Organization of behavior

Chapter 6

(1st lecture)

Up to this point, we have considered behaviors as isolated events that animals exhibit in response to specific events

For animals to survive in a complex and changing world, they must have the ability to:

Prioritize specific behaviors at any given time (e.g., a male must terminate its flight to a females when it hears an approaching bat)

Have mechanisms for terminating specific behaviors when they could become dangerous (e.g., know when to stop feeding)

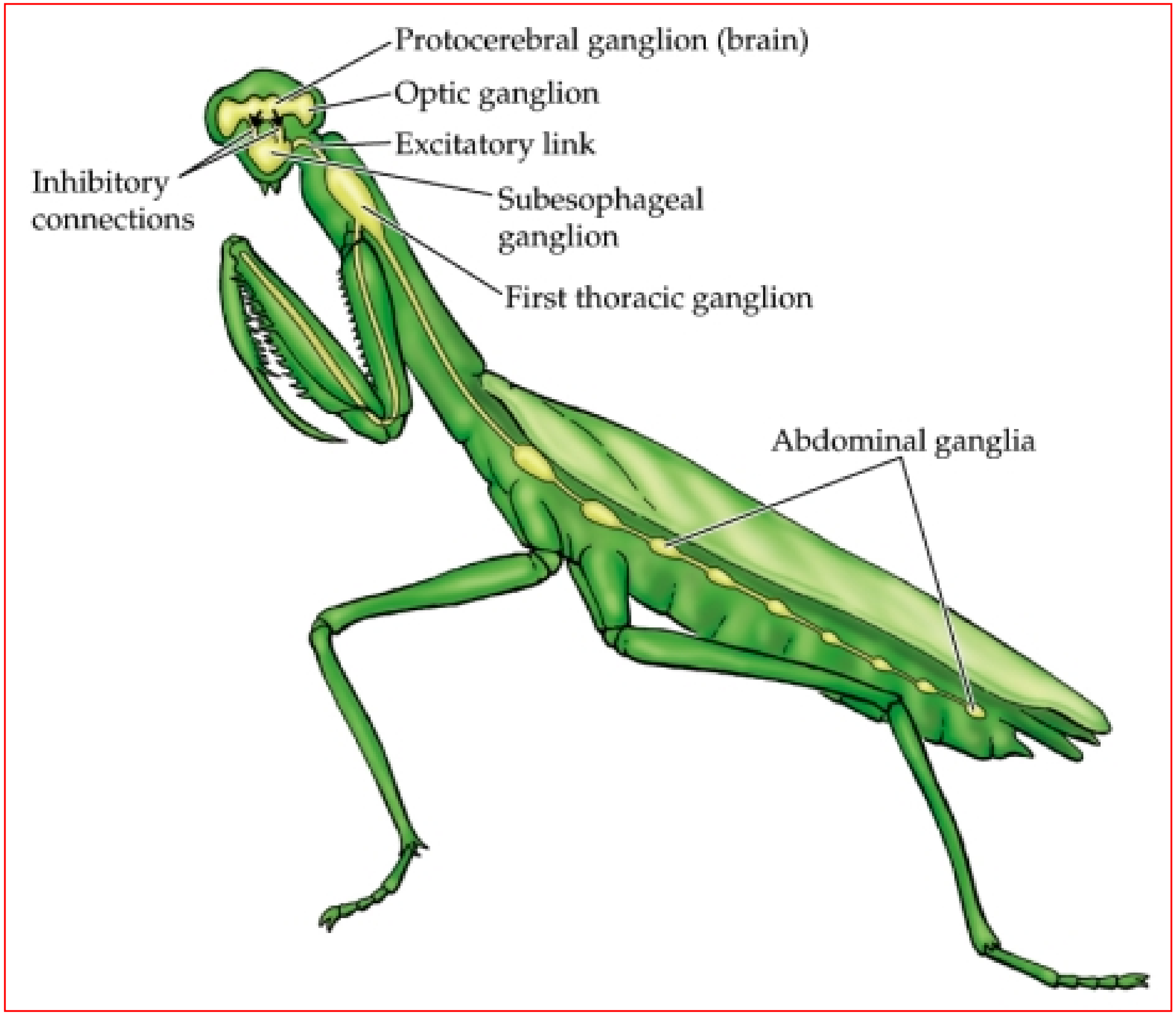
Be able to organize behaviors over time so that it can effectively anticipate regular changes in the environment (e.g., day/night transitions and seasonal changes)

Preying mantises exhibit a variety of different behaviors:

search for mates, copulate, thermoregulate, fly, evade bat attacks, or attack insects that have move within striking distance

How does the female's nervous system ensure that only one behavior is exhibited at any given time?

