



**Confidential**

### **Review of USB FFPW PhD Thesis**

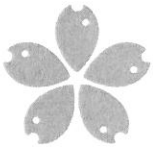
<b>First name(s), surname, titles of the PhD student:</b> Lukáš Veselý, Dipl.-Ing.	<b>First name(s), surname, titles of supervisor:</b> Dipl.-Ing. Antonín Kouba, Ph.D.
<b>Title of PhD thesis:</b> Crayfish in changing biotic and abiotic conditions	
<b>REVIEWER:</b>	
<b>Surname:</b> Jones	<b>Institution:</b> University of Jyväskylä
<b>Name:</b> Roger I.	
<b>Titles:</b> Prof.	<b>E-mail:</b> roger.i.jones@jyu.fi
<b>Please describe your professional relationship to the PhD student:</b> None, but he has visited my department	<b>Please describe your field of expertise:</b> Limnology, freshwater 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 thesis contains novel results derived from an impressive amount of extended experimental work. The spread of non-indigenous crayfish species (mainly from N America) through Europe is a major conservation concern, as well as raising many fundamental issues of ecological theory relating to competition, food web structure, and ecosystem functioning. Although there is now a substantial body of literature on the topic, understanding remains imperfect, both of the theoretical ecological issues and of the implications for effective and pre-emptive management. This thesis presents findings from several independent but linked experimental studies. The first three deal with abiotic factors (winter temperature, drought, and salinity) which are all potentially critical for establishment and spread of alien crayfish and their ability to compete with and displace native species. The fourth experiment investigated the possibility that an alien crayfish species newly arrived in European waters from Australia might have higher resistance to crayfish plague than native species and thus might act as a vector for further spread of the disease. The final experiment tackled the important but very challenging issue of how different factors may interact to influence the relative performance of top predators and their trophic interactions. Overall, the work in the thesis makes an important contribution to advancing knowledge of both basic and applied research related to some topical issues in invasion ecology. Four of the experimental studies have already been published in peer-reviewed international journals, which is testament to the international value of the work. The fifth study is still in manuscript form, but I have no doubt that this interesting and novel piece of work can be published in a well-regarded international ecological journal. I anticipate that the thesis work will come to be well cited and will make a positive impact in the field.



***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 PhD thesis is well-constructed, well-presented, and well-written. The thesis appears to conform to the general guidelines. The General Introduction provides a concise but informative account of the current state of knowledge, and provides a clear and logical rationale for the specific aims of the thesis which are clearly set out at the end of the chapter. The text demonstrates an excellent awareness of the specialized literature and of some relevant more general literature, and also demonstrates that the student is able to use the literature appropriately to develop and support his arguments. The following five chapters each present an account of one of the experimental studies. Each chapter is logically organized in the standard format of a scientific paper (four have already been published), and the chapters follow a logical sequence. The General Discussion attempts to draw the individual chapters together to put the thesis work into context and to highlight the implications of the findings. The discussion achieves this aim reasonably well, although I feel it might have been developed a little further. I appreciate that the length of this chapter is in accord with the general recommendations (5-10 pages), but as about half of the pages of this chapter are the list of references I think the actual text could have been longer without contravening the spirit of the guidelines. Considering that the student is not a native English speaker the text is very well written, with just a smattering of minor linguistic flaws which do not interfere with the readability and comprehension.

The experimental work has been well designed and appears to have been carried out diligently. The statistical analysis of the results appears to be appropriate. The results obtained have allowed the student to address the original aims of the thesis and have resulted in several valuable publications.

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***OVERALL COMMENTARY ON THE PhD THESIS***

**Please write comments in extent of 1-2 pages:**

This PhD thesis concerns a timely and topical issue in ecology, namely the global spread of alien species and their potential impact on native species and ecosystems. Freshwater crayfish, the specific subject of the thesis, are amongst the most notorious alien species. Several alien crayfish species, mainly from North America but also more recently from Australia, have become established in European freshwaters to varying extents and are the cause of very real concern. Despite an extensive literature, predicting the spread and impact of these invaders on native species and ecosystems, and developing sound pre-emptive management strategies, remain elusive goals. As new species arrive in Europe and alien crayfish species spread to parts of Europe previously unaffected, it is clear that better understanding of the multiple processes that may promote or constrain their spread is urgently needed. This thesis makes a valuable contribution to meeting that need.



