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Clines and Ecotypes

Clines and ecotypes are variants of a particular species adapted to a specific locale or set of environmental conditions. Charles Darwin (1809-1882) put forth his concept of evolution by natural selection to explain patterns of within species variation in 1859. Early-twentieth-century plant ecologists and **systematists** such as Frederic Clements (1874-1945) and Gote Turesson (1892-1970) recognized the usefulness of Darwin's theory and built on it. These plant biologists reasoned that variation within species reflects adaptations to specific environmental conditions.

Different **populations** of the same species often grow across a range of environmental conditions, encompassing variation in moisture levels, soil composition, length of growing season, types and amounts of **herbivores**, and, for animal-pollinated species, even variation in the composition of the pollinators. These differences in environmental conditions may generate different selection pressures across the species range, resulting in genetic divergence among populations. For example, studies of Northern Hemisphere native plants often reveal that populations from more southern latitudes require shorter day length to flower than higher latitude populations of the same species. Natural selection has favored individuals found at higher latitudes to flower later, when conditions are more favorable for growth and when pollinators are abundant. In many examples researchers have conducted transplant experiments, taking plants from one locale and growing them in the site of another population of the same species. Often the transplants perform less successfully than plants from the home locale, demonstrating that the two populations are genetically diverged in terms of their adaptation to local environmental conditions (see Briggs and Walters, 1984, for examples).

These genetically based adaptations to the environment were first termed "ecotypes" by Turesson. The ecotype concept integrates the type concept of systematists, who group organisms that are most similar to the type specimen (the "ideal" representative of the species) with the realization that within-species variation has important ecological significance. The eco-type concept suggests that variation is discrete or discontinuous and early critics noted that important environmental variation, such as the day length example, is continuous and graded. Thus to the ecotype concept was added the notion of clinal variation, such that continuous variation of traits would reflect responses by populations to environmental selective agents. The demonstration of ecotypes and clines was very important to the confirmation of Darwin's theory of evolution by natural selection and continues to provide insight into the mechanisms of evolution of biological variation.

The recognition of ecotypic and clinal variation has also figured prominently in the development of conservation and restoration policy of biodiversity. The primary concerns are the permanent loss of adaptive genetic variation as rare plants become reduced to few populations, deciding which populations to save based on strategies to maximize the

species range, and the adaptation of captive populations (in zoos or botanical gardens) to their captive environment at the cost of their ability to survive in their native wild environment. Most of the current questions in the study of biodiversity revolve around our limited understanding of the genetics of adaptations, in particular how rapidly populations can evolve ecotypes. This, in turn, depends on the amount of genetic variation maintained within populations and the ability of new mutations to contribute to adaptive change.

SEE ALSO BIOGEOGRAPHY; BIOME; CLEMENTS, FREDERIC; DARWIN, CHARLES.

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