Chapter 51

Animal Behavior

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Key concepts

1. Animal behaviors are shaped by evolution, environment, and gene.
2. Animal behaviors provide a link between physiology and ecology.

Fig. 51-1

Fig. 51-2

Ethology is the scientific study of animal behavior, particularly in natural environments

- According to early ethologist Niko Tinbergen, four questions should be asked about behavior:

1. What stimulus elicits the behavior, and what physiological mechanisms mediate the response?
2. How does the animal's experience during growth and development influence the response mechanisms?
3. How does the behavior aid survival and reproduction?
4. What is the behavior's evolutionary history?

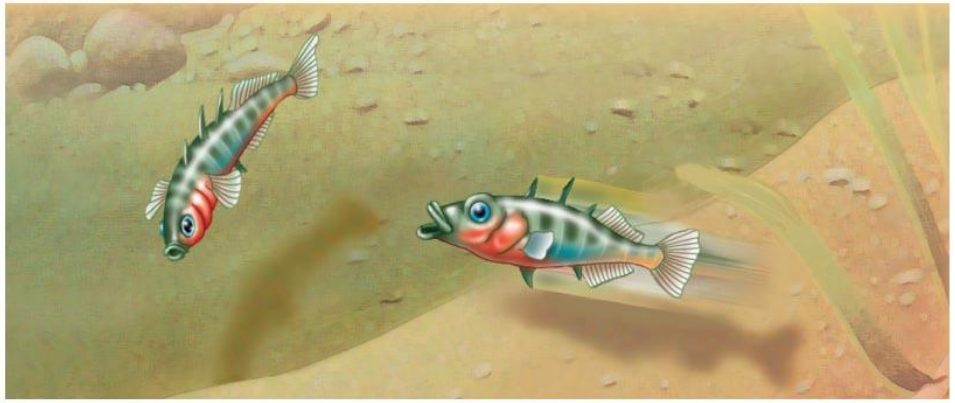
These questions highlight the complementary nature of proximate and ultimate perspectives

Behavioral ecology is the study of the ecological and evolutionary basis for animal behavior

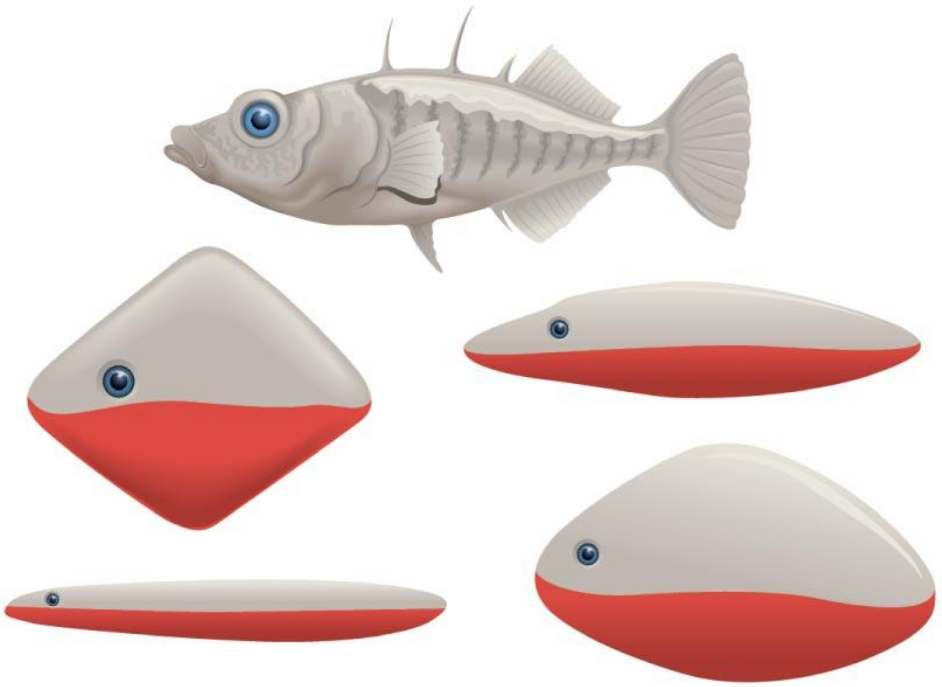
- **Proximate causation**, or "how" explanations, focus on
  - Environmental stimuli that trigger a behavior
  - Genetic, physiological, and anatomical mechanisms underlying a behavior
- **Ultimate causation**, or "why" explanations, focus on
  - Evolutionary significance of a behavior

Fig. 51-3

Sign stimuli in a classic fixed action pattern (FAP)



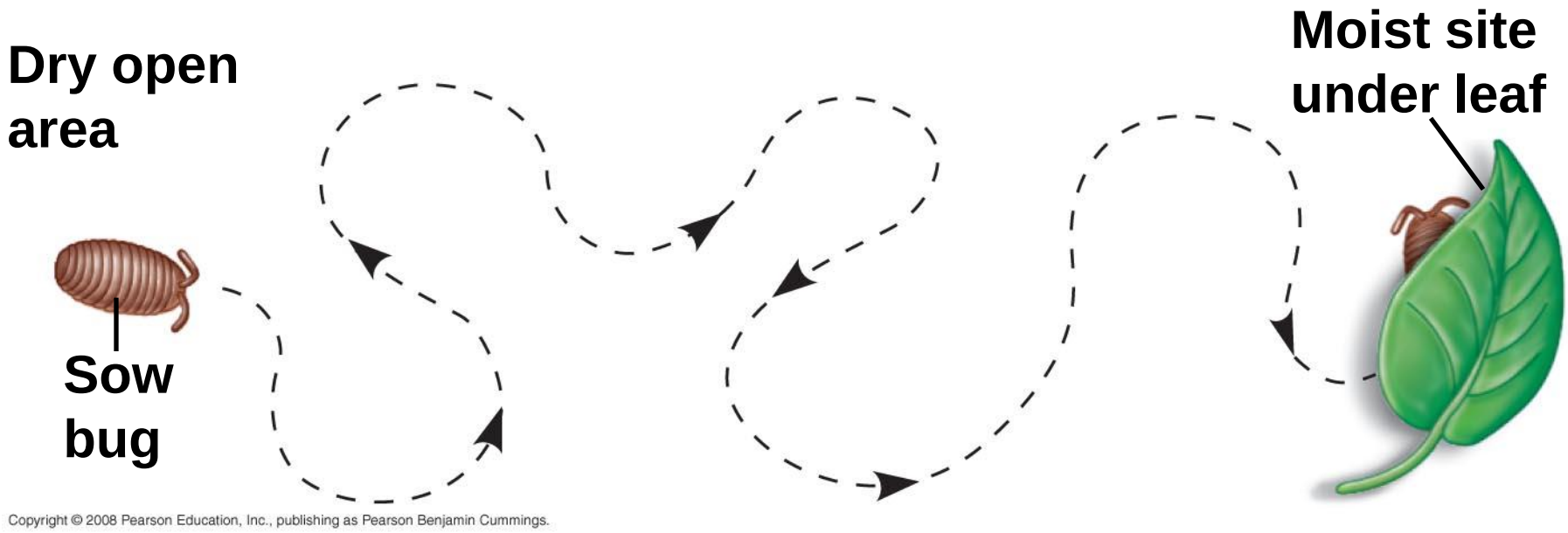
(a)



(b)

Fig. 51-4

A **kinesis** is a simple change in activity or turning rate in response to a stimulus



- A **taxis** is a more or less automatic, oriented movement toward or away from a stimulus
- Many stream fish exhibit a positive taxis and automatically swim in an upstream direction
- This taxis prevents them from being swept away and keeps them facing the direction from which food will come

Migration

- **Migration** is a regular, long-distance change in location
- Animals can orient themselves using
  - The position of the sun and their circadian clock, an internal 24-hour clock that is an integral part of their nervous system
  - The position of the North Star
  - The Earth's magnetic field

