LIVING PLANET
UNIT FIVE

SUMMARY OF UNIT FIVE MATERIAL

The videotapes to watch for this unit are:

Video Episode 9 - Margins of the Land
Video Episode 10 - Worlds Apart

For each video episode in this unit:

read the **CONCEPTS** section in the study guide
answer the **Concepts Study Questions**
watch the Video Episode
answer the **Video Study Questions**

OVERVIEW OF UNIT 5 LEARNING OBJECTIVES

Video Episode 9 - Margins of the Land

To become acquainted with:

1. tides
2. seaweeds: different types and characteristics
3. ecology of estuaries: location, characteristics, life forms and adaptations
4. ecology of mud flats: formation, location, characteristics, life forms & adaptations
5. ecology of mangrove flats: location, characteristics, life forms and adaptations
6. ecology of intertidal zone: location, characteristics, life forms and adaptations
7. inhabitants of seaside cliffs
8. ecology of sandy beaches: location, characteristics, life forms and adaptations

Video Episode 10 - Worlds Apart

To become acquainted with:

1. the characteristics and different types of islands
2. island ecology: location, climate, characteristics, life forms and adaptations
3. coconut palms and seed dispersal
4. specific islands, their characteristics and inhabitants:
    - Aldabra
    - Seychelles
    - Komodo
    - Hawaiian Islands
    - Galapagos
    - New Zealand
5. the concept of isolation
6. the effects of isolation on island inhabitants
7. relationship between island inhabitants and humans
8. the concept of extinction
9. the Polynesians

CONCEPTS FOR EPISODE 9 - MARGINS OF THE LAND

TIDES

Tides are the periodic rise and fall of the water level of the ocean due to the gravitational pull of the moon and sun on the water. The ocean bulges on the sides of the earth that are in a straight line with the sun and moon, and hollows out on the sides perpendicular to the sun and moon. The bulges and hollows cause the tides as the earth rotates. The moon pulls harder on the water than the sun because it is closer to the earth.

The **highest tides** occur when the earth, moon and sun are arranged in a straight line:

EARTH - MOON - SUN or SUN - EARTH - MOON

At that time, the pull of the moon and sun add up to a very strong yank on the water.

The **lowest tides** occur when the moon and sun are at right angles to each other:

MOON
|
SUN - EARTH

In this position, the pulls from the moon and sun conflict (each pulls in a different direction) and the sum is a weak pull on the water.

There's a great website to help you understand these concepts at:
http://oceanlink.island.net/oinfo/tides/tides.html

SEAWEEDS: MARINE ALGAE

Seaweeds are large marine algae that grow attached to solid objects such as rocks in the intertidal zone. Their bodies are divided up into three regions:

(1) the **blade,** a broad flat surface that resembles the leaf of a land plant;

(2) the **holdfast,** a branching rootlike structure with which the seaweed holds on to the solid surface of the bottom; and

(3) the **stalk,** a more or less narrow region that connects the blade with the holdfast.

The largest seaweeds, the kelps and their relatives, often have swollen gas-filled blisters or balloons, called **air bladders,** along the blade and/or stalk. The air bladders act as floats, keeping the blades at the surface of the water when the tide comes in so that they can use the abundant light at the surface for photosynthesis.

There are **three main groups** of seaweeds. They can be told apart by their colors. The color differences are caused by differences in the light-absorbing pigments involved in photosynthesis.

(1) The **red** algae are mostly small seaweeds, often lacy in appearance, and most common in warm tropical waters (although some species do occur in cold waters). Their red pigments are adapted for absorbing the weak blue light found at some depth in the water, so the red algae are often the deepest-occurring seaweeds in places where all three types are found.

(2) The **green algae** are also mostly small seaweeds that occur in ocean waters all over the planet. They vary widely in appearance. This group also includes a lot of microscopic algae, most of which occur in fresh water. The green algae are considered to be the ancestors of plants.

