Genome integrity and the heritability of somatic mutations in clonal, colonial corals

Elora H. López[1], Rebecca Albright[2], Stephen R. Palumbi[1]
[1]Stanford University
[2]California Academy of Sciences

An *Acropora hyacinthus* colony spawning at Cal Academy's Spawning Lab in April 2019.

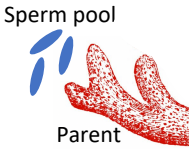
Evolution of the germline

- In many animals, mutations in germ cells are inherited by the offspring, while somatic cells accumulate more mutations and are not inherited.
- **However, plants and many animal taxa may lack embryonic germ-soma distinction.**
- Reef-building corals are long-lived animals in the phylum Cnidaria. Whether they have embryonic germline differentiation is controversial.
- We identified somatic mutations in 10 parent tissue samples from 3 different colonies, then determined whether the mutation unique to a parent tissue was also in the sperm from that parent.

Definitions:
- Inherited somatic mutation: appears in the parent somatic tissue as well as the sperm from that parent
- Non-inherited somatic mutation: appears in the parent somatic tissue but not the sperm from that parent
- Unique germline mutation: appears in a single sperm pool but not in the parent it was spawned from
- Global germline mutation: appears in all of the sperm pools from a colony but none of the parents in that colony

Sperm do inherit some somatic mutations from parent polyps!

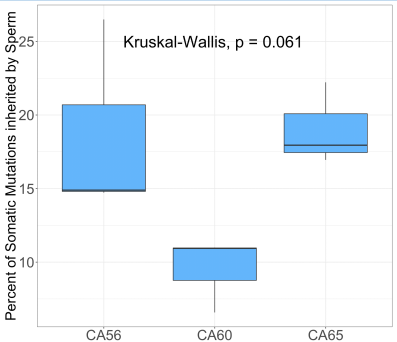
Full genome libraries sequenced:



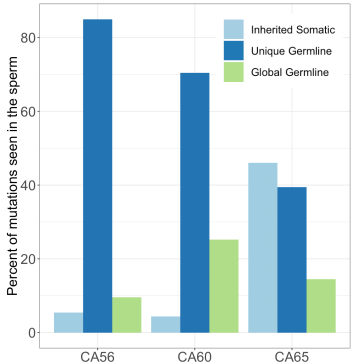
- 10 parent branches * 2 replicate libraries per branch
- 10 sperm pools * 2 replicate libraries per pool
- Average depth of coverage for each parent library: 31x
- Average depth of coverage for each sperm pool library: 48x

Number of mutations found per colony

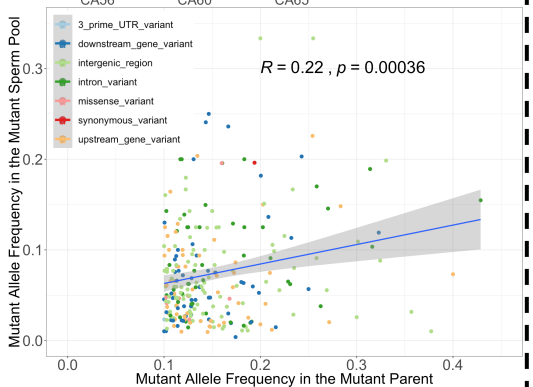
Colony	# Somatic	# Unique Germline	# Global Germline
CA56	3556	2534	286
CA60	2104	760	33
CA65	2368	90	33



On average, 10-20% of somatic mutations are inherited by the sperm.



Inherited somatic mutations account for 5-45% of the mutations found in a colony's sperm.



For inherited somatic mutations, the allele frequency of the mutant allele in the sperm is positively correlated with mutant allele frequency in the parent, but it is not a 1:1 relationship.

Conclusions

- The presence of somatic mutations in sperm pools is evidence of lack of embryonic germ-soma distinction in corals.
- That some somatic mutations are inherited by sperm and some are not supports the Primordial Stem Cell hypothesis, in which self-renewing stem cells can differentiate into either germ or somatic cells for the duration of an animal's lifetime (Solana 2013).
- A mutation that arises in this stem cell line could appear both in the soma and sperm (inherited somatic mutation), whereas mutations that occur post-differentiation would show up only in the soma (non-inherited somatic mutation) or only in the sperm (unique or global germline mutation).
- **We hypothesize that reef-building corals possess self-renewing stem cells that can differentiate into either germ or somatic cells throughout the animal's lifetime. Input of inherited somatic mutations into the sperm pool increases the genetic diversity of the next generation.**