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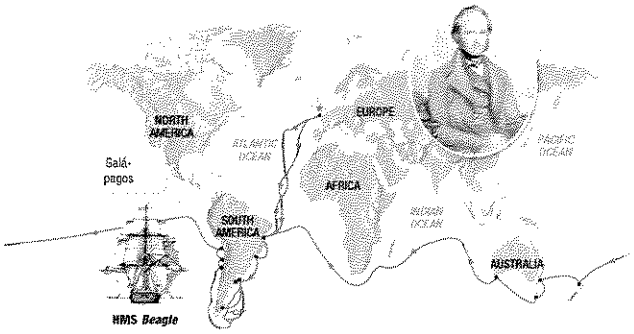
Chapter 15: Evolutionary Theory



Section 1: Developing a Theory (p. 375-379)

1. Define **Evolution:** THE PROCESS BY WHICH SPECIES CHANGE OVER TIME

2. Use the glossary in the back of the book to define **Species:** A GROUP OF ORGANISMS THAT ARE CLOSELY RELATED AND CAN MATE TO PRODUCE FERTILE OFFSPRING

A Theory to Explain Change Over Time

3. Refer to Figure 1. What inspired Darwin? HIS 1831 VOYAGE ON THE BEAGLE

Refer to Figure 1. On which continent did Darwin seem to spend most of his time? SOUTH AMERICA

5. Define **Theory:** A BROAD EXPLANATION THAT HAS BEEN SCIENTIFICALLY TESTED AND SUPPORTED.

6. Has the Theory of Evolution been altered since Darwin's day? YES

Darwin's Ideas from Experience

7. What was the name of the ship on which Darwin first observed evidence for evolution? BEAGLE

8. What did Darwin notice about the armadillo fossils in South America? THEY WERE SIMILAR BUT NOT IDENTICAL.

9. Many of Darwin's observations were made on the GALAPAGOS Islands.

10. What finch characteristic did Darwin observe? BEAK

11. Refer to Figure 2. Describe the differences between the beaks of the finches in relation to the food's they eat.
THE CACTUS FINCH HAS A NARROW STRONG BEAK FOR EATING INSECTS AND CACTUS.
THE WARBLER FINCH HAS A LONG NARROW BEAK FOR EATING SMALL INSECTS.
THE LARGE GROUND FINCH HAS A SHORT STRONG BEAK FOR CRUSHING LARGE SEEDS.

12. Darwin suggested that the finches from the Galapogos Islands all descended from SOUTH AMERICA.

13. When Darwin returned from his voyage he took interest in the practice of breeding other animals and plants based on inherited traits. This process is called ARTIFICIAL SELECTION (SELECTIVE BREEDING).

14. Darwin was influenced by ideas from the fields of NATURAL HISTORY, ECONOMICS, and GEOLOGY.

NEXT PAGE

Darwin's Ideas from Others

15. What did Lamark propose? ORGANISMS CHANGE OVER TIME AS THEY ADAPT TO CHANGING ENVIRONMENTS.

16. Lamark was incorrect in thinking that changes are due to USE and DISUSE of a characteristic.

17. After reviewing Malthus's ideas, Darwin saw that all kinds of POPULATIONS tend to produce more OFFSPRING than can SURVIVE. So, all populations must be limited by their ENVIRONMENT.

18. Refer to Figure 4. Layers of rock contain evidence of changes occurring over MILLIONS of years in organisms and environments on Earth.

Section 2: Applying Darwin's Ideas

Evolution by Natural Selection

1. Define **Natural Selection:** INDIVIDUALS THAT HAVE CERTAIN TRAITS TEND TO PRODUCE MORE OFFSPRING THAN OTHERS; THE CAUSE FOR EVOLUTION

2. Refer to Figure 5. Has this insect adapted well to its environment? YES Is it likely to survive? YES Is it likely to produce offspring in its lifetime? YES Will its offspring have similar traits? YES

3. Summarize the four steps of Darwin's theory using Figure 6.

Overproduction: EVERY POPULATION PRODUCES MORE OFFSPRING THAN CAN SURVIVE.

Variation: VARIATION EXISTS IN EVERY POPULATION AND IS CAUSED BY INHERITED TRAITS.

