Collective Behavior: Social Insects

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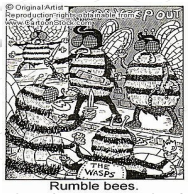
Complex Systems
4.16.08



Rumble bees.

Herding Behavior

- **Herding behavior** – emergent behavior of individuals in a group acting without a planned direction
- examples:
  - insect groups
  - mob violence
  - stock market bubbles
  - 'sheeple'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Hamilton's Selfish Herd Theory (1971)

- Animals move toward the group's center to avoid predation.
  - Mechanism of emerging group behavior is a product of uncoordinated selfish interactions
  - Does not benefit population or species


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Why are social insects a special case?

- **Eusociality:**
  - Reproductive division of labor
  - overlapping generations
  - cooperative care of young


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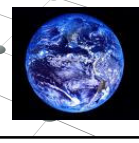
Why are social insects a special case?

- **Superorganisms**: groups of interdependent individual insects
- **Distinct from**:
  - Single celled animals
  - Colonial single celled animals
  - Multicellular animals
    - Groups of interdependent cells



Why are social insects a special case?

- **Multilevel selection**
  - Population
  - Colony
  - Caste
  - Individual

- **Haplodiploidy** – general method of sex determination in Hymenoptera
  - Males haploid (unfertilized)
  - Females diploid

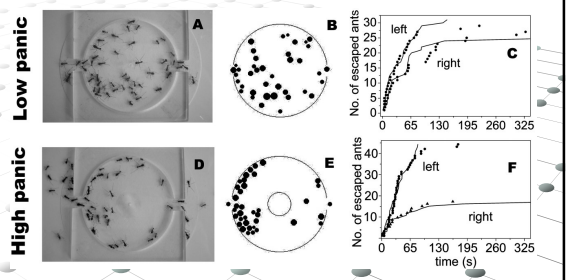
Who's Where?

- **Ernesto Altshuler**
  - Social insect dynamics
  - Transport in superconductors
  - Granular matter
- **Henri Poincare" Group of Complex Systems**
  - Department of Physics, Havana Cuba
  - Combine statistical physics with complex systems thinking

Symmetry Breaking in Escaping Ants

Control = no repellent
Experimental = repellent used to create panic

Symmetry Breaking in Escaping Ants



Symmetry Breaking in Escaping Ants

Symmetric escape

↓

Induced panic

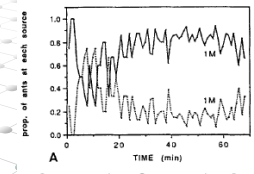
↓ ?

What's the mechanism?

Nonsymmetric escape

Symmetry Breaking in Foraging Behavior

- Cooperative transmission explains asymmetric *Lasius niger* foraging
- Asymmetric foraging in opposition of IFD



Discussion Questions

1. Is panic aggregation a form of self organization or a byproduct? Runaway positive feedback?
2. How could panic herding behavior be advantageous?
3. Altshuler suggests collective panic behavior in ants is similar to human behavior. Why do we see similarity cross-taxa and cross social structure?
4. What was the significance of the lack of influence of genetic similarity on symmetry breaking?

References

- BIESMEIJER JC. Exploration and exploitation of food sources by social insect colonies: a revision of the scout-recruit concept. BEHAVIORAL ECOLOGY AND SOCIOBIOLOGY 49 : 89 2001.
- E. Altshuler., et. Al. Symmetry Breaking in Escaping Ants. The American Naturalist. 166:6. 2005.
- R. BECKERS, J.L.D.ENEUBOURG, S. GOSS and J.M. PASTEELS. COLLECTIVE DECISION MAKING THROUGH FOOD RECRUITMEN. Insectes Sociaux. 37:7. 1990
- S. Camazine, J.L. Deneubourg, N.R. Franks, J. Sneyd, G.Theraulaz, E. Bonabeau. Self-Organization in Biological Systems. Princeton University Press. 2001.
- W.D. Hamilton. Geometry for the Selfish Herd. J. theor. Biol. 31 295-311. 1971