(3) The **brown algae** includes the largest seaweeds of all: the giant kelps that occur in the Pacific Ocean off the west coast of North America. These seaweeds can reach lengths greater than 100 m. Other kinds of kelps and rockweeds, all brown algae, are very common in cool ocean waters the world over. Look for the sea palm in the videotape.

Seaweeds provide an important food source for intertidal organisms on rocky shores. Herbivores like sea urchins and snails graze on the seaweeds, and they are in turn food for predators like starfish and sea otters. In addition, where seaweeds such as the giant kelps are common, they provide hiding places for the vulnerable young of crustaceans and fishes. These young animals hide and feed among the kelp, only leaving when they are large enough to defend themselves. These areas are often called **nurseries.** Many commercially important species of fish and shellfish depend on these nurseries to ensure the survival of their young. When the nurseries disappear or are damaged, due perhaps to pollution, the fish and shellfish numbers decrease, endangering the livelihood of fishermen and driving up seafood prices. (You'll see the giant kelps in Tape 11.)

Seaweed Web Site: http://www.seaweed.ie/

WEB SITES FOR ROCKY INTERTIDAL ZONES

There are several web sites that have pictures and virtual field trips in the intertidal zone. Be sure and check these sites out, if you have difficulty understanding the intertidal community discussed in the video.

http://www.fhsu.edu/biology/Eberle/PacificNW/OregonCoastTidepools.html

http://www.pbs.org/wnet/nature/edgeofsea/index.html

http://omp.gso.uri.edu/doee/science/biology/inter1.htm

http://oceanlink.island.net/oinfo/intertidal/intertidal.html

CONCEPTS STUDY QUESTIONS FOR EPISODE 9 - Margins of the Land:

1. Explain what causes tides.

2. Describe the body of a typical seaweed (marine algae).

3. Compare the three groups of seaweeds (marine algae).

VIDEO STUDY QUESTIONS FOR EPISODE 9 - Margins of the Land:

1. What forces are responsible for the tides?

Locator: Bay of Fundy

species mentioned in this section: axis deer, Indian golden-banded woodpecker, wild boar, terns, kingfishers, great white heron

2. How high are the tides in the Bay of Fundy?

3. Is the boundary between sea and land permanent? Explain your answer.

4. Describe an estuary. What problems face the inhabitants of an estuary? What are the benefits of living in an estuary?

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ADDITIONAL INFO: Estuaries are found at the mouths of rivers where they meet the sea. The water in estuaries is brackish (saltier than fresh water, but not as salty as sea water). Estuaries are under the influence of the tides. When the tide comes in, sea water moves up the river, making the water saltier. When the tide goes out, fresh water from the river makes the water less salty. Thus, estuaries experience daily swings in the saltiness of the water. Most organisms find it difficult to adjust so quickly to changes in saltiness. Thus, most estuaries are inhabited by the relatively few organisms that are tough enough to handle this challenge. They are rewarded by the vast amount of organic material provided by the rivers, making estuaries some of the richest habitats in the world in terms of growth and reproduction.

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5. Where do these estuarine inhabitants live and what do they eat?

    a. mollusk (*Scorbicularia*)

    b. crustacean (*Corophium*)

    c. lugworms

    d. spire shell

    e. peacock worm

    f. cockles and mussels

6. How do the mussels cope with the tides?

7. Describe the oystercatcher. What three different techniques for opening mussels are used by oystercatchers? How does one learn its technique?

8. How many spire shells are found per square yard in the estuary mud?

9. Describe the following wading birds and their feeding behavior:

    a. godwit

    b. curlew

    c. dunlin

    d. ringed plover

    e. avocet

10. In one year, what is the amount of (mussel) flesh eaten by one oystercatcher? What does this indicate about the fertility of the estuaries?

11. How do plants get a hold in the estuary flats? How do glassworts promote the buildup of land?

12. What plant is the mud colonizer of the tropics?

13. Describe the tidal mangrove flats.

14. What animals are found here?

15. Describe the proboscis monkey. Where are they found? Why are they restricted in their distribution?

16. Describe the mangroves. How many species of mangroves are found throughout the world?

17. How are their flowers pollinated?

18. Describe the seed of the mangrove. Where does it germinate and begin to grow? How is it suited for establishing a new plant?