Ken Roeder proposed a *command center hypothesis* to explain how the preying mantis regulates which behavior it exhibits at any given time



Observations:

Behavioral output of each body segment is controlled by the local ganglion

The brain (protocerebral ganglion) appears to inhibit neural activity in each ganglion

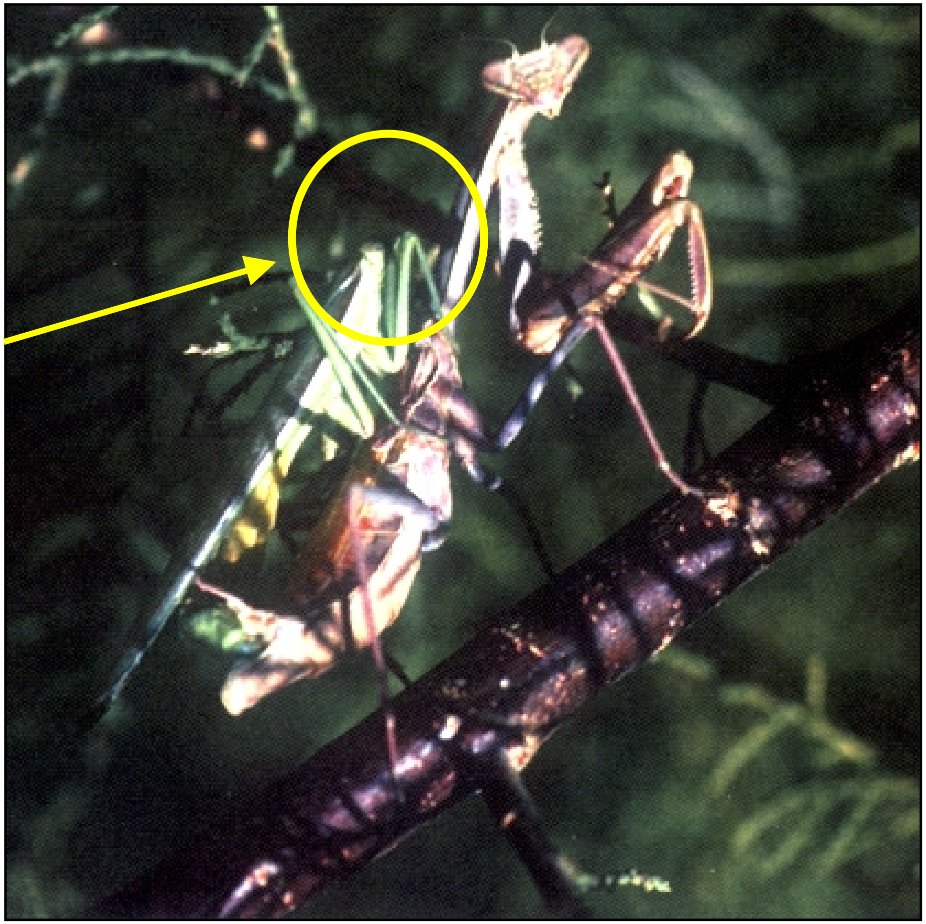
Cutting the link between thebrain and the rest of the body caused the insect to engage in multiple behaviors simultaneously (e.g., walking and grasping)

According to this hypothesis, the brain is the command center, and it selectively disinhibits the activity of certain behavioral programs generated within each individual ganglia

One observation that is inconsistent with this hypothesis was made while Ken Roeder was observing the mating behavior of the preying mantis

As with many invertebrates, mating is a dangerous business for male preying mantises, often resulting in death. In this case, the female often attacks the male as he approaches, and consumes his head. Despite his headlessness, the male can often still mate successfully with the female.

Note the absence of a head



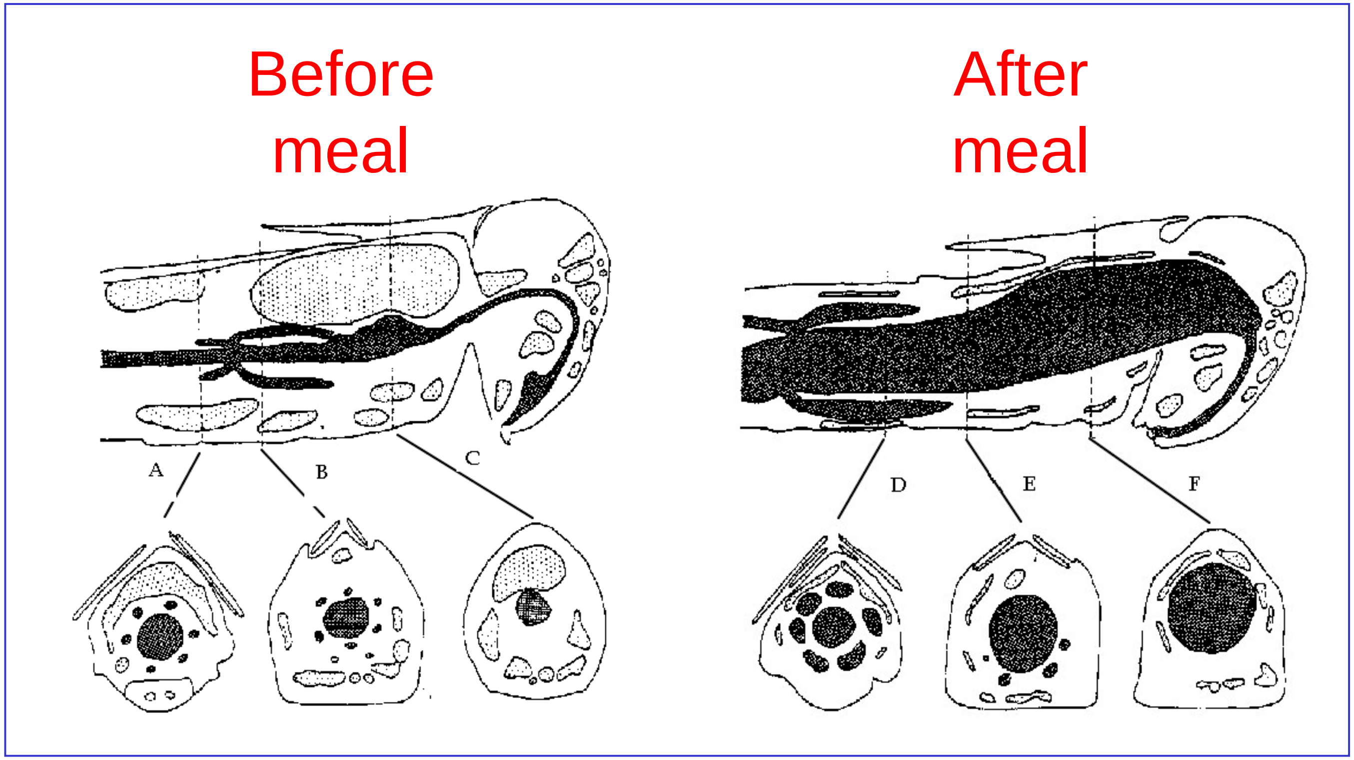
Why is this observation inconsistent with the command center hypothesis?

Another important feature of the nervous system, which helps regulate behavior, is *negative feedback*

The nervous system must be able to determine when to inhibit certain behaviors to avoid harming the body:

e.g., eating, drinking, grooming or flying

In moat animals, feeding causes substantial distension of the intestinal tract. The animal's nervous system must know when to stop feeding to avoid overfilling.



