Phase Variation in Grasshoppers

THE family Acridiidæ includes the so-called 'short-horned' grasshoppers and locusts. Locusts are, in fact, grasshoppers showing special behaviour: they differ from other members of their family on account of their habit, under suitable ecological conditions, of becoming predominantly gregarious, and migrating considerable distances in large swarms.

In 1921, B. P. Uvarov formulated the theory that locusts occur in two forms or phases, hitherto regarded as separate species. In one phase, namely, solitaria, these insects do not differ in behaviour from other short-horned grasshoppers. In the other phase—gregaria—they become gregarious and swarm. In this phase their nymphal coloration is very different from that of the solitary phase and when they become adult, difference in form and the proportional growth of parts reveal themselves. Uvarov's theory was confirmed experimentally by Faure in 1932 and later by others. It has been generally believed that the existence of such phases is a peculiarity of locusts alone. Quite recently, however, I. A. Rubtzov* has shown that an essentially similar phenomenon also occurs in non-swarming short-horned grasshoppers, but that the amplitude of such phase differences is less pronounced than in locusts. Rubtzov's observations were carried out in Siberia and embodied in a paper written in the Russian language. Biologists are indebted to Uvarov for translating this paper and assisting in its publication.

Rubtzov was impressed by the colour variations found in a number of species of grasshoppers. They were found to differ in coloration more or less in accordance with the population density per unit area of territory. Individuals collected from relatively dense associations, with up to 300 grasshoppers per square metre, were notably dark-coloured, larger and had longer wings than those distributed in the proportion of one, or fewer, over the same unit area. These differences are especially marked in *Aeropus sibiricus* and *Chorthippus albomarginatus*, while a number of other species can be arranged in descending order of their tendency to show marked colour differences. The most pronounced differences are found in *A. sibiricus*, which is an active species tending to form dense aggregations of individuals. These differences are almost equally well shown in *C. albomarginatus*. In all cases, the dark-coloured forms occurring collectively are interpreted as representing the phase gregaria, while the pale examples found singly and sparsely are regarded as representing the solitaria phase. This conclusion is supported by such experimental evidence as is available.

Thus, individuals of *C. albomarginatus*, reared in isolation, showed a tendency to develop into the pale-coloured solitaria form, while those reared gregariously, in crowded conditions, produced a very definite gregaria type. Apart from the colour differences alluded to, the supposed phase differences are also betrayed in: (1) solitaria individuals being smaller, with femur and tegmen shorter; (2) shortening of the tegmen in solitaria being more pronounced than that of the femora, the ratio being greater in solitaria than gregaria; and (3) variability in solitaria being always greater than in gregaria—as can be seen by comparing the maximum and minimum figures. Rubtzov's data are accompanied by coloured figures portraying supposed phase differences and they unmistakably suggest that we have, among non-swarming grasshoppers, clear evidence of the existence of those same phases that feature so markedly in the economy of locusts.

A further phenomenon, discussed by Rubtzov, can only be very briefly alluded to here. He shows that a homologous series of colour variations reveal themselves through many species of Acridiidæ. These are inheritable variations and, according to him, each such race possesses the potentiality, to a greater or lesser degree, to exhibit phase characteristics. The latter, as it were, are super-added to the former in response to the extreme conditions of individual life. In practice, it resolves into the necessity, fully recognised by this author, of clearly determining which race of a given species is being utilised in all studies designed to explore the phase idea.

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* Rubtzov, "Phase Variation in Non-Swarming Grasshoppers", *Bull. Entomol. Res.*, **26**, Pt. 4, 499–520 (Dec. 1935).

Underground Water Supplies

THE Cantor Lectures of the Royal Society of Arts, delivered last winter by Dr. Bernard Smith, director of the Geological Survey of Great Britain, dealt with the "Geological Aspects of Underground Water Supplies". The lectures, which give a comprehensive review of the geological conditions affecting water supplies from underground sources, are now available. In his first lecture, Dr. Smith alluded to the universality of underground water, though, in some cases, it might lie at depths too great to be of practical value, and stated that most of it, in Great Britain, is rain water, which has made its way down from the surface, though a residual quantity of 'fossil' or 'connate' water may have been held in the rocks for great periods of time. Rainfall disappears from the surface of the ground chiefly by run-off, and secondarily by percolation, evaporation and absorption by vegetation, the relative proportions at any given locality depending upon the topography, the degree of rainfall, the porosity of the soil or rock, the amount of water in the soil at the time, the amount of vegetation and the humidity of the atmosphere.

While run-off constitutes surface waters (rivers, lakes, etc.), it should be recognised that much of what is measured as run-off is actually a steady