

# Cultural Evolution

## Next Factor in Drake Equation: $f_c$

- $f_c$ : fraction of planets with intelligent life that develop a technological phase, during which there is a **capability for** and **interest in** interstellar communication
- No significant biological evolution in last 40,000 to 200,000 years (maybe 6000 yr)
- Evolutionary Takeover
  - Cultural evolution instead of biological
  - Much shorter timescale

# What is Cultural Evolution?

- No longer changes in genes (biological)
- Extra-somatic information
  - Information stored outside the body
- Changes in knowledge of group
  - Passed on by learning from others
- Allows combination of “lessons learned” from many individuals

## Example

- Culture in primates other than humans?
  - Differences in behavior of groups
- Example: Orangutans in Kluet swamp in Sumatra
  - Make and use tools (bark-stripped twigs) to get honey and seeds from fruit
  - Genetically similar group across Alas river do not
  - River too wide to cross
  - Key feature is high density: observe each other's behavior and learn

Van Schaik, Sci. Am. April 2006

# Concepts

1. Timescales
2. Origin of agriculture
3. Extra-somatic information storage
4. Tools, technology
5. Interactions: written language, cities, taxes, classes, technology
6. Interest in communication
7. World view evolution
8. Coupling between technology and world view

# Timescales

- On next slide (which we will look at in more detail later) notice the timescales
- MUCH shorter than the previous kinds of evolution
- And accelerating!

|                 |            |                          |
|-----------------|------------|--------------------------|
| Oral language   | 400,000?   | Cooperative hunting?     |
| Oral historians | 30,000?    | Traditions and Lore      |
| Clay tokens     | ~ 8500 BCE | Sumeria (record keeping) |
| Clay tablets    | ~ 3000 BCE | Business, Taxes          |
| Paper           | ~ 100      | China                    |
| Printing press  | 1456       | Europe                   |
| Radio           | 1895       | Italy                    |
| Television      | ~ 1936     | First “strong” broadcast |
| Computers       | ~ 1950’s   |                          |
| World-wide-web  | ~ 1990’s   |                          |

## Importance of farming

- The rise of civilizations all based on farming
- Understand origins of agriculture
- How likely to arise?
- Did it arise **independently** more than once?



# Origin of Agriculture

10,000 years ago within 50-100 miles of Dead Sea  
Natufian culture - well built houses & signs of rank  
Harvested wild wheat, barley - used flint sickles,  
Stone mortars, and hunted

Climate becomes hotter, drier

Overcrowding, shortages led to need for food source  
favors annuals over perennials (shorter cycle)

larger seeds in husks - easier to collect

Save, plant, harvest

Evidence: seeds in settlements of Natufians successors

Mutant: fatter, adheres to husk better

⇒ domestication, selection without forethought  
leads to rapid evolution of wheat  
and hunting decreases rapidly

Domestication (and farmers?) spread northward  
at ~ 1 km/year

Hole & McCorrison *American Anthropology*

~ April 1991

# Agriculture leads to higher level political organization

|                        | <i>Band</i> | <i>Tribe</i> | <i>Chiefdom</i>               | <i>State</i>                |
|------------------------|-------------|--------------|-------------------------------|-----------------------------|
| <b>Religion</b>        |             |              |                               |                             |
| Justifies kleptocracy? | no          | no           | yes                           | yes → no                    |
| <b>Economy</b>         |             |              |                               |                             |
| → Food production      | no          | no → yes     | yes → intensive               | intensive                   |
| Division of labor      | no          | no           | no → yes                      | yes                         |
| Exchanges              | reciprocal  | reciprocal   | redistributive<br>("tribute") | redistributive<br>("taxes") |
| Control of land        | band        | clan         | chief                         | various                     |
| <b>Society</b>         |             |              |                               |                             |
| Stratified             | no          | no           | yes, by kin                   | yes, not by kin             |
| Slavery                | no          | no           | small-scale                   | large-scale                 |
| Luxury goods for elite | no          | no           | yes                           | yes                         |
| Public architecture    | no          | no           | no → yes                      | yes                         |
| Indigenous literacy    | no          | no           | no                            | often                       |

A horizontal arrow indicates that the attribute varies between less and more complex societies of that type.

