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Changing Patterns of Plant Communities in the Drawdown Zone of Baijia Creek Under the Influence of Three Gorges Reservoir Impoundment*

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Abstract: Since October of 2006, the Three Gorges Reservoir (TGR) has finished the impoundment from 156 m to 175 m. In order to find the influence of the impoundment to the plant community and its' pattern in the drawdown zone further, an investigation on the plant community of the Baijia Creek was conducted again from July to August 2011. The plant community and its' pattern under the influence of impoundment at 175 m was compared to the 156 m. The results show 101 species of vascular plant belong to 39 families, 93 generas have been investigated, among which 84 species belong to 30 families, 74 generas distributed in the drawdown zone. The distribute area of *Xanthium sibiricum* and *Paspalum paspaloides*, which once were dominant species in the drawdown zone, decreased obviously. *Cyperus rotundus*, *Echinochloa crusgali* var. *zelayensis*, and *Aeschynomene indica* come to be new dominant species in the study area. The impoundment of the TGR to 175 m influenced the plant community and its' pattern in the drawdown zone significantly.

Key words: Three Gorges Reservoir; impoundment; drawdown area; plant community

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Reservoir impoundment causes wide-scale flooding with the consequence of major changes in ecosystems. The drawdown zones of reservoir ecosystems are subject to periodic water-level fluctuation which has unpredictable effects that vary according to local conditions. Research on changes in plant communities of the drawdown zone help to inform understanding of the local ecological effects of impoundment and assist in reservoir management decision-making.

From 2008 to 2011, the Three Gorges Reservoir (TGR) had been impounded four times to its maximum height of 175 m above sea level. During the summer of 2008, Wang et al. [1-2] and Sun et al. [3] independently investigated the plant communities in the drawdown zone of Baijia Creek, and they came to the conclusions that the periodic water level changes had significantly altered the plant communities there. In order to reveal trends in changes to plant communities in the drawdown zone of the TGR, and provide a scientific foundation for the reconstruction of the TGR's ecosystem, we again investigated the plant communities at the Baijia Creek estuary during July and August, 2011, and compared the results of our investigation with comparable data that were acquired in 2008 [1-3] after the first significant impoundment of the reservoir.

1 Methods

Field work was carried out in July and August,

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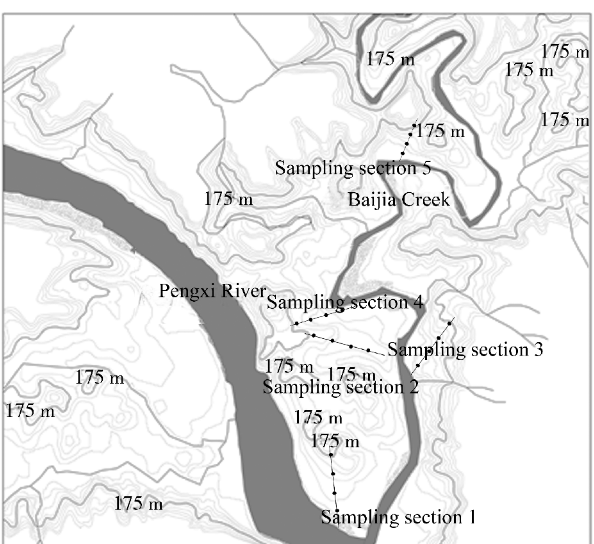
2011. Five transects were set at four selected points that had been studied previously [1,3] along the Baijia Creek, and one new site was added so as to sample an additional terraced landform. Sample plots were set at sites along each of the 5 transects at 5 m height intervals, at least 3 plots per sampling site, from 180 m above sea level to the river bank. By this means a total of 113 square sample plots each of 1 m^2 in area were placed within the sample area (Fig. 1).

Microsoft Excel software was used to obtain the species richness and the Shannon-Weiner index was calculated as

$$H = -\sum_{i=1}^{s} (p_i)(\ln p_i)$$

Where s is the total number of plant species in a sample plot, and p_i is the proportion of individuals of species i in relation to the total number of individuals of all species[4].



