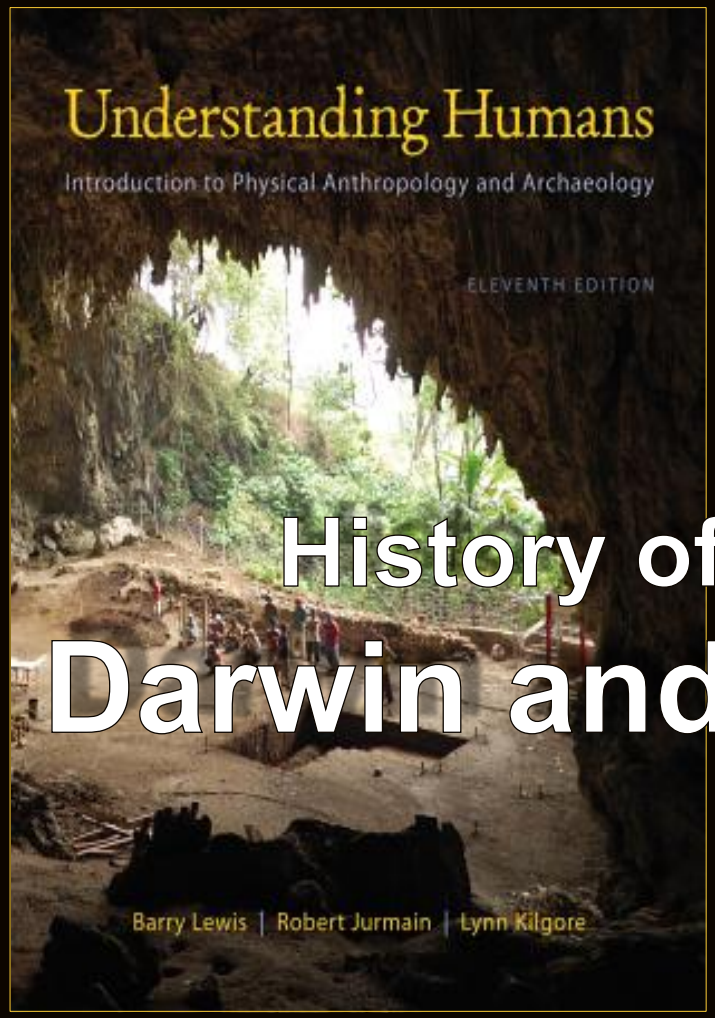
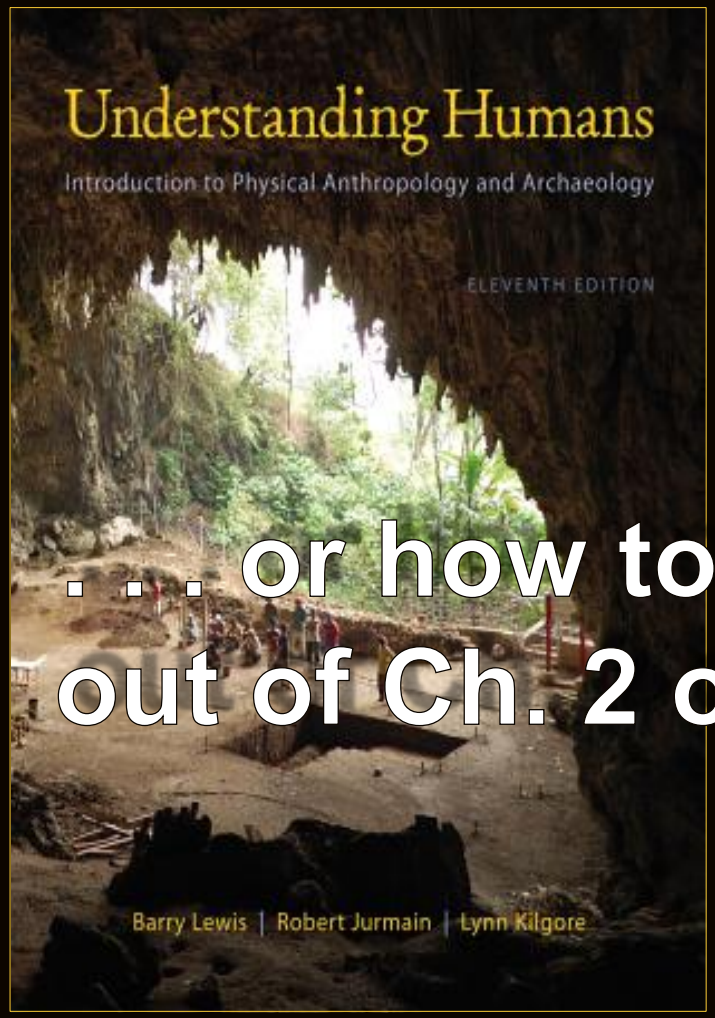


History of Though:
Darwin and Wallace

University of Minnesota Duluth
Tim Roufs

http://www.d.umn.edu/cla/faculty/troufs/anth1602/



. . . or how to make sense out of Ch. 2 of the text . . .

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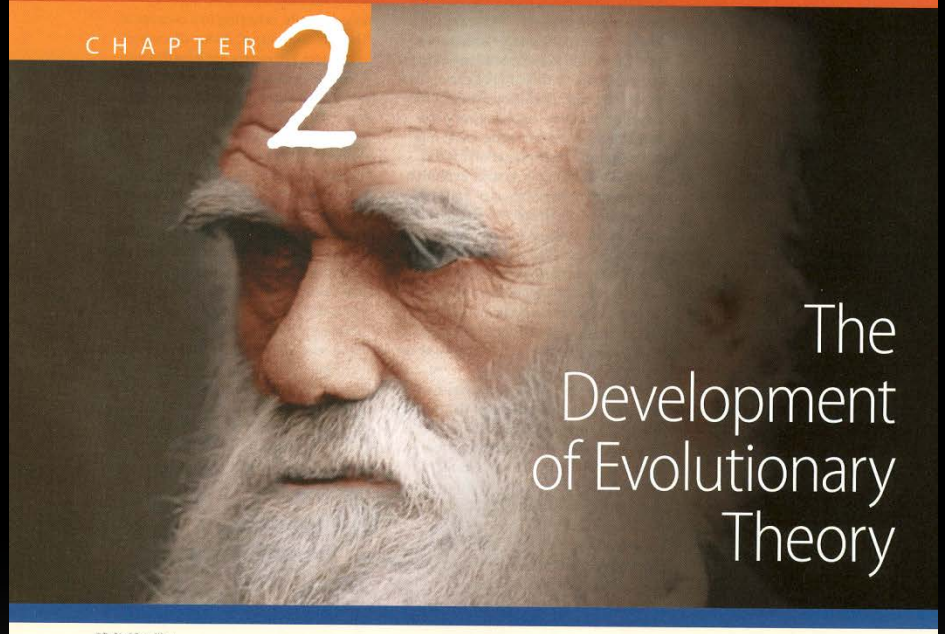
Heredity and Evolution

CHAPTER 2



The Development of Evolutionary Theory

LEARNING OBJECTIVES

After you have mastered the material in this chapter, you will be able to:

- Describe the key contributions to evolutionary theory made by precursors to Darwin and explain how each influenced the development of evolutionary theory.
- Explain how natural selection works.
- Contrast the scientific understanding of biological evolution with nonscientific approaches that seek to explain the origins of life and how life has changed on earth.

Charles Darwin

(1809 - 1882)

- ***Origin of Species***

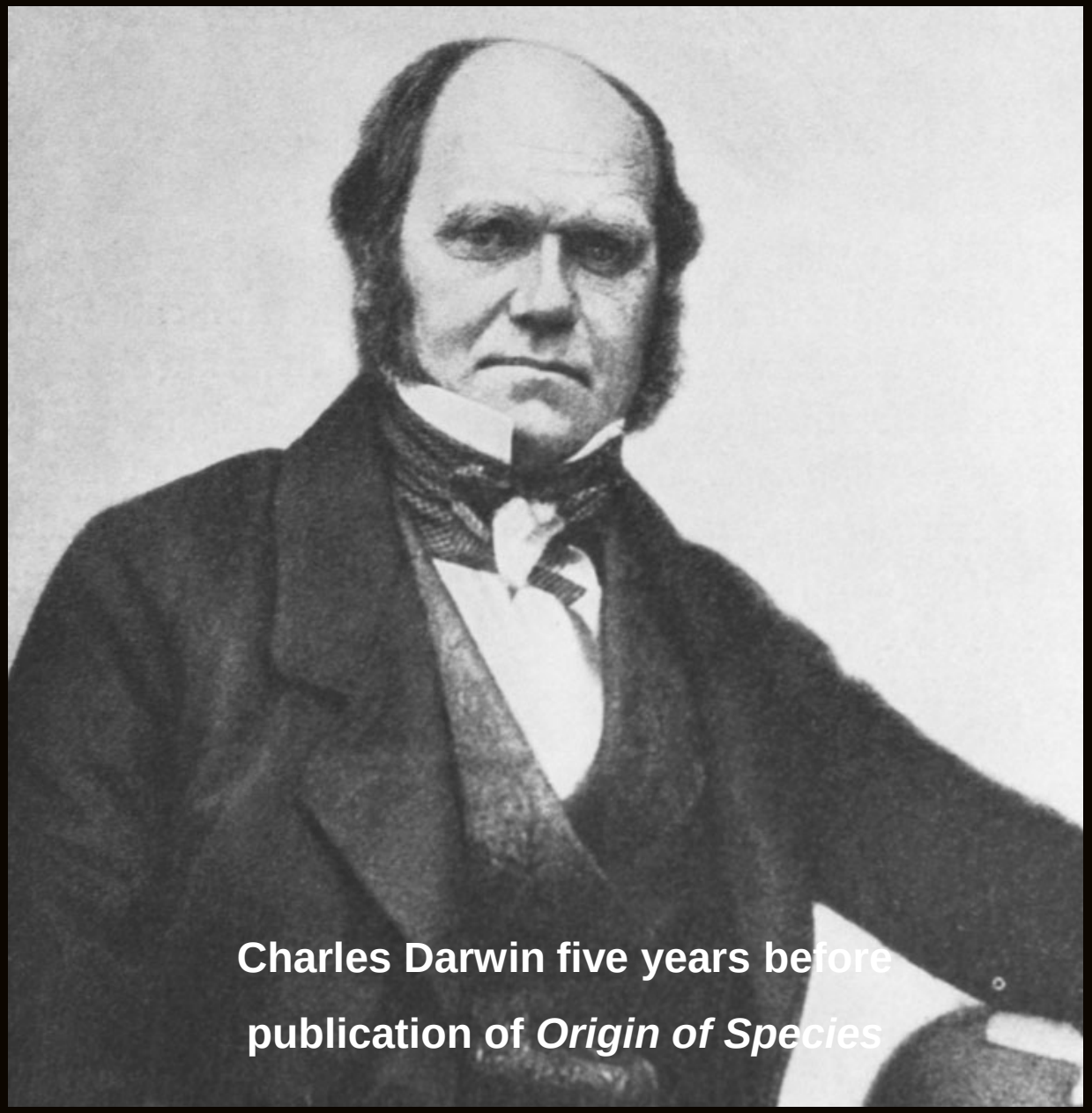
1859

- ***Descent of Man***

1871

Charles Darwin as a young man

Understanding Physical Anthropology and Archaeology, 8th ed., p. 30



Charles Darwin five years before publication of *Origin of Species*

Understanding Humans, 11th ed., p. 26

Figure 2-11

Down House, as seen from the rear. *On the Origin of Species* and numerous other publications were written here.

op his views on what he called *natural selection*. This concept was borrowed from animal breeders, who choose, or "select," as breeding stock those animals that possess certain traits they want to

Robert Jurmain

By the late 1830s, Darwin had realized that biological variation within a species (that is, differences among individuals) was crucial. Furthermore, he recognized that sexual reproduction increased variation, although he didn't know why. Then, in 1838, he read Malthus' essay, and there he found the answer to the question of how new species came to be. He accepted from Malthus that populations increase at a faster rate than do resources, and he recognized that in nonhuman animals, increase in population size is continuously restricted by limited food supplies. He also accepted that in nature there is a constant "struggle for existence." The idea that in each generation more offspring are born than survive to adulthood, coupled with the notions of competition for resources and biological diversity, was all Darwin needed to develop his theory of natural selection. He wrote: "It at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed.

The Darwin home, Down House, in the village of Down

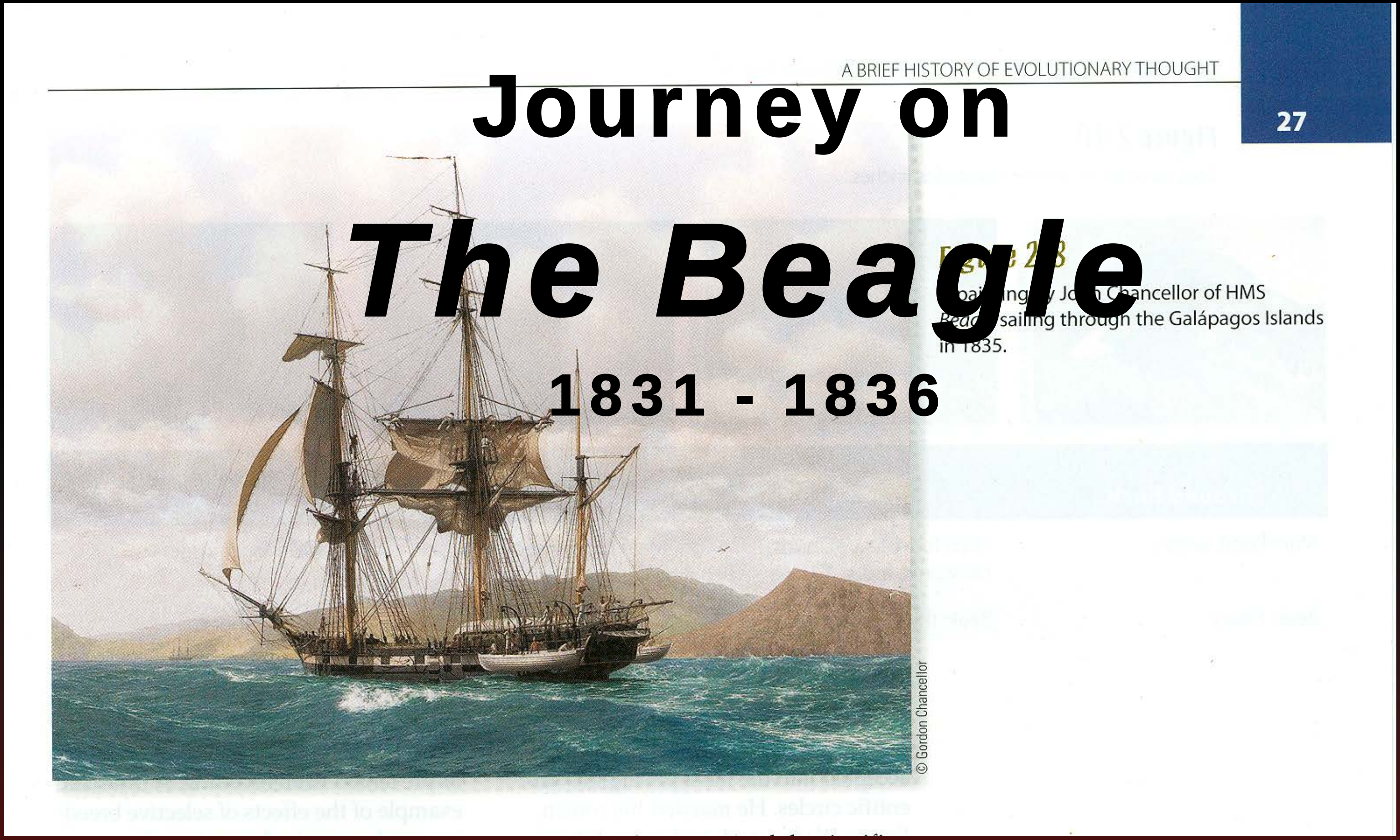
Understanding Physical Anthropology and Archaeology, 8th ed., p. 28

Charles Darwin

Journey on

The Beagle

1831 - 1836



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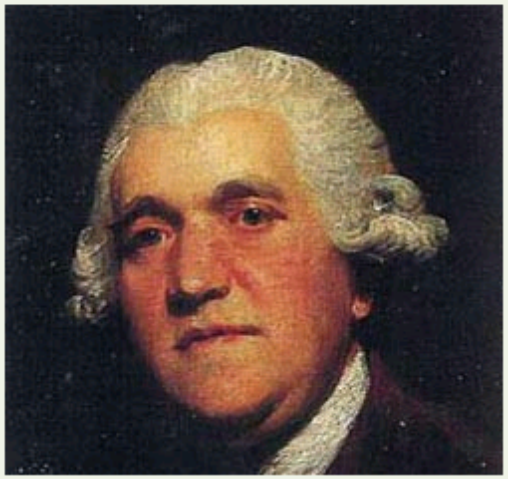

Wedgwood China

The founder, Josiah Wedgwood built his pottery at Etruria in 1769. Known as 'The Father of English potters', he was given royal patronage by Queen Charlotte, and the Empress Catherine II of Russia. Wedgwood china fine bone china tableware has been in continuous production at Wedgwood for over 100 years ranging from plain white china .....