TABLE 14.1 Types of Societies

|                                   | <i>Band</i>   | <i>Tribe</i>             | <i>Chiefdom</i>           | <i>State</i>                    |
|-----------------------------------|---------------|--------------------------|---------------------------|---------------------------------|
| <i>Membership</i>                 |               |                          |                           |                                 |
| Number of people                  | dozens        | hundreds                 | thousands                 | over 50,000                     |
| Settlement pattern                | nomadic       | fixed: 1 village         | fixed: 1 or more villages | fixed: many villages and cities |
| Basis of relationships            | kin           | kin-based clans          | class and residence       | class and residence             |
| Ethnicities and languages         | 1             | 1                        | 1                         | 1 or more                       |
| <i>Government</i>                 |               |                          |                           |                                 |
| Decision making, leadership       | “egalitarian” | “egalitarian” or big-man | centralized, hereditary   | centralized                     |
| Bureaucracy                       | none          | none                     | none, or 1 or 2 levels    | many levels                     |
| Monopoly of force and information | no            | no                       | yes                       | yes                             |
| Conflict resolution               | informal      | informal                 | centralized               | laws, judges                    |
| Hierarchy of settlement           | no            | no                       | no → para-mount village   | capital                         |

# Information

Genes >  $10^{10}$  bits (or less)

Brains >  $10^{14}$  bits

>  $1400 \text{ cm}^3$  in humans



Extra-somatic information

leads to communication: information passed between individuals.

Allows **societies** to evolve.

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## Information and Intelligence

- Can we think of extra-somatic information as intelligence?
- Collective “intelligence” of the species
- But cannot be assimilated by any individual
- Collective knowledge does lead to ability to engage in interstellar communication

# Written Language

- Played key role in expanding knowledge
- Could be stored outside **any person's** body
- Developed first in Sumeria
  - Clay tokens to keep accounting
  - Clay tablets



# Tools and Technology

## Stone

|   |             |            |                     |
|---|-------------|------------|---------------------|
| — |             |            |                     |
| — | Oldowan     | 2.4        | MyrH. habilis       |
|   | Acheulian   | 1.6        | MyrH. erectus       |
|   | Mousterian  | 200,000 yr | Neanderthals        |
|   | Paleolithic | 90,000 yr  | H. sapiens (Africa) |
|   | Paleolithic | 40,000 yr  | H. sapiens (Europe) |
|   | Pottery     | 7,000 BCE  |                     |
|   | Wheel       | 6,500 BCE  | Sumeria             |

## Oldowan Tools



- OLDOWAN TOOLS (left to right): end chopper, heavy-duty scraper, spheroid hammer stone (Olduvai Gorge); flake chopper (Gadeb); bone point, horn core tool or digger (Swartkrans).

From <http://www.handprint.com/LS/ANC/stones.html>

# Acheulian



- ACHEULIAN TOOLS (left to right): cleaver stone (Bihorei oest, France); lanceolate hand ax (Briqueterie, France); large hand ax (Olduvai Gorge).

# Mousterian



- MOUSTERIAN TOOLS (left to right): cutter or point, Levallois core and point, Aterian point with base tang, double-sided scraper (various sites in France).

## Upper Paleolithic



- UPPER PALEOLITHIC TOOLS (left to right): biconical bone point, Perigordian flint blade, prismatic blade core, Soluterean Willow leaf point, double-row barbed harpoon point (various sites in France).

# Tools and Technology

## Metal

\_\_\_ Copper Tools            4,000 BCE

Bronze Tools    2,800 BCE

(bronze is a copper alloy: arsenic, tin, ...)

Iron Tools                    1,500 BCE

Industrial Revolution

Mass Production

## Silicon

\_\_\_ Transistor    1948            U.S.

\_\_\_ Microchip    1959

Internet            1990's

# Metal Tools



Copper



Bronze



Iron

## The Importance of Iron

- Iron played crucial role because of strength
- But late because it requires very high temperatures to 'reduce' to elemental state
  - And addition of carbon to make an alloy
- In 1800 BCE, 40 ounces of silver to buy one ounce of iron!
- By 600 BCE, one ounce of silver bought 2000 ounces of iron

From The Substance of Civilization by Stephen Sass



# Uniqueness

## 1. Agriculture

At least 5 (and maybe 9) independent origins

Southwest Asia, China, Mesoamerica, Andes,  
Eastern U.S.

## 2. Written language

2-4 independent origins

Sumer, Mesoamerica, China(?), Egypt (??)