19. Describe the characteristics of the mangrove mud.

20. Why are the roots of the mangrove shallow? How do these shallow roots support the trees?

21. Explain how the mangrove roots gather nutrients.

22. How do the mangroves gather water? How do they deal with the problem of salt?

23. How do mangroves solve the problem of acquiring oxygen?

24. How do the mollusks deal with the problem of low tide? Why?

25. Describe the three types of mudskippers found in the mangrove flats. What do they eat?

26. How does the largest species advertise for a mate?

27. How do some terrestrial crabs manage to get oxygen?

28. Describe the soldier crabs. What do they eat?

29. Describe the mangrove crab. How does it keep moist? What does it eat?

30. Describe the fiddler crab. What is the large pincer of the male fiddler crab used for?

31. What birds are found in the mangrove flats at low tide? What do they eat?

32. What problems arise at high tide?

33. How do the following animals deal with the problems of high tide?

    a. African mangrove snail

    b. soldier crab

    c. mudskipper

34. Describe the archerfish.

35. Describe the otters. What do they eat? Where are they found?

36. Describe the estuarine crocodile. Why is it so widely distributed?

37. How are dry forests produced from the mud flats? How do banks of mud and sand protect the land from waves?

38. Are tall waves associated with shallow water or deep water?

39. How big is the intertidal zone in areas where the land drops sharply off into the sea?

40. What are the two problems that intertidal communities have to cope with?

Locator: northwest coasts, North America

species mentioned in this section: sea urchin, giant sea anemones, sea squirts, starfish, mussels, winkles, gooseneck barnacles

41. Describe the organisms that live on the bottom band of the tidal community. When is this lower band exposed? What happens to these animals during the low tides?

42. What determines the lower limit of the band of mussels?

43. Why are mussels found in dense bands in the middle intertidal zone? What other animals are found here? How do mussels attach themselves to the rock?

44. What animal replaces the mussel in more exposed areas? How do they attach to the rocks? How do they feed?

45. Describe the sea palms. How do these plants actively remove the mussels from the bare rock?

46. What determines the upper limit of the band of mussels?

47. What animal dominates the highest intertidal band? How do barnacles survive at the high tide band?

48. What three factors determine which organisms will dominate in each band of the rocky intertidal zone?

Locator: southernmost tip of Australia

species mentioned in this section: mollusk larva, hydra, nematode worm

49. What is the effect of the waves on the sandstone cliffs of Australia? What happens to the debris?

50. What are the problems of living on a sandy shore?

51. How do sand grains retain moisture? What tiny organisms live in the sand grains?

52. Describe the sandmason worm (larvae and adult).

53. Describe the sand hoppers. What do they eat? How do they protect themselves from drying out?

54. How many sand hoppers can be found in one square yard of beach sand?

55. Describe the ghost crabs. What do they eat?

Locator: South African beach

56. Describe the plough snail. How does it locate food? How does it travel? How does it avoid being stranded on the beach?

Locator: Costa Rica

57. Turtles belong to what group of animals? Why do they lay their eggs on the beach?

58. Describe the nesting habits of the Ridley turtle. Why do they lay their eggs within a few days? How many young turtles will survive?

59. Describe the nesting habit of the giant leatherback turtle. What do we know about these turtles? Where are the two nesting sites that we know about? Why is it endangered?

CONCEPTS FOR EPISODE 10 - WORLDS APART

ISLAND ECOLOGY

Islands, especially remote islands, are often studied as miniature terrestrial ecosystems. A remote oceanic island is a fully functional ecosystem but, due its isolated location, few life forms come to the island or leave it.

Also, it is probable that genetic change (evolution) may occur more quickly on these islands, since island populations are smaller than ones on the mainland. A change in the genetic makeup of one plant, for example, may spread more quickly through a population if it is one of 10 plants, as opposed to 100,000 plants.

