscape becomes a new subject for research[2-3]. As one of the countries with the highest urbanization level and the largest immigration country, the United States values multi-functional demand of people for urban green land; its more than 100 years of community gardens has wielded considerable influence on social, economic and cultural development of the US; for the nonce, there are about 150 000 community gardens in US, 22% higher than 5 years ago[4-6]. American Community Garden Association defines the community garden as a single piece of land gardened collectively by a group of people. The community garden can increase urban vegetation coverage, produce fruit and vegetable, ensure food security and nutrition supply[7-9]. Besides, it can improve the quality of life the people in the garden, create opportunity for recreation, exercise, therapy and education[8,10], reduce budget of municipal administration and garden department[10-11], provide a catalyst for neighborhood and community development[12], and form an important approach of citizens to get close to nature and recreational service[8]. In China, with increasing high demand for urban living quality and spread of environmental protection, food security and sustainable development concepts, diverse urban agricultural modes receive enthusiastic response and participation. Thus, research of community garden in the US will provide reference for China's urban green land construction and development of urban agriculture, and leisure agriculture.

In spite of widespread concern and researches of management idea, mode and social value of community garden[8,10,13], people lack understanding of eco-system structure, function and distribution pattern[4 5]. Previous researches indicate that cultural and social factors, as driving factors of plant species diversity, will play a great role in plant diversity of community garden[14], members with immigrant background will increase characteristic species when participating in planting community gardens, so it will influence vegetation structure and species diversity of community gardens. Besides, cultural background affects landscape preference and species selection, so people with different cultural background will have different selection preference for edible plant, horticultural plant and native species[14,16]. Community garden creates opportunity for members to plant fruits and vegetables, medicinal materials or ornamental plant[15] and is the important species pool of urban biological diversity[17 18]. However, it is not clear about source of plant and seed or nursery stock[19]. Understanding function, living style and source composition of these varieties of plants can predict how the planting action influences plant diversity of community gardens to a certain extent.

Based on difference of structural mode and planting group of community gardens, we selected 14 community gardens in Los Angeles. We studied the contribution of community garden to urban eco-service value and the influence of planting ethnics and construction mode. Finally we analyzed the implications of vegetation

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landscape construction of community gardens to China's urban green land construction and urban agriculture.

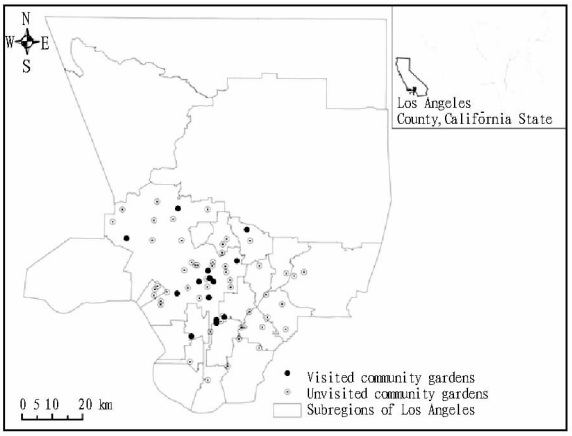

Fig. 1 Distribution of surveyed community gardens in Los Angeles County

2 General situations of study region and research methods

2.1 Distribution of study region and community gardens

The study was carried out in Los Angeles County, surrounded by mountains in three sides and open basin in one side. Except hills in some places, the land there is flat and has average height above sea level is 84 m. Situated in Mediterranean climatic zone, the study region is temperate in climate, large day – night temperature difference, mean daily temperature up to 18℃, dry and short of rain, annual precipitation 373 mm, and its season is mainly winter. Los Angeles County is a county in Greater Los Angeles Area. According to statistics of US Census Bureau in 2010, the population of Los Angeles County has exceeded 9 million and Los Angeles County becomes the most populous county in US. In this study, we randomly selected 14 community gardens (shown in Fig. 1) in 60 community gardens provided by technical popularization department of University of California. Neither planting nor management of community gardens involves private corporations. Instead, all community gardens have collective participation of near community residents.

