Evolution of mammalian venom: a molecular, ecological and morphofunctional approach

Supervisory team:
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Project description:
The biological importance of the venomous trait in the evolution of the animal kingdom is highlighted by the multiple independent recruitments of venom systems in many distinct lineages. Research has determined that venom systems evolved primarily to provide defensive (e.g. fish, bees) or predatory (e.g. snakes, spiders) functions. Very few extant mammals are venomous, and all known venomous mammals are representatives of basal orders such as the platypus and some lipotyphlans (Whittington *et al*. 2010). This suggests an ancient evolutionary origin for venom and the potential for new insights into broad-scale patterns of mammalian evolution (Fox & Scott, 2005; Turvey 2010). The venomous Caribbean solenodons are the only extant mammals to possess modified dental venom delivery systems and specialised oral venom glands. However, the evolutionary origin, protein composition and function of mammalian venom systems remain very poorly understood. This project therefore aims to investigate why solenodons have a venom system, what does it do, and how did it evolve, by addressing the following questions:

1. Does solenodon venom likely function for predation, defence, or intraspecific competition?
2. What is the toxin composition and biochemical activity of solenodon venom?
3. Are the venom systems of solenodons homologous to those of other mammals with known venom capacity (e.g. platypus, shrews), and do other eulipotyphlans (e.g. moles, hedgehogs) exhibit evidence of a venom system?

This will be achieved via a multidisciplinary approach. The student will conduct musculoskeletal and biomechanical analyses of comparative lipotyphlan skull anatomy and function to determine the ecological role of venom (to subdue prey in absence of bite strength? for defence? intraspecific competition?) (Rayfield 2007; Gill *et al*. 2014). This will be combined with field studies in the Caribbean as part of the ZSL established programme, to determine solenodon diet and intraspecific social interactions. Fieldwork will also involve collecting solenodon venom, saliva and blood samples, to supplement existing samples that will be used to address the molecular biology of solenodon venom – characterising the venom proteome and using functional assays to characterise male and female venom bioactivity.

The project would suit a student with a background and interest in organismal and evolutionary biology/palaeontology, who is keen to learn and apply a diverse set of quantitative and laboratory skills.

Casewell NR. *et al*. 2014. PNAS 111:9205-9210. Fox & Scott. 2005. Nature 435: 1091–3. Gill PG *et al*. […] Rayfield EJ. 2014. Nature 512:303-305. Rayfield EJ. 2007. Ann. Rev. Earth Plan. Sci. 35:541-576. Turvey. 2010. J. Vert. Paleontol. 30:1294–1299. Whittington *et al*. 2010. Genome Biol. 11: R95.