Fig. 51-5

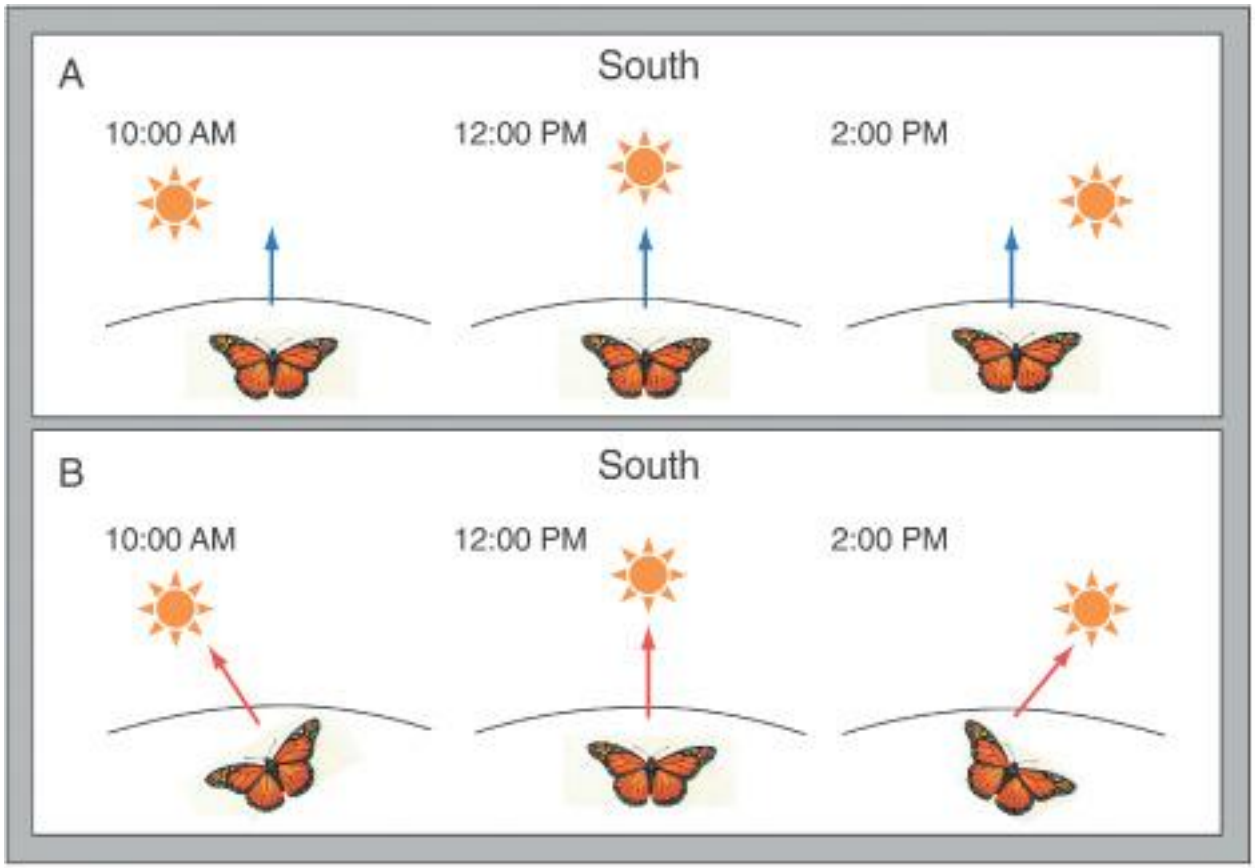


FIGURE 3 A. Monarch butterflies use a time-compensated sun compass to orient south during their fall migration. The butterfly circadian clock allows the butterflies to compensate for the movement of the sun. They are thereby able to maintain a constant bearing in the southerly direction over the course of the day. **B.** Monarch butterflies follow the sun without a functioning circadian clock. A broken circadian clock would disrupt the migration south, and the butterflies would not be able to travel successfully to their overwintering grounds.

Behavioral Rhythms

- Some animal behavior is affected by the animal's circadian rhythm, a daily cycle of rest and activity
- Behaviors such as migration and reproduction are linked to changing seasons, or a *circannual rhythm*
- Some behaviors are linked to lunar cycles
  - For example, courtship in fiddler crabs occurs during the new and full moon

Fig. 51-6

Fig. 51-7

Courtship behavior of the fruit fly

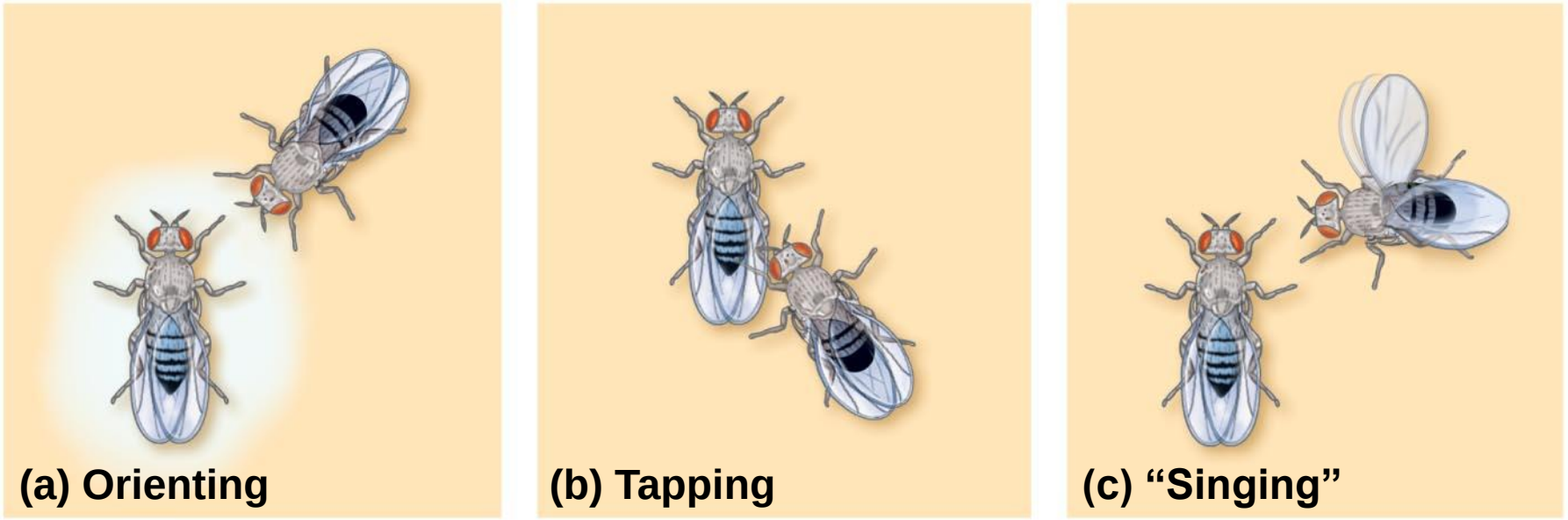
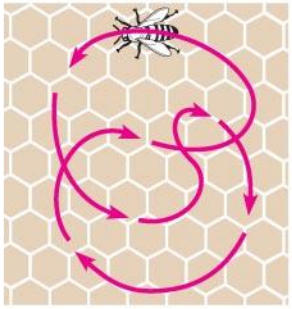


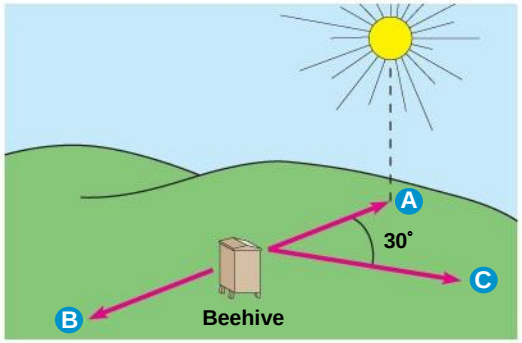
Fig. 51-8

Honeybee dance language

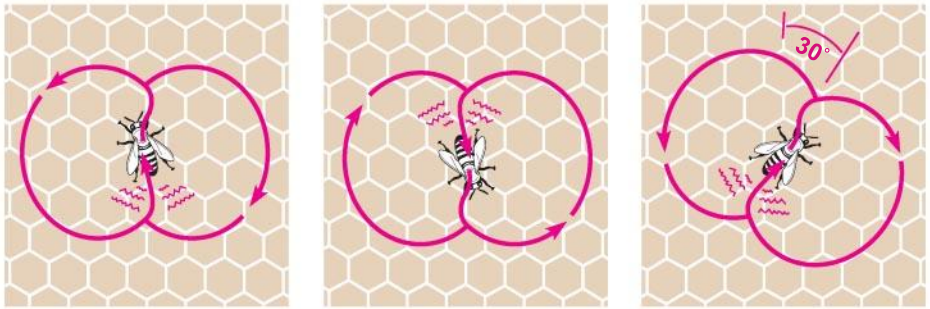
(a) Worker bees



(b) Round dance
(food near)

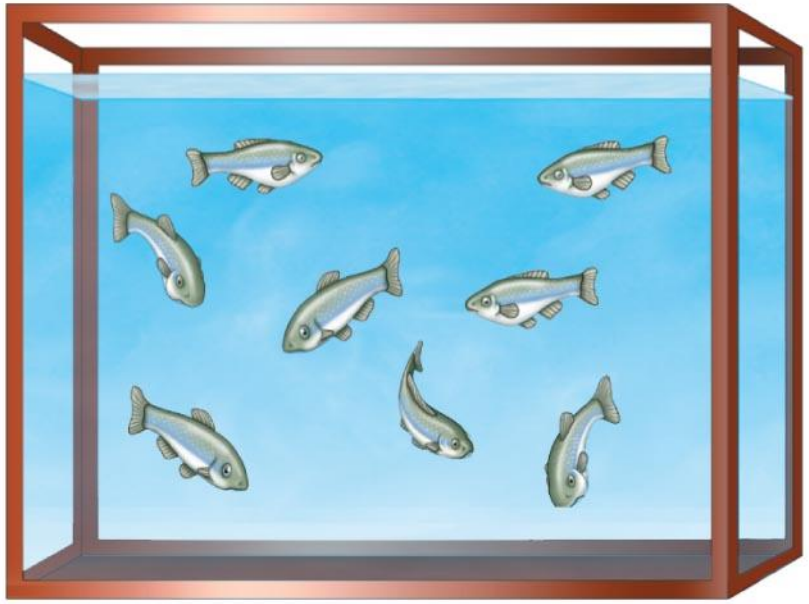


(c) Waggle dance
(food distant)



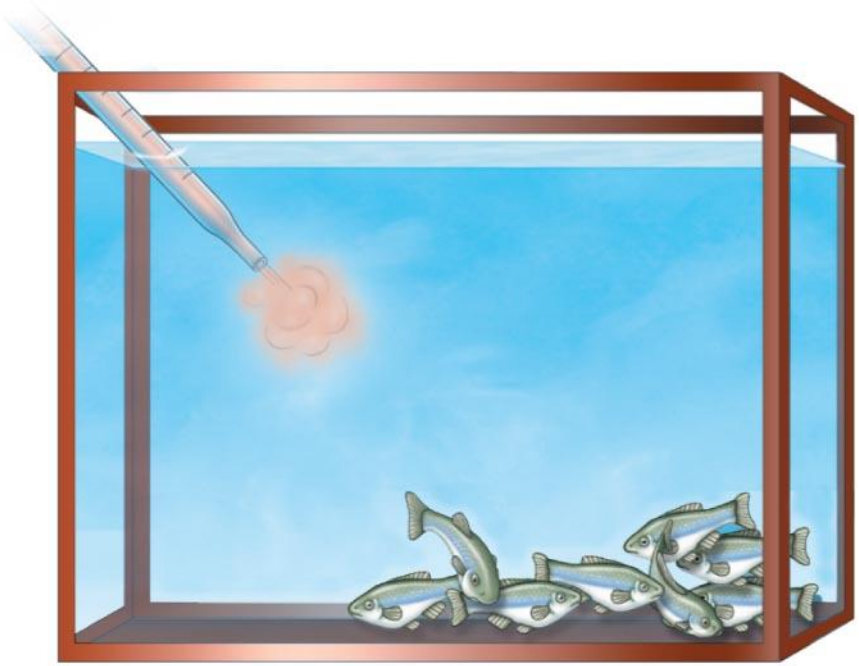
Location A Location B Location C

Fig. 51-9



(a) Minnows before alarm

Minnows responding to the presence of an alarm substance



(b) Minnows after alarm

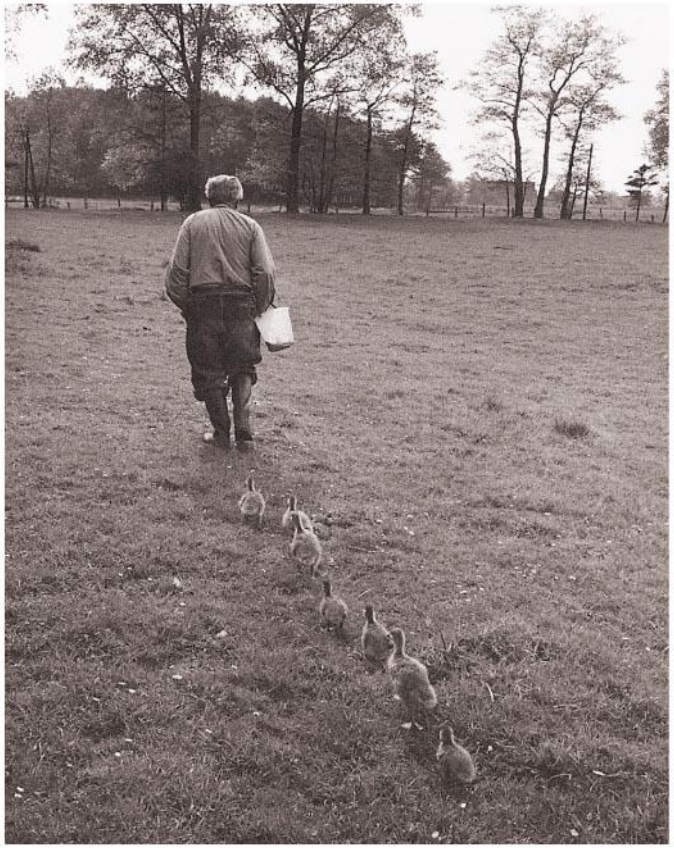
Concept 51.2: Learning establishes specific links between experience and behavior

- **Innate behavior** is developmentally fixed and under strong genetic influence
- **Learning** is the modification of behavior based on specific experiences
- **Habituation** is a simple form of learning that involves loss of responsiveness to stimuli that convey little or no information

Imprinting

- **Imprinting** is a behavior that includes learning and innate components and is generally irreversible
- It is distinguished from other learning by a **sensitive period**

Fig. 51-10



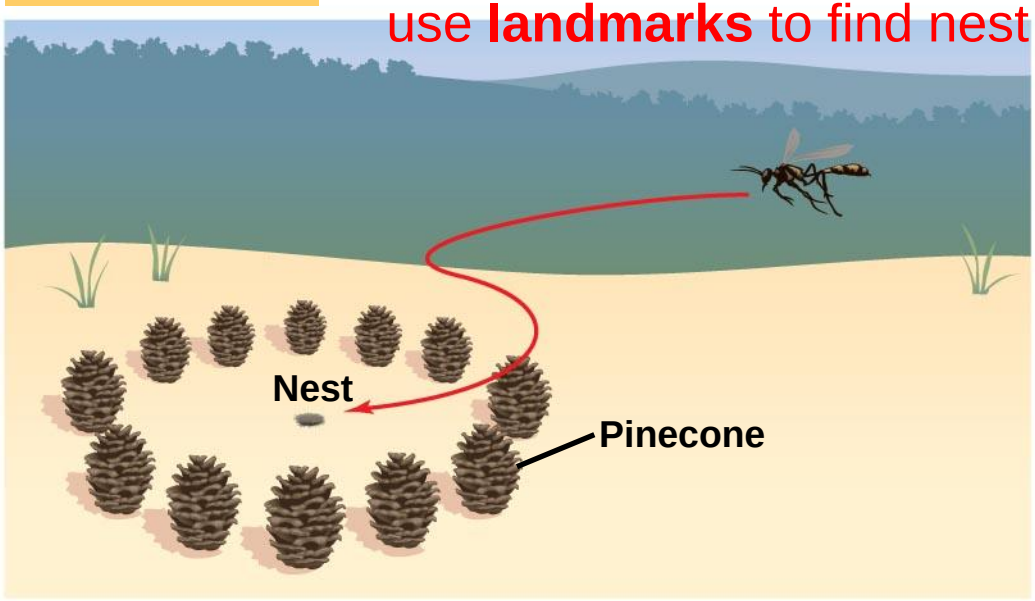
(a) Konrad Lorenz and geese

(b) Pilot and cranes

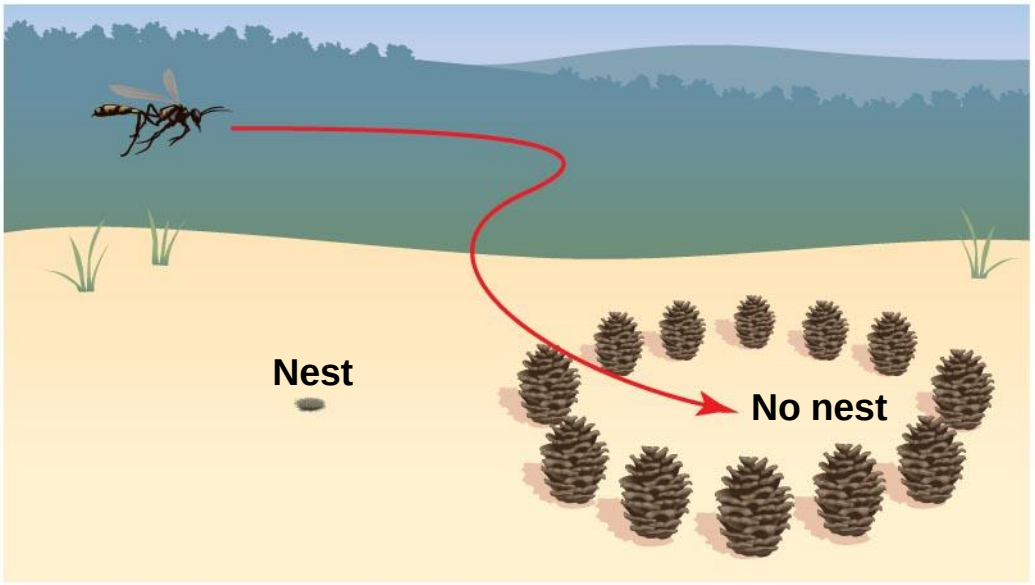
Fig. 51-11

EXPERIMENT

Niko Tinbergen showed how digger wasps use **landmarks** to find nest entrances



RESULTS



Associative Learning

- In **associative learning**, animals associate one feature of their environment with another
- **Classical conditioning** is a type of associative learning in which an arbitrary stimulus is associated with a reward or punishment
- **Operant conditioning** is a type of associative learning in which an animal learns to associate one of its behaviors with a reward or punishment

