

Announcements

- Homework due before next class:
 - Check out our web site at <http://www.as.ua.edu/ant/bindon/ant475/>
 - Respond to this week's discussion topic
 - E-mail me at: jbindon@tenhoor.as.ua.edu
 - Your name and preferred e-mail address
 - Your year and major and how you chose this class
 - A potential paper topic
- Readings other than Frisancho are available in Room 10

Human Adaptation Studies

History and Concepts

The Historical Roots

- One of the primary goals of physical anthropology is to understand human variability
 - Differences between various human populations have been interpreted in many ways throughout history
 - Interpretations always bear the cultural imprimatur of their time
 - Understanding variability as the result of adaptation to differing environmental circumstances has been popular since before Darwin

Herodotus (484 - 425 B.C.)

- Greek historian presaged many elements of later studies
 - In his work, *Historiae*, he argues for an environmental cause of variability
 - He sees human variability as a result of adaptation to differing environments
 - Portrays culture as a modifier, generator of environmental stresses
 - Empirical research to test hypotheses

Herodotus, 2

- Example of early empiricism
 - Studied a collection of skulls from Egypt and Persia
 - Tossed stones at skulls to see which broke easier
 - Egyptians resisted breaking, had thicker skulls
 - Explained that Persians historically wore caps, providing a culturally based environmental buffer, Egyptians without caps had thicker skulls to compensate.

Adaptive “Just-So” Stories

- Since the time of Herodotus, adaptive explanations have followed the same general pattern:
 - The demonstration of some kind of biological or behavioral difference between groups
 - The postulation of some kind of adaptive basis for the differences
 - The explanation draws from current notions of man's place in nature

Hippocrates (c. 460 - 377 B.C.)

- Early medical practitioner and teacher
- *Corpus Hippocraticum*, 70 treatises
 - Viewed the body as an organism and claimed that it could not be understood without an understanding of the relationship between the environment, behavior, and the body
 - Humoral system accounted for disease
 - Health was a function of the balance between blood, phlegm, yellow bile, and black bile in the body

Hippocrates, 2

- *Airs, Waters, Places*, treatise on influence of the environment on health and temperament
 - Provides comparisons of the peoples of Asia Minor with Europe and Egypt
 - Recognized two fundamental somatotypes (body build or habitus types) adapted to environment
 - Phthisic: long, thin, and choleric (Easily angered; bad-tempered; showing or expressing anger)
 - Apoplectic: short, squat, and phlegmatic (Having or suggesting a calm, sluggish temperament; unemotional)

Aristotle (384-322 B.C.)

- Greek philosopher and naturalist
 - *Historia Animalium* describes similarities between man, apes, and monkeys, attributed to position in the great chain of being
 - Argued for environmental causes of variation
 - Woolly hair of Ethiopians (Africans) due to harsh, arid climate
 - Straight hair of Thracians and Scythians due to moist air

Early views on variation

- Herodotus, among other early travelers never perceived human differences as categorical (i.e., racial), but rather as continuous
 - Early travel from place to place was by land, travelling no more than about 25 miles in a day
 - The gradation of one human group into another over such short distances belies the existence of categorical differences

Renaissance

- 14th - 17th Centuries: Transition from medieval to modern philosophy
 - From interpretations of natural phenomena based on the bible to science and empiricism
- Rise of commercial capitalism
 - Voyages of exploration and discovery lead to the perception of categorical differences between human populations

Andreas Vesalius (1514-1564)

- First modern human anatomy text: *De humani corporis fabrica libri septem*
- Notes an environmentally-mediated relationship between race and the shape of the skull
 - It seems that certain nations have something peculiar in the shape of their head. The Genoese, and more particularly the Greeks and Turks, almost exhibit a round shape. To this also (which not a few of them think elegant and consider well adapted to turbans which they use various ways) the midwives sometimes contribute at the urgent request of the mother. The Germans, indeed, have a very flattened occiput and a broad head, because the boys always lie on their backs in their cradles

Comte de Buffon (1707 - 1788)

