Cooperators Can Coexist with Cheaters, as Long as There Is Room to Grow

Philadelphia, Pa. – Microbes exhibit bewildering diversity even in relatively tight living quarters. But when a population is a mix of cooperators, microbes that share resources, and cheaters, those that selfishly take yet give nothing back, the natural outcome is perpetual war. A new model by a team of researchers from Princeton University in New Jersey and Ben-Gurion University in Israel reveals that even with never-ending battles, the exploiter and the exploited can survive, but only if they have room to expand and grow. The researchers present their findings at the 57th Annual Meeting of the Biophysical Society (BPS), held Feb. 2-6, 2013, in Philadelphia, Pa.

“In a fixed population, cells that share can’t live together with cells that only take,” said David Bruce Borenstein, a researcher at Princeton. “But if the population repeatedly expands and contracts then such ‘cooperators’ and ‘cheaters’ can coexist.”

Our world and our bodies play host to a vast array of microbes. On our teeth alone, there are approximately a thousand different kinds of bacteria, all living in very close quarters. This is amazing, the researchers observe, because many of those species share resources with nearby neighbors, who might not be so cooperative or even related [1].

At the scale of cells, individuals cooperate mainly by exporting resources into the environment and letting them float away. “This is a deceptively complex process in which cells interact at long ranges, but compete only with nearby individuals,” explained Borenstein. “Our models predict that, even when this exploitation prevents any possibility of peaceful coexistence, the exploiter and the exploited can survive across generations in what is basically a perpetual war.” The researchers speculate that similar competition might occur between cancer cells and normal tissue.

Borenstein and his colleagues made their conclusions based on a computer model that considered two types of cells, cooperators and cheaters, and laid them out on a grid. Cooperators were given the ability, not uncommon in nature, to make a resource that speeds up growth in both kinds of cells. Producing this resource slowed down the growth of cooperators, because they have to divert some energy to resource production. This resource then spread out from the cooperator by diffusion, so that the cells closest to a producer have the greatest resource access. The model revealed that the producers tended to cluster, meaning that being a producer gave you greater access to resources. It also meant that even though cheaters are avoiding the cost of production, they pay for it with reduced resource access.

Within these basic constraints it was found that when the two populations must compete directly for survival, no coexistence is possible. “One type always wins out,” observed Borenstein. However, when the two populations can grow into empty space, the researchers found a strange and paradoxical interaction: cheaters may be outcompeting cooperators locally, even as cooperators grow better overall. These complex interactions may play an important role in the maintenance of diverse microbial communities, like those seen in the mouth.

“To our astonishment, we found that while cheaters can exploit cooperators, cooperators can isolate cheaters, just from cooperation and growth,” concludes Borenstein. “As a result, the community can persist in a sort of perpetual race from which a winner need not emerge.”

[1] J. M. ten Cate. “Biofilms, a new approach to the microbiology of dental plaque.” Odontolgy 2006(94):1-9.

Presentation #2530-Pos, "Diffusion of public goods prevents coexistence of cooperators and cheaters in a stochastic competition model," will take place at 1:45 p.m. on Tuesday, Feb. 5, 2013, in the Pennsylvania Convention Center, Hall C. ABSTRACT: http://tinyurl.com/ba46sdb

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This news release was prepared for the Biophysical Society (BPS) by the American Institute of Physics (AIP).

ABOUT THE 2013 ANNUAL MEETING

Each year, the Biophysical Society Annual Meeting brings together over 6,000 research scientists in the multidisciplinary fields representing biophysics. With more than 3,900 poster presentations, over 200 exhibits, and more than 20 symposia, the Annual Meeting is the largest meeting of biophysicists in the world. Despite its size, the meeting retains its small-meeting flavor through its subgroup meetings, platform sessions, social activities, and committee programs.

The 57th Annual Meeting will be held at the Pennsylvania Convention Center (1101 Arch Street, Philadelphia, PA 19107). For maps and directions, please visit: http://www.paconvention.com/explore-philadelphia/directions-and-parking.

QUICK LINKS

Meeting Home Page:
http://www.biophysics.org/2013meeting/Main/tabid/3523/Default.aspx
Housing and Travel Information:
http://www.biophysics.org/2013meeting/AccommodationsTravel/HotelInformation/tabid/3621/Default.aspx
Program Abstracts and Itinerary Planner:
http://www.abstractsonline.com/plan/start.aspx?mkey=%7B763246BB-EBE4-430F-9545-81BC84D0C68C%7D

PRESS REGISTRATION

The Biophysical Society invites credentialed journalists, freelance reporters working on assignment, and public information officers to attend its Annual Meeting free of charge. For more information on registering as a member of the press, contact BPS Director of Public Affairs and Communications Ellen Weiss at eweiss@biophysics.org or 240-290-5606, or visit http://www.biophysics.org/2013meeting/Registration/Press/tabid/3619/Default.aspx. Press registration will also be available onsite at the Pennsylvania Convention Center in the Biophysical Society's meeting office, Room 304VIP.

ABOUT BPS

The Biophysical Society (BPS), founded in 1958, is a professional scientific society established to encourage development and dissemination of knowledge in biophysics. The Society promotes growth in this expanding field through its annual meeting, monthly journal, and committee and outreach activities. Its 9000 members are located throughout the U.S. and the world, where they teach and conduct research in colleges, universities, laboratories, government agencies, and industry. For more information on the Society or the 2013 Annual Meeting, visit www.biophysics.org.

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