# On the link between endothermy, energy budget, and parental care: a comment on Beekman et al

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Why do some species have parents that provision newborn offspring with food, whereas others have parents that abandon their offspring just after emergence? In their review, Beekman et al. (2019) suggest that an answer to this question could be found in the thermodynamic constraints of these species. The central tenet of their hypothesis conveys that all species range along a supply-demand spectrum of energy budget (associated with their mode of heat gain – see below), and that their position on this spectrum determines the strength of selection for post-natal parental care. On the supply-side of this spectrum, species typically suffer periods of severe imbalance between energy assimilation and maintenance, so that they build large reserves when resources are available in excess, and exhibit sessile lifestyles to survive periods of starvations. Beekman et al. (2019) propose that this need and capability to process additional resources can select for post-natal parental care. Conversely, demand-side species often have an efficient balance between energy assimilation and maintenance, which comes with homeostatic controls to buffer metabolism, greater flexibility in life-history traits and motile lifestyles to pursue the right amount of energetic resources. The authors propose that this absence of need for excessive amount of resources (even if they would provide individuals with significant benefits) relaxes selection for post-natal parental care. Because most ectothermic vertebrates are on the supply-side and most endothermic vertebrates are on the demand-side of the energy budget spectrum (Sousa et al. 2010), Beekman et al. (2019) conclude that the energy budget

of the ectothermy may explain why post-natal parental food provisioning is less frequent in these species compared to endotherms (Balshine 2012).

The strength and weakness of the proposed hypothesis derive from the fact that it relies on the tight association between the type of energy budget (supply- versus demand-side) and the mode of heat gain (endo- versus ectotherms, respectively). The strength is that a robust theoretical framework of dynamic energy budget (DEB) exists and offers a solid ground to discuss the importance of energetic budgets in the evolution of multiple life-history traits including parental care. The weakness, on the other hand, is that the line of arguments directly relies on this energy budget, and only indirectly on the mode of heat gain. A tight association is not the same as a causation, and drawing conclusions on the effects of balanced energy budget cannot be the same as drawing conclusions on the sole effects of ectothermy. Hence, it is difficult to identify the sole importance of endo/ectothermy in the evolution of parental care based on the present arguments, and the conclusion proposed by Beekman et al. (2019) should thus be taken with caution.

Notwithstanding this limit, the review by Beekman et al. (2019) offers a very interesting view on the determinants of family evolution, and generates novel ideas that should be explored in future studies. For instance, the type of energy budget and/or the mode of heat gain could have broader implications in the evolution of post-natal parental care among all living animals, including arthropods. Although arthropods represent the vast majority of all known animals, the number of arthropod species exhibiting post-hatching parental care in the form of offspring food provisioning is indeed marginal (Wong et al. 2013; Yip and Rayor 2013). If the hypothesis proposed by Beekman et al. (2019) holds true, this rarity could be driven by the ubiquitous ectothermy in this phylum. Future studies should thus explore this effect and particularly look at how the few arthropod species exhibiting post-hatching care (e.g. earwigs, burying beetles and bugs) deal with thermal constraints. A second idea generated by this review comes from its demonstration that most ectotherm offspring do not receive parental care whereas it would provide them with significant benefits. This apparent discrepancy emphasizes that the evolution of parental care comes with important costs for parents. It calls for

further exploring the origin of these costs in ectotherms (e.g. lower investment in future reproduction, increased mortality, etc.) and determining their direct link with ectothermy. Last but not least, the review by Beekman et al. (2019) confirms that several factors are still neglected in our current understanding of the evolution of parental care (Kramer and Meunier 2019). This proves that broadening our view on this issue could be essential to get a more comprehensive understanding of all forms of family life across species and taxa.

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