Highlight: Sponges Reveal Stepping Stones in Early Animal Evolution

Danielle Venton*

*Corresponding author: E-mail: danielle.venton@gmail.com.

Accepted: March 13, 2017

Sponges seem relatively simple. They have no specialized tissues or organs. Some have even argued that sponges aren't animals at all, just colonies of cells that work together to function. That said, for those who study sponges, these delicate, simple animals are remarkable, with much to teach us. As the phylum Porifera is a key candidate to be the sister-group to all other animals (Telford et al. 2016), close study of these organisms' genes and life cycles can illuminate features of early animal evolution.

A recent paper published in *Genome Biology Evolution* (Fierro-Constaín et al. 2017) aims to settle an evolutionary question, one raised in the early part of this decade. After the discovery that genes once thought to be only expressed in forming sex cells were also expressed in other cell types (e.g., multipotent cells) in animals with bilateral symmetry, researchers began proposing the existence of a set of genes—a germline multipotency program (GMP)—that had long been part of the animal family tree and was able to operate in both pluri- and multipotent somatic cells and germ cells.

In 2013, Jordi Solana elaborated on this (Solana 2013), proposing the hypothesis of primordial stem cells (PriSCs). These cells would appear while the embryo was forming and developing. In most sexually reproducing bilaterians (e.g., animals other than sponges, jellyfish and comb jellies), Solana expected, the PriSCs would give rise to the primordial germ cells and some somatic stem cells. In animals reproducing asexually and/or capable of regeneration, such as flatworms (a bilatrian lineage), these cells might be present at the adult stage keeping a mixed germ/soma potential.

But, were these genes inherited from an animal ancestor? The data needed to answer that, says Emmanuelle Renard, wasn't conclusive. His lab and team at the Station marine d'Endoume in Marseille has considerable expertise in sponge biology (which is no easy feat given that sponges can be extremely challenging to grow in the lab). So, some of his research team, including then PhD student Laura Fierro-Constaín, sought to illuminate the question by examining the expression of this set of genes during the formation of sex cells and other stages of the life cycle in their favorite sponge model *Oscarella lobularis*.

They found that the GMP toolkit is involved in sexual reproduction in sponges, as it is in every animal examined so far. They also find the GMP expressed in other sponge cell types not involved in sexual reproduction. Therefore, write the authors, "not only the well documented—in a plethora of bilaterians—*piwi*, *vasa* and *nanos* genesg have to be abandoned as germline specific markers, but rather a wider GMP set (for which expression data were sparser until now)."

"Eleven of these genes are expressed not only in sex cells but also in other cell types," says Renard. "Therefore, exciting questions are raised. Our results suggest that all cell types—except one—are expected to be multipotent in this species. Crazy isn't it? The next question can be, why other animals did not keep such capacity—so useful for regenerating a body in case of injury, for example?"

Renard and his team are also interested in investigating how environmental cues, like temperature and pollutants, trigger gene expression and the switching between sexual and asexual reproduction.

For researchers like Solana, who was not involved in the study, this work is further confirmation that genes classically thought to be only involved in the germline, are quite active in all stages of life for some animals. Multipotent cells like choanocytes (in sponges) and the neoblasts of planarians, which express the GMP program and are able to become all other types of cells, can be thought of as equivalent to embryonic stem cells in humans.

"I think this is the broader picture," says Solana. "We are starting to see that somehow all of this is connected together. This is my opinion only, but I would say they are homologous characters."

Currently, the fields of embryonic stem cell research and early animal evolution are very separate. This division is not supported by the work of Fierro-Constaín and colleagues. Instead, the goal, says Solana, is to connect these two fields. "Once we do," he says, "planarians and sponges could become a model for human embryonic stem cell research."

Given the relatively slow progress of developing stem cell therapies to date, the linking could be a welcome change as it could broaden areas of research in the field.

Literature Cited

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Highlights Editor: Laura Katz