Spatial Distribution Pattern of Nitraria L. in Tarim Basin

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Abstract. Based on the field survey and integrated with typical sample area recording, the quantifying spatial distribution patterns of *Nitraria* populations were analyzed with dispersion coefficient, average clumping index, aggregation index, Cassie index, Morisita index, and negative binomial indexes. The results showed that the five species of *Nitraria* of spatial distribution patterns are the cluster distribution, which are different in the level of aggregation, in order of most intensity, it goes: *Nitraria sphaerocarpa*, *N.sibirica*, *N. tangutorum*, *N. roborowskii* and *N. pamirica*. This is related to the population characteristics, habitat condition and species density effect.

1. Introduction

Spatial distribution pattern is an important tool in plant ecology [1, 2]. Generally speaking, the spatial distributions of plant species are mainly three types: there are random distribution, regular distribution and clumped distribution. The population spatial distribution pattern is refers to the population individual present the spatial distribution state in the community. All there are each species biology characteristics, the embodiment of the interspecific relationship and its effect by the environmental conditions, and it is an important attribute of the population [3, 4]. Living spatial distribution pattern adapting to its environment is one of natural selection's results. The population spatial distribution pattern of the study is not only quantitatively described spatial structure but also exposing its cause, expound dynamically change in population and communities. In our study, the dynamic spatial pattern of the dominant population in a community had been investigated; understand the intraspecific competition and interspecific competition of life history strategy. To grasp ecological environment status and infer basis for environmental protection and fashioning conservation measures.

The genus *Nitraria* L.(Nitrariaceae) consists of 11 species grows in desert areas of Asia ,Europe, African and Australian[5]. In China species of *Nitraria* mainly distributes in northwestern desert [6,7]. There are 5 species in China and 5 species in Xinjiang province [8] . They possess the characteristics of toleration of drought and freezing salinity sand burying, grow well in the arid and semi-arid area of China They can easily produce adventitious roots and rhizomes and develop new stems when covered by sand leads to a local decrease in wind velocity So they are excellent pioneer sand shrubs for the restoration of ecosystem in desertification areas. *Nitraria* L. plants may have all

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ecological function for an obstruction to movement of sand and stabilization of Xinjiang oasis this paper gives an account of *Nitraria* the classification, resources distribution and the spatial distributions of plant species in Xinjiang Tarim Basin. Which are can provide valuable information for community protection and manage desert floras and rational utilization of *Nitraria* L. plants.

2. Materials and methods

2.1. Natural situation of the research area

Tarim basin is the largest inland basin in China, is also one of the famous arid basin in the world. Which about 1100 km long east-west, 600 km wide north-south and 10634 square km land area. The terrain of Tarim Basin slopes downwards from the southwest to the northeast. Mountains, plains and desert of the three major types of landforms are total Tarim basin area of 47.3%, 21.6% and 31.1 % [9].Because is located in the inland, and surrounded by mountains, forming typical arid desert climate. Annual sunshine hours is around 2800 ~ 3200 hours. Frost-free period is around 180 ~ 270 days. Annual average temperature is around 10 ~ 12 ℃, annual precipitation is around 20 -70 mm, but annual evaporation is as high as 2000 ~ 3000 mm. All this makes desert plants lacking in variety, sparsely distributed and giving very low coverage, the vegetative composition was simple and dominated by xeric resistance saline and alkaline vegetative community. So the natural vegetation mainly consists of xerophytes and desert species, including *Sympegma regelii*, *Sarcozygium xanthoxylon*, *Haloxylon ammodendron*, *Hexinia polydichotoma*, *Reaumuria soongoric*, *Anabasis aphylla* ,*Lycium ruthenicum* etc. In conclusion, the southern part of the Tarim Basin is the most fragile eec-environment area in Xinjiang. *Nitraria* plants are typical native and desert species, and it also possesses significant ecological and scientific value in arid and semi-arid regions [10]. This paper discussed is an important constructive and dominant species of Nitraria distribution in Tarim basin. This vegetation is the basis of vegetation restoration and construction of the Tarim basin.

