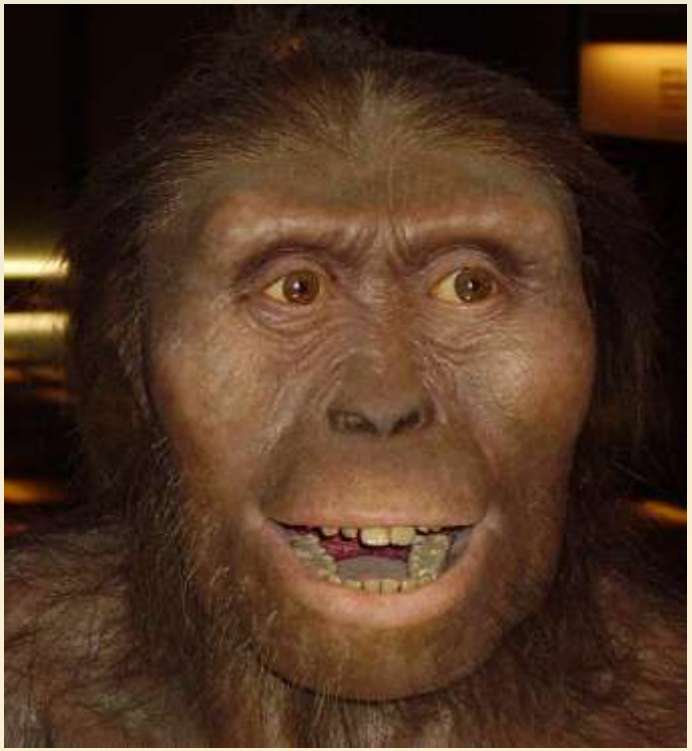
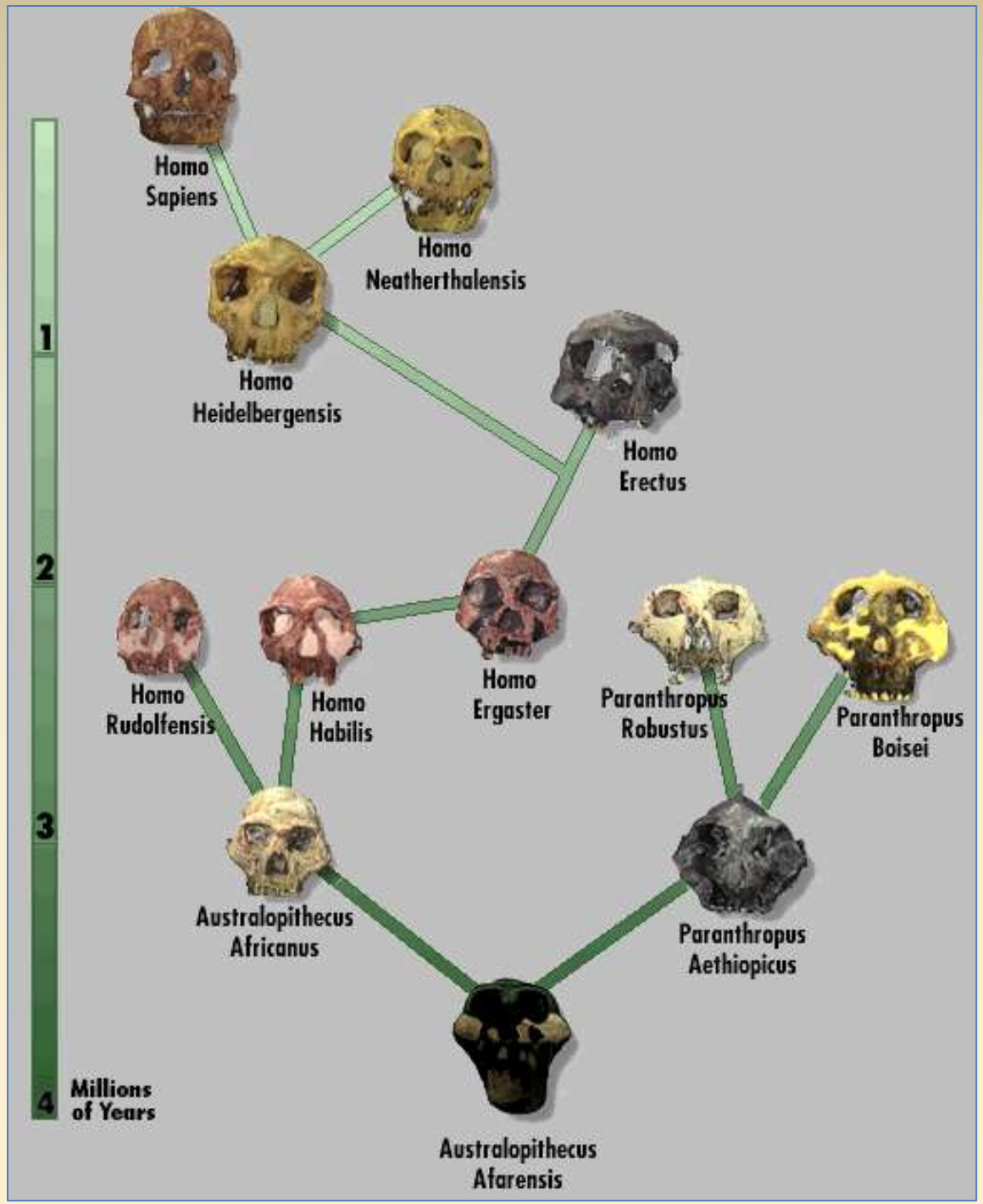
Origins of Agriculture

Hunters and Gatherers
Agricultural Revolution
Characters of Domesticated Plants
Centers of Origin

