Variable Life History Characteristics along an Altitudinal Gradient in Three Species of Australian Grasshopper

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Summary. Variation in life history characteristics was examined in three closely related species of univoltine grasshopper, *Praxibulus* sp., *Kosciuscola cognatus* and *K. usitatus*, along three altitudinal transects in South East Australia. With increasing altitude females lay fewer eggs in total over the summer season but lay their eggs in larger clutches. This pattern of variation, which is not related to variation in egg size, is observed both between and within species. The relationship between clutch size and altitude is similar in all three species but quite distinct reproductive strategies are maintained between species even where different species are found together at the same altitude. It is proposed that both the length and predictability of the summer growing season could be important in determining the evolution of life history characteristics along the altitudinal gradient.

Introduction

Although it is accepted that natural selection operates by differential reproductive success there are different ways this may occur. Many characteristics of an individual will influence its reproductive success and together these characteristics may be considered as a set of coadapted traits comprising a life history strategy. A spectrum of different life history strategies are observed in different populations each of which represents one way of allocating the available resources in the time available such that individuals maximise their genetic contribution to the next generation.

The type of life history strategy exhibited by a population will play a large
part in determining the genetic structure of that population and will consequently be important in influencing the way the population responds to environmental change. It is of considerable interest, therefore, to ask what life history strategies are likely to evolve in particular environments.

Recent interest in the evolution and significance of life history strategies has resulted in a large number of theoretical papers (Cole, 1954; Demetrius, 1975; Fagen, 1972; Gadgil and Bossert, 1970; Tinkle et al., 1970; Hairston et al., 1970; Mertz, 1971; Murphy, 1968; Pianka, 1970; Schaffer, 1974; Williams, 1966) and these, together with analyses of empirical data (Lack, 1966; Price, 1973; Salthe, 1969; Tinkle, 1969; Tinkle et al., 1970), have led to a variety of hypotheses which attempt to explain the adaptive significance of different life history strategies. Few of these appear to have been tested experimentally however. Nevertheless, these studies all agree that the most important life history characteristics are (1) the mean and variance of the first age of reproduction, (2) the clutch size, (3) the size of young, (4) the number of clutches per lifetime, and (5) the interbrood interval (Stearns, 1976).

In attempting to investigate the evolution of life history strategies it is clearly important to know how much variation for life history characteristics exists within and between natural populations since it is on this variation that natural selection will act. While many empirical studies have dealt with interspecific comparisons, there are an increasing number of studies comparing life history characteristics between different populations of the same species (Abrahamson and Gadgil, 1973; Birch et al., 1963; Cravello and Hacker, 1972; Gadgil and Solbrig, 1972; Gilbert and Singer, 1973; Johnson and Cook, 1968; Linhart, 1974; Menge, 1974; Schaffer and Elson, 1975; Strong, 1972; Tilley, 1974). An examination of phenotypic differentiation between adjacent populations distributed along an environmental gradient can be particularly informative when attempting to analyse the possible selective forces determining variation in a character and this approach has been adopted in the present study which examines certain life history characteristics within and between three species of closely related Acridid grasshopper along an altitudinal gradient. These grasshopper species offer many advantages for life history studies since they are univoltine, do not exhibit the phenomenon of delayed reproduction and in common with other grasshoppers lay multiple clutches of eggs (iteroparity) and do not show post-natal parental care of offspring. Furthermore, their reproductive anatomy is such that a number of important life history variables can be estimated from dissected females.

Kosciuscola cognatus, Kosciuscola usitatus and a species belonging to the genus Praxibulus are small brachypterous grasshoppers within the sub-family Oxyinae. All three species are restricted to the higher regions of South East Australia and their distributions are altitudinally zoned with respect to one another. The total distributional range covered by the species, approximately 900 to 2100 metres in the areas studied here, encompasses a wide range of variation for a large number of physical and biotic variables which are correlated with altitude. This paper reports the variation in clutch size, the number of clutches laid per female, egg size and female body size along three independent altitudinal transects.