- French naturalist and author, *Histoire Naturelle* (44 vols., 1749–1804)
- Denied speciation, but espoused microevolution
 - The differences between populations of a species (including humans) were the result of their accommodation to local environmental conditions

Buffon, 2

- Three causes for changes within a species
 - Climatic temperature takes a long time to cause differences such as skin color
 - Suggested an experiment of moving Senegalese to Denmark and seeing how long it took for them to turn white
 - Food changes the organic molecules of the body, slowly changing the organism
 - Slavery removes individuals from their native food and climate, hence causes changes through those mechanisms

Johann Friedrich Blumenbach (1752 - 1840)

- German Anatomy Professor
- *On the Natural Variety of Mankind* (1775)
 - Classified humans into five races
 - Coined the term “Caucasian” for his most favorite skull from (Asian) Georgia
 - He saw this as the primordial human type, and the other races degenerated from this type as a result of **adaptation** to different environmental conditions
 - He viewed an organism’s morphology as being environmentally modifiable, but speciation was a special creation process
 - Modification of existing species by the environment was essentially a degenerative process for Blumenbach

Chevalier de Lamarck (1744 - 1829)

- French natural historian, *Philosophie Zoologique* (1809)
 - Part of his evolutionary philosophy included organisms adapting to their environment
 - In new environment, animals develop new needs and habits
 - New behavior leads to the exercise of different parts of the body, more exercised parts grow larger
 - These changes were passed on to offspring
 - Inheritance of acquired characteristics

Samuel Stanhope Smith (1751-1819)

- *An Essay on the Causes of the Variety of Complexion and Figure in the Human Species*, 2nd Edition (1810)
 - Presbyterian minister, President of the College of New Jersey (Princeton), 1795 – 1812
 - Argued for the unity of mankind and the environmental causation of racial differences

Smith on human variation

- Smith felt that if he could account for the differences between the races through environmental causes, he could refute a polygenist origin of man and a ranking of the races
- He argued that climate affected skin color
 - Evidence: the darkening and lightening of complexion with the seasons
 - Cold air “chafes the countenance and increases the ruddiness of the complexion”

Carl Bergmann (1814 - 1865)

- German Biologist, *Über die Verhältnisse der Wärmenökonomie der Thiere zu ihrer Grösse. Göttingen Studien* III:95-108(1847).
 - Formulated Bergmann's rule
 - Body size changes to achieve an optimal volume-to-surface ratio
 - Body size tends to be greater in cold than in warm climates

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)
 - Speciation is predicated upon the concept of adaptation to the environment
 - individuals with favorable adaptations (variations) are most likely to survive and leave offspring, **Survival of the Fittest**

Evolution by Natural Selection

- Individuals with favorable variations increase in relative number from generation to generation, so greater and greater numbers within the species share the adaptations that better suit the individuals to their environment
- Over long periods of time, such successful variations (adaptations) produce differences that result in the formation of new species

Darwin on Human Adaptation

- On the Origin of Species (1859):
 - “In the future I see open fields for far more important researches. Psychology will be securely based on the foundation already well laid by Mr. Herbert Spencer, that of the necessary acquirement of each mental power and capacity by gradation. ***Much light will be thrown on the origin of man and his history.***” (1859:477, page prior to the end)

Darwin on Human Adaptation

- The Descent of Man (1871):
 - In this book Darwin defines sexual selection as accounting for variability between males and females as well as some of the differences between the races
 - Sexual Selection is natural selection on traits related to obtaining mates for sexual reproduction:
 - Ability to compete with members of the same sex for a mate
 - Increased body size, strength, cunning, intelligence
 - Attraction between the sexes
 - Large breasts, buttocks, penis, large body size

The Descent of Man (1871)

- Darwin cautions about overly adaptationist explanations in this discussion of the direction of hair on the arms:
 - According to Livingstone, the gorilla...sits in pelting rain with his hands over his head [where the hairs on the arm ward off the water]... the direction of the hair on our own arms [is not] of any use in throwing off the rain; nor, in our present erect condition, is it properly directed for this purpose.
 - It would, however, be rash to trust too much to the principle of adaptation in regard to the direction of the hair in man or his early progenitors...