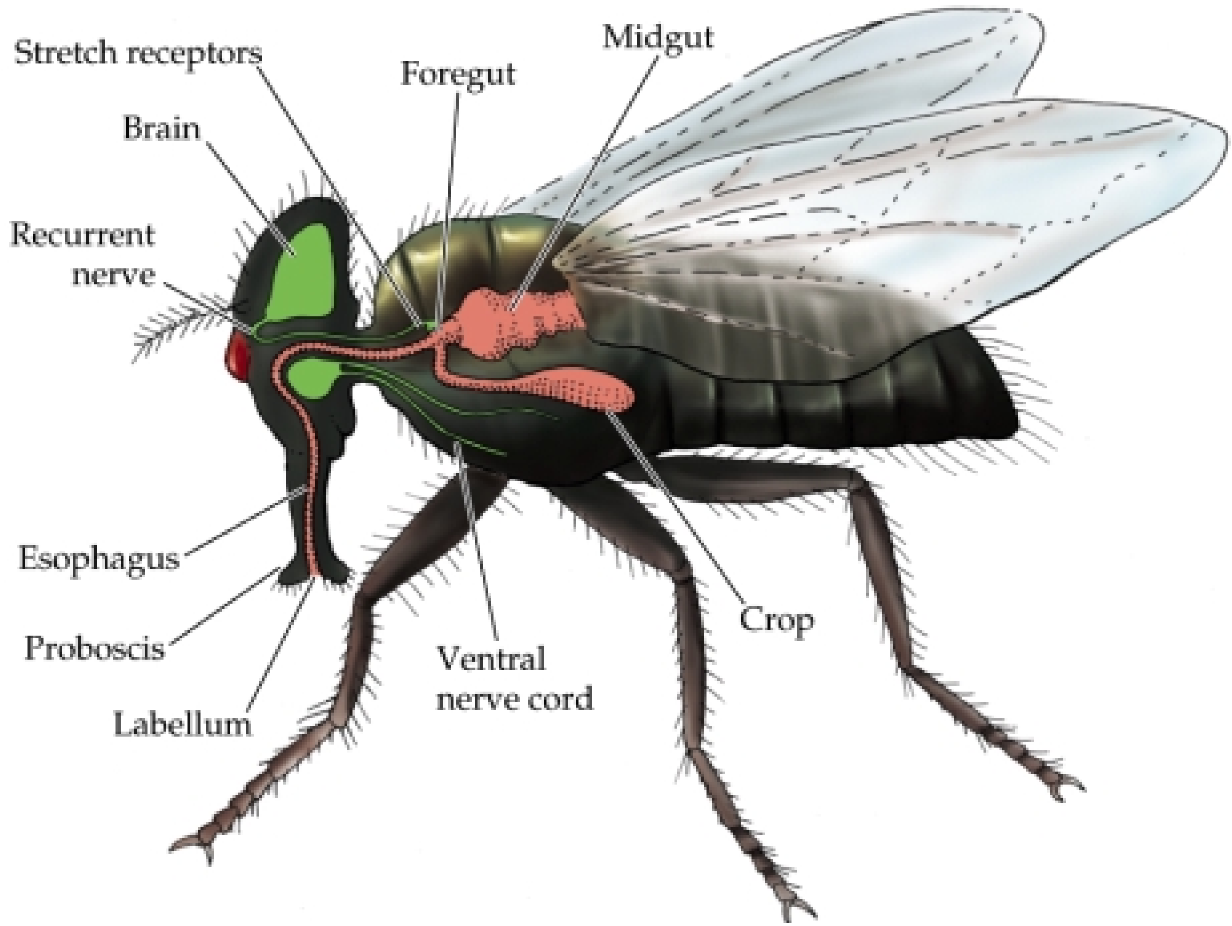
What types of negative feedback mechanisms could they use to avoid overfilling?

A sucrose solution stimulates vigorous drinking by this fly.

Taste cells located in sensilla on the feet and proboscis detect the sucrose solution and stimulate drinking

Sugar-sensitive taste cells in sensilla on the feet and proboscis detect the sucrose solution and stimulate drinking

As the animal drinks, fluid accumulates in the crop, causing it to distend; this activates stretch receptors



What is the source of negative feedback in this system?