Selection: SOME ORGANISMS ARE MORE OR LESS LIKELY TO SURVIVE AND HAVE SUCCESSFUL OFFSPRING

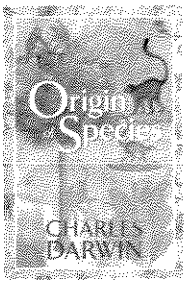
Adaptation: OVER TIME, SUCCESSFUL TRAITS WILL BECOME MORE COMMON AS THEY ARE PASSED TO THE NEXT GENERATION

4. Define **Adaptation:** AN INHERITED TRAIT THAT IMPROVES AN ORGANISMS ABILITY TO SURVIVE AND REPRODUCE

5. It is important to note that Darwin's theory refers to POPULATIONS and SPECIES not INDIVIDUALS.

6. What inspired Darwin to finally go public with his theory? WALLACE HAD SIMILAR IDEAS

7. What was the name of Darwin's book? ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION.



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READ THEN COMPLETE WORKSHEET ON BACK!

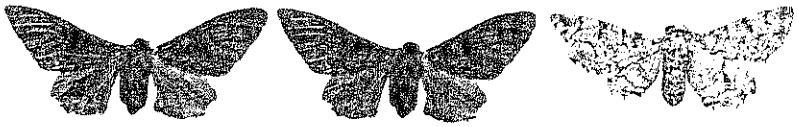
The Peppered Moth: Natural Selection in Action

Over many generations natural selection gradually changes a species in response to the demands of its environment. **Adaptation** is the process by which a species becomes better suited to its environment. The word *adaptation* can also refer to any change in a trait that increases the likelihood that an organism will survive or reproduce. For an example of natural selection's effects, look closely at the light and dark peppered moths in **Figure 10-9**. Until the 1850s, dark gray peppered moths were rare and were treasured by British butterfly and moth collectors. Almost all peppered moths were pale. Around 1850, however, dark peppered moths started to become more common, usually in heavily industrialized areas. By 1950, peppered moth populations living near industrial centers consisted almost entirely of dark individuals.

Figure 10-9 Studies of light and dark peppered moths provide an example of adaptation.

Why did the dark peppered moths become more common? Darwin's theory of evolution by natural selection suggests a hypothesis. The color change coincided with a great increase in the number of factories in England. Pale tree trunks were blackened by heavy pollution from these factories. Perhaps dark moths sitting on soot-darkened bark escaped being eaten by birds because it was hard for the birds to see the dark moths against the dark background. Light-colored moths, on the other hand, would have stood out against a dark background and would have been easily spotted by hungry birds. H.B.D. Kettlewell, a British biologist, tested this hypothesis in the late 1950s. **Table 10-2** describes Kettlewell's experiments.

Table 10-2 How Kettlewell Demonstrated Natural Selection in Peppered Moths

	What Kettlewell did	What Kettlewell found
Step 1	Kettlewell knew that coloration was an inherited trait. He raised large numbers of both light and dark moths in the laboratory. He released equal numbers of light and dark moths into a forest near Birmingham, England, where trees were blackened by soot. For identification, each of these moths was marked with a dot on the underside of its wings. 	Kettlewell set out rings of traps to recapture moths that survived. He found that two-thirds of the recaptured moths were dark. More moths that matched the dark tree trunks had survived.
Step 2	Again using marked moths, Kettlewell released equal numbers of light and dark moths into an unpolluted forest in Dorset, England. Trees here were light gray, not black. 	When Kettlewell set out traps, two-thirds of the moths that were recaptured were light. Again, more moths that matched the color of the tree trunks survived.
Step 3	Kettlewell set up hidden cameras in both forests to record the capture of moths by birds.	Films showed that birds were more likely to capture light moths on the dark trunks near Birmingham. In Dorset, birds were more likely to eat the dark moths, which were easily seen against the light trunks.

Peppered Moth Analysis: Use the Peppered Moth story on the previous page and data below to graph the data then answer the conclusion questions.

