LETTERS

Edited by **Jennifer Sills**

Many paths to parity for women in science

IN HER LETTER "Sexism discussion misses the point" (24 July, p. 390), H. S. Young advocates for improved infrastructure to assist women in the child-bearing years, when "research productivity needs to be the highest." She contends that the lack of support mechanisms that enable women to work at this level is the substantial barrier that impedes women from reaching full equality in science. We also advocate for improved infrastructure for women who desire to work within the framework of a standard career trajectory, but we are concerned by the underlying assumption that this is the only path to parity.

The prevailing notion that research productivity needs to be the highest during typical child-bearing years has the underlying message that women need to be working fully and aggressively during that period in order to be successful. Many women are not willing, or able, to take on that lifestyle. Faced with this choice, even if in the presence of strong departmental support and outstanding childcare facilities, many opt out completely.

Alternative frameworks are needed to keep talented women (and increasingly men who share child-rearing) in science. Working at a limited scope full-time, or working part-time, can and does yield important work, and this must be respected and recognized by the community and by institutions. Additional mechanisms and practices need to be developed to engage women without the current level of time and travel commitment, and the standard criteria for institutional promotion need to be reexamined to reward a broader range of substantial contributions.

As senior women members of the International Society of Magnetic Resonance in Medicine (ISMRM), we are working with other members in the society and with ISMRM leadership and staff to develop such mechanisms in our organization, and we encourage other organizations and institutions to do the same.

Deborah Burstein,[1]* Margaret Hall-Craggs,[2] Clare Tempany[3]

[1]Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, MA 02115, USA. [2]University College Hospital London, London, NW1 BU, UK. [3]Brigham and Women's Hospital, Boston, MA 02115, USA.

*Corresponding author. E-mail: dburstei@bidmc.harvard.edu

REFERENCE NOTE

1. The authors endorse this letter along with 37 additional senior international signatories, available online as supplementary material.

SUPPLEMENTARY MATERIAL

www.sciencemag.org/content/350/6258/286.1/suppl/DC1
Full author list

Relocation risky for bumblebee colonies

WE DO NOT dispute the results of the Report "Climate change impacts on bumblebees converge across continents" (10 July, p. 177), in which J. T. Kerr *et al.* show that shrinking bumblebee ranges track temperature changes in unexpected and alarming ways at a continental scale, supporting previous suggestions (*1*) that climate change will affect *Bombus* distributions. We are concerned, however, by Kerr *et al.*'s suggestion that "[e]xperimental relocation of bumblebee colonies into new areas could mitigate these range losses."

Such a simple solution may have great appeal to the public and policy-makers, but complex and unpredictable repercussions if put into practice. Movement of bumblebee species for pollination services has been implicated in threats to native bumblebee fauna worldwide (*2*). For example, the introduction of European species into South America has contributed to the catastrophic collapse of native bumblebees (*3*). At a time when researchers are arguing for greater regulation of bumblebee movement [e.g., (*4*, *5*)], Kerr *et al.*'s suggestion of colony relocation as a conservation strategy should be approached with caution.

Perhaps the greatest risk of interregional transportation lies with the spread of disease, a factor not considered by Kerr *et al.*, but suspected to be behind the decline of some species (*6*). Bumblebees may host a diversity of parasites and pathogens, and relocated colonies reared in captivity may negatively affect native pollinator communities through co-introduction and spread of disease (*5*). Competition with native fauna is also a concern (*2*), as are population genetic factors (e.g., incomplete knowledge of taxonomy and population structure resulting in unfavorable outbreeding) (*7*). Concerns are not limited to intercontinental transportation, but also apply to movement of native species within and between regions (*5*, *7*).

In the absence of comprehensive mechanistic knowledge, it may be preferable to facilitate natural range changes through habitat management, rather than conducting interventions that may have short-term benefits to ecosystem services but long-term consequences for global pollinator communities. Ultimately, efforts to overcome perceived challenges to a species' natural ability to match climatic shifts should be preceded by detailed ecological and evolutionary studies in both source and destination regions.

Jeffrey D. Lozier,[1]* Sydney A. Cameron,[2] Michelle A. Duennes,[2] James P. Strange,[3] Paul H. Williams,[4] David Goulson,[5] Mark J. F. Brown,[6] Carolina Morales,[7] Sarina Jepsen[8]

[1]Department of Biological Sciences, University of Alabama, Tuscaloosa, AL 35487, USA. [2]Department of Entomology, University of Illinois, Urbana, IL 61801, USA. [3]USDA-ARS, Pollinating Insect Research Unit, Utah State University, Logan, UT 84322, USA. [4]Department of Life Sciences, Natural History Museum, London, SW7 5BD, UK. [5]Evolution, Behaviour, and Environment, School of Life Sciences, University of Sussex, Falmer, East Sussex, BN1 9QG, UK. [6]School of Biological Sciences, Royal Holloway University of London, Egham, TW20 0EX, UK. [7]Laboratorio Ecotono, INIBIOMA (Universidad Nacional del Comahue-CONICET), Bariloche, Rio Negro, Argentina. [8]The Xerces Society for Invertebrate Conservation, Portland, OR 97232, USA.

