NUMERICAL CHANGE IN INSECT POPULATION

The body temperature of insects is largely determined by the temperature of their surroundings. Within the range of ambient temperatures to which insects are naturally exposed, the rates of their physiological processes vary directly with temperature. Thus, in many places, the seasonal, cyclical, and other variations of weather exert a profound influence on the *rates* of change of insect numbers. all biotic components of the life system react to variations of temperature in essentially the same way. the size of an insect population in an area is estimated at frequent intervals) e.g. by sampling, a graph can be drawn showing the variation of numbers with time. Such graphs are usually called population curves.

The annual cycle of an insect species may consist of a single generation. Since numerical increase for an insect species can result only from egg laying (or larviposition), the pattern of numerical increase depends upon the duration of the oviposition period relative to the time taken by the rest of the life cycle (figure 2). If the oviposition period is relatively short, an early asymmetrical peak of numbers is usually observed. If the oviposition period is longer in comparison, the peak of numbers is less pronounced and more symmetrical. When the oviposition period is very long, no marked peak of numbers occurs and a smooth population curve is obtained.

When the season is favourable for development is long, two or more generations of a species may occur each year. Successive generations often show different patterns of numerical change. A well-defined break of diapauses at the end of winter, or after a period of summer drought, is often followed by a short period of concentrated oviposition, and numbers in the first generation may rise rapidly to an early.

Due to normal variation in the time taken to complete development during the first generation, the oviposition period of the second generation tends to be longer than that of the first, showing a mare symmetrical peak of numbers. The mode of decline from the peak of insect numbers after oviposition

can be expected to vary with the mortality to which a population is subjected. If the mortality affects only one developmental stage of the insect, i.e. is markedly 'age-specific', this will be indicated clearly by the population curve of species which have a relatively short oviposition period. When the oviposition period is long relative to the time taken to complete subsequent development, individuals belonging to different developmental stages arc present at the same time and, consequently, age-specific mortalities are less apparent.

Individuals of two or more generations may be reproducing at the same time and successive generations become indis-tinguishable. The complete overlapping of generations is therefore characterized by the absence of shortterm change in population numbers. Numbers tend to rise and fall over periods longer than the time taken to complete a generation.

Change in the shape of a population curve over any length of time depends only on the changing relation between births and deaths. When the oviposition period is relatively long, more deaths occur during the period of population increase and the resulting curve tends to be flatter and more symmetrical. Finally, in the situation in which successive generations overlap, young continue to be produced as other individuals die, and any excess of births over deaths and *vice versa* results in slow changes in population numbers.

$N_t = N ,e(b.d)t$

where t is a very short interval of time;

Nt the number of insects after time t;

No the number of insects at the beginning of *the* interval;

b the birth rate during time t;

d the death rate during time t; and

e is a constant which, for convenience, is taken as the base of *Napierian logarithms.*

Each segment of the curve can be defined mathematically by the equation:

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In practice, *studies* of *insect numbers* usually have to *be* restricted to 'sub-populations' of a species within limited areas. In such areas, population numbers are affected by the movement of individuals to and from them. For this reason, the general equation for population change has to be modified to incorporate the effects of such movements. The equation now becomes:

Nt = Noe(b-a)t-Et+It (2)

Where *E,* represents the number of individuals that leave an area in time *t,* and *It* the number which enter it.

Weather, with its seasonal and perhaps shorter cycles, is clearly all environmental component whose attributes affect the *rate* of numerical change directly, and numerical change itself, through the interaction of temperature-dependent and temperature independent events. The influences which affect the rates of birth, death, and movement, the significance of the initial number of insects in the equation must be made clear. *No* represents the combined numbers of the different age-groups of individuals present in the population.

The species characteristics and environmental influences which affect population numbers find their expression in the birth rate, the death rate, and the rates of movement into and out of an area. The birth rate of a population is determined primarily by the characteristics of the subject species, and environmental influences playa modifying role. Conversely, the death rate is determined primarily by environmental influences with species characteristics in the modifying role.