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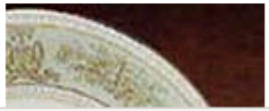
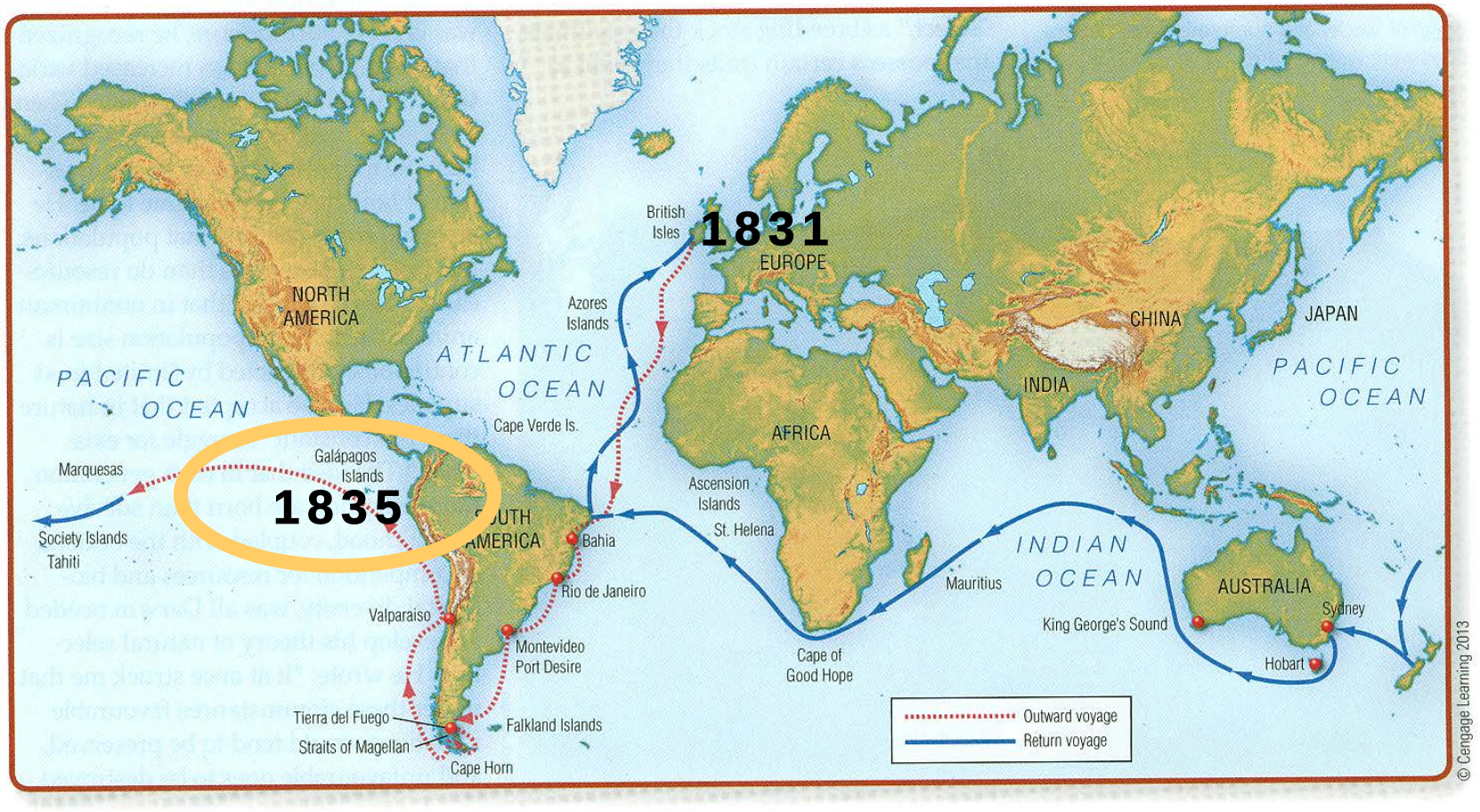


In 1839 Charles Darwin married his first cousin, Emma Wedgwood

- Daughter of the younger Josiah Wedgwood, son of the Josiah Wedgwood who founded the pottery works
- Darwin's mother Susannah was the sister of his wife’s father

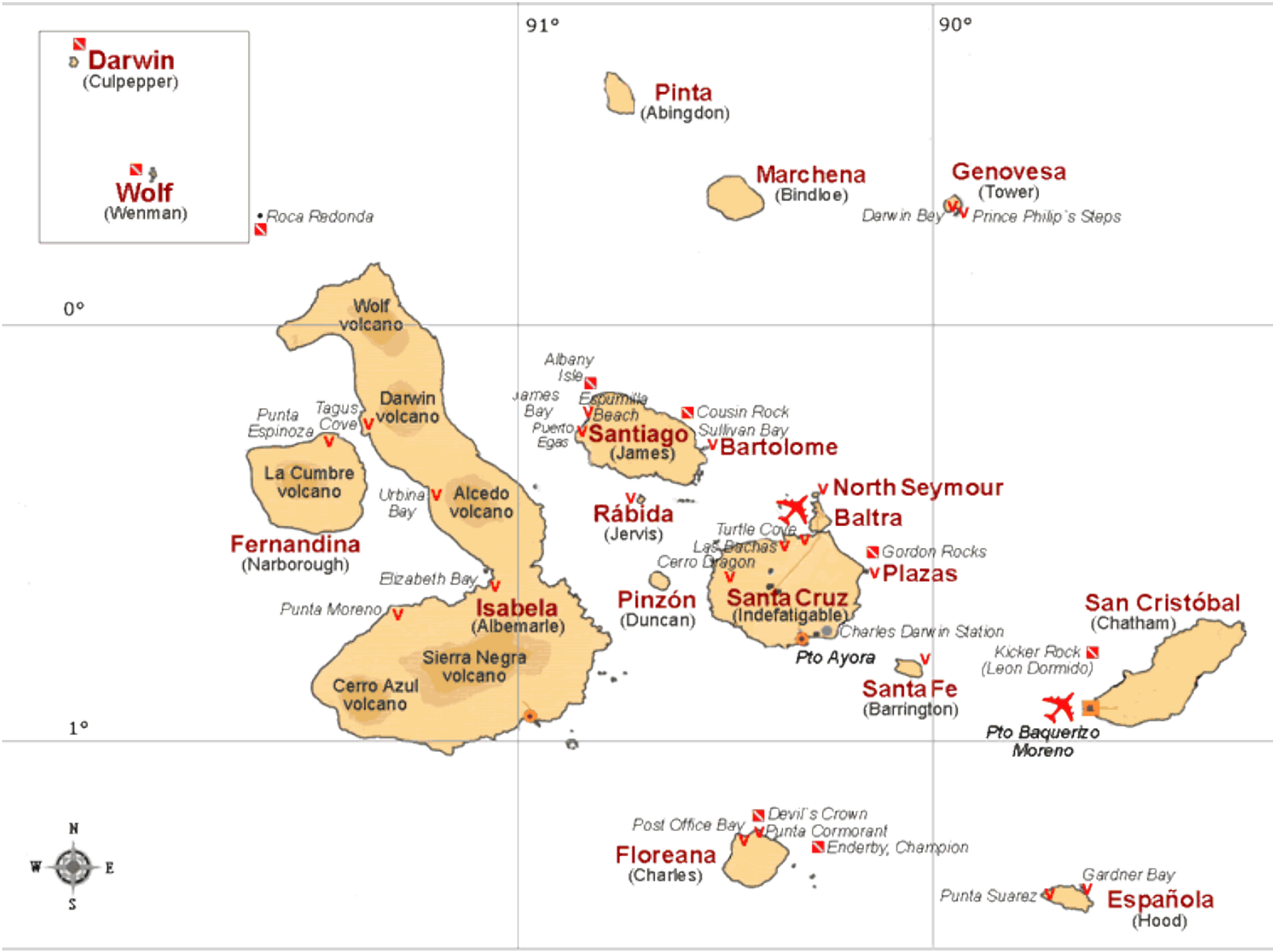
time in response to different island habitats and dietary preferences. But actually, it wasn't until *after* he returned to could lead to the modification of one species into 13 (Gould, 1985; Desmond and Moore, 1991).

Figure 2-9
The route of HMS *Beagle*.



The route of the HMS *Beagle*

Understanding Humans, 11th ed., p. 27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(Culpepper)
Wolf
(Wenman)
Roca Redonda
91°
90°
Pinta
(Abingdon)
Marchena
(Bindloe)
Genovesa
(Tower)
Darwin Bay
Prince Philip's Steps
0°
Wolf volcano
Darwin volcano
Punta Espinoza
Tagus Cove
La Cumbre volcano
Fernandina
(Narborough)
Urbina Bay
Alcedo volcano
Elizabeth Bay
Punta Moreno
Isabela
(Albemarle)
Sierra Negra volcano
Cerro Azul volcano
Albany Isle
James Bay
Espumilla Beach
Puerto Egas
Santiago
(James)
Cousin Rock
Sullivan Bay
Bartolome
Rábida
(Jervis)
North Seymour
Baltra
Turtle Cove
Las Bachas
Cerro Dragon
Gordon Rocks
Plazas
Pinzón
(Duncan)
Santa Cruz
(Indefatigable)
Charles Darwin Station
Pto Ayora
Santa Fe
(Barrington)
San Cristóbal
(Chatham)
Kicker Rock
(Leon Dormido)
Pto Baquerizo Moreno
1°
Post Office Bay
Devil's Crown
Punta Cormorant
Enderby, Champion
Floreana
(Charles)
Gardner Bay
Punta Suarez
Española
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Galapagos

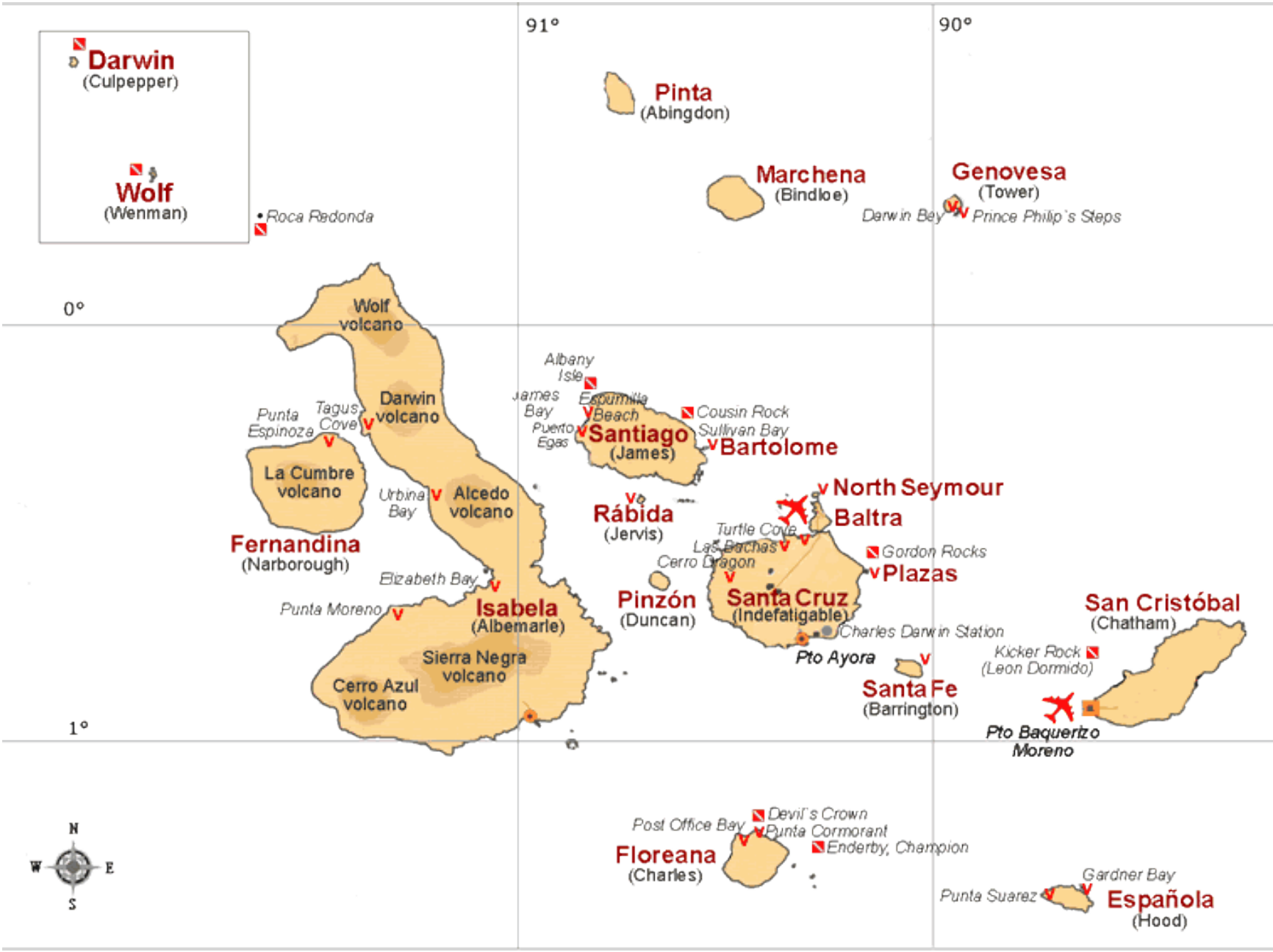
Alexandra Boulat, Associated Press

Cactus, seals and tourists on the surreal landscape of Bartolomew Island, which was named for one of Charles Darwin's life-long friends. It's one of the youngest in the archipelago.

"The only place in the world where you will see penguins next to a cactus."