The Descent of Man (1871)

- Darwin calls on sexual selection to account for differences in mental powers of males and females:
 - The chief distinction in the intellectual powers of the two sexes is shewn by man's attaining to a higher...than can woman-whether requiring deep thought, reason, or imagination, or merely the use of the senses and hands
 - Amongst...savages, there have been struggles between the males... for the possession of the females...[which] requires the aid of the higher mental faculties, namely, observation, reason, invention, or imagination
 - Consequently...we might expect that they would at least tend to be transmitted chiefly to the male offspring at the corresponding period of manhood

The Descent of Man (1871)

- And for steatopygia:
 - It is well known that with many Hottentot women the posterior part of the body projects in a wonderful manner; they are steatopygous...this peculiarity is greatly admired by the men
 - [A] woman who was considered a beauty...was so immensely developed behind, that when seated on level ground she could not rise, and had to push herself along until she came to a slope
 - [T]he Somal men are said to choose their wives by ranging them in a line, and by picking her out who projects farthest [to the rear]

A steatopygous Andaman Islands mother with child.

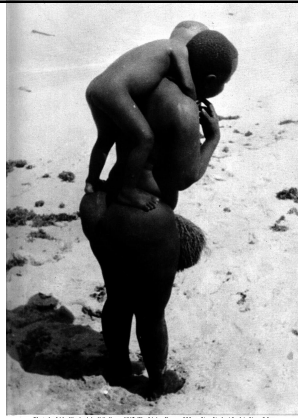


Photo by L.H. Cresson, U.S. Coast, 1905, The Living Races of Man, New York: Alfred A. Knopf, Inc. © A steatopygous Andamanese mother.

Joel Allen (1838 - 1921)

- American zoologist, The influence of physical conditions in the genesis of species. *Radical Review* 1 - 108 (1877)
 - Elaborated on Bergmann's observations to formulate Allen's Rule:
 - Extremities and appendages such as ears, limbs, etc., tend to be shorter in cold climates than in warmer ones

Rediscovery of Mendel (1900)

- Hugo de Vries, Holland; Erich von Tschermak, Austria; Carl Correns, Germany
 - Independently rediscovered the principles of particulate inheritance (chromosomal genetics) originally elucidated by Gregor Mendel in 1865
 - Reinforced the "Nature" side of the nature vs. nurture debate
 - Tended to decrease the importance of adaptation, increase significance of genes

Modeling Genes in Populations

- William E. Castle (1903) American animal breeder; Godfrey H. Hardy (1908) British mathematician; Wilhelm Weinberg (1908) German physician
 - Developed a model predicting how genes behave in populations if no adaptation is taking place--i.e., an equilibrium model.
 - Later modifications of this model predict how natural selection causes changes in allele frequencies

Franz Boas (1858 - 1942)

- German Physicist, who became a founding father of American anthropology, Boas was an emphatic environmentalist
 - Hence, naturally predisposed to adaptation as a powerful force shaping and modifying the influence of the genes
- Undertook studies of children of European migrants to the U.S.
- Summary publication in 1911
 - Differences between foreign- and American-born children documented plasticity in growth and development including traits that had long been viewed as quintessential unchanging components of race: skull measurements

Boas' migrant studies

- He also found that more advanced growth was associated with higher socioeconomic status
- Boas did not interpret the findings as evidence of adaptation, per se
 - Rather he interpreted the changes as evidence of the significant impact of the environment and its ability to mold the anatomy through the growth process
 - Further support for his "historical particularist/ possibilist school of thought"
 - Nature limits the cultural paths people may choose