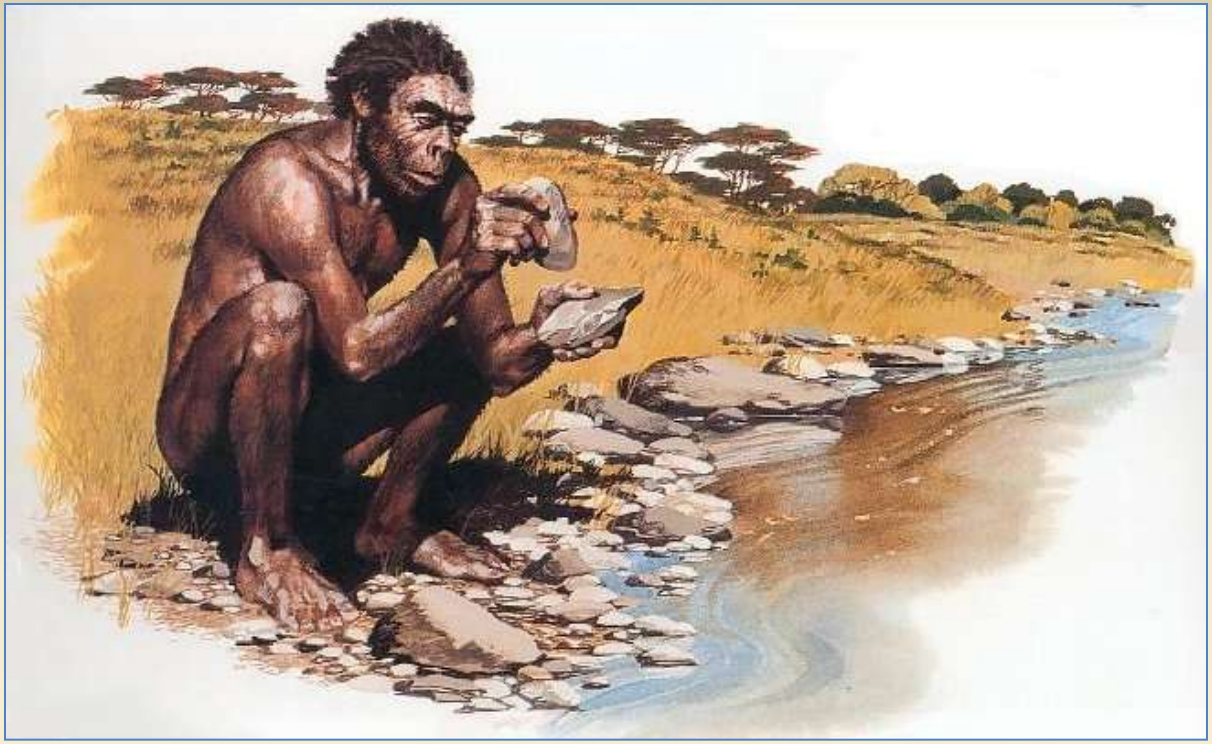
Human Evolution



Australopithecus afarensis

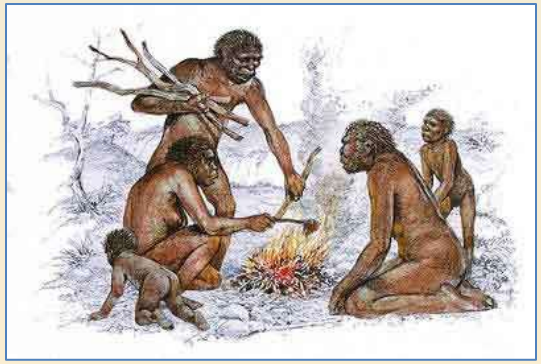


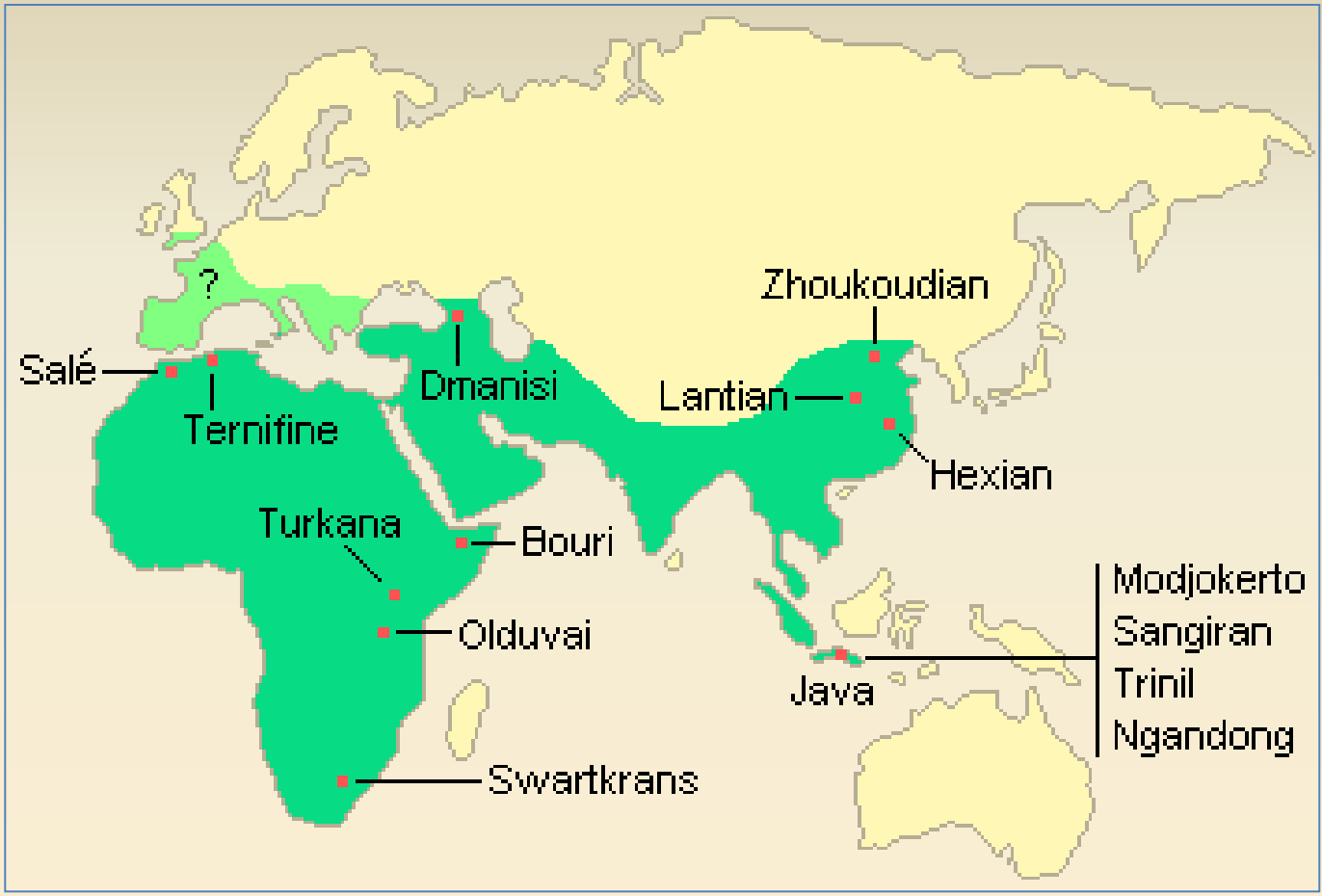
Rise of the genus *Homo*

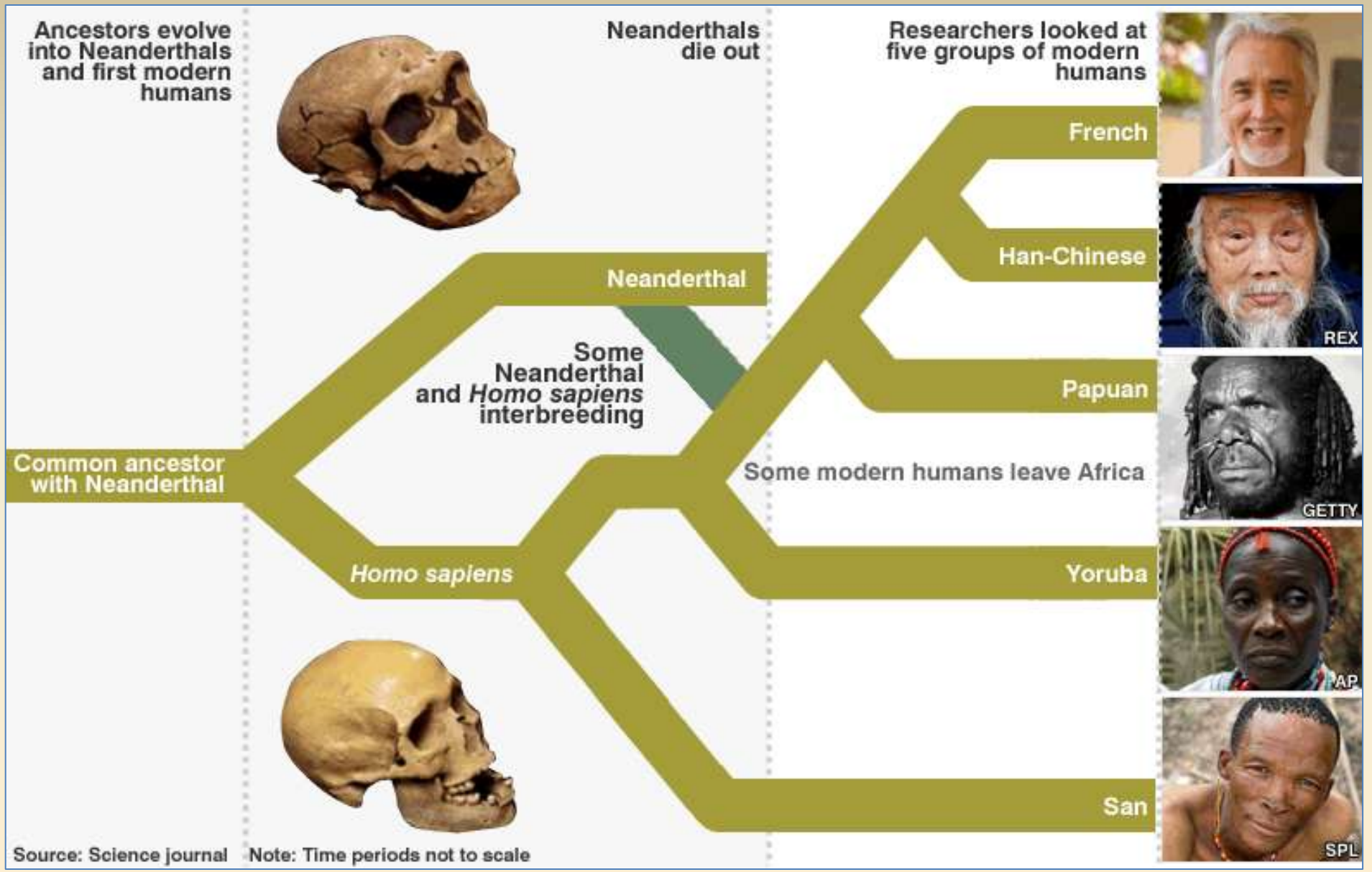


- Earliest fossils from same African sites as *Australopithecines*
- Most date between 2.4 and 1.8 mya
- *Homo habilis* means "handy man" – made tools
- May have been 2 or more species of *Homo* living at the same time by about 2 mya

Homo erectus, made tools, was the first to be found outside of Africa. Used fire to prepare food. Probably wore clothes.






Ancestors evolve into Neanderthals and first modern humans
Neanderthals die out
Researchers looked at five groups of modern humans
French
Han-Chinese
Papuan
Yoruba
San
Neanderthal
Some Neanderthal and Homo sapiens interbreeding
Common ancestor with Neanderthal
Homo sapiens
Some modern humans leave Africa
REX
GETTY
AP
SPL
Source: Science journal
Note: Time periods not to scale

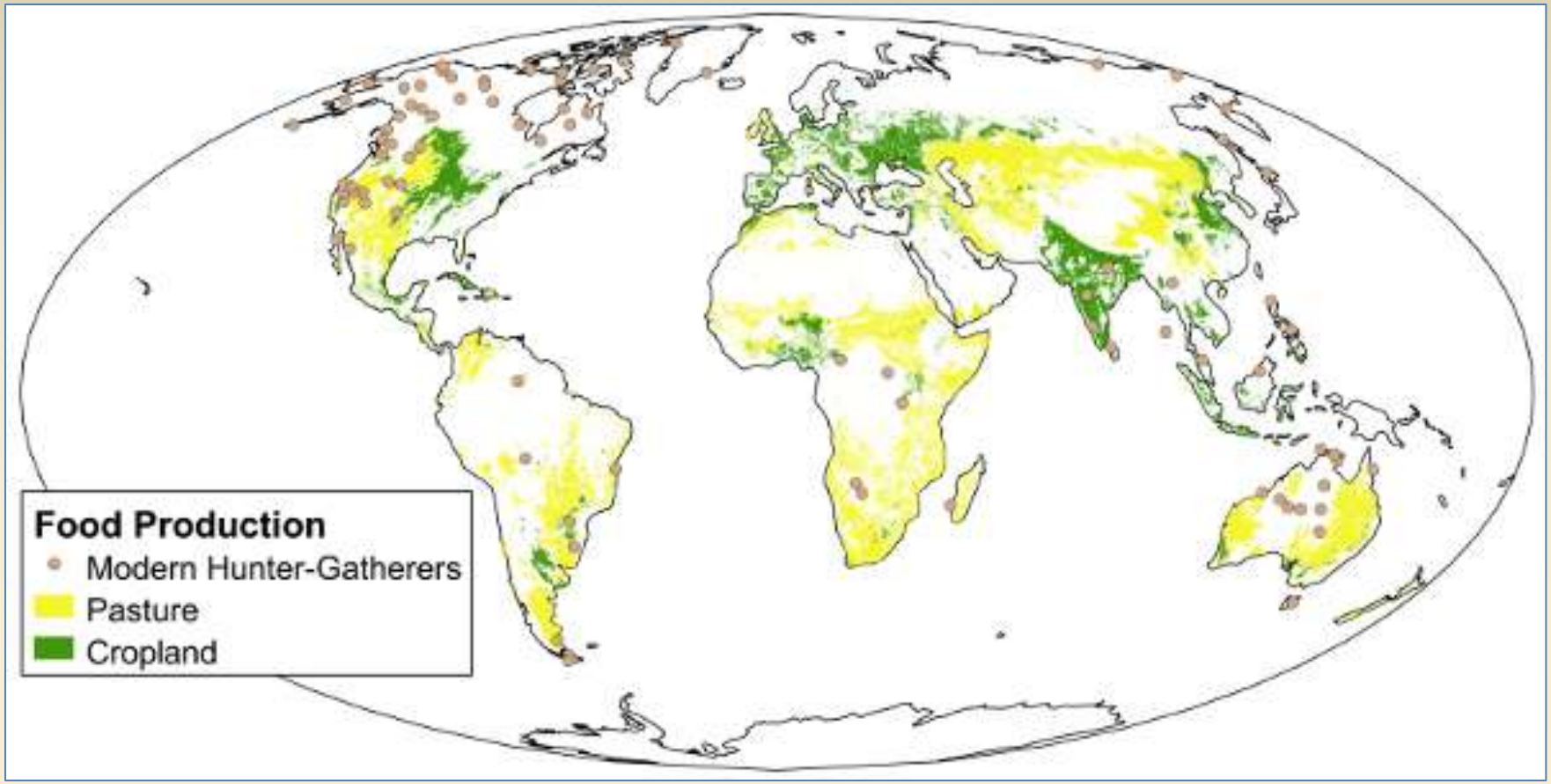
Hunters and Gatherers
Foraging Societies and Their Diets

99% of mankind's existence on Earth has been as a HUNTER & GATHERER!

Hunter/gatherer?

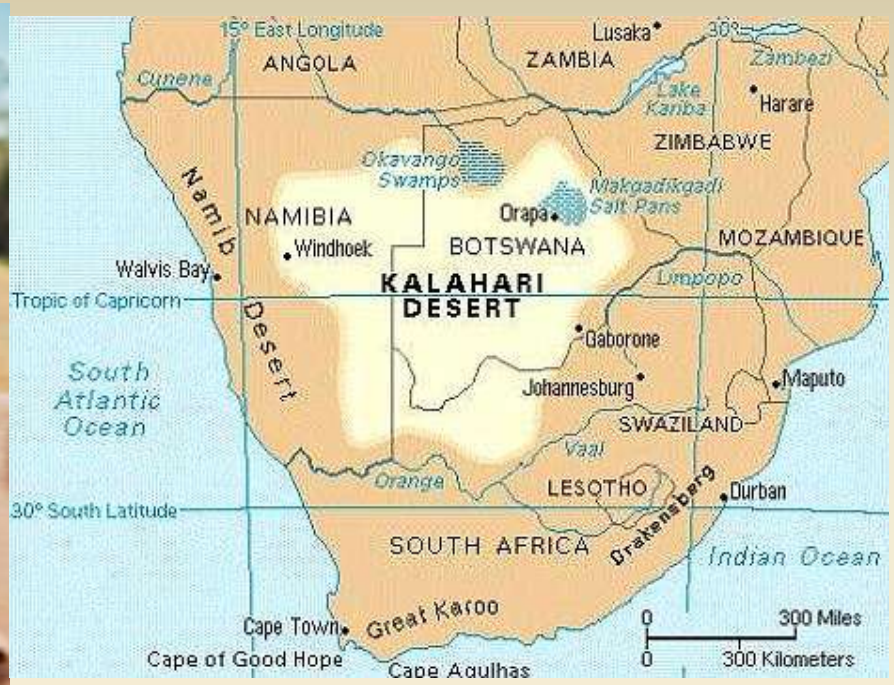
- Don’t practice agriculture, or very limited
- Hunting/gathering behaviors exist back 2 million years to the dawn of man’s cultural evolution.
- No word for “work” exists in various languages of hunters/gatherers.
- Do hunting/gathering societies still exist today?
- Does modern mankind exhibit characteristics of hunter/gatherers??

Hunters and Gatherers Today



Map shows area used for major agricultural and pastoral production in 2000, and locations of societies that have depended on hunting and gathering for a significant portion of their food in the modern era.

Modern Foragers - !Kung San

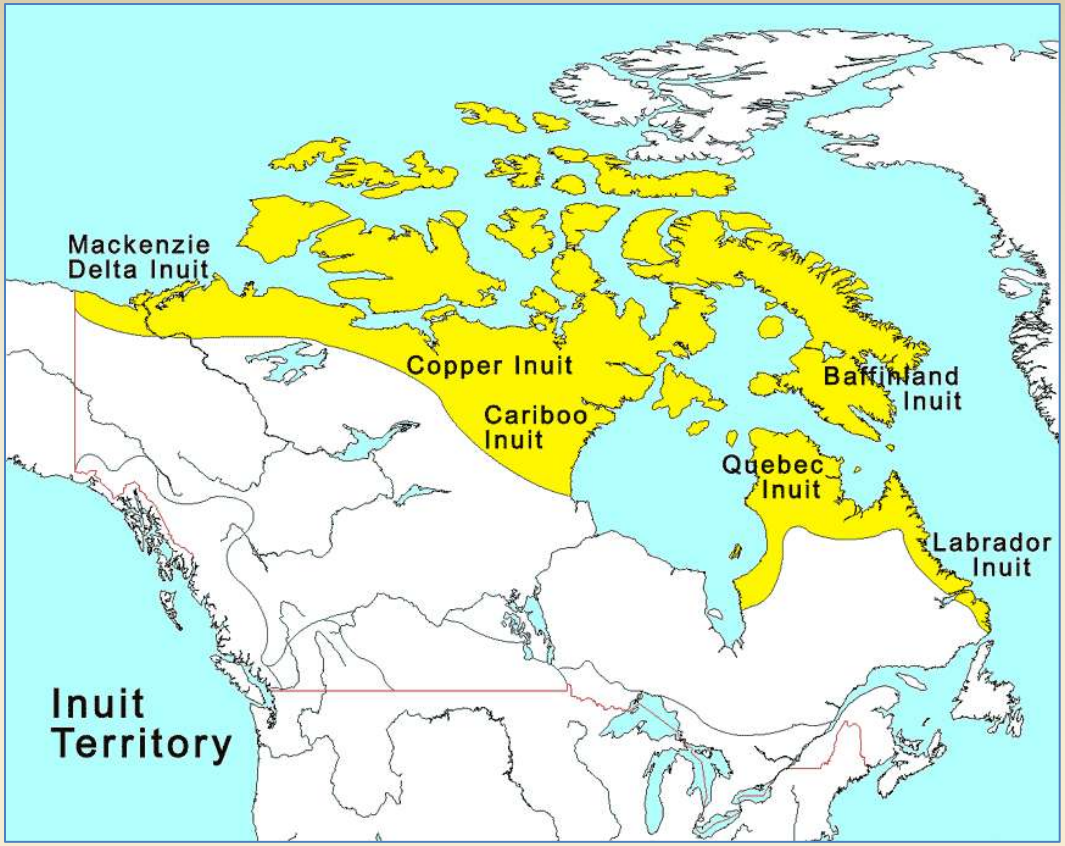


Modern Foragers - Hadza - Tanzania

They have no crops, no livestock, no permanent shelters. . . .