By PETER MANDEL, SPECIAL TO THE STAR TRIBUNE

Last update: October 3, 2009 - 1:14 PM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Friday, 8 November, 2002, 00:00 GMT

Darwin's finches at risk

The finches hold a unique place in the history of science

By Jonathan Amos
BBC News Online science staff

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Dr Nigel Collar, expert on threatened birds "We should be very alarmed indeed about this"

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Galapagos: Darwin's Finches - 1 - Netscape

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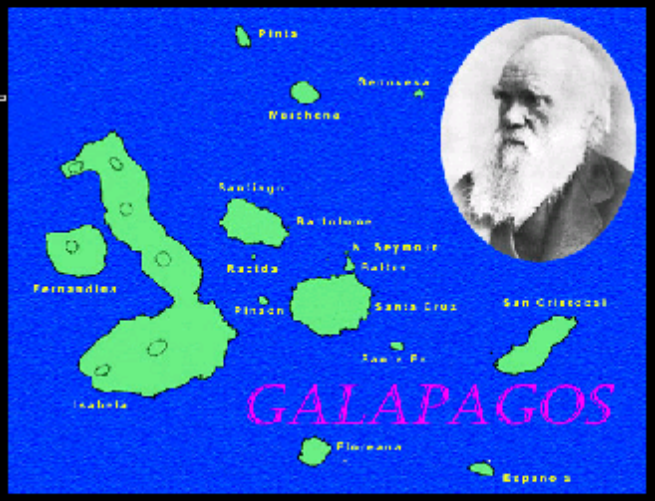
- Galapagos Hawk
- Galapgos Dove
- Flycatchers
- Short-eared Owl
- Yellow Warbler
- Smooth-billed Ani



Darwin's Finches

If the giant tortoise is the symbol of the Galapagos Islands, then Darwin's finches must be the symbol of evolution in the Galapagos. It may seem curious that of all the animals in the Galapagos,this group of very drab and dull birds is most closely associated with Darwin's name. He was neither the first to see them (they are

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www.rit.edu/~rhrsbi/GalapagosPages/DarwinFinch.html

Figure 2-10

Beak variation in Darwin's Galápagos finches.

Tui De Roy / Minden Pictures

Mark Moffett / Minden Pictures

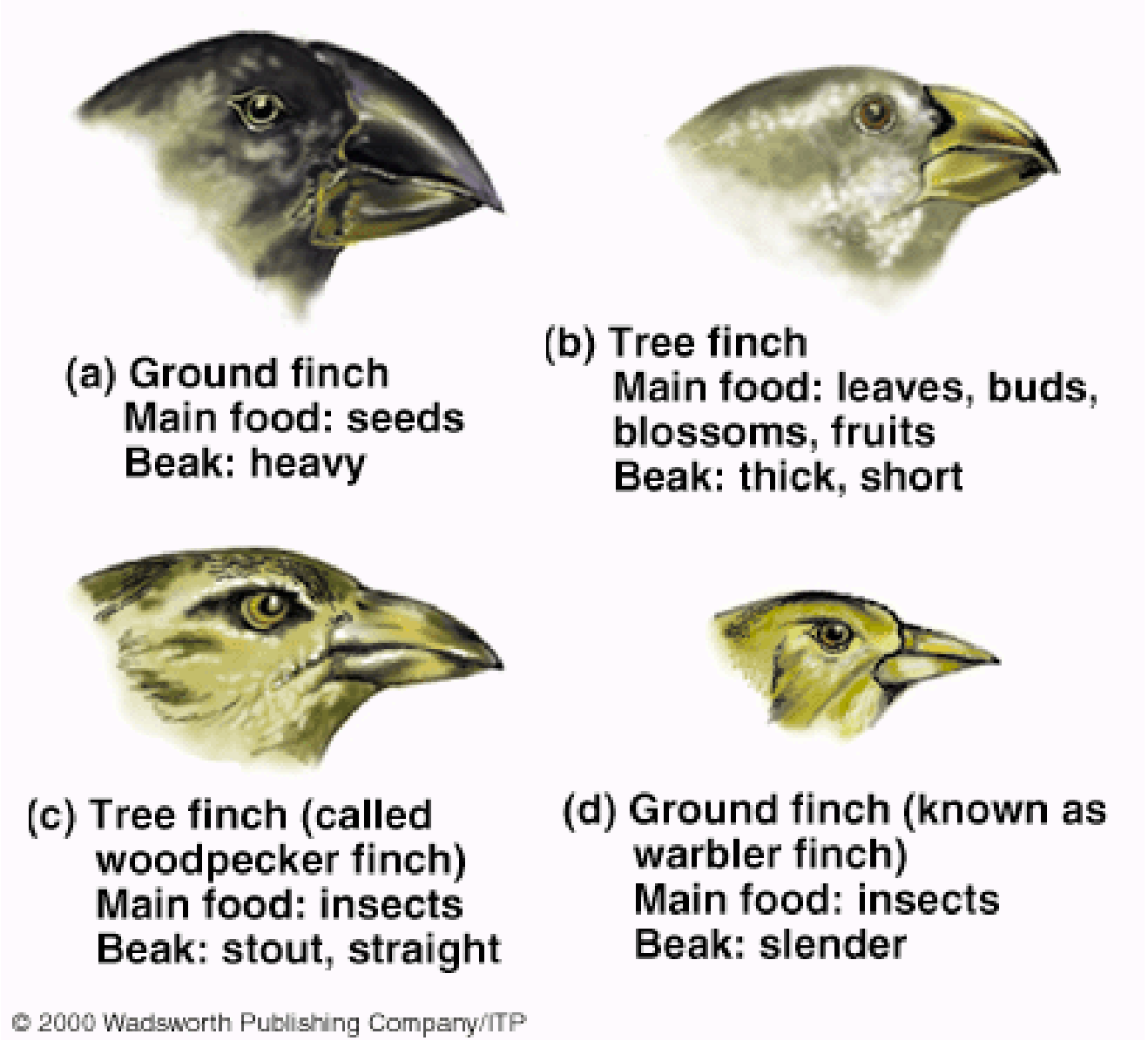
D. Parer & E. Parer-Cook / Auscape / Minden Pictures

Tui De Roy / Minden Pictures

Ground finch	Tree finch	Tree finch (called woodpecker finch)	Ground finch (known as warbler finch)
Main Food: seeds	Main food: leaves, buds, blossoms, fruits	Main food: insects	Main food: insects
Beak: heavy	Beak: thick, short	Beak: stout, straight	Beak: slender

Beak variation in Darwin's Galápagos finches

Understanding Humans, 11th ed., p. 28



Beak variation in Darwin's Galápagos finches

Understanding Humans, 10th ed., p. 27

Galapagos Tortoise - Netscape

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Galapagos Tortoise

Galapagos Tortoise Nesting Video

Sam

PHYSICAL CHARACTERISTICS

Geochelone elephantopus. There are 14 described subspecies of the Galapagos tortoise of which 11 still exist, some with only small populations. There are "dome-shelled" and "saddle-backed" Galapagos tortoises. Where ground vegetation is the main source of food the animals are dome-shelled. Those that feed on higher growing cactus have a curved shell front to allow their longer neck to reach the pads.

Galapagos tortoises vary in size from 29 inches (shell length) and 60 pounds to 4 feet and 700 pounds. There is little variation in color, overall dull-brown being standard. The male has concave underside, which facilitates mating.

Document: Done

www.honoluluzoo.org/galapagos_tortoise.htm

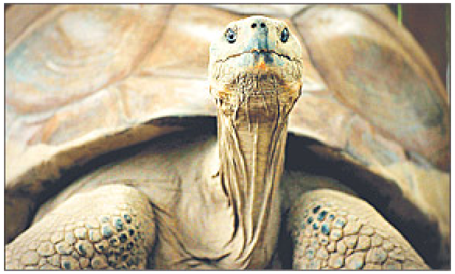
http://www.news.com.au/story/0,10117,16864720-13762,00.html

World's oldest party girl

October 10, 2005

From: Daily Telegraph

SOON to turn 175 years of age, Harriet the Galapagos tortoise - possibly the world's oldest living creature - is finally getting the recognition she surely deserves.



Harriet the tortoise ... 175 years young. She was originally collected by legendary botanist Charles Darwin, who promptly went and mis-identified her as a male.

Harriet, which was first taken from her home on the Galapagos Islands, off South America, by English naturalist Charles Darwin, is now the subject of a book about her amazing life.

Harriet was hatched in 1830. Five years later, she and two other tortoises were collected by Darwin and taken to England aboard his ship, *HMS Beagle*.

The three, then named Tom, Dick and Harry, were cared for by Darwin, but five years of freezing English winters and a lack of sunshine reduced them to a state of virtual hibernation and they were brought to Australia in 1842.

Dick died in the late 1880s and it is not known where its remains were buried, while Tom died in 1949.

In 1960, a visiting director of Hawaii's Honolulu Zoo examined Harry and found he was a she, a move that prompted the name Harriet. She now lives

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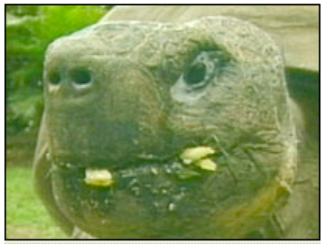
Harriet the Tortoise dies at 175

Harriet the tortoise, one of the world's oldest known living creatures, has died in Australia aged about 175.



VIDEO 175th birthday bash

Senior vet Dr John Hangar told Australia's ABC that Harriet, a Giant Galapagos tortoise, had died of heart failure after a short illness.

"She had a very fairly acute heart attack and thankfully passed away quietly overnight," Dr Hangar said.

Last year staff at Australia Zoo, where Harriet had lived for 17 years, held a party to celebrate her 175th birthday.

Some people believe that Harriet was studied by British naturalist Charles Darwin.

Darwin took several young Giant Galapagos tortoises back to London after his epic voyage on board HMS Beagle.

DNA testing has suggested the giant creature was born around 1830, a few years before Darwin visited the Galapagos archipelago in 1835.

However, Harriet belonged to a sub-species of tortoise only found on an island that Darwin never visited.

At the time of her 175th birthday party, Harriet weighed 150kg (23 stone) and was roughly the size of a dinner table.

She was the star attraction at the Australia Zoo on Queensland's

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Darwin reaches the Galapagos

Eventually
Darwin asked the question:

Why would God make a separate species for each island?

- **Observation 1**

  Without environmental pressures, every species tends to *multiply in geometric progression*

(Thomas Malthus, *Essay on the Principle of Population*, 1798, and others)

Theory of Natural Selection

- **population, *when unchecked*, grows in a geometric ratio**
- **population, if unchecked, the human population will double every 25 years because of *geometric progression***
  - **1, 2, 4, 8, 16, 32, 64. . . .**

Theory of Natural Selection

- **Arithmatic**

  (+2) 2 -- 4 -- 6 -- 8 -- 10 -- 12 -- *n*

- **Geometric**

  (X 2) 2 -- 4 -- 8 -- 16 -- 32 -- 64 -- *n*

Potential exponential increase of populations =

“superfecundity”

(Thomas Malthus, 1798 and others)

With permission from the Master of Haileybury

Figure 2-4
Portrait of Thomas Malthus.

in from unaffected regions. But Cuvier needed to account for the emerging fossil evidence that organisms had become more complex over time, so he suggested that after each disaster, the incoming migrants had a more modern appearance because they were the results of more recent creation events. (The last of these events was the one described in Genesis.) So Cuvier's explanation of increased complexity over time avoided any notion of evolution while still being able to account for the evidence for change that was preserved in the fossil record.

Thomas Malthus In 1798, Thomas Malthus (1766–1834), an English clergyman and economist, wrote *An Essay on the Principle of Population*, which inspired both Charles Darwin and Alfred Wallace in their separate discoveries of natural selection (**Fig. 2-4**). In his essay, Malthus argued for limits to human population growth and pointed out that human populations could double in size every 25 years if they weren't kept in check by limited food supplies. Of course, humans, unlike other species, can increase their food supplies and aren't dependent on natural sources, but Malthus warned that increased numbers of humans would eventually lead to famine.

Darwin and Wallace accepted Malthus' proposition that population size increases exponentially while food supplies remain relatively constant, and they extended it to all organisms. But what impressed them the most was something Malthus hadn't written about. They both recognized the important fact that when population size is limited by

Thomas Malthus

Understanding Humans, 11th ed., p. 24

Hordes of houseflies bug Philadelphians

Knight-Ridder Newspapers

PHILADELPHIA — The city's garbage strike ended three weeks ago, but a vestige of the walkout remains: flies.

"My husband is presently going around the kitchen killing flies as I am trying to cook," Rosemary Cubas, who lives on North Second Street, said on a recent evening. "We have never in my house had so many flies. They're everywhere. It's getting on people's nerves."

For 20 days in July, Philadelphia residents piled up garbage in basements, back yards, gutters and emergency dump sites throughout the city. The refuse is gone. But health officials say the acres of rotting garbage and high temperatures combined to create a model breeding ground for flies, and now the city is plagued with hordes of flies.

"I would have to say that this is probably the worst I've seen," said

home from work and find hundreds of flies in their basements. The maggots — customers see them and call us. They're hysterical."

"The strike was the best thing that happened to us.... If the strike went on for another two weeks, I would have been very well off," Kanya said.

Those surprised at the large number of flies should talk to Stanley Green, an entomologist with the Pennsylvania State University Cooperative Extension Service in Philadelphia.

"The reproductive potential of a pregnant housefly between April 1 and Aug. 31 is 191 quintillion flies," Green said.

That's 191 with 18 zeros after it. "A lot of flies," Green said, noting that the average housefly lays about 500 eggs at a time. In this weather, he said, those eggs go from maggots to pupae to full-grown flies in about a week.

Sutton said that the flies did not

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Last Updated: Tuesday, 10 July 2007, 10:02 GMT 11:02 UK

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US warns tourists of Naples waste

The US embassy in Rome has warned American tourists that they may face health risks if they travel to Naples, because of the city's rubbish crisis.

The city's landfill sites are full and rubbish is overflowing in the streets

The streets of the southern Italian city have been strewn with rotting waste since May.

The US embassy warns that fires lit by local citizens to try and get rid of the rubbish may give off toxic fumes.

It also warns that tourists may encounter demonstrations from residents angered by the crisis.

Correspondents say the crisis has its roots in political mismanagement and the involvement of organised crime.

"US citizens travelling to or through the area may encounter mounds of garbage, open fires with potentially toxic fumes and sporadic public demonstrations by local residents," the embassy warns

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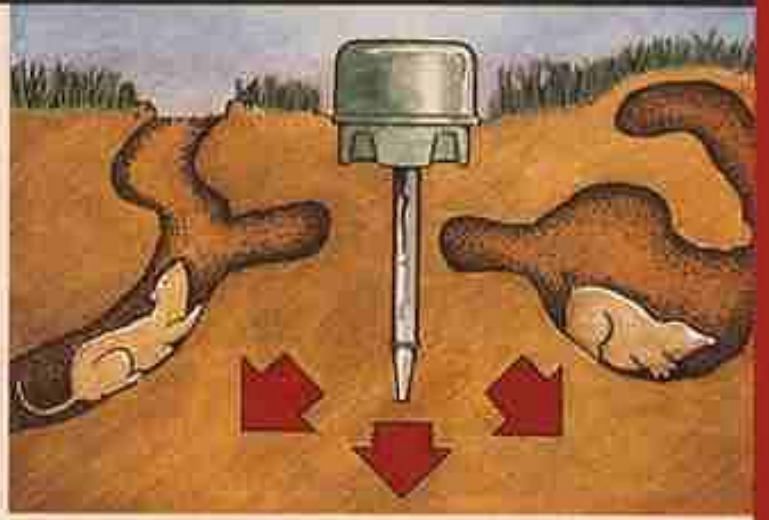
Rid Your Lawn of Voles, Moles, and Other Underground Bulldozers with Mole Evictor.

We've found an environmentally safe and effective way to banish mice, moles, and voles from your lawn and garden. One healthy pair can produce 30 to 40 young per year, which themselves can reproduce every 3 months. This pyramids to 10,000 per year! These critters cause millions of dollars of damage each year to crops, lawns, and trees.

Moles are very sensitive to vibrations in the ground. Such shock waves mean danger, and they vacate the area. Mole Evictor takes advantage of this by surrounding a battery-driven vibrator with a thin-walled housing. Every five minutes a series of impulses spreads from Mole Evictor into the surrounding earth. Use wooden dibble to make hole for aluminum vibrator shaft. Evictor is easily moved from one area to another.

Extensive testing shows that these pests abandon their burrows for good. Average coverage for each Mole Evictor is 500 sq. yds. Coverage may be less in sandy soils. Mole Evictor runs for 1 to 2 months on four alkaline flashlight batteries (included). Made in W. Germany. 4½" diameter x 12" long.