Cowdry, E.V. (ed) (1930) *Human Biology and Racial Welfare*

- Contributors included extreme genetic determinists and extreme environmentalists
- Four presidents of the American Association of Physical Anthropologists
 - Ales Hrdlička, Charles B. Davenport, William King Gregory, Raymond Pearl
- Genetic Determinism
 - Hrdlička, "Human Races" and Davenport, "The Mingling of Races" depict races with rigid genetic boundaries and fixed morphology, physiology, behavior, and temperament
 - Divergence from these fixed states is explained through racial admixture, not adaptation to the environment
 - European superiority maintained in both chapters

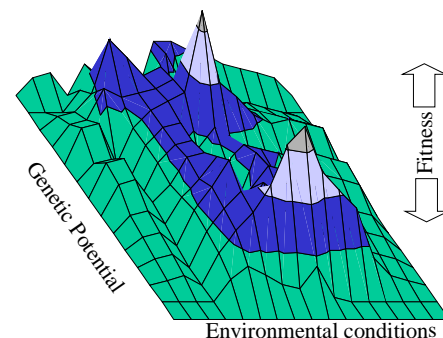
Cowdry, E.V. (ed) (1930) *Human Biology and Racial Welfare, 2*

- Environmental Determinism
 - Ellsworth Huntington, "The Effect of Climate and Weather" focuses on heat, cold, storms shaping racial morphology, physiology and behavior
 - The interpretation is still biased in favor of temperate zone (specifically European) superiority over races from other climatic zones
 - The temperate climate is seen as selecting for superior characteristics
 - Referred several times to "forms of adaptation" in human populations responding to temperature, humidity, solar UV radiation
 - Some of his conclusions on morphological adaptation to climate are still acceptable today
- While both extreme positions are scientifically dubious, the environmental position is trying to deal with process, not just taxonomy

Elaboration of Population Genetics

- Took the Hardy-Weinberg equilibrium model and showed how the various forces of evolution, including adaptation by natural selection, would affect genes in populations
 - R.A. Fisher (1930) *The Genetical Theory of Natural Selection*
 - Sewall Wright (1931) *Evolution in Mendelian Populations*
 - J.B.S. Haldane (1932) *The Causes of Evolution*

Sewall Wright: The Adaptive Landscape



Synthesis of Genetics and Darwinism

- The process of speciation through Darwinian adaptation by natural selection is formalized in modern terms based on Mendelian and population genetics
 - Theodosius Dobzhansky (1937) *Genetics and the Origin of Species*
 - Julian S. Huxley (1942) *Evolution. The Modern Synthesis*
 - Ernst Mayr (1942) *Systematics and the Origin of Species*
 - George Gaylord Simpson (1944) *Tempo and Mode in Evolution*

Anthropology and Adaptation

- **Functionalism:** The institutions of a society function to meet the needs of the individuals or sustain the social organization of the group
 - Basic premise is adaptationist, with the institutions of society providing for maintenance or expansion of groups by providing for the biological and cultural sustenance of the individuals in the group

Julian Steward

- Cultural ecological approach expounded in *Theory of Culture Change* (1955)
 - Summary work based on work done during the 1930s and 1940s
 - Focus on resource utilization--obtaining food and shelter--as the central roles of social organization
 - Level of technology works in conjunction with environmental limitations to produce the human-environment interaction
 - Culture seen as key adaptive technique among humans

Post WW II focus on Race

- Early 1950s resurgence of anthropological interest in human variability and the concept of race in response to WW II Nazi racism
- Three key works:
 - Boyd (1950) *Genetics and the Races of Man*
 - Application of genetic analysis to questions of racial differences, focusing on population adaptation
 - First real mapping and interpretation of genetic data for humans
 - Coon, Garn, and Birdsell (1950) *Races: A Study of the Problems of Race Formation in Man*
 - Views races as populations adapted to different environmental conditions
 - Chapters dealt with adaptation to excess light and heat under different degrees of humidity, to dry cold, and to cool, damp cloudiness

