Swarm Intelligence
Social Insects

Chris Quick
Thomas Root

Social Insects
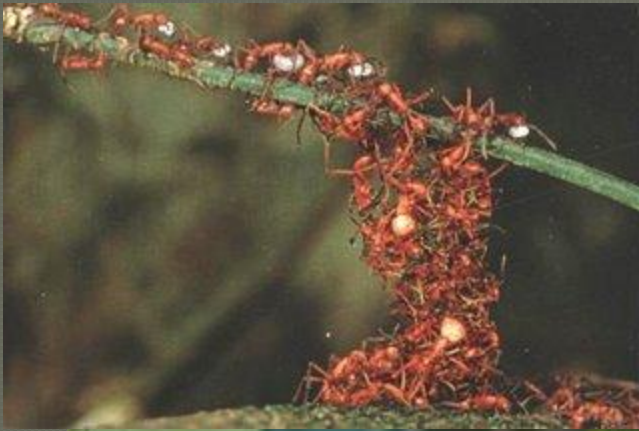
- What governs in a colony?
- Where do the plans come form?
- What foresees the future?
- How is equilibrium preserved?
- When observing an insect in a colony each seem to have its own agenda, and yet the group is organized.

•Leafcutter ants forge for leaves hundreds of meters away.

•Ants work to form chains to span gaps for other workers to pass over.
•Ants will also form chains to create more force to pull leaf edges together.