Modern Foragers - Hadza - Tanzania

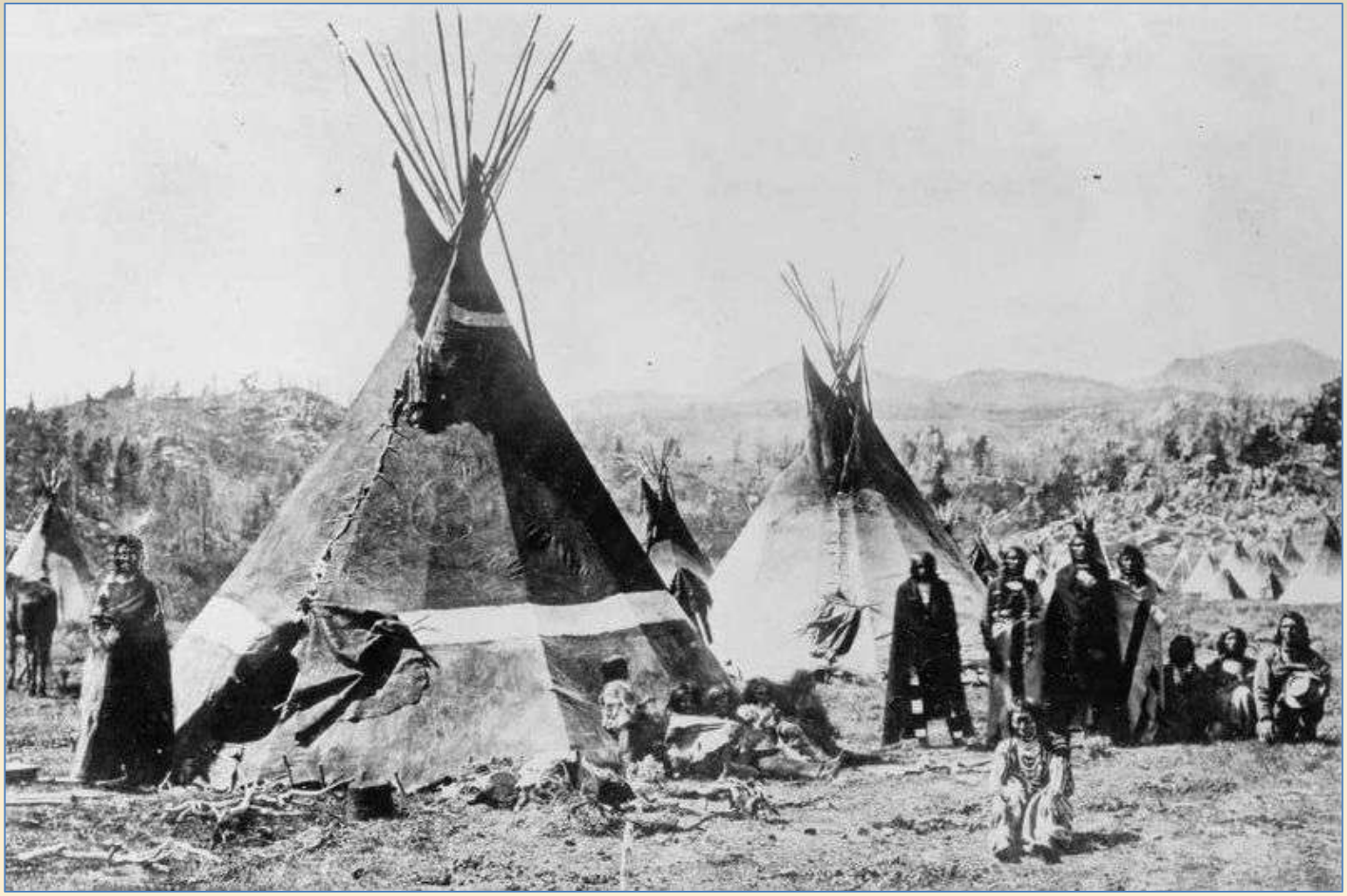
Inuit



Relied mostly on hunting, and gathering some fruits

Inuit Diet – lots of meat and fat

Native Americans – hunted, gathered, and practiced agriculture to a greater or lesser extent. Moved around a lot, or some had semi-permanent villages.



Shoshoni Encampment, 1870s, Wind River Mountains of Wyoming,

Australian Aborigines – hunted mostly, gathered bush tucker, practiced no agriculture, domesticated no crops

Bush tucker is food native to the Australia

Foragers and the Environment

Fire - May deliberately manipulate the environment to encourage the production of the plants and animals they want through the use of fire.

Some things about Hunters and Gatherers

- Their work week is short (2-3 days)
- Enjoy almost unbelievable egalitarianism – no headman, no hierarchy
- High levels of sexual freedom, experimentation, and enjoyment.
- Happy people, laughing freely way more than we do.
- Have a division of labor, but women have total social equality with men.
- Rarely resort to violence or war
- Strong social safety nets support the disabled, old, and in many cases, even the lazy.
- Usually live to be at least as old as we do
- Their health is more robust than ours, and they're frequently immune to diseases ravaging their sedentary neighbors.
- Social lives are rich, and they have the free time to indulge themselves.
- With a few exceptions, their lifestyle lets them live in harmony with the earth, relying mostly on renewable resources, and keeping their numbers at a sustainable level.
- Senses many times sharper than ours, seem immune to extremes of temperature.
- Strength often seems unbelievable.
- Intelligently use their time to create more productive environments that need little care.

Have we lost something? Can we regain it?

Hunter – Gatherer Youtube Videos

Khoisan click language
https://www.youtube.com/watch?v=W6WO5XabD-s
Bushman -Once we were Hunters
https://www.youtube.com/watch?v=UeRq3CkFm-A

Hadza bushmen: Tanzania East Africa 2000
https://www.youtube.com/watch?v=Y619h01VUDE

Iñupiaq Whale Hunt
https://www.youtube.com/watch?v=LAqEK7K5oCQ
Nunavut Whale Hunt.wmv
https://www.youtube.com/watch?v=QrH0S68-luc
Iglulingmiut: Inuit Hunters In Transition — Part 1
https://www.youtube.com/watch?v=_2q3MHUFXBg
Iglulingmiut: Inuit Hunters In Transition — Part 2
https://www.youtube.com/watch?v=DuFNkQhSfSs

Fire Hunting in Australia
https://www.youtube.com/watch?v=j8zb44roDTM

Evidence for Diet of Prehistoric Foragers / Farmers

- Archeological remains
- Tools, implements
- Charred seeds
- Radiocarbon rating
- Coprolites
- Middens, refuse, dumpsite
- Teeth-wear, skeletons, bones

Recovery of Archaeobotanical Remains

Archaeologists separate the plant material from the dirt very simply - by mixing it with water so the interesting stuff floats to the top!

Charred Plant Remains

Tiny bits of charcoal, when properly identified, tell us which plants were grown as crops, which were gathered in the wild, and which kinds of wood were used for fuel.

Retrieving charred plant remains by flotation.

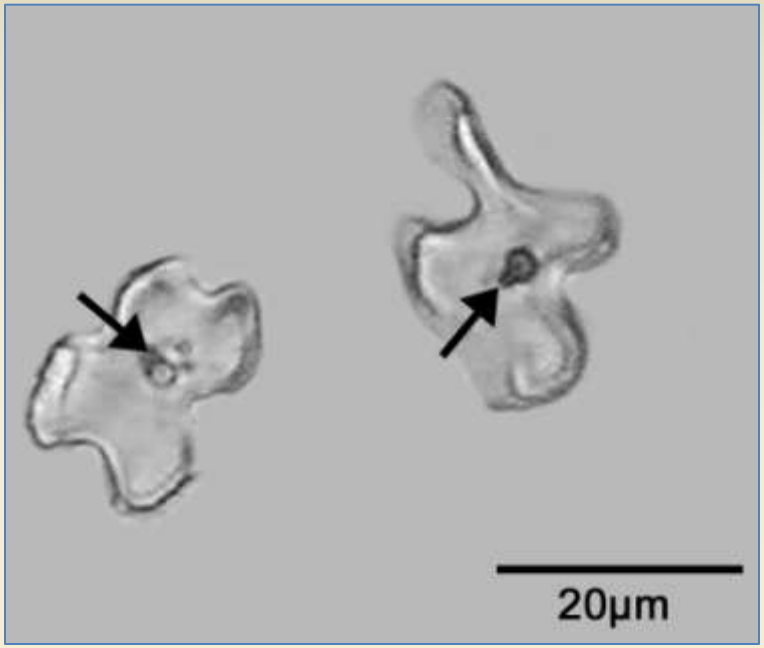
Charred Wheat seeds, 10,000 years old

Grinding Stones, Tools, Cultivating Implements

Coprolites

- dried human feces
- found in dry caves
- information on individual's diet.
- remnants of food products such as partially digested seeds or leaves , stalks and roots, small bones from birds and fish etc.
- tell us the type of plants, climate, and environment

Phytoliths - microscopic pieces of silica that form in the cells of many kinds of plants. They can be used to identify plant remains in archaeological and other ancient contexts



Phytoliths from Maize leaves. Arrows point to inclusions of carbon from the cells in which the phytoliths formed that we use to radiocarbon date

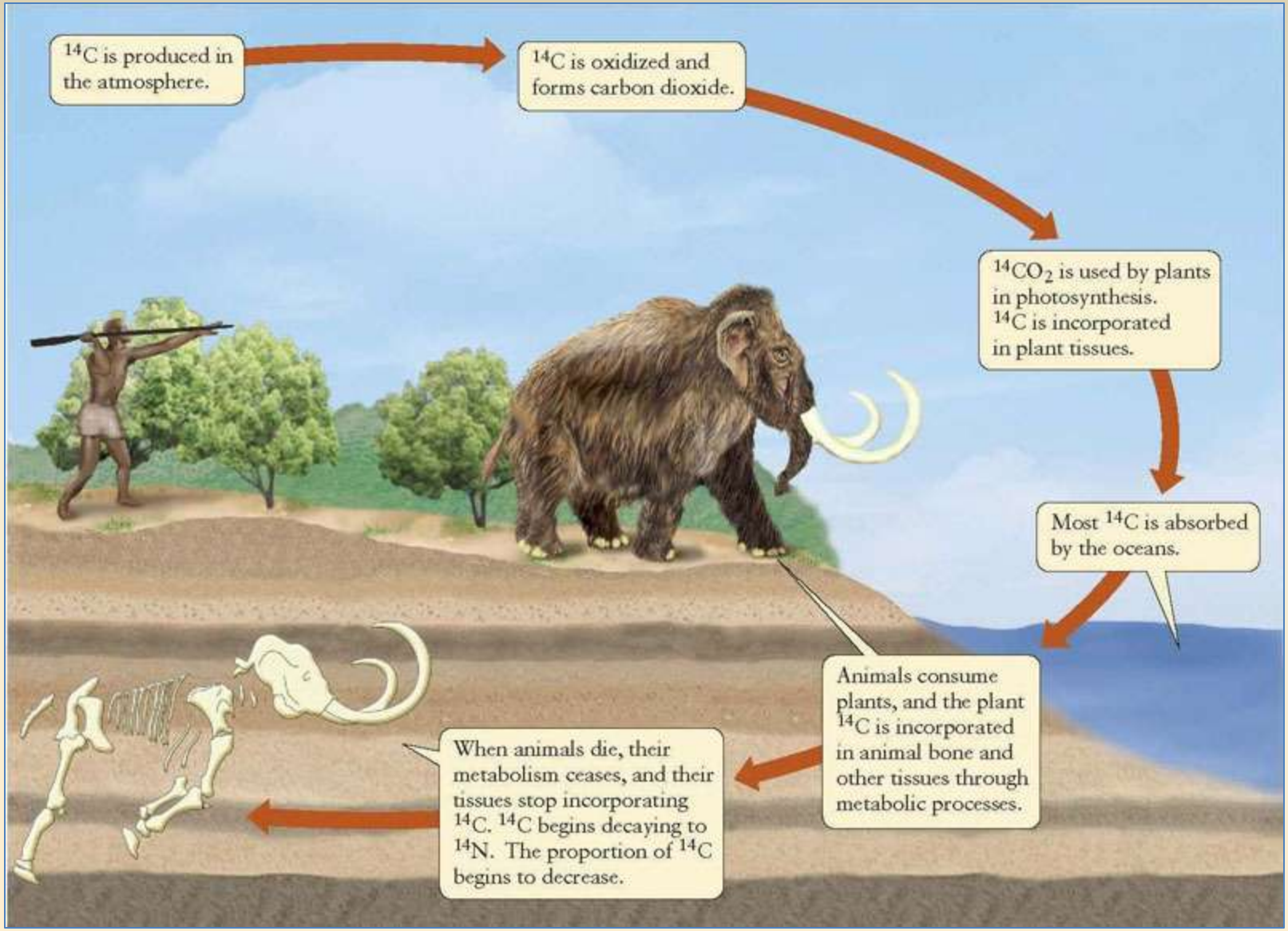
Phytoliths from the domesticated squash species *Cucurbita moschata*.

http://www.mnh.si.edu/highlight/phytoliths/

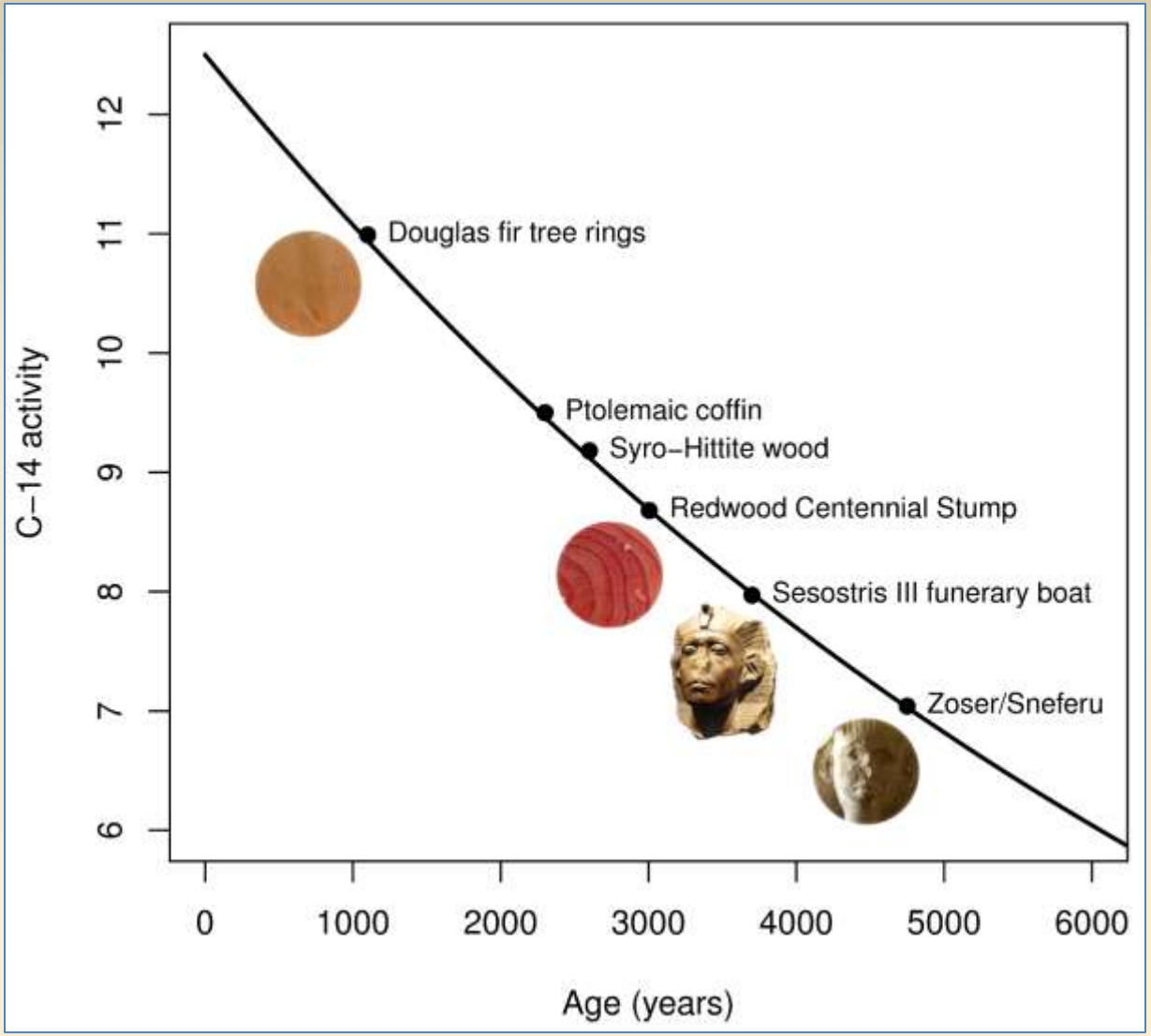
C-14 Radiocarbon Dating

- Developed by W.F. Libby in 1946–47
- The best known means of dating organic material.
- Measurement of Carbon 14, (a radioactive form of carbon)
- Every organism absorbs the C14 isotope from the atmosphere when they are alive.
- When the organism dies, the flow of C14 is interrupted and any C14 absorbed during its life gradually disappears
- Half disappears every 5730 years (the half-life of the isotope).
- By measuring the relative amount of C-14 in a fossil, compared with modern material, the age can be calculated.
- After about 40,000 years, too little C-14 remains for accurate measurement, have to use different isotope

Radiocarbon Dating

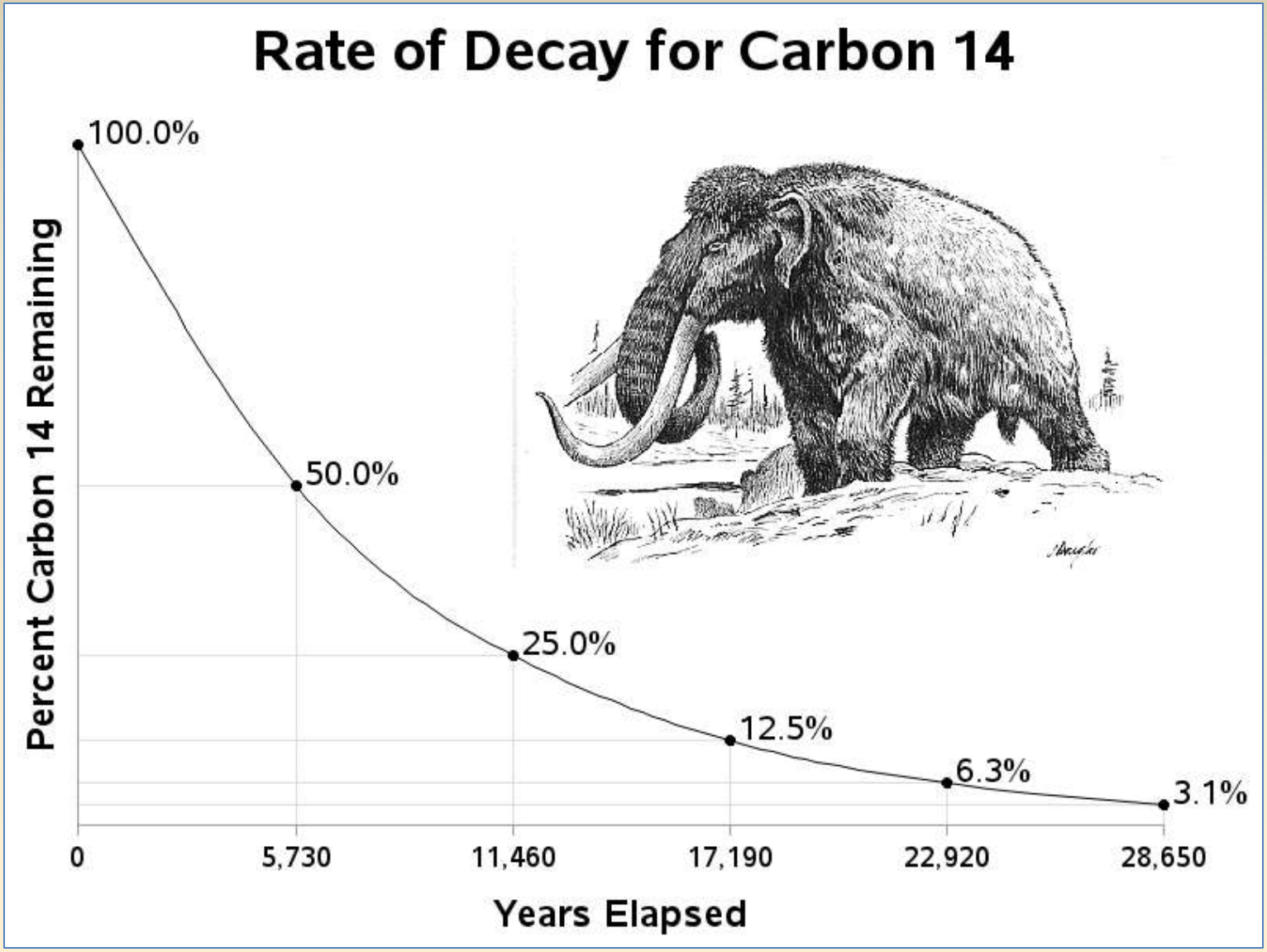


Decay curve for carbon-14, together with some comparison samples Libby used (including wood dated by tree rings and items from the tomb of Pharaoh Zoser, for whom the first of the pyramids was built). It's a very good fit!



[redrawn from J. R. Arnold & W. F. Libby, "Age Determinations by Radiocarbon Content: Checks with Samples of Known Age," *Science* **110** (2869), 678–680, 23 Dec 1949]

Radiocarbon Dating



Why Farm?

- Hunting and gathering can supply a day's calories with a couple of hours' work
- Many early farmers *less* well off than hunter-gatherers
- Line between hunter-gatherers and farmers is fuzzy
  - In rich environments, hunter-gatherers may have permanent settlements (Pacific Northwest)
  - May practice some agriculture along with hunting and gathering (Apaches)

Theories for Origin of Agriculture

Many questions……

- How did it get started?
- Was it a revolution or evolution, a fast or slow transition?
- Which came first, sedentary living or agriculture?
- Independent origins, or connected somehow (diffusion)?

Brilliant Sage Model – single smart person noticed plants growing from seeds, started collecting, saving and growing them.

Oasis Model – climatic change, warmer and dryer conditions, less big game, people settled around Oasis

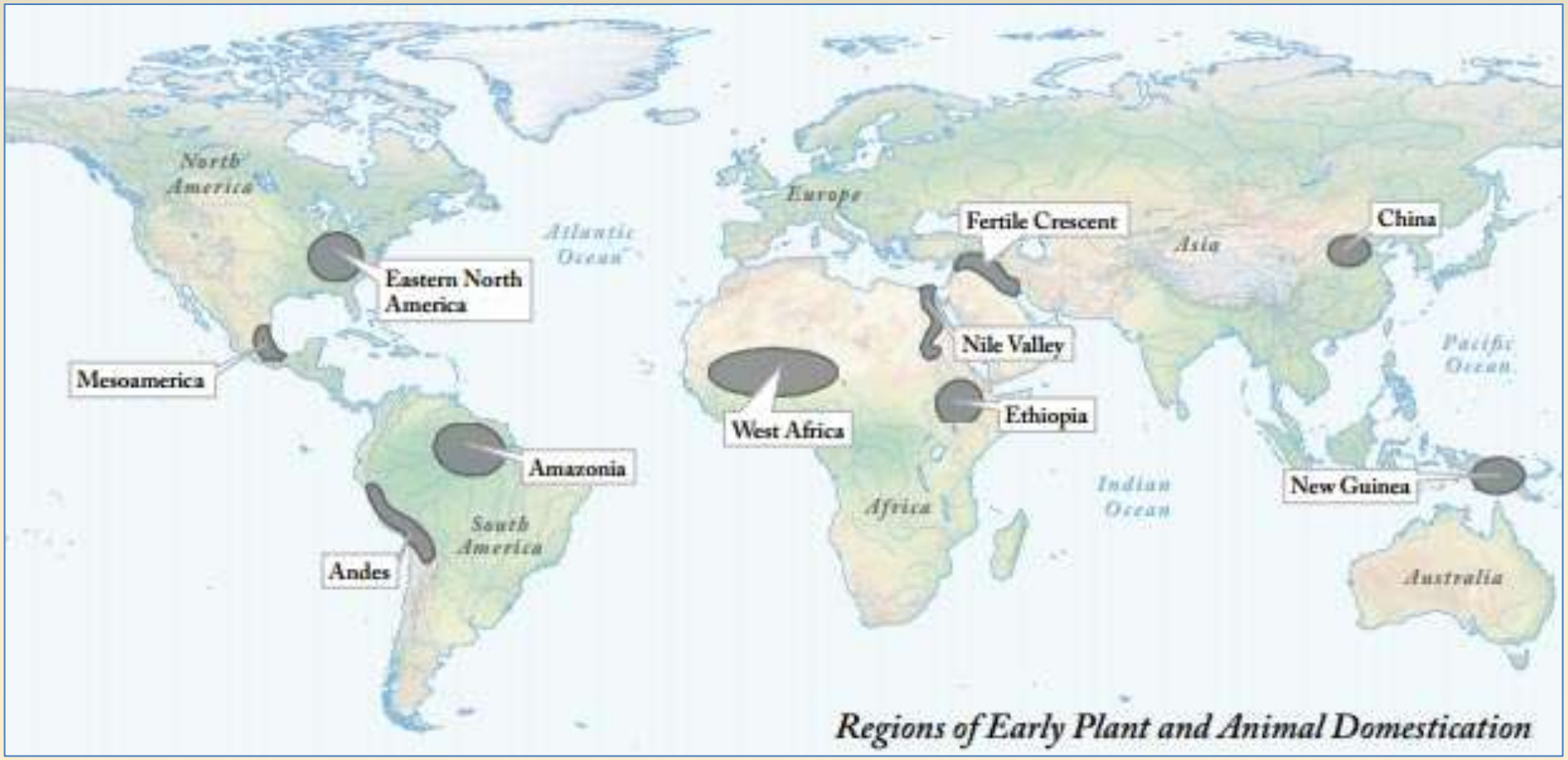
Dump Heap Model – plants grew in and around refuse pits, hybridized, formed lots of new varieties, selection began