2.2. Field investigations

During vegetations growth period 2013-2014 year, the research team studied Nitraria L. spatial distribution data of the 5 species in the arid and semi-arid Xinjiang Tarim Basin regions. Forty-five quadrates of 10×10m were selected more representative, comprehensive and integrity in every plot, the herbaceous species composition, individual density and coverage (%) were evaluated. Then 45 distribution plots were collected and mapped using ArcGis10.0 **(**Figure 1.**)**.

Results show that the shrub of Nitraria had a distribution mainly between 37.09°-42.35°N**,** 74.11°-88.16°E**,** elevation is 840-3800 m. They have been diversified the living environment**,** circle around piedmont alluvial floodplain Gobi, desert and salt desert wetlands of Tarim Basin, with often grow widely in the fixed and semi fixed sands dune, covered sand beach. Among them, *N. sphaerocarpa* and *N. sibirica* are widely-distributed community type, but *N. tangutorum* are seemed only distributed in north of Tarim Basin. *N. pamirica* are only distributed at high altitudes in Pamirs of Tarim Basin. *N. roborowskii* are seemed only distributed in the five counties of Tarim Basin.

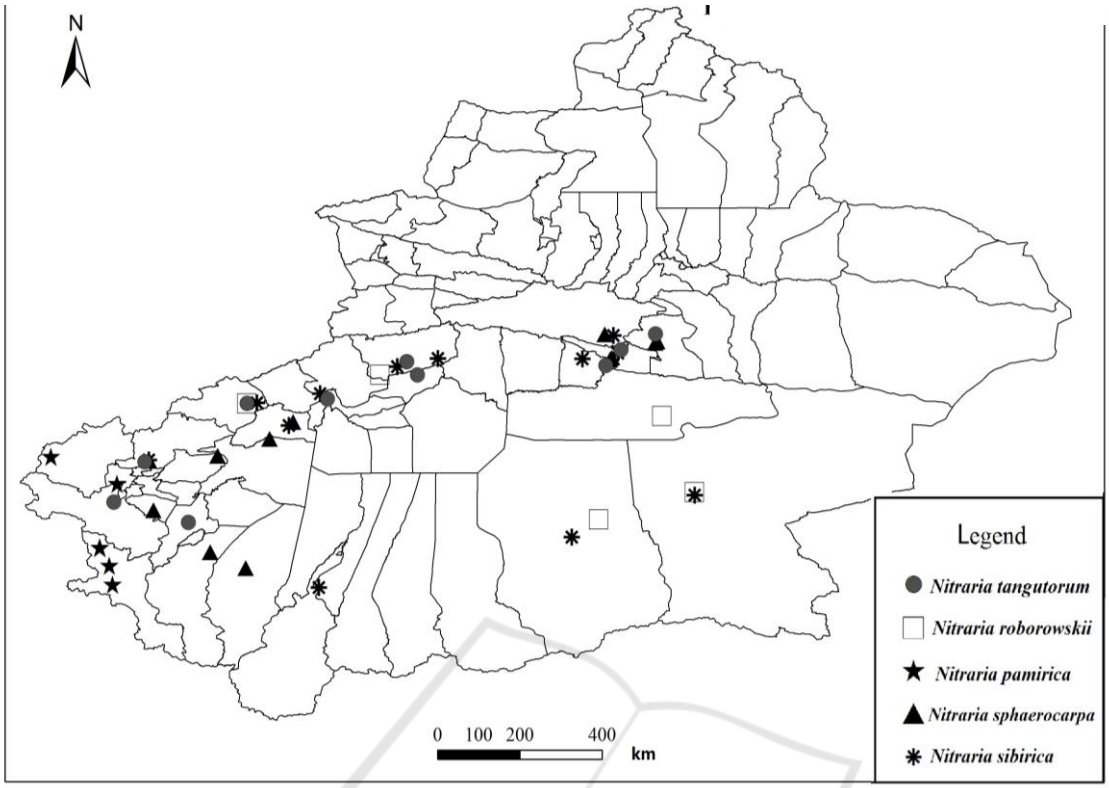

Figure 1. Distribution of the five *Nitraria L.*

2.3. Data analysis

The purpose of this experiment was to investigate *Nitraria* population dynamics**,** quantifying spatial patterns and its position in the community. One of the most frequently employed methods in detecting spatial distribution patterns of population's is the dispersion coefficient Method, negative binomial method and aggregation intensity index[11,12,13]. According to quadrate investigation and for above-ground vegetation individual plants per quadrat were computed for each species of variance and mean**,** then spatial pattern of *Nitraria* was analyzed in detail as follows.

(i)Dispersion coefficient (C) was calculated as:

$$C = S^2 / \overline{X} \tag{1}$$

In the formula, S2 is sample variance, and $\overline{X}$ is the sample mean. When $S^2 = \overline{X}$; it indicates random or Poisson distribution, when $S^2 < \overline{X}$ distribution of the population is uniform and when $S^2 > \overline{X}$**,** it indicates aggregation.

(ii) Average crowded degree (t).

$$t = \frac{S^2 / \overline{X} - 1}{\sqrt{2/(n-1)}} \tag{2}$$