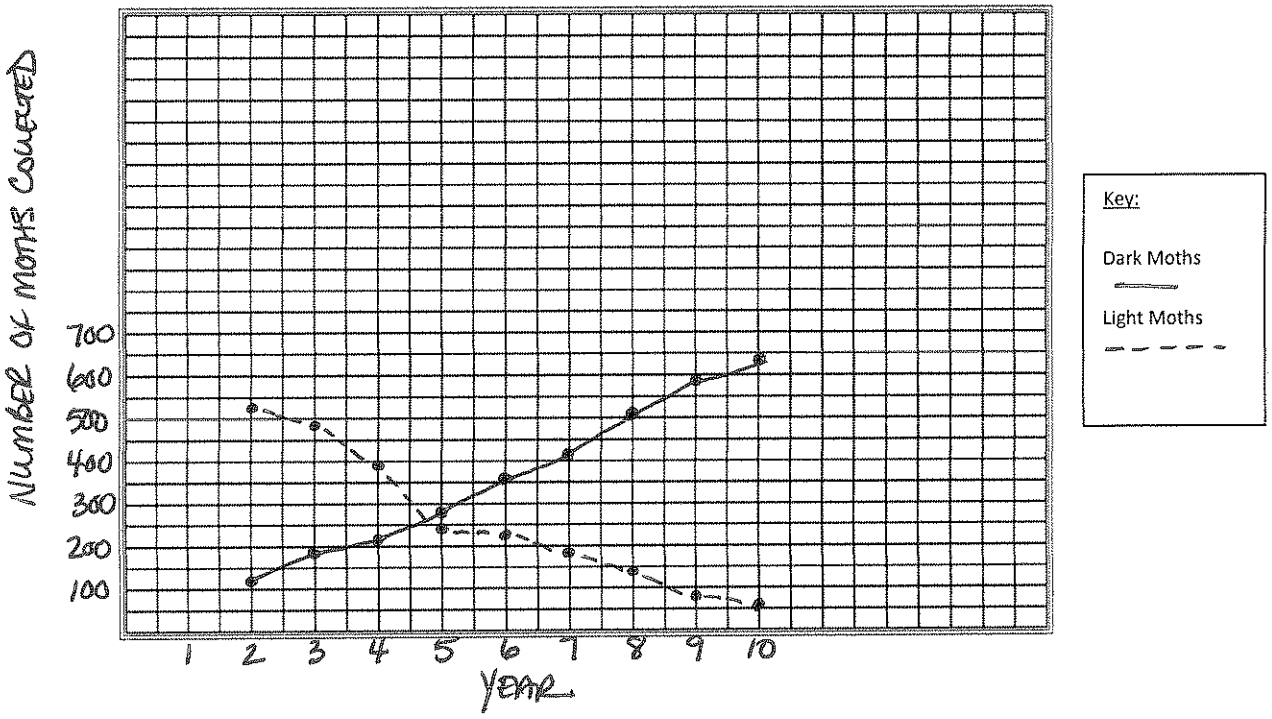
The data table below represents actual data collected during a 10 year study in which peppered moths were collected, counted, and released. Examine the results.

Number of Light and Dark Peppered Moths over 10 Years

Year	Number of Light Moths Collected	Number of Dark Moths Collected
2	537	112
3	484	198
4	392	210
5	246	281
6	225	357
7	193	412
8	147	503
9	84	594
10	56	638

Use the information in Data Table Three to construct a multiple line graph showing how the number of light and dark moths changes over time on the graph below. You will need to use a different color pencil or pen for each color moth.

Title: NUMBER OF LIGHT & DARK PEPPERED MOTHS OVER 10 YRS.



Conclusions

1. Why is the percentage of dark colored moths so small in year 2? THE TREES WERE NOT POLLUTED YET. DARK MOTHS WERE BEING EATEN OFF OF LIGHT TREES.

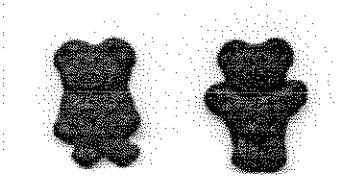
2. What environmental change caused the peppered moth population change? THE POLLUTION DARKENED THE TREES

3. Which peppered moths were "selected for" before the Industrial Revolution? LIGHT After? DARK

4. As the population of dark colored moths increased, how might the predators of the moth (birds) need to adapt? THE BIRDS THAT CAN SEE LIGHT AND DARK COLORED MOTHS WILL BE SELECTED FOR. *GOOD VISION AT NIGHT?

NAMES OF PARTNERS_____

Natural Selection in a Population of Teddy Grahams



Objective:
Students will demonstrate the concept of natural selection in a population of bears.

Materials:
Happy and Sad Teddy Grahams
Paper plate Den

Introduction:
Welcome to the Land of Teddy Grahams. These bears are a peaceful, herbivorous species that has long enjoyed life without a predator. Their population size remains around 10-12 bears. They are limited by the number of caves in which to hibernate. The bears live in a habitat with lots of shrubs.