Demographic Models – population grew, pressure for new foods

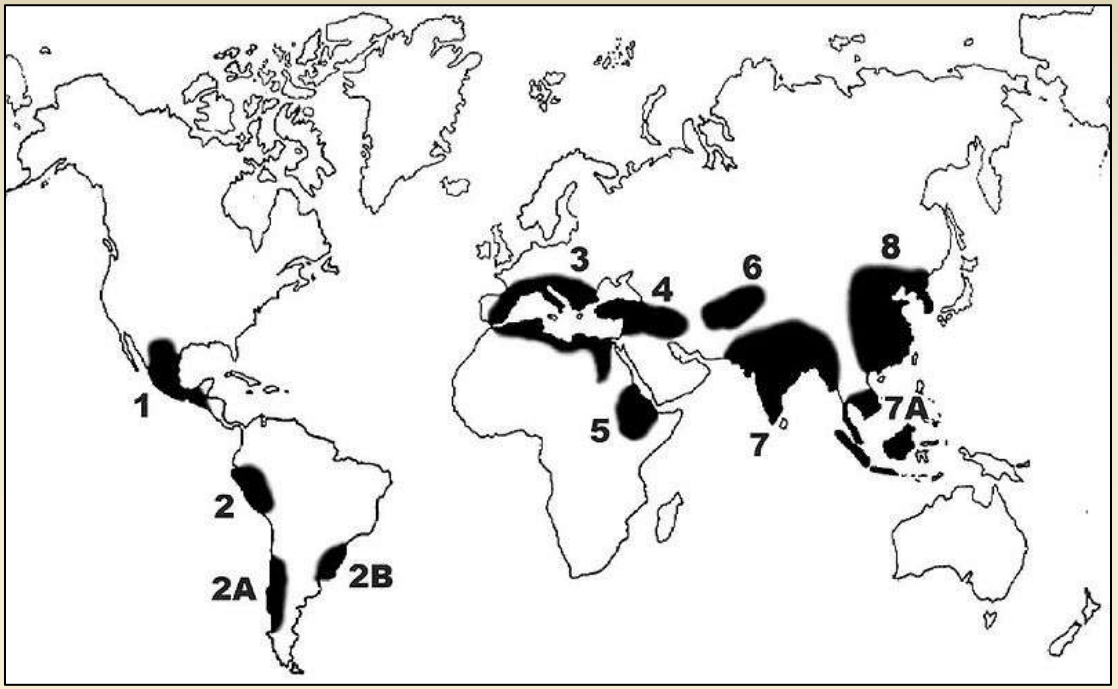
Fishermen Model – would have been settled, started growing vegetative crops, seeds came later

"No Model" Model – no one hypothesis is correct, originated in several ways in different places

Where did Agriculture Begin?
Early Sites of Agriculture



Nikolai Vavilov - Genetics in the Soviet Union, Centers of Crop Diversity, 1920s and 1930s



Crop Centers of Origin

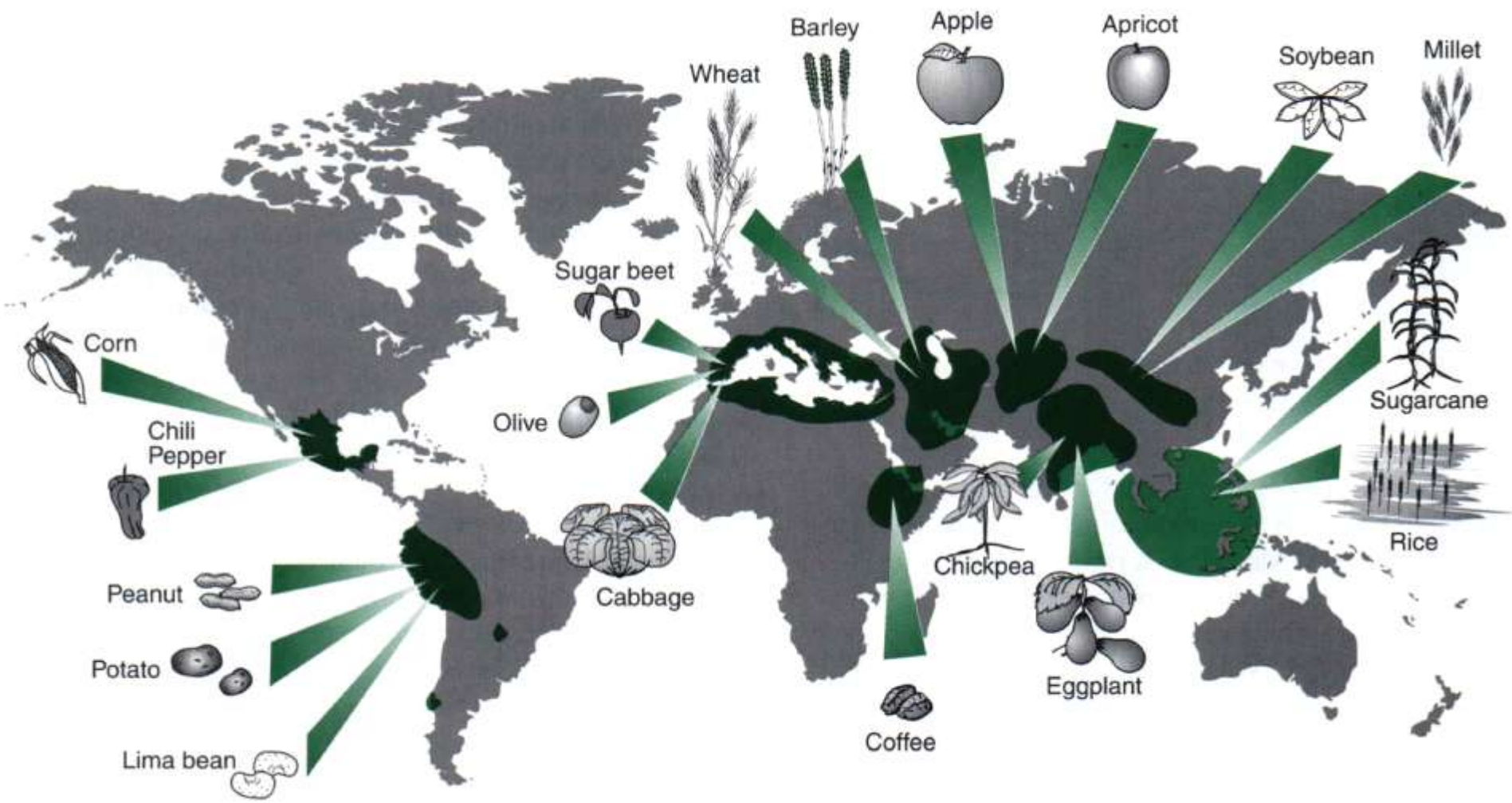
(1) Mexico-Guatemala, (2) Peru-Ecuador-Bolivia, (2A) Southern Chile, (2B) Southern Brazil, (3) Mediterranean, (4) Middle East, (5) Ethiopia, (6) Central Asia, (7) Indo-Burma, (7A) Siam-Malaya-Java, (8) China and Korea

Trofim Lysenko – Lysenkoism – State Sponsored Lamarckism

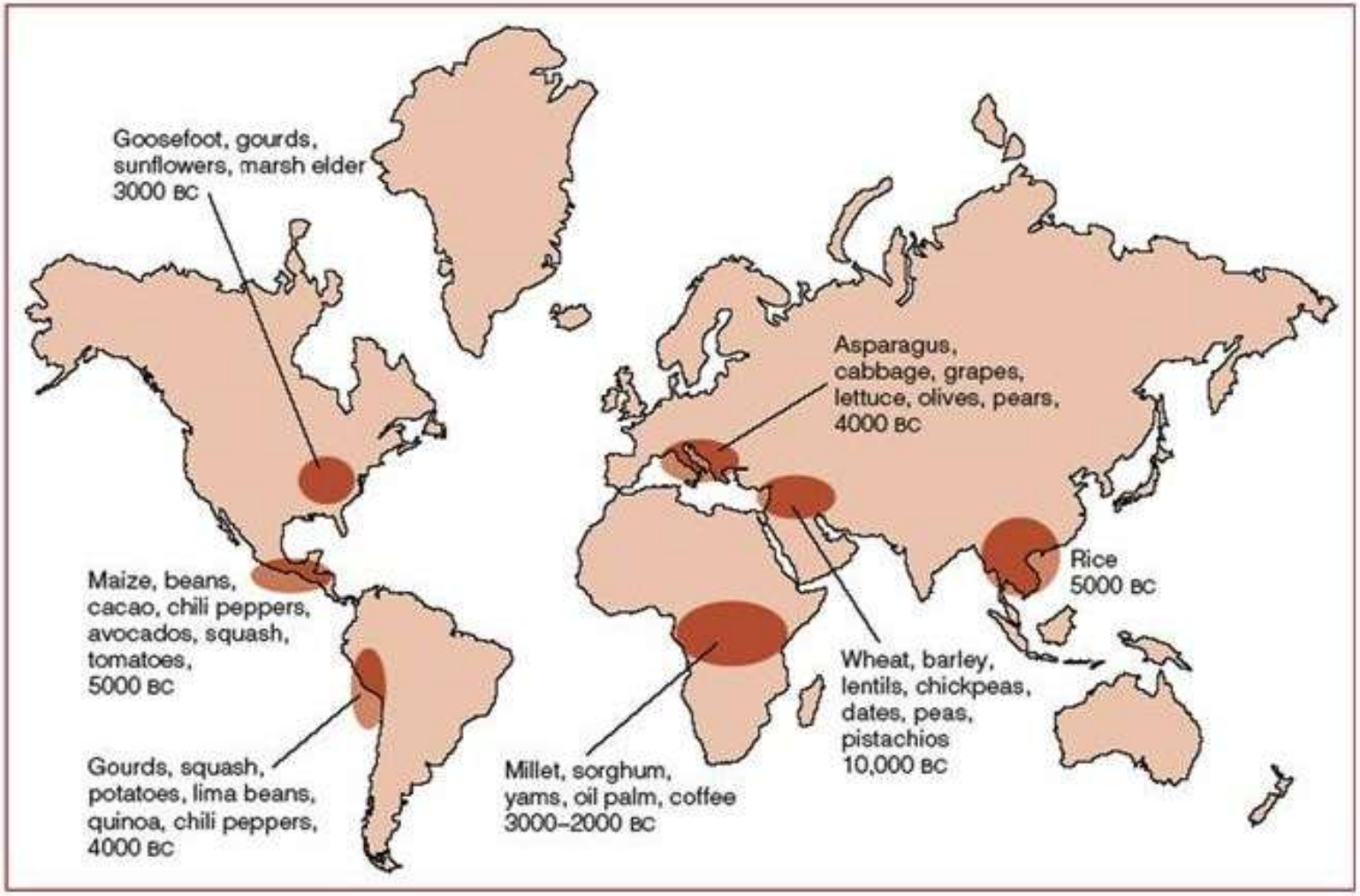
Rejected Mendelian genetics. Mandated that all biological research conducted in the USSR conform to a modified Lamarckian evolutionary theory. The underlying appeal was that it promised a biology based on a plastic view of life that was consistent with the plastic view of human nature insisted upon by Marxist-Leninist dogma

Vavilov imprisoned, starved to death in 1943
Study of Mendelian genetics banned
Millions starved to death in 1950's in USSR

Vavilov centers of plant diversity and areas of origin for agriculture



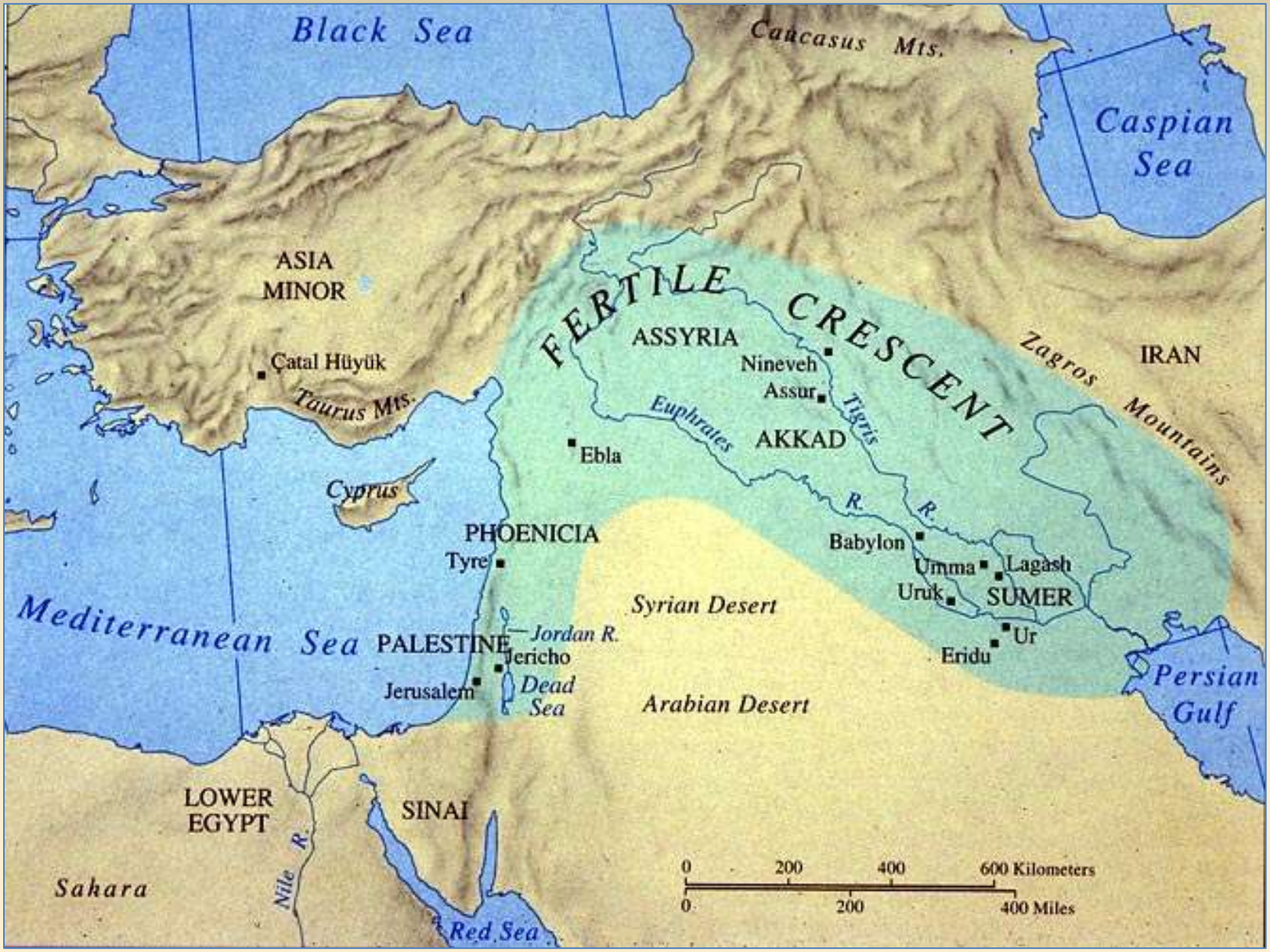
Major Hearths of Agriculture



Old World Centers

- **The Near East:** 9,000 – 14,000 years ago. Fertile crescent of Mesopotamia. Wheat, barley, peas and vetch
- **The Far East:** 7,000- 8,000 years ago. China, Thailand, India. Rice, millet, rape and hemp

The Near East – Fertile Crescent

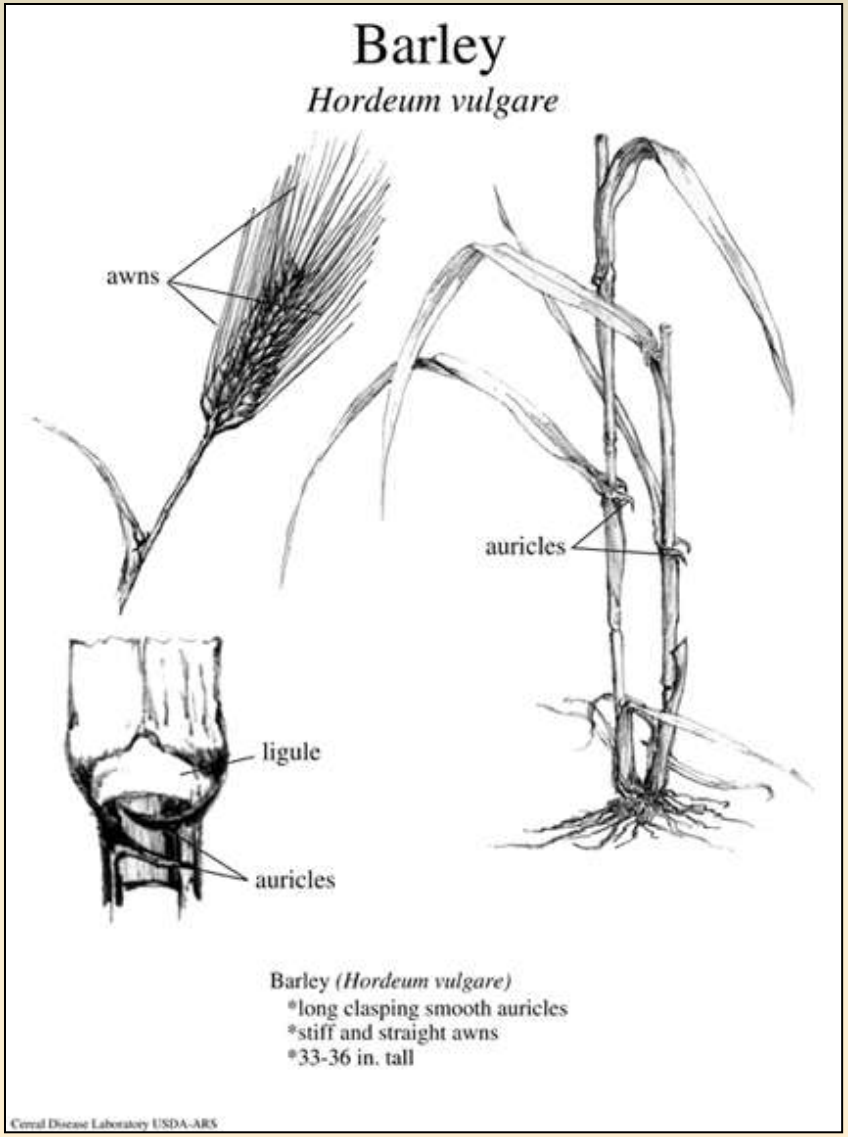


Plants from Near East – Fertile Crescent

- Barley (*Hordeum vulgare*)
- Wheat (*Triticum*)
- Lentils (*Lens culinaris*)
- Peas (*Pisum sativum)*
- Chickpeas or garbanzos (*Cicer arietinum*)
- Olives (*Olea europaea*)
- Dates (*Phoenix dactylifera*)
- Grapes *(Vitis vinifera*) –
- Wine began to be made from the grapes and beer from the cereal grains
- Flax (*Linum usitatissimum*) – food and fiber

Barley – *Hordeum vulgare*

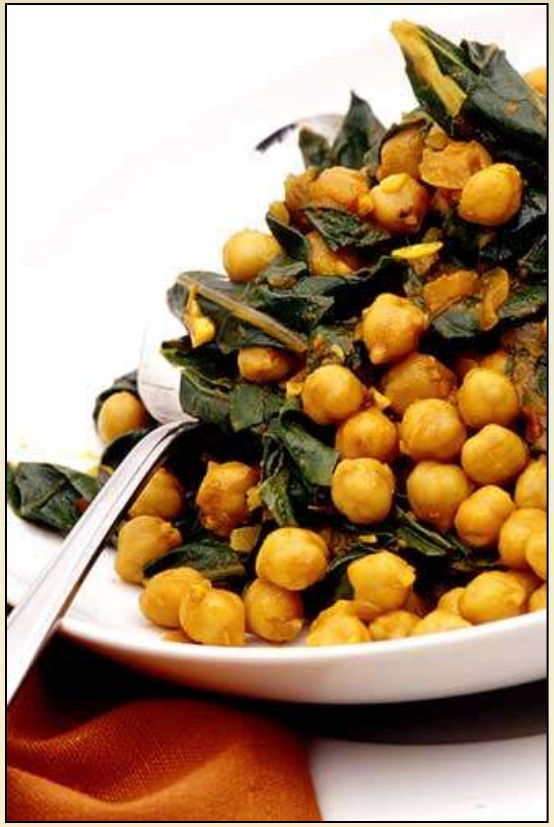
May have been the first crop domesticated in the Near East, 10,000 years ago, older than wheat