Washburn (1951) The new physical anthropology

- Co-hosted Cold Spring Harbor conference on the "Origin and Evolution of Man" with Theodosius Dobzhansky in 1950
 - Sought to redefine the field of physical anthropology by emphasizing the significance of the "new synthesis" of Darwin and genetics for answering anthropological questions
- Washburn outlined five goals
 - Diagnose evolutionary complexes (adaptations)
 - Describe variations in adaptations
 - Determine the underlying biology and genetics of each adaptive complex
 - Identify the conditions that would have selected for the adaptation
 - Improve the quality of phylogenetic reconstructions
- First four are explicitly adaptive, fifth implicit

The Paradigm Succeeds

- Sickle cell anemia – Malaria association worked out in the mid 1950s
 - In two papers published in 1954 Allison convincingly demonstrates that sickle cell heterozygotes have an advantage in resistance to malaria
 - Geographic relationship between the frequency of the Hb^S allele and the distribution of malaria
 - Tested Ugandan tribesmen by direct exposure to malaria

Frank B. Livingstone

- 1958 Anthropological implications of sickle cell gene distribution in West Africa, *American Anthropologist*, 60:533-562.
 - Most widely read paper in the history of Physical Anthropology
 - Argues that the frequency of HbS varies locally in a pattern that was best understood in terms of the distribution and historical duration of malaria and that this was determined by the history of the spread of agriculture
 - That is, human culture itself was responsible for the selection on this gene

The Sickle Cell Model

- The elegance of this model drove human biologists to seek additional evidence of natural selection in human populations
 - Much data collection was undertaken from 1960 – 1990 in an attempt to duplicate these findings for other adaptations
 - Their relative failure is explained by the strength of the sickle cell – malaria association
 - As Livingstone has noted on many occasions, malaria is the strongest selective force shaping the human gene pool over the past 5,000 years
 - All other adaptive systems being studied are the result of lesser selection, hence they have proved harder to demonstrate

Accumulation of Data

- 1950's: Data collected on climatic adaptation, especially to heat and cold
- 1960's: Human Adaptability Section of the International Biological Program
 - 40 Countries, 230 projects to examine the ecology of mankind
 - High Altitude: Peru, Ethiopia, Nepal
 - Cold Stress: Inuit
 - Heat Stress: Berbers in Tunisia, Mbuti in Central Africa

Adoption of New Concepts and Techniques

- Environmental physiology: stress, homeostasis, acclimatization: Heat, cold, altitude
- Growth and Development: the importance of the developmental pathway for environmental adaptation
- Genetics and Demography: Darwinian fitness as measured by population statistics

The Influence of Funding

- Very little governmental funding of human biological research prior to WWII
- During the war, the Army came in and supported E.A. Hooton and his graduate students at Harvard in measuring bodies to standardize production of clothes and equipment to be used by troops
 - Led to the accumulation of large body of data on variation in body size and shape
- Research funding from NSF and NIH trickled in during 1950s

The Further Influence of Funding

- Environmental Physiology research picked up in the 1960s and 1970s from Department of Defense
 - Concern about potential warfare in Korea, India, Israel led to funding research on cold stress, altitude stress, and heat stress to determine limits on battlefield performance
- IBP-HA was funded in part by US Public Health Service, including training grants for predoctoral students in human population biology (including me)
 - The training grants provided much more flexibility in what could be studied, but much less money
- Starting with the economic collapse of the late 1970s, government funding started to dry up and researchers were forced back to NSF and NIH for bits and pieces
 - Became increasingly difficult to fund the large multidisciplinary studies necessary for human adaptation

Concepts of Adaptation

- There are many different views on adaptation. Even within single disciplines, the concept of adaptation has different meanings
- Adaptation takes on meanings such as the process underlying natural selection in genetics and the process maintaining social homeostasis in human ecology.

American Heritage Dictionary (1994)

- Defines adaptation as:
 - The act or process of adapting. The state of being adapted.
 - Something, such as a device or mechanism, that is changed or changes so as to become suitable to a new or special application or situation.
 - *Biology*. An alteration or adjustment in structure or *habits*, often hereditary, by which a species or individual *improves* its condition in relationship to its environment.

