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Large-Scale DNA Analysis of Bumble Bees: Worldwide Phylogeny Points to Commonality in the Decline of North American Species



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A new phylogeny study sheds light on the relationship between different species of bumble bees throughout the world. This information helps narrow the search for which bumble bee species, important to agricultural crop pollination, are on the decline in the United States.

a)



b)



c)



Bumble bees are among the most important wild bees in the United States. These insects are increasingly used in the managed pollination of greenhouse crops, such as tomatoes and peppers. Despite their elevated importance to agriculture, bumble bee populations are on the decline in Western Europe and North America. Five bumble bee species in the United States are currently on the Xerces Society Red List of threatened insects. The timely work of entomology professor Sydney Cameron and her colleagues at the University of Illinois and the Natural History Museum in London contributes important insight into this critical agricultural problem.

BUMBLE BEE PHYLOGENY

Until recently, the relationship between bumble bee species remained unclear. Most prior bumble bee studies focused on morphological traits, which provided too few characters to resolve species relationships. In this study, the researchers conducted a phylogenetic analysis of nearly 90 percent of the world's 250 described bumble bee species based on DNA sequences from five genes, comprising approximately 4,000 base pairs. Independent Bayesian and parsimony analyses of each gene across 220 bumble bee species tested the reliability of the relationships estimated from the data. The researchers found strong evidence that the majority

Figure. 1. Images of bumble bees from the long-tongued species a) *B. (Megabombus) supremus*; b) *B. (Diversobombus) trifasciatus*, and the short-tongued species c) *B. (Melanobombus) keriensis*.

Photograph Credit - Paul Williams, Natural History Museum, London.



Figure 2. Bumble bee field work on the Tibetan Plateau in the Sichuan basin of southwestern China.

Photograph Credit - James Whitfield, University of Illinois, Urbana-Champaign.

of bumble bee species fall into two distinct groups, the longer-tongued species in one group and their shorter-tongued sisters in the other. The complete bumble bee phylogeny is available as a PDF*. Using the robust bumble bee phylogeny, Cameron's team inferred that bumble bees originated approximately 35 million years ago in central Asia and dispersed into the New World primarily between 15 and 10 million years ago.

Most bumble bees in the United States belong to the shorter-tongued group. From the phylogeny study, the researchers determined that out of the 47 bumble bee species in the United States, five of the declining species belong to the subgenus *Bombus sensu stricto*.

The reasons for the decline remain unclear and may vary regionally. Species in this subgenus include the most important pollinators for managed agriculture, specifically *B. occidentalis* in the United States and *B. terrestris* in Europe. *Bombus occidentalis* and another species *B. franklini* have all but disappeared in the United States. In addition, the range of their close relatives has been radically reduced compared to a decade ago. The bumble bee phylogenetic tree also reveals that two species, *B. impatiens* and *B. vosnesenskii*, within another subgenus, *Pyrobombus*, are undergoing range expansion in the United States. These species are distantly related to the species from the subgenus *Bombus s.s.*, currently in decline.

IMPACT

The information gained from this novel and comprehensive phylogenetic tree may allow scientists to resolve the causes leading to the decline of subgenus *Bombus s.s.*, and the increased range expansion in different bumble bees groups. Ultimately, the knowledge gained from understanding bumble bee relationships may assist scientists in working with other bumble bee groups to aid future agricultural applications.

*Bumble bee phylogeny available at http://www.life.uiuc.edu/scameron/news/USDAchronogram_maptree.pdf



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