The thesis is based on a number of carefully designed and well-executed experimental studies that have provided new information about abiotic factors (winter temperature, drought, salinity) and biotic interactions (disease, competition) that are likely to affect the ability of several crayfish species of concern to spread through central and eastern Europe. Some of the results challenge previous reports. For example, the thesis results appear to indicate that the Australian yabby is better able to survive low winter temperatures than has been thought previously, opening the alarming possibility that this species may be able to spread more widely than anticipated. As the thesis work also shows that the species has a degree of resistance to the crayfish plague (a resistance that might increase through evolutionary selection) there is a real and highly alarming possibility that the yabby could act as a vector to promote wider spread of crayfish plague into areas where it is not yet present, with dire consequences for the highly susceptible native crayfish species. Similarly, the finding that the marbled crayfish originally from Florida has a higher than expected degree of tolerance to salinity (which again might be enhanced by selection) raises the alarming possibility that this species might be able to penetrate into some of the important brackish waters of Europe with potentially damaging consequences.

Chapter 5 presents a very interesting experimental study of how 'temperature and resource density jointly influence trophic and non-trophic interactions in a multiple predator-prey system'. While studies of the effects of individual factors can be very informative, nature is complex and in practice the distributions and functioning of species are governed by multiple interacting factors. Studying these interactive impacts in a meaningful way so that the results have 'real world' significance is extremely challenging, but is essential for more effective ecological management. I very much enjoyed reading this chapter and I suggest this is an approach that the student might profitably pursue in the future.

In my quite wide experience of examining PhD theses from several different European countries, I have no doubt that this thesis easily meets the expected standards for both quantity of work undertaken and quality of the work. Indeed the bulk of the work undertaken for the thesis (Chapters 2-5) has already been published as four papers in peer-reviewed international journals, while Chapter 5 is in the form a manuscript that I am sure can be published in a well-regarded ecological journal. Hence there can be no doubt that the thesis meets the general requirement for a PhD of contributing novel findings of international significance. I found the thesis to be well-constructed, well-presented, and well-written. As pointed out above, although the General Discussion is effective I feel it might have gone further in tying the components of the thesis together and drawing out their implications for ecology and management. However, in fairness I should add that in my experience this is a common issue with PhD theses, and my comment is not intended to detract from my overall very favourable impression of the thesis. One minor observation is that my copy of thesis did not appear to have page numbers, and this might be rectified before the final version of the thesis is published and archived.

Overall I commend the student for an excellent thesis. I have no hesitation in recommending that the thesis can progress to the defence.



Fakulta rybnářství  
a ochrany vod  
Faculty of Fisheries  
and Protection  
of Waters

Jihočeská univerzita  
v Českých Budějovicích  
University of South Bohemia  
in České Budějovice  
Czech Republic

### **FINAL RECOMMENDATION**

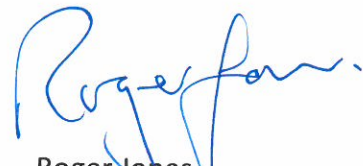
**PhD Thesis can be recommended for defence**

**PhD Thesis can be recommended with reservations for defence**

**PhD Thesis can not be recommended for defence**

...19.6.2017 Jyväskylä.....

