

HABILITATION THESIS REVIEWER'S REPORT

Masaryk University

Applicant

Dr Simon Karl-Maria Rasso Rittmann

Habilitation thesis

Physiology and biotechnology of archaea

Reviewer

Dr Guillaume Borrel

Reviewer's home unit, institution

Institut Pasteur, Paris

Dr. Rittmann's habilitation thesis focuses on archaeal physiology for the development of biotechnological applications based on archaea. This includes development of strategy for best strain selection and cultivation scale-up, medium optimization in link with physiological parameters, enzyme characterizations and identification of novel microbial potentials.

The habilitation thesis is based on a selection of 12 peer-reviewed research articles given in the appendices. Dr. Rittmann was the last and corresponding author on 6 papers associated to the habilitation and last or first author of 43 papers published in peer-reviewed journal since 2011. Over the last ten years, Dr. Rittmann was PI of 11 projects and Co-PI of 6 additional projects. From the publication and patent lists, it is clear that Dr. Rittmann has an extensive network of national and international collaborations. Dr. Rittmann was invited lecturer (incl. 2 keynotes lectures) in 32 national and international events, and his work was presented in a large number of national and international conferences, demonstrating his well-established recognition as an international expert in the domain of (Archaea) biotechnology. He engages intensively in the training of junior researchers, with the supervision of 8 PhD students and 20 Master/Bachelor students.

The habilitation thesis outlines a range of promising biotechnological applications based on archaea to address important societal issues. A major part of the work aims at developing the triple use of methanogens as 1) CO₂ sinks, 2) sources of biogas, and 3) sources of high value-added compounds such as amino acids and lipids, the latter offering unique characteristics and numerous advantages over lipids from eukaryotes and bacteria. In addition, a novel method and its application to the characterization of carbonic anhydrases are presented. This work settles the basis for selection of enzymes that represent promising alternative to chemical methods for CO₂ sequestration in industrial processes. All those aspects are highly needed to minimize CO₂ emission to the atmosphere and associated effect on climate change. Well selected and illustrative examples are given in each of these areas, mainly based on the Dr. Rittmann's work.

Overall, this is a good habilitation thesis.

Reviewer's questions for the habilitation thesis defence

1. How does the production of amino-acids compares between archaea and bacteria/eukaryotes in term of yield?

2. Among methanogens, (hyper)thermophilic Methanobacteriales and Methanococcales species appear to be the most suited for biotechnological applications. Are Methanobacteriales species better cell factories for some applications and Methanococcales species for other applications? What are the specific pros and cons associated with the use of these two groups of species (if any)?
3. Are Methanobacteriales/Methanopyrales cells more resistant to high-speed steering/shaking due to their unique cell envelope in archaea? And would it represent an advantage over other methanogens?
4. How can CO₂-reducing methanogens change their CH₄/H₂O ratio? Is it related to the variation in the methanogenesis/CO₂ fixation ratio (as CO₂ fixation with the WL pathway releases H₂O but no CH₄, while methanogenesis releases both)? Is this change observed in heterotrophic methanogens?
5. In addition to the amino-acid motif found in the McrA of high-performance methanogens, could the high-performance of some methanogens be linked with the presence of the Mcr paralogue Mrt (also called Mcr-II)?
6. Would it be possible to use the pH modification by carbonic anhydrases (CAs) as a selective pressure to evolve or select randomly modified CAs toward more efficient enzymes?

Conclusion

The habilitation thesis entitled “Physiology and biotechnology of archaea” by Dr Simon Karl-Maria Rasso Rittmann **fulfils** requirements expected of a habilitation thesis in the field of Microbiology.

Date:
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Signature: