Publication

A behavioural analysis of phase change in the desert locust

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 43169
Author(s) Simpson, S. J.; McCaffery, A. R.; Hägele, B. F.
Author(s) at UniBasel Hägele, Bernd ;
Year 1999
Title A behavioural analysis of phase change in the desert locust
Journal Biological reviews of the Cambridge Philosophical Society
Volume 74
Pages / **Article-Number** 461-480
Keywords Schistocerca gregaria; locusts; swarming; phase change; phenotypic; plasticity; polymorphism; gregarization; maternal effect; paternal; effect; egg pod foam; epigenetic; behaviour; individual-based; modelling; cellular automata; population dynamics; SCHISTOCERCA-GREGARIA FORSKAL; AGGREGATION PHEROMONE SYSTEM; ORTHOPTERA; ACRIDIDAE; NYMPHS; RESPONSES; POLYMORPHISM; TRANSITION; SOLITARY; STATE
A programme of research into phase change in the desert locust, Schistocerca gregaria, is described. The ability to change phase between solitarious and gregarious forms in response to population density is a key feature of locusts and is central to their occasional yet catastrophic impact on humans. Phase polymorphism is an extreme form of phenotypic plasticity. The most labile phase characteristic is behaviour. It is argued that a fully integrated study of behavioural phase change provides a powerful tool for understanding both the mechanisms of phase change and locust population dynamics, both of which offer possibilities for improved management and control. of desert locust plagues. An assay for measuring behavioural phase-state in individual locusts was derived, based on logistic regression analysis. Experiments are described that used the assay to quantify the time-course of behavioural change, both within the life of individual locusts and across generations. The locust-related stimuli that provoke behavioural gregarization were investigated. Complex interactions were found between tactile, visual and olfactory stimuli, with the former exerting the strongest effect. Behavioural analysis also directed a study of the mechanisms whereby adult females exert an epigenetic influence over the phase-state of their developing offspring. Female locusts use their experience of the extent and recency of being crowded to predict the probability that their offspring will emerge into a high-density population, and alter the development of their embryos accordingly through a gregarizing agent added to the foam that surrounds the eggs at laying. There is also a less pronounced paternal influence on hatchling phase-state. An understanding of the time-course of behavioural phase change led to a study of the effect of the fine-scale distribution of resources in the environment on interactions between individual locusts, and hence on phase change. This, in turn, stimulated an exploration of the implications of individual behavioural phase change for population dynamics. Cellular automata models were derived that explore the relationships between population density, density of food resources and the distribution of resources in the environment. The results of the simulation showed how the extent of gregarization within a population increases with rising population size relative to food abundance and increasing concentration of food resources. Of particular interest was the emergence of critical zones across particular combinations of resource abundance, resource distribution and population size, where a solitarious population would rapidly gregarize. The model provided the basis for further laboratory and field experiments, which are described.

ISSN/ISBN 0006-3231
Full Text on edoc ;