## ScienceWatch – Roaches That Check Out of the Roach Motel

**"We don't know if glucose actually tastes bitter to glucose-averse roaches, but we do know [it] … causes the glucose-averse roach to close its mouth and run away from glucose in tests." – C. Schal**

Cockroaches appeared about 200 million years ago around the time of the first dinosaurs. Dinosaurs, of course, are long gone but cockroaches are still doing quite well, which speaks to their great adaptability. Of the 4,500 species of cockroaches found worldwide just four are considered common pests. One that is well-known to city dwellers is the German cockroach (*Blattella germanica*). A study appearing in the May 24, 2013 issue of *Science* highlights its ability to adapt in ways we never thought possible.


In the 1980's poison baits containing sugar (glucose) laced with insecticide became widespread because of their effectiveness in controlling roaches. Extensive use of an insecticide often results in resistance to it by the target insect. But in this case something different occurred. Experts noticed that some roach populations began avoiding the baits because they had developed an unusual adaptation. The glucose in the bait, which formally attracted the roaches, had become a repellant. The roaches had become" glucose averse" and the aversion was inherited. Now Coby Schal and his colleagues at North Carolina State University, Raleigh, NC, have found out why this occurs.

The entomologists attached electrodes to the nerves that lead to the brain from different taste receptors in the roaches' mouthparts. They then tested various substances to see which ones bound to each receptor, causing its nerve to fire. In normal roaches, they found a "sweet" receptor, which was selectively stimulated by glucose and another sugar, fructose*. Stimulating this receptor sent a "sweet" signal to the brain and induced feeding. They also found a "bitter" receptor, which only responded to the bitter taste of caffeine. Stimulating this receptor sent a "bitter" signal to the brain, depressed feeding and made the roaches avoid the caffeine.

The same experiments with glucose-averse roaches showed that, surprisingly, the bitter receptor now responded to glucose. In addition, the sweet receptor in these roaches responded only very weakly to glucose as compared to normal roaches. In other words, glucose-averse roaches had rewired their taste neurons so that glucose now tasted bitter to them and they avoided it.

Lacking any genetic or neurological information on how the change occurred, the authors say there are two possible explanations for such a receptor switch. One or more mutations caused a structural change in the usually "bitter" receptors so that now they

bind glucose instead of caffeine, but still send a "bitter" signal to the brain. Or mutations now produce glucose-detectors instead of "bitter" receptors on the neurons that normally send the "bitter" signal to the brain. They favor the former, but either would effectively cause the roaches to avoid sugar-laden poison baits.

Because they avoid glucose these roaches grow more slowly. However, in a world where glucose is deadly for them, they survive and that's what counts.

Humans have devised many clever ways to kill roaches. But the insects always seem to be one step ahead of us. Nevertheless, researchers remain hopeful. Co-author Jules Silverman says, "It is extremely gratifying that we now understand the neural mechanism that underlies this unusual, yet adaptive, behavior." Senior author Colby Schal agrees that understanding what is happening at the neurological level is important "for developing new strategies for controlling these insects."

Let's hope he's right.

Saul Scheinbach

*When a molecule of glucose combines with a molecule of fructose it forms table sugar (sucrose).