



MARTIN-LUTHER-UNIVERSITÄT
HALLE-WITTENBERG

Institut für Biologie
Allgemeine Zoologie
Prof. Dr. Robert J. Paxton

18. October 2013

Betr.: Review of PhD thesis by Mgr Katerina Cerná

Dear Profs. Marketa Martinkova and Bohuslav Gas,

Please find attached my review of the PhD thesis of Mgr Katerina Cerná entitled:

Nesting behaviour and population genetics of solitary bees (Hymenoptera, Anthophila)

Yours sincerely,

Prof. Dr. Robert Paxton

Hausanschrift:
Hoher Weg 8
06120 Halle (Saale)

Prof. Dr.
Robert J. Paxton
Tel: (0345) 5526500

e-mail:
robert.paxton@zoologie.uni-halle.de
Fax: (0345) 5527428



17th October 2013

REVIEW

of the PhD thesis of Katerina Cerná with the title

Nesting behaviour and population genetics of solitary bees (Hymenoptera, Anthophila)

Bees are a diverse group of >20,000 species distributed across terrestrial habitats that are gaining increasing attention because they and the ecological services they perform are threatened. Solitary bees in particular have recently come to the fore because of their hitherto underappreciated role in pollination (Garibaldi *et al.*, 2013). Though much research has been directed at honey bees and other eusocial species, particularly bumble bees, solitary bees have been largely understudied. Yet from a basic biological perspective, they are highly interesting because eusociality – a major evolutionary transition – has evolved independently many times within the bees, a taxon that is ancestrally solitary.

The thesis of Katerina Cerná represents a comprehensive and integrated study of diverse aspects of the biology of bees, focusing in particular on solitary species as precursors to sociality and cleptoparasitism (another major evolutionary development within the bees). It comprises 6 papers (or chapters), 4 of which have been published in good international peer-reviewed journals (the candidate is 1st author on all of these), one of which has been submitted and is currently under review (the candidate is 2nd author) and one of which exists as a draft manuscript (the candidate is 1st author). This in itself is an excellent and voluminous contribution to the field. More significantly, the candidate integrates a variety of techniques in her researches, from ecological and behavioural though to genetic, including next-gen sequencing, and she employs a rich and sophisticated arsenal of statistical and population genetic approaches to analyse and appropriately interpret her data. I am extremely impressed by the depth of analysis and quality of presentation of the data and analyses.

Paper/chapter 1 uses the candidate's own detailed behavioural observations of nesting activities of individual solitary bees to define the behavioural schedule of females in nest provisioning. Paper/chapter 2 again uses behavioural observations, this time of four different bee species, to quantify nesting and usurpation, suggesting that the latter may represent nest re-use rather than active displacement and take-over of a nest. The idea that these behaviours may be precursors of more complex social organisation, as put forward by the candidate, are interesting, though I wonder about their relevance in relation to the extreme forms of nestmate recognition exhibited by highly eusocial bee species. This may be a topic I wish to raise with the candidate as part of her thesis defence. Paper/chapter 3 uses the candidate's own population genetic data to understand the genetic structure of a solitary bee species across the Czech Republic, highlighting the phylogeographic component to interpretation of population genetic structure. Bayesian statistical analyses of the dataset have allowed the candidate to go beyond interpretation of population genetic structure on terms of on-going gene flow. It will be interesting to explore other causes of variation in Wright's inbreeding coefficients with the candidate in her oral defence. Paper/chapter 4 is a short one describing the candidate's use of

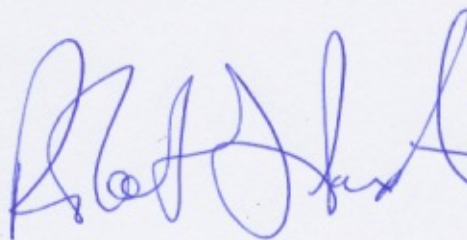
nextgen DNA sequence data for the development of microsatellite genetic markers for a solitary bee species. Paper/chapter 5 explores the relationship between activity, climate and host parasitism for host (solitary bee) longevity. I was surprised and interested to learn that activity rate during a day did not impact lifespan; this is a novel finding that might not have been anticipated. That the candidate also found solitary bees active on wet days to live longer is also somewhat counterintuitive, though more difficult to interpret. I wonder whether the introduction in this paper of 'parasitism' into the analysis of ecological factors impacting lifespan is something of a red herring, given that the studied parasite is known to have profound effects of host behaviour and life history. Paper/chapter 6 is another population genetic analysis of a solitary bee that has relatively recently been introduced to North America, using microsatellite markers developed in paper/chapter 4. The laudable geographically broad sampling employed by the candidate has allowed her to uncover surprising biodiversity (potential cryptic species) in the Mediterranean basin. One area I wish to develop with the candidate in the oral defence is a point developed by her in this chapter, namely the relationship between heterozygosity and effective population size, particularly for markers such as microsatellites.

The six primary data papers/chapters are bounded by an inciteful introduction that not only sets the scene for the thesis data chapters but also provides some interesting perspectives on the traits of solitary bees that may have played a role in the evolution of sociality in the bees. Nest usurpation is one such trait highlighted by the candidate as having played a role. Though I have no doubt from the candidate's research that nest usurpation is widespread in bees, I would question its role for social evolution, a point made above that I shall raise at the thesis defence. This and other points of critique of the thesis are a reflection of how the candidate meaningfully and fruitfully extends the scientific field. The introduction is well referenced, with up-to-date citations, and demonstrates the candidate's excellent conceptual understanding of the subject matter of her thesis. The last page and a half of the thesis is a brief conclusions and future prospects.

Overall, this is an excellent thesis which goes well beyond what I would expect of a PhD in terms of volume of science, novelty, originality, academic contribution to the field, depth of analysis and interpretation as well as intellectual challenge and critical appraisal, including self-appraisal. I have no hesitation whatsoever in recommending this thesis to the committee.

I have a minor note to the review committee. Nowadays multi-author publications are common practice. From a reviewer's perspective, it would be best for PhD candidates to provide a statement for each publication within their thesis that identifies their contribution to that publication (or manuscript). That the current candidate is 1st author of 5 of 6 manuscripts does not throw this thesis into doubt. But such a statement of personal contribution would assist future reviewers of future theses.

Yours faithfully,



Prof. Dr. Robert J. Paxton

Martin-Luther-Universität
Halle-Wittenberg
Institut für Biologie/ZOOLOGIE
Prof. Dr. Robert Paxton
Allgemeine Zoologie
D-06099 Halle (Saale)