

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 100,000 years
- Evolutionary Takeover
 - Cultural evolution instead of biological
 - Much shorter timescale

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

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 & McCorriston *American Anthropology*

~ April 1991

Agriculture leads to higher level political organization

	<i>Band</i>	<i>Tribe</i>	<i>Chiefdom</i>	<i>State</i>
Religion				
Justifies kleptocracy?	no	no	yes	yes → no
Economy				
→ Food production	no	no → yes	yes → intensive	intensive
Division of labor	no	no	no → yes	yes
Exchanges	reciprocal	reciprocal	redistributive ("tribute")	redistributive ("taxes")
Control of land	band	clan	chief	various
Society				
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>
Membership				
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
Government				
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 → paramount village	capital

Information

Genes → 10^{10} bits (or less)

Brains → 10^{14} bits

↳ 1400 cm^3 in humans



Extra-somatic information

leads to communication: information passed
between individuals.

Allows **societies** to evolve.

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

Information and Intelligence

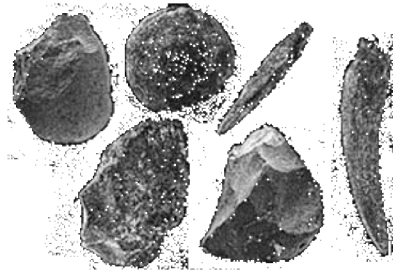
- Can we think of extra-somatic information as intelligence?
- Collective “intelligence” of the species
- But cannot be assimilated by any individual
- Collective knowledge does lead to ability to engage in interstellar communication

Tools and Technology

Stone

Oldowan	2.4 Myr	H. habilis
Acheulian	1.6 Myr	H. 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



- ACHEULEAN 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
Iron Tools	1,500 BCE
Industrial Revolution	
Mass Production	

Silicon

Transistor	1948	U.S.
Microchip	1959	
Internet	1990's	

Metal Tools



Copper



Bronze



Iron

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

From Guns, Germs, and Steel Jared Diamond

HISTORY'S HAVES AND HAVE-NOTS ▪ 99

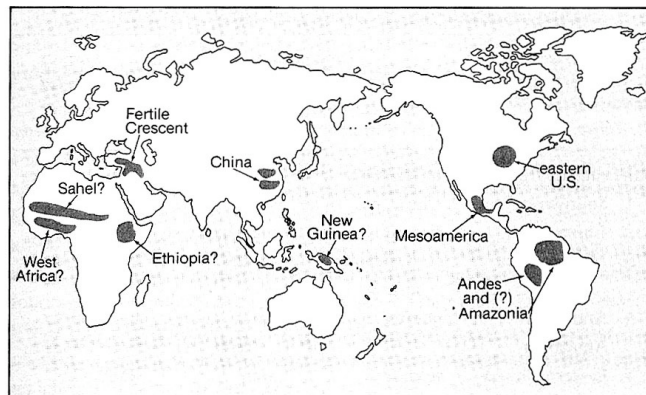


Figure 5.1. Centers of origin of food production. A question mark indicates some uncertainty whether the rise of food production at that center was really uninfluenced by the spread of food production from other centers, or (in the case of New Guinea) what the earliest crops were.

From Guns, Germs, and Steel Jared Diamond

I O O • GUNS, GERMS, AND STEEL

TABLE 5.1 Examples of Species Domesticated in Each Area

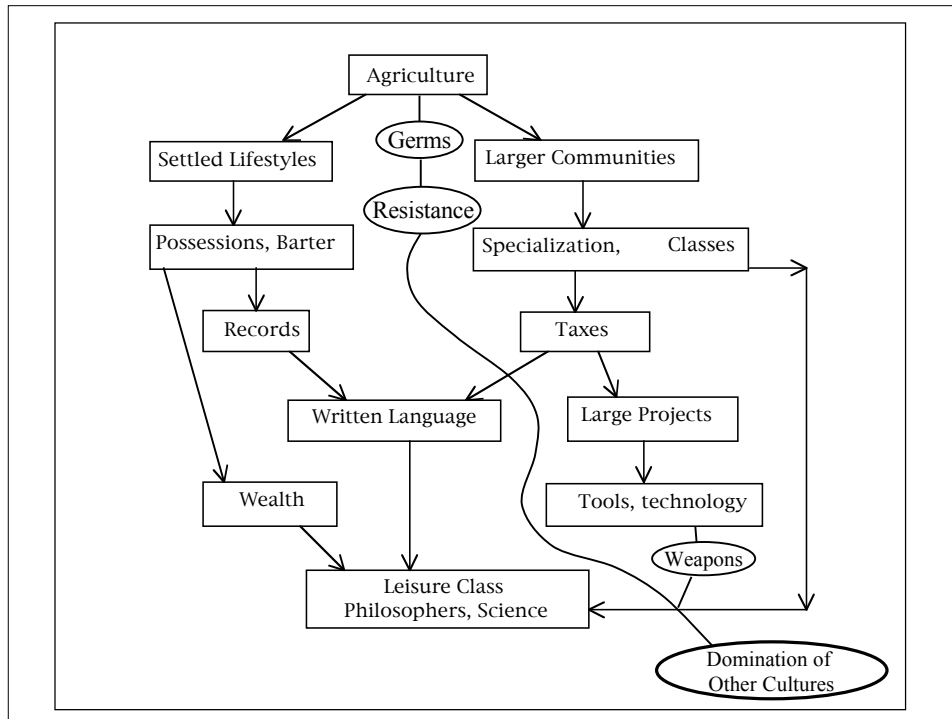
Area	Domesticated		Earliest Attested Date of Domestication
	Plants	Animals	
Independent Origins of Domestication			
1. Southwest Asia	wheat, pea, olive	sheep, goat	8500 B.C.
2. China	rice, millet	pig, silkworm	by 7500 B.C.
3. Mesoamerica	corn, beans, squash	turkey	by 3500 B.C.
4. Andes and Amazonia	potato, 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.?
Local Domestication Following Arrival of Founder Crops from Elsewhere			
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)



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”?