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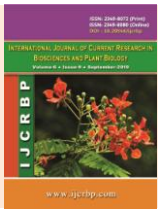

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Investigation and application evaluation of tree species for street greening in Dali city

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ABSTRACT

Using sampling method, the species, quantity and other indexes of street greening trees in main urban area were investigated. The diversity and disposition of tree species in street greening were analyzed. And countermeasures were put forward for the construction of street greening landscape in Dali city.

Introduction

Street greening is an important part in urban green space system. It influences the Ecological Function and landscape effect of urban greening. It's an important symbol of a city. Through it, the Geographic Character would be reflected to some extent. Beside that, if the application of tree species is suitable, the street greening will be good at adjusting temperature and humidity, reducing the wind and dust, conserving soil and water and so on (Zhu and Cao, 2018; Konijnendijk, 2003). It's popular to develop an Ecological Garden City in China, including Dali that is a famous tourist city. But at the same time, there are many problems in the process such as irrational plant arrangement, deficiency of tree species diversity and native feature. Therefore, investigation of tree species is very important for the street greening. Street tree species and indigenous landscape plant resources of Dali or Yunnan have been investigated and studied partly by some scholars (Yang, 1996; Huang et al., 2006; Zhu et al., 2011; Yuan and Wei, 2011). Base on that, the situation of the street greening in Dali was analyzed and studied in this paper to provide reference for the plant planning.

The general situation of Dali city

Dali located in the Northwest of Yunnan Province that belongs to low latitudes plateau with monsoon climate. The mean annual precipitation is about 1000mm, and the mean annual temperature is 15°C. There are various plant resources and

the main vegetation types are Semi-humid evergreen broad-leaved forest, Cold-temperate mountainous sclerophyllous evergreen oak forest, cold temperate coniferous forest , cold temperate shrub, dry-hot valleys shrub and plateau lake aquatic vegetation.

Investigation methods

On-spot investigation method and sampling survey method are used to investigate the quantity of trees and tree species, the planting mode, growth situation and ornamental value.

Results

Analysis on quantity and species of the trees for street greening

It is shown that there are 4,532 arbors (2221 evergreen, 2311 deciduous), belonging to 30 species (18 evergreen, 12 deciduous), 26 genera and 19 families, in the 13 streets of ancient urban area of Dali. Among them, the main families are *Rosaceae, Cupressaceae* and *Moraceae*, they account for 29.04%, 19.55% and 9.71%. The main species are *Cerasus caudata* (Franch.) Yu and Li, *Cerasus serrula* (Franch.) Yu and Li, *Sabina chinensis* (L.) Ant. cv. *Pyramidalis, Ficus concinna* (Miq.) Miq. and *Salix babylonica* Linn. The proportions of evergreen and deciduous arbors and their species are nearly 1:1 and 3:2.

At the same time, in the 21 streets of Xiaguan's main area of Dali, there are 13,719 arbors (9736 evergreen, 3983 deciduous), belonging to 31 species (21 evergreen, 10 deciduous), 23 genera and 17 families. The main families are *Platanaceae, Lauraceae* and *Olaeceae*, and most of them are *Platanus orientalis* Linn., *Osmanthus fragrans* (Thumb.) Lour. var. *semperflorens* Hort. and *Magnolia grandiflora* Linn. These four exotic species account for 37%. The proportions of evergreen and deciduous arbors and their species are 2.4:1 and nearly 2:1.

It was found that the proportion of native and exotic species is 23:77 in the investigated 34 streets. Most of the capital species are exotic. The species quantity of deciduous trees is not enough, and some of them have high repetition rates.

Analysis on the way of tree species disposition in street greening

Among the 13 streets of ancient urban area, there are 3 green belts in 2 streets, and 2 in the other 11 streets respectively. The native species, *C. caudata* and *C. serrula*, and the adaptive species, *F. concinna*, play important parts in street greening. They make the cultural and historical feelings of the city wall more sensible, together with *S. chinensis*. Besides, the main shrubs are *Rhododendron radendum* Fang, *Bougainvillea spectabilis* Willd. and *Ligustrum* × *vicaryi* Rehd. in the 2 streets. In the other 11 streets, there isn't any shrub.

In Xiaguan area, on No. 214 national highway where the patterns of 3 and 5 green belts are combined, *M. grandiflora, Ficus benjamina* Linn. and *O. fragrans* are applied as basic species. They optimize the spatial levels, together with *Parakmeria yunnanensis* Hu and *Ficus altissima* Bl. At the same time, there are 2 green belts in 12 streets, and 3 in 6 streets. The patterns of 2 and 3 green belts appear in 2 streets. And the main arbors are *P. orientalis*, *C. camphora* and *F. concinna*, the main shrubs are *B. spectabilis*, *L.* × *vicaryi*, *Duranta repens* Linn. and *Loropetalum chinense* Oliv. var. *rubrum* Yieh. In the last 3 streets, the pattern of greening is too simple, lacking of shrub or ground flora.