The river height at junction of Pengxi River and Baijia Creek is about 145 m above mean sea level, which is the lowest drawdown level of the reservoir. Sampling section 4 is a new sampling site. The other sections (1 ~ 3 and 5) were sampled both in the current work and in the previous studies described here.

Fig. 1 Sketch map of study area and five sampling sections

The One-way ANOVA method in the statistical analysis software SPSS 15.0 was used to test for significant differences ($p < 0.05$) between H from sample plots at different altitudes. Duncan's multiple range test was conducted also. The plant community type was determined by the formula $IV = (RH\% + RC\%)/2$, where IV is the importance value index, $RH\%$ is the relative height, and $RC\%$ is the relative coverage [5-6].

2 Results

In the research area, there were 101 species of vascular plants belonging to 93 genera of 39 families, among which 46 species were found between 175 ~ 180 m above mean sea level and 84 species were found in the drawdown zone. Among those in the drawdown zone, 19 vascular plant species were observed at elevations below 156 m above mean sea level.

According to the One-way ANOVA and Duncan multiple range tests, there is a significant difference in the Shannon-Wiener index (H) between the drawdown zone and the non-inundated zone (175 ~ 180 m) ($df = 5$, $F = 6.461$, $p = 0.001$).

The plant associations in the research area could be divided into 13 types according to Wang Bosun's "Phytoecology"[7]: *Cynodon dactylon* Association, *Aeschynomene indica* Association, *Echinochloa crusgali* var. *zelayensis* Association, *Fimbristylis miliacea* Association, *Xanthium sibiricum* Association, *Bidens pilosa* Association, *Imperata cylindrical* Association, *Dendrocalamus latiflorus* Association, *Echinochloa crusgali* var. *zelayensis+Aeschynomene indica* Association, *Cynodon dactylon + Xanthium sibiricum* Association, *Cynodon dactylon + Cyperus rotundus* Association, *Aeschynomene indica + Cynodon dactylon* Association, *Echinochloa crusgali* var. *zelayensis + Cyperus rotundus* Association.

3 Discussion

Through this investigation, 19 vascular plant species were observed in the drawdown zone below 156 m above mean sea level. This number of species is much lower than the 96 species which were reported by Sun Rong in the same research area during July and August, 2008[3].

The area covered by *Xanthium sibiricum* and *Paspalum paspaloides*, which once were dominant species in the drawdown zone, had obviously decreased. By contrast, *Cyperus rotundus*, *Echinochloa crusgali* var. *zelayensis*, and *Aeschynomene indica* had come to be new dominant species.

We conclude that impoundment of the TGR to 175 m above mean sea level has significantly influenced the plant community and the pattern of distribution of plant associations in the drawdown zone. These patterns are not stable and we can expect changes to continue as the residual seed bank is diminished and new dominant species arise. When seeking for countermeasures for controlling eco-environmental problems in the drawdown area, more attention will need to be paid to the naturally-selected flood-tolerant plants that will increase in frequency. Ongoing monitoring of the plant community will be necessary, with particular attention to plants that multiply rapidly.

More research is required before we will know what specific factors are driving the changes in community composition. We can expect that immigration of new species and population-level evolution will lead to new dominant species and ongoing community-level changes. At the same time, some species that were previously present will be unable to tolerate the new conditions and will disappear. Loss of dominant species will have strong community-level interactive effects. For example, even if *Echinochloa crusgali* var. *zelayensis* is mowed before setting seed, it can grow very quickly, and the seeds will be ripe about a month later. As a result *Echinochloa crusgali* var. *zelayensis* has increased rapidly and has come to be a new dominant species in the Baijia Creek drawdown zone. By contrast *Xanthium sibiricum* has been much depressed by flooding. It appears that if it is submerged once during the growing season, the seed-setting rate is significantly decreased. For reasons like these, ongoing plant community succession is expected to occur in the drawdown zone and will continue to be monitored and investigated.

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