#5308 Mole Evictor $99.00



Great Horned Owl Repels Rabbits, Rodents, Pigeons and Other Garden Pests.

Superb lifelike reproduction of Great Horned Owl is made of tough, durable weatherproof plastic. Mount it on a pole and it

Starting point	Initial mass	Period in which mass would be doubled	Time it would take for the total mass to equal that of	
			Earth	The observable universe
1 pair of elephants	8.7 tons	50 yr	3500 yr	7350 yr
1 pair of houseflies	0.0175 oz	42 hr	163 days	306 days
1 bacterium	0.00000000001 oz	5 min	11 hr	18 hr

In the same vein: if Adam and Eve and all their progeny, starting in Bishop Ussher's 4004 B.C., had heeded the admonition to be fruitful and multiply only at the lazy rate by which each couple would have four children each thirty-eight years, the total mass of humanity in 1967 would have equaled that of the observable universe.

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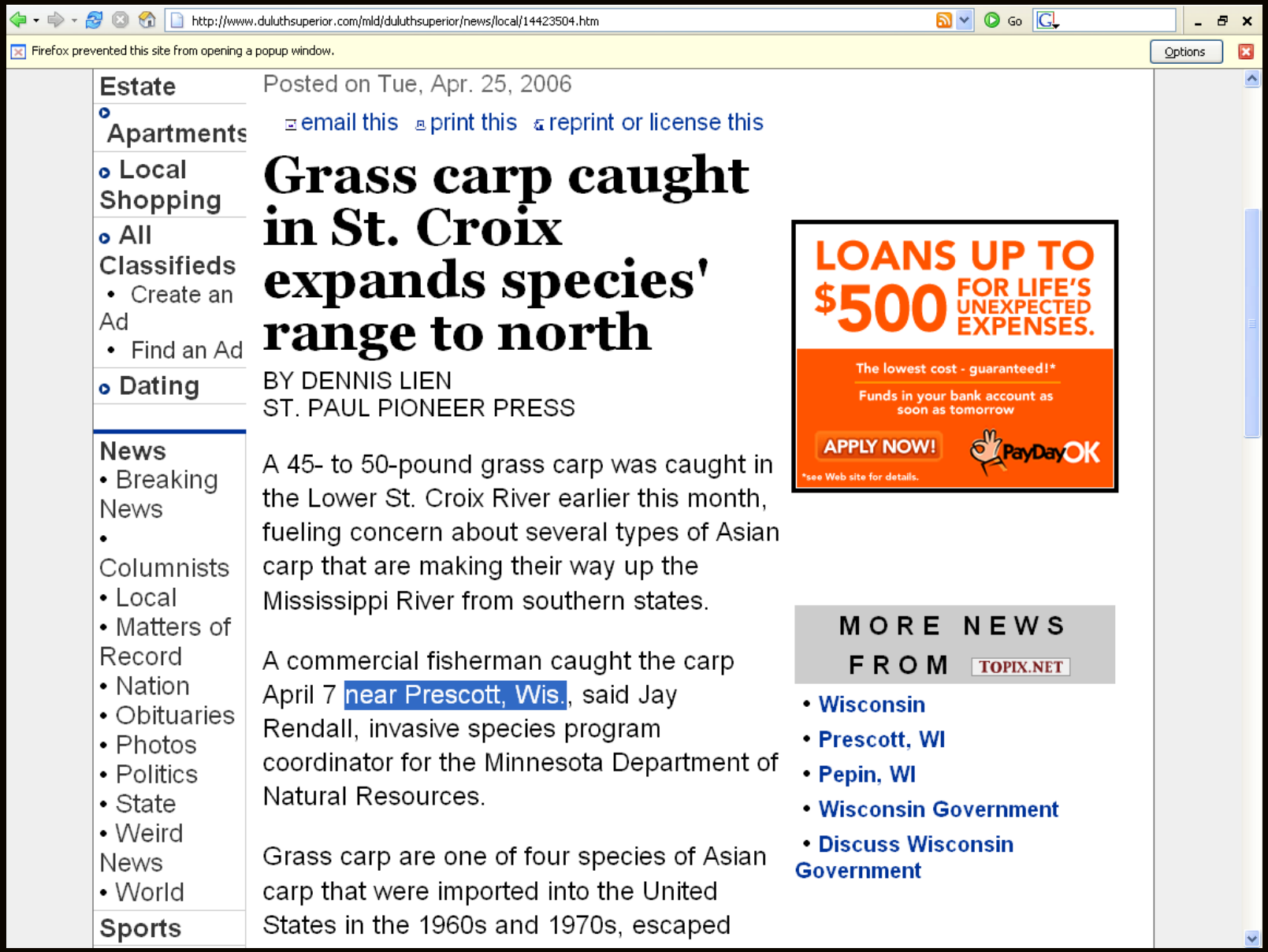
Foreign invaders--from Asian carp to zebra mussels--threaten Minnesota from all directions

Jay Rendall knows that 20 lakes in Wisconsin contain zebra mussels and more than 100 Michigan lakes have populations of the insidious exotic species. He also knows that zebra mussel-infested boats from those lakes could someday visit Minnesota, if they

Photo: A 50-pound

www.dnr.state.mn.us/fwt/back_issues/september00/article3.html



www.duluthsuperior.com/mld/duluthsuperior/news/local/14423504.htm

Maryland Wages War on Invasive Walking Fish

02 July 2002

Hillary Mayell
for National Geographic News
July 2, 2002

Alien Species Photo Gallery: Go >>

An angler caught an air-breathing, land-crawling, voracious predator this past weekend in a pond in Crofton, Maryland.

The good news is that the fish, a northern snakehead that has been targeted by biologists for the last several weeks, was caught. The bad news is that it was 26 inches (66 centimeters) long; the fish caught in mid-May that alerted wildlife officers to the possibility of an invasion by an alien species was only 20 inches (51 centimeters) long.

The snakehead is shown here next to a U.S. dollar bill, for scale.

news.nationalgeographic.com/news/2002/07/0702_020702_snakehead.html

In 2 years 2 snakeheads bred to 1000+ in a 4-acre pond

CROFTON, MD.

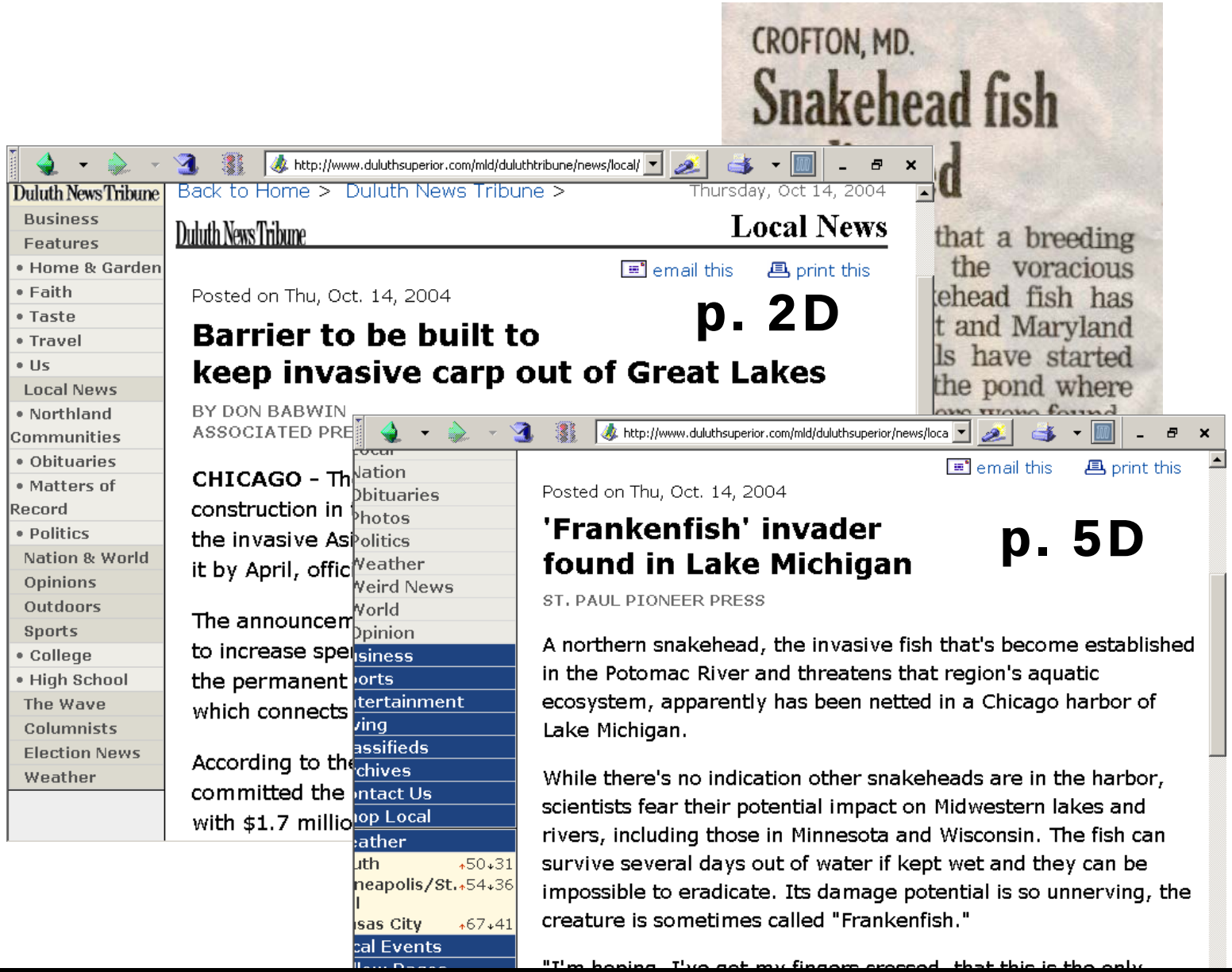
Snakehead fish eradicated

Tests show that a breeding population of the voracious northern snakehead fish has been wiped out and Maryland wildlife officials have started rehabilitating the pond where the alien invaders were found.

State biologists have found the bodies of six adult snakeheads and more than 1,000 juveniles since they sprayed the fish poison rotenone on the 4-acre pond about two weeks ago. The fish were descendants of just one pair dropped into the pond two years ago by a man who had bought them at a New York market.

Late last week, electroshock tests showed there were no live fish remaining in the pond, the Maryland Department of Natural Resource said.

***Duluth News Tribune*, Thursday 19 September, 2002, 2A**



***Duluth News Tribune*, Thursday 14 October, 2004**

- **Observation 2**

  But under field conditions, although fluctuations occur frequently, the size of a population remains *remarkable constant* over long periods of time

  (Source: Universal observations)

The Wolf, the Moose, and the Fir Tree: Who Controls Whom on Isle Royal? A Case Study of Trophic Inte - Netscape

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The Wolf, the Moose, and the Fir Tree: Who Controls Whom on Isle Royal?

A case study of trophic interactions

by
Gary M. Fortier
Department of Small Animal Science
Delaware Valley College

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Wolf, moose numbers rebound on Isle Royale

By Sam Cook
News-Tribune outdoors writer

Isle Royale's wolf and moose populations both increased last year, nearing what biologists say would be an equilibrium for the predators and their major prey.

The wolf population now numbers 29, up from 25 last year. Five pups were born to packs on the island, but one adult wolf was killed this winter, said Rolf Peterson, a researcher with Michigan Technical University who has been studying the wolf-moose balance on the island for 30 years.

The wolf population had plummeted to just 14 in 1998, and biologists were concerned about the species' continued survival.

"In general, the island's wolves appear to be in good health, and the packs are experiencing normal reproductive success," said Park Superintendent Douglas Barnard.

Biologists: Populations near balance

There has been some rearranging of packs on the island over the past year, Peterson said.

"Whereas we used to have three packs dividing the island, now there are essentially only two," Peterson said. "The Middle Pack, which had three surviving pups from last year and now numbers 12 animals, has virtually taken over the former West Pack territory. The West Pack's numbers have steadily declined, and they are simply no longer able to defend their territory."

The East Pack numbers 10 and controls the east end of the 45-mile-long island in Lake Superior. Three other pairs and a single adult wolf round out the population.

Isle Royale is a unique laboratory in which to study predator-prey relationships. Wolves are the only major predator on the island, and moose are the only major prey. Because there is no human-caused mortality — no hunting or highway deaths — and because no new wolves or moose come to the island, it makes for a controlled situation to study predator and prey.

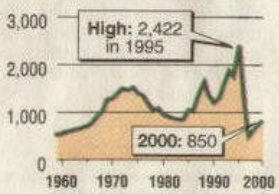
Although one might expect wolves and moose always to be in balance in such an environment, that isn't the case, Peterson said. If there were an

Please see **REBOUND, Page 3B**

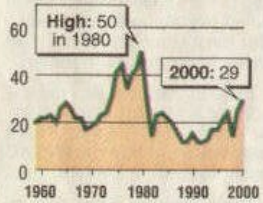
Isle Royale wolves: *coming back*

The roller coaster relationship between Isle Royale's wolves and moose is heading up. Both moose and wolf populations are rebounding after major downturns in recent years.

Moose population trend
1959-2000



Wolf population trend
1959-2000



SOURCE: Rolf Peterson, Michigan Tech

News-Tribune Graphics

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Posted on Fri, Mar. 10, 2006

Isle Royale's moose numbers continue crash

ENVIRONMENT: Once-booming moose population faces tough times, while wolf packs show strain of dwindling food source.

BY JOHN MYERS
NEWS TRIBUNE STAFF WRITER

The number of moose on Isle Royale dropped to 450 this winter, the lowest level since scientists began tracking the animals nearly a half-century ago.

The moose population is down from 540 last year and is just a fraction of the all-time high moose population of 2,442 in 1995.

The number of wolves on the island are holding steady at 30, according to the annual survey by Michigan Technological University researchers. But that may not last as moose become too scarce to feed the island's three

RELATED CONTENT

Submitted by Michigan Technological University

The photograph was taken by researchers this winter as they studied the relationship between wolves and moose on the island. Moose numbers are crahsing while wolves are holding their own.

http://www.duluthsuperior.com/mld/duluthsuperior/news/local/14064838.htm

Duluth News Tribune

Isle Royale moose, wolf continue decline

TREND CONTINUES: The battle between predator and prey on Lake Superior's largest island is turning out to be a lose-lose situation this winter as wolf and moose numbers continue a downward spiral.

Duluth News Tribune

Isle Royale moose, wolf continue decline

John Myers
Duluth News Tribune - 03/08/2007

The battle between predator and prey on Lake Superior's largest island is turning out to be a lose-lose situation this winter as wolf and moose numbers continue a downward spiral.

Isle Royale moose numbers crashed another 15 percent from the 2006 record low level of 450, at just 385 animals. Wolf numbers declined nearly one-third, from 30 to 21.

Moose on the island are dying for a variety of reasons, including hot summers, infestations of ticks and relentless hunting pressure from remaining wolves, said John Vucetich, an assistant professor at Michigan Technological University in Houghton who helped conduct this winter's survey.

