

of the female preferences that allows the population bifurcation, leading to sympatric speciation. But, whereas Higashi *et al.* envisage preferences localized in trait space, we describe a mechanism that localizes the preferences in real space. It is interesting to note the equivalence of the two mechanisms, which suggests a minimal condition for true sympatric divergence. In addition, disruptive sexual selection based on emergent spatial variation in mating preferences might provide the most appropriate solution to recent ideas concerning sympatric speciation in migratory species<sup>5</sup>, because it directly embraces the role of spatial movement.

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#### References

- 1 Bridle, J.R. and Jiggins, C.D. (2000) Adaptive dynamics: is speciation too easy? *Trends Ecol. Evol.* 15, 225–226
- 2 Fisher, R.A. (1930) *The Genetical Theory of Natural Selection*. Clarendon Press
- 3 Payne, R.J.H. and Krakauer, D.C. (1997) Sexual selection, space and speciation. *Evolution* 51, 1–9
- 4 Higashi, M. *et al.* (1999) Sympatric speciation by sexual selection. *Nature* 402, 523–526
- 5 Winker, K. (2000) Migration and speciation. *Nature* 404, 36

### Reply from J.R. Bridle, C.D. Jiggins and T. Tregenza

We agree with Payne and Krakauer<sup>1</sup> that sexual selection might play an important role in speciation – the emphasis of our article was more a reflection of the meeting on which we reported<sup>2</sup>. Fisherian runaway sexual selection is a potential cause of rapid changes in female preferences and male traits (but see Ref. 3). In addition, the observation that many recent radiations have occurred in groups with conspicuous coloration, such as birds of paradise and African lake cichlids, intuitively implies a role for sexual selection in the generation of biodiversity.

Payne and Krakauer highlight two recent models that provide a theoretical basis for sympatric speciation by sexual selection<sup>4,5</sup> (see also Refs 6 and 7). However, despite their undoubted interest, questions remain as to how closely these models resemble the reality of male traits and female preferences. For example, in the Higashi *et al.* model, and the Turner and Burrows<sup>6</sup> model, female preferences are constructed so that intermediate male phenotypes will never be the preferred mate of a female. Although not implausible, such models seem inherently weighted in favour of generating population divergence.

By contrast, Payne and Krakauer<sup>5</sup> model a situation where male dispersal is dependent on mating success; spatial segregation of male trait genotypes and associated female preferences leads to divergence. As they mention in their letter<sup>1</sup>, one novel feature of this approach is that bifurcation is encouraged by the spatial heterogeneity that might limit speciation in the Higashi *et al.*<sup>4</sup> model. However, this model also raises questions of biological realism. For example, how does the tendency for males to move away from areas where they are less successful evolve before the evolution of variation in female preference? In more complicated scenarios, with recombination between more than two loci contributing to variation in male traits or female preferences, does it still pay males to move?

We welcome the continued investigation of sexual selection as a driving force in speciation, and look forward to further theoretical developments, and to empirical tests of the genetic and behavioural assumptions involved. However, we believe disruptive natural selection remains the simplest way to generate new species, because it automatically generates ecologically distinct daughter lineages. By contrast, although sexual selection can precipitate rapid initial divergence, the resulting lineages are presumably transient, unless natural selection also produces the adaptive differentiation that forms the basis of long-term coexistence. For example, although some African cichlids provide probable examples of rapid speciation without ecological divergence (owing to the exploitation of niches in female preference space<sup>9</sup>), most cichlid diversity is characterized by striking adaptive radiation. This suggests that speciation must be either accompanied by, or closely followed by, ecological divergence in order to generate biodiversity<sup>8</sup>.

What struck many at the adaptive dynamics meeting was the mismatch between the rampant sympatric speciation predicted by theoretical models (be it by natural or sexual selection) and the restricted ecological circumstances in which likely examples are found in nature. Is this because sympatric speciation is actually relatively rare?

Alternatively, are empirical examples rare because the genetic, ecological and phylogenetic signal of population bifurcation is rapidly lost after speciation? If this is the case, then only the study of very young or currently speciating lineages will reveal how easy sympatric speciation is in nature, compared with the ease with which it is predicted in theory.

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#### References

- 1 Payne, R. and Krakauer, D.C. (2000) Disruptive sexual selection. *Trends Ecol. Evol.* 15, 419–420
- 2 Bridle, J.R. and Jiggins, C.D. (2000) Adaptive dynamics: is speciation too easy? *Trends Ecol. Evol.* 15, 225–226
- 3 Nichols, R.A. and Butlin, R.K. (1989) Does runaway sexual selection work in finite populations? *J. Evol. Biol.* 2, 299–313
- 4 Higashi, M. *et al.* (1999) Sympatric speciation by sexual selection. *Nature* 402, 523–536
- 5 Payne, R.J.H. and Krakauer, D.C. (1997) Sexual selection, space and speciation. *Evolution* 51, 1–9
- 6 Turner, G.F. and Burrows, M.T. (1995) A model of sympatric speciation by sexual selection. *Proc. R. Soc. London Ser. B* 260, 287–292
- 7 van Doorn, G.S. *et al.* (1998) Sympatric speciation and extinction driven by environment-dependent sexual selection. *Proc. R. Soc. London Ser. B* 265, 1915–1919
- 8 Seehausen, O. *et al.* (1999) Color polymorphism and sex ratio distortion in a cichlid fish as an incipient stage in sympatric speciation by sexual selection. *Ecol. Lett.* 2, 367–378

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