Overall, it's found as follows: (1) Compared with the arbors, shrub species are not abundant, they account for only 27% of the total species. (2) Arbor and shrub both have been applied, but 23.5% of the streets have no shrub, or the situation of the shrubs is not well. (3) The growth state of shrubs in 5 streets of Xiaguan is not well for lacking of maintenance and pruning.

Analysis on application frequency of tree species for street greening

In Fig. 1 and Fig. 2, the 'Street Number' means the number of streets where each species was applied. It was shown as follows:

(1) In the 34 investigated streets, the most frequently applied arbor species are *C. camphora* (47%), *F. concinna* (38.2%), *C.*

caudate (35.3%), *P. orientalis* (29.4%) and *S. chinensis* (29.4%).

(2) At the same time, the main shrubs are *Duranta repens* (35.3%), *L. chinense* (35.3%), *L.* × *vicaryi* (32.4%), *B. spectabilis* (32.4%) and *R. radendum* (23.5%).

(3) It's obviously that very few species have high application frequencies. It makes the street view more similar with each other.

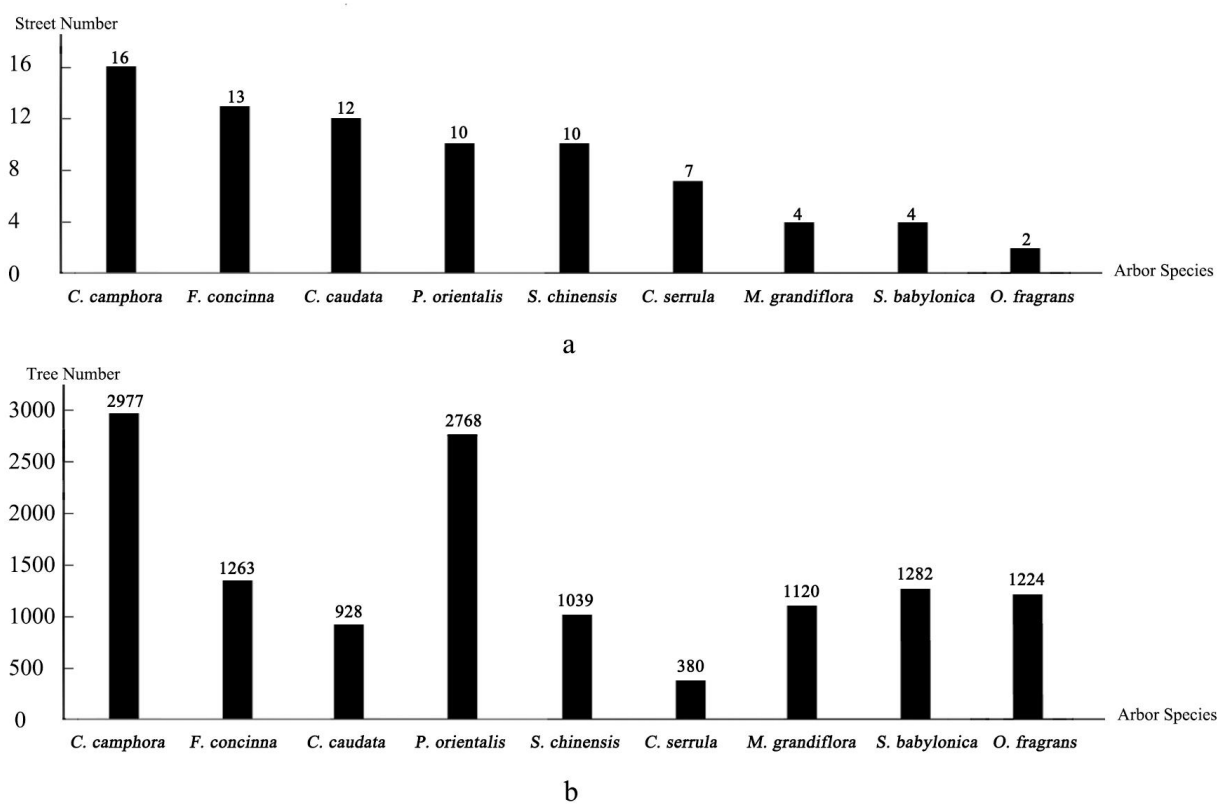

Fig. 1: The application of main arbor species in the streets of Dali.

