ISRAEL JOURNAL OF PLANT SCIENCES, Vol. 42, 1994, pp. 331–345

CORE AND PERIPHERAL POPULATIONS AND GLOBAL CLIMATE CHANGE

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ABSTRACT

Environmental conditions outside the periphery of a species' distribution prevent population persistence, hence peripheral populations live under conditions different from those of core populations. Peripheral areas are characterized by variable and unstable conditions, relative to core areas. Peripheral populations are expected to be genetically more variable, since the variable conditions induce fluctuating selection, which maintains high genetic diversity. Alternatively, due to marginal ecological conditions at the periphery, populations there are small and isolated; the within-population diversity is low, but the between-population genetic diversity is high due to genetic drift. It is also likely that peripheral populations evolve resistance to extreme conditions. Thus, peripheral populations rather than core ones may be resistant to environmental extremes and changes, such as global climate change induced by the anthropogenically emitted "greenhouse gases". They should be treated as a biogenetic resource used for rehabilitation and restoration of damaged ecosystems. Climatic transition zones are characterized by a high incidence of species represented by peripheral populations, and therefore should be conserved now as repositories of these resources, to be used in the future for mitigating undesirable effects of global climate change. Preliminary research revealed high phenotypic variability and high genetic diversity in peripheral populations relative to core populations of wild barley and the chukar partridge, respectively.

INTRODUCTION

GLOBAL CLIMATE CHANGE AND ECOLOGY

An Intergovernmental Panel on Climate Change (IPCC) scientific assessment states that emissions resulting from human activities are substantially increasing the atmospheric concentration of "greenhouse gases", which will cause an increase of global mean

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Received 8 December 1994.

temperature of 0.3 °C per decade during the next century, a rate faster than that seen over the past 10,000 years (Houghton et al., 1990). The IPCC predicts that these "rapid changes in climate will change the composition of ecosystems; some species will benefit while others will be unable to migrate or adapt fast enough and may become extinct" (Houghton et al., 1990). Environmental and ecological management problems are likely to emerge due to global warming (Overpeck et al., 1990; Poiani and Johnson, 1991; Mintzer, 1993). Though much uncertainty exists, and more research is required, attempts to predict the ecological effects of possible scenarios of global climate change (GCC), with a focus on ecosystem preservation (Ausubel, 1991), should not wait for unequivocal climatic predictions (Ojima et al., 1991). This is because "The costs of rejecting the greenhouse hypothesis, if true, are vastly greater than the costs of accepting the hypothesis if it proves to be false", and "The greenhouse threat is more than sufficient to justify action now, even if only as an insurance" (Goodland, 1991).

LOCAL EFFECTS OF GLOBAL CLIMATE CHANGE

For the eastern Mediterranean basin, global circulation models suggest a rise of 2–4 °C, similar to the global trend, by the middle of next century, provided that the concentration of greenhouse gases will be equivalent to doubling the current CO_2 concentrations (Cohen et al., 1993). Using paleoclimatic analogues, composite difference or superposed epochs analyses of modern records, and global circulation models, it is predicted that precipitation will exhibit greater spatial variability than temperature. Therefore, reliable regional scenarios are hard to obtain, and result in conflicting projections of precipitation for Israel (Kay, 1993). For example, warmer sea surface temperatures will increase the rainfall over Israel, but possible thermal stabilization will reduce precipitation (Alpert et al., 1993). Potential evaporation due to increased temperatures can compensate substantially for the possible increase in precipitation. Thus, general aridification is expected in spite of a possible increase in precipitation (Cohen et al., 1993).

ECOLOGICAL RISKS

What should ecologists do about global climate change? Besides monitoring ecological responses, they should (a) strive to predict the ecological effects of climate change, (b) identify the risks, and (c) propose risk-aversion strategies and tactics. Though "there is almost no species for which we know enough relevant ecology, physiology and genetics to predict its evolutionary response to climate change" (Holt, 1990), a paramount risk is that of species extinctions. Throughout the past slow changes in climate, spontaneous mutations have occurred and have been selected, and species have evolved and have adapted. In addition, species have dispersed and migrated to regions of favorable climate. Under the predicted fast change (predicted rate of warming of 2.5–5 °C for the next 100 years, compared with 0.05 °C per century during the last 10,000 years; Hinckley and Tierney, 1992), selection will operate on the current genetic structure. Populations with no pre-adaptations, or those unable to migrate through the extensive man-made barriers, may perish (Hinckley and Tierney, 1992). Species extinctions will alter community structure and ecosystem functions, and cascading effects may lead to additional, indirect extinctions.