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Report on ESF ThermAdapt Short Visit Grant No. 2234: Linking physiology to population structure and geographic range size in European diving beetles

Host & Institution: Dr Ignacio Ribera, Institut de Biologia Evolutiva (CSIC-UPF), Barcelona, Spain.

Goals and work conducted: Understanding the factors determining the geographic range size of organisms is a key unresolved issue in ecology: why are most species rare, whilst some are common? A better understanding of this question is of fundamental interest, and crucial in predicting how organisms may respond to global climate change. Both ecological and evolutionary processes may underlie variation in species' range sizes, and work on range size variation requires an integrative approach which links organismal ecology, physiology and phylogeny.

Work initiated by the applicant (e.g. Calosi *et al.*, 2007; 2008) has established European diving beetles as a model system for studying range size variation in a phylogenetically controlled manner. Results to date, for 18 species in two genera, suggest that thermal physiologies are related to geographical range extent: widespread species being more tolerant of high and low temperatures than their restricted relatives. Having demonstrated such an association between physiology and biogeography, it will be interesting to examine whether physiology directly relates to dispersal ability in these taxa. Recent work on vertebrates (Bernardo *et al.*, 2007) suggests that species' BMR shapes range size and genetic structure, by determining how much individuals move. Do such findings apply more widely?

We are keen to explore possible links between thermal physiology, activity levels, and phylogeographic structure in *Deronectes* diving beetles. Funding was sought for a 5-day visit to develop collaborative work on these topics, in terms of both grant applications and publications.

I spent 5 days between 19-24 January working with Dr Ribera and colleagues in the Water and Cave Beetle Evolution Lab at CSIC, Barcelona. During this time we discussed,

a number of topics related to the determinants of range size variation in diving beetles, and how we should link data my group have assembled on thermal physiology and activity levels, with data from Dr Ribera's group on comparative phylogeography. In addition, I gave a seminar to the Institut de Biologia Evolutiva, entitled "*What determines a species' geographical range? Physiological niche, geographical range size and vulnerability to climate change in European diving beetles*".

From our discussions, we have developed ideas and datasets for two collaborative papers which we are currently exploring (see below), dealing with: 1) the link between thermal physiology, activity levels, phylogeography and range size variation in *Deronectes* species, and 2) the evolution of thermal tolerance traits in the genus *Deronectes*. In addition, we began preparation of a collaborative grant application, to be submitted to the Human Frontier Science Program (<http://www.hfsp.org/>), together with potential collaborators in the United States. This will integrate our thermal physiology approaches with proteomics and integrative modelling, and explore determinants of range size variation, including comparative thermal physiology, across a number of water beetle clades. We are actively working on this proposal, and it is anticipated that this application will be submitted in March this year.

Planned publications:

Bilton, Ribera *et al.* Physiology, population structure and geographical range size in *Deronectes* diving beetles. Target Journal- *Ecology?*

Ribera, Bilton *et al.* The evolution of thermal physiology in a group of European diving beetles. Target Journal – *Evolution?*

Planned further collaboration:

Application to Human Frontier Science Program

In short, both myself and Dr Ribera found this to be a most productive visit, and are grateful to the ThermAdapt scheme of ESF for contributing to the costs of my trip.

References

- Bernardo, J., Ossola, R.J., Spotila, J. & Crandall, K.A. 2007. Interspecific physiological variation as a tool for cross-species assessments of global warming-induced endangerment: validation of an intrinsic determinant of macroecological and phylogeographic structure. *Biology Letters* **3**: 695-698
- Calosi, P., Bilton, D.T., Spicer, J.I. & Atfield, A. 2007. Thermal tolerance and geographic range size in the *Agabus brunneus* group of European diving beetles (Coleoptera: Dytiscidae). *Journal of Biogeography* **35**: 295-305.
- Calosi, P., Bilton, D.T. & Spicer, J.I. 2008. Thermal tolerance, acclimatory capacity and vulnerability to global climate change. *Biology Letters* **4**: 99-102.

Dr David Bilton