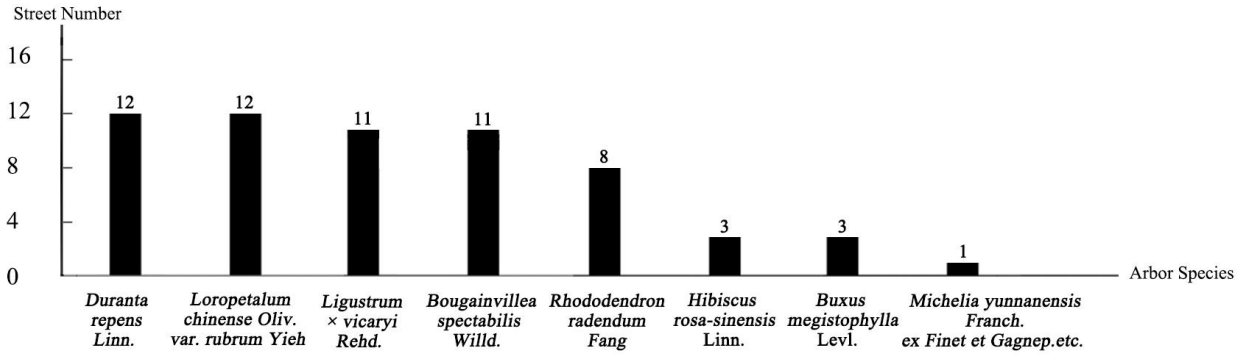

Fig. 2: The application frequency of shrub species in the streets of Dali.

Analysis on street greening of the characteristic streets

Street greening of Fuxing Road in Dali ancient urban area: Fuxing Road is the most characteristic commercial pedestrian street across the ancient urban area from south to north. *C. caudata*, *C. serrula* and *Camellia taliensis* (W. W. Sm.) Melch., the native spring flowering trees, are key species in the 2 green belts of it. By the

characteristics of these trees, the street culture is reflected. Most of the trees are evergreen arbors, and the shrubs and their species are not abundant enough.

Street greening of Yunling Road in Xiaguan area: Yunling Road that is next to the Dali Train Station, Mingzhu Square and Erhai Park is a key Street for the traffic. In the 3 green belts of this road, *F. concinna* and *C. camphora* are the main street trees. Arbors, shrubs and ground floras form a multilevel spatial structure. Especially in the central dividing strip, shrubs and ground floras are applied together with characteristic sculptures.

The problems

These years, more and more native species of Yunnan are applied in Dali. But compared with other kinds of green land, most of the attention was not paid on street greening. There are some problems as follows:

(1) Poor tree species and monotonous landscape,
(2) Unreasonable allocation of tree species and simple spatial structure,
(3) Lacking of native species and seasonal variation.

Suggestions and measures

Tree species should be applied logically

At present, most of the streets are divided into several sections. Each section has only one species of street tree, however it's different with the others. Tree species of fast and slow growth, evergreen and deciduous, tower and umbrella shape and flowering in different seasons should be combined to make the street view more beautiful and change with time. Not only the arbor, but also the shrub and ground flora should be applied logically to construct ecological street green belts.

Native tree species planning

Some native landscape tree species have been summarized, such as *Celtis tetrandra* Roxb., *P. yunnanensis, Populus yunnanensis* Dode, *C. serrula, C. caudata, Camellia reticulata* Lindl., *Pinus yunnanensis* Franch., *Salix cavaleriei* Levl., *Jasminum mesnyi* Hance, *Catalpa fargesii* Bur. f. *duclouxii* (Dode) Gilmour, *Machilus yunnanensis* Lec., *Cunninghamia lanceolata* (Lamb.) Hook., *Podocarpus forrestii* Craib and W. W. Smith, *Magnolia delavayi* Franch., etc. (Hang, 2010; Li, 2013). They should be applied more to intensify the cultural feeling in street greening.

Seasonal plant landscape of street

Autumn-leaf trees are lacking, so that the seasonal change of street view in Dali is not so obvious, especially in autumn. Some native species that have some color changes in different seasons can be used more in street plant planning, such as *C. tetrandra, Ginkgo biloba* Linn., *Koelreuteria paniculata* Laxm. *M. yunnanensis,* etc.

Conclusion

Dali is a popular city for touring, the street scene is very important to show the local culture. But the proportion of native tree species is very low. It's unfavorable for Dali image. Moreover, the street scene needs more variation factors. In the future planning and transformation, more attention should be paid in these aspects.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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