With fewer moose to eat, wolves are battling and killing each other over the right to the remaining moose.

xxx

- **Observation 3**

  Limits are placed on population expansion by limited environmental resources

  (Source: observations reinforced by Malthus)

- **Conclusion 1**

  Therefore not all organisms will survive to adulthood and reproduce

  – **therefore there must be a *"struggle for existence"***

(Author of inference: Thomas Malthus)

- **Observation 4**

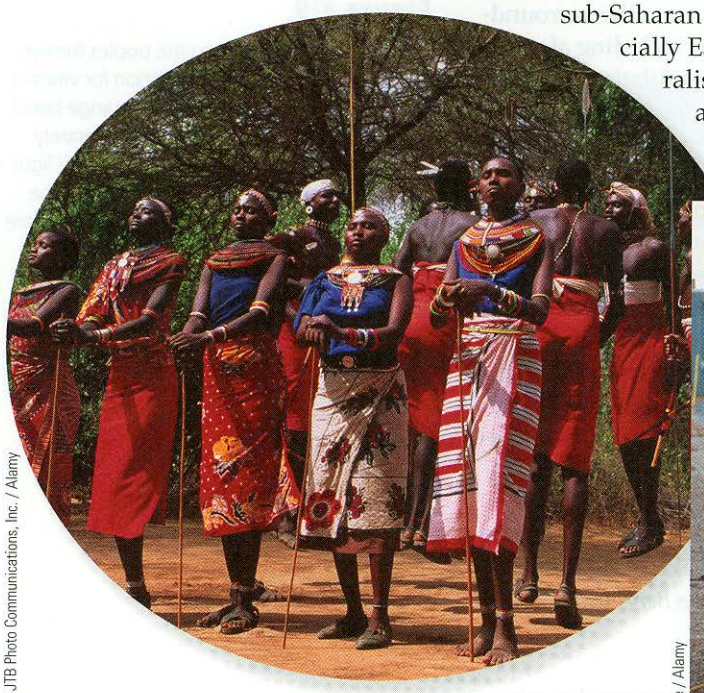
  Not all members of a species are alike

  – **that is, there exists considerable *individual uniqueness and variation***

(Source: Animal breeders, taxonomists)

tend to be short and stocky, while many sub-Saharan Africans, especially East African pastoralists, are, on average, tall and linear

layer throughout the body. Behavioral modifications include increased activity, wearing warmer clothing, increased food consumption, and even curling up into a ball.



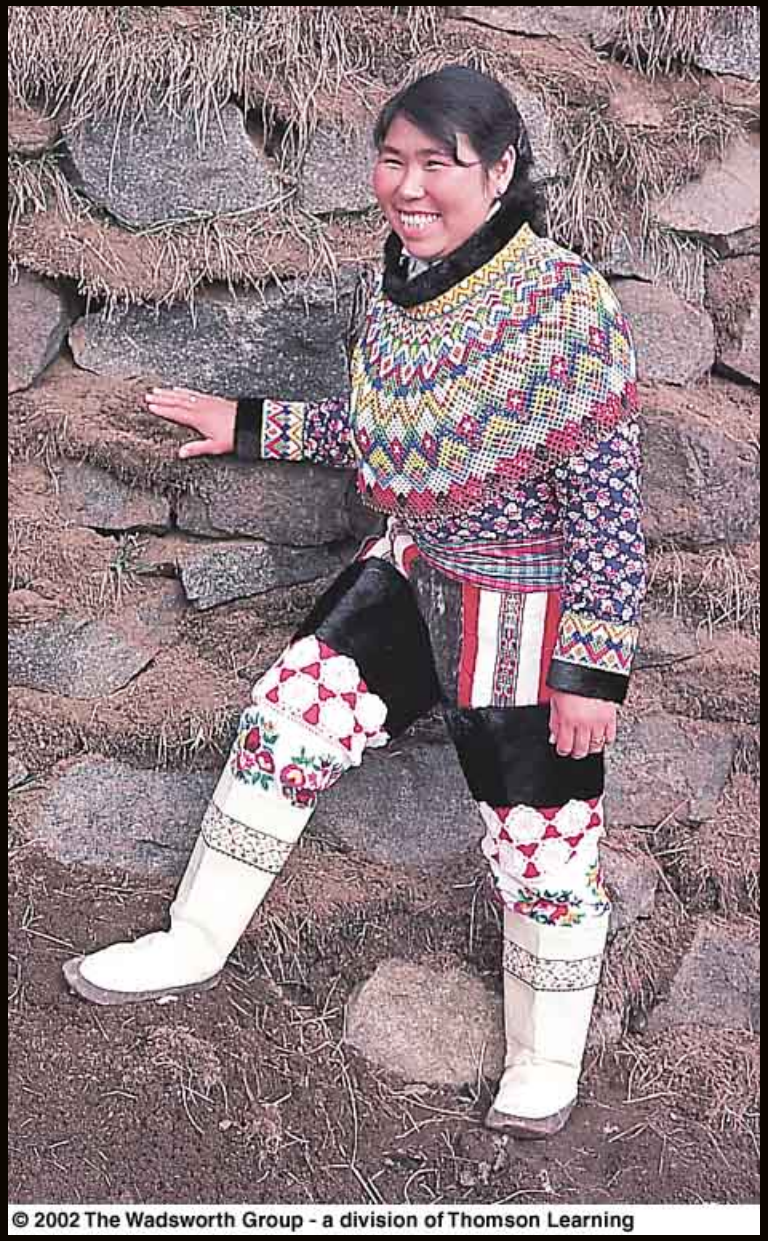
(a)

(b)

Figure 4-10

(a) These Samburu women (and men in the background) have the linear proportions characteristic of many inhabitants of East Africa. The Samburu are cattle-herding people who live in northern Kenya. Here they are shown dancing. (b) By comparison, these Canadian Inuit women are shorter and stockier. Although the people in these two pictures don't typify everyone in their populations, they do serve as good examples of Bergmann's and Allen's rules.

vasoconstriction Narrowing of blood vessels to reduce blood flow to the skin. Vasoconstriction is an involuntary response to cold and reduces heat loss at the skin's surface.



Understanding Humans, 10th ed., p. 89

- **Observation 5**

  Parents often pass their individual variations on to their offspring

(Source: Animal breeders, taxonomists)

- **Conclusion 2**

  Hence in “the struggle for existence” individuals featuring favorable variations will enjoy a *competitive advantage* over others . . .

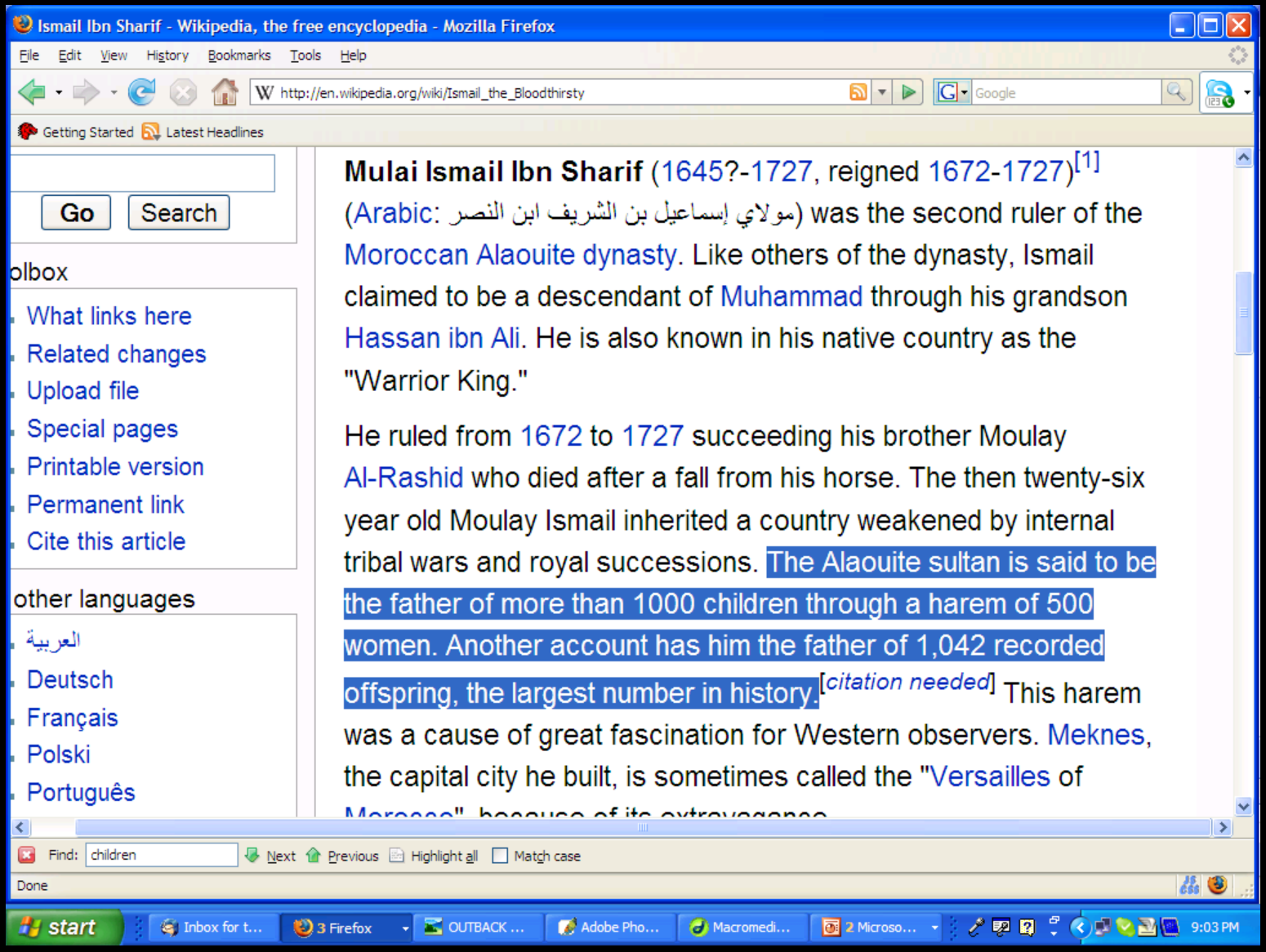
. . . and they will survive in proportionately greater numbers

. . . and will *produce offspring in increasingly greater numbers*

THE GENOGRAPHIC PROJECT

Genghis Khan
Khagan of Mongol Empire
("Khan of the Mongols")

http://en.wikipedia.org/wiki/Genghis_khan



"Ismail the Bloodthirsty"

http://en.wikipedia.org/wiki/Ismail_the_Bloodthirsty

There is

“differential reproduction”

and

“differential survival

—*i.e.*, “natural selection”

(Author of inference: Darwin)

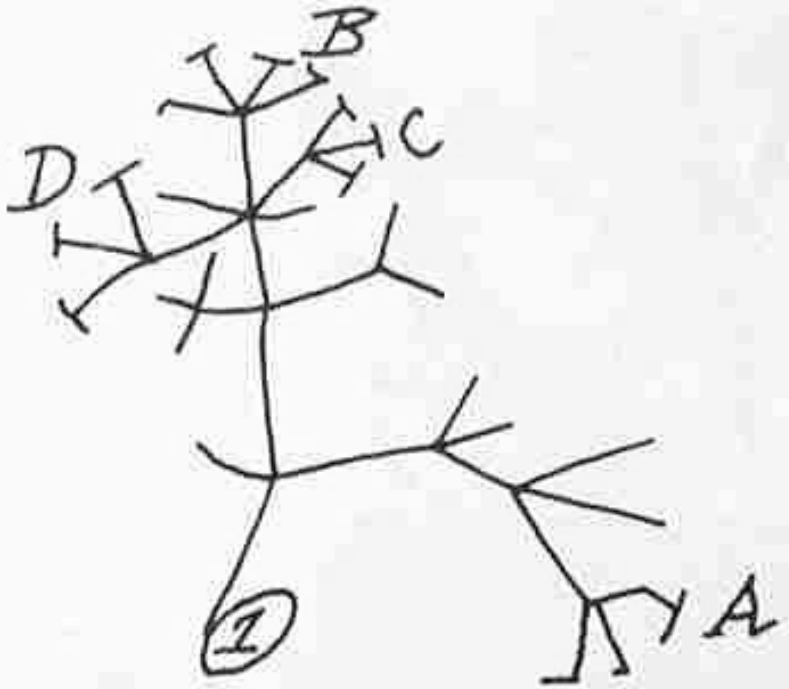
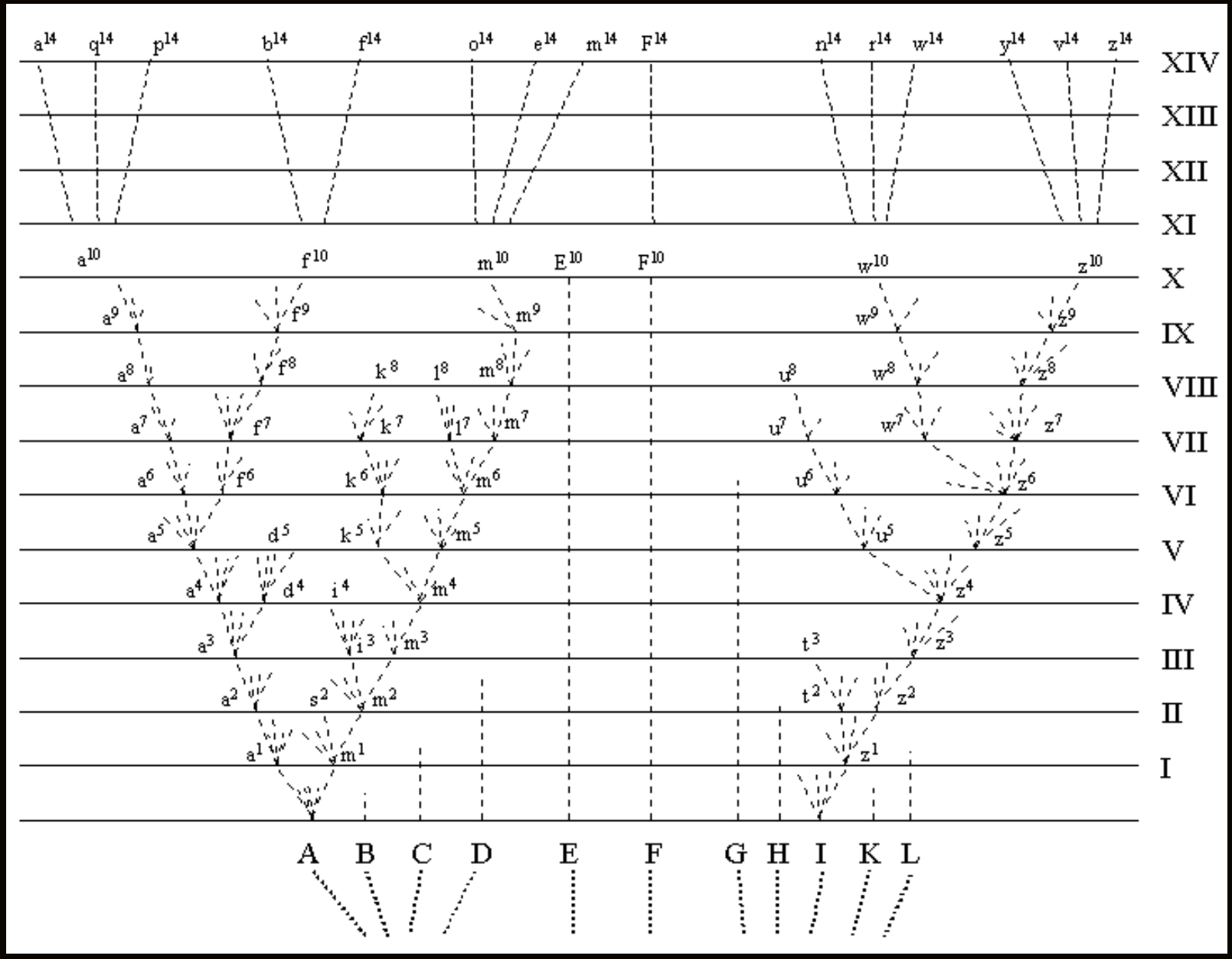


Figure 3-1. Darwin's first diagram of an evolutionary tree appeared in his "First Notebook on Transmutation of Species," 1837.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VIII
a7 f7 k7 l7 m7 u7 w7 z7
VII
a6 f6 k6 m6 u6 z6
VI
a5 d5 k5 m5 u5 z5
V
a4 d4 i4 m4 z4
IV
a3 i3 m3 t3 z3
III
a2 s2 m2 t2 z2
II
a1 m1 z1
I
A B C D E F G H I K L

- **Conclusion 3**

  Through the action of natural selection over many generations a species could evolve

(Author of inference: Darwin)

Natural Selection:

The principle mechanism of Darwinian evolutionary change, by which the individuals best adapted to the environment contributed more offspring to succeeding generations than others do. . .

