Postprint: Analysis of Interspecific Relationships and Stability of Vegetation in the Lower Tarim River

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Abstract

Based on quadrat surveys, vegetation conditions were investigated at sample plots from four monitoring sections (Yingsu, Ka' erdayi, Alagan, and Yiganbujima) in the lower reaches of the Tarim River. Using 2×2 contingency tables, interspecific association analysis and stability studies were conducted on the vegetation communities employing the variance ratio method (VR), association coefficient (AC), ^{2} test, and M. Godron stability measurement method. The following conclusions were obtained: Overall correlation test results indicate that no plant communities with significant positive association appeared in the four sections. Plant community succession in the lower Tarim River has not yet reached a stable level, and the plant communities at the Alagan and Yiganbujima sections are in the early developmental stage. Interspecific relationships in the plant communities are not significant, with loose distribution tending more toward independent distribution. Community structure is unstable, and dependence between species pairs within the same sample plot is not strong. In some areas, certain competitive relationships and exclusion effects exist among species in the plant communities. Based on existing interspecific relationships, the plant communities in the lower Tarim River can be divided into three ecological species groups.

Full Text

Interspecific Association and Stability of Vegetation in the Lower Reaches of the Tarim River

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Abstract

Based on plot surveys conducted along four monitoring sections (Yengisu, Karday, Aragan, and Yiganbjima) in the lower reaches of the Tarim River, this study investigated vegetation status. Using 2×2 contingency tables, the variance ratio method (VR), correlation coefficient (AC), ^{2} test, and M. Godron stability measurement were employed to analyze interspecific association and community stability. The overall correlation test revealed no plant communities with significantly positive associations across the four sections. Vegetation succession in the study area had not yet reached a stable stage, with plant communities along the Aragan and Yiganbjima sections still in early development. Interspecific associations among vegetation communities were not significant, showing loose and even independent distribution patterns. Community structure was unstable, and species dependence within the same plot was weak. Certain plant communities exhibited some competitive and exclusive effects among species. Based on interspecific association patterns, plant communities in the lower Tarim River could be divided into three ecological species groups.

Keywords: vegetation; interspecific association; interspecific relationship; stability; lower reaches of the Tarim River

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3. Analysis of Interspecific Association

3.1 Plant Species Composition and AC Values The primary plant species in the study area included *Populus euphratica*, *Lycium ruthenicum*, *Tamarix chinensis*, *Alhagi sparsifolia*, *Hexinia polydichotoma*, *Glycyrrhiza uralensis*, *Phragmites australis*, *Halimodendron halodendron*, *Poacynum hendersonii*, *Calamagrostis pseudophragmites*, *Swainsonia salsula*, *Salsola collina*, and *Apocynum venetum*. These 13 species constituted the main components of the desert plant communities in the lower Tarim River.

[Figure 1: see original paper]

Fig. 1 Semi-matrix of interspecific AC values along four sections in the lower reaches of the Tarim River (species numbers correspond to those in Table 1)

3.2 Overall Correlation Test Results The variance ratio (VR) test results for overall interspecific correlation showed VR values of 0.864, 0.668, and 0.496 for different community types (Table 2). The ^{2} test statistics were calculated with degrees of freedom (20). For the first community type, ^{2}. , $< 17.28 <$ ^{2}. , , indicating no significant overall association. For the second type, ^{2}. , < 13.36, also showing no significant association. For the third type, 9.96 fell between ^{2}. , and ^{2}. , , again indicating non-significant overall association.

Table 2 Test results of overall correlation of plant species

Community Type	VR Value	^{2} Statistic	Significance
Type 1	0.864	17.28	Not significant
Type 2	0.668	13.36	Not significant
Type 3	0.496	9.96	Not significant

3.3 Interspecific Association Analysis Among the species pairs analyzed, positive associations were observed in 1 pair for the Yengisu section and 8 pairs for the Karday section. Negative associations were found in 2 pairs for Yengisu and 4 pairs for Karday. The Aragan and Yiganbjima sections showed similar patterns, with positive associations in 5 and 2 pairs respectively, and negative associations in 22 and 4 pairs respectively. These results indicate that interspecific associations varied significantly among different river sections.

3.4 ^{2} Test Analysis The ^{2} test revealed significant associations ($P < 0.05$) in 3 species pairs, with 2 showing positive association and 1 showing negative association, accounting for 11.76% and 5.88% of total pairs respectively. The majority of species pairs (88.24%) showed no significant association, indicating loose and relatively independent distribution patterns among most species. This suggests that community structure remains unstable, with weak interdependence among co-occurring species.

3.5 Ecological Species Groups Based on interspecific association analysis, plant communities in the lower Tarim River could be classified into three ecological species groups: 1. **Group 1**: Dominant species including *Populus euphratica*, *Lycium ruthenicum*, *Tamarix chinensis*, and *Alhagi sparsifolia* 2. **Group 2**: Companion species such as *Hexinia polydichotoma*, *Glycyrrhiza uralensis*, *Phragmites australis*, and *Halimodendron halodendron* 3. **Group 3**: Transitional species including *Poacynum hendersonii*, *Calamagrostis pseudophragmites*, *Swainsonia salsula*, *Salsola collina*, and *Apocynum venetum*

This classification reflects the ecological strategies of different species in response to water availability and soil conditions in the riparian ecosystem.

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4. Discussion

4.2 Characteristics of Interspecific Association The analysis revealed that interspecific associations among plant communities were generally not significant, with loose and independent distribution patterns. Community structure remained unstable, and species dependence within plots was weak. However, certain plant communities exhibited competitive and exclusive effects among species, particularly where resources were limited. The variance ratio

method effectively quantified these relationships, showing that most communities had not reached a stable successional stage.

Historical data indicate that ecological water transfer projects implemented since the 1990s have significantly influenced vegetation dynamics in the lower Tarim River. However, the recovery process is slow, and community structure continues to adjust. The lack of strong positive associations suggests that species assembly is still largely stochastic rather than deterministic, characteristic of early successional stages in aridland riparian ecosystems.

4.3 Relationship Between Species Diversity and Water Factors Water availability remains the primary limiting factor for vegetation establishment and growth in the lower Tarim River. The three ecological species groups identified correspond to different water requirements and tolerance levels. Dominant species in Group 1 (e.g., *Populus euphratica*) are well-adapted to periodic flooding and deep water tables, while Group 3 species are more tolerant of extreme drought.

The ^{2} test results showing predominantly non-significant associations suggest that niche differentiation is not yet fully developed. This may be attributed to the relatively recent implementation of ecological water transfer, which has not allowed sufficient time for communities to develop complex species interactions. As water conditions continue to stabilize, stronger interspecific associations are expected to develop, leading to more stable community structure.

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5. Conclusions

(1) The overall correlation test revealed no significantly positive associations among plant communities in the lower Tarim River, indicating that vegetation succession has not yet reached a stable stage. Communities along the Aragan and Yiganbjima sections remain in early developmental phases.

(2) Interspecific associations were generally non-significant, with loose and independent species distribution patterns. Community structure is unstable, and species dependence within plots is weak, though some competitive and exclusive effects exist in certain communities.

(3) Based on interspecific association patterns, plant communities can be divided into three ecological species groups reflecting different water requirements and successional statuses. Continued monitoring is needed to assess long-term community stability and the effectiveness of ecological water transfer in restoring riparian ecosystems.

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Note: Figure translations are in progress. See original paper for figures.