Fig. 51-12

Operant conditioning

Cognition and Problem Solving

- **Cognition** is a process of knowing that may include awareness, reasoning, recollection, and judgment
- **Problem solving** is the process of devising a strategy to overcome an obstacle

Fig. 51-13

A young chimpanzee learning to crack oil palm nuts by observing an experienced elder

Development of Learned Behaviors

- Development of some behaviors occurs in distinct stages
  - For example a white-crowned sparrow memorizes the song of its species during an early sensitive period
  - The bird then learns to sing the song during a second learning phase

Concept 51.3: Both genetic makeup and environment contribute to the development of behaviors

- Animal behavior is governed by complex interactions between genetic and environmental factors
- **A cross-fostering study** places the young from one species in the care of adults from another species

Table 51-1

Table 51.1 Influence of Cross-Fostering on Male Mice*

Species	Aggression Toward an Intruder	Aggression in Neutral Situation	Paternal Behavior
California mice fostered by white-footed mice	Reduced	No difference	Reduced
White-footed mice fostered by California mice	No difference	Increased	No difference

*Comparisons are with mice raised by parents of their own species.

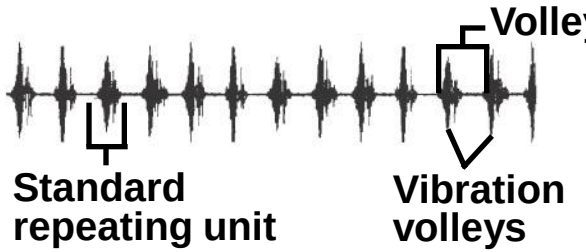
Fig. 51-14

multiple independent genes govern different components of the courtship song

EXPERIMENT

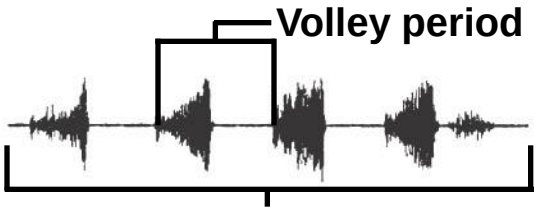
SOUND RECORDINGS

***Chrysoperla plorabunda* parent:**



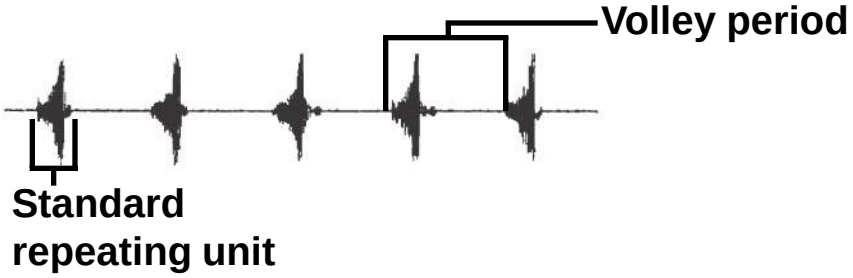
crossed with

***Chrysoperla johnsoni* parent:**



RESULTS

F_1 hybrids, typical phenotype:



Genetically Based Behavioral Variation in Natural Populations

- When behavioral variation within a species corresponds to environmental variation, it may be evidence of past evolution

Fig. 51-15

EXPERIMENT

RESULTS

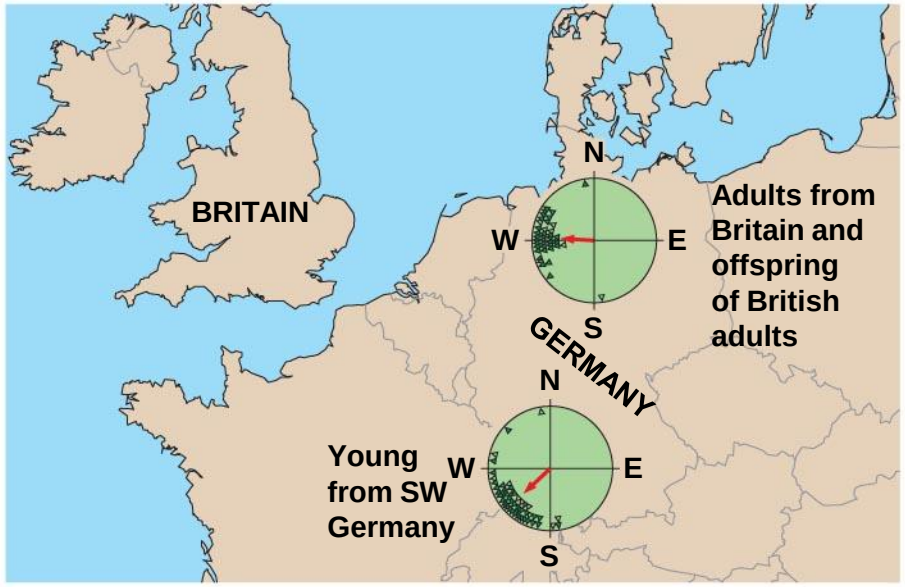


Fig. 51-16

Western garter snake from a coastal habitat eating a banana slug

Influence of Single-Locus Variation

- Differences at a single locus can sometimes have a large effect on behavior
  - For example, male prairie voles pair-bond with their mates, while male meadow voles do not
  - The level of a specific receptor for a neurotransmitter (vasopressin, ADH) determines which behavioral pattern develops

Fig. 51-17

Concept 51.4: Selection for individual survival and reproductive success can explain most behaviors

- Genetic components of behavior evolve through natural selection
- Behavior can affect fitness by influencing foraging and mate choice

Fig. 51-18

Natural selection favors different foraging behavior depending on the density of the population

