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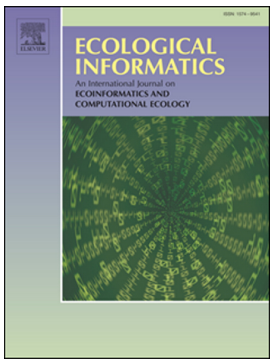

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Environmental interpretation of forest communities in Xiaowutai Mountain by fuzzy mathematics analysis

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ABSTRACT

Fuzzy mathematics theory has been recognized as an appropriate approach for dealing with fuzzy uncertainty that is mainly due to incomplete information in ecological problems. The forest communities in Xiaowutai Mountain were analyzed by fuzzy mathematics methods. The results showed that all quadrats (n=148) which contained a total of 392 vascular plant species in 75 families were classified into 16 groups representing 16 plant communities by fuzzy C-means clustering. The distribution of plant community types in two-dimensional ordination diagram reflected community space variation trends and environmental gradients by fuzzy set ordination. In addition, the ordination results reflected altitude, slope position, litter layer thickness, soil electrical conductivity, soil thickness, soil temperature, soil moisture, disturbance, slope, aspect, soil pH successively affected community distribution along environmental gradients. From the two-dimensional ordination diagram, it seemed that altitude played the greatest impact on forest community distribution in all environmental factors. Analyzing the actual effect of plant community by fuzzy mathematics methods can help us to provide ideas and case studies in ecology research.

Keywords: forest community structure, fuzzy C-means clustering, fuzzy set ordination, environmental gradient, community distribution

1.Introduction

Understanding community structure and environmental variation on biodiversity are key tasks in ecological research. Multivariate statistical methods are used to analyze forest community structure and explain vegetation variation along dominant environmental gradients. Cluster analysis is one of the several important tools in modern data analysis and regards objects as many points in the multi-dimensional space. Its goal is to be able to uncover natural tendencies of cluster or structure in the data. Using multivariate statistical values can reasonably divide them into several classifications by close and distant relationships. Fuzzy clustering is a necessary and useful method because the description of ecological systems is not always possible in terms of a binary approach (Zhang et al., 2015; Chuang et al.,2006). Fuzzy clustering is an effective soft method in the clustering family, and fuzzy mathematics theory might be more appropriate in ecological analysis.

Fuzzy C-means clustering (FCM) is based on fuzzy set theory which has been developed by numerous scientists, and is now applied in various fields of sciences, such as in pattern recognition, data mining, image processing and other fields (Sarbu and Zwanziger, 2001;Yu et al.,2014). FCM is a non-hierarchical clustering method and the data set is divided into multiple clusters. The data objects in the same cluster has larger similarities, while the data objects in the different cluster has

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