As a general rule, species diversity is richer on large islands than on small islands. There are several possible reasons: (1) large islands may have more different types of habitats than small ones; (2) larger islands may be easier for plants and animals to find as they move from the mainlands (either voluntarily or involuntarily, if they are blown out to sea by a storm); and (3) the larger populations on large islands may have a better chance of surviving, since there will be more resources, more area, more genetic diversity and less chance of being wiped out by accident. As Attenborough talks about the Hawaiian Islands in the videotape, look at the multitude of habitats. Also, he discusses how animals, such as the ancestral honeycreeper and ancestral *Drosophila*, probably reached the islands in the first place.

There are often a number of problems that face plants and animals which live on islands, especially remote oceanic islands. One is the availability of fresh water. While some birds, such as sea birds, are able to drink salt water by extracting the salt from it, most animals require fresh water to drink. Most plants also require fresh water. Thus, an island with more-or-less permanent pools of rainwater has a far better chance of sustaining more life forms than an island with no immediate source of fresh water.

Another problem is finding food. Plants, if they can get established, can make their own food. If there is abundant plant life, then animals can survive by eating the plants. Many animals, especially birds, can find food by fishing in the surrounding oceans. Food can be a real problem for animals, especially if there are seasonal differences in food availability. A tropical island may have food available year round but this is not always the case. Think of the small islands in the Great Lakes, which have isolated populations of small deer mice and other animals. Winter conditions are harsh and food is scarce.

TYPES OF ISLANDS

Islands are not all the same. Some are formed from volcanic activity. Others, like New Zealand, formed when a large supercontinent split apart. Others are stabilized sandbars. Still other islands are formed from the activity of corals.

Barrier islands form when sandbars become colonized and stabilized by plants. These islands usually form in the shallow waters next to a continent. These barrier islands break up the force of the water and protect the mainland from storms. Usually, a quiet stretch of water lies between the barrier island and the mainland. If you look at a good map of Texas, you will see a chain of barrier islands stretching along the Gulf Coast. Padre Island, Matagorda Island and Mustang Island are good examples of barrier islands. Look between the mainland and

Padre Island and locate the Laguna Madre. The Laguna Madre is a valuable nursery for many of the deep sea inhabitants that lay eggs in these waters and leave their young to grow up in this more protected setting.

The wave action on rocky coasts (as shown in Episode 9) can separate chunks of the mainland into isolated islands.

Mangroves, growing in shallow off-shore waters, can create isolated **mangrove islands.** These can be found in Florida, along the fringing tip of the Florida Peninsula and around the Keys.

The best-known islands built by living organisms are built from the activity of corals. You will see coral reefs discussed in Tape 11. Coral reefs form in shallow, tropical waters, either along the edges of continents or around submerged volcanic islands. The water must be clean and unpolluted. According to Smith (1992), there are three main categories of coral reefs: (1) a **fringing reef,** which grows from a mainland or island into the sea, (2) a **barrier reef** which grows along a shoreline and is separated from the mainland by a shallow stretch of water called a lagoon, and (3) a **coral atoll** which forms when a volcanic island lowers, leaving a horseshoe or ring of coral reefs and islands enclosing a shallow lagoon. The Great Barrier Reef off the eastern coast of Australia is an example of a barrier reef. Many of the islands of Hawaii are surrounded by fringing reefs that grow from the edge of islands out. The island of Aldabra, shown in this video, is typical of a coral atoll.

Volcanic islands are formed from basalt, as seen in Tape 1.

References:

Amos, William H. 1980. *Wildlife of the Islands.* Harry N. Abrams, Inc., NY.

Jensen, Albert C. 1979. *Wildlife of the Oceans.* Harry N. Abrams, Inc., NY.