Ant Organization

- Hunt in large organized groups.
- Works don't do all the work, they specialize in a set of tasks, according to its morphology, age, or chance.
- Task are preformed by specialized individuals.
- Colonies can include physically different types of ants that coexist.
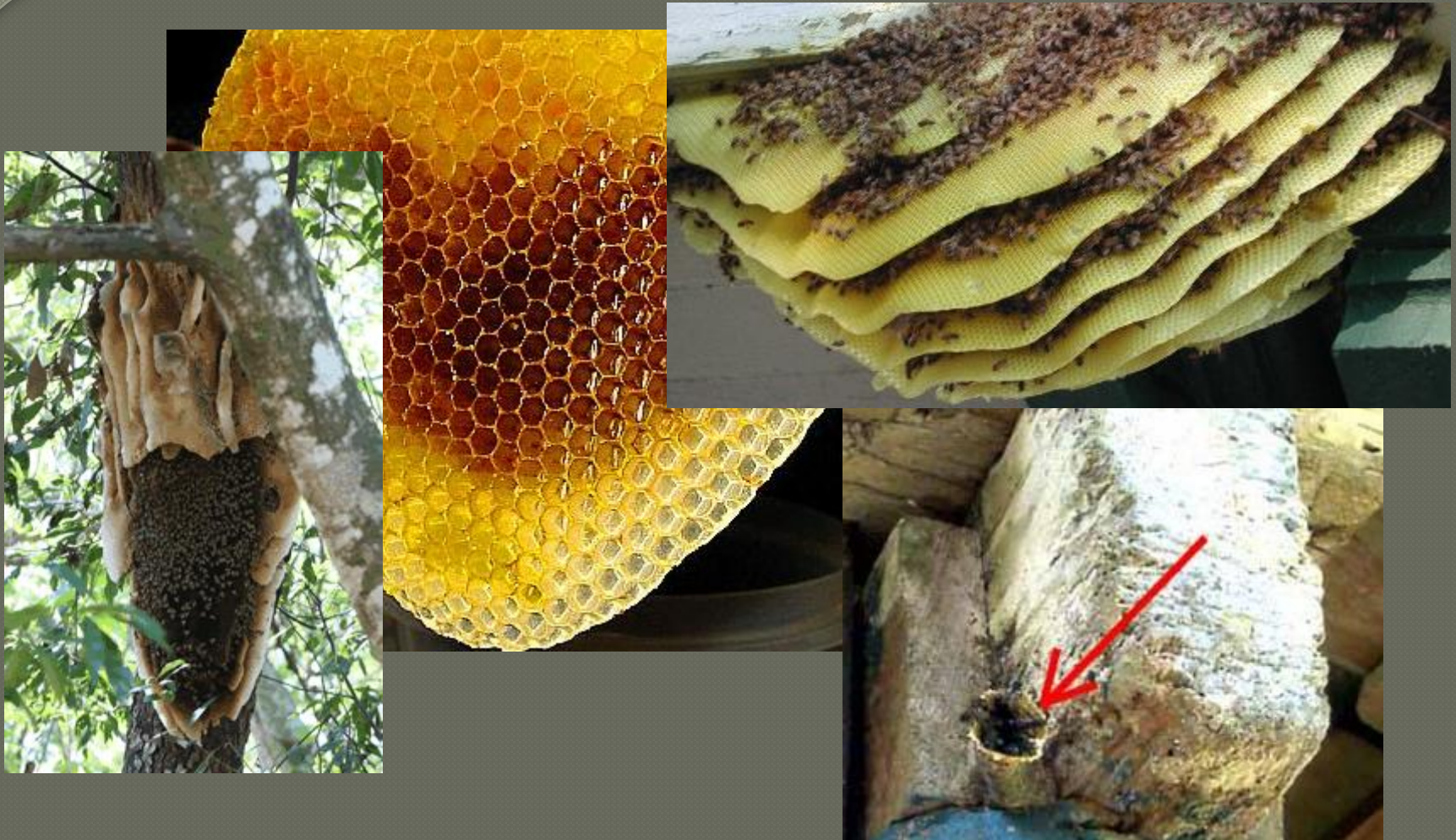
•Bees work in groups to untwist combs to make them parallel.
•Combs are organized into rings of brood, pollen, and honey.
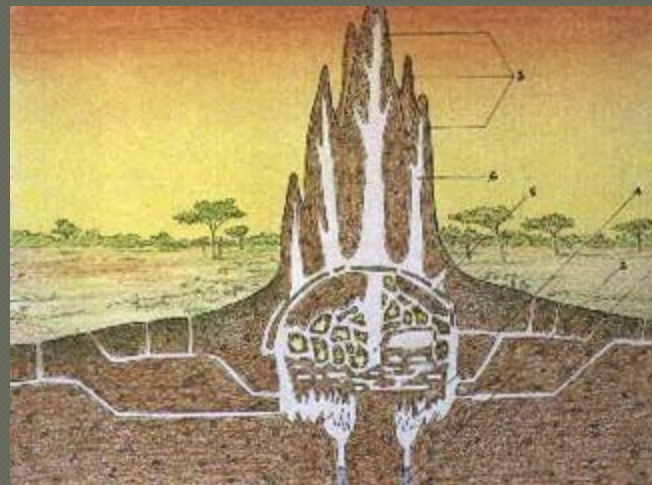
•Termites build very complex nests, with different sections.
•Outer walls, ventilation ducts, brood chambers with pillars, thick walled protective bunker, fungus gardens, and a royal chamber.

Self-Organization

- Insects are complex, they can process a lot of sensory inputs, and respond to them.

- However, book clams that the behavior shown is too complex to be explained by individual insect organization.

- Examples from physics and chemistry show complex behavior can arise from simple interactions.

How Its Helpful

- Solves problems in a flexible and robust way.

- A model of a system that can self-organize to solve a problem.

- Insect Behavior: Catalog
                        Model and Modify

Modeling Insects in Software

- Biological parallels leverage evolution

- Tools of self-organization
  - Positive feedback
  - Negative feedback
  - Fluctuation
  - Multiplicity

Self-Organized Systems

- Order from homogeny
  - Queen lays eggs randomly; close to other eggs
  - Honey and pollen added randomly in 4:1 ratio
  - Removed in 12:19 ratio from cells not near eggs

- Multistability

- Decision thresholds

Making it Useful

- Stigmergy
  - Direct
  - Indirect
- Parameter qualification
  - Not necessary to include all
  - Should include only relevant
- Parameter quantification
  - When possible compare to natural systems
  - When useful deviate from natural systems

Questions?