Natural Selection:

As more of such individuals' characteristics are incorporated into the gene pool, the characteristics of the population evolve.

evolution

1. **A change in the genetic structure of a population**

2. **The term is also frequently used to refer to the appearance of a new species**

evolution

Modern genetic definition:

a change in the frequency of alleles
(one of a group of genes)
from one generation to the next

Evolution:

cumulative changes in the average characteristics of a population that occur over many generations

Charles Darwin

(1809 - 1882)

Origin of Species

1859

Charles Darwin

(1809 - 1882)

On the Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life

1859

biospecies

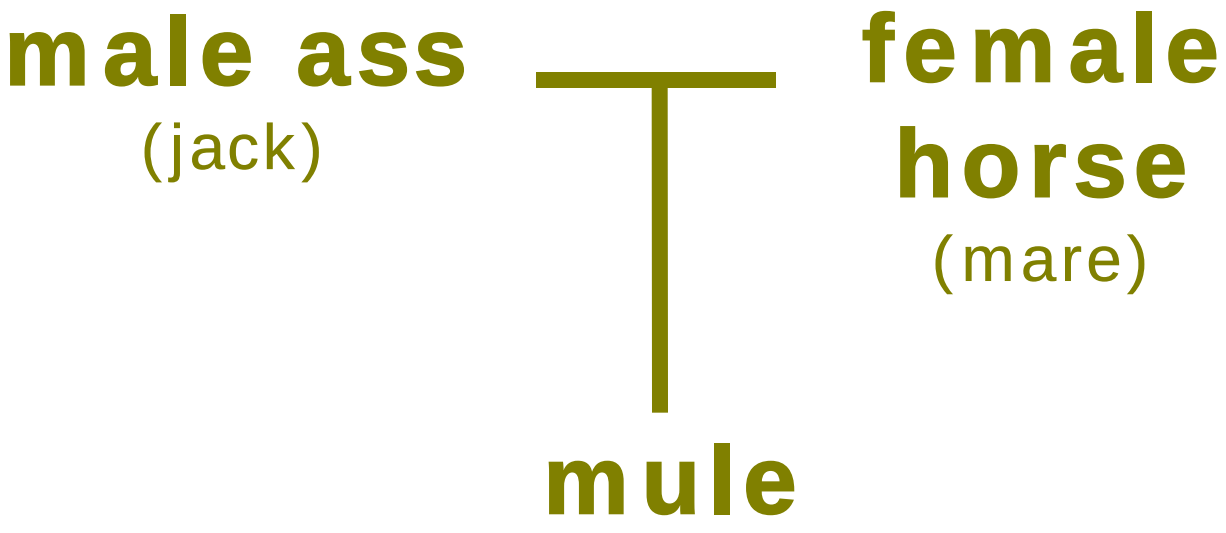
paleospecies

chronospecies

biospecies

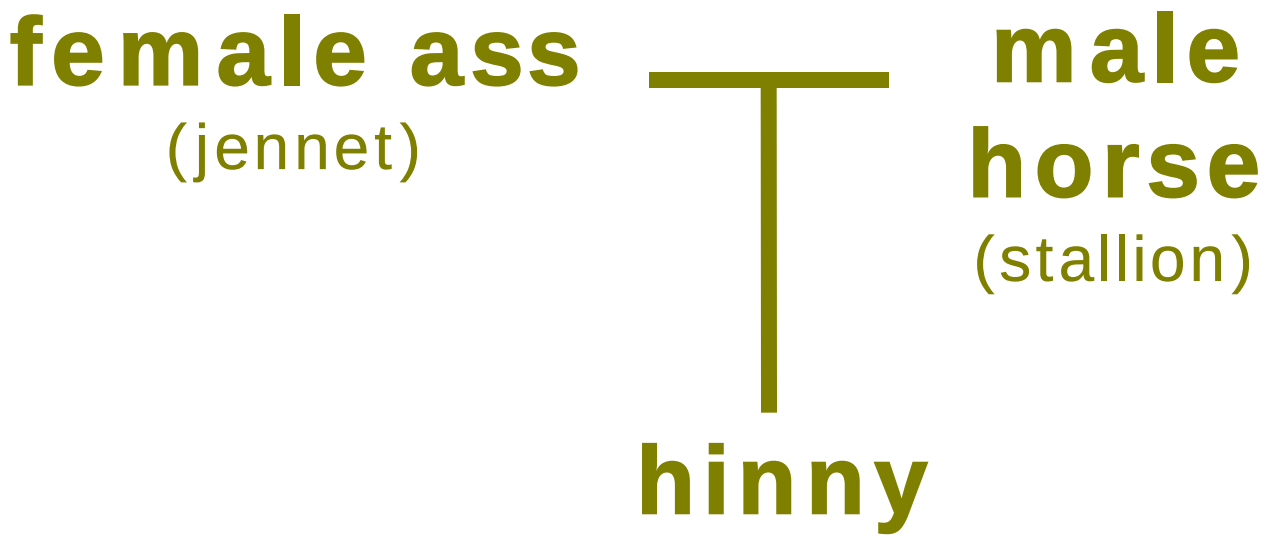
Paul H. Ristau driving a mule-drawn cart in Superior, Wisconsin, *ca.* 1890

Photo courtesy of the Minnesota Historical Society

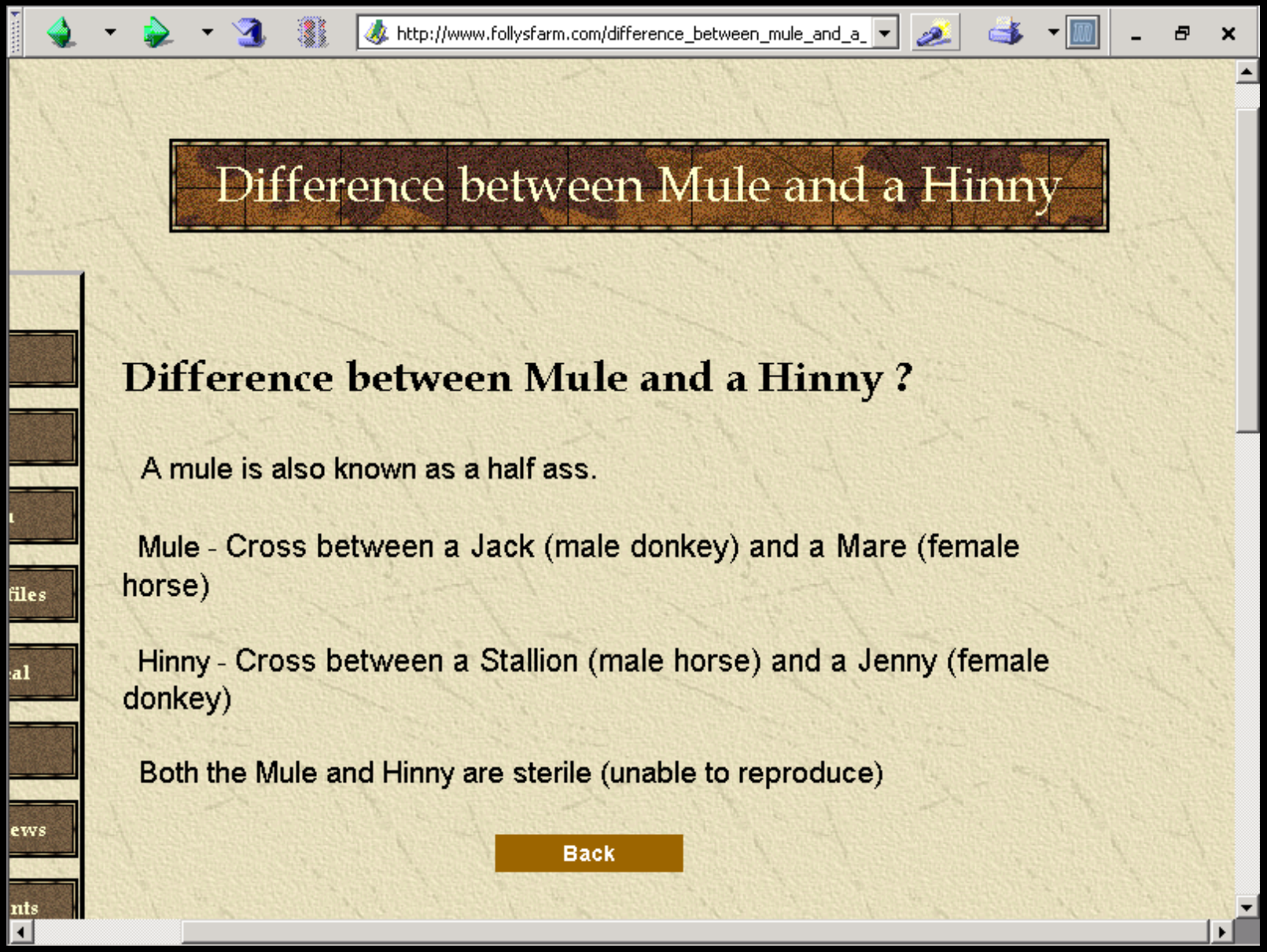


- all male mules are sterile

- almost all female mules are sterile
  if not ¾ horse or ¾ ass



- **all hinnies are sterile, except in rare cases**



www.follysfarm.com/difference_between_mule_and_a_hinny.htm

But species are sometimes not easy to define

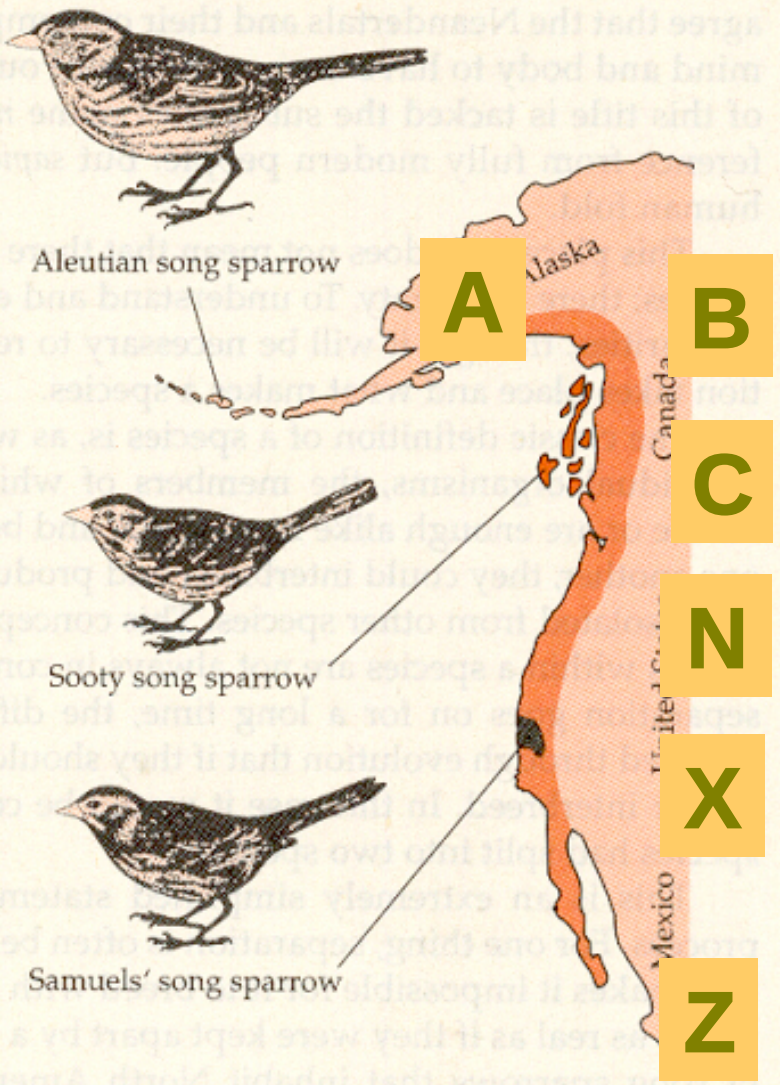


FIGURE 14–14 At present there are 34 subspecies of the song sparrow (*Passarella melodia*) in North America; 3 are shown here. Their approximate breeding ranges are indicated and those of 14 other subspecies along the West Coast are shown by medium shading (from the West Coast to the Midwest of the United States are the breeding ranges of 5 other subspecies). The subspecies vary greatly in color and size, but if we look at representatives of all 34, we find a continuous, gradual series.

Humankind Emerging, 7th edition, p. 418


A
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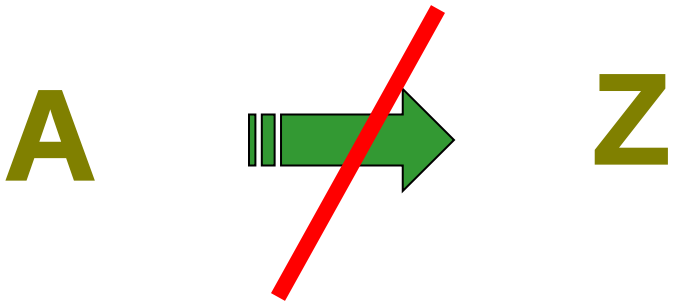
A
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Parallel from Linguistics

Smithwick

“Smíth-wick”
(Duluth)

“Smidt-whick”
(Galway, Ireland)

“Sméddik”
(Birmingham, England)

“Smærɨk”
(Smithwick , England)

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Thursday, 26 September, 2002, 11:58 GMT 12:58 UK

W African elephants 'separate' species

African elephants have a high conservation profile

See also:

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http://news.bbc.co.uk/1/hi/sci/tech/2282801.stm

Will Primate Genetics Split One Gorilla Into Two?

To human eyes, our ape cousins look remarkably alike. But molecular anthropologists, probing the primate gene pool, are learning that appearances are indeed deceptive. New data indicate that members of the single gorilla species show a surprising degree of genetic variation—indeed, gorillas appear to be more distinct from one another than are members of the two established chimpanzee species. And some scientists suggest this may lead to the naming of a new gorilla species.

These new data were reported by Maryellen Ruvolo, a molecular anthropologist at Harvard University, and her colleagues in the 15 September issue of the *Proceedings of the National Academy of Sciences*. They found a striking genetic gap between the West African lowland gorilla (*Gorilla gorilla gorilla*) and the two eastern subspecies (*G. g. graueri* and *G. g. beringei*). And while Ruvolo's team is careful not to claim that a new species can be created on the basis of genetics alone, her data "do raise the possibility that there are two gorilla species," says

had largely concluded that the human-chimp link is the tightest bond. But some scientists are unconvinced. Among them is Jeffrey Rogers, a primate geneticist at Texas' Southwest Foundation for Biomedical Research. He contends that the genetic data leave open the possibility that chimps, gorillas, and humans parted ways at about the same time. "I know I'm squarely in the minority camp," says Rogers, "but I don't think we have sufficient data yet to resolve whether it was a two-way or three-way split."

Ruvolo attempted a resolution by exam-

Separated before birth? The western lowland gorilla *(right)* has enough genetic distance from the mountain gorilla *(left)* to suggest it might be a separate species.

Science, 16 Sept. 1994

the genetic variation
West and East Africa
are so different that,
lished study, Ruvolo c
groups have been sepa
lion years. That degree
possibility that the tw
might have evolved in

Only last month, g
from UC Davis and
similar suggestion ab
chimpanzee (*Science*,
But the issue is far f
gorillas or chimps.
and eastern gorillas
in their mtDNA,
genes also need to be

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geneticist Alan Wils
that relied on a less
netic analysis.

biospecies

paleospecies

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7 million-year-old skull startles anthropologists It is by far the earliest human ancestor

Thursday, July 11, 2002
San Francisco Chronicle
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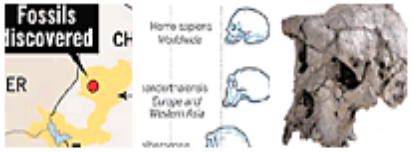
David Perlman, Chronicle Science Editor



Sahelanthropus tchadensis

An international team of fossil
scouring the sands of a windsw
African desert have unearthed the skull and jaw fragments of a creature that lived nearly 7 million years ago -- by far the earliest of all known human ancestors.

