Images like this one were flashed on a screen too rapidly for the dots to be counted. Subjects were asked to estimate which color was more numerous. Here there are 8 yellow dots and 6 blue; ratios varied randomly from 1:2 to 7:8.

The authors discovered a "surprisingly large variation in the ANS acuity". Some subjects could detect excesses as relatively small as 10 over 9 with 75

This research was picked up by Natalie Angier in the September 16 2008 New York Times under the headline "Gut Instinct's Surprising Role in Math".

Midge dynamics in Lake Myvatn.

50 generations of midge population in Lake Myvatn. The solid line represents observations, the dashed line output from the mathematical model with nine tuned parameters. Image courtesy of Anthony Ives.

"Mathematics Explains Mysterious Midge Behavior" is the title of an article by Kenneth Chang in the March 7 2008 *New York Times*. At Myrvatn ("Midge Lake") in northern Iceland, during mating season, the air can be thick with male midges (*Tanytarsus gracilentus*), billions of them. Chang quotes Anthony Ives (Wisconsin) "It's like a fog, a brown dense fog that just rises around the lake." And yet in other years, at the same time, there are almost none. Ives was the lead author on a report in *Nature* (March 6 2008) that gave an explanation for this boom-and-bust behavior in which, as Chang describes it, "the density of midges can rise or fall by a factor of a million within a few years." In the *Nature* report ("High-amplitude fluctuations and alternative dynamical states of midges in Lake Myvatn"), Ives and his co-authors characterize the midge ecology as one "driven by consumer-resource interactions, with midges being the consumers and algae/detritus the resources" and they set up a system of three coupled nonlinear difference equations, one each for midges, algae and detritus, to model it. The dynamics of this system include a stable state as well as a stable high-amplitude cycle; small variations in parameters can drive the system from one of those attractors to the other.

Alternative stable states of the midge-algae-detritus model. In the panel on the left, the plane is tangent to the manifold containing the cyclic component of the dynamics around the stationary point. The white region in the plane shows the domain of attraction to the invariant closed set, whereas the region in grey gives the domain of attraction to the outer stable cycle. The red lines give two examples of trajectories that converge to the outer stable cycle. The panel on the right shows the plane in more detail to illustrate the fine structure of the domain of attraction to the invariant closed set. The blue pentagon shows the unstable period 5 cycle that makes up part of the boundary between domains of attraction to the inner invariant closed set and the outer stable cycle. Image courtesy of Anthony Ives.

19-27 August 2010: International Congress of Mathematicians - ICM 2010,

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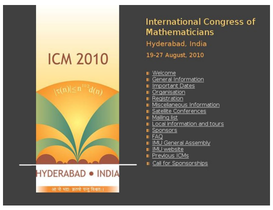

July 18–22, 2011: 7th International Congress on Industrial and Applied Mathematics - ICIAM 2011,

Vancouver, BC, Canada.

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