American Heritage Dictionary, 2

- *Physiology*. The responsive adjustment of a sense organ, such as the eye, to varying conditions, such as light intensity.
- Change in *behavior* of a person or group in response or adjustment to new or modified surroundings.

Lasker

- Lasker defines adaptation as "...the change by which organisms surmount the challenges to life...If one way of functioning is adaptive, another is less adaptive." (Lasker 1969)
- For Lasker, adaptation operates in three modes:
 - Selection of the *genotype*
 - Ontogenetic modification or *plasticity* which occurs during growth and development
 - Short term behavioral and physiological changes yielding an *acclimatization* response

Lasker's Examples

- Selection favors larger chests at high altitude, large body size in cold climates, and upright posture to reduce insolation in hot climates
- Increasing body size and changing cranial morphology of migrants to the U.S. would be an example of ontogenetic modification
- Increasing hemoglobin concentration in red blood cells at high altitude and improved heat tolerance are acclimatization responses
- Shelter, clothing, and fire are behavioral adjustments to cold

Baker

- Baker defines an adaptation as "...simply any biological or cultural trait which aids the biological functioning of a population in a given environment." (Baker 1984)
- Each act of adaptation holds in it the seeds of future stress
 - The thrifty genotype that provided energetic efficiency for early Samoans produces diabetes and cardiovascular disease in modern settings

Frisancho

- Frisancho defines adaptation as "any change in an organism resulting from exposure to an altered environment that enables the organism to function more efficiently in the new environment..." (Frisancho 1993:486), but "it is applied to all levels of biological organization from individuals to populations" (Frisancho 1993:4).

Moran

- Moran says adaptation is a change "...at the level of the population due to changes in gene frequencies that confer reproductive advantage to the population in a particular environment." (Moran 1979)
- For Moran, changes which are beneficial to an individual in physiology, culture, and growth are termed adjustments

Marks

- Marks (1995) defines adaptation as the process by which a feature providing a benefit over its alternatives to an individual in a particular environmental circumstance arises
- Adaptation subsumes four processes:
 - Adaptation by natural selection
 - Physiological or behavioral plasticity during the developmental process
 - Behavioral choices that enhance individual welfare
 - Corporate behavioral choices that benefit the group

Relethford

- Adaptation is the successful interaction of a **population** with its environment
 - Operates on many levels
 - Physiologic
 - Acclimation (short-term; e.g., sweating to cool)
 - Acclimatization (long-term; e.g., increased red blood cell count in response to hypoxia)
 - Developmental Acclimatization--a change occurring during the physical growth of any organism
 - Cultural--housing, clothing, technology
 - Genetic--natural selection

Mazess

- Mazess says that "...adaptation involves...(a) relative benefit or (b) degree of necessity, relative to an environmental stress." (Mazess 1975)
 - Adaptation operates within specified **domains** at various levels of the **Biological Hierarchy**

Mazess' Concept

- Ecosystem domains
 - Diversity and Stability
 - Succession
- Population domains
 - Reproductive advantage (selective advantage)
 - Demographic optimality (age-sex structure)
 - Spatial-temporal spread (dominance, persistence)
 - Ecological efficiency (biomass)

Mazess' Concept, 2

- Individual domains
 - Physical performance: exercise and motor abilities, skills
 - Nervous system functioning: sensory, motor, and neural function
 - Growth and development: progression in rate and attainment
 - Nutrition: requirements, utilization, efficiency
 - Reproduction: survival, reproductive advantage
 - Health: morbidity, mortality, disease resistance

Mazess' Concept, 3

- Individual
 - Cross-tolerance and resistance: generalized stress resistance
 - Affective functioning: happiness, tolerance, sexuality
 - Intellectual ability: learning, expression
- Organ Systems
- Cells
- Molecules (DNA self-repair)

How would this work?

