Lecture 1
Introduction to Anth 115
Origins of Agriculture

So what is the Big Deal About the Last 10,000 Years (more or less)?
• Two dramatic developments occurred in the ways that humans subsist and organize their societies
  – Agriculture
  – Complex Societies

Places where agriculture independently developed over the last 15 ky
- What caused humans to abandon hunting and gathering and become farmers in many parts of the world relatively recently (invention, overpopulation, environmental or social change)?
- What were the consequences for society, health, behavior, culture?

Places where cities and civilizations independently developed over the last 5 ky
What caused humans to live in cities and develop complex societies in many parts of the world relatively recently (invention, overpopulation, environmental or social change)?
- What were the consequences for society, health, behavior, culture?

Dates for Earliest Evidence of Agriculture by Region

Prehistory
• Refers to the period of human history extending back before the time of written records and encompasses the bulk of human cultural evolution over the last 2.5 m.y.

Prehistoric Time Scale
1 mile = 100 ky
In 1519, Cortez in the Aztec Capital of Tenochtitlan
“passed through cities, towns, villages, markets, and irrigated fields; he saw slavery, poverty, potentates, farmers, judges, churches, massive pyramids, roads, boats, pottery, and textiles; in short he encountered a world whose almost every aspect he could understand in terms of his own experience as an urban Spaniard of the 16th century (Wenke 1980)

You need to understand these two developments in prehistory if you want to understand the following current issues:
• Climatic Change (Global Warming)
• Deforestation
• Pollution
• Overpopulation
• Economic Downturns and Collapses
• Warfare
• Economic Downturns and Collapses
• Warfare
Three Misconceptions to Get Out of the Way
• Civilization – What do we mean by this term?
• Progress/Invention – Isn’t it Obvious?
• Ethnographic Analogy- Is the Present the Key to the Past?

Morgan’s Evolutionary Sequence
(divides into three ethnical periods)

Lower Savagery Earliest stage

Middle Savagery Fish subsistence to fire

Upper Savagery Bow and Arrow

Lower Barbarism Pottery

Middle Barbarism Agriculture, Masonry

Upper Barbarism Iron Metallurgy

Civilization Phonetic Alphabet

Who’s Calling Whom Civilized?
• We will use the terms:
  – Complex Society
• Chiefdom
  – City/Urban Center
  – State
• Archaic State
Isn’t it Obviously Human Progress? and
What about Great Ideas and Human Invention?
Ethnographic Analogy - using information about ethnographic peoples to understand human prehistory.

**Ethnographic Analogy**
Is the present the key to the past?

**Lecture 2**
Basic Concepts About the Consequences of Agriculture for Humans

**Central Points of J. Diamonds “Guns, Germs, and Steel”**
- The ultimate causes for the domination of the world by Western civilization can be traced back to geographic influences on the origins of farming that favored the Fertile Crescent over other regions
  - Domesticable Plants and Animals
  - Food Surpluses allowed larger populations
  - Formed Basis of large complex civilizations
  - Also caused epidemic diseases
  - Created technological and military advantages

**A couple of misconceptions**
- Many traditional societies do not "envy" the materialism of western civilization.
- Many of the events leading to the development of western civilization were not advantageous or progressive. Instead they were responses to stresses caused by overpopulation, climatic change, and environmental degradation.

**Definition: Agriculture**
- An economic system based on the cultivation or husbandry of domesticated plants and animals.

**Is agriculture more economical or productive than hunting and gathering?**
- Are the lives of hunter-gatherers "nasty, brutish, and short" (sensu Thomas Hobbes)?

**Original Affluent Society**
- *Notes on the Original Affluent Society* by Marshall Sahlins
- Ethnographic work Among the !Kung Bushmen had shown that hunter-gatherers
  - Lived long lives
  - Ate well
  - Had Plenty of Spare time
  - Did not work as hard as farmers or urban dwellers
• Proposed that hunting and gathering societies (bands) had economies characterized by “limited needs and wants”

**How can we reconcile this with Diamond’s argument that farming allows greater population sizes and promotes the development of more complex societies?**

**Ester Boserup**

**Definition: Agricultural Intensification**

- The process of raising the productivity of agriculture PER UNIT OF LAND at the cost of more work at lower efficiency PER UNIT OF TIME.
- Intensification occurs when plots are cultivated more frequently and with higher labor and technological investments.

**Low Yield but Energetically Efficient forms of Agriculture**

- Horticulture - Cultivation using hand tools only. Usually limited to fertile, easily tilled soils or to soils which are allowed to lie fallow for a few years to regain fertility.
- Pastoralism- Mode of subsistence based primarily on herd animals.

**Swidden (slash-and-burn) agriculture**

- A horticultural system in which plots of land are cleared and burned of natural vegetation, thus returning nutrients to the soil. This allows the plot to be cultivated for several year, but then abandoned and allowed to fallow. Swidden systems are relatively labor efficient but can only support a limited population size.

**Intensive Agriculture**

- cultivation using draft animals, machinery, irrigation, terracing raised fields, fertilizers and/or other techniques that allow annual, sustained use of plots.

**Forms of Intensive Agriculture**

- Irrigation
- Terracing
- Plow
- Raised Field (Chinampa)

**Chinampa**

- An agricultural field created by drainage or landfill along the margins of lakes and swamps. Especially common in prehistoric Mesoamerica.