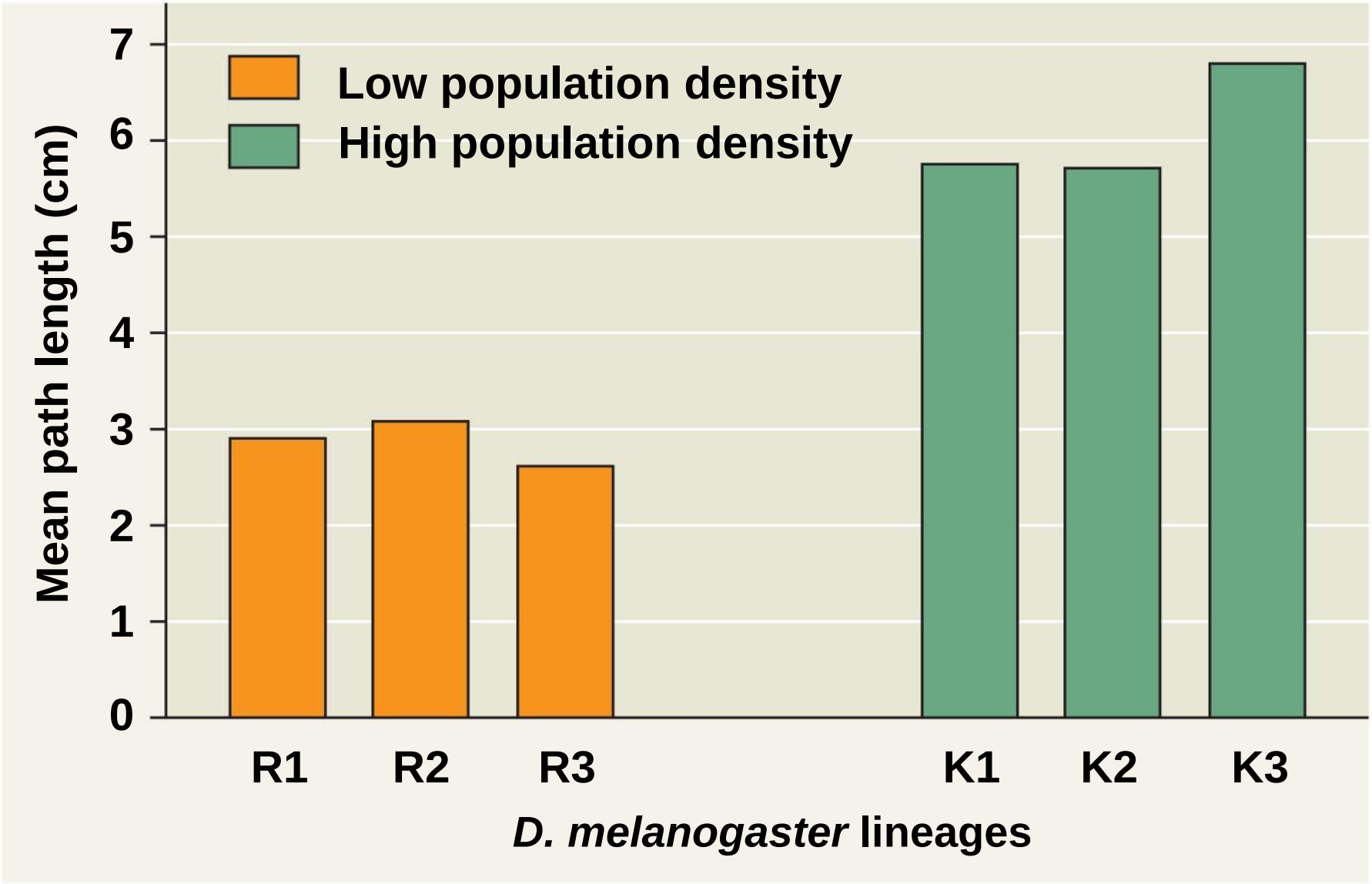


Fig. 51-19

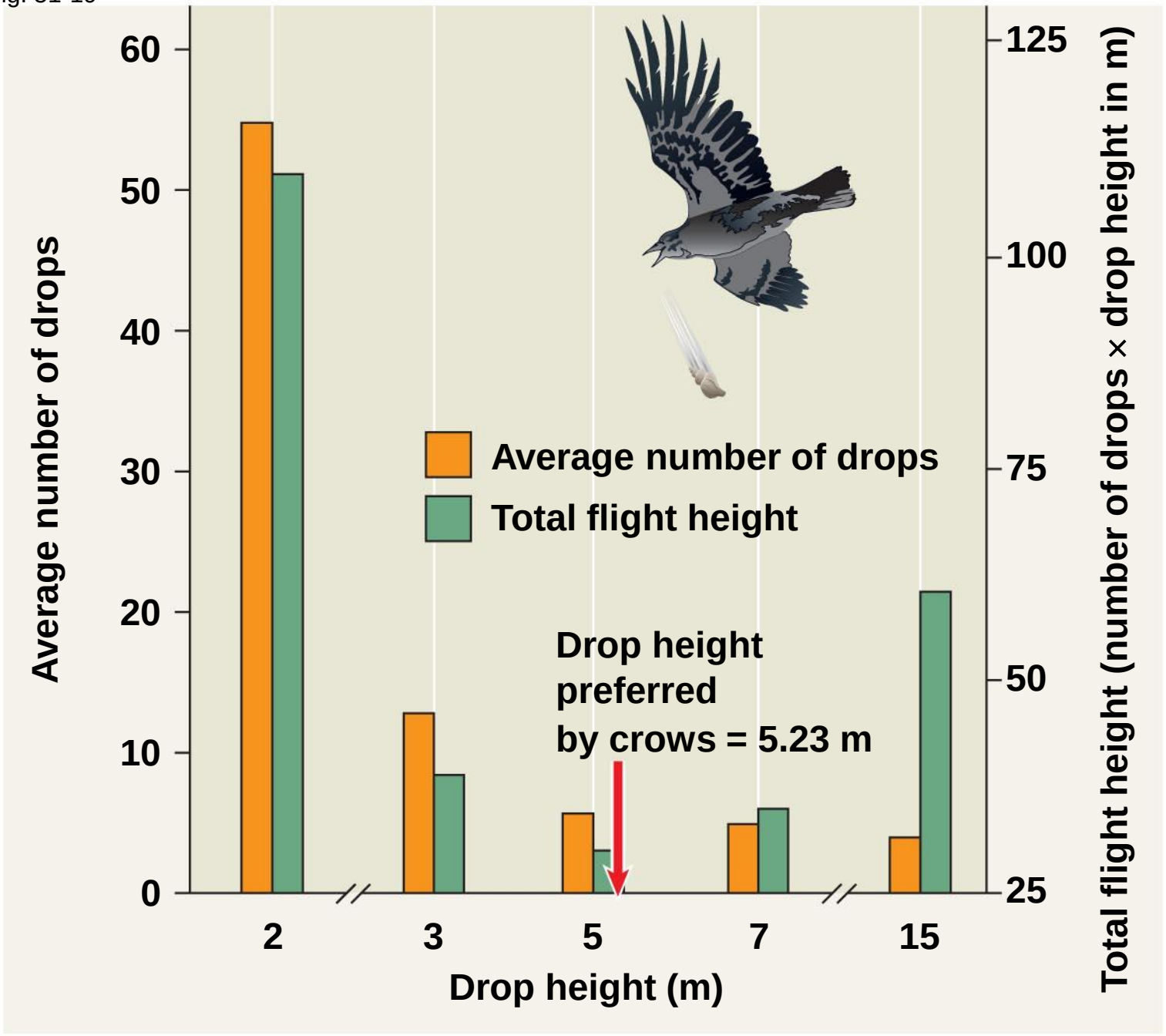


Fig. 51-20

(a) Monogamous species

(b) Polygynous species

(c) Polyandrous species

- Paternal certainty is relatively low in species with internal fertilization because mating and birth are separated over time
- Certainty of paternity is much higher when egg laying and mating occur together, as in external fertilization
- In species with external fertilization, parental care is at least as likely to be by males as by females

Fig. 51-21

Fig. 51-22

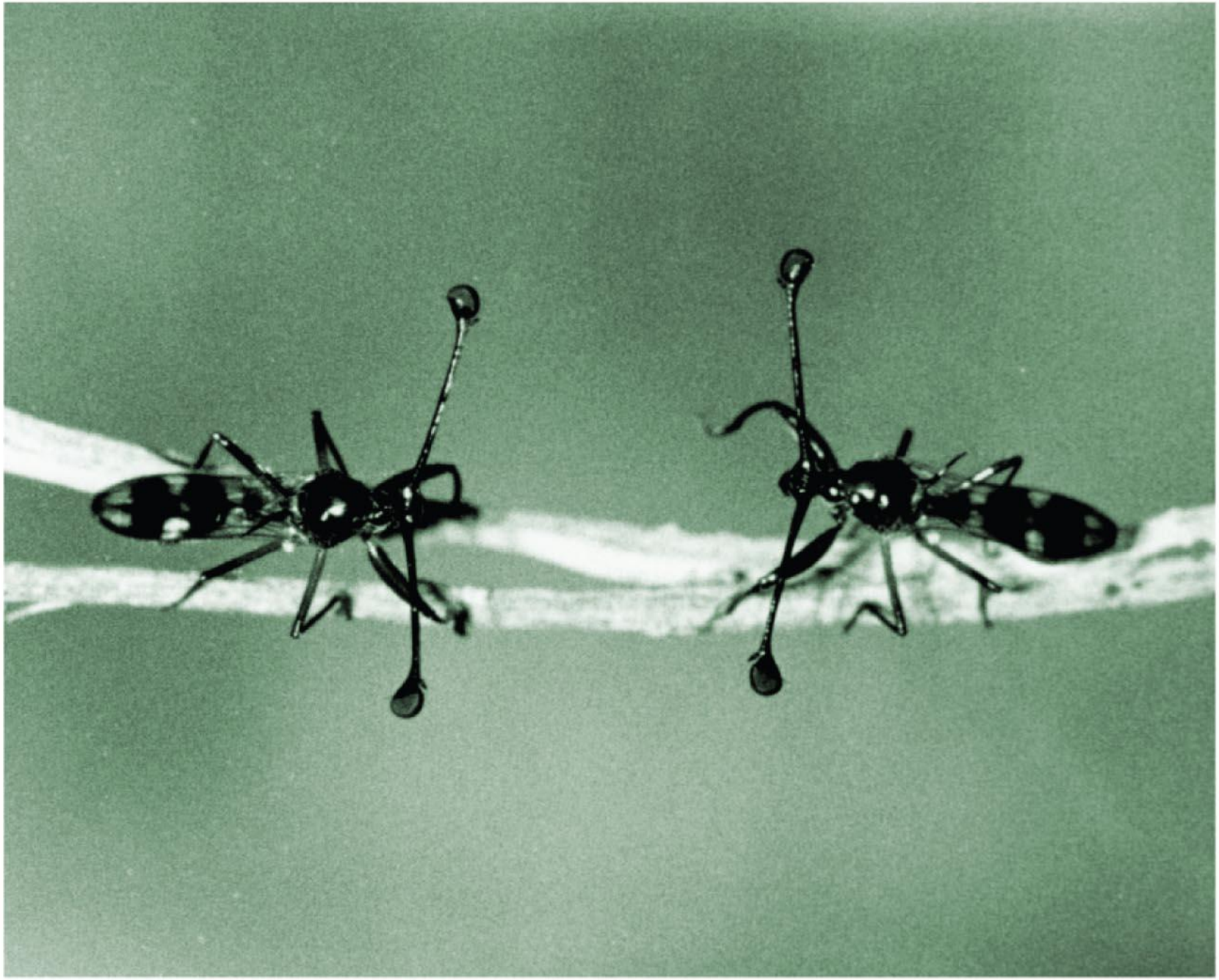


Fig. 51-23

Appearance of zebra finches in nature

Female chicks who imprint on ornamented fathers are more likely to select ornamented mates

