Insect Behavior
General Entomology

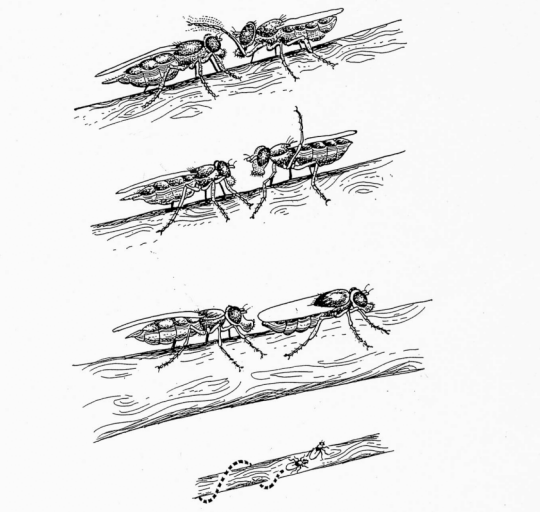
Fixed Action Patterns (FAP's)

Genetically programmed behaviors
* elaborate courtship and mating rituals
* intricate nest building behaviors
* tool use (*Ammophila*, a sand wasp, tamps its nest entrances and weaver ants use their larvae to sew together tree nests)
* migration routes of monarchs

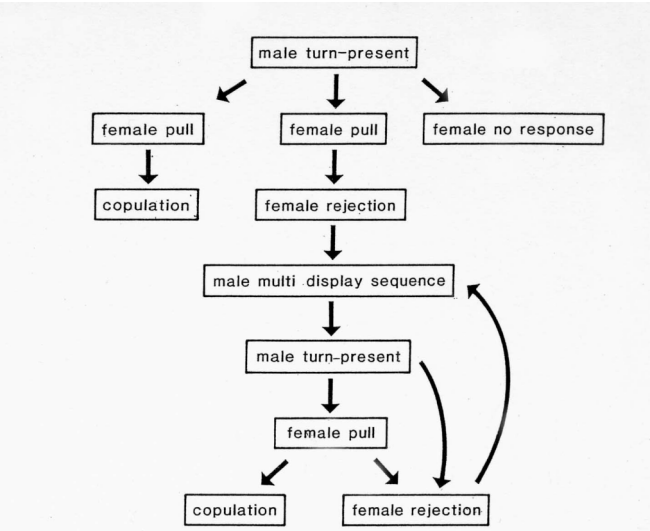
Often condition dependent

Insects are great examples of engineered flexibility

* FAP's are condition dependent
* built-in flexibility
  - Example: calling rate of field cricket as a f(x) temp:
    T = 50 + (n-40/4)
* Example: ethogram or reaction chain for *Physiphora demandata*
  - several paths and outcomes are possible given different stimuli, hormonal states, etc.
  - reaction chains with pre-programmed behavioral flexibility



13.6 Three of the displays employed by courting males of the otitid fly *Physiphora demandata*. (*Top*) The male drums on the female's thorax with his foreleg. (*Middle*) The male stiffly raises his metathoracic leg on the side away from the female. (*Bottom*) The male turns to face away from the female. She may respond by placing her proboscis on the tip of the male's abdomen. She then appears to "pull" the male backward along his perch in a spiral course. (From Alcock and Pyle, 1979.)



13.7 The pattern of use of courtship displays by *Physiphora demandata*. A male attempts to copulate with a female immediately upon encountering her. Only if she refuses does the male employ a series of displays before trying again to copulate. The pattern is repeated over and over until the male succeeds or the female departs. (From Alcock and Pyle, 1979.)

Endogenous Rhythms

* many insect behaviors occur on a 24-clocklike basis
* these are often referred to as *Circadian rhythms*, literally meaning "around one day"
* some insects only active for brief intervals each day

1. walking behavior in crickets (they get restless at night)
   - hormonally induced Circadian rhythm (probably) the common control

2. ghost moths fly only for 20 minutes at twilight
3. emergence of adults is often closely timed to some part of day: some morning, some nocturnal, etc.
4. honey bee foraging activity
   - bees showed up at Carl von Frisch's tea at the same time every day at 10:00 AM
   von Frisch discovered Circadian rhythms when bees arrived at 10:00 AM but tea and sweets were late and had not yet been brought by the housekeeper.

* biological clocks entrained by
  - protocerebrum and interneurons
  - *ocelli* appear important in setting the internal clocks of insects

Orientation

* ***taxes***: directed movements
* ***kineses***: undirected movements, but where speed or freq. of turning is determined by stimulus strength
* responses may be positive or negative
  e.g.., negative phototaxis: insect turns a lot when there is much light;
  positive phototaxis moves less with reduced light or flies towards light

Common taxes:
- *photokinesis*
- *geotaxis*
  - directed movement with respect to gravity
  - ants use this extensively; all ground dwellers
- *anemotaxis*
  - movement with respect to air movement (wind direction)
  - insects orienting to pheromones
- *phototaxis*
  - many diurnal insects are positively phototacic
- *astrotaxis*
  - orienting to sun or moon (includes polarized light)
  - see Figure 7-7 from Evan's *Insect Biology*
- *chemotaxis*
  - orientation to taste or odor
- *phonotaxis*
  - orientation with respect to sound

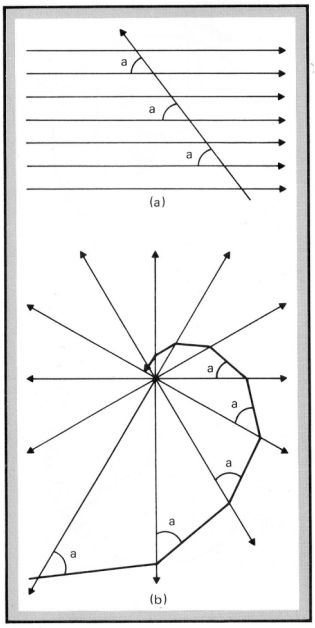


Figure 7–7
(a) A moth maintains a straight line when navigation is via rays of light that are from a distant source and thus essentially parallel. (b) But when the source is close by, maintenance of a constant angle with the light rays causes the moth to circle toward the source.

Klinotaxic behaviors: movements dependent on stimulus gradient: e.g., light, chemical (pheromone), sound, etc.

FAP's/behavioral actions are often condition-dependent
* hungry ant: positively phototactic, negatively geotactic
* well-fed ant: negatively phototactic, postitively geotactic
* any given behavioral actions will be dependent upon
  - *stimulus* (e.g., bright or dark)

- *age, sex*, etc.
- *hormonal states*
- *physiological state* (e.g., hungry or sated)
- *previous experience* (learned behavior)

Learning and Memory in Insects

* *learning = changes in behavior as a result of previous experience*
* most insects (cockroaches) begin forgetting soon after they learn something
* honeybees hold memories up to 14 days
* few insects selected to learn over long periods (life too short)

Location of Learning

* principally in the protocerebrum
* some learning in the *mushroom bodies*
* but some learning in thoracic ganglia in cockroach = ganglionic learning

What do insects learn?

* maze-learning: some can learn: ants and cockroaches
* some insects have remarkable abilities to learn some things more closely tied to their survival:

1. Honeybees learn (four) colors and shapes reasonably well
2. *Heliconiine* butterflies (long wing butterflies)
   - *trapliners* in tropics
3. Sand Wasps and ground-nesting bees
   - orientation flights
   - rapid capture of complicated surface details
   - some easily fooled (*Ammophila*): move one or two key markers and all is lost
   - others not easily fooled (*Bembix*) (digger wasp that nest on open sands)