**A central point of Boserups' Intensification Hypothesis**

- Improvements in the energetic efficiency and productivity of
agriculture come from the developments of new and technologies. 
• These advances often occur when growing populations have reached a point of “diminishing returns” when they can no longer increase the yield of farming per unit of land by working harder.
• Necessity is truly the mother of invention!

A Fundamental Point of the Entire Course!
• Agriculture can support more people and spur technological change, but only at the cost of making most people work harder!

Adverse Consequences of Agriculture
• Environmental Degradation
• Disease
• Population Growth

The Demographic Consequences of Agriculture
1) The adoption and intensification of agriculture is usually accompanied by population growth.

Rate of Growth of the Human Population

Carrying Capacity
• The number of individuals a habitat can support with a specified subsistence technology without deleterious effects to the environment.
• Population Pressure- the effects of a population reaching carrying capacity.

Possible Causes of Population Growth Among Early Farmers
• Greater value of children in agricultural labor.
• Lower inter-birth intervals (time between successful births) among women.
• Less mobility and greater sedentism
• Reduced period of breastfeeding
• Availability of substitute “baby” foods (cereals, dairy milk)
• Lactational amenorrhea- the suppression of lactation and menstruation during breast feeding.

Adverse Consequences of Agriculture
• Environmental Degradation
  – Erosion
  – Deforestation
  – Salinization
• Disease
• Population Growth
The Demographic Consequences of Agriculture
2) The migration and spread of agricultural populations.
- archaeologists and linguists often link to language spreads
  Indo-European
  Austronesian
  Bantu
  Uto-Aztecan

The gradual disappearance of hunters and gatherers
• Hunter-gatherers competing with growing and expanding
  populations of farmers may
  – Adopt agriculture themselves
  – Be absorbed into a population of farmers
  – Persist in environments too marginal for agriculture to succeed
  – Develop symbiotic relationships with neighboring groups of
    farmers

Lecture 3
Basic Concepts About the Consequences of Agriculture for
Plants and Animals

Two Critical Concepts
• Cultigen – a plant (wild or domesticated) that is being
  intentionally cultivated by humans (hunter-gatherers or
  farmers).
• Domesticate- a plant or animal whose behavior, morphology,
  and/or genetics have been modified to make them more
  beneficial to humans. However, those modifications may be
  intentional or an inadvertent consequence of human behavior.

Domestication of Plants (I)
• Literally thousands of species have been domesticated over
  the last 10,000 years.
• Some of the earliest may have been utilized as containers or
  medicine/drugs
  – Gourds
  – Tobacco

Domestication of Plants (II)
However, six genera of grains and tubers were domesticated
very early and are now most important for feeding the world.
  1. Wheat- Fertile Crescent (10 kya)
  2. Barley- Fertile Crescent (10 kya)
  3. Rice – Southern China (8 kya)
4. Millet – Northern China (8 kya)
5. Maize- Highland Mexico (9-7 kya)
6. Potatoes- Andean South American (7-5 kya)

**Plant** | **Where Domesticated** | **Date**
--- | --- | ---
Fig trees | Near East | 9000 BC
Rice | East Asia | 9000 BC
Barley | Near East | 8500 BC
Einkorn wheat | Near East | 8500 BC
Emmer wheat | Near East | 8500 BC
Chickpea | Anatolia | 8500 BC
Bottle gourd | Central America | 8000 BC
Broomcorn millet | East Asia | 6500 BC
Maize | Central America | 6000 BC
Bread wheat | Near East | 6000 BC
Manioc | South America | 5500 BC
Potato | South America | 5000 BC
Avocado | Central America | 5000 BC
Chili peppers | Central America | 4000 BC
Watermelon | Near East | 4000 BC
Pomegranate | Iran | 3500 BC
Hemp | East Asia | 3500 BC
Sunflower | Central America | 2600 BC
Sweet Potato | Peru | 2500 BC
Sorghum | Africa | 2000 BC
Sunflower | North America | 2000 BC
Pearl millet | Africa | 1800 BC
Chocolate | Mexico | 1600 BC
Chenopodium | North America | 750 BC
Vanilla (cultivar) | Central America | 14th century AD

**Domestication of Plants (III)**
What makes a good candidate for a domesticable plant?
1. Annual not perennial
2. Large seed or fruit size
3. Easily stored seed
4. No major competitors with human predation
5. No toxins or toxins easily bred out

**Domestication of Plants (IV)**
How can archaeologists tell if a plant remain is domesticated or wild?
1. Larger seed or fruit size or density
2. More sturdy attachments of seeds to plants
3. Thinner seed coats
4. Recovered from sites outside the natural distribution of wild varieties.

**Domestication of Animals (I)**
- Many fewer species have been domesticated over the last 10,000 years.
- Dogs appear to be a special case and were probably the earliest domesticate.