Fig. 51-24

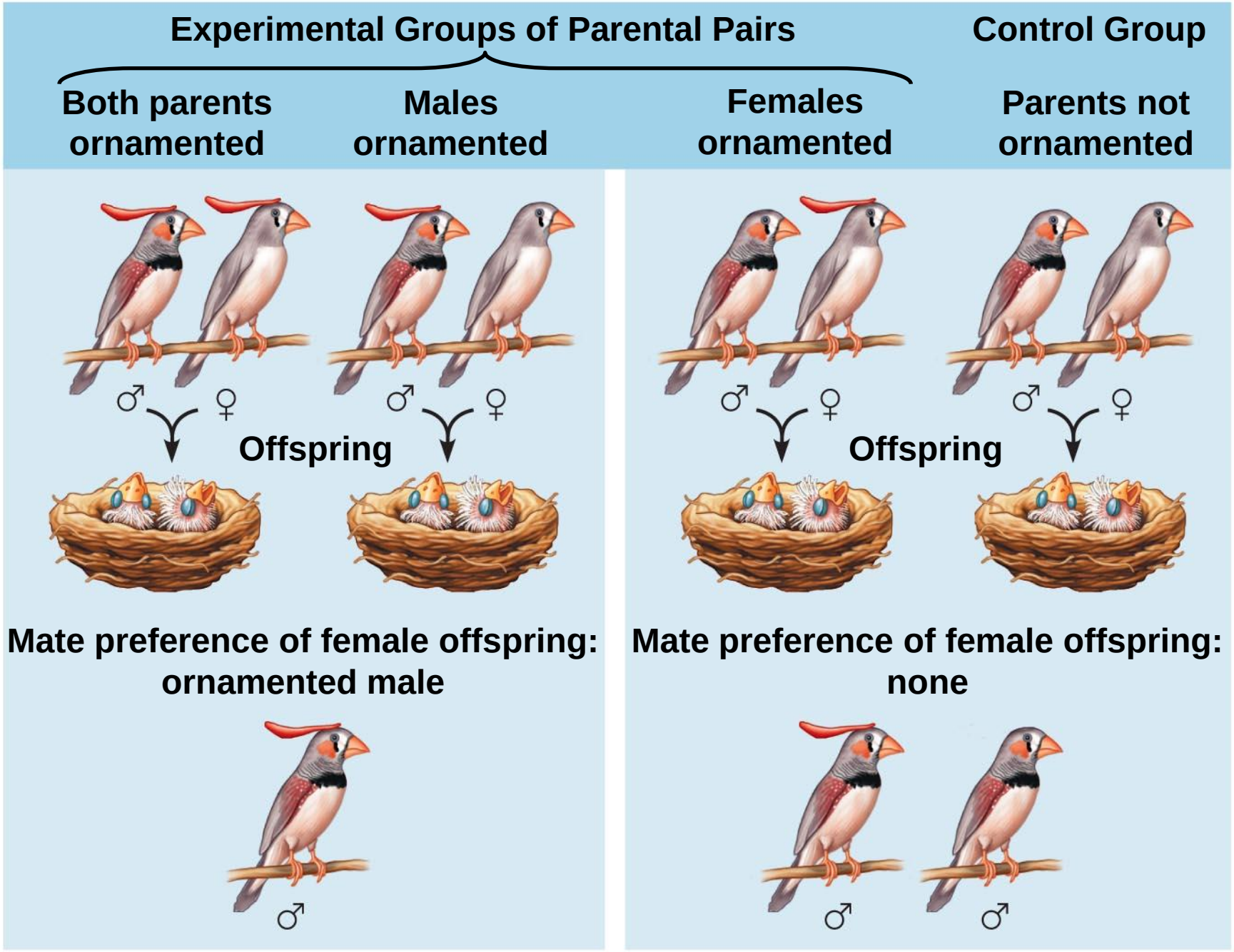


Fig. 51-25

Applying Game Theory

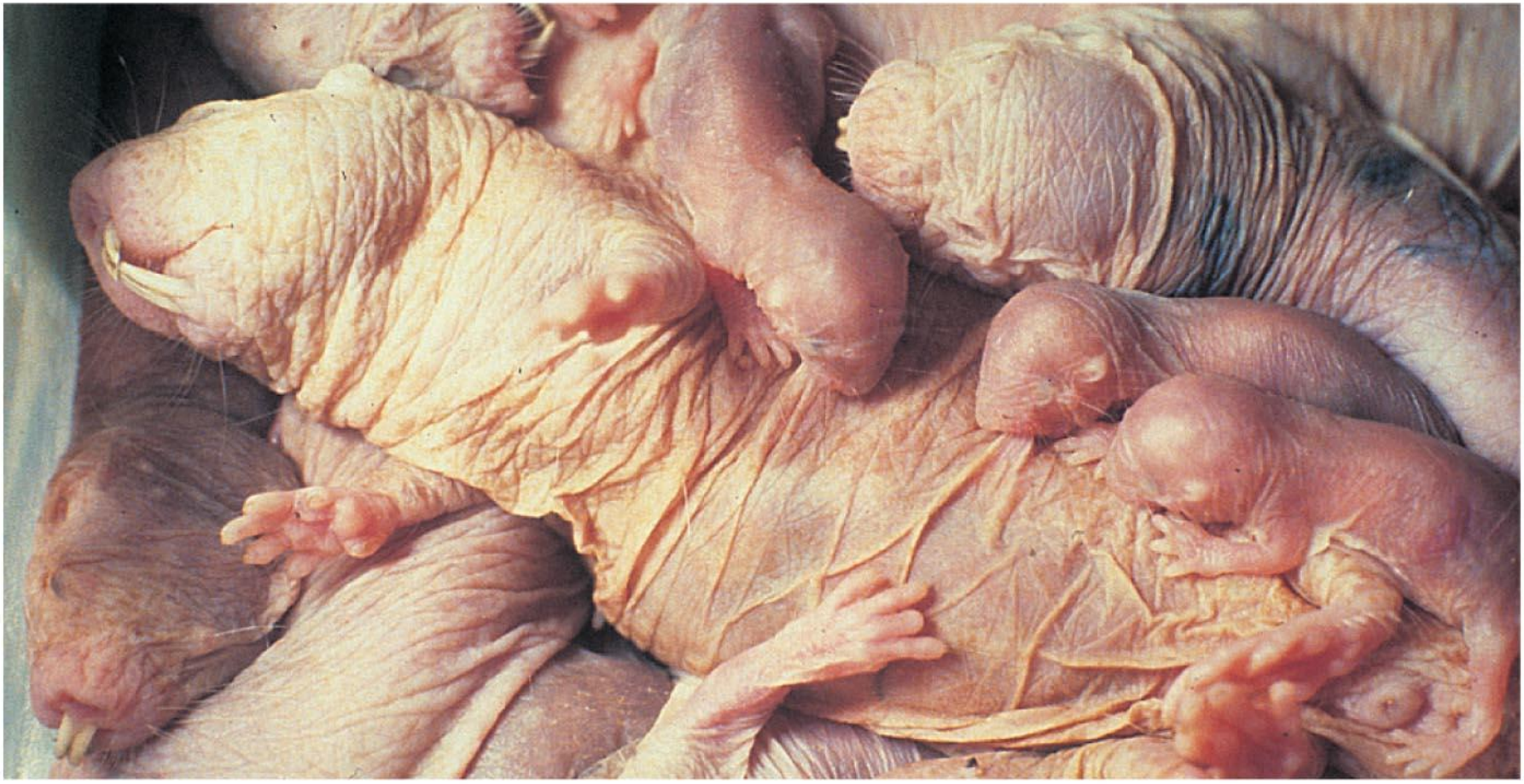
- The fitness of a particular phenotype (behavior or morphology) depends on the phenotypes of other individuals in the population
- The success of each strategy depends on the frequency of all of the strategies; this drives frequency-dependent selection