2.2 Field survey and data collection method Data collection methods include vegetation sample land survey, field mapping of plane layout, field semi-structural interview, e-mail questionnaire investigation and relevant documentation collection. In 2010 – 2011, we carried out systematic and detailed field survey on vegetation structure and species diversity of these 14 community gardens two times respectively in peak growth period of November 2010 and February and June and September, 2011, we consolidated two times of data and obtained general data of plant survey. For vegetation structure and species diversity, we took small plot planted and managed by each member in community as basic survey unit, surveyed all plots in community gardens, and investigated plant species and coverage, and had statistics of frequency. By the coverage grade visual method, we recorded coverage of each plant species of each plot in the community garden. The species coverage is divided into 6 grades: 1 = 0 – 5% (rare); 2 = 5% – 25% (uncommon); 3 = 25% – 50% (common); 4 = 50% – 75% (very common); 5 = 75% – 95% (abundant); 6 = 95% – 100% (dominant). On the basis of average value (1 = 2.5%; 2 = 15.5%; 3 = 38.0%; 4 = 63.0%; 5 = 85.5%; 6 = 98.0%) of coverage grade, we calculated the distribution of plot area, obtained total coverage, total area and the proportion of species in the community garden. Since some plants overlap, the total coverage may be higher than 1, and finally it is concluded that the total area sum of species may be greater than actual area of sample plot.

Using field semi-structural interview and e-mail questionnaire investigation, we made systematic survey on construction types, member ethnics, vegetation composition and functions. Through interview with planters and referring to related documentation, we classified functions of plants[20], such as edible, ornamental, medicinal and sun-shading types represent eco-service functions of plants. With reference to native flora of California State[20], we made judgment of native taxa distribution and life forms of composition species.

2.3 Data analysis method Based on general analysis of family and genera of species diversity, functions, life form structure and native species distribution, with the aid of SPSS 11.3 statistical software, we analyzed and compared plant diversity, functions, and native taxa composition of different types of community gardens. By two way ANOVA method, we calculated average value and standard deviation, and analyzed the influence of construction mode of community gardens and ethnics of planters on diversity of garden plants.

3 Results and discussion

3.1 Diversity composition of vegetation ornamental plants in community gardens

3.1.1 Composition of family and genera. In 14 community gardens in Los Angeles, we surveyed 439 species (including varieties), subordinate to 90 families and 242 genus. The 6 largest families are Asteethnicae, Lamiaceae, Brassicaceae, Liliaceae, Fabaceae, and Cucurbitaceae, including 178 species, accounting for 40.5% of the total species.

3.1.2 Distribution of native taxa plant in community gardens. The native taxa plant of California State refers to plant species already existed in the area before being colonized by Europe in the 18th century. In the entire California State, there are 3 423 such species, accounting for 58.4% of the total species; alien taxa are species introduced from other places intentionally and unintentionally, including naturalized and unnaturalized species[20]. This study is based on whether the species has natural distribution in California State. We surveyed about 230 native taxa and naturalized species, accounting for 52.4% of the total; 209 alien and unnaturalized species, accounting for 47.6%. In general, plant species in community gardens is abundant. Native taxa and naturalized species take up the major part, which will play a great role in

protecting biological diversity of this region, especially the landscape plant diversity in urban green land. At the same time, it should be noted that alien and unnaturalized species also take up a large portion and it is required to value the monitoring of alien taxa because of potential invasion risk of alien taxa.

3.1.3 Characteristics of life forms. The plant composition of community garden is mainly herbaceous plant, about 257 varieties, accounting for 58.6% of the total. Perennial herbs take up the largest portion; the second is shrub and subshrub (about 107 varieties); 38 vine and 37 tree varieties, as shown in Fig. 2a. Composition of life forms reflects ecological structure, especially vertical structure of vegetation in community gardens, and depends on planters' selection of plant functions. In the community gardens, edible function takes priority, taking consideration of ornamental, medicinal and sun-shading functions at the same time. Life forms are mainly herbaceous plants and perennial herbs take up the largest part due to suitable for simple management and water-saving irrigation.

