Analysis of Inter-Species Association and Covariation in a Natural Deciduous Forest

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ABSTRACT

Utilizing chi-square test statistics, inter-species association and covariation were analyzed for the 37 woody plant species in a deciduous forest dominated by Quercus mongolica and Q. variabilis. Within 50 temporarily established 20 m × 20 m square quadrats, the association for each pair of species was presented based on the presence-absence parameters. Acer palmatum had significant positive association with Acer mono and Kalopanax pictus, but negative association with Pinus densiflora. Other positively associated species pairs were Prunus serrulata-Mackia amurensis, Quercus serrata-Kalopanax pictus, Symplacos chinensis var. pilosa-Euonymus oophyllus, and Ulmus davidiana var. japonica-Lindera obtusiloba. The covariation for each pair of species was evaluated based on the quantitative measures, density and basal area. Overall results showed that the association and covariation values among species generally agreed with each other. Because covariation was calculated by density and basal area of the tallied species in the sample plots, the number of species pairs of covariation tended to be greater than those of association. Especially, Pinus densiflora, considered to be pioneer species in the successional stage, had negative covariation with most of climax species.

These ecological information could be applied to silvicultural practices, such as ecosystem classification, establishment of mixed hardwood forest, and tending operations for marking crop trees and desirable species.

Key words: Deciduous forest, inter-species association, inter-species covariation, $X^2$ test.

要 約

신갈나무와 동참나무가 우일한 간식에서는 37가지 체부생물에 대한 간식 간 상관 (association) 관계와 개체질 (covariation) 관계를 $X^2$ 검정을 이용하여 분석하였다. 50개의 20 m × 20 m 정방형 표본구역 내에서 각 간식의 발생·비가 발생하는 상관관계를 분석한 결과, 단풍나무는 고로쇠나무 및 음나무와 높이 ($a = 0.01$)의 정의 상관관계를 갖고 있으며, 소나무는 소나무와 간식의 상관관계를 갖고 있었다. 출장나무와 음나무, 참허나무와 노린재나무, 노린재나무와 다른나무, 다른 나무와 삼랑나무, 그리고 생장나무와 느릅나무의 상호 정의 상관관계가 있는 것으로 나타났다. 간식 간의 도수와 두가지 간식의 상관관계를 비교한 결과, 상호 상관관계가 매우 복잡한 형태로 나타났다. 이는 간식의 개체질과 두가지 간식의 상호 상관관계가 서로 상관관계가 되는 것으로 나타났다.
INTRODUCTION

A natural forest community is an aggregation of living organisms having mutual interactions among themselves and interrelationships with their surrounding environment. The distribution, the abundance, and the interaction of plant species are influenced by those biotic and abiotic factors that exist in the community.

In the natural deciduous forest of temperate region, assemblage of various woody plant species is an ecological product of such concepts by one way or another. The occurrence or nonoccurrence of a species in a particular area seems to be somewhat related to the occurrence of another species. We are interested here in investigating how a certain pair of tree species are growing in the same area and avoiding each other. This affinity of occurrence or repulsion of two species is so called interspecies association (Pielou, 1977; Greig-Smith, 1983; Schluter, 1984; Ludwig and Reynolds, 1988).

The species association is detected entirely by the presence and absence data of species in the collection of sampling units, resulting in being positive, negative, or absent. However, if the sample contains quantitative measures of species, for example, density, basal area, or biomass, additional information can be obtained compared to that of species association itself. The abundance data may have the tendency to increase and/or decrease together between two species. It is referred to as inter-species covariation (Ludwig and Reynolds, 1988). The procedure for examining species covariation is based on such abundance data, depending on whether or not the abundance data of two species covary.

Presumably, the association and covariation between two tree species in the forest community exist because of one or more among three main reasons. They are 1) same habitat selection, 2) similar environmental requirements, and 3) intrinsic interaction (Hubalek, 1982). Nevertheless, we are tend not to explain the possible underlying reasons why the association and covariation might occur, but to test statistical significance of those correlations in this study, which would be served as preceding information to generate suitable hypotheses to explain such complex ecological patterns. Practical considerations will be discussed with coming information as well.

THE STUDY AREA

The study area is located on Yongwha Mountain (38° 02' north latitude, 127° 45' east longitude) in Whacheon-Gun, Kangweon-Do. Vegetation type is classified to a temperate broad-leaved deciduous forest, dominated by Quercus species.

The climate of the study area is typically continental with summer rainfall and winter drought. Annual precipitation at the meteorological station in Chuncheon, about 12 km away from the study area, has been recorded in excess of 1200 mm, which is characterized by localized torrential downpour in summer, mainly in June, July, and August. The mean annual temperature has been 11.2°C, with cold season means (average for December, January, and February) of -0.3°C to 3.5°C and warm season means (average for June, July, and August) of 26.4°C to 32.1°C.

The landscape is hilly to mountainous with exposed ridges and steep slopes up to 40°. Approximate elevation ranges from 200-600 m above mean sea level and aspects are various. The area is highly dissected by many small streams flowing between ridges of various width.

The soils of the study area have been weathered from igneous and metamorphic rocks, primarily granites and gneisses. They are chiefly well-drained and slightly acid brownish soils. Surface soil textures range from loamy sand to loam, and those of subsoil are commonly high in clay, generally