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Introduction to the Study of Animal Populations

Information about animal populations is sought for a variety of purposes; but the *object* of a study will largely determine the methods used and thus this must be clearly defined at the outset. Very broadly studies may be divided into *extensive* and *intensive* (Morris, 1960). Extensive studies are carried out over a large area and are normally concerned with the distribution of insect species or with the relation of insect pest population to crop damage or with the prediction of damage and the application of control measures (e.g. Kaelin & Auer, 1954; Strickland, 1961; Chiang *et al.*, 1961; National Academy of Sciences, 1969). A particular area will be sampled once or at the most a few times during the season, and emphasis will normally be placed on a particular developmental stage of the insect. The timing of such sampling is obviously of critical importance: it must be appropriate in relation to the phenology of the chosen stage (Morris & Bennett, 1967). Such studies will produce considerable information about the pattern of population level over a large area or in successive years, and it is often possible to relate the level of the population to certain edaphic or climatic factors (Kaelin & Auer, 1954; Chiang *et al.*, 1961).

Intensive studies involve the continual observation of the population of an animal in the same area. Usually information is required on the sizes of the populations of successive developmental stages so that a life-table or budget may be constructed and an attempt made at determining the factors that cause the major fluctuations in population size (key factors) and those that govern or regulate it (Morris, 1960; Richards, 1961; Varley & Gradwell, 1963). It is important to consider at the start the type of analysis (see Chapter 10) that will be applied and so ensure that the necessary data is collected in the best manner. Intensive studies may have more limited objectives, such as the determination of the level of parasitism, the amount of dispersal or the overall rate of population change.

The census of populations and the stages at which mortality factors operate are necessary first stages in the estimation of the productivity (Chapter 14) of ecosystems. In survey and conservation work, the species make-up of the population and changes in its diversity associated with man's activities are most frequently the features it is desired to measure. Special methods of analysis need to be used (Chapter 13), but difficulties usually arise because of

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the virtual impossibility of extracting the many different species from a habitat with equal efficiency by a single method (e.g. Nef, 1960).

1.1 Population estimates

Population estimates can be classified into a number of different types; the most convenient classification is that adopted by Morris (1955), although he used the terms somewhat differently in a later paper (1960).

1.1.1 Absolute and related estimates

The animal numbers may be expressed as a density per unit area of the ground of the habitat. Such estimates are given by nearest neighbour and related techniques (Chapter 2), marking and recapture (Chapter 3), by sampling a known fraction of the habitat (Chapter 4–6) and by removal sampling and random walk techniques (Chapter 7).

Absolute population

The number of animals per unit area (e.g. hectare, acre). It is almost impossible to construct a budget or to study mortality factors without the conversion of population estimates to absolute figures, for not only do insects often move from the plant to the soil at different developmental stages, but the amount of plant material is itself always changing. The importance of obtaining absolute estimates cannot be overemphasized.

Population intensity

The number of animals per unit of habitat, e.g. per leaf, per shoot, per plant, per host. Such a measure is often, from the nature of the sampling, the type first obtained (see also p. 138) and when the level of the insect population is being related to plant or host damage it is more meaningful than an estimate in absolute terms. It is also valuable in comparing the densities of natural enemies and their prey. However, the number of habitat units/area should be assessed, for differences in plant density can easily lead to the most intense population being the least dense in absolute terms (Pimentel, 1961). When dealing with different varieties of plants differences in leaf area may account for apparently denser populations, in absolute terms, on certain varieties (Bradley, 1952), and the actual choice of the leaf or of the plant as the unit for expressing population intensity can affect the relative population levels (Broadbent, 1948) (Fig. 1.1). With litter fauna owing to the effects of seasonal leaf fall the intensity measure (on animals/weight of litter) will give a different seasonal picture from an absolute estimate per square metre (Gabbutt, 1958). These examples also underline the importance of absolute estimates where one's interest lies primarily in the animal population.

Basic population

In some habitats, especially forests and orchards, it is often convenient to have