Fig. 51-26

Male polymorphism in the side-blotched lizard

Fig. 51-27

Naked mole rats, a species of colonial mammal that exhibits altruistic behavior



Hamilton's Rule and Kin Selection

- William Hamilton proposed a quantitative measure for predicting when natural selection would favor altruistic acts among related individuals
- Three key variables in an altruistic act:
  - Benefit to the recipient (*B*)
  - Cost to the altruist (*C*)
  - **Coefficient of relatedness** (the fraction of genes that, on average, are shared; *r*)

- Natural selection favors altruism when:

$$rB > C$$

- This inequality is called **Hamilton's rule**
- **Kin selection** is the natural selection that favors this kind of altruistic behavior by enhancing reproductive success of relatives

Fig. 51-28

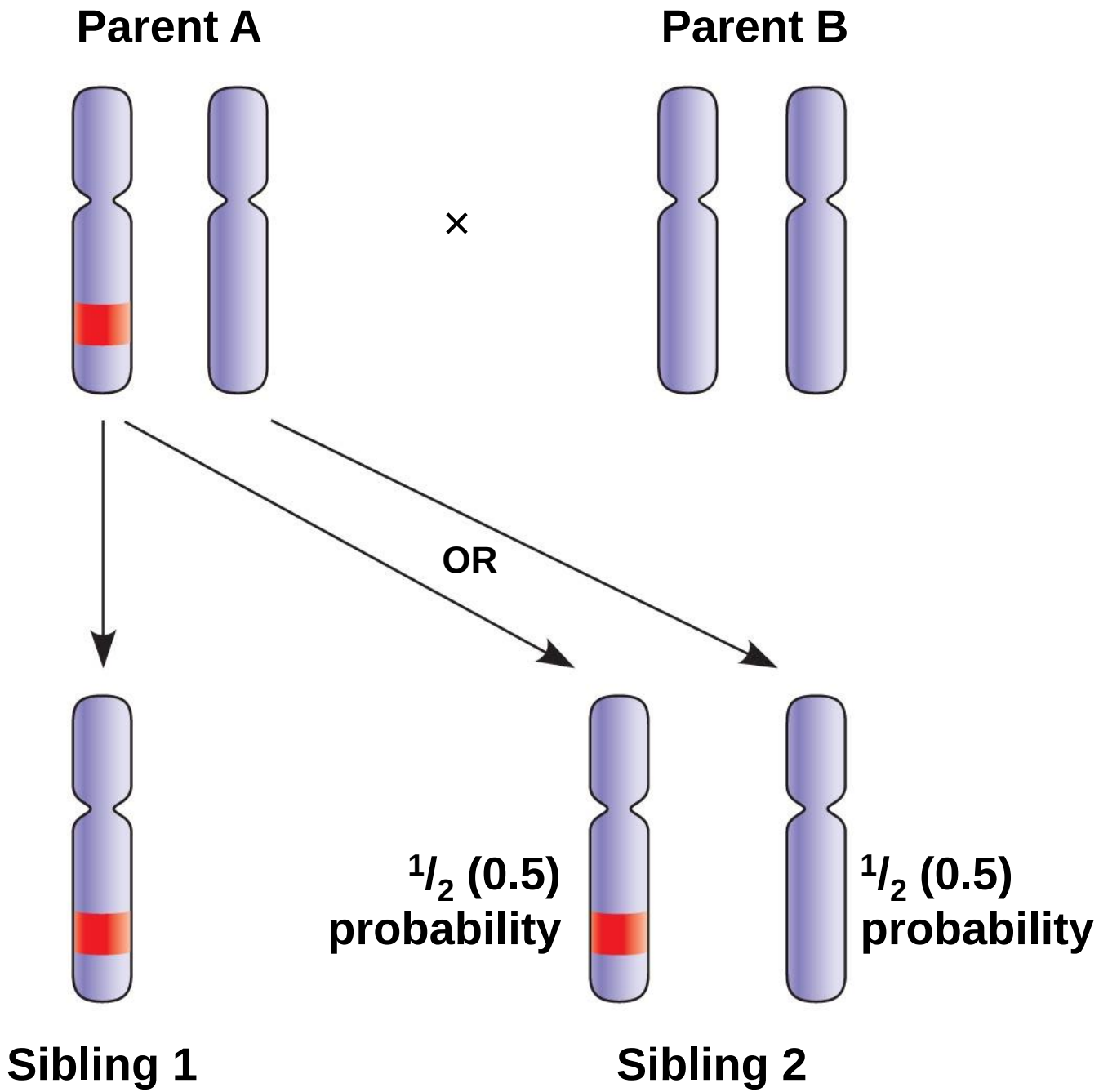
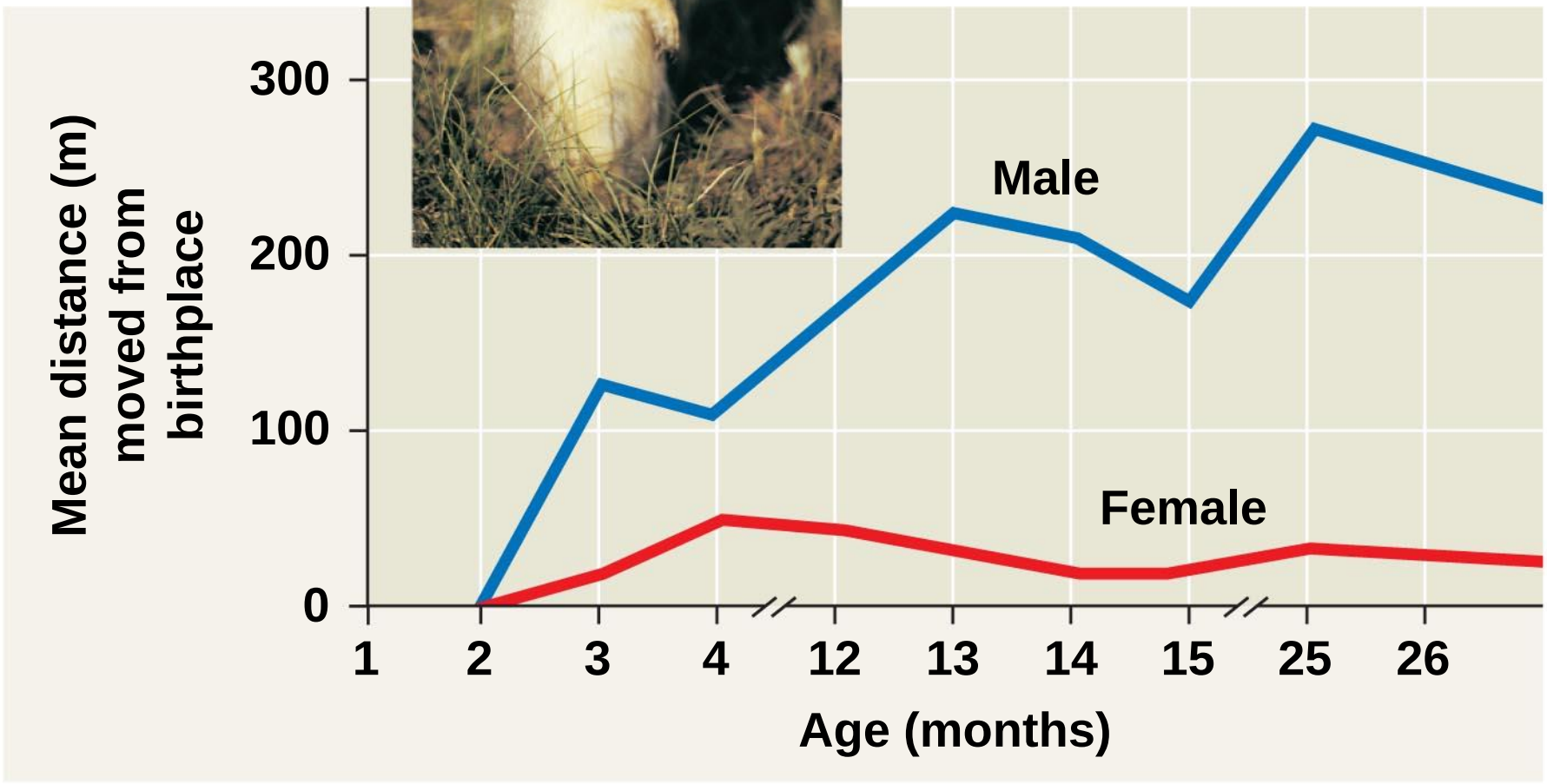


Fig. 51-29



Reciprocal Altruism

- Altruistic behavior toward unrelated individuals can be adaptive if the aided individual returns the favor in the future
- This type of altruism is called **reciprocal altruism**

Social Learning

- **Social learning** is learning through the observation of others and forms the roots of culture
- **Culture** is a system of information transfer through observation or teaching that influences behavior of individuals in a population
- Culture can alter behavior and influence the fitness of individuals