In the formula, n is the total number of the sampling unit, and confirm the significant level of difference by comparing t and t (n-1).When the calculated value of T is less than the corresponding SE (T), the population is known to follow negative binomial distribution.

(iii) Clumping David index and Moore's index (I_t).

$$I_t = S^2 / \overline{X} - 1 \tag{3}$$

In the formula, If It < 0, the population will be uniform distribution, if the It > 0, it is aggregated distribution, and if It =1, it is be random distribution.

(iv) Lloyd's index of mean crowding index (m*) and aggregation index (m*/m).

$$m^* = \frac{\sum x^2}{\sum x} - 1 = \overline{X} + \frac{S^2 - \overline{X}}{\overline{X}} \tag{4}$$

In the formula, m* is average crowded degree, X is the number of individual in a sample plot, m is the total mean. If m*/m < 1, the population will be uniform distribution, if the m*/m > l, it is aggregated distribution, and if m*/m = 1, it is random distribution.

(v) Cassie index (Ca).

$$C_a = \frac{S^2 - \overline{X}}{\overline{X^2}} \tag{5}$$

If Ca < 0, the population will be uniform distribution, if the Ca > 0, it is aggregated distribution, and if Ca = 0, it is random distribution.

(vi) Morisita index (Iδ).

$$I_\delta = \frac{\sum x^2 - \sum x}{(\sum x)^2 - \sum x} \bullet n \tag{6}$$

x is the total number of plants in the sampling area**,** n is the number of quadrat in the sampling area. If Iδ < 1, the population will be uniform distribution, if the Iδ > 1, it is aggregated distribution, and if Iδ = 1, it is random distribution.

(vii) Negative binomial indexes (K).

$$K = \frac{\overline{X^2}}{S^2 - \overline{X}} \tag{7}$$

K value of less than eight indicates aggregated distribution, while K values of more than eight signifies random or Poisson distribution.

3. Results

We can see from Table1, which seven indices of pattern is well provides a simple quantitative description of spatial patterns.

The five species of *Nitraria* of C Values were all greater than 1, the degree of clustered distribution from high to low are *N.sphaerocarpa*, *N.tangutorum*, *N.sibirica*, *N.roborowskii* and *N.pamirica*.

T test were 0.735-4.615, respectively, all significantly greater than 1, indicating all had a clustered distribution based on the T -Value.

Table1. Spatial distribution patterns of the five species of *Nitraria* L.