*Corresponding author. E-mail: jlozier@ua.edu

REFERENCES

1. P. H. Williams, M. Araujo, P. Rasmont, *Biol. Conserv.* **138**, 493 (2007).
2. D. Goulson, *Appl. Entomol. Zool.* **45**, 7 (2010).
3. C. L. Morales, M. P. Arbetman, S. A. Cameron, M. A. Aizen, *Front. Ecol. Environ.* **11**, 529 (2013).
4. International Union for Conservation of Nature

Bumblebee Specialist Group, Commercial Bumblebee Policy Statement (www.iucn.org/about/work/programmes/species/who_we_are/ssc_specialist_groups_and_red_list_authorities_directory/invertebrates/bumblebee_specialist_group/commercial_bumblebee_policy_statement/).
5. D. Goulson, W. O. H. Hughes, *Biol. Conserv.* **191**, 10 (2015).
6. S. A. Cameron *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **108**, 662 (2011).
7. S. H. Woodard *et al.*, *Mol. Ecol.* **24**, 2916 (2015).

Response

LOZIER *ET AL.* accept our findings but take issue with a concluding sentence alluding to relocation to mitigate potential climate change impacts on bumblebee species. We welcome thoughtful discussion of this admittedly difficult area (*1*). However, Lozier *et al.* present an idiosyncratic view of managed relocation involving indiscriminate movement of colonies into new continents or islands. Such "maverick" (*2*) relocation approaches do not represent best practices to mitigate climate change impacts (*3*). Instead, we recommend well-known criteria for evaluating the appropriateness and safety of relocation (*4*–*6*). If implemented, managed relocation would experimentally nudge colonies beyond historical boundaries into areas made newly available by changing climatic conditions. Species relocated to adjacent areas would encounter other bumblebee species with which they are already sympatric. Managed relocation frameworks require understanding of pathogen risks (*4*).

Lozier *et al.* propose managing habitats in areas near species' range limits and hoping that bumblebee species will generally begin to shift north. The desired outcome, scale, and risks for this intervention match relocation. However, managing habitats on two continents for bees to enable range expansion will incur costs that are hard to calculate and could harm nontarget taxa. It may also fail, as range expansion in bumblebees over several decades has not compensated for rapid range losses from the south. Habitat management alone will not conserve even relatively thermophilic organisms if climate changes continue unabated (*7*).

Jeremy T. Kerr,[1]* Alana Pindar,[1] Paul Galpern,[2] Laurence Packer,[3] Simon G. Potts,[4] Stuart M. Roberts,[4] Pierre Rasmont,[5] Oliver Schweiger,[6] Sheila R. Colla,[7] Leif L. Richardson,[8] David L. Wagner,[9] Lawrence F. Gall,[10] Derek S. Sikes,[11] Alberto Pantoja[12]†

[1]Department of Biology, University of Ottawa, Ottawa, ON, K1N6N5, Canada. [2]Faculty of Environmental Design, University of Calgary, Calgary, AB, T2N 1N, Canada. [3]Department of Biology, York University, Toronto, ON, M3J 1P3, Canada. [4]School of Agriculture, Policy and Development, The University of Reading, Reading, RG6 6AR, UK. [5]Department of Zoology, Université de Mons, Mons, 7000, Belgium. [6]Department of Community Ecology, Helmholtz Centre for Environmental Research, Halle, 06120, Germany. [7]Wildlife Preservation Canada, Guelph, ON, N1H 6J2, Canada. [8]Gund Institute, University of Vermont, Burlington, VT 05405, USA. [9]Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269, USA. [10]Peabody Museum of Natural History, Entomology Division, Yale University, New Haven, CT 06511, USA. [11]University of Alaska Museum, University of Alaska Fairbanks, Fairbanks, AK 99775, USA. [12]U.S. Department of Agriculture, Agricultural Research Service, Subarctic Agricultural Research Unit, Fairbanks, AK 99775, USA.

*Corresponding author. E-mail: jkerr@uottawa.ca

†Present address: United Nations Food and Agriculture Organization, Santiago, 7630412, Chile.

REFERENCES

1. N. Hewitt *et al.*, *Biol. Conserv.* **144**, 2560 (2011).
2. J. S. McLachlan, J. J. Hellmann, M. W. Schwartz, *Conserv. Biol.* **21**, 297 (2007).
3. M. W. Schwartz *et al.*, *BioScience* **62**, 732 (2012).
4. O. Hoegh-Guldberg *et al.*, *Science* **321**, 345 (2008).
5. D. M. Richardson *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **106**, 9721 (2009).
6. P. Rasmont *et al.*, *BioRisk* **10**, 1 (2015).
7. T. H. Oliver *et al.*, *Nat. Clim. Change* **5**, 941 (2015).