**Domestication of Animals (II)**
However, most of the earliest domesticates were large, terrestrial herbivores.
Of 148 large herbivores worldwide only 14 have been successfully domesticated- 13 from the Old World.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Where Domesticated</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>East Asia</td>
<td>13,000 BC</td>
</tr>
<tr>
<td>Sheep</td>
<td>Western Asia</td>
<td>8500 BC</td>
</tr>
<tr>
<td>Cat</td>
<td>Fertile Crescent</td>
<td>8500 BC</td>
</tr>
<tr>
<td>Goats</td>
<td>Western Asia</td>
<td>8000 BC</td>
</tr>
<tr>
<td>Pigs</td>
<td>Western Asia</td>
<td>7000 BC</td>
</tr>
<tr>
<td>Cattle</td>
<td>Eastern Sahara</td>
<td>7000 BC</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>Peru</td>
<td>6000 BC</td>
</tr>
<tr>
<td>Chicken</td>
<td>Thailand</td>
<td>6000 BC</td>
</tr>
<tr>
<td>Donkey</td>
<td>Northeast Africa</td>
<td>4000 BC</td>
</tr>
<tr>
<td>Horse</td>
<td>Kazakhstan</td>
<td>3600 BC</td>
</tr>
<tr>
<td>Silkworm</td>
<td>China</td>
<td>3500 BC</td>
</tr>
<tr>
<td>Llama</td>
<td>Peru</td>
<td>3500 BC</td>
</tr>
<tr>
<td>Bactrian camel</td>
<td>Southern Russia</td>
<td>3000 BC</td>
</tr>
<tr>
<td>Dromedary camel</td>
<td>Saudi Arabia</td>
<td>3000 BC</td>
</tr>
<tr>
<td>Honey Bee</td>
<td>Egypt</td>
<td>3000 BC</td>
</tr>
<tr>
<td>Banteng</td>
<td>Thailand</td>
<td>3000 BC</td>
</tr>
<tr>
<td>Water buffalo</td>
<td>Pakistan</td>
<td>2500 BC</td>
</tr>
<tr>
<td>Duck</td>
<td>Western Asia</td>
<td>2500 BC</td>
</tr>
<tr>
<td>Yak</td>
<td>Tibet</td>
<td>2500 BC</td>
</tr>
<tr>
<td>Goose</td>
<td>Germany</td>
<td>1500 BC</td>
</tr>
<tr>
<td>Alpaca</td>
<td>Peru</td>
<td>1500 BC</td>
</tr>
<tr>
<td>Reindeer</td>
<td>Siberia</td>
<td>1000 BC</td>
</tr>
<tr>
<td>Turkey</td>
<td>Mexico</td>
<td>100 BC-AD 100</td>
</tr>
</tbody>
</table>

**Domestication of Animals (III)**

**What makes a good candidate for a domesticable animal?**
1. Short lifespan
2. Quick maturation period
3. Large number of offspring
4. Meat
5. Secondary Products (Milk, eggs, leather, bones, hair)
6. Amenable Social Structure and Behavior to Humans
Domestication of Animals (IV)
How can archaeologists tell if an animal remain is domesticated or wild?
1. Body Morphology (often smaller)
2. Population Demography
3. Site Assemblages
4. Animal Burials
5. Diets
6. Distribution

- Cultigen – a plant (wild or domesticated) that is being intentionally cultivated by humans (hunter-gatherers or farmers).
- Domesticate- a plant or animal whose behavior, morphology, and/or genetics have been modified to make them more beneficial to humans. However, those modifications may be intentional or an inadvertent consequence of human behavior.

Important Point
- Domestication is NOT Unique to Humans!
- It is a form of Mutualistic Co-Selection often found in Nature

Co-evolution
- The mutual evolutionary influence between two species. Each party in a co-evolutionary relationship exerts selective pressures on the other, thereby affecting each others’ evolution.

Mutualism
- The a co-evolutionary relationship between two species in which the reproductive success of both benefit from the predation of one by the other. Therefore, traits encouraging the relationship are selected for in both species.
- Leaf-cutter ants and gonglidia fungus
- Acacia Trees and Ants

Were Humans Genetically Selected by the Plants and Animals they Domesticated?
Early Neolithic Agriculture in Europe
- Lactose intolerance is an inability to digest and absorb lactose (the sugar in milk) that results in gastrointestinal symptoms when milk or products containing milk are drunk or eaten.

Hunter-Gatherer behaviors that could have inadvertently started a mutualistic relationship with plants and animals
- Animals
Most of the changes in humans caused by domestication are behavioral, social, and cultural - not genetic.

Lecture 4
Archaeological Investigations and Theories for the Causes of Agriculture

Archaeological Investigations of the Origins of Agriculture
• Interdisciplinary Approaches - began in 1950s. Large, regional scale archaeological approaches involving teams of specialists (botanists, zoologists, palynologists etc.).
  – Robert Braidwood - Jarmo Iraq
  – Scotty MacNeish (Tehuacan Valley)
  – Kent Flannery - (Oaxaca)

Archaeological Advances in Investigating the Origins of Agriculture
• Pollen Sequences
• Flotation
• Direct Radiocarbon Dating
• Scanning Electron Microscopy
• DNA Extraction
• Bioarchaeology

Palynology
• Most plants produce large quantities of pollen which
  – Can be identified to family, genus, or species,
  – Is readily transported through the air (pollen rain),
  – Is preserved in waterlogged sediments (bogs, springs, lake sediments)

PALYNOLOGY is used to identify vegetation changes associated with the beginning of agriculture
  – Appearance of domesticated plants
– Forest clearance
• Anthropogenic burning

**Plant Macrofossils**
• Remains that can be observed with the naked eye
  – Seeds, nuts and other plant remains
• Recovered by flotation technique. Can also be recovered from human coprolites and as residues on ceramics

**Flotation**
A method used to recover plant macrofossils by sieving soil from an archaeological feature manually in a water bath in order to allow organic material, such as charred seeds, wood and bone, to float to the surface and be gathered with a sieve.

