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Subject: external review of thesis submitted by Marta Grosiak

Dear Board of Examiners,

I have reviewed Marta Grosiak's thesis entitled „Can heat dissipation limit (HDL) theory explain reproductive ageing? Insights from experimental evolution in bank voles" in my capacity as Associate (Adjunct) Professor from Zhejiang University and researcher in the field. The dissertation clearly represents an outstanding contribution to an exciting research field that is moving rapidly and that receives broad attention by the scientific community for good reasons. Her main and novel hypothesis under test was to find out about the role of heat dissipation limitation in bank voles in an ageing context. Specifically, ageing may lead to a decrease in heat dissipation and thereby to a drop in reproductive output in particular in animals with high rates of metabolism. As informative model system, *Myodes*

glareolus selected for high swim-induced rate of aerobic metabolism and their controls, were used. Marta therefore addressed the relationships between metabolism, thermoregulation and ageing. In carefully prepared six chapters, her thesis provides an in-depth compilation of background, experimental work and interpretation of the topic.

The PhD thesis presents four main findings and conclusions. Indeed, heat dissipation limitation acts differently on animals at different ages and with a different metabolic rate. Interestingly, litter growth rates were highest in middle-aged mothers but peak-lactation milk energy output did not differ between age classes. Thus, it is possible that milk biochemical composition may be explaining the observed differences in litter mass and growth rate. This particular aspect also warrants future interesting research.

Maternal age did not adversely affect adult offspring quality and Marta Grosiak speculates that age is not the prime determinant of offspring adult locomotory fitness. Clearly, reproductive performance in bank voles decreased with maternal age but the adult offspring performance traits remained unchanged.

From my point of view as external reviewer, the candidate has presented a sound and comprehensive dissertation belonging to the top 15% of theses that I regularly review. I therefore recommend the best grade for Marta Grosiak based on my detailed assessment, and I wish her all the best for her future (hopefully) science career.

My overall impression of the presented material in the thesis (figures, tables, text) is very good, so I don't have any corrections to suggest at this stage. The scientific writing style is better than in other theses, the text is well structured and at the same time very readable. The data are properly presented in the given figures and tables and all the statements in the discussion are backed up by in-text citations, wide reading therefore is obvious. In Chapter 1, the broad context is introduced concisely and comprehensively: the main hypotheses and the specific goals are specified by following a logical structure from a general introduction to specific information and the broad context of aging. The characterisation of the animal model system and the bank vole selection experiment is described in Chapter 2 and makes it possible to follow the logic. The straightforward and clear way in which the chapter 3 is written demonstrates the depth of subject knowledge and state of the art experimental skills that Marta Grosiak acquired, and leaves me convinced that all the presented results were obtained from accurate, sound, and reproducible laboratory work. Not surprisingly therefore, the results of these experiments were already published in "Frontiers in Physiology".

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Chapter 4 describes "The immediate effects of maternal age and heat dissipation burden on reproductive performance" and can be considered another (besides chapter 3) stand-alone original paper in the context as well as chapter 5, dealing with the long-term effects of ageing and heat dissipation limitation on adult offspring quality. The last chapter, the sixth, represents an overall discussion of the experiments performed and results obtained.

Marta Grosiak most successfully discusses the outcome of her work by putting the results into a wider context (chapter 6). Her PhD thesis provides a very successful mix of primary papers, background information and discussing and reviewing parts. Based on all these impressions, after thorough reading of the dissertation and searching the web for original investigations already published by Marta Grosiak, I have no doubt that the presented thesis, and the valuable experimental data generated during the PhD, will receive much attention in the field. Very convincingly, the PhD thesis provides enough detail without being excessive and the quality of the presented material incl. the supplementary tables and figures in the Appendix is very good.

Congratulations to this excellent thesis, with best wishes,

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