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# Population and Community Ecology for Insect Management and Conservation

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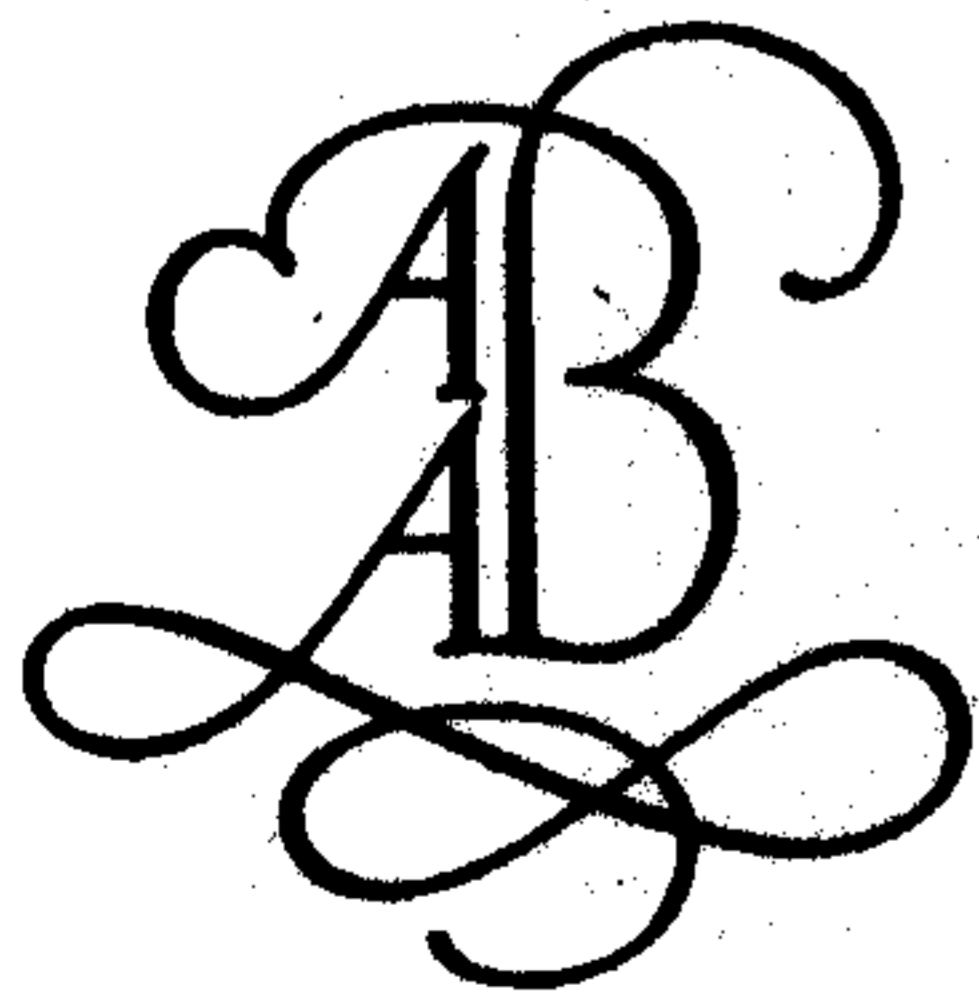
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# Measures of spatial pattern and spatial association for insect counts

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**ABSTRACT:** This paper introduces new methods to measure the spatial association or dissociation between two populations measured simultaneously, or between the same population measured on two occasions. It is suitable for ecological data in the form of counts, where the two populations are sampled at identical specified locations. The methods form part of the SADIE system, that uses all the spatial information in the sample. Examples are given using data from the literature. Fortran software is freely available from the author.

## 1 INTRODUCTION

This paper is concerned with the problem of measuring and testing for spatial association between two populations for which the data are counts of individuals. Both populations are assumed to have been sampled at the same spatial locations, for which the two-dimensional coordinates are all known. As an example, Harkness & Isham (1983) reported the number of nests of each of two ant species, *Cataglyphis bicolor* and *Messor wasmanni* in a 4x8 grid of quadrats covering a 0.5ha field in Northern Greece (see their Tables 3 & 4). The two populations might be spatially dissociated, perhaps because of competition between nests of different species for the same limited resource, or positively associated, perhaps because of the need to occupy areas with similar microclimates, or they may occur at random with respect to one another. It is impossible to consider association in isolation from the spatial pattern of its two component populations. For example, the presence of a parasitoid population may clearly affect the spatial pattern of its host, which will attempt to relocate in refuges. This escape response by the host may then cause an alteration in the spatial pattern of the parasitoid, which strives to seek out the new locations of the host aggregations. This process is dynamic, and may result in a ceaseless shifting of positions of both species. Then again, there may be absolutely no direct effect of one species on another, yet the spatial pattern of both may be affected by some third species or by an environmental component that induces a degree of spatial association. Without further information, these two cases, of direct and indirect association, are indistinguishable in the data as defined. The null hypothesis is one of lack of any association or dissociation, i.e. that the location of the individuals of either one population are random with respect to those of the other. Whether or not this is the case, both populations may still exhibit strong spatial pattern individually, and these patterns may in any event be described and tested in each species in isolation from the other. Indeed, this should be done before the problem of spatial association is addressed so that the effect of spatial pattern for an individual population may be eliminated; this may be done by conditioning, as described more fully below.

Lack of space precludes a more detailed account of the principles underlying the methodology, which are given in more detail in Perry (1997a). Briefly, the technique forms part of a class termed SADIE (Spatial Analysis by Distance IndicEs) first introduced by Perry & Hewitt (1991). The basis of SADIE is to quantify the spatial pattern in a sampled population by measuring the total effort (in terms of the minimum distance moved), which the individuals in the observed sample must expend, to move