**Scanning Electron Microscopy**
• The scanning electron microscope (SEM) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons.

**Accelerator Mass Spectrometry (AMS)**
• A method of radiocarbon dating using an accelerator to directly count the individual isotopes of the carbon sample.
• Can be used to accurately and directly date very small samples of carbon (plant macrofossils).

**Recommended Sample Sizes for Radiocarbon and AMS Dating**

<table>
<thead>
<tr>
<th></th>
<th>(Grams)</th>
<th>Ams (Milligrams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>10–30</td>
<td>20–50</td>
</tr>
<tr>
<td>Wood</td>
<td>15–100</td>
<td>20–100</td>
</tr>
<tr>
<td>Bone/antler</td>
<td>200</td>
<td>2–10 grams</td>
</tr>
<tr>
<td>Shell</td>
<td>20–100</td>
<td>50–100</td>
</tr>
</tbody>
</table>
Using Bioarchaeology to study the origins of agriculture
The transition from foraging to agriculture can be detected biarchaeologically four ways.

7

8 • The recovery of food remains in coprolites (preserved feces) and stomach/intestinal contents
• Changes in Dentition - Cavities indicate a starchy diet/ heavy dental wear - a foraged diet.
• Changes in nutrition, health, work effort can be detected in human bone.
• Changes in the isotopic composition of human bone - Ancient diets can also be reconstructed by analyzing the carbon and nitrogen stable isotopes preserved in human bone.

Bone and Stable Isotopes
You Are What You Eat
• Human bones reflect the isotopic ratios of plants ingested during life.
• We reconstruct the dietary importance of plants by measuring the ratio of carbon isotopes in bone collagen.
  – A diet rich in C4 plants (maize), can produce bones with a higher ratio of 13C to 12C.
  – Humans who consume large amounts of meat or marine food have a higher ratio of 15N to 14N.

DNA Extraction
• Detecting the evolution of a domesticated plant or animal by comparing its genetic makeup with that of other wild and domesticated varieties

Theories to Explain the Origins of Agriculture
• Old Approaches
  – Oasis Hypothesis
  – Hilly Flanks Theory
• New Approaches
  – Population Pressure Theory
  – Co-selection Hypothesis
  – Ideological Theories
  – Multicausal Theories

Oasis Theory
Proposed by V.G. Childe. It argues that domestication arose as people, plants, animals were forced to congregate around water sources during the arid years following the Pleistocene.
In this scenario, agriculture developed because people learned/discovered how to cultivate plants and herd animals.

**Oasis Theory**
- Climates dry at the end of the Ice Age
- Force people, plants, and animals in close proximity near water sources
- People have a chance to observe and manipulate plant/animal interactions (planting, irrigation, herding)
- Agriculture inevitable result

**Oasis Theory**
- Problems
  - Climate important factor but not directly correlated.
  - Hunter-Gatherers have expert knowledge of plants and animals.
  - Earliest evidence of agriculture is not along Nile (as predicted) or similar oasis spots

However
- Climatic Change may be associated the earliest case of agriculture

**Vere Gordon Childe**  
(1892-1957)

**Neolithic Revolution**
Term coined by V. Gordon Childe to describe the origin and consequences of farming (stock raising and agriculture), allowing the widespread development of settled village life.

**Hilly Flanks Theory**
Proposed by Robert Braidwood based on excavations in Iraq (Jarmo). Claims that agriculture arose in areas where the wild ancestors of domesticated plants and animals naturally occurred, attributing the appearance of agriculture to human efforts to increase the productivity and reliability of their food base, coupled with culture being ready to accept and agricultural lifeway.

**Jarmo**
An archeological site located in the foothills of the Zagros Mountains of Northern Iraq. It is one of the oldest known agricultural communities in the world, dating back to 7000
BC. Jarmo lies at an altitude of 800 meters above sea level in a belt of oak and pistachio woodlands.

**Hilly Flanks Theory**
- Implications
  - Earliest agriculture should be found in the areas where the wild ancestors of domesticates occur naturally
  - Should be preceded/ accompanied by technological and social changes such as development of grinding stones, sedentism, storage, etc.
  - Agriculture occurred because people were culturally and socially ready to accept

**Hilly Flanks Theory**
- Successes
  - Seemed to explain earliest agriculture in areas such as Fertile Crescent/highland Mexico
  - preceded/ accompanied by technological and social changes such as development of grinding stones, sedentism, storage, etc.
- Problems
  - Why do agriculture where plants and animals naturally occur?
  - Why are people were ready to accept agriculture at that time?

**Jack Harlan's experimental wild wheat harvest**

**Theories to Explain the Origins of Agriculture**
Could gather 1 kg of seed per hour, enough seed in 3 weeks to feed a family for a year!

**Food Crisis Theory**
Proposed by Mark Cohen- attributes the origins of agriculture to pressure on food resources caused by population growth worldwide.
Predictions: Agriculture should only develop after
- evidence of population growth and sedentism.
- evidence of use of a broader array of resources by hunter-gatherers

Problem- Why does population reach critical point in different locations only in the last 10,000 years?