Factors That Affect The Population

(i) *The average fecundity of the females* - i.e. the potential number of **young they could produce in the time.**

(ii) The average fertility of the females - i.e. the realized production of

offspring resulting from the modification of fecundity either by **physiological factors or by fertilization success, where that is necessary.**

(iii) The sex ratio - i.e. the proportion of females in the population. The sex ratio, and therefore the birth rate, varies with the conditions that affect mating or fertilization, e.g. population density and the prevailing weather.

Other influences. The birth rate of a population is affected by the presence of non-reproducing females.

INFLUENCE.S AFFECTING THE Death RATE

The amount by which *initial* numbers would be reduced during a short interval of time in the absence of births and death of movements to and from the area. Since death can occur at any stage in the life cycle of an insect, the species characteristics and environmental influences which affect the relative numbers in each age-group are often of primary importance in determining the effect of a particular mortality on the death rate of a population. The causes of mortality may be outlined as follows:

(i) Ageing. The percentage of individuals in a natural population which **die from 'old age' is usually small, but varies from one species to another. In populations where the reproductive rate is low (for any reason) the** numbers in older age groups will be relatively high, and seniliry may become an important component of total mortality.

(ii) Low vitality. Many environmental agencies which cause mortality, **first weaken an insect and later kill it. Some may weaken an insect andthereby render it more liable to destruction by other agencies.**

(iii) Accidents. Accidental death is quite common among insects - especially death caused by malfunctions of the moulting process.

(iv) Physico-chemical conditions. **Extremes of temperature are usually fatal to insects.**

(v) Natural enemies. The species that either prey upon insects or parasitizethem are usually classified as predators, parasites and pathogens.

Predators. Insects form part or all of the diet of a vast number of animal species including vertebrates. Fishes, amphibia, and reptiles all utilizeinsects as a major source of food.

Parasites. The parasites of insects include those insect species (frequently regarded as a special kind of predator) whose larvae feed internallyor externally upon single host individuals and eventually kill them. Certain nematode worms are also classified as parasites of insects. Three orders of insects contain many species adapted to the parasitic mode of life, namely Hymenoptera, Diptera, and Strepsiptera, Parasitic insects cause age-specific mortalities.

Pathogens. Mortality resulting from disease has been traced to viruses, **bacteria, protozoa, and fungi. Perhaps the chief distinguishing feature of** pathogens is the shortness of the time taken by them to develop and killtheir hosts relative to the length of the host life cycle.

(vi) Shortage of food. Starvation is frequently the direct cause of death to **individual insects after accidental loss of their food supply or separation from it.** *

(vii) Shelter. Many insect species utilize kinds of protective shelter to **avoid exposure either to unfavourable weather conditions or to natural enemies.**

MOVEMENT AS A Cause OF NUMERICAL CHANGE

This is particularly important if different developmental stages of a species**live in different places even though movemen'into and out of an area may cause a high rate of population 'turnover', the numbers of individuals present may not change greatly.** Movement into and out of areas selected for the study of particular **populations, i.e. 'immigration' and 'emigration', can be classified** broadly into three types: *'spread'*, *'dispersal'*, and *'migration'*. Spread occurs in all insect species. It is due simply to the movement of individuals in the course of searching for food and other requisites Dispersal may be defined as a form of movement which leads to theremoval of a variable percentage of individuals from an area to other places, irrespective of the favourableness of the latter. In the course of such movement, it is usual for some individuals to find new sites favourable for survival and reproduction *(effective dispersal)*, and for other individuals to be unsuccessful and perish. Migration is the term used here to describe the movement of individualsfrom one breeding area to another, or from a breeding area to an areafavourable for some other phase of existence (aestivation or hibernation) and back again. The term is also used to describe mass movements which lead to the removal and premature mortality of individuals which constitute a population surplus. **influences which affect numerical change in populations. These influences, namely species characteristics** and environmental agencies, bring about the ecological events which are all that we can actually observe of the functioning of life systems.