Wheat - *Triticum*

Lentils - *Lens*

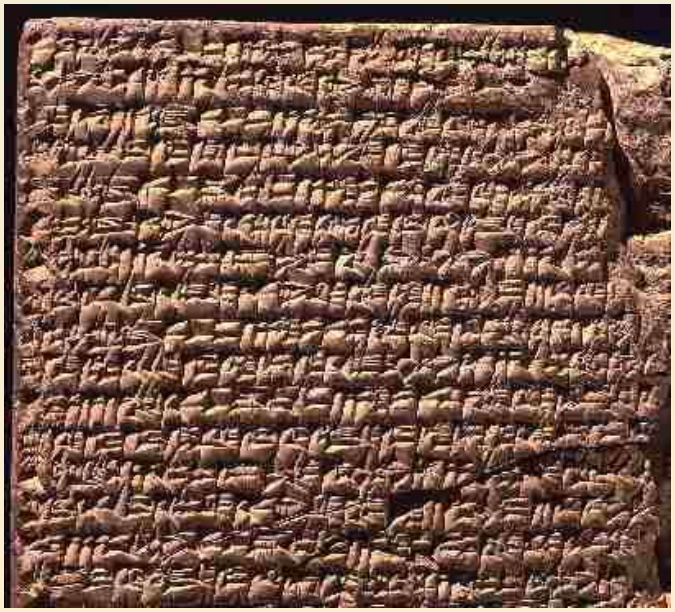
Chickpeas - Cicer



Date Palm - *Phoenix*

Flax - *Linum*

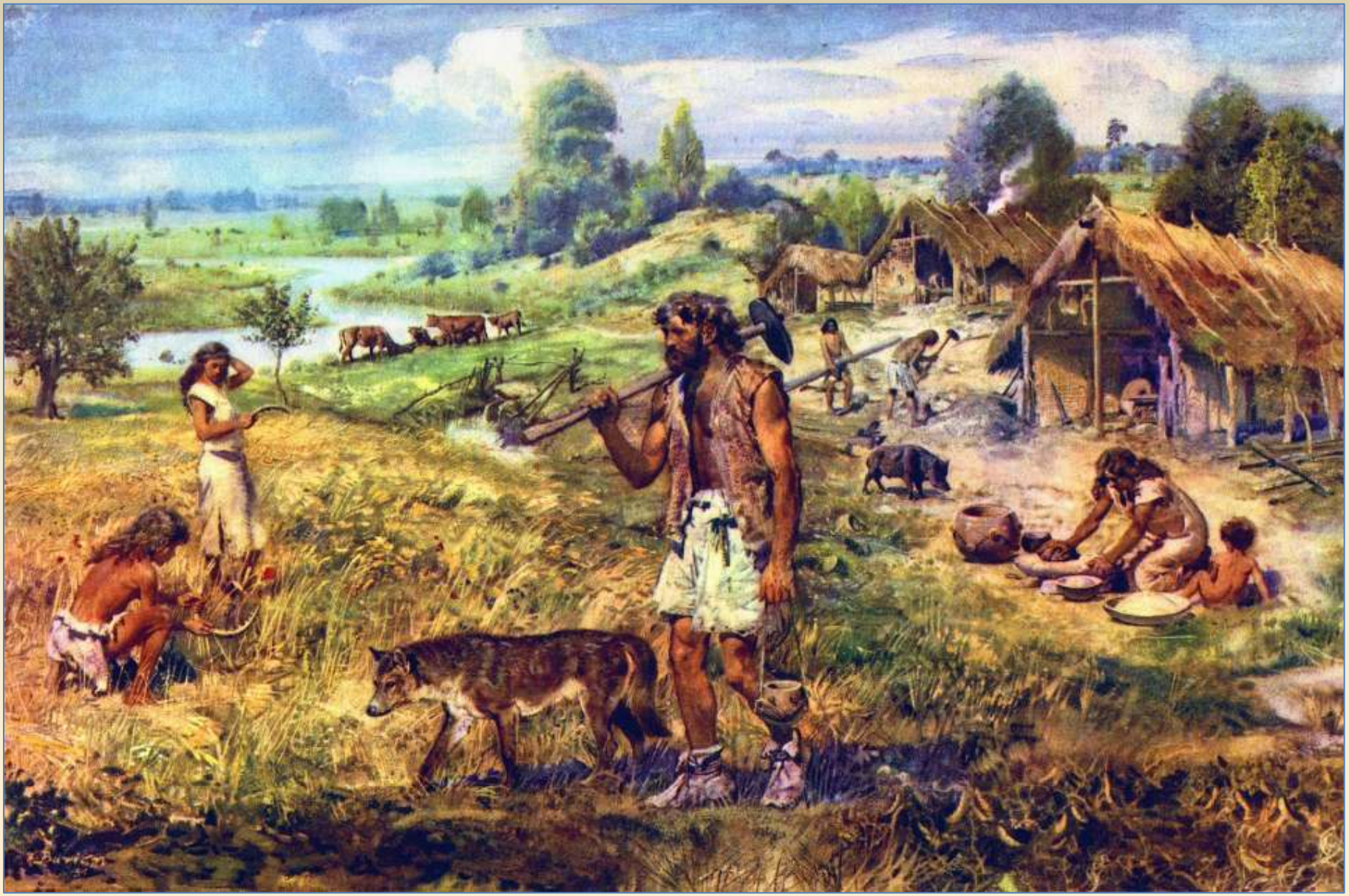
History 101: Settled Communities, Cities, Rise of the State, Social Classes, Kings, Priests, Writing, Taxes, Wars



Dog Domestication – 30,000 to 15,000 years ago

- Wolves and wild dogs began to live alongside hunters around 100,000 years ago
- Orphaned pups raised by people?
- Dogs domesticated themselves?, took advantage of humans, fed scraps? More social wolves rewarded with food?
- Came with humans to the New World

Neolithic Scene - Man and Wolf-Dog



Cats

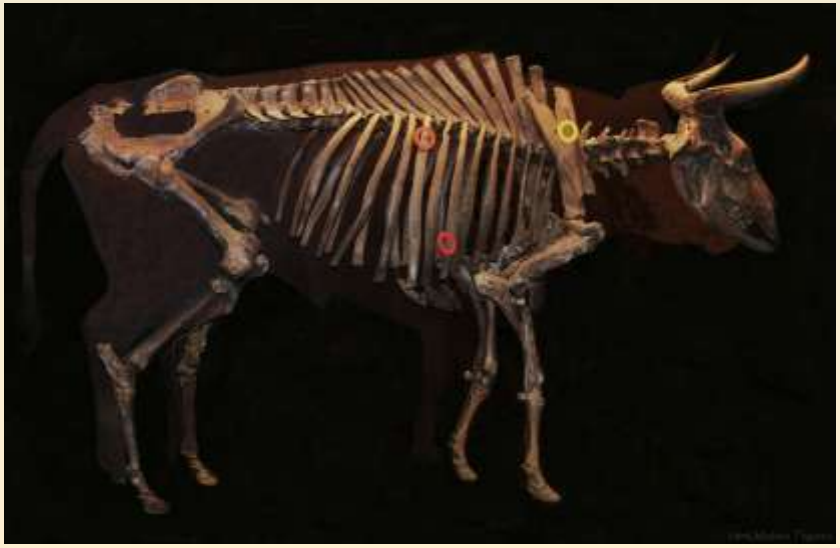
- Wildcats - single Old World species. Five subspecies.
- First domesticated from the Middle Eastern subspecies about 10,000 years ago
- Possibly attracted by rodents infesting the first agricultural settlements?
- Egyptians converted cats from work animals to sacred pets
- Also domesticated in China? Peru??

Egypt Cat God Bastet

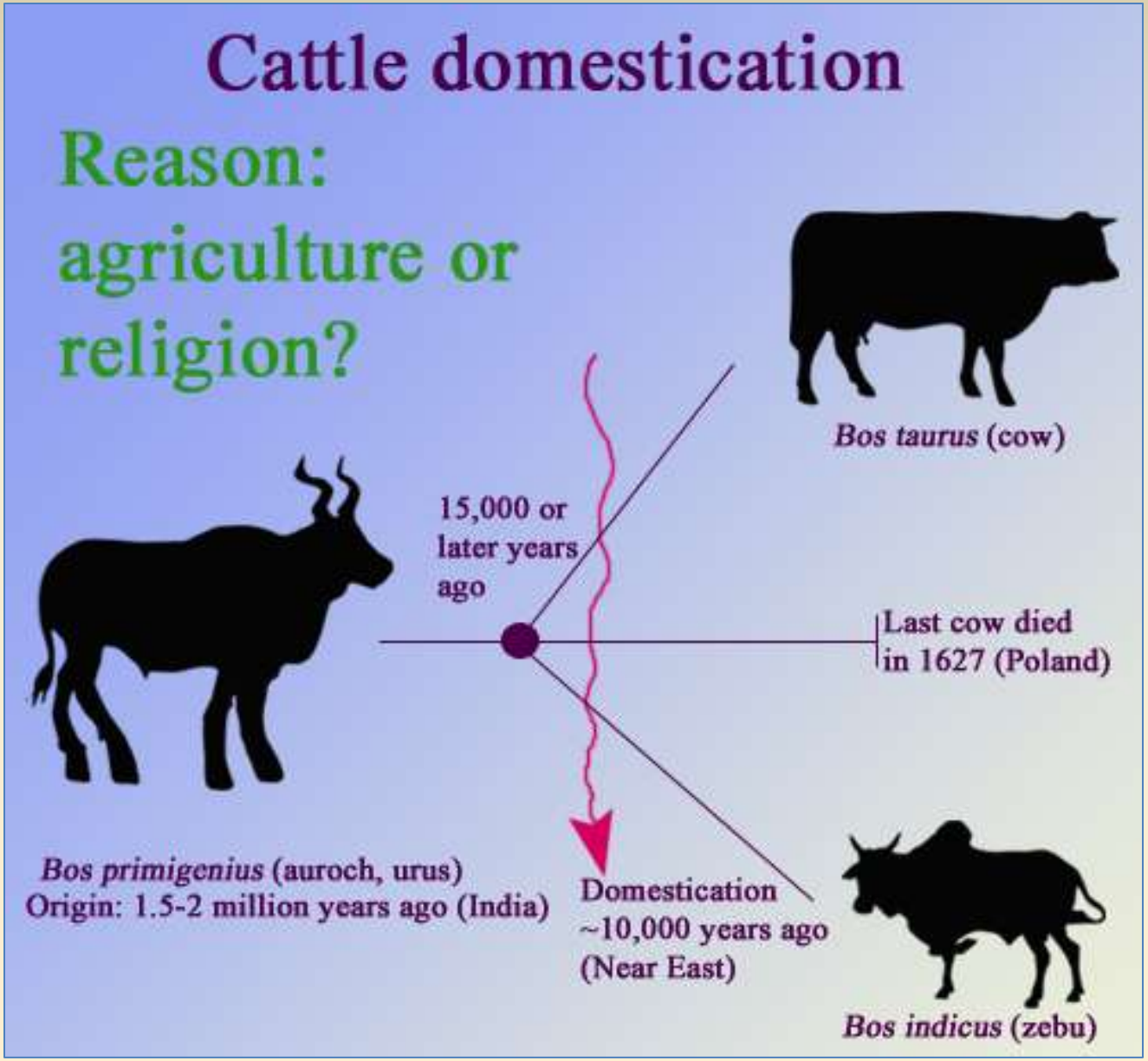
Cattle – *Bos*

domesticated in southeast Turkey about 10,500 years ago

Long Horned European Wild Ox
(aurochs)
ancestor of domestic cattle. The species survived in Europe until the last recorded aurochs died in the Jaktorów Forest, Poland in 1627.



Cattle - *Bos*


Cattle domestication
Reason:
agriculture or
religion?
Bos taurus (cow)
15,000 or
later years
ago
Last cow died
in 1627 (Poland)
Bos primigenius (auroch, urus)
Origin: 1.5-2 million years ago (India)
Domestication
~10,000 years ago
(Near East)
Bos indicus (zebu)

Old World Centers

- The near east: 9,000 – 14,000 years ago. Fertile crescent of Mesopotamia. Wheat, barley, peas and vetch
- **The far east:** 7,000- 8,000 years ago. China, Thailand, India. Rice, millet, rape and hemp

Plants from China, Far East

- Rice (*Oryza sativa*)
- Soybeans (*Glycine max*)
- Mango (*Mangifera indica*)
- Various kinds of citrus fruits (*Citrus sp.*)
- Taro (*Colocasia esculenta*)
- Bananas (*Musa x paradisiaca*)

Rice – *Oryza sativa*

Mango

Taro

Silkworm Moth, *Bombyx mori*

- Feeds on the leaves of the mulberry tree
- Cocoon thick , composed of a single thread commonly 900 meters (2,950 ft) long.
- Unraveled to provide commercial silk
- Domesticated 5,000 years ago in China

Horses

- Hunted for meat in Paleolithic
- Botai in Kazakhstan, 5,000 years ago, rode horses, milked them

Domestication of the Horse –
5,000 years ago, probably Central Asia

Lascaux, 17,300 years old
Horses hunted for meat

Horse used for warfare
Hyksos Chariots , 1600 BC

Plants from Africa

- Sorghum (*Sorghum sp.*)
- Millet grains (several genera and species)
- Okra (*Hibiscus esculentus*)
- Yams (*Dioscrorea sp.*)
- Cotton (*Gossypium sp.*)
- Coffee (*Coffea arabica*)

Sorghum and Millet

Okra

Yams - *Dioscorea*

Coffee

New World Centers

- Eastern North America: Cherokee Sunflower and cranberries
- Western North America: Pueblo Dwellers Trees and shrubs; pine nuts and pigweed
- Mexico: Aztecs and Mayans; Corn and beans
- South American: Inca; Potato and chocolate

Plants from Mexico

- Corn (*Zea mays*),
- Kidney beans (*Phaseolus vulgaris*)
- Lima beans (*P. lunatus*)
- Peanuts (*Arachis hypogaea*)
- Cotton (developed independently from Africa)
- Chili peppers (*Capiscum sp.*)
- Tomatoes (*Lycopersicon sp.*)
- Tobacco (*Nicotiana tabacum*)
- Cacao (*Theobroma cacao*)
- Pineapple (*Ananas comosus*)
- Pumpkins, squashes (*Cucurbita sp.*)
- Avocados (*Persea americana*)

Corn – *Zea mays*

Tehuacan Valley in Mexico – well documented record for corn and other crops, record goes back 12,000 years.