**What came first- agriculture or population growth?**
Density-Equilibrium Theory  
(mixture of oasis and food crisis theories)  
Proposed by Binford- attributes the origins of agriculture to population pressure in favorable environments that resulted in emigration to marginal lands where agriculture was needed to sustain productivity.  
Problem – many of the “favorable environments” of the Ice Age are now unavailable for archaeological investigation.

Coevolutionary Theory  
Advocated by David Rindos. The origins of agriculture are a natural result of natural evolutionary processes between humans, and domesticated plants, and animals leading to the development of mutualism.  
Prediction: Coevolutionary relationships should be the earliest signs of agriculture.  
Problem: Why did mutualistic relationships evolve only after the Plesitocene?

Social Competition Theories –  
Proposed by Barbara Bender and Brian Hayden- The theory that agriculture developed as a means to allow status-seeking individuals to accumulate food surpluses as a means of acquiring prestige, building social alliance, competitive feasting, and extortion.

Social Competition Theories –  
Predictions:  
Agriculture should develop in environmentally rich, not poor areas.  
Earliest domesticates may be cultivated because of non-food values (i.e., alcohol, narcotic).  
Signs of Social Complexity, Wealth (trade), and status-prestige seeking should precede agriculture.  
Problem: Why did social change occur in multiple cultures only in the last 10,000 years?

Ideological Theories –  
Proposed by Jacque Cauvin and Ian Hodder- The theory that agriculture developed as a consequence of changing perceptions of humans as a part of nature to dominating nature. Reflected in religious ideology.
Prediction: Changes in ideology as evidenced in religious symbols and agriculture should precede agriculture. Problem: Why did ideological change occur in multiple societies only in the last 10,000 years?

**Multicausal Theories** –
Proposed by Flannery- The theory that agriculture developed as a consequence of multiple interrelated factors including population growth, climate change, co-selection, social and ideological change. Problem: Does this really explain anything?

**Critical Prime Mover Forces Suggested to have Caused the Development of Agriculture**
- Progress/Invention
- Climatic Change
- Population Pressure
- Broad Spectrum Resource Use
- Co-selection
- Social Prestige
- Religious Ideology

**Test Implications- Which comes first?**
- Co-selection Theories
  – Domestication
- Culture Change Theories (hilly flanks, ideological, social change
  – New inventions
  – Culture complexity (ranking, prestige)
  – New Religious Beliefs
- Stress Theories (oasis, food crisis, and density equilibrium)
  – Climatic Stress
  – Population Pressure (sedentism)
  – Broad Spectrum Resource Use

1

**Lecture 5**
Paleoenvironmental Context

**Definitions**
- The Pleistocene is the epoch from 1.8 million to 10,000 years
BP covering the world's recent period of repeated glaciations (ice ages).

- The Holocene is a geological epoch which began approximately 10,000 years ago (about 8000 BC and continues to the present.

**Milankovich Theory**

Sawtooth pattern predicted by Serbian mathematician

<table>
<thead>
<tr>
<th>Orbital Variable</th>
<th>Description</th>
<th>Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procession of Equinoxes</td>
<td>How closely equinoxes and solstices correspond w/ earth’s perihelion and aphelion.</td>
<td>19 and 23 k</td>
</tr>
<tr>
<td>Orbital Eccentricity</td>
<td>The departure of earth’s orbit from a perfect circle.</td>
<td>100 ky</td>
</tr>
<tr>
<td>Tilt Angle</td>
<td>The angle between the earth’ rotation axis and plane of orbit.</td>
<td>40 ky</td>
</tr>
</tbody>
</table>

Calculated variations in the amount of solar radiation received by earth over the last million years

Variation attributable to three fluctuations in earth orbital geometry

**Marine Biostratigraphy**

- Ocean floors contain unbroken stratigraphic sequence of the last several my. Sediments can be cored from research vessels.
- Cores can be dated by paleomagnetic dating.
- Oceans sediments preserve the fossils shells of microscopic
organisms (foraminifera).
- The ratio of O16 to O18 in these shells reflect ocean temperature at the time that organisms lived.
  - O16 is lighter and more readily evaporated- tends to concentrate in glaciers and lakes.
  - O18 is heavier, oceans become richer in O18 during glacial.
- Reveal characteristic sawtooth pattern of about 100 ky patterns of gradual cooling, marked by rapid warming.

**Important Note: Milankovich Theory proves that the Holocene Epoch is only the last interglacial cycle.**
We still live in the Ice Age!

**Unpredictability of the Ice Ages**
- Intensity and duration of climatic events is influenced by unique events (i.e., volcanic eruptions, land mass at high latitudes, comet dust).
- Also influences by the degree to which Milankovich cycles coincide or resonate.
- Short term cycles, not explained by orbital geometry also occur in ice cores.

**Ice Cores**
- Polar Ice Sheets in Greenland and Antarctica form annual deposits of winter and summer ice. Can be read back to 40 kya like tree-rings.
- Air bubbles trapped in ice can be analyzed for indicators of climatic change (carbon dioxide, oxygen isotopes, methane).
- Reveals short-term, millennial (1-1.5 ky) cycles not predicted by orbital geometry (Dansgaard-Oeschegger cycles)
- Cycle can be marked by rapid rises and drops of temperature (5-8° C) within a few decades.