Fig. 51-30

Mate choice copying by female guppies

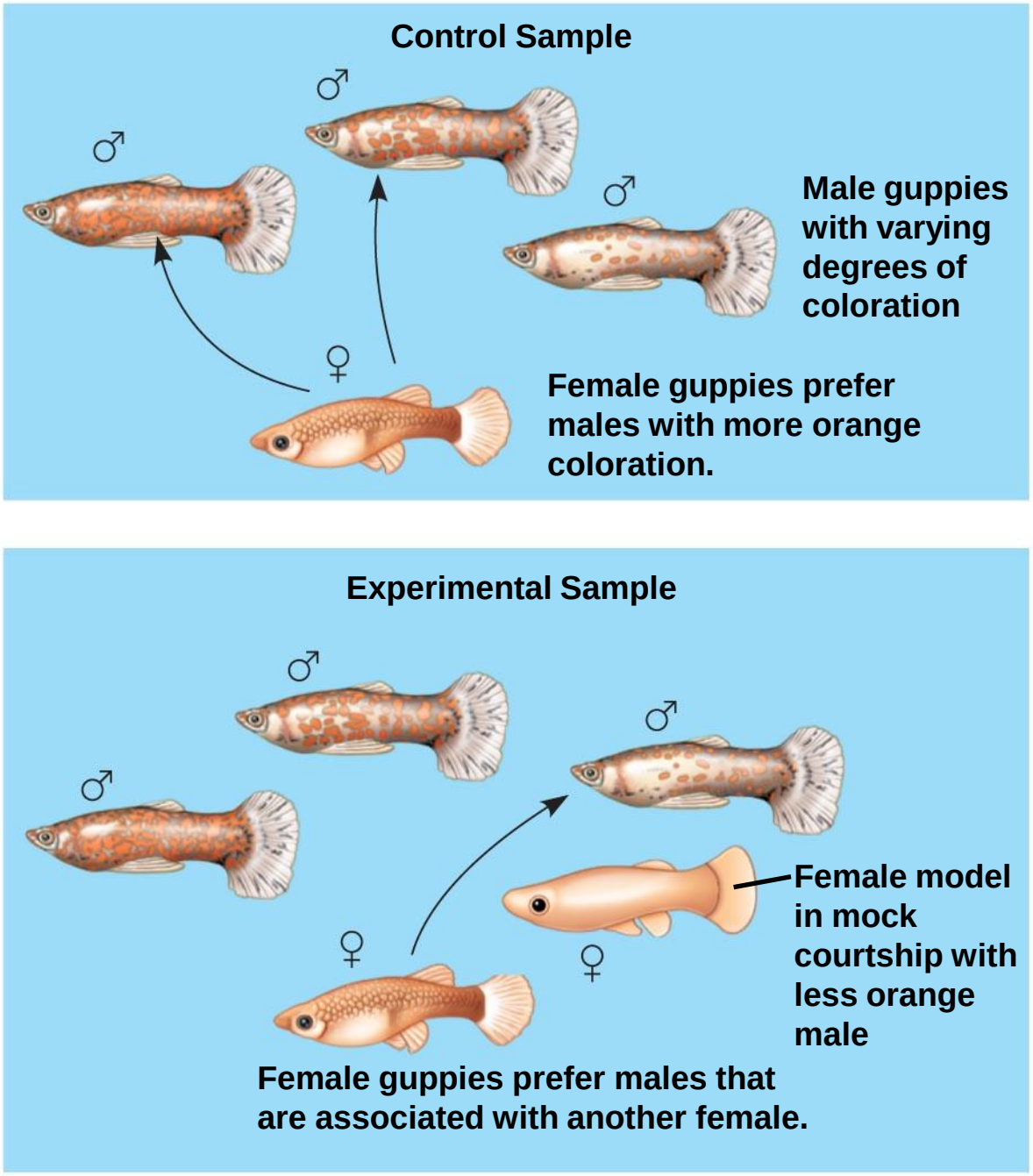


Fig. 51-31

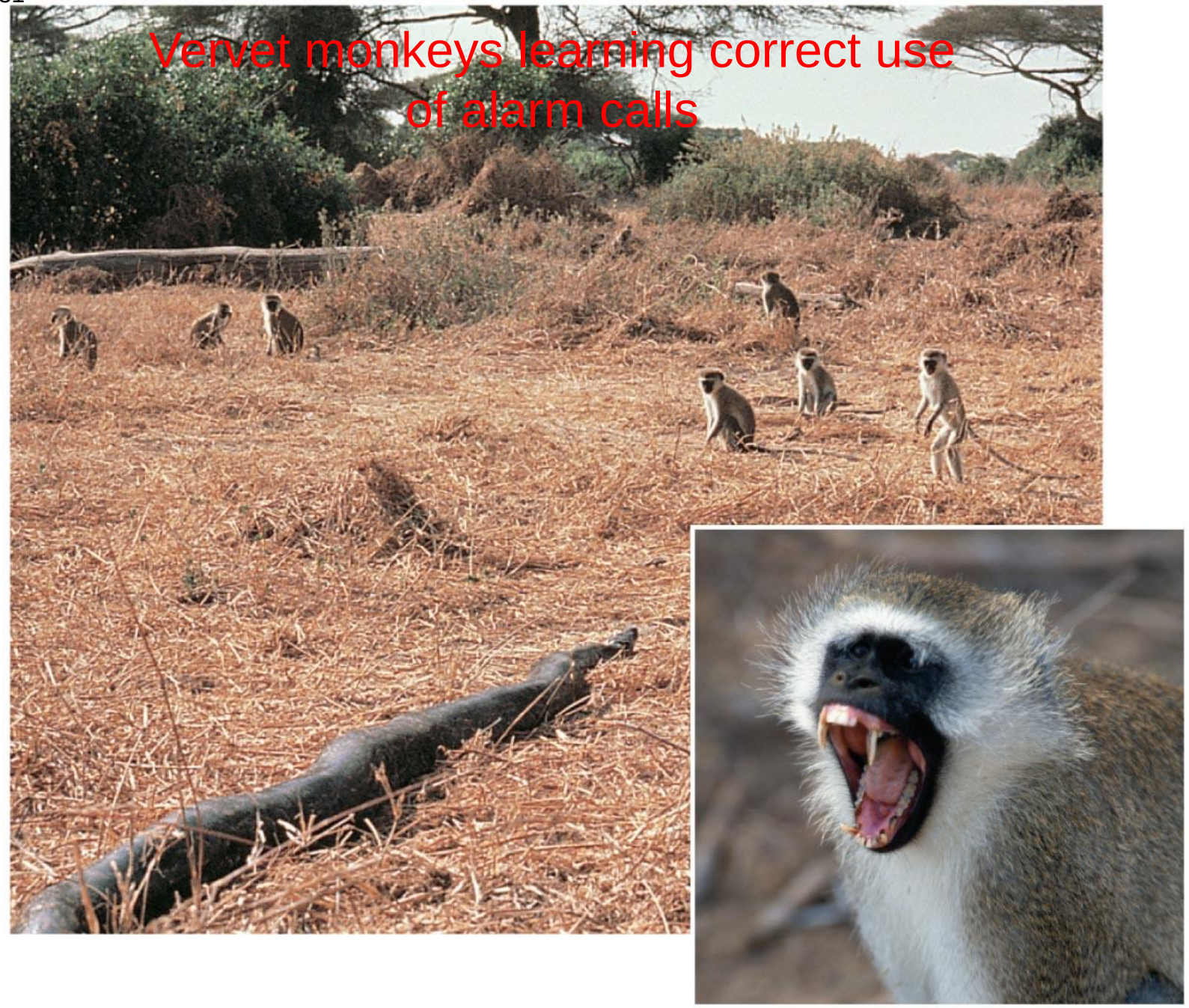


Fig. 51-32

You should now be able to:

1. State Tinbergen's four questions and identify each as a proximate or ultimate causation
2. Distinguish between the following pairs of terms: kinesis and taxis, circadian and circannual behavioral rhythms, landmarks and cognitive maps, classical and operant conditioning
3. Suggest a proximate and an ultimate cause for imprinting in newly hatched geese
4. Explain how associative learning may help a predator avoid toxic prey

5. Describe how cross-fostering experiments help identify the relative importance of environmental and genetic factors in determining specific behaviors

6. Describe optimal foraging theory

7. Define and distinguish among promiscuous, monogamous, and polygamous mating systems

8. Describe how the certainty of paternity may influence the development of mating systems

9. Distinguish between intersexual and intrasexual selection
10. Explain how game theory may be used to evaluate alternative behavioral strategies
11. Define altruistic behavior and relate the coefficient of relatedness to the concept of altruism
12. Distinguish between kin selection and reciprocal altruism
13. Define social learning and culture