



Confidential

Review of USB FFPW PhD Thesis

First name(s), surname, titles of the PhD student: Jan Kubec, Dipl.-Ing.	First name(s), surname, titles of supervisor: Dipl.-Ing. Miloš Buřič, Ph.D.
Title of PhD thesis: Decision making in crayfish: behavioural and reproductive issues	

REVIEWER:

Surname: Patoka	Institution: ČZU Praha
Name: Jiří	
Titles: Assoc. Prof, Dipl.-Ing., Ph.D., DiS.	E-mail: patoka@af.czu.cz
Please describe your professional relationship to the PhD student:	Please describe your field of expertise:
No relationship	Biology, ecology, ethology and taxonomy of crayfish, biological invasions, risk assessment, pet trade

QUESTIONNAIRE

Originality, scientific importance, perspectives and impacts of results presented in the PhD thesis for basic and/or applied research

Evaluate competitiveness of the PhD thesis in the international context and compare its level with the current state of the art in the field (**extent ¼ – ½ page**):

The presented thesis is focused on ethology of freshwater crayfish. This topic is so wide and it is obvious, that it is not possible to survey all aspects related to decision making and reproduction in crayfish during PhD study. However, Jan Kubec focused his papers on specific issues and the thesis is readable, clear and comprehensive as much as it can be during the four years of the study. Since the thesis is based on scientific papers, its scientific importance is indisputable. I see also a huge potential overlap to applied research.



Elaboration of the PhD thesis, objectives of the work and deliverables

Evaluate the overall level of elaboration of the PhD thesis (structuring of the main text, comprehensibility, logicity of the chapters and their ordering) and the originality of the selected approaches to solve the objectives; evaluate publications and whether the results described correspond to objectives of the PhD thesis (**extent ¼ – ½ page**):

The main text is logically structured and ordered. The results are described clearly and correspond to the objectives of the thesis. I have just one reservation: obviously, the Czech summary has not been proofread and its quality is poor. It is surprising because the author is a native speaker. And also glorification of crayfish as following: “Crayfish are advantageous over other invertebrates given their high level of social interaction in both the field and the laboratory” is too bombastic. One can see also other crustaceans (e.g. freshwater crabs) and invertebrates in general (e.g. water bugs) which are similarly important as crayfish. Keep in your mind for future, that glorified statement like this is usually declined by editors of scientific journals (my personal experience).

OVERALL COMMENTARY ON THE PhD THESIS

Please write comments in extent of 1-2 pages:

The topic of presented thesis is in line with the current research focused on aquatic biota in general. Since aquatic animals can be perceived as first indicators of the impact of pollutants which are also consumed by humans in drinking water, the topic is highly relevant not only for hydrobiology but also to other disciplines. Therefore, the potential of presented papers to be cited not only by astacological community exists. Also, ethological experiments on individual recognition and agonistic behaviour are very interesting and in line with the current research focused social behaviour in crayfish on one side, and also the behaviour of invasive species including marbled and red swamp crayfish. The study on agonistic behaviour of both mentioned species and finding of the higher aggressiveness in marbled crayfish is in line with personal observation of some keepers and this is the first evidence of this behaviour to be published (up today, majority of authors of popular literature had stated that marbled crayfish is not aggressive). This is very important point for improve the management of this invasive crayfish and its risk assessment which should be of a high attention of many scientists, conservationists, traders, wildlife managers, decision makers and other stakeholders not only in Europe. This finding supports the previous labelling of this crayfish as the “perfect invader”.

Since the PhD student has to work as a researcher, I much appreciate that Jan Kubec is able to cooperate with other colleagues not only from the Czech Republic, which is documented by wide author team in presented papers and also by foreign stays. Although some manuscripts where Jan Kubec is the first author have not been published yet, I see the data included there to be very interesting also for future study. I recommend to continue with ethological and ecotoxicological experiments, especially with the supervisor Dr. Miloš Buřič and his team. I assume that both presented and future findings and outputs should be highlighted in some international conferences such as the 23rd IAA conference in Hluboká, Czech Republic next year.

Since Jan Kubec published numerous scientific papers (partly also as the first author), in which he



presented novel data and findings, I perceived the thesis to be sufficient. For that reason, it is my great pleasure to recommend the thesis for defence.

Questions:

- 1) Do you plan future experiments on agonistic behaviour between *Procambarus virginalis* and *P. alleni* or some other crayfish?
- 2) Do you plan future experiments focused on agonistic behaviour between socially deprived crayfish? (see: Patoka, J., Kalous, L., & Bartoš, L. 2019 Early ontogeny social deprivation modifies future agonistic behaviour in crayfish. *Scientific reports*, 9, 4667.)
- 3) Can you explain a role of brood pheromones on aggressiveness of young crayfish? (see: Little 1976 and others.)