**Example of the Younger Dryas**
- At the end of the last glacial cycles (16-13 kya) temperatures warmed, and glaciers retreated almost to modern standards.
- Between 13-11 kya, climate shifted back to full glacial circumstances (Younger Dryas)
- During event, temperatures in temperate regions may have dropped as much as 15°C (27°F) within a single decade.
- Between 11 and 8 kya climate gradually returned to regular interglacial conditions.
**Environmental Characteristics of the Pleistocene (1)**
- Temperature: long periods (100 ky) of temperatures colder than today (10° C), separated by short bouts (10 ky) of warm temperature.
- Climate: generally climate much more variable from year to year (volatility), but relatively less variable season to season (equability).

**Environmental Characteristics of the Pleistocene (1)**
- Glaciers
  - Long periods of glacial advance (glacials), separated by periods of glacial retreat (interglacials)
  - Alpine: mountain glaciers, Sierra Nevada, Rocky Mountains
  - Continental: like present day Antarctica and Greenland, much of earth surface covered with ice sheets up to 1 mile thick,

**Environmental Characteristics of the Pleistocene (3)**
- Water Level
  - Lower ocean levels correspond with glaciers. Sea levels as much as 120m lower than today.
  - Higher lake levels and more numerous lakes *generally* correspond with glacials
- • Pluvials: periods of high lake levels
- • Interpluvials: periods of low lake levels

**Environmental Characteristics of the Pleistocene (4)**
- Land Exposure
  - Lower sea levels expose large areas of continent currently under water: examples Berengia, English Channel, Sahul
- • Lakes
  - Cover many areas of continent now exposed; examples Lakes Bonneville and Lahontan

**Environmental Characteristics of the Pleistocene (5)**
- Vegetation: during glacial and pluvials
  - Plants found in communities that no longer exist
  - Generally, most species found at
  - • lower elevations and
  - • lower latitudes
  - Note Pleistocene Relict Communities
Environmental Characteristics of the Pleistocene (6)
• Fauna-
  – Small animals- like plants, found in communities that no longer exist, but generally found at lower elevations and lower latitudes during glacial/pluvials.
  – Large Mammals- Whole suite of now-extinct fauna, many much larger than closest living relatives (mammoths, saber-tooths)
• Many found in environments and communities where they do not occur today

Pleistocene Overkill
Did the extinction of megafauna cause agriculture?

Was Agriculture Even Possible in the Pleistocene?
• Ice Age Environments were too
  – Deprived in CO2 to encourage the growth of annual plants,
  – Radically unstable to allow humans to stay in one place to farm.

Did Climatic Change Cause the Origins of Agriculture?
• Episode of Younger Dryas
  – Younger Dryas - a brief (approximately 1300 ± 70 years) cold climate period at the end of the Pleistocene between approximately 12,800 to 11,500 years. The period saw a rapid return to glacial conditions in the higher latitudes of the Northern Hemisphere
• Altithermal- an extremely warm period during roughly the interval 9,000 to 5,000 years B.P. The period witnessed extremely arid conditions in much of western North America but wet conditions elsewhere.

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Lecture 6
Broad Spectrum Foragers

Broad Spectrum Revolution
• proposed by Kent Flannery, suggested that that the emergence Agriculture was prefaced by increases in dietary breadth among foraging societies. The subsistence base broadened to
include more fish, small game, water fowl, invertebrates like snails and shellfish, as well as previously ignored or marginal plant sources.

• Mesolithic – The period of time of broad spectrum hunter-gatherers in Europe, North Africa, and parts of Asia between the end of the Pleistocene and the introduction of farming.
• Archaic – The term used for broad spectrum hunter-gatherers in the Holocene of the New World before the introduction of farming.

Possible Explanations
• Increased Availability/ Greater Familiarity
• Invention/Diffusion
• Resource Depression
  – Environmental Decline
  – Population Growth
• Food Storage/ Security
• Social Intensification
  – Private Property
  – Prestige-Social Relations (BEER!!)

Changes associated with Broad Spectrum Economies (1)
• Evidence of reduced mobility and greater sedentism
  – Middens
  – Burials/ cemeteries
  – Food storage
  – houses

Changes associated with Broad Spectrum Economies (2)
  – Transhumance – a strategy of regular seasonal mobility practiced by hunter-gatherers and pastoralists wherein groups seasonally move between different environments.
  – Sedentism – Living in permanently (year-round) in villages or settlements.

• Midden – An accumulation of waste and trash near a dwelling on an archaeological site. Usually a marker of prolonged habitations.
• Tell – A very large midden occupied over a long period of time
• Shell Midden – A mound of shells accumulated from human collection, processing, consumption, and disposal of shellfish
found along rivers and coasts. Usually dates to the Holocene and associated with broad spectrum foraging.

**Emmeryville Shellmound**

**Changes associated with Broad Spectrum Economies (2)**

- **Technological.**
  - Appearance of new technologies intended to facilitate the use of new resources.
- **Microliths**
- **Pottery**
- **Ground Stone Tools***

**Microliths**

- Microliths were produced (from the end of the Ice Age until the introduction of agriculture and are found throughout Europe and Asia. A microlith is a very small stone tool, snapped from small blades and were used as composite tools, such as:
- Sickle—a tool for cutting the stalks of cereals, especially wheat and emmer. In the prehistoric Fertile Crescent, sickles were usually stone blades set in a wood or antler handle.

