Insect overwintering in a changing climate.

Author: J S Bale
S A L Hayward
Author Affiliation: School of Biosciences, University of Birmingham, Birmingham, B15 2TT, UK. j.s.bale@bham.ac.uk

Source: J Exp Biol. 2010 Mar 15;213(6):980-94
Date: Mar-15-2010
Language: English
Publication Type: Article
Keywords: Acclimatization - physiology
Animals
Climate change
Cold Climate
Environment
Insects - physiology
Photoperiod
Seasons
Temperature
Trees
Tropical Climate

Abstract: Insects are highly successful animals inhabiting marine, freshwater and terrestrial habitats from the equator to the poles. As a group, insects have limited ability to regulate their body temperature and have thus required a range of strategies to support life in thermally stressful environments, including behavioural avoidance through migration and seasonal changes in cold tolerance. With respect to overwintering strategies, insects have traditionally been divided into two main groups: freeze tolerant and freeze avoiding, although this simple classification is underpinned by a complex of interacting processes, i.e. synthesis of ice nucleating agents, cryoprotectants, antifreeze proteins and changes in membrane lipid composition. Also, in temperate and colder climates, the overwintering ability of many species is closely linked to the diapause state, which often increases cold tolerance ahead of temperature-induced seasonal acclimatisation. Importantly, even though most species can invoke one or both of these responses, the majority of insects die from the effects of cold rather than freezing. Most studies on the effects of a changing climate on insects have focused on processes that occur predominantly in summer (development, reproduction) and on changes in distributions rather than winter survival per se. For species that routinely experience cold stress, a general hypothesis would be that predicted temperature increases of 1 degree C to 5 degrees C over the next 50-100 years would increase winter survival in some climatic zones. However, this is unlikely to be a universal effect. Negative impacts may occur if climate warming leads to a reduction or loss of winter snow cover in polar and sub-polar areas, resulting in exposure to more severe air temperatures, increasing frequency of freeze-thaw cycles and risks of ice encasement. Likewise, whilst the dominant diapause-inducing cue (photoperiod) will be unaffected by global climate change, higher temperatures may modify normal rates of development, leading to a decoupling of synchrony between diapause-sensitive life-cycle stages and critical photoperiods for diapause induction. In terms of climate warming and potential heat stress, the most recent predictions of summer temperatures in Europe of 40 degrees C or higher in 50-75 years, are close to the current upper lethal limit of some insects. Long-term data sets on insect distributions and the timing of annual migrations provide strong evidence for 'positive' responses to higher winter temperatures over timescales of the past 20-50 years in North America, Europe and Asia.

PubMed ID: 20190123 View in PubMed