What would happen if this negative feedback was eliminated?

Another way to organize behavior is to evolve mechanisms for keeping track of time

How would animals benefit from this ability?

Could anticipate daily, monthly and seasonal changes

Could adapt their daily patterns of activity to changes in local resource abundance

Biological rhythms occur over many different time-scales

Type of Cycle	Organism	Behavior
Ultradian (variable)	lugworm	feeding (every 6–8 min.)
	meadow vole	feeding/resting (every 15–120 min. during daylight)
	euglena	motility
Tidal (12.4 hours)	oyster	opening of shell valves
	fiddler crab	locomotion/feeding
Lunar (28 days)	midge (marine insect)	mating/egg laying
	grunion (marine fish)	egg laying
Circadian (24 hours)	deermouse	drinking/general activity
	fruit fly	emergence of adults from pupa
Circannual (12 months)	woodchuck	hibernation
	chickadee	reproduction
	robin	migration/reproduction
Intermittent	desert insect	reproduction (triggered by rain)
(variable—several days to several years)	lion	feeding (triggered by hunger)
	shiner (river fish)	reproduction (triggered by flooding)

One can ask both ultimate and proximate questions about these rhythms:

Why do they occur?

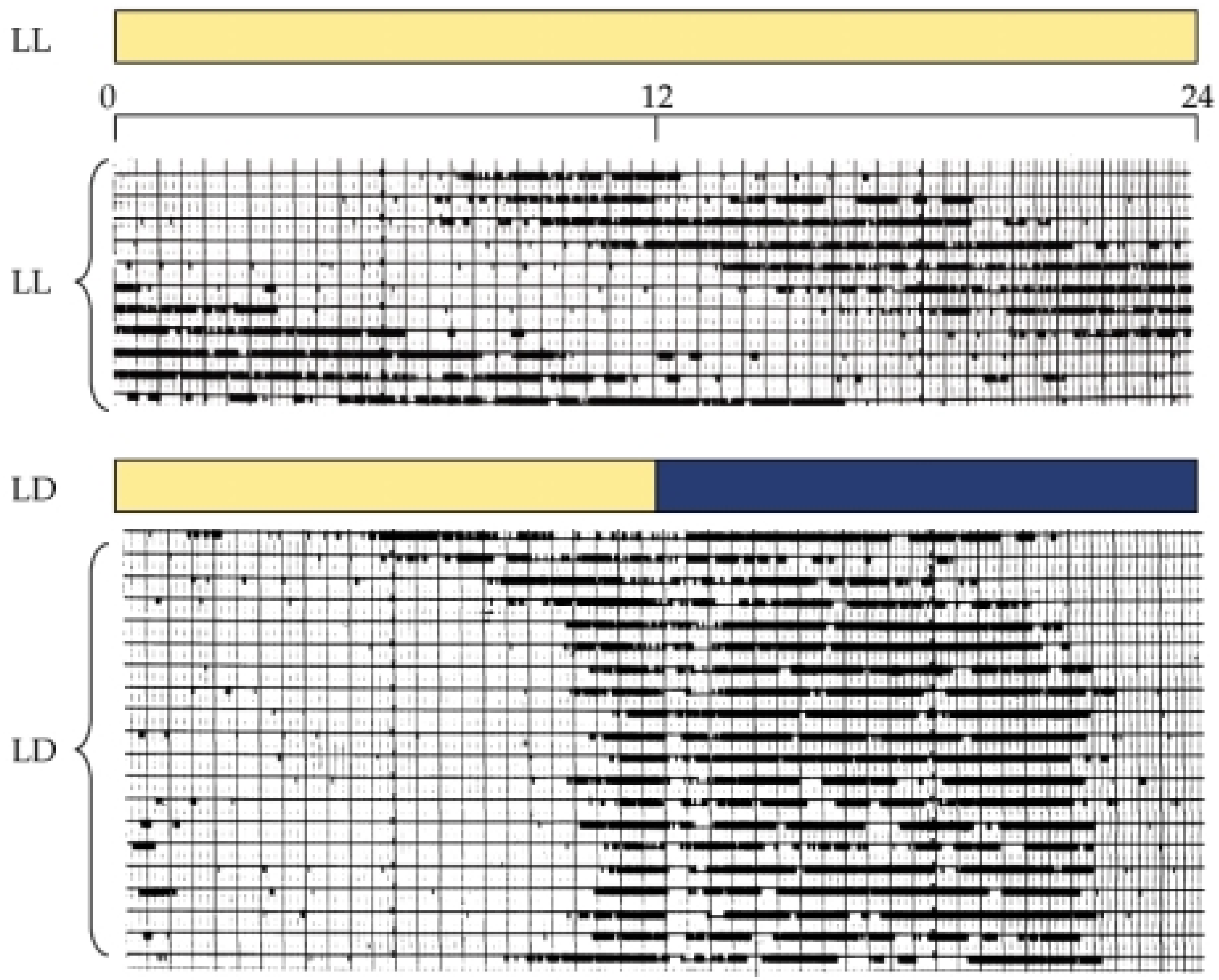
How does the animal keep track of time?