**Pottery**

Jomon – Mesolithic Culture
Of Japan dating between 14 8 kya. Associated with some of the earliest known pottery in the world.

**Ground Stone Tools**

Stone Tools produced by pecking, grinding (rather than chipping) hard, stones. coarse-grained tool stone, such as basalt, rhyolite, granite, or sandstone.

- **Handstone / Milling Stone**
- (aka mano/metate, quern)
  - a ground stone tool usually used for processing grain, tubers, nuts and seeds. The milling stone is the larger, slablike, stationary surface against which the handstone is used.

**Diet Breadth Model**

**aka Prey Choice Model**

- Ranks resources by ratio of calories to handling time.
• Adds Search time (abundance) as the variable.
• Predicts whether a forager will take or ignore and encountered resource.

Predictions of the Diet Breadth Model
- High ranked foods should always be taken
- Whether lower ranked food taken depends on the abundance of higher ranked item, not its own abundance
- A decline in the abundance of high ranked foods can cause the diet breadth to expand to include lower ranked foods

Intensification
• Population growth can cause further diet broadening and technological change.
• This in turn can cause further population growth.
• Cycle is called intensification
• Can lead to Agriculture

Lecture 7
The Origins of Agriculture in the Fertile Crescent

Fertile Crescent
An upland zone in southwest Asia running from the Levant to the Zagros Mountains, including portions of modern Israel, Lebanon, Syria, Turkey, Iraq, and Iran.

Jack Harlan’s experimental wild wheat harvest
• Rachis–the stem that holds the seed to the stalk in wheat and other plants.
• Glume- the tough seed cover of many cereal kernels
• Shattering- a seed dispersal mechanism of many grasses.

15 kya - Climate and Vegetation very similar to California!

Early Epipaleolithic
(20 -14 kya)
• Culture- Kebaran
• Technology- microliths, occasional ground stone
• Most sites – small, open, faunal remains common, plant remains rare
• Exception- Ohalo II

Desert Kites- Large rock features used for driving gazelle
Ohalo II
• Dates @ 20 kya.
• Located on Pleistocene lake margin.
• Cluster of six ephemeral huts, hearths, and human grave.
• Wide range of plant and animal remains present.

Ohalo II
• Broad Spectrum Foragers already established 20 kya.
• Using a wide variety of food resources, INCLUDING wild ancestors of domesticates.
• Pattern appear stable for 7000 years!

13 kya
Younger Dryas (12.8-11.6 kya)

Natufian- Archaeological culture of the western Fertile Crescent dating from 14.5 to 11.6 kya and consisting of the first settled villages, trade goods, and intensive use of wild wheat and barley

Late Epipaleolithic
(14 -11.6 kya)
• Culture- Natufian
• Technology- microliths (sickles), abundant ground stone (milling stones and mortars)
• Most sites – sedentary-semisedentary occupation sites with rock-lined pithouse
• Typical Site- Ain Mallaha (Eynan)

Ain Mallaha (Eynan)
• Dates @ 12-10 kya
• Located in Fertile Crescent.
• Three different stratigraphic occupations
• Sedentary village (200-300 people)
• Broad spectrum of resources but intensive use of wild cereals

Large Public Structure
Ain Mallaha
• Broad Spectrum Foraging economy continues.
• But increased specialization on harvest of wild cereals.
• Development of sedentary villages, long distance trade.
• Few signs of domestication yet.
Early Holocene (9.5 kya)
Early Aceramic Neolithic
(11.6 – 10.8 kya)
• Culture- Prepottery Neolithic A (PPNA)
• First definite evidence of farming
• Technology- new lithics (one piece arrowheads)
• Most sites – sedentary-semisedentary occupation sites with substantial structure
• Typical Sites Jericho, Abu Hureya

Jericho
• Longest known occupation in the world
• Contains 2.5 ha PPNA/B settlement

Çatalhöyük

Test Implications- Which comes first?
• Co-selection Theories
  – Domestication
• Culture Change Theories (hilly flanks, ideological, social change
  – New inventions
  – Culture complexity (ranking, prestige)
  – New Religious Beliefs
• Stress Theories (oasis, food crisis, and density equilibrium)
  – Climatic Stress
  – Population Pressure (sedentism)
  – Broad Spectrum Resource Use

Implications of the Development of Agriculture in the Fertile Crescent
• Sedentism, population growth, and social change (?) precede domestication
• Domestication occurs after major climatic stress (Younger Dryas), although YD may have prompted
  Evidence of domestication becomes common AFTER cultigens appear outside of their area of natural occurrence

Lecture 8
Origins of Agriculture in Highland Mesoamerica (8.8-2.8 kya)
Mesoamerica- term applied to geographic region of central and southern Mexico and Northern Central America (Guatemala, Belize, Honduras)
Mesoamerica Agriculture
- Domesticated more than 100 species of plants (maize, beans, squash, chile peppers, avocados, tomato, among many others)
- Few domesticated animals (chihuahuas and turkeys)
  - Most suitable ungulate species went extinct at the end of the Pleistocene
- Most important domesticated crop was maize

Theories for the Evolution of Maize
- Two Possibilities for Evolution of Maize
  - Evolved directly from extinct ancestor
  - Diverged from close grass relative (teosinte)
- Molecular evidence shows that maize developed from a wild annual teosinte.
- Teosinte- a tall annual grass, native to Mexico and Central America that is ancestral and the closest living relative of maize.