There are two general phenotypes in teddy grahams. "Happy bears" run around with their hands up. This was an adaptation for preventing the growth of a deadly mold under their armpits. "Sad bears", more rare than Happy bears, run around with their hands down. For the past few hundred years, the mold has no longer been a problem, so neither type of behavior is better than the other, therefore this genetic variation makes no difference.

Recently, a terrible thing has occurred. A new predator has emerged in the teddy graham's environment. The predator has developed a taste for teddy grahams. The hands-up bears are easy to see and catch, with their hands rising high above the shrubs and bushes. Happy bears also taste sweet, therefore they make easy prey for the predator. The hands-down bears however, are sneaky and easily hidden so they are quite safe from the predator. The Sad bears also taste bitter. Fortunately, the predator can only manage to catch and eat four bears a year.

Hypothesis:
What do you expect to happen to the number of Happy and Sad Bears over time?

HAPPY - HANDS UP POPULATION - DECREASE
SAD - HANDS DOWN POPULATION - INCREASE

Procedure:

1. Obtain a population of 12 bears. The population of bears this year is made up 10 Happy and 2 Sad Bears (remember the sad bears are more rare). Place the population in the den.
2. Record the number of each in the generation 1 row of your data table 1.
3. The predator eats 4 happy bears. Pull 4 happy bears out of your den and eat them.
4. Now it is breeding season. For every pair of happy bears left two new happy bear cubs are born. For every sad pair of bears left a sad bear cub is born. Round down if you have an odd number (7 sad bears= 3 breeding pairs = 6 baby sad bears). Get the new cubs from your teacher and add them to your den.
5. Count the number of happy and sad bears and record the numbers in the generation 2 row of your data table 1.
6. Repeat for two more generations starting with step 3.
7. Determine the percentage of happy and sad bears for each generation in your data table 1 and record in data table 2. Remember that percentage is calculated by (part/whole) x 100.
8. Graph the data from table 2 on the provided graph paper.

*GROUPS START WITH 36 HAPPY 16 SAD

RESULTS:

Table 1: The number of bears for each generation

Generation	Number of Happy Bears	Number of Sad Bears	Total Bears
1	10	2	12
2	12	4	16
3	16	8	24
4	24	16	40

Table 2: The percentage of bears for each generation

Generation	Percentage of Happy Bears	Percentage of Sad Bears
1	(10/12) x 100 = 83%	(2/12) x 100 = 17%
2	(12/16) x 100 = 75%	(4/16) x 100 = 25%
3	(16/24) x 100 = 67%	(8/24) x 100 = 33%
4	(24/40) x 100 = 60%	(16/40) x 100 = 40%

What Darwin Explained

8. Define **Fossils:** TRACE OF ORGANISMS THAT LIVED IN THE PAST.

Refer to Figure 7. What did Darwin propose was the ancestor of the modern whale? A FOUR-LEGGED, LAND-DWELLING, MEAT-EATING MAMMAL

10. Refer to Figure 7. What bone do modern whales have that they no longer need? HIP BONE

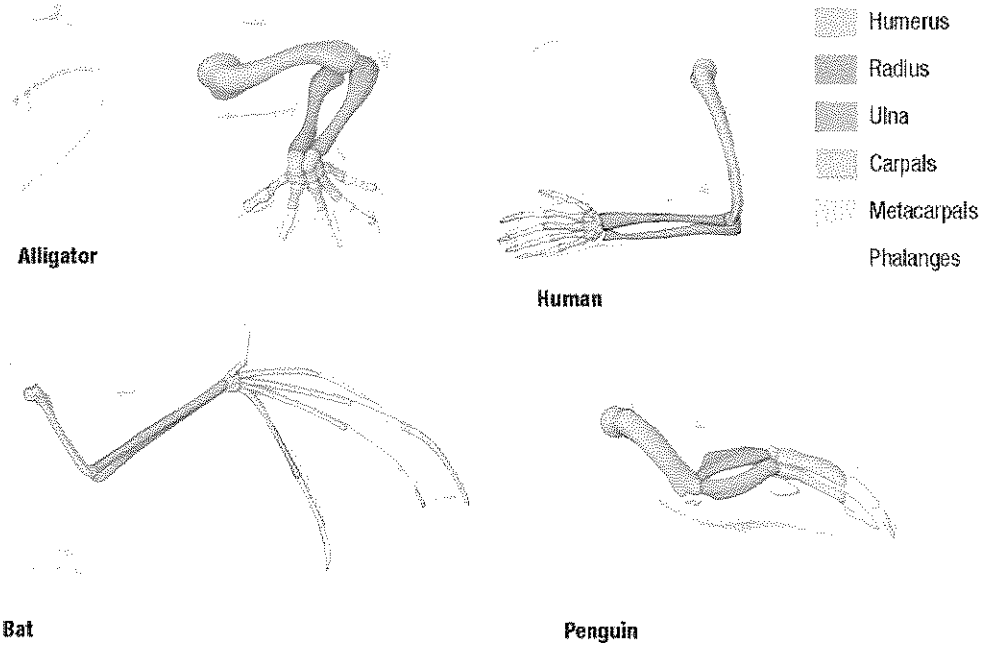
11. What did Darwin call the "in between" species linking two groups of species? INTERMEDIATE FORM