3.1.4 Composition of vegetation functions. Our survey indicates that the largest function group is edible plant, up to 228 species, accounting for 51.9% of the total, followed by ornamental plants (200 species, accounting for 46%), medicinal plants (35 species, accounting for 8%), other functional plants such as sun-shading and building materials (34 species, accounting for 7.7%), as shown in Fig. 2b. Some plants have multiple functions, so the sum of percentage of each function is larger than 100%. 54 species (accounting for 12% of the total) have more than 2 functions. It shows that plants in community gardens are multi-functional and practical.

3.2 Plant diversity distribution of community gardens with different characteristics

3.2.1 Exponential distribution characteristics of plant diversity in community gardens. In these 14 community gardens, there are 4 native ethnic garden, 5 alien ethnic gardens, 3 native ethnic farms and 2 alien ethnic farms, as listed in Table 1. The history is varied in 4 – 48 times with the fewest planters of 11 and the most planters up to 150, the smallest planting size of 448 m^2 and the largest size up to 23 070 m^2, and mean species number in plots of 16 – 118. For the plant species, we surveyed 82 species at least, and 234 species at most.

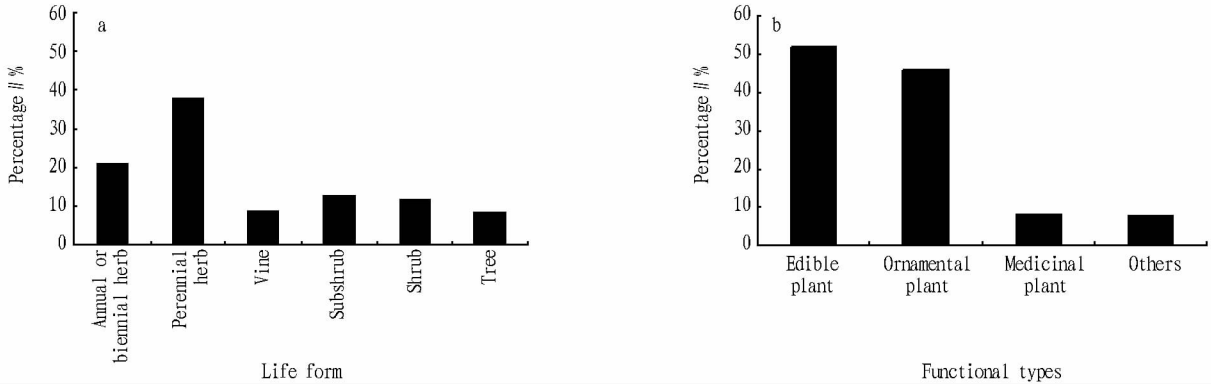

Fig. 2 Compositions of life forms (a) and functional types (b) of plants in community gardens in Los Angeles County

Table 1 Basic characteristics of 14 community gardens (CG) in Los Angeles and their plant characteristics

No. of CG	History years	Types of CG	Planters	Ethnic of planters	Size // m^2	Plots	Mean size of plots	Species	Mean sp. in plots
1	38	Garden	133	Native ethnic	10 117	57	60	234	13.52
2	17	Farm	150	Native ethnic	9 520	118	58.34	82	7.36
3	19	Garden	32	Alien ethnic	1 440	32	46.46	145	12.54
4	48	Garden	16	Alien ethnic	448	16	17.5	134	14.31
5	32	Farm	40	Native ethnic	2 006	44	37	95	9.66
6	12	Garden	16	Native ethnic	672	19	4.5	121	7.68
7	2	Garden	32	Alien ethnic	930	32	7	104	7.88
8	15	Farm	20	Alien ethnic	2 244	25	52.63	126	8.48
9	4	Garden	75	Native ethnic	4 500	60	11.875	141	6.58
10	12	Garden	25	Native ethnic	819	26	9	161	9.35
11	5	Farm	69	Native ethnic	23 070	69	135	198	8.74
12	22	Garden	27	Native ethnic	852	34	5.7	83	5.56
13	22	Garden	11	Alien ethnic	900	24	4.5	136	5.63
14	46	Farm	60	Alien ethnic	6 120	44	85.01	75	6.38