*Only* after farming

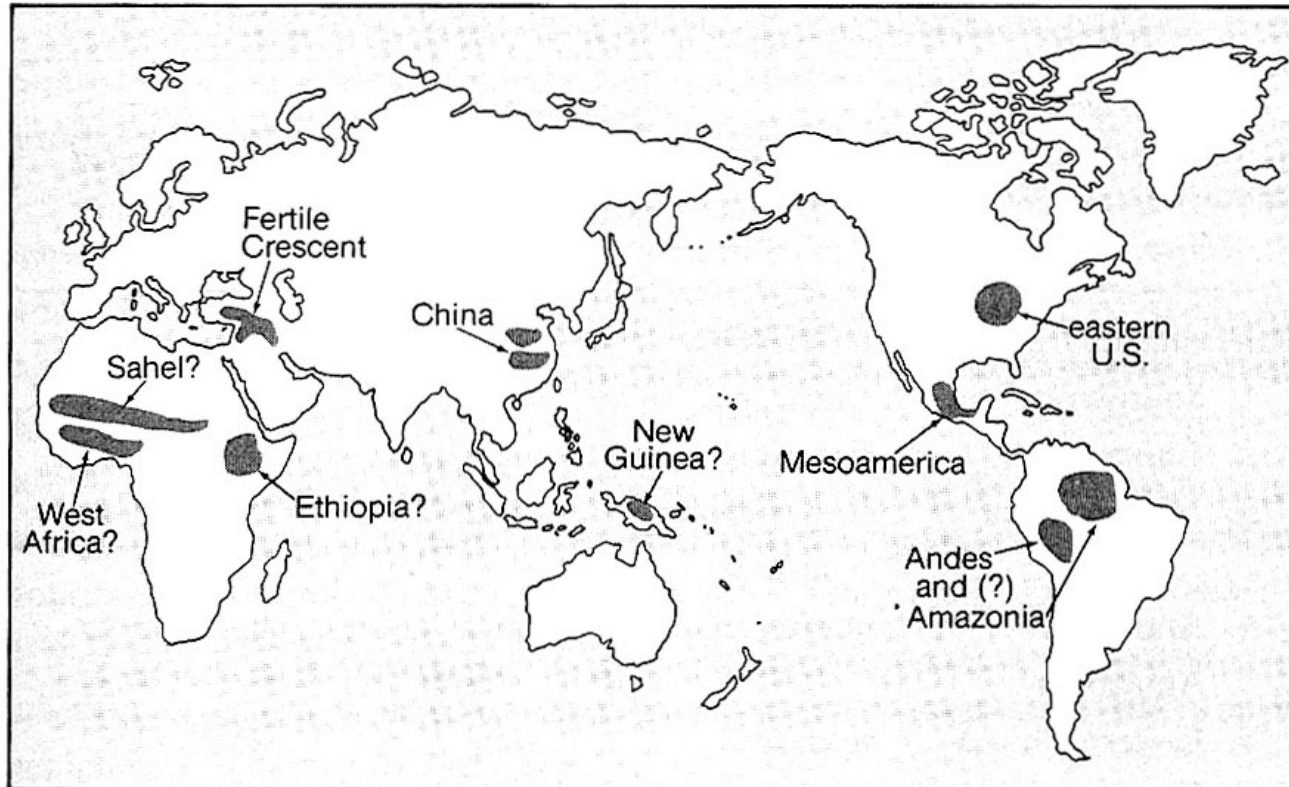


Figure 5.1. Centers of origin of food production. A question mark indicates some uncertainty whether the rise of food production at that center was really uninfluenced by the spread of food production from other centers, or (in the case of New Guinea) what the earliest crops were.

# From Guns, Germs, and Steel

Jared Diamond

I O O ■ GUNS, GERMS, AND STEEL

TABLE 5.1 Examples of Species Domesticated in Each Area

| <i>Area</i>  | <i>Domesticated</i>    |                   | <i>Earliest Attested Date of Domestication</i> |
|--|------------------------|-------------------|--|
|  | <i>Plants</i>          | <i>Animals</i>    |  |
| <b>Independent Origins of Domestication</b>                                  |                        |                   |  |
| 1. Southwest Asia  | wheat, pea, olive      | sheep, goat       | 8500 B.C.                                      |
| 2. China   | rice, millet           | pig, silkworm     | by 7500 B.C.                                   |
| 3. Mesoamerica   | corn, beans, squash    | turkey            | by 3500 B.C.                                   |
| 4. Andes and Amazonia  | potato, manioc         | llama, guinea pig | by 3500 B.C.                                   |
| 5. Eastern United States   | sunflower, goosefoot   | none              | 2500 B.C.                                      |
| ? 6. Sahel   | sorghum, African rice  | guinea fowl       | by 5000 B.C.                                   |
| ? 7. Tropical West Africa  | African yams, oil palm | none              | by 3000 B.C.                                   |
| ? 8. Ethiopia  | coffee, teff           | none              | ?  |
| ? 9. New Guinea  | sugar cane, banana     | none              | 7000 B.C.?                                     |
| <b>Local Domestication Following Arrival of Founder Crops from Elsewhere</b> |                        |                   |  |
| 10. Western Europe   | poppy, oat             | none              | 6000–3500 B.C.                                 |
| 11. Indus Valley   | sesame, eggplant       | humped cattle     | 7000 B.C.                                      |
| 12. Egypt  | sycamore fig, chufa    | donkey, cat       | 6000 B.C.                                      |

