Review of Doctoral Thesis of Brandon Meter

Description

The doctoral thesis by Brandon Meter focuses on character of growth and ontogeny of sexual size dimorphism (SSD) in a group of lizards – Madagascan/Malagasy geckos. It is based on two published and one submitted paper where Brandon Meter is the first author. The thesis covers life-history evolution - mainly growth; its regulation and sex differences. The core of the Ph.D. thesis aims at examining and testing proximate causes of sexual size dimorphism in one male-larger and the other female-larger species of *Paroedura* geckos. It is a part of long-term endeavour of his lab to disentangle the causes of sexual dimorphism in lizards.

The thesis itself provides background to regulation of metabolism and growth, especially the role of somatotropic axis and the influence of sex hormones. The genus *Paroedura* is introduced as a valuable model system to study sexual size dimorphism with *Paroedura picta* representing the male-larger species and *P. vazimba* species where females are the larger sex. The Author then presents alternative hypotheses on proximate causes of sex-specific body size, namely "cost of reproduction" (in females in male-larger species), "androgen control" (growth stimulation) and "ovarian control" (growth inhibition). The explicit aim was to "uncover the proximate causes that dictate growth and SSD" (using genus *Paroedura* as a model system). Then, a brief summary of the main results and discussion follow with conclusion and perspectives. The first publication reviews the extensive and complementary experimental work on life history of *P. picta* mainly coming from Author's lab over the past ca. 15 years. It synthesizes the published findings in a comprehensive way and puts together evidence for growth of *P. picta* being largely canalized, hormonally regulated in a sex-specific manner under various interventions. Second article specifically tested the role of growth-regulating hormones in males and females of *P. picta* through gene expression assay. The focus was mainly on insulin-like growth factors, their receptors and two receptors of sex hormones in liver samples from different age-groups of *P. picta*. The results suggest that only IGF-1 expression shows interpretable variation with regard to the sex-specific growth, i.e. the timing of IGF-1 expression peak in males overlaps with their growth separation from females. Third part of the thesis is a manuscript submitted to a journal describing complex analysis of growth regulation in female-larger *Paroedura* species, *P. vazimba.*

Evaluation

Overall, the submitted Ph.D. thesis is an excellent example of a compact project that tries to fill empty spots in a long-term research. The synthetic part brings valuable and thorough summary of the previously atomized work. I think it would be helpful if the Introduction and Paper I contained more general background (for example, I would like to know about regulation of sexual size dimorphism in endotherms or look into other examples of intraspecific size polymorphism in vertebrates - species with alternative reproductive tactics). In the experimental part, the Author combined multiple approaches, used various techniques himself and collaborated with specialists on bone histology or hormonal assay. This was instrumental for demonstrating the insufficiency of the simple schematic models explaining SSD, like the resource allocation model. I appreciate the delving into hormonal regulation network as it is notoriously difficult to draw firm conclusions. This proved true in Paper II that confirmed mediation of sex-specific growth in *P. picta* through IGF-1 while other markers appeared inconclusive. Paper III used integrative approach to test the regulation of growth in P. vazimba. The results, however, do not point to a specific explanation for why males of this female-larger species grow slower than females. It is necessary to explore and better understand the proximate mechanisms of life history strategies and this pioneering data provide basis for further research and interpretation. The thesis is well written with few typos.

Questions

1. Despite focusing on two closely related species, *Paroedura* geckos seem handy and very interesting study system with variable sexual size dimorphism, de-differentiated sex chromosomes, and with determinate character of growth as shown. In this respect, I would appreciate putting biology and life history of *Paroedura* and the two focal species in context of other squamates – how similar they are to a "typical lizard"?
2. Why is it so important to prove determinate growth in *Paroedura*? It seems to me that *P. picta* maturing very early 10% (20% for females) of their final body size quite fulfils the indeterminate growth notion. What is their natural lifespan?
3. Does choice of reference group affect inference in the gene expression analysis? What would be the result if using average group as a reference instead of the youngest 42d old females as in Paper II (Figure 2)?

4. Is the growth plate cartilage closure definitive for termination of structural growth in *P. vazimba*? Results on growth plate closure in Paper III suggest that the growth cartilage was closed in 156d old females and 198d old males but there is still considerable growth past these ages in Figure 1 (and no Supplementary file 2 was provided).
5. What would be the growth comparison between males and females of *P. vazimba* if relative growth was analysed (as in e.g. Kubicka et al. 2022iSc, Fig1)? Could that affect interpretation in Paper III?
6. What in the end is probably making males of *P. vazimba* the smaller sex (or females the larger sex)? I did not completely understand it from the Paper III. The growth plate cartilage closes late in males, the hormones remained at similar levels between males and females throughout their lives, or were below detectable level (estradiol).
7. What is the lifetime reproductive effort and lifespan in the two *Paroedura* species? There is rich evidence across vertebrates on the cost of rapid growth and high reproduction in terms of lifespan and ageing. For example, IGF-1 generally increases growth and reproduction but also speeds up ageing and reduces lifespan (Dantzer & Swanson 2012BioRev).
8. As mentioned in the thesis, one of the selection factors for female larger body size would be reproductive output. Do the two studied *Paroedura* species differ in this respect (for example in correlation between body size and egg size)?
9. Is there any information about growth regulation differences in sexually dimorphic species that have genetic determination of sex (like *Paroedura picta*) compared to species where sex is determined environmentally?
10. What is the sexual selection in *Paroedura*? The thesis discusses evolution of their SSD and proposes male-male interactions as the main driver. Is anything known about female mate choice and its potential effect on female-male body size difference?

Conclusion

As mentioned above, the work of Brandon Meter adds important new findings into the knowledge of sexual size dimorphism in reptiles. The two papers are published in impacted journals and were peer-reviewed. The third manuscript is in a mature form and submitted. The Author participated in a collaborative team project while also showing independence (gene expression analysis). Although I would like to see a bit more of independent initiative, he is the leading author of all the three papers. I have full respect for doctoral work of Brandon Meter and I recommend his thesis for defence.

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