3.2.2 Exponential distribution characteristics of plant diversity in community gardens. In general, community gardens keep higher plant diversity, rich plant diversity and higher evenness. On average, each citizen owns 88.5 ± 32.6 species; the species richness in 100 m^2 is 6.3 ± 6.4; Shannon's diversity index is 3.40 ± 0.33 on average; Simpson dominance index is 0.07 ± 0.02, and Evenness index is 0.77 ± 0.04. According to composition of planter ethnic and construction mode of community gardens, we carried out plant diversity exponential analysis of vegetation composition of different community gardens, as listed in Table 2.

Table 2 Exponential distribution characteristics of plant diversity in different community gardens in Los Angeles

Types of community gardens	Native ethnic – Gardens ($n=4$)	Alien ethnic – Gardens ($n=5$)	Native ethnic – Farms ($n=3$)	Alien ethnic – Farms ($n=2$)
Species richness S	64.25	110.20	93.67	75.00
Richness/100 m^2	6.27	10.33	2.03	2.66
Shannon's diversity index H'	3.29	3.57	3.29	3.36
Simpson's dominance index D	0.064	0.066	0.068	0.061

Since actual area of each community is different, to increase the comparability, the diversity index was calculated on the basis of unit area of 100 m^2. From comparison, it is found that alien ethnic gardens keep higher species richness and plant diversity, while alien ethnic farms have the lowest species richness and plant diversity. As for plant richness in unit area, garden type is higher than farm type; in Shannon diversity index, plant diversity of alien ethnic community gardens is higher than that of native ethnic community gardens, and Shannon diversity index of garden type and farm type of native ethnic community gardens is equal (3.29); from analysis of Simpson dominance, native ethnic farm type takes the lead, followed by alien ethnic garden and native ethnic garden type, and the lowest is alien ethnic farm type. Such ecological dominance difference is caused mainly by unevenness of composition of plant species in community gardens. In garden type and farm type community gardens, people care about different functions, so the ecological structure of vegetation and plant diversity are different. For example, garden type community gardens lay stress on environment beautifying and leisure functions, so there are more ornamental, sun-shading and nectariferous plants. These have greater influence on plant diversity, so both alien ethnic and native ethnic garden type community gardens keep more species (10.33 and 6.27 respectively) than farm type community gardens in every 100 m^2. Besides, due to different cultural background and habits and customs of alien ethnic, the selection of plant species is inclined to keep original preference of immigrant country and ethnics. Such diversity of ethnic cultural background increases plant diversity of their community gardens to a certain extent. In addition, native ethnic farm type community gardens show the highest ecological dominance due to wide and uniform distribution of main edible plants, while alien ethnic farm type community gardens have lower ecological dominance because of difference of cultural background of planters and diversity of plant preference.

3.2.3 The influence of different ethnic background of planters on composition of plant functions. From Fig. 3a, it can be known that community gardens managed by alien ethnics keep higher number of species (99.5 species on average), while that managed by native ethnics have only 74.8 species; from comparing number of species in edible, medicinal, ornamental and other functions, alien ethnic community gardens are higher than native ethnic community gardens, the average species in these 4 functional groups of the former is 63.4, 6.6, 31.8 and 5.1 respectively, while that of the latter is 58.2, 4.7, 12.2 and 4.7. Data indicates that compared with native ethnic community gardens, alien ethnic community gardens not only increase number of total species, but also increase the plant richness of each functional groups, so alien ethnic community garden has become an important species pool of urban plant diversity. From Fig. 3b, we found that native ethnic and alien ethnic have different preference in plant selection: native ethnic community gardens pay attention to planting edible plant, whose average relative coverage is up to 88.1% (for alien ethnic community gardens, it is 81.7%); the average relative coverage of medicinal, sun-shading and other function plants in native ethnic community gardens is also higher than that in alien ethnic community gardens; alien ethnic community gardens attach importance to ornamental plants, the average relative coverage is up to 9.6%, while that of the native ethnic community gardens is only 4.1%.