# Uniqueness

## 3. Centralized states, specialization

Several independent origins

Only after farming

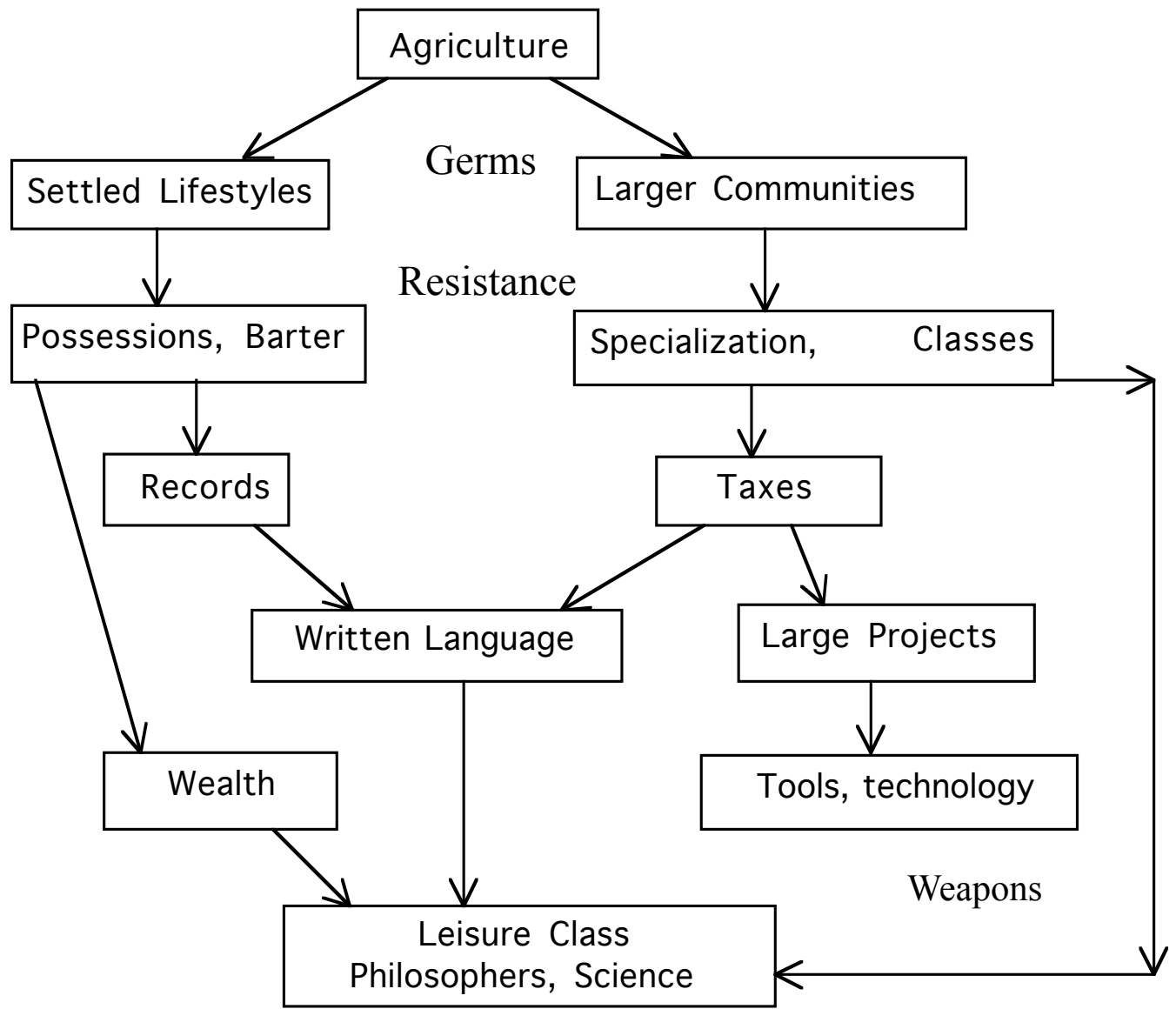
## 4. Metal use

Near East

New World (Andes) mostly decorative

## 5. Industrial Revolution, modern electronics

(no test possible - all world in contact)



Agriculture

Settled Lifestyles

Germs

Larger Communities

Resistance

Possessions, Barter

Specialization, Classes

Records

Taxes

Written Language

Large Projects

Wealth

Tools, technology

Leisure Class  
Philosophers, Science

Weapons

Domination of  
Other Cultures

# Questions

How does cultural evolution differ from biological evolution?

Does “natural selection” operate in cultural evolution?

If so, is technology an “advantageous trait”?

Is “cultural evolution” a valid description of “history”?