Their spectacular find will force

Ser- vices (A

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July 23, 2001

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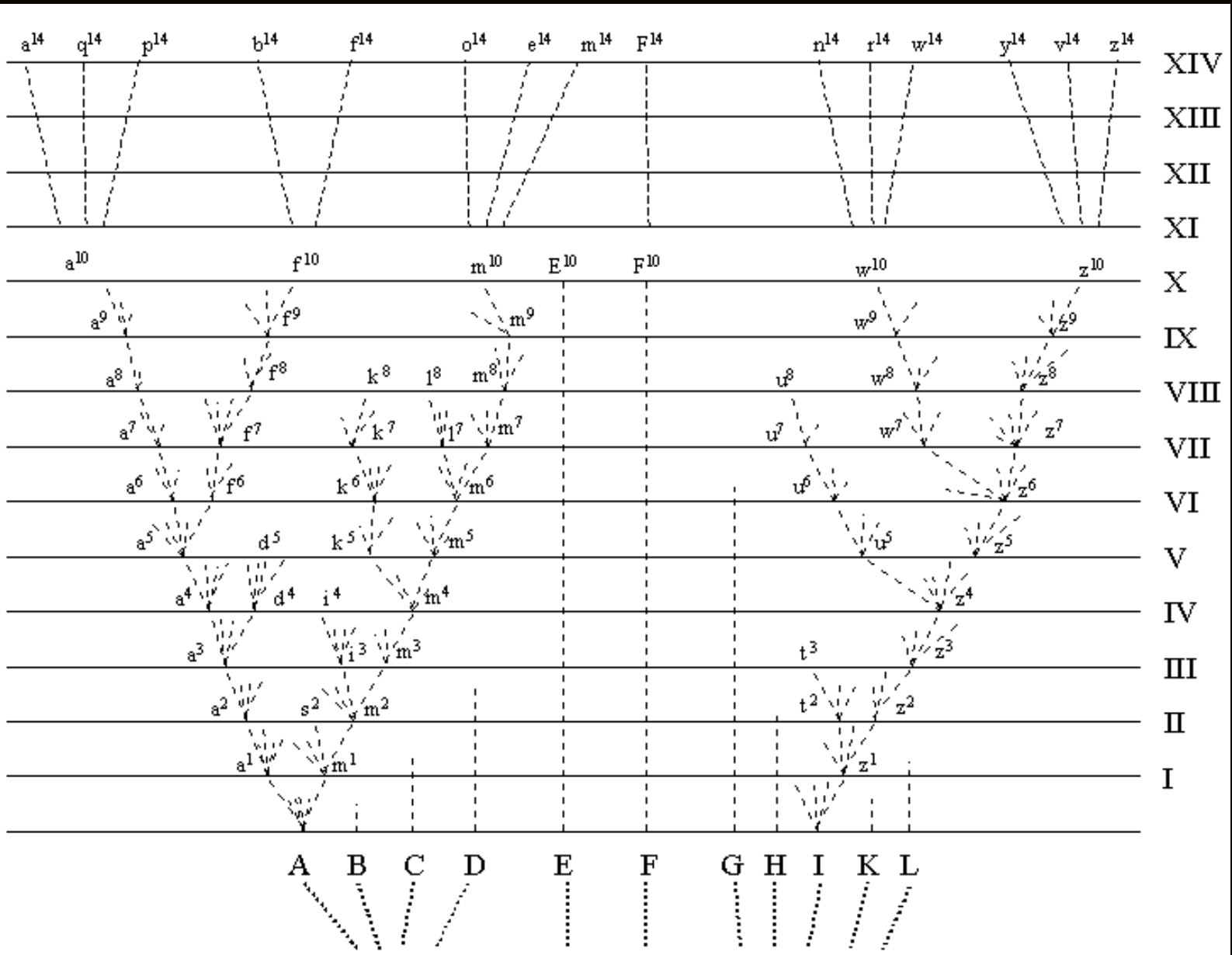
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VII
a6 f6 k6 m6 u6 z6
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III
a2 s2 m2 t2 z2
II
a1 m1 z1
I
A B C D E F G H I K L

genotype

phenotype

genotype

includes genetic items
you *can not see*

phenotype

the observable physical characteristics of an organism

- **the things you can see**
- **the detectable expressions of genotypes**

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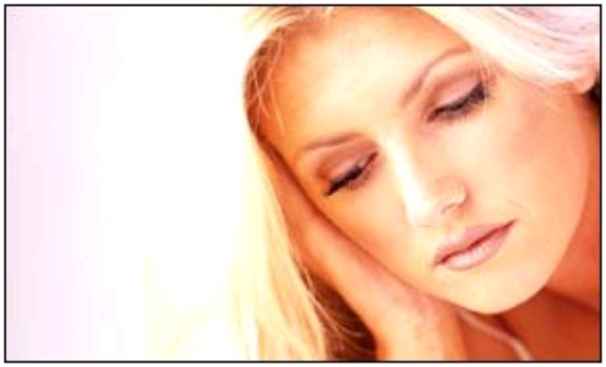
Friday, 27 September, 2002, 11:51 GMT 12:51 UK

Blondes 'to die out in 200 years'



Scientists believe the last blondes will be in Finland

The last natural blondes will die out within 200 years, scientists believe.

A study by experts in Germany suggests people with blonde hair are an endangered

See also:

- 28 Mar 01 | Education
  What is it about blondes?
- 09 Apr 99 | Health
  Platinum blondes are labelled as dumb
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Phenotype / Genotype

my wife's family's feet

Phenotype / Genotype

my cousins' feet

Polydactyly in a human infant (a) and in a cat (b).

Understanding Humans, 10th ed., p. 38

Phenotype / Genotype

my wife’s heart

Alfred Wallace

(1823 - 1913)

working separately from Darwin arrived at the same generalizations at the same time as Darwin

Figure 2-13

Alfred Russel Wallace independently identified natural selection as the key to the evolutionary process.

Natural Selection

Early in his research, Darwin had realized that natural selection was the key to evolution. With the help of Malthus' ideas, he saw *how* selection in nature could be explained. In the struggle for existence, those *individuals* with favorable variations would survive and reproduce, but those with unfavorable variations wouldn't. For Darwin, the explanation of evolution was simple. The basic processes, as he understood them, are as follows:

1. All species are capable of producing offspring at a faster rate than food supplies increase.
2. There is biological variation within all species.
3. Since in each generation more offspring are produced than can survive, and owing to limited resources, there is competition between individuals. (*Note*: This statement doesn't mean that there is

Then, in 1858, Wallace sent Darwin

Alfred Russel Wallace

Understanding Humans, 11h ed., p. 30

- **Observation 1**

  Without environmental pressures, every species tends to *multiply in geometric progression*

(Thomas Malthus, *Essay on the Principle of Population*, 1798, and others)

- **Observation 2**

  But under field conditions, although fluctuations occur frequently, the size of a population remains *remarkable constant* over long periods of time

(Source: Universal observations)

- **Observation 3**

  Limits are placed on population expansion by limited environmental resources

(Source: observations reinforced by Malthus)

- **Conclusion 1**

  Therefore not all organisms will survive to adulthood and reproduce

  – **therefore there must be a *"struggle for existence"***

(Author of inference: Thomas Malthus)

- **Observation 4**

  Not all members of a species are alike; that is, there exists considerable *individual uniqueness and variation*

(Source: Animal breeders, taxonomists)

- **Observation 5**

  Parents often pass their individual variations on to their offspring

(Source: Animal breeders, taxonomists)

- **Conclusion 2**

  Hence in the struggle for existence individuals featuring favorable variations will enjoy a *competitive advantage* over others . . .

. . . And they will survive in proportionately greater numbers and will *produce offspring in increasingly greater numbers*

There is “differential reproduction” and “differential survival,” *i.e.*, “natural selection”

(Author of inference: Darwin)

- **Conclusion 3**

  Through the action of natural selection over many generations a species could evolve

(Author of inference: Darwin)

Both Darwin and Wallace knew:

the principle cause of natural selection is the environment

so they weren't studied. But as we've seen, Darwin recognized the uniqueness of individuals and realized that variation among them could explain how selection occurs. Favorable variations are selected, or chosen, for survival by nature; unfavorable ones are eliminated. *Natural selection operates on individuals*, favorably or unfavorably, but *it's the population that evolves*. The unit of natural selection is the individual; the unit of evolution is the population (because individuals don't change genetically, but over time, populations do).

Natural Selection in Action

The most frequently cited example of natural selection concerns changes in the coloration of "peppered" moths around Manchester, England. In recent years, the moth story has come under some criticism; but the basic premise remains valid, so we use it to illustrate how natural selection works.

Before the nineteenth century, the most common variety of the peppered moth was a mottled gray color. During the day, as moths rested on lichen-covered tree trunks, their coloration provided camouflage (**Fig. 2-15**). There

Figure 2-15

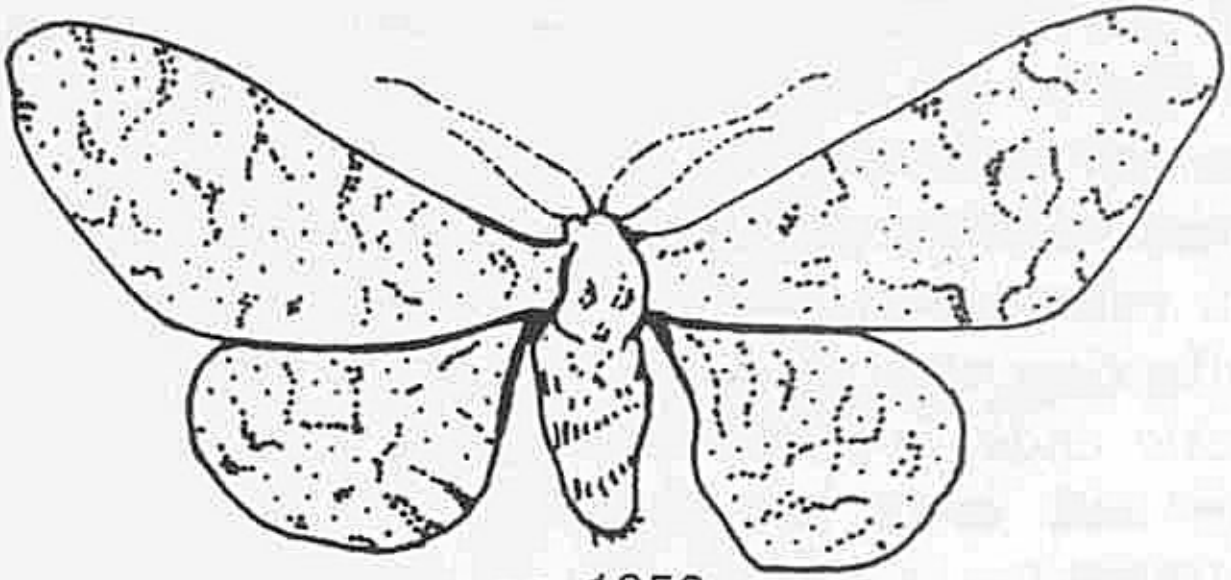
Variation in the peppered moth. (a) The dark form is more visible on the light, lichen-covered tree. (b) On trees darkened by pollution, the lighter form is more visible.

selective pressures Factors in the environment that influence reproductive success in individuals.

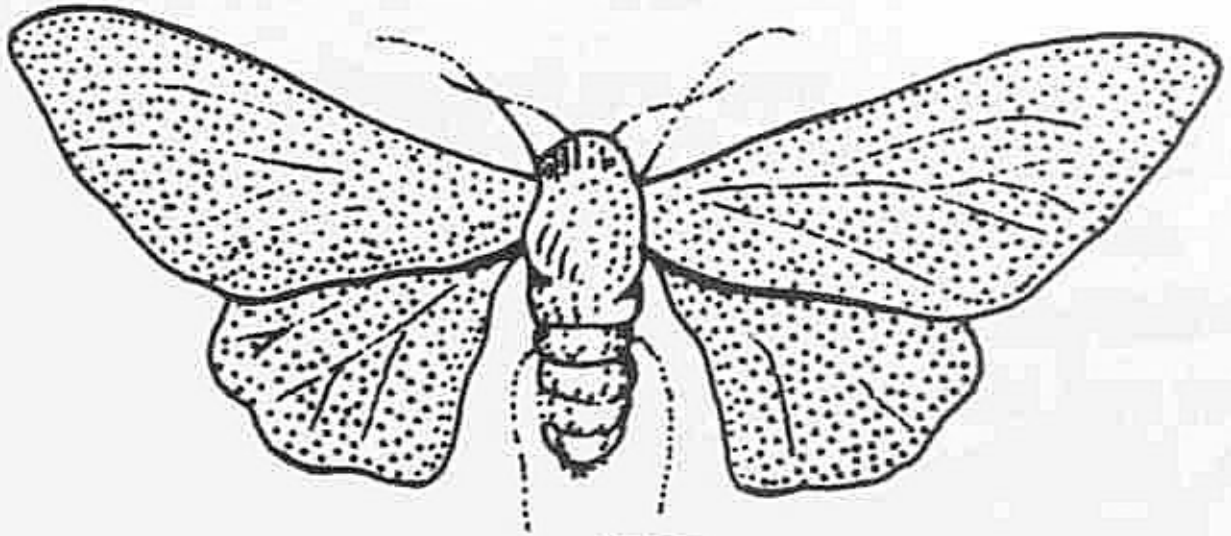
Understanding Humans, 10th ed., p. 31

www.blackwellpublishing.com/ridley/a-z/Peppered_moth.asp

But look at them without color vision.



ca. 1850



ca. 1895

Wolf: © Corbis / Superstock Dogs surrounding wolf: Lynn Kilgore and Lin Marshall; Great dane, Eric Isselée / Shutterstock; Chihuahua, © iStockphoto.com / Marcin Pikula; Yorkshire terrier, © iStockphoto.com / Erik lam

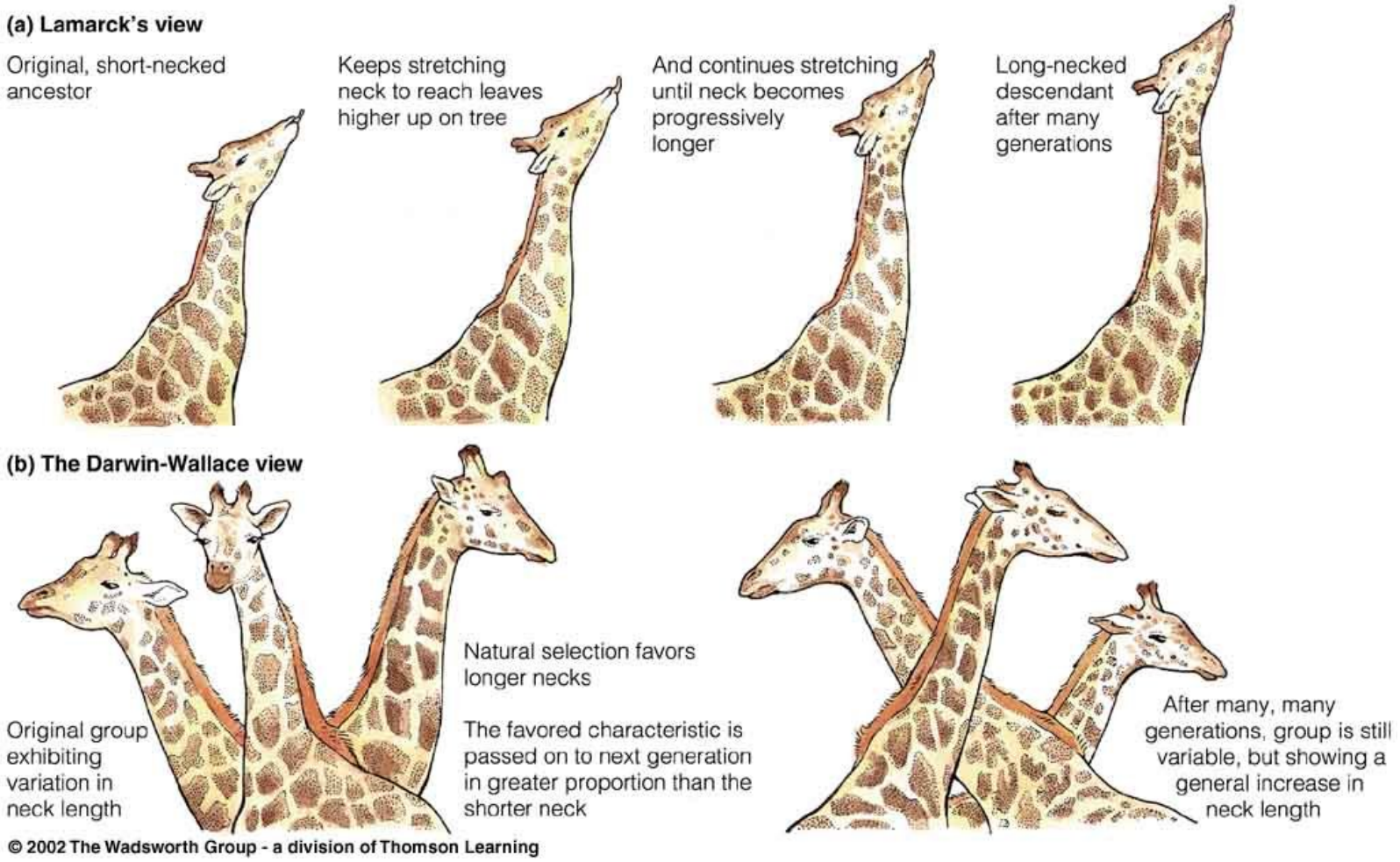
Figure 2-12

All domestic dog breeds share a common ancestor, the wolf. The extreme variation exhibited by dog breeds today has been achieved in a relatively short time through artificial selection. In this situation, humans allow only certain dogs to breed to emphasize specific characteristics. (We should note that not all traits desired by human breeders are advantageous to the dogs themselves.)

