ANTH151 Human Evolution and Diversity
Lecture notes

Lecture 1:

Anthropology Introduction

- The study of humans – previously the study of 'primitive man' (non-western cultures)
- Human development, what makes humans human, effect of technology
- Study of cultural diversity through fieldwork
- Holistic anthropology – biocultural, evolutionary, neuro-psychological
    - Understanding humanity with a multi-dimensional, cross-cultural and comparative framework
    - Looking at present and past – how does evolution affect us today?
- Origin of and functional capacities of the human body
- Human body is shaped by values/obsessions e.g. steroids changed views/stereotypes of the physical appearance (men)
- Sport – diversity is badly misunderstood
- 'Plasticity' – human body sets as an adult e.g. learning language as a child is easier than learning as an adult

Human Coccyx (tailbone)

- Vestigial structure – ancestors had tails
    - Common/universal, present in adult, organ useful or useless, still has evidence of previous function
    - Examples: appendix, Goosebumps, toes, hiccups, wisdom teeth
    - Mammalian dive reflex – splashing cold water on face = 10-20% decrease in heart rate, vasoconstriction (blood is shut between heart and brain)
    - Non-functioning
- Atavism – reappearance of a lost characteristic (behaviour or physical structure) seen in remote ancestors, not seen in parents/recent ancestors
    - Rare, present in adult, missing from parents, trait of evolutionary ancestor
    - 'Evolutionary throwback'
    - Re-emergence of a trait from a distant ancestor
- Human embryo has a tail – up to week 8 then cell death terminate tail, immune system digests tissue
- Homologous structures – structures seen in a variety of species, come form early ancestor e.g. forearm of mammals very similar (structures different, bones similar)
    - Similar structure due to common descent but different function

Human body

- Body has host of 'kluges' – design problems e.g. throat
    - 'Sub-optimal' solutions to 'design' problems
    - Throat – breathing, eating and talking overlaps
    - Testicles – descent problem and prostate with urethra through it, men are prone to hernia (intestines pushed out of hole left by descent of testicles)
    - Eyes – nerve is in front of the retina
- Do you 'believe' in evolution?
    - Evolution is not faith, best explanation for evidence, not finished
    - Not a progress, chain of being – things improving

Lecture 2: Darwin on Natural Selection

Charles Darwin

- Voyage on the Beagle
    - Travelling by boat and stopping at successive ports for substantial periods of time allowed Darwin the opportunity to observe and analyse changes from location to location
    - Studied local fauna and flora
    - Went to Australia 3x, visited Brazil
    - 5yr journey
    - Experimentalist
    - Theorising about Natural Selection – used the metaphor of 'coral'
        - Species varied from place to place, islands with isolated species
        - Population ever increasing – survival not guaranteed, evidence of extinct animals

        - Species change – bones of related but distinct earlier forms
        - Variation – species had deep relations and shared origins
- Context of his ideas
    - How did the concept of evolution become thinkable?
        - Geographical, population mathematics, zoological, fossil and theoretical knowledge – concept of evolution middle of 19th-20th century
        - Principle of Population essay by Thomas Malthus – foundation of competition of resources, more animals in population than resources
    - Darwin's predecessors
        - Linnaeus – taxonomy, classified species
        - Buffon – theory of degeneration, imperfections in organisms
        - Erasmus Darwin – divine creation with speciation
        - Lamarck – species change for environment, will to change, inheritance, law of disuse and use, focused on adaptation
        - Lyell and Hutton – geological uniformitarianism, earth was very old ('deep time')
    - William Wells described natural selection in 1818, Patrick Matthew in 1831, Darwin wrote book but held it secret in 1844, Darwin received package from Wallace in 1858
    - 1858 – Wallace and Darwin revealed principle of evolution
    - 1859 – Darwin published Origin of Species
    - Contemporaries already considering species change, sense of time depth growing due to geology, most theorists believed in degeneration/aspirational change/catastrophism
- On the Origin of Species
    - Staggering breadth e.g. finches, pigeons – lots of evidence, gave an explanation
    - Wrote many books about animals, plants and humans e.g. earthworms, descent of humans
- Intellectual Legacy
    - Renowned for evolution – preferred 'transmutation'
    - Natural selection not widely accepted – 1875, largely neglected by biologists
    - Reluctant Revolutionary – natural selection 'confessing a murder'
    - Worried about religion and social respectability
    - Changed the shape and tenor of biology
    - Humans = animals
    - Species do not have an 'essence' – populations with variation and speciation/change over time
    - 'Fitness' – depends on situation
    - 'Evolution' = not a result of design, striving or effort
    - Unity of the origins of all species
    - Dawning recognition that we are linked to all life, unbroken tree of speciation
- Natural Selection
    - Species have significant inheritable variation
    - More individuals are born that can survive to reproduce
    - Variation affects reproductive success
    - Species adapt to ecological niches over time
    - Variation + Inheritance + Selection + Time = Adaptation (VISTA)

