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Contribution to CR Special 21 'Climate and evolutionary physiology'

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Preface

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The workshop 'Evolutionary and physiological adaptation to climate induced environmental changes'—funded by the ConGen and ThermAdapt programs and the European Science Foundation, and organised by Cino Pertoldi, Marek Konarzewski, Paulina A. Szafrańska and Torsten Nygaard Kristensen—was held from 28 June to 1 July 2009 at the EU Centre of Excellence, Mammal Research Institute of the Polish Academy of Sciences (MRI PAS), in Białowieża, Poland.

The main goal of this workshop was to increase our understanding of thermal adaptation in poikilotherms and homeotherms using a cross-disciplinary approach. By bringing together people with different fields of expertise (Box 1) we improved our understanding of the genetic and physiological basis of thermal adaptation, from individual molecules and cells to entire ecological systems. We invited leading researchers in physiology, conservation genetics, evolutionary biology, ecology and genomics, working at various levels of biological organisation, from molecules to populations and species. The wide variety of methodological approaches provided for inspiring discussions on cutting edge approaches to studying thermal adaptation in free living as well as in model organisms.

To understand the mechanisms behind thermal adaptation, insight is needed from different levels of biological complexity, and to understand what limits the ability of species to adapt to climate induced changes; there is also a need to integrate (local) short-term and (local) long-term changes and to increase our knowledge on the importance of genetic and environmental components for the variability of ecologically relevant traits. In the workshop, we discussed population genetics and molecular and evolutionary physiology from a multidisciplinary perspective, and we explored approaches to gain a deeper understanding of the mechanisms behind adaptation to thermal changes.

The workshop was organized into 3 sessions: (1) population genetics, plasticity and theoretical aspects; (2) experimental population genetics, (3) collection and analysis of empirical field data. Discussion focused on the following topics:

(1) How close are tropical organisms to thermal thresholds? Can this be predicted? Can predictions be validated?

(2) Plastic responses occur for phenological responses and for resistance traits. To what extent do these allow organisms to cope with climate change?

Box 1. Speakers at the workshop on 'Evolutionary and physiological adaptation to climate induced environmental changes'

Michael J. Angilletta Jr. (USA)	Phillip Gienapp (Finland)	Johannes Overgaard (Denmark)
Simon Bahrndorf (Denmark)	Ary A. Hoffmann (Australia)	Cino Pertoldi (Denmark)
Kuke R. Bijlsma (The Netherlands)	Vanessa Kellermann (Denmark)	Mauro Santos (Spain)
Wolf Blanckenhorn (Switzerland)	Anders Kjærsgaard (Denmark)	Christian Schlötterer (Austria)
Steven L. Chown (South Africa)	Torsten N. Kristensen (Denmark)	Nils Chr. Stenseth (Norway)
Andrew Cossins (UK)	Marek Konarzewski (Poland)	Robby Stoks (Belgium)
Marcin Czarnołęski (Poland)	Jan Kozłowski (Poland)	Piotr Tryjanowski (Poland)
Jean R. David (France)	Jonathan Lenoir (Denmark)	Josh Van Buskirk (Switzerland)
Luc De Meester (Belgium)	Maartje Liefting (The Netherlands)	Karol Zub (Poland)
Klaus Fischer (Germany)	Volker Loeschcke (Denmark)	

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When are the limits reached? What role do patterns of resource distribution play?

(3) Genetic limits appear to apply to restricted specialist groups of *Drosophila*. Is this the case also for other groups?

(4) Observed evolutionary changes under climate change depend on biotic interactions. Can these ever be predicted? Do we need to simulate each situation to obtain realistic predictions?

(5) Warm adapted genotypes may expand their range and displace local genotypes. Can *in situ* microevolution be strong enough to compete with this process?

(6) What are the implications for management? When should genetic translocation occur (with multiple individuals) to maximize adaptive responses? When should a species/population be considered to be facing extinction based on physiological data, and therefore warrant management responses?

(7) Are associations between size components and temperature due to selection within immature developmental stages, or to selection at the adult stage?

(8) To what extent is niche conservation determined by what other species do?

(9) Is adaptation to temperature a blessing or a problem?

(10) To what extent do predictions derived from abundant species apply to rare species (and are the latter more vulnerable to climate change due to abundance *per se*, or due to particular traits)?

(11) Are the genomics and transcriptomics carried out so far merely 'bits and pieces'?

(12) What are the relative roles of the 3 alternative response processes to climate change: adaptation, phenotypic plasticity, dispersal? What do we need to measure — genetic variability, genotypic × environmental variability, environmental variability (V_g / V_{gxe} / V_e)?

Participants also debated the validity of assumptions on which several models have been built: (1) no dispersal, (2) no evolutionary change, (3) physiological limits not explicitly defined, (4) no interaction among species. There was consensus that emphasis must be placed on more complex models that can incorporate additional components such as space complexity, species interactions, evolutionary constraint, physiological limits. However, an open question remained: what works best, individual-based, demographic, or mechanistic models?