The result of this would be the formation of a new species" (F. Darwin, 1950, pp. 53–54). Basically, this quotation summarizes the entire theory of natural selection.

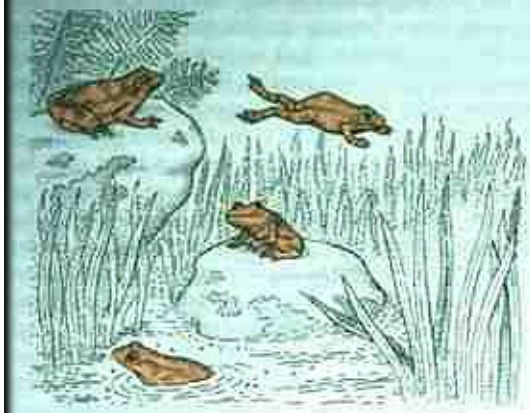
By 1844, Darwin had written a short summary of his views on natural selection, but he didn't think he had enough data to support his hypothesis, so he continued his research without pub-

Alfred Russel Wallace Unlike Darwin, Alfred Russel Wallace (1823–1913) was born into a family of modest means (**Fig. 2-13**). He went to work at the age of 14, and with little formal education, he moved from one job to the next. He became interested in collecting plants and animals, and in 1848 he joined an expedition to the Amazon, where he acquired

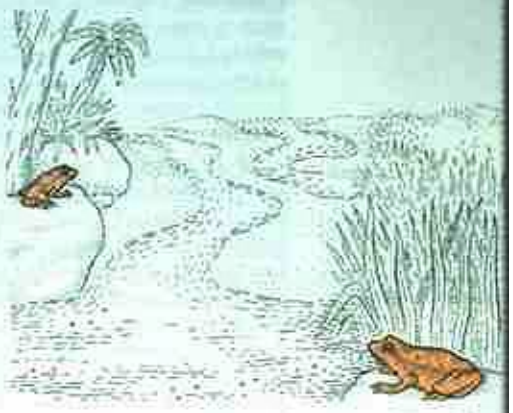


Contrasting ideas about the mechanism of evolution.
(a) According to Lamarck's theory
(b) According to the Darwin-Wallace

Understanding Humans, 11th ed., p. 24

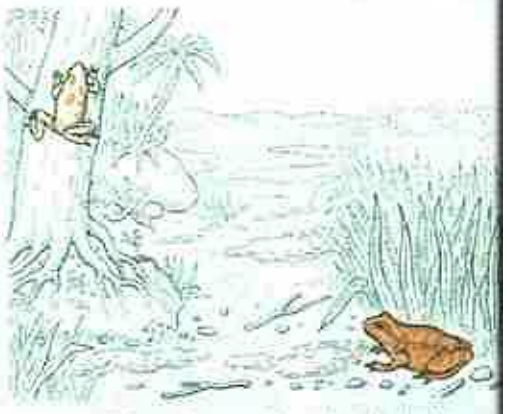


1. The original frogs in this area interbreed with each other and constitute a single species.



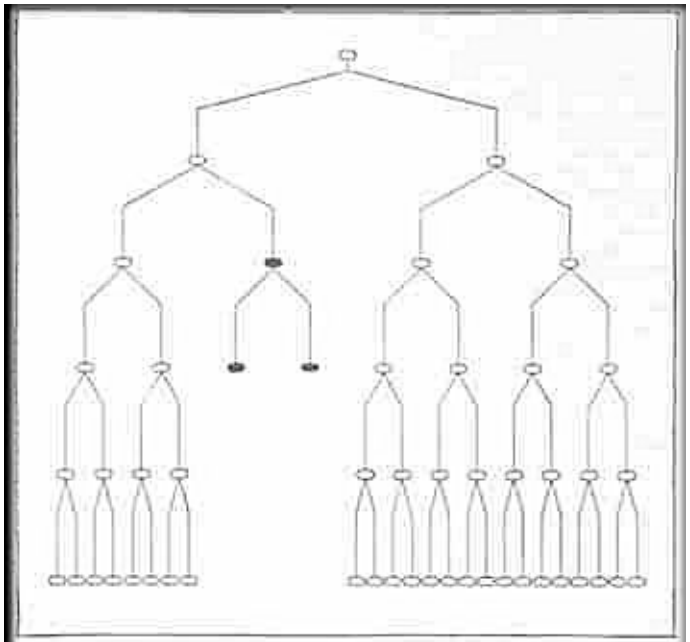
2. Changes in the topography and drainage conditions of the region eventually create two distinct regions—swamp and forest—with a barrier between the two that the frogs cannot cro

3. Over a long period of time, the frogs in the swamp and those in the forest adapt to their different environments. As they adapt and remain isolated from each other, the frogs in the two areas become different.

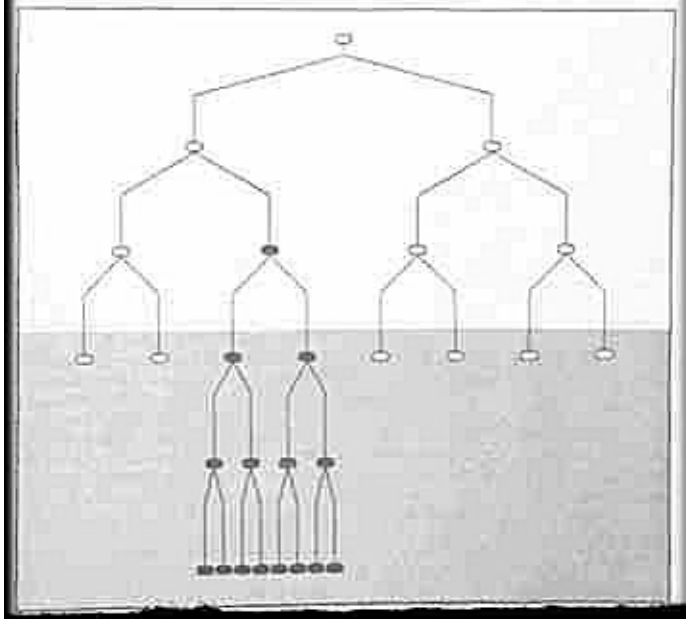


4. So many differences have now been selected in the two populations that the frogs do not interbreed even if they meet; they do not recognize foreigners as potential mates.

FIGURE 3–12 A simplified visual description of allopatric speciation in an imaginary frog population. In the last stage, two separate and independent gene pools now exist, eventually constituting two species where one existed before.



IN NORMAL ENVIRONMENT the common strain of the bacterium *Escherichia coli* (*white bacteria*) multiplies. A mutant strain resistant to streptomycin (*black bacteria*) remains rare because the mutation is not useful.



- **Problem**

  What is the *source* of individual variation?

Didn't know then because of lack of knowledge of modern genetics

Neither Darwin nor Wallace knew:

the source of individual variation

Neither Darwin nor Wallace knew:

the source of individual variation = genetics

(inherited characteristics)

Problem:

If natural selection only weeds out what already exists, how can it produce anything new?

Didn't know then because of lack of knowledge of mutation and sexual recombination from modern genetics

Mutation

"genetic alphabet"
"misspelling"

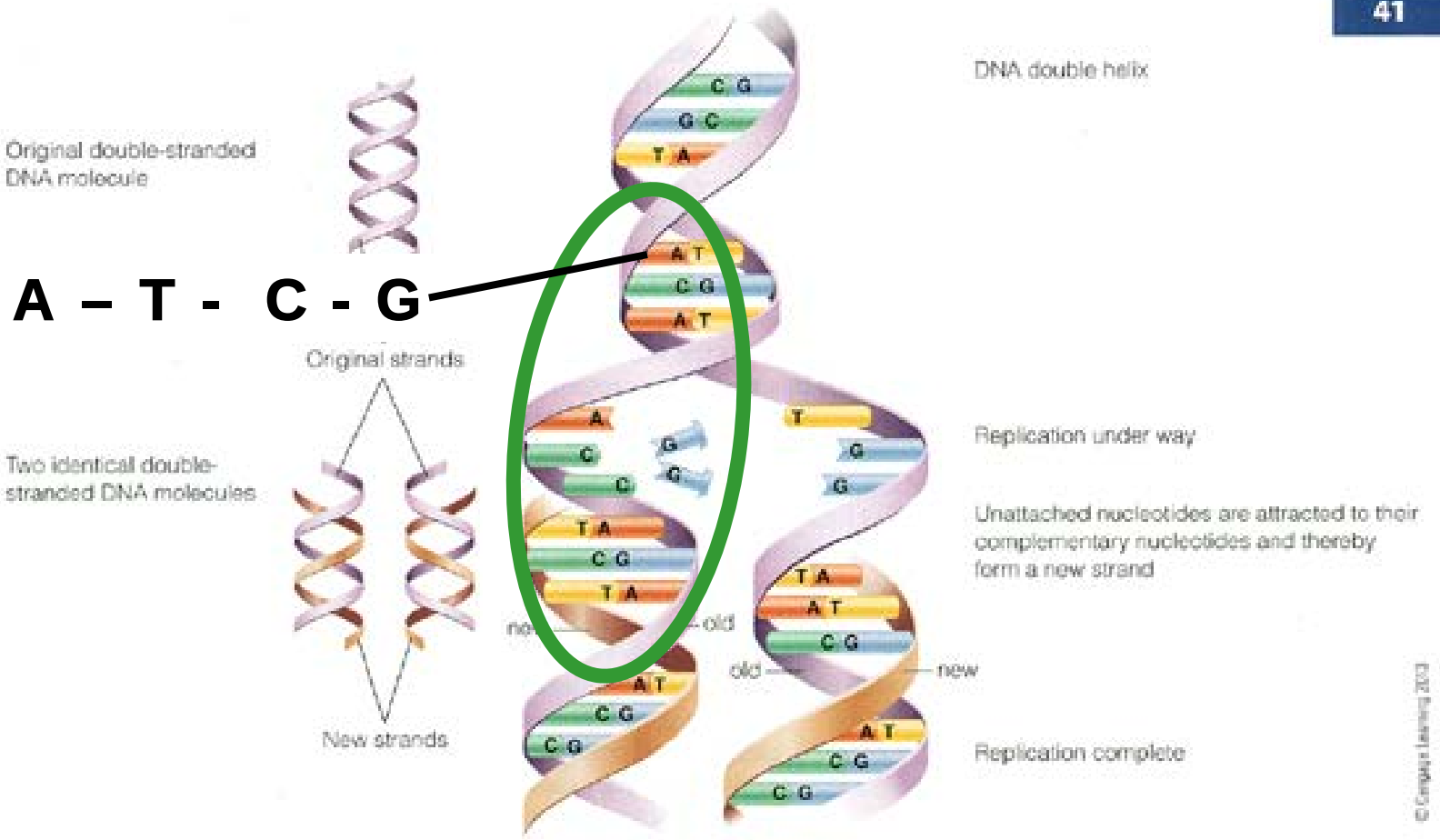
"A – T – C – G" → "A – G – C – T"

↓

mutations

↓

new species



Understanding Physical Anthropology and Archaeology, 11th ed., p. 41

LONDON, England (AP) -- The Church of England owes Charles Darwin an apology for its hostile 19th-century reaction to the naturalist's theory of evolution, a cleric wrote on an Anglican Web site launched Monday.

Charles Darwin's theory that species evolve by natural selection brought him into conflict with the church.

The Rev. Malcolm Brown, who heads the church's public affairs department, issued the statement to mark Darwin's bicentenary and the 150th anniversary of the seminal work "On the Origin of Species," both of which fall next year.

Brown said the Church of England should say it is sorry for misunderstanding him at the time he released his findings and, "by getting our first reaction wrong, encouraging others to misunderstand (Darwin) still."

The Church of England said Brown's statement reflected its position on Darwin but did not constitute an official apology.

The church's stance sets it apart from fundamentalist Christians, who believe evolutionary theory is incompatible with the biblical story of the Earth's creation.

Darwin was born into the Church of England, educated at a church boarding school and trained to become an Anglican priest.

However, his theory that species evolve over generations through a process of natural selection brought him into conflict with the church.

The Church of England did not take an official stance against Darwin's theories, but many senior Anglicans reacted with hostility to his ideas, arguing against them at public debates.

www.cnn.com/2008/WORLD/europe/09/15/uk.church.darwin.apology.ap/index.html

Evolution and the Roman Catholic Church

From Wikipedia, the free encyclopedia

This article may require cleanup to meet Wikipedia's quality standards.

Please improve this article if you can. *(August 2007)*

The **position of the Catholic Church on the theory of evolution** has moved over the last two centuries from a large period of no official mention, to a statement of neutrality in the 1950s, to a more explicit acceptance in recent years. Today, the official Church's position remains a focus of controversy and is fairly non-specific, stating only that faith and scientific findings regarding human evolution are not in conflict, though humans are regarded as a "special creation", and that the existence of God is required to explain the spiritual component of human origins. This view falls into the spectrum of viewpoints that are grouped under the concept of *theistic evolution*.[1][2]

http://en.wikipedia.org/wiki/Evolution_and_the_Roman_Catholic_Church

Important People / Works

Continue on to Set #06A

Raychel Ciemma and Precision Graphics

Figure 3-12
Portrait of Gregor Mendel.

selection (and evolution) couldn't occur. Although there are other sources of variation (mutation being the only source of *new* variation), sexual reproduction and meiosis are of major evolutionary importance because they enhance the role of natural selection in populations.

The Genetic Principles Discovered by Mendel

It wasn't until Gregor Mendel (1822–1884) addressed the question of heredity that this crucial biological process began to be scientifically resolved (**Fig. 3-12**). Mendel was a monk living in an abbey in what is now the Czech Republic. At the time he began his research, he had already studied botany, physics, and

Gregor Johann Mendel

(1822 - 1884)

Understanding Physical Anthropology and Archaeology, 11th ed., p. 48