Date and place



...Roger Jones.....  
Name and signature





Fakulta rybnářství  
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and Protection  
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### **Review of USB FFPW PhD Thesis**

<b>First name(s), surname, titles of the PhD student:</b> Lukáš Veselý, Dipl.-Ing.	<b>First name(s), surname, titles of supervisor:</b> Dipl.-Ing. Antonín Kouba, Ph.D.
<b>Title of PhD thesis:</b> Crayfish in changing biotic and abiotic conditions	
<b>REVIEWER:</b>	
<b>Surname:</b> Tricarico	<b>Institution:</b> University of Florence
<b>Name:</b> Elena	
<b>Titles:</b> Dr.	<b>E-mail:</b> elena.tricarico@unifi.it
<b>Please describe your professional relationship to the PhD student:</b> I met the student during the IAA meeting in Spain (September 2016)	<b>Please describe your field of expertise:</b> Biological invasions, behavioural ecology of crayfish, management of crayfish and other aquatic alien species

### **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 effect of changes in biotic and abiotic factors on behaviour and life cycle of crayfish is an interesting and crucial issue in the light of conservation for native species and management of alien invasive ones. Climate change and biological invasions represent two major threats for biodiversity and studies including both aspects are needed to better understand and forecast the potential invasiveness of alien invasive crayfish, particularly of novel invaders as the marbled crayfish, which ecology and behaviour need to be clarified. Moreover, despite most of the species used for the PhD thesis have been studied since years, several aspects remains poorly known (e.g. the interactions between predators). The thesis addresses these gaps, and its results are noteworthy and important, improving the knowledge on crayfish biology. The level and quality of the thesis are high, as also testified by the already published articles in high impact factor journals. The work is thus very interesting and timely for the scientific pertinent field, and is relevant for pure and 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 thesis has five main aims, well elucidated at the beginning of the volume, for whose achievement the candidate conducted several laboratory experiments. Overall, the thesis is a very good and solid work, well and clearly structured, and the English is fluent and well written. The methods are appropriate, clearly illustrated and explained. The statistical analyses have been conducted in the appropriate way. All results are well illustrated, discussed with a good critical ability, and accomplished the thesis objectives. The results are mostly published (except Chapter 6) in relevant journals. They are novel and provide a great contribution to crayfish biology. Chapter 6 is particularly interesting for its approach (the effect of temperature and prey density in a multipredator system), and, even if its results do not strongly depict a general mechanism for individual traits and environmental drivers in this system, it offers interesting starting points for future research.

### **OVERALL COMMENTARY ON THE PhD THESIS**

**Please write comments in extent of 1-2 pages:**

The thesis is composed by 5 main articles, 4 already published (3 in high impact factor journals).

Chapter 1: the introduction is exhaustive and clearly lists the main topic addressed in the thesis and the objectives. I suggest only citing more recent literature on general biological invasions. Last row of paragraph on tolerance to winter temperatures: the year is missing in Patoka et al.

Chapter 2: the work, already published in Scientific Reports, shows how three invasive crayfish (the red swamp crayfish, the marbled crayfish and the yabby) tolerate low temperatures, typical of winter in Central Europe, highlighting their potential invasiveness also in this area.

Chapter 3: the work, already published in Scientific Reports, evidences the capability of the red swamp crayfish and marbled crayfish to construct bigger and deeper burrows compared to other invasive crayfish and native European ones. I suggest better considering the classification of crayfish based on burrows (e.g. primary, secondary, tertiary burrower), and the difference between native and invaded range (e.g. *Orconectes limosus* is capable of constructing burrows in England, while in other invaded European countries, this activity has been scantily observed; *Pacifastacus leniusculus*, considered a tertiary burrower crayfish in North America, as an invasive in Europe frequently digs burrows under rocks or river and lake banks).





Chapter 4: this part, already published in Knowledge and management of aquatic ecosystems, shows how the marbled crayfish can tolerate salinity in brackish areas (representing a potential threat for them), even if it has a lower tolerance compared to other alien crayfish.

Chapter 5: the results of the work, already published in Aquatic Invasions, highlight how the yabby, in certain conditions, can resist to the crayfish plague, potentially spreading it. This is a novel and worrying achievement, underlying the complexity of tolerance and vulnerability of certain crayfish to *A. astaci*.

Chapter 6: as already stated, this last part of the thesis has not yet been published and represents a novel approach, trying to combine the effect of temperature, prey density and different predators, and opening new interesting field of research. A submitted paper is cited (Veselý et al., on surplus killing) and it could have been included in the thesis, as it seems pertinent to it.

### **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

30/06/2017, Firenze

Elena Tricarico