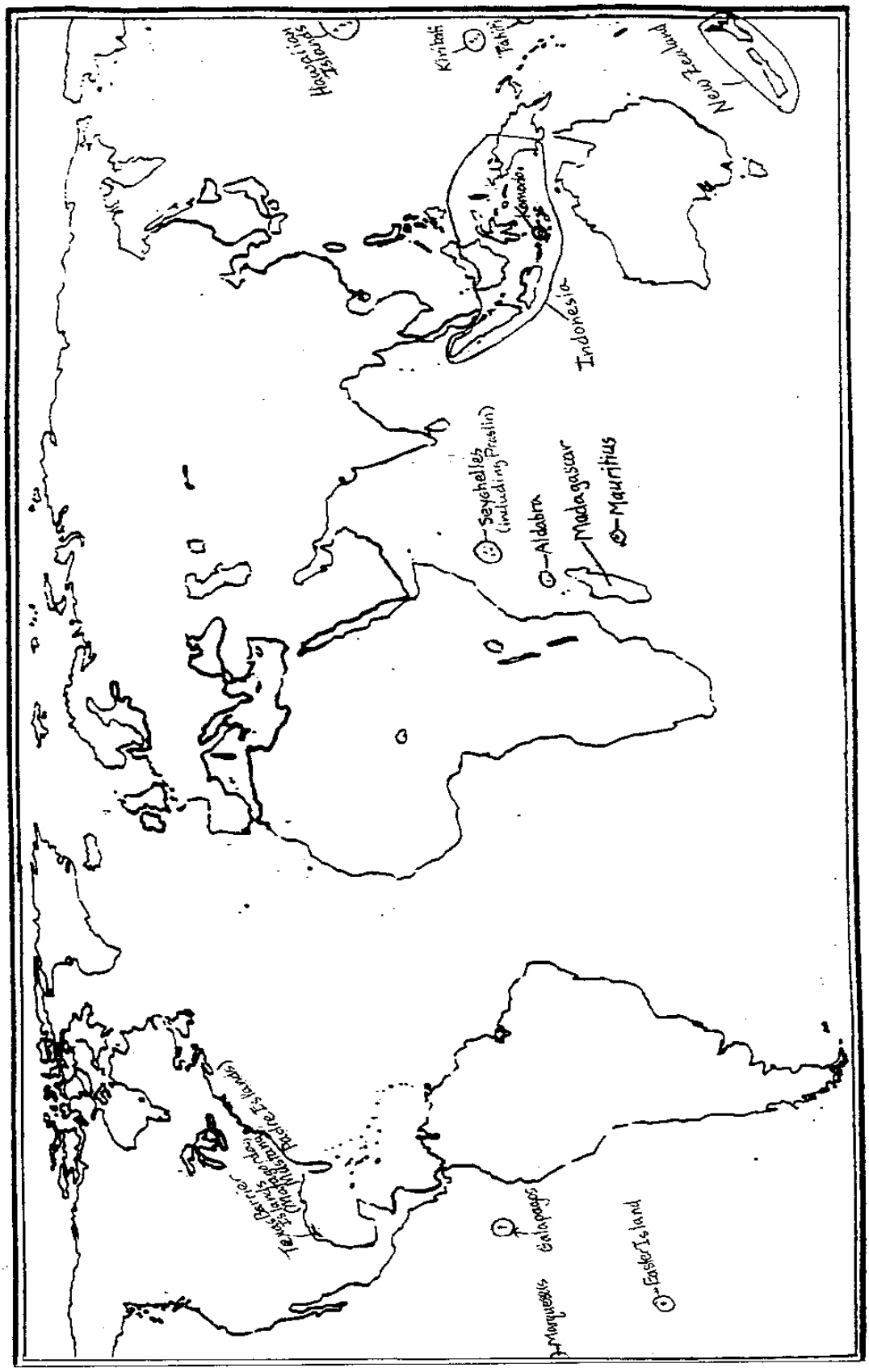
Smith, Robert Leo. 1992. *Elements of Ecology*, 3rd ed. HarperCollins, NY.

Thurman, Harold V. *Introductory Oceanography*, 5th ed., Merrill, Columbus, Ohio.

