ON THE RESOLVING POWER OF PRINCIPAL COMPONENT ANALYSIS IN PLANT COMMUNITY ORDINATION*

Enrico FEOLI**

Istituto ed Orto Botanico, Università degli Studi di Trieste, Italy I 34100

Keywords: Centering, Non-centering, Principal component analysis, Resolving power

Introduction

The method of principal component analysis (PCA) is commonly used for the ordination of plant communities (through relevés or synoptic tables). Its diffusion in ecology is due to the work of Goodall (1954), Dagnelie (1960), van Groenewoud (1965), Orłoci (1966, 1973), Austin & Orłoci (1966), Ivimey-Cook & Proctor (1967), van der Maarel (1969), and others. Although PCA is a statistical method, in ecology it serves as an ordination technique in indirect gradient analysis (Whittaker 1967) without much statistical content.

In a PCA, plant communities are ordered basing on co-ordinates obtained by the eigenvalue and eigenvector solutions of a real symmetric matrix; generally a resemblance matrix (Orłoci 1973) of the cross product type. Such co-ordinates may be computed in two different ways (Gower 1966, Orłoci 1966, 1967, 1973, 1975): 1) On the basis of the resemblance of relevés (Q-PCA). 2) On the basis of species correlation, covariance or similarity (R-PCA). The former is generally used when there are more species than relevés, the latter when there are more relevés than species. The results, as component scores of relevés, are mathematically identical in both cases. Therefore, this paper deals only with the former, 1).

A resemblance matrix may be generated by using different coefficients, which may be centered or not. Although, strictly speaking, the term principal component analysis applies only to procedures in which the coefficient is centered, being of the covariance type, in the present paper its use will be less restricted. The coefficients have been treated by Orłoci (1972, 1975) and Goodall (1973). The problem of centering and non-centering has been dealt with by Orłoci (1967, 1975) and Noy-Meir (1973). Two types of centering are distinguished: 1) centering by species (variable) and 2) centering by site (relevé or synoptic table).

When the ecologist applies PCA to a data matrix, he should realize that the information content in the data undergoes transformations (Orłoci 1974) through which it assumes a determinate structure in the ordination models. The structure strictly depends on the type of coefficient used. The non-centering coefficients, for instance the coefficients of Jaccard (1901) and Sørensen (1948), lead to models where at least one component is unipolar. This is believed to be a disadvantage in ordinations by Orłoci (1966) and Gower (1966), but an advantage by Noy-Meir (1973). Both these points of view may be accepted depending on what the ecologist would like to accomplish by PCA.

The present work describes the way in which centered and non-centered PCA achieve the discrimination of different objects as distinct points in a scatter diagram.

The data

Two sets of data have been used in the illustrations: 1) 12
Fig. 1. Dendrograms showing the structure of the artificial matrices described in the text. Numbers across identify relevés or synoptic tables. Vertical scales represent the similarity levels within and between the clusters.