Since Darwin

- Darwin's work on evolution was a change-maker for the field of biology
    - Descent with modification
    - Natural Selection
    - Power of evidence
- What was the mechanism of inheritance? – Mendel
- Natural Selection as a prime cause of evolution did not become widely accepted until statistics in late 19th century and integration with genetics in the 20th century
- Genetic information is insufficient
- Netherlands (Dutch) Famine cohort study – Trans-generational inheritance

ANTH151 Human Evolution and Diversity
Lecture notes

- Epigenetics - study of changes in organisms caused by modification of gene expression rather than alteration of the genetic code itself due to environment

Evolutionary System

- Variation – interaction between system and environment = random fluctuations
- Selection – positive or negative dissipation of innovations introduced by variation
- Memory/Inheritance – ability to create correlations between ongoing dynamic patterns and past patterns
- Organisation – interplay between variation and selection alters arrangement of constituent elements
- Complexity – ability to incorporate and coordinate selective pressures

Genetic Inheritance

- DNA -- (transcription) --> RNA -- (translation) --> Protein
- 1.5% of DNA codes for proteins
- Non-coding DNA is 'regulatory' affecting gene expression
- Other molecules act on DNA info – DNA inert by itself

How fast is evolution?

- Mostly slow, at times very fast
- E.g. birds reading traffic lights, spiders making webs near street lights in Vienna

'Punctuated Equilibrium'

- Darwin focussed on gradual change and long periods of similar fossils support this
- Moments in fossil record where pace accelerates
- No inherent reason pace of evolution needs to be consistent if environment was not (and environment includes animals
- E.g. of rapid change = QLD frog-eating snakes, antibiotic resistant bacteria
- Important: 'Selection' always occurring
- Periods of stability due to stabilising selection
- Equilibrium can be punctuated by sudden change due to shift in environment or new niche/competitor/trait
- Fossil record – change = gap/missing link due to rarity of remains and consistency during equilibrium

Challenges to Darwin

- How did variation arise?
    - Gregor Mendel, 1860s – began to report research on inheritance of traits
        - Traits didn't blend (dominant/recessive), acquired traits not transmitted
        - Work rediscovered in 20th century
        - Inheritance of traits, offspring received traits from both parents, dominant traits expressed
    - Phenotype – expressed trait
    - Genotype – genetic type
- If offspring are 'blending of inheritance' – all variation should disappear through sexual reproduction
- Genetics added to understanding of mechanisms to natural selection

Discovery of DNA

- Watson and Crick drawing on the work of Franklin, first described the double helix structure of DNA in chromosomes
- DNA creates proteins and genes, other parts regulate the production of proteins
    - Tails, atavisms and homologous organs show how gene regulation can produced variation

