Reply: Bridging the regeneration gap: insights from echinoderm models

Attention was indeed paid to echinoderms in our recent Review[1]. In fact, they are highlighted in FIG. 1a, and the remarkable abilities of the sea cucumber (a *bona fide* echinoderm) are described on page 877. The objective of our Review was not to highlight all organisms that are capable of regenerating. This makes for an extensive list that has been painstakingly assembled, described and discussed at length in other published work[2–4]. Instead, we had a more focused approach: that is, to highlight species for which a large number of modern molecular tools have been applied specifically to investigate and uncover the molecular and cellular mechanisms underpinning regeneration. Our speciesselection criteria are laid out in TABLE 2. In the case of echinoderms, the only organism that meets these criteria is the sea urchin; however, this animal and the attendant molecular tools that are available for use in this system have not been used in any systematic way to address problems of regeneration. By contrast, starfish (Asteroidea), brittle stars (Ophiuroidea), sea cucumbers (Holothuroidea) and feather stars (Crinoidea) have been used extensively to study regenerative properties, but the corresponding molecular tools (microarrays, transgenesis, knockout and knockdown, and genome sequences) have yet to be either developed or reported in the literature.

I appreciate the point of view of Drs Dupont and Thorndyke, but still insist that the wonderful regenerative capacities of the classes of echinoderms that were highlighted in their correspondence (Asteroidea, Ophiuroidea and Crinoidea), and their evolutionary association to the deuterostome lineage, have yet to be explored systematically using either loss- or gain-of-function assays, or using the genome- and proteome-wide profiling approaches that are afforded by modern genetic and genomic tools. I share with Drs Dupont and Thorndyke the hope that interrogation of gene functions in sea stars, brittle stars and crinoids will eventually be of great value, and look forward to the development and optimization of the necessary tools to do so in these organisms. Knowledge of regeneration will undoubtedly be enriched by such efforts.

Alejandro Sánchez Alvarado

Howard Hughes Medical Institute, University of Utah School of Medicine, Department of Neurobiology and Anatomy, Salt Lake City, Utah 84132, USA.

1. Sánchez Alvarado, A. & Tsonis, P. A. Bridging the regeneration gap: genetic insight from diverse animal models. *Nature Rev. Genet.* **7**, 873–883 (2006).
2. Goss, R. J. *Principles of Regeneration* (Academic Press, New York, 1969).
3. Needham, A. E. *Regeneration and Wound-healing*, (John Wiley & Sons, New York, 1952).
4. Sánchez Alvarado, A. in *Keywords and Concepts in Evolutionary Developmental Biology* (eds Hall, B. K. & Olson, W. M.) (Harvard Univ. Press, Cambridge, Massachusetts, 2003).