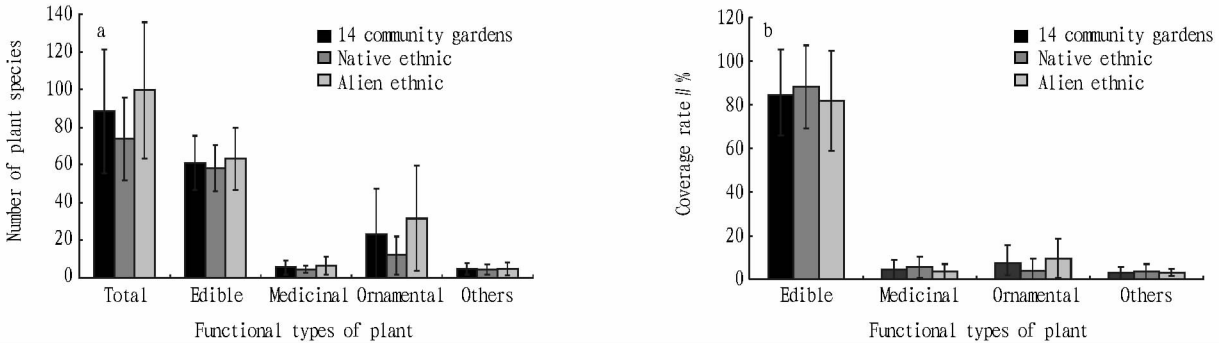

Fig. 3 Number of plant species (a) and coverage (b) of different functional types in community gardens of Los Angeles

3.2.4 Analysis on composition of native plants in different community gardens. From analysis on composition of native plant species and source of plant species, we can see that native ethnic community gardens possess more endemic species and naturalized species, with proportion of 65% and 61.4% into the total species; in other words, composition of species in native ethnic community gardens is closer to nature distribution and can maintain more native species. The comparison of the same type community

gardens managed by different ethnics indicates: there is no difference in proportion of endemic species and naturalized species for farm type community gardens, while endemic species and naturalized species managed by native ethnics take up higher proportion (about 67.6%) for garden type community gardens.

4 Conclusions

Based on the framework of Millennium Ecosystem Assessment[21] and focusing on eco-service functions of community gardens, we discussed the connection between structural diversity and function diversity of urban vegetation landscape, and analyzed the influence of ethnic culture on biological diversity. Through the above analysis, it can be concluded that community garden has become important species pool in urban eco-system of Los Angeles, it can maintain rich native plant resources, such landscape mode manifests significant function in protecting traditional plant culture and native knowledge, and its vegetation landscape structure and function are influenced by ethnic background. Therefore, community gardens, as the intersection landscape of ecological diversity and cultural diversity, play important role in safeguarding urban green infrastructure and developing urban agriculture.

In China, there will be more than half of the population living in cities. How to satisfy demands of these people's living habits and establish livable green landscape at rapid urbanization background? It requires considering habits and customs and selection preference of these people when making urban planning and conducting green capital construction. We can learn from construction mode of community gardens in US, encourage people with different cultural background to do cultivating, to make community gardens become gathering point of ecological diversity and cultural diversity, and then carry out urban ecological vegetation construction and develop leisure agriculture at the context of building powerful harmonious social and cultural country. At the same time, it is required to pay attention to invasion of alien species and pollution of heavy metals, to prevent invasion of species and protect food security.

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chain logistics service system, and increase the competitive power of agricultural cold chain service enterprises, so as to change resource advantage into economic, industrial, management and competitive advantage, improve the modernization level of agricultural circulation in Heilongjiang Province, meet the demand of people's lives, and promote our national economy developing rapidly.

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