12. Biologists and geologists have found that the movement of LANDFORMS in Earth's past helps to explain patterns in the types of locations of both LIVING and FOSSIL organisms.

13. The study of multicellular organism development is called EMBRYOLOGY.

14. At some time during development, all vertebrates have a TAILBONE.

15. Define **Homologous Structure:** CHARACTERISTICS THAT ARE SIMILAR IN TWO OR MORE SPECIES THAT HAVE BEEN INHERITED FROM A COMMON ANCESTOR.



16. Refer to Figure 9. What homologous structure do we share with alligators, bats, and penguins? FORELIMB

17. What two molecule structures can be compared to make evolutionary connections? DNA & PROTEINS (ORDER OF A-ACIDS)

18. Refer to Figure 10. Using the number of amino acid differences in the hemoglobin protein, would humans have a closer evolutionary connection to the Rhesus monkey or the frog? RHESUS MONKEY

Evaluating Darwin's Ideas

19. What was Darwin's testable mechanism that could account for the process of evolution? NATURAL SELECTION

20. What was the crucial missing piece in Darwin's Theory? GENETICS KNOWLEDGE

21. Which scientist was currently working on an explanation for the inheritance of traits? MENDEL

Section 3: Beyond Darwinian Theory

Darwin's Theory Updated

Evolution can result in processes other than natural selection. SURVIVAL and REPRODUCTION can be limited by chance or by the way GENES work.

2. Hypothesize your answers to the remaining questions...

- Can an individual evolve? NO
- Is evolution survival of the fittest? NO
- Is evolution predictable? SOMETIMES

Studying Evolution at All Scales

3. What is the difference between microevolution and macroevolution? MICROEVOLUTION IS A CHANGE CAUSED BY GENES. MACROEVOLUTION IS THE APPEARANCE OF A SPECIES OVER TIME.

4. Summarize the five major processes that can affect the kinds of genes that will exist in a population from generation to generation.

- *Natural Selection:* CAN CAUSE AN INCREASE OR DECREASE IN CERTAIN ALLELES IN A POPULATION
- *Migration:* CAN CHANGE THE NUMBERS AND TYPES OF ALLELES IN A POPULATION
- *Mate Choice:* IF PARENTS ARE LIMITED OR SELECTIVE IN THEIR CHOICE OF MATES, A LIMITED SET OF TRAITS IS PASSED ON.
- *Mutation:* DNA MUTATIONS CAN CAUSE A CHANGE IN THE TYPE OF ALLELES PASSED FROM ONE GENERATION TO THE NEXT.
- *Genetic Drift:* RANDOM EVENTS OF EVERYDAY LIFE CAN CAUSE ALLELES TO BE MORE OR LESS COMMON IN A POPULATION.

5. Describe the patterns of macroevolution in which new species evolve.

- *Convergent Evolution:* SPECIES LIVING IN SIMILAR ENVIRONMENTS SHOULD EVOLVE SIMILAR ADAPTATIONS.
- *Coevolution:* SPECIES THAT LIVE IN CLOSE CONTACT WITH ONE ANOTHER OFTEN HAVE CLEAR ADAPTATIONS TO ONE ANOTHER'S ENVIRONMENT
- *Adaptive Radiation:* A SPLIT IN THE LINE OF DESCENT WILL OCCUR QUICKLY IF A NEW SPECIES ENTERS THE ENVIRONMENT
- *Extinction:* IF ALL MEMBERS OF A SPECIES DIE OR CAN NO LONGER REPRODUCE.
- *Gradualism:* SMALL, SLOW CHANGES RESULTING IN THE FORMATION OF A NEW SPECIES.
- *Punctuated Equilibrium:* ENVIRONMENTAL FACTORS CAUSE "SUDDEN" APPEARANCE OF A NEW SPECIES.