Coenotype	Scale (m×m)	S^2	$\overline{X}$	C	T_{test}	I_t	m*	m*/m	C_a	I_δ	K	Pattern
N.sibirica	10*10	4.218	5.913	1.713	1.607	0.859	5.626	1.152	0.044	1.157	-22.814	C
N.roborowskii	10*10	2,542	4.583	1.555	1.121	0.709	4.138	1.103	0.052	1.116	-19.417	C
N.sphaerocarpa	10*10	5.636	4.114	1.370	4.615	1.810	4.484	1.990	0.169	1.285	14.562	P
N.pamirica	10*10	1.756	3.925	1.447	0.735	0.600	3.372	1.059	0.1129	1.087	-7.728	C
N.tangutorum	10*10	3.286	4.429	1.742	1.660	0.958	4.171	1.142	0.051	1.149	-19.618	C

* C represents clumped distribution, P represents Poisson distribution.

Clumping David index (It) were greater than 0, the results show that 5 species are clustered distribution, but only in the range of 0.6~1.81, the degree of clustered is not so high.

5 species of m* /m values were all greater than 1, they are all clustered distribution.

5 species of Ca values were all greater than 0, they are all clustered distribution.

5 species of I_δ values were all greater than 1, they are all clustered distribution.

K values of *Nitraria* sphaerocarpa is greater than 8, so *Nitraria* sphaerocarpa is Poisson distribution. In addition, *N.tangutorum, N.sibirica*, *N.roborowskii* and *N.pamirica* are all clustered distribution.

To this end, each values of analysis result indicating spatial distribution patterns of the five species of *Nitraria* are all cluster distribution, but are different in the level of aggregation, in order of most intensity, it goes: *Nitraria sphaerocarpa, N.sibirica, N. tangutorum, N. roborowskii* and *N. pamirica*. These results conform to *Nitraria* population of fragment distribution features.

The results showed that *Nitraria* biomass was significantly affected by the spatial pattern. Based on aboveground biomass production we defined *Nitraria sphaerocarpa, N.sibirica* as a strong and *N. roborowskii* and *N. pamirica* as a weak competitor. The degree of clustered results is also in agreement with 5 species of wide growth status. And the level of clustered was relied on the density of population.

In the dunes, the relief becomes more uneven. Surface quicksand were blown away, seeds were down to the bottom. When soil moisture and temperature of the cache microhabitat are beneficial to seed germination, fall off in the concave of seeds will sprout, So that the population expansion, density increased, formed a cluster distribution. Cluster distribution is more advantageous to adapt to the harsh environment and ensure the populations multiply.

4. Discussion

This article made the conclusion below: the five species of *Nitraria* L. of spatial distribution patterns are the cluster distribution. This is related to the population characteristics**,** habitat condition and species density effect. *Nitraria* is drought shrub with propagate by seed**,** It owns strong adaptability and self-reproduction ability**,** First the seeds grow into little plants. Then their clustered distribution around the centre of mother plant**,** along with the seed scattering and the plant rhizome reproducing**,** the aggregation intensity gradually strengthened and community stability gradually increased .The population diffusing periods are intrude into and settle down mother plant of matrix centered.

Nitraria growth environment is more severe, the structure of community was not perfect, having relatively few species and low coverage. Therefore, gathered strength is plants reduce specific competition relations, avoid animal feeding, and also is the important strategy to maintain community stability. In order to adapting to the bitter natural geographical environment and a race for limited resources, the shrub of *Nitraria* occupies dominant status to survive by clannishness and

the cluster distribution. Generally speaking, the high community stability, the power dominant species cluster degree. So, the stability of the community is in proportion to cluster degree [14].

It is a consequence of *Nitraria* modern distribution pattern is a historical period, geology, climate and human activity**,** as so on. Correct analysis of the *Nitraria* situation and find out the cost of management measures is a very urgent task. Because of *Nitraria* living from arid land that not only gets little rain but also has been damaged by overgrazing, deforestation and human destruction. Under drought stress, *Nitraria* of the branches are aging**,** and new branches germination ability weak and low seed setting percentage. Nitraria resource has been gradually reduce [15].All this influences soil conservation, ecological balance, climate adjustment, and windbreak and sand-fixation. *Nitraria* habitats are very fragile, where natural resources are depleted. Maintain and improve the ecological system of *Nitraria* helps to maintain ecosystem balance and prevent land desertification in south of Xinjiang.

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