FINAL RECOMMENDATION

- PhD Thesis can be recommended for defence
 PhD Thesis can be recommended with reservations for defence
 PhD Thesis can not be recommended for defence

19. 07. 2019, Prague.....
Date and place

Jiří Patoka.....
Name and signature



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and Protection
of Waters

Jihočeská univerzita
v Českých Budějovicích
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Title of PhD thesis: Decision making in crayfish: behavioural and reproductive issues	

REVIEWER:

Surname: Moore	Institution: Bowling Green State University Ohio, USA
Name: Paul	
Titles: Dr.	E-mail: pmoore@bgsu.edu
Please describe your professional relationship to the PhD student: none	Please describe your field of expertise: Crayfish ecology and sensory ecology

QUESTIONNAIRE

Originality, scientific importance, perspectives and impacts of results presented in the PhD thesis for basic and/or applied research

Evaluate competitiveness of the PhD thesis in the international context and compare its level with the current state of the art in the field (**extent ¼ – ½ page**):

The review chapter to begin the dissertation is an excellent coverage of the existing field of scientific knowledge on decision making in general and in crayfish decision making specifically. The experimental chapters show that the candidate has gained considerable knowledge within the experimental sciences. The questions that each chapter asks are timely and important questions. In general the experimental design and statistical analysis of the data uses appropriate techniques. The writing of the chapters is clear and presents both the data and the ideas being tested in coherent fashion. Overall, the dissertation is an excellent piece of work and provides the international field with good data and good conclusions in which to work. The first chapter is already published in a good journal as well as the data chapters of 3, 4, and 5. All of these are solid pieces of work and shows that the ideas, execution, and presentation of the work is competitive on an international level.



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Elaboration of the PhD thesis, objectives of the work and deliverables

Evaluate the overall level of elaboration of the PhD thesis (structuring of the main text, comprehensibility, logicity of the chapters and their ordering) and the originality of the selected approaches to solve the objectives; evaluate publications and whether the results described correspond to objectives of the PhD thesis (**extent ¼ – ½ page**):

The Ph.D. thesis is actually more of a collection of projects than a single themed document. Thus, the connectivity of each chapter to another is, at times, a small connection. Still, this should not be held against the thesis or the candidate. The modern Ph.D. thesis should be a collection of papers rather than a single large monograph. The modern scientist needs to collaborate and work across boundaries of disciplines while keeping a main focus. The candidate has done that with this thesis. The collaborative nature of the environment is clear and the thesis clearly spells out the level of contribution that the candidate has provided as well as which parts of the project are the candidates. Having 4 of the 6 chapters published already is an excellent sign that this work has been judged worthy by peers in the fields and the journals selected for publication are good journals. So, the deliverables are good and should be the expected output of a good Ph.D. candidate. Despite the wide range of activities within the papers, all can be grouped appropriately within the field of decision making, so the thesis and its papers fulfill the objectives that the candidate has put stated.

OVERALL COMMENTARY ON THE PhD THESIS

Please write comments in extent of 1-2 pages:

The candidate has presented a thesis document that is aimed at understanding decision making in crayfish. Within the document, the candidate has 6 chapters (introduction, four data chapters, and a conclusion).

The introduction of the thesis, which should be noted is published, is a review of the literature surrounding decision making in crayfish. This is commendable that a scientifically-young investigator produced a review of this quality. The candidate had to read a disparate series of papers and to synthesize those into a coherent concept of decision-making is quite a remarkable job. I recently saw this review before reading the thesis and was impressed with the work. I have sent it to all of my current graduate students to read and have already begun using the paper to guide the development of projects.

The second chapter has not been published and appears to be the weakest section of the thesis. The idea behind the chapter is an excellent idea and definitely worthy of testing. The arena for the behavioral assay and the structure of the assay probably should be modified, but as a project the chapter is a good attempt at distinguishing choices related to aggression and sexual selection.

The third chapter on social behavior and agonism across species is well-designed from a behavioral and ecological point of view. The results are applicable for both social behavior and invasiveness in



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crustacean populations. The statistical analysis is quite appropriate and the findings are presented in a clear fashion. I also read this chapter before the thesis and have used its findings to guide my thinking. So, this is an excellent addition to the literature.

The fourth and fifth chapters examine the effect of anthropogenic chemicals on crayfish behavior and physiology. These papers are both important and timely as they selected relevant chemicals to test for effects on crayfish. Having already been published, the papers are sure to influence the growing literature on ecotoxicology of crustaceans. These chapters also highlight a growing and diverse skill set for the candidate.

Overall, I found the thesis to be a solid piece of work. The candidate clearly did a significant amount of research and writing to produce this document. The skill set of statistical, behavioral, and physiological work shows that the candidate has excellent training and has applied this training in a productive way. The quality of the writing (despite English not being the native language) is very well done and the ideas and thoughts presented represent a maturing scientific mind. I have used two of the chapters in my own work and expect to use the other chapters as well. Thus, the candidate has made substantial and likely lasting additions to the crustacean literature. Beyond just crustaceans, the candidate's work should influence experimental design when researchers are considering the effect of chemicals on decision making in a broad range of animals. I found no major flaws either in the writing or the thinking in the thesis. This is a contribution that would be appropriate for a Ph.D. for all of the university systems that I have participated in. In many of those systems, this piece of work would be considered significantly beyond what would be expected for a student. It was a pleasure to read and the work made me think deeply about the concepts of decision making and how those decisions could be influenced by chemicals (both natural and anthropogenic).



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FINAL RECOMMENDATION

- PhD Thesis can be recommended for defence
- PhD Thesis can be recommended with reservations for defence
- PhD Thesis can not be recommended for defence

04/07/2019, Pellston, Michigan, USA

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Date and place

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Name and signature

Paul A. Moore