Theories for the Evolution of Maize
- Maize is a thoroughly domesticated plant,
  - Tight seed mass on cob is unable to disperse without intervention of humans
  - Maize pollen from cultivated fields wipes out any nearby wild relatives.
  - Therefore, there are no examples of wild maize

The origins of Agriculture have been studied intensively in two highland valleys of Mesoamerica
- Tehuacan Valley- survey and excavations by Richard Macneish,
  - Coxcatlan Cave- stratified cave showing evolutionary development of maize
- Oaxaca Valley- survey and excavations by Kent Flannery,
  - Guila Naquitz- stratified cave showing evolutionary development of maize

Guila Naquitz and Coxcatlan
- Earliest domesticated squash and bottle gourd (10-8 kya- GN; 8-7- C)
- Maize does not appear until 6.3 kya (5.5 kya at Tehucan Cave)
- Beans do not appear until 3 kya
Hunter-Gatherer Ecology of Tehuacan and Oaxaca Valleys
(I)
– Wet Season (May to September)- abundant plant food, plenty of water,
  • Important foods
    – Mesquite Pods (lowland arroyos and stream
    – Cactus Fruit (dry alluvial fans and slopes
    – Agave Root (dry foothills)
    – Small game- rabbits, rodents, turkeys (widespread)
    – Large game- deer, peccary (widespread, but dispersed and hard to find)
  • Because of richness and dispersion of food, hunter-gatherers were highly mobile
  • However Mesquite Pods most important plant food

Hunter-Gatherer Ecology of Tehuacan and Oaxaca Valleys
(II)
– Dry Season (October to March)- limited water and food resources. Food storage may be critical.
  • Important Foods
    – Small Game widespread
    – Large Game- Concentrated around upland springs and waterholes, may be best time to hunt
    – Pinyon Nuts, Oak acorns (highland slopes)
    – Annual seeds -Corn/teosinte, amaranth
  » Best in floodplains (mesquite forests)
  » Natural stands on upland slopes
  • Because of scarcity of food and water, and availability of storable plants and game, hunter-gatherers tended to camp in uplands

Hunter-Gatherer Ecology of Tehuacan and Oaxaca Valleys
(III)
Seasonal concentrations of resources kept hunter-gatherer groups small, mobile, and dispersed, without exerting pressure on resources.
  • Seasonality- the changing availability of resources according to different seasons of the year
  • Scheduling- the process of arranging the extraction of resources according to their seasonal availability and reconciling conflicts.
  • Microband – a small family group of hunter-gatherers
Macroband – a seasonal gathering of multiple family bands

Archaeological Sequence (I)
• Ajureado Phase (<12-9 kya)
  – Few sites, mostly in uplands
  – Evidence of hunting horse, deer, antelope, jackrabbits, cottontail, small mammals, birds, turtles
  – No evidence of Plant Foods

Archaeological Sequence (I)
• El Riego Phase (9 - 7 kya)
  – Widespread sites in all environmental zones
  – First groundstone tools and basketry
  – Some cultivated plant use in uplands near wet season camps
  – Dietary remains (55% game, 42% wild plants, <3% cultivated
  – Squash and bottle gourds domesticated

Gheo-Shih
• Large, open site interpreted as a seasonal camp

Archaeological Sequence (II)
• Coxcatlan Phase (<7- 5.4 kya)
  – More groundstone tools and widespread sites
  – First evidence of food storage in winter camps
  – First evidence of maize
  – Most cultivated plant use in uplands near wet season camps, some evidence of cultivation in lowlands
  – Dietary remains (35% game, 55% wild plants, 10% cultivated plants (.squash, peppers, avocados, amaranth, maize)

Archaeological Sequence (III)
• El Riego Phase (5.4- 4.3 kya)
  – Significant Change in Settlement Pattern- Pithouse Villages (wet season camps) in lowlands
  – Maize cultivated in floodplains (mesquite forests begin to be cleared)
  – Dietary remains (25% game, 50% wild plants, 25% cultivated plants (corn, beans, squash, peppers, avocados, amaranth, bottle gourd, dog)
Archaeological Sequence (IV)
• Purron Phase (4.3-2.8 kya)
  – Permanent Villages (rectangular, above ground structures)
  – First evidence of irrigation, pottery
  – Multiple Varieties of Maize cultivated in floodplains (mesquite forests begin to be cleared)
  – Dietary remains (25% game, 35% wild plants, 40% cultivated plants (corn, beans, squash, peppers, avocados, amaranth, bottle gourd, dog)

San José Mogote
• Located on flat bottom of the Valley of Oaxaca.
• First Occupied 3.5-3.2 kya
• Largest village in area
• Irrigation, Defensive Palisades and Ceremonial Buildings
• Long Distance Trade

Implications
• Gradual Increase in Use of Cultivated Plants over time accompanied by broadening diet and technological change (Intensification)
• Domestication (co-selection) precedes sedentism and population growth.
• Domestication may have begun as a way to alleviate seasonal scheduling conflicts
• Process of maize domestication- increasing seed and cob size means increasing yields
• Critical shift comes in El Riego Phase- forager/farmers clear mesquite forests to grow corn most effectively.
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• In terms of diet breadth model, maize had become more highly ranked than mesquite.
• Evidence of domestication becomes common AFTER cultigens appear outside of their area of natural occurrence