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# Think like a sponge: the genetic signal of sensory cells in sponges

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## Abstract

A complex genetic repertoire underlies the apparently simple body plan of sponges. Among the genes present in poriferans are those fundamental to the sensory and nervous systems of other animals. Sponges are dynamic and sensitive animals and it is intuitive to link these genes to behaviour. The proposal that ctenophores are the earliest diverging metazoan has led to the question of whether sponges possess a 'pre-nervous' system or have undergone nervous system loss. Both lines of thought generally assume that the last common ancestor of sponges and eumetazoans possessed the genetic modules that underlie sensory abilities. By corollary extant sponges may possess a sensory cell homologous to one present in the last common ancestor, a hypothesis that has been studied by gene expression. We have performed a meta-analysis of all gene expression studies published to date to explore whether gene expression is indicative of a feature's sensory function. In sponges we find that eumetazoan sensory-neural markers are not particularly expressed in structures with known sensory functions. Instead it is common for these genes to be expressed in cells with no known or uncharacterized sensory function. Indeed, many sensory-neural markers so far studied are expressed during development, perhaps because many are transcription factors. This suggests that the genetic signal of a sponge sensory cell is dissimilar enough to be unrecognizable when compared to a bilaterian sensory or neural cell. It is possible that sensory-neural markers have as yet unknown functions in sponge cells, such as assembling an immunological synapse in the larval globular cell. Furthermore, the expression of sensory-neural markers in non-sensory cells, such as adult and larval epithelial cells, suggest that these cells may have uncharacterized sensory functions. While this does not rule out the co-option of ancestral sensory modules in later evolving groups, a distinct genetic foundation may underlie the sponge sensory system.

Keywords

Nervous system evolution, Porifera, gene expression, sponge

## 1. Introduction

Sponges lack muscles, a gut and a nervous system, and consequently have emerged as a model to study complex character evolution in Metazoa. But sequencing has revealed substantial genetic complexity despite an apparently simple body plan (Srivastava et al., 2010; Riesgo et al., 2014). The presence of 'neural' genes and evident sensory behaviour in sponges intuitively suggests that the latter emerges from the former. The proposal that ctenophores are basal to all other metazoans (Dunn et al., 2008; Ryan et al., 2013; Moroz et al., 2014), has led to discussion about whether these genes are characters of a 'pre-nervous' system or the remnants of a lost nervous system (Richards et al., 2008; Nickel, 2010; Ryan and Chiodin, 2015). However it is not yet possible to distinguish between these two hypotheses; our paper examines the data from the perspective that nervous system loss has not occurred. Additionally, there is no evidence for the

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