- At the **cellular level**, Sickle Cell anemia is maladaptive for the affected Red Blood Cells, causing premature aging and cell death
- At the **individual level**, however, the domains of health (disease resistance) and reproduction (survival to maturity) are positively affected if the environment includes a high risk of malarial infection
- At the **population level**, groups with a substantial frequency of the sickle cell allele (up to 0.2) would be better adapted to malarial environments

Criticism of Adaptation

- There is little consensus about adaptation today, and some like Bargatzky criticize the misuse of the concept of adaptation, especially in ecological anthropology. (Bargatzky 1984)
 - In part he is critiquing the claim of adaptation for biological and social structures simply because they exist or persist

Postmodern Criticism

- Treats evolutionary theory, including adaptation, as reductionist
 - Evolutionary biology is considered nothing more than a sexist and racist story line created by Western European White males
 - Denies any innate traits in humans, focusing on the cultural constructions of human characteristics as driven by power conflicts

Response to Postmodernism

- This is theoretically and empirically a bankrupt approach
 - Humans are a part of nature and subject to all of the applicable principles of biological organisms
 - There are many important biological universals in man (such as the capacity for language) and there is also important patterning to biological variability, much of which is related to environmental adaptation

Critical Theory Criticism

- Singer (1996) denies the validity of adaptation in both biological and cultural studies
 - He argues that the phenomenon termed adaptation is best understood as a dialectic between nature and political economy
 - Since both the organisms and the environment are constantly changing, this approach denies the possibility of adaptation
 - Rather he claims that species are transforming their environment while simultaneously it transforms them

Critical Theory Example

- Sickle Cell Anemia and Malaria in Africa
 - Singer argues that the prehistoric increase in malaria was a result of cultivation and political centralization including food tribute
 - In his view the class conflict between elites and producers led to the development of mosquito breeding sites and increased disease in the subjugated populations
 - Focus is on the power struggle as the source of change and both malaria and sickle cell are interpreted as being secondary to the hegemonic exercise of political authority

Response to Critical Theory

- While starting from truths (organisms and environments are constantly transforming one another), this critique clearly misses the point
 - To deny the reality of genetic selection in humans and the impact of cultural transformations on population growth and stability in favor of a focus on class struggle is tantamount to denying the biological existence of humans
 - Runs counter to a holistic perspective of the human experience in favor of a particular cultural focus

The Adaptationist Programme or the Panglossian Paradigm

- Gould and Lewontin (1979) criticized the overuse of adaptive “just-so” stories to account for all phenomena without critical testing of the relative benefit conferred
 - The Panglossian Paradigm takes its title from the character Dr. Pangloss in Voltaire’s novel *Candide* (1759)
 - Dr. Pangloss had a ridiculously optimistic view of life

The Panglossian Paradigm

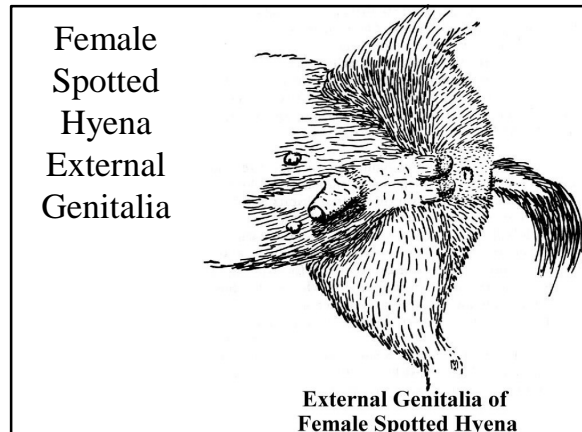
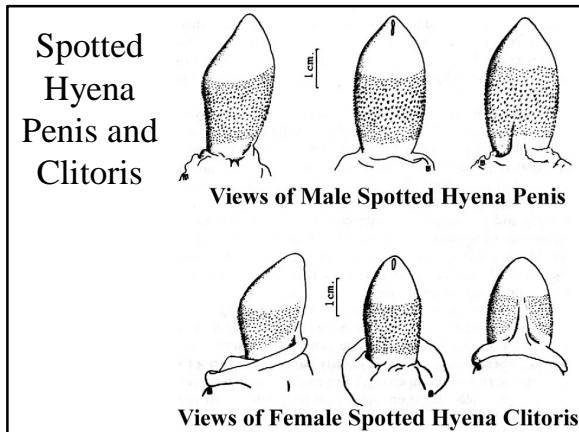
- Dr. Pangloss on his own case of syphilis:

“It is indispensable in this best of worlds. For if Columbus, when visiting the West Indies, had not caught this disease, which poisons the source of generation, which frequently even hinders generation, and is clearly opposed to the great end of Nature, we should have neither chocolate nor cochineal (a red dye made from a cactus-feeding insect)”

 - In other words, everything has a (good) purpose unto nature--all changes are for the better, or
 - “It’s All Good”

A Panglossian Example

- Gould (1983) debunks a Panglossian explanation of the similarity in form of the external genitalia of male and female spotted hyenas
 - Ancient myths claimed that they were hermaphroditic, bearing both male and female genitalia
 - Actually, the external genitalia are very similar in both sexes



A Panglossian Example, 2

- An ethological (and adaptationist) explanation suggests the similarity is an adaptation to a greeting ritual used by spotted hyenas to detect clan members
 - A closer examination suggests that the similarity in form of external genitalia results from high testosterone levels in females producing large body size (spotted hyena females are larger than males), and altering the development of external genitalia as would occur in any mammalian fetus exposed to high testosterone levels

A Panglossian Example, 3

- While the external genitalia may be used in the greeting ritual today, it is more likely that the original adaptation involved large female body size (as part of the social pattern of spotted versus the other two species of hyenas)
 - Explanations focusing on the current purpose of the feature would be likely to miss the actual adaptive functioning
 - This is most likely to happen when everything is viewed as adaptive

Stress

- Implicit or explicit in all of the definitions of adaptation is a force causing change
- Borrowing from environmental physiology, this force is referred to as stress
 - Evolutionary biologists rarely use the concept of stress, but where they do, it would be defined as the selective pressure applied to a population's genotype

Stress, 2

- Stresses are "those natural or cultural environmental forces which potentially reduce the population's ability to function in a given situation." (Baker 1984)
- Stress is "loosely used to refer to any stressful environmental condition capable of producing a physiologic response or deterioration of performance." (Frisancho 1993)

Stress, 3

- Stress is "a force or extreme situation in the environment of an organism or population that produces a deviation from homeostasis. Unless positive feedback responses can head the system away from the stress, death or disruption will tend to occur." (Moran 1979)
- To behavioral scientists, stress is seen as a generalized social or psychological process that disrupts normal body function. (Dressler 1991)

Stress and Strain

- Stress "involves some environmental stimulus that produces a reaction in a living organism that may be either favorable or unfavorable to the organism"
- Strain is "a deviation from homeostasis or dynamic steady state that requires a human response" (Little, 1995:126)

Response

- The response to strain can take many forms
 - Reduce the strain or reduce or remove the stress, returning the individual to homeostasis (this would be an adaptive response)
 - There may even be a shift to a new homeostatic level
 - Failure to reduce or remove the stress/strain
 - Chronic or acute maladaptation which leads to illness, lowered function, death

Homeostasis

- Homeostasis is the maintenance of normal function in the face of varying external conditions.
 - Example: Heat stress causes an increase in blood flow to peripheral tissue along with vasodilation to reduce body heat and return temperature to normal.

Acclimatization

- Acclimatization is the physiological adjustment an individual makes to an environmental stress or change
 - Over a period of a couple of weeks, individuals experiencing heat stress become more efficient at sweating
 - Begin to sweat faster at a lower temperature, excrete more water, conserve more electrolytes

Acclimation vs. Acclimatization

- Most researchers, including Frisancho define these as
 - **acclimation** refers to the adjustment to a single stress (e.g., heat or cold)
 - **acclimatization** refers to adjustments to multiple stressors (e.g., hypoxia, cold, radiation seen together at high altitude)
- Relethford, defines these as
 - **acclimation** is a short term response to stress occurring within hours or minutes
 - **acclimatization** is a long-term physiologic response to stress, taking from days to months

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