Web sites for information about New Zealand birds:

Kiwi Recovery: http://www.kiwirecovery.org.nz/

Takahe and other flightless New Zealand birds:
http://www.terranature.org/flightlessBirds.htm


Hawaiian Islands
Kiribati
Tahiti
New Zealand
Indonesia
Seychelles (including Praslin)
Aldabra
Madagascar
Mauritius
Galapagos
Easter Island

CONCEPTS STUDY QUESTIONS FOR EPISODE 10 - Worlds Apart:

1. Describe the effect of island size and isolation on genetic change (evolution).

2. Explain the effect of island size on the number of species living on the island.

3. Describe the different types of islands, how they are formed, and give examples.

4. Describe how a barrier island is formed and how it protects the mainland.

VIDEO STUDY QUESTIONS FOR EPISODE 10 - Worlds Apart:

1. What is the impact of islands on the species that inhabit the islands?

Locator: Aldabra, Indian Ocean

2. Describe the island. Where is Aldabra located?

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Aldabra Website:
http://www.nationalgeographic.com/wildworld/profiles/terrestrial/at/at1301.html

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3. What types of birds are found on the island?

4. Describe the frigatebirds and their mating behavior.

5. Where do the red-footed boobies nest?

6. Where do the sooty terns nest? How many sooty terns nest on Aldabra?

7. What does the vast number of animals indicate about the surrounding sea? How much food is available for animals on the island itself?

8. Why do the terns nest on this island?

9. How do plants reach remote islands?

10. Describe the nut of the coconut palm. How is this plant adapted to dispersing its seeds into the sea? How long can the coconut seed survive in salt water?

11. How did the coconut crab reach Aldabra?

12. Describe the coconut crab. What does it eat?

13. How do most crabs breathe in water? What adaptation allows the crab to breathe in air?

14. How does the coconut crab breed?

15. Describe the giant tortoises of Aldabra. How did their ancestor probably reach the island?

16. What are the dangers involved in living on Aldabra?

17. How do the tortoises cope with the heat of midday?

18. How do the birds prevent themselves from overheating? How often must tortoises drink fresh water?

19. How many giant tortoises are found on Aldabra? What do they eat?

20. Describe the changes that 50,000 years of evolution have produced in the plants of Aldabra:

    a. the sedges

    b. *Lomatophyllum*

21. Describe the coco-de-mer nut.

22. Where are the coco-de-mer palm trees found?

23. Describe the male coco-de-mer tree and the gecko that lives on them.

24. Describe the female tree. How long does it take to produce a nut? (Remember K strategy from Unit 4, page 29?)

25. How is the coco-de-mer nut different from a coconut? What is unusual about the seeds of this plant?

26. Why has the coco-de-mer not spread to other islands?

27. What changes have occurred in the birds that are isolated on Aldabra?

    a. sacred ibis

    b. kestrel

    c. Aldabran sunbird

    d. Aldabran rail

28. Why would an island bird become flightless?

29. Describe the dodo of Mauritius. Why did it become extinct?

30. Why did the giant tortoises of Mauritius and other islands become extinct?

31. How did the tortoises of Aldabra manage to avoid extinction?

32. How do the tortoises of Aldabra differ from the African tortoise that is closely related?

33. How does a normal African tortoise protect itself? How does this compare to an adult Aldabran tortoise? Why is there a difference?

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AUTHORS' NOTE: Why are the Aldabran tortoises (and other island residents) giants? One possible reason may be due to the very small gene pool on islands, which magnifies any small differences. This magnification often leads to very large changes in the characteristics of the entire population. You would not expect to see this in a large population, just due to the overall size of the gene pool. However, in isolated situations like islands, small genetic changes can lead to large changes in the appearance of the island residents.

Also, there is a very good possibility that there is a strong selection pressure in being large. Perhaps it helps the animals with temperature regulation or help the animal better survive periods when food is scarce. Remember how natural selection works -- if there is an advantage to being very large, then those animals would be more likely to have offspring, which in turn have a better chance of surviving and passing on their genes.