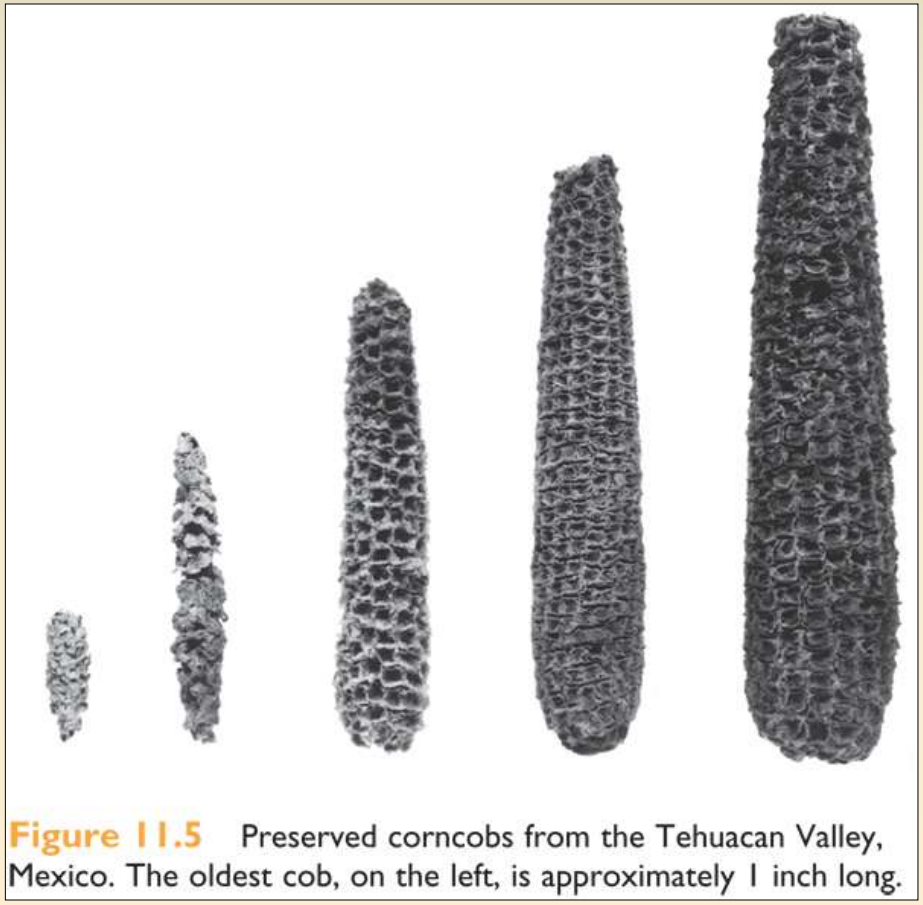


Figure 11.5 Preserved corncobs from the Tehuacan Valley, Mexico. The oldest cob, on the left, is approximately 1 inch long.

photo by John Doebley

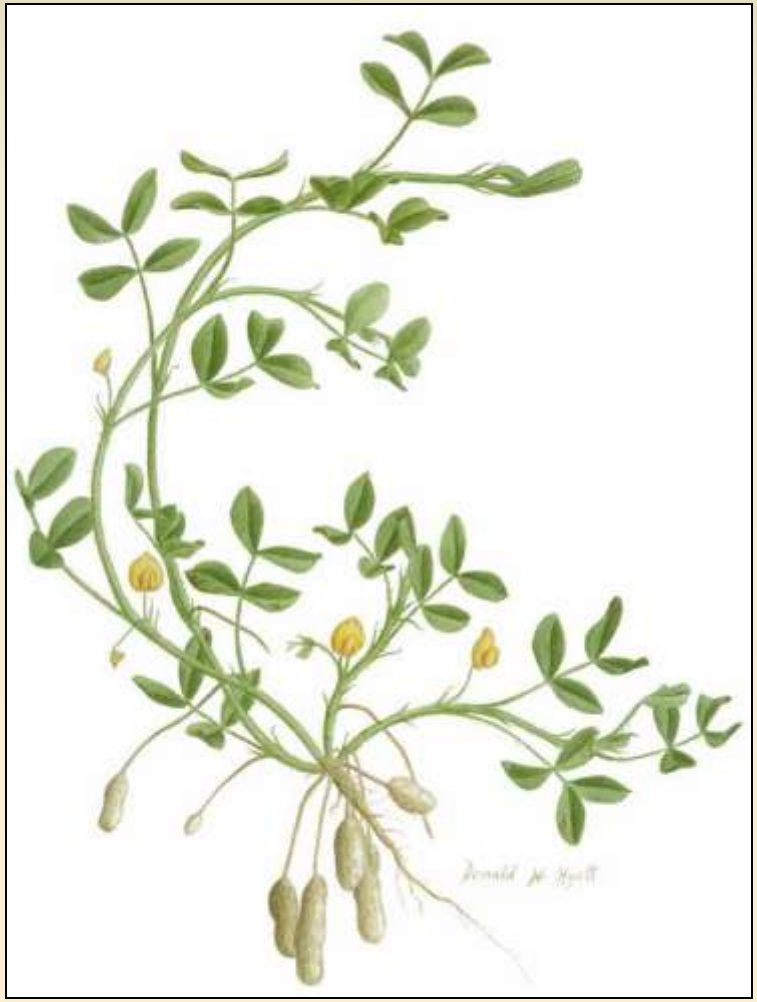
5,000 years

Teotehuacan, Mexico

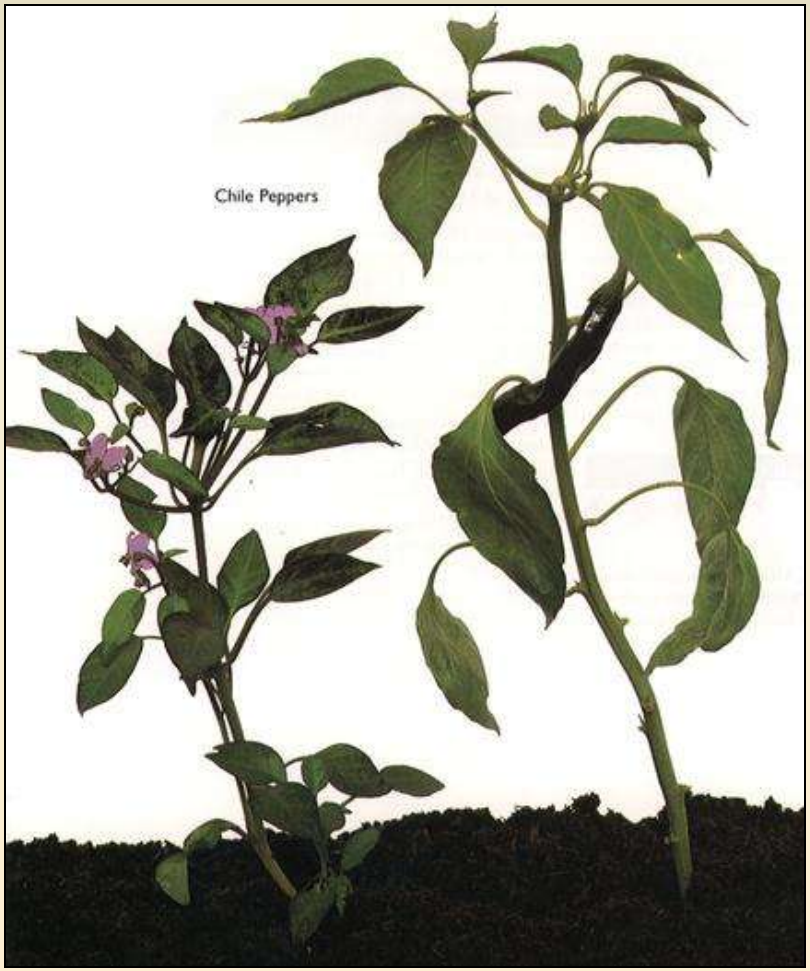
Cahokia, Illinois

Beans – *Phaseolus vulgaris*

Peanut - *Arachis*



Chili Peppers – *Capsicum* sp.



Pumpkins and Squashes
Cucurbita

Plants from Peru

- Potato (*Solanum tuberosum* and many related species)
- Quinoa *(Chenopodium quinoa*)
- Tomatoes and peanuts may have really originated in Peru and then been taken to Mexico

Potato - Solanum

Native to highlands of Peru

Quinoa


BIOFAIR
ORGANIC FAIR TRADE
organic
Quinoa
Økologiske Quinoa/Luomu Quinoa
FAIR TRADE
Gluten Free • Cholesterol free

North American Crops

- Gourds
- Sunflower
- Sumpweed (seed crop)
- Goosefoot (leaf crop)
- Corn (from Mexico)
- Beans (from Mexico)
- Squash (from Mexico)

Eastern American Plant Domestication

<u>Cast of Plants</u>
Sunflower
Little Barley
Goosefoot or Lamb's Quarters
Marshelder
or Sumpweed
Erect Knotweed
Maygrass
Gourds and Squashes
Maize or Corn
Beans
Tobacco

Montage Images Provided By:

Wendy and Michael Scullin

Jeff McMillian @ USDA-NRCS PLANTS Database

Tracey Slotta @ USDA-NRCS PLANTS Database

Steve Hurst @ USDA-NRCS PLANTS Database

What happens during domestication?

- **Cultivation** – growing plants beyond their natural range
- **Domestication** – changing plants genetically to the human-manipulated environment

- **Natural selection** – traits selected for survival value
- **Artificial selection** – traits do not necessarily have survival value, useful for humans

Many domesticated species are unknown in the wild and can't survive on their own.

Most domesticated food plants have been selected for:

- larger plant parts
- soft edible tissue
- thick flesh with intense color
- fruits attached to tough stems
- Non-shattering fruits

Traits Associated with Domestication Process

- Increased reproductive effort
- Larger seeds and fruits
- More even and rapid germination
- More uniform ripening period
- Nondehiscent fruits and seeds
- Self-pollination
- Trends to annuality
- Increased palatability
- Color changes
- Loss of defensive structures
- Increased local adaptations

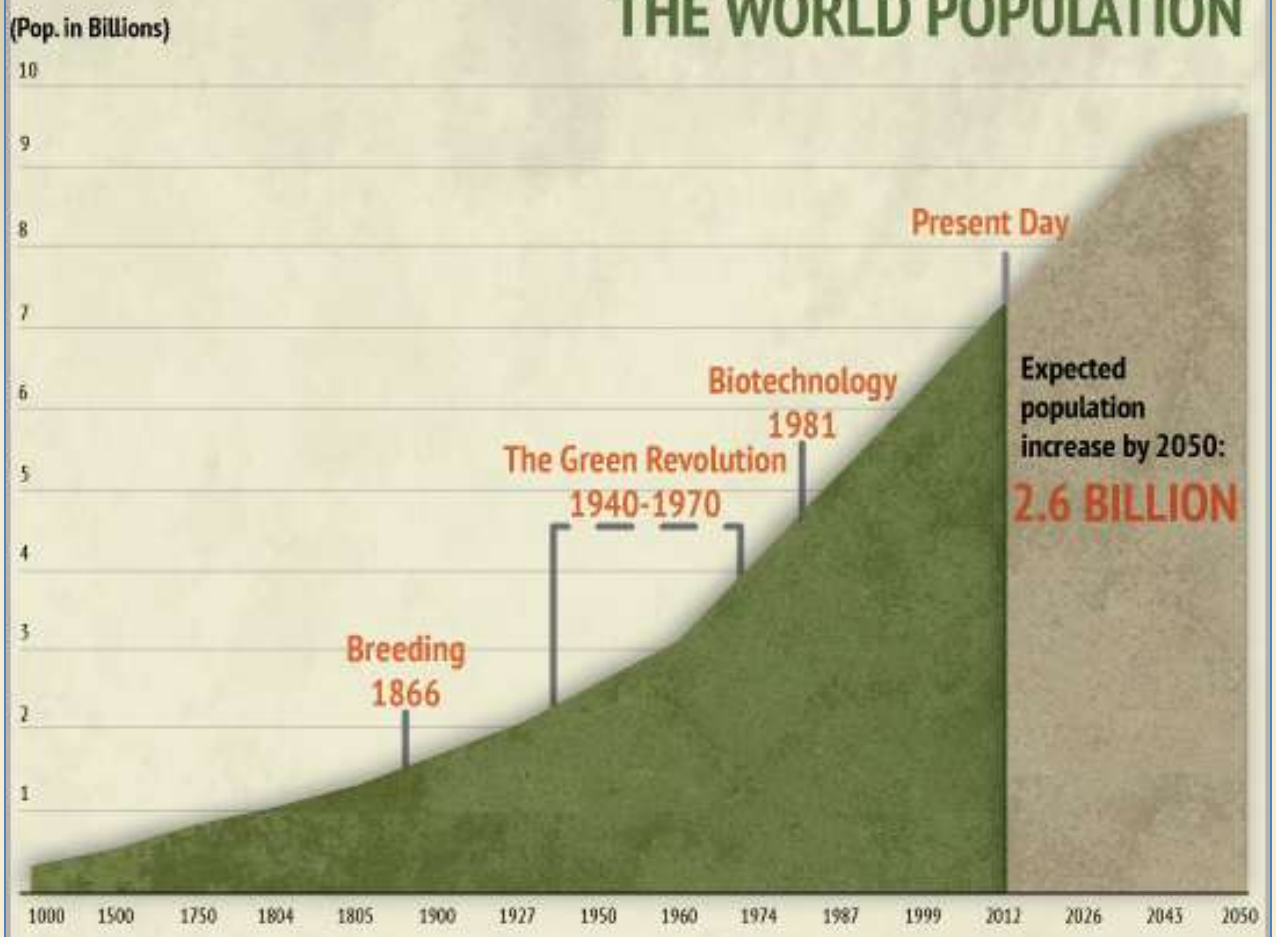
How much domestication?

- About 5000 species have been grown for human food – less than 1% of all plant species
- Today about 150 species are commercially grown for food (not including spices)
- About 50 very productive species supply almost all of our caloric needs

Benefits of Domestication

- 10,000 years ago, before agriculture began, the world's total human population was about 5 million. There was one person for every 25 square kilometers.
- Today we have more than 6.6 billion people, with a density of just over 25 people per square kilometer

THE EFFECT OF AGRICULTURAL MILESTONES ON THE WORLD POPULATION



"The rate of population increase exceeds the rate of increase in food production"

- Dr. Norman Borlaug

Source: United Nations, The Danforth Center, USDA

End