Mutations

- DNA sequence can be: deleted, duplicated, inverted or inserted in the wrong place
- Result in some form of damage or neutral outcomes if the DNA is sufficiently buttressed
- Positive mutations are extremely rare
- DNA + mutation + natural selection = evolution
- Errors in transcription might produce unusual variants
- Variants have differential possibility of survival
- Mutated alleles might be eliminated or become dominant genotype
- E.g. mutated colouration in peppered moths

ANTH151 Human Evolution and Diversity
Lecture notes

- Remember – genetic pool also already contains variation
- Mycobacterium tuberculosis – antibiotics = selective pressure, resistance becomes dominant

Population Selection

- Natural species have inherent genetic variation including unexpressed traits
- Selection acts on phenotype but is affecting genetic variation pool
    - Evolution is a 'change of allele frequency over time'
- Variation is always present and constantly generated in populations

'Modern Synthesis'

- Variation is generated genetic mutation
- Inheritance is only through genotype
- Selection is only process of change
- Adaptation is a change in a population's genetic pool

Lecture 3: Primates – Origins and Distinctive Niche

Jane Goodall

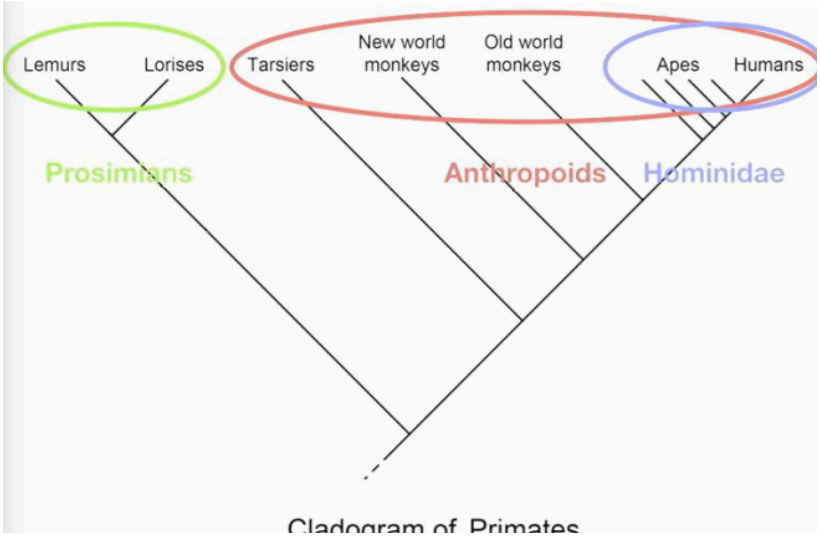
- Studied chimpanzees, observed tool use/violence/actions/feeding stations

Evidence for human evolution

- Anatomical – vestigial organs
- Genetic – similarities in genes
- Biochemical – same amino acids/proteins
- Embryological – as embryo develops
- Bio-geographical – animals clustered in space
- Comparative – relations among contemporary species

Cladistics – study of the 'tree of life'

- Adaptive radiation has produced all new species
- Clades – based on shared ancestor
- Conserved traits – kept from ancestor
- Derived traits – newly evolved
- 'Paraphyletic' category error
- Order Primate: Mostly tropical, Arboreal (strong grasping hands/feet, non-slip soles/palms, flexible spine), shift in sensory dominance from smell → sight
- Characteristics of primates:
    - Grasping foot with divergent big toe (hallux)
    - Nails rather than claws
    - Grasping hands with opposable thumbs
    - Elongated heel
    - Dominance of hind limbs in locomotion
    - Eyes rotated forward and close together (stereoscopic vision)
    - Increased brain size
    - Long gestation period relative to body weight
    - Foetal growth rate is slow relative to mother's body weight
    - Life history prolonged
    - Loss of one incisor and one premolar from tooth rows
- Why Primates? 3 Hypotheses
    - Adaptation to arboreal life
    - Adaptation to predation on small prey (eyes and fingers)



Cladogram of Primates