Reply to Lukas and Clutton-Brock: Infanticide still drives primate monogamy

For many years, it has been variously suggested that the evolution of monogamy in primates was due to paternal care, dispersed female ranging, or infanticide. It was therefore of little surprise to us that we should find that these traits are strongly associated with mating systems in primates (1). The crucial question, however, is whether these traits are potential drivers of, or secondary responses to, the appearance of monogamy. We found that it was only infanticide that reliably preceded monogamy and could therefore be implicated in its evolution. In contrast, dispersed female ranges and paternal care followed the adoption of monogamy, suggesting they are consequences and not causes of monogamy.

A recent analysis by Lukas and Clutton-Brock (2) also found a strong association between dispersed female ranges and monogamy across a number of mammal orders, including primates. They argued that dispersion is the cause of monogamy in mammals. However, their analyses did not explicitly evaluate the timing of changes in the two traits. Furthermore, their two main criticisms of our findings are invalid (3). First, they argue that if many species are removed from the analyses because of uncertainty of evidence, there is, not surprisingly, no longer any association between infanticide and mating systems. Van Schaik (4) highlighted the difficulty of documenting infanticide from observational data and developed an independent proxy measure of infanticide risk. We ran a parallel analysis based on this risk index and found the same results as with our data on inferred infanticide rates. Second, Lukas and Clutton-Brock argue that the

relationship is not robust to a covariation model of evolution. However, the value of this model for comparative studies has not been established (5).

Moreover, there are a number of problems with the supporting evidence the authors provide in their supplementary material (6). These include, but are not limited to, the following: (i) a lack of phylogenetic control in contingency tests, (ii) unwarranted removal of calibrated branch lengths from phylogenies, (iii) lack of explicit tests for the timing of changes, and (iv) erroneous inferences about how the data would impact on the results (they suggest, for example, that the inclusion of false negatives would overestimate transitions to noninfanticide in polygynous species; if true, the inclusion of these species should have weakened the relationship between infanticide and monogamy and not strengthened it).

The relative merits of the data and methods aside, we think there is a more obvious reason for the difference in findings. As both papers (1, 2) highlight, rates of monogamy in primates are much higher than in other mammals, which suggests that a different mechanism was at work in the evolution of primate mating systems. This taxonomic difference is expected: infanticide risk in primates is driven by their unusually late weaning (because of unusually large brains), which creates a reproductive strategy problem for males. This issue is unlikely to arise in other mammals with their shorter development periods, making infanticide an unlikely selection factor for monogamy. We do not disagree with Lukas and Clutton-Brock's conclusions with regard to nonprimate mammals.

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2 Lukas D, Clutton-Brock TH (2013) The evolution of social monogamy in mammals. *Science* 341(6145):526–530.

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6 Lukas D, Clutton-Brock T (2014) Data from: Evolution of social monogamy in primates is not consistently associated with male infanticide. Available at <http://doi.org/10.5061/dryad.hc967>.

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