Male crickets dig holes in the ground, and then call directly over the holes. The hole serves to amplify its call, and thus increase its chances of attracting a female.

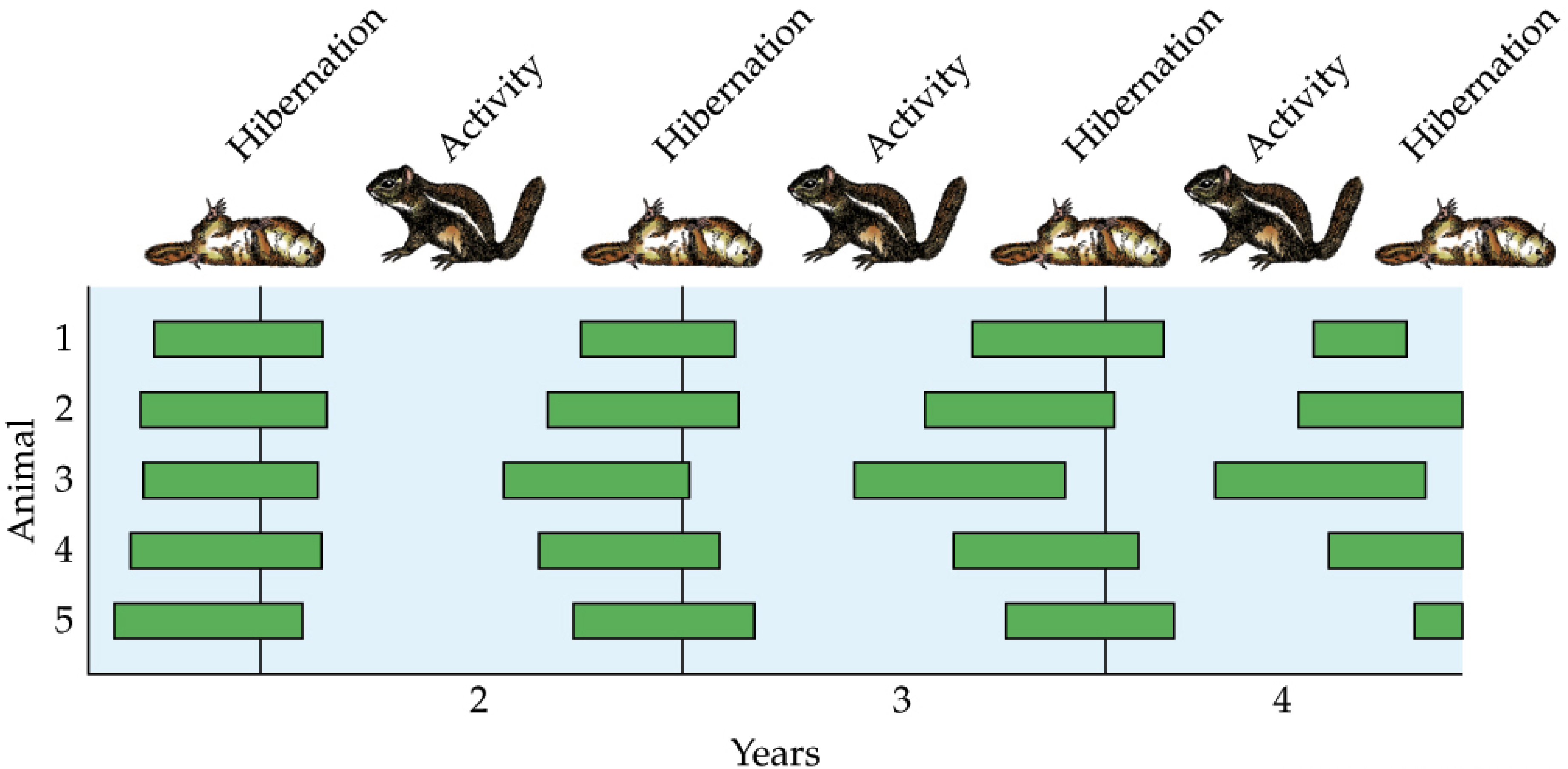
The male cricket can also increase its chances of attracting a female by calling at a time when she is looking for a mate (i.e., at dusk and during the night)