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Locator: Komodo in Indonesia

34. Describe the Komodo dragon. What do they eat?

35. What sense do they rely upon to detect prey?

36. What is the advantage to their large size?

37. What other lizards are they related to?

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AUTHORS' NOTE: Until recently, no one thought the Komodo dragons were poisonous. However, recent work with Komodo dragons has revealed that their bite is indeed venomous. You can find more information at: http://www.abc.net.au/rn/science/ss/stories/s1520986.htm

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Locator: Hawaiian Islands

38. Where are the Hawaiian Islands located? How were they formed?

39. Why are there so many different habitats on these islands?

40. What is the effect of the multitude of habitats on the organisms that live there?

41. Describe the different honeycreepers and their diet:

    a. palila

    b. amakihi

    c. apapane

    d. akohekohe

    e. iiwi

    f. akiapolaau

42. How did the ancestral finch get to the Hawaiian islands?

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NOTE: There is a thorough article on Hawaii's vanishing species, including honeycreepers and many other unusual species, in the September 1995 issue of *National Geographic.* This article, in addition to spectacular pictures, has a lot of information on island ecology.

Hawaiian honeycreepers web site:
http://people.eku.edu/ritchisong/hawaiihoneycreepers.html

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43. How many species of *Drosophila* are found in Hawaii? In North America?

44. How many species of ancestral *Drosophila* probably arrived on the islands by wind?

45. What has allowed so many different species of *Drosophila* to evolve?

46. Describe two of the different courtship rituals used by these flies.

47. Why is flying dangerous for an island insect?

48. What is unusual about the wings of the Hawaiian lacewing?

49. What is unusual about the wings of the Hawaiian crane fly? What does it eat?

50. Describe the twig caterpillar. How does it locate prey?

51. What is the effect of introduced predators on the native species that inhabit an isolated island?

52. How long ago did the Polynesians reach Hawaii?

53. Describe the techniques used by the Polynesians to build ocean-going canoes.

54. How are the leaves of the pandamus tree used?

55. Describe the Polynesian colonization of the Pacific. What did they use to find their way?

56. Describe the remains of the culture that developed on Easter Island.

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Easter Island web site: http://www.pbs.org/wgbh/nova/easter/

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Locator: New Zealand

57. How far did the Polynesians sail to reach New Zealand? When did they arrive in New Zealand?

58. What new challenges faced the Polynesians that colonized New Zealand?

59. How does New Zealand differ from the coral atolls and volcanic islands? How was New Zealand formed?

60. Describe the tuatara. What does it eat? Why is it unusual?

61. Describe the kiwi. Where does it live? In these New Zealand forests, the kiwi is the bird equivalent of what animal?

62. What does the kiwi eat?

63. What birds, besides the kiwi, are ratites? Where are they found?

64. Describe the extinct moa. What did it eat? How do we learn about its diet or other features?

65. What two activities of the Maori people were responsible for the extinction of the moa by the 16th century?

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ADDITIONAL INFO: In his book, Attenborough also explains that the Maori had a huge impact on the moa, using their skins, eggs and bones in addition to eating them for food. Skins were used for clothing; the big eggs became containers; the bones were used to make jewels, tools and weapon tips. The Maori also cleared the forests for home sites, thus reducing the suitable habitats for moa. All in all, the effects were so devastating that the moa were extinct within a few hundred years after the Maoris colonization of New Zealand. And, as Attenborough explains, so were about 44 other species. (page 265)

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66. How did other, more modern animals reach New Zealand after it was isolated?

67. Describe the kea. What is it related to? Where does it live? What does it eat?

68. Describe the kakapo. Where does it live? What does it eat?

69. What are the three characteristics commonly found in island inhabitants?

70. What impact did the Polynesians have on the kakapo's population?

71. What impact did the European settlers have on the kakapo's population?

72. Where are the kakapo located now and why?

73. What is the impact of imported animals on native island animals? Name some of these imported species. Be familiar with the types of problems these imported species create for native species.

74. Describe the takahe. What type of bird is it?

75. How many takahes are alive today? Where are they located? Why?