Microbial Communication, Cooperation and Cheating: Quorum Sensing Drives the Evolution of Cooperation in Bacteria - Review

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Paper Summary:

The authors of this paper use a cellular automata approach to studying the evolution of altruistic behavior of bacteria in extracting beneficial agents into the environment. They also communicate through quorum sensing (QS) to measure the population density, which above a certain level, triggers cooperative behavior. "Cheaters" might utilize this resource without cooperating themselves. So called "liars" may boost this signal falsely, not contributing to the community, but reaping the benefits of the excreted compounds. The authors found that cooperation and communication can evolve and is not susceptible to invasions of liars and cheaters. The model consists of a genome of 3 positions which can either be off or on (C=does a "public good", S=produces signal and R=repsonds to signal). It is run on a 300x300 toroidal matrix. Each of the 8 combinations has an associated cost. Individuals can compete for space n the metric and mutations can occur at each position on the genome. After altering the parameters their models to test how these combinations play out in with and without QS and with cooperation have various costs (low and high), the following conclusions are made:

1) Relatedness is important and populations need to have clusters or neighborhoods of related cells to evolve this cooperative behavior.

2) The gene for QS is very strong and when present in the population, the pressure to select for it is very strong.

3) Equilibria were met for 6 out of the 8 classes and there seems to be a place in the community for "liars" and "cheaters".

Critique:

I enjoyed this paper in conjunction with the Communication of Reproductive Restraint paper. Does communication constitute an evolutionary advancement and if so, what kinds of signals can potential destroy this innovation. The authors of this paper do an excellent job of framing their model with the biologically relevant background material. I also immensely enjoyed the sense of humor employed by these authors in naming the states based in different combinations of C, R and S. That being said, the names and all of the possible combinations did confuse me as a reader.

Questions and observations:

- If unreliable signals are not able to invade the population completely, why do "liars" exist in the actual population at all? Ah, I see because it is in their interest to boost the signal and reap the rewards. However, unreliable signals in evolution usefully weaken the election pressure in favor of them.

- I didn't understand the "spiteful" section at the vary end of the paper.