This figure illustrates the the cricket has an endogenously controlled circadian rhythm that is slightly longer than 24hr

This endogenous rhythm is “set” or entrained to a 24 hr cycle by an external 12 hr L: 12 hr D cycle



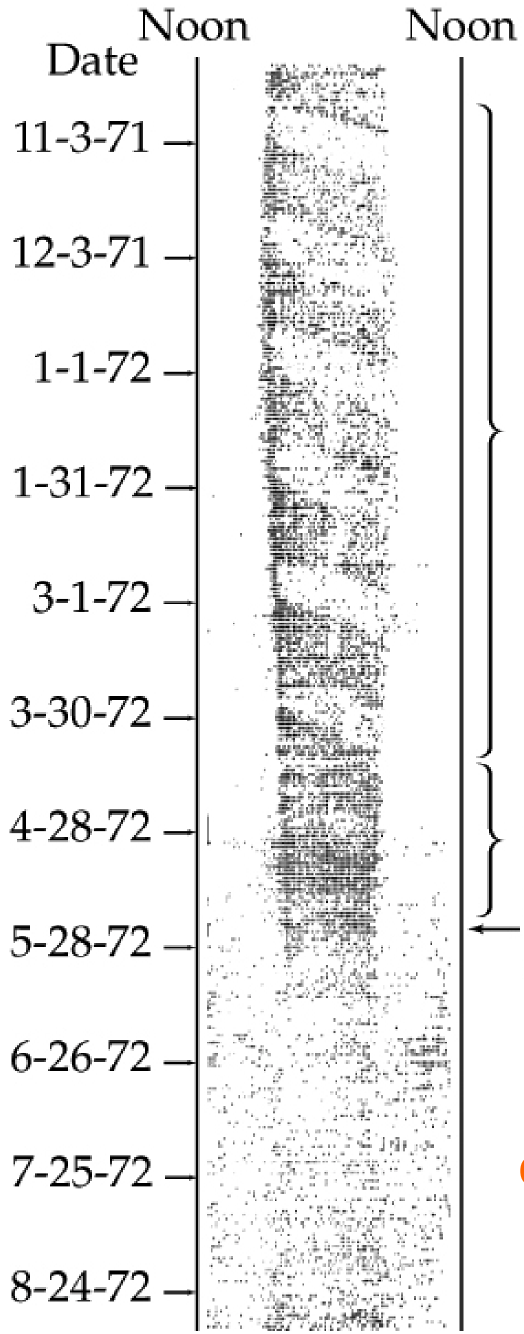
Circannual cycle of the golden-mantled ground squirrel



Animals kept is constant darkness and temperature nevertheless entered hibernation (black bars) at certain times year after year

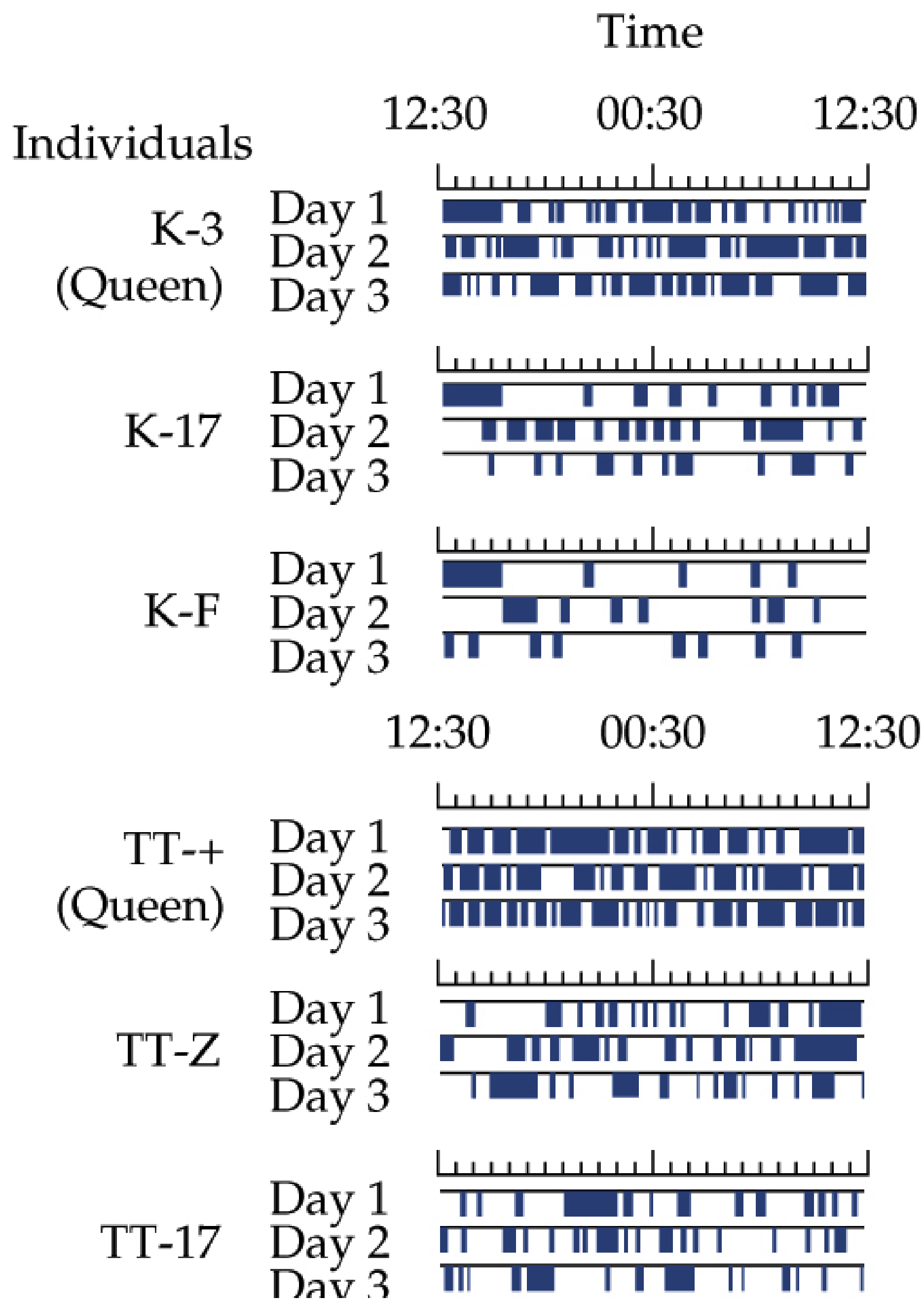
How are these results possible?

During period from November to March, the rats were active at night only when it was dark (the white diagonal lines correspond to the hours when the moon was shining). A shortage of seeds later caused the animals to feed throughout the night, even when the moon was up, and later still, to forage during all hours of the day.



Lunar cycle of banner-tailed kangaroo rats

These data illustrate that environmental constraints can over-ride biological rhythms



Some fossorial animals have no circadian rhythm