

Chapter 16

Darwinism and beyond

16.1 Homework

Readings – Larson, Chap 3-end

Study Questions :

- On Darwinism:
 1. What is the difference between the theory of evolution and Darwinism?
 2. How does evolution work according to strict Darwinism?
 3. Which evidence speaks in favor of Darwinism over Creationism?
 4. Which are the main objections against Darwinism?
 5. What were the alternative views on how evolution works?
- On the theory of evolution applied to man
 1. Which evidence was found concerning the history of the human species?
 2. Which are the characteristics that are often thought to radically distinguish humans from non-human animals?
 3. How were these characteristics explained by the theory of evolution?
 4. Which kind of social theory did Haeckel think the theory of evolution supports? Which kind of social theory did Wallace think the theory of evolution supports? Which kind of social theory did Spencer think the theory of evolution supports? What does it say about the application of the theory of evolution to human societies?
 5. What is Social Darwinism? Who were its main defendants? Can it be founded on the theory of evolution? Why, why not?
 6. What is “eugenics”? distinguish between positive and negative. Who were the most important advocates of eugenics at the beginning of the 20th century?
 7. What is Wilson’s sociobiology? What is evolutionary psychology? Explain the controversy about these fields.

- On the modern theory of evolution
 1. Why did the work of Galton, Weismann and de Vries help biologist to accept Mendel’s studies as important?
 2. What kind of study did Mendel conduct? Was his study intended to support hard heredity? Explain how his findings make sense when heredity is understood in terms of genes carried by chromosomes.
 3. Were “genes” always considered as material? Who was the inceptor of classical genetics? On which animals did he work?
 4. How did Haldane and Fisher manage to revive Darwinism (i.e. the idea that evolution works through natural selection)?
 5. Explain how a new species appears according to Wright.
 6. Explain how Darwin’s finches provide striking evidence for the theory of the modern synthesis.
 7. Who discovered the double helix structure of DNA? What does the fact that all animals share DNA show?
 8. How did Hamilton manage to explain cases of “altruism” in the animal realm?
 9. What is the “parasite Red Queen Hypothesis”? Why can we say that the best evolutionary strategy is to seek diversity?
 10. What is the theory of punctuated equilibria? How does it explain the gaps in the fossil record? Is it incompatible with neo-Darwinism?
 11. What is lateral gene transfer? Give examples. How does the discovery of lateral gene transfer transform our traditional view of the “tree of life”?

16.2 Introduction

The main aim of the chapter is to understand precisely what Darwinism is, which alternative theories of evolution were considered in the last two centuries, and which domain the theory of evolution can be legitimately applied to.

For this, it is crucial to understand the distinction between:

1. **The theory of evolution** – which is that species appear through descent
2. **Darwinism** – which is that evolution works through natural selection
3. **Darwinisticism** – (the word is from Morse Peckham¹) the application of Darwin’s theory of evolution beyond its original domain, i.e. species descent

→ Darwinism is one of the many theories on how evolution works. Very soon after the publication of the *Origin of Species*, the idea of evolution as the explanation for the

¹See for example his “Darwinism and Darwinisticism.” *Victorian Studies* 3 1959: 1940.

appearance and extinction of species is well accepted within the scientific community. What will remain a matter of controversy is not whether evolution occurs, but *how* it occurs, that is, what is the mechanism for it.

→ Darwinisticism is the usage of Darwin's theory for other domains than the one the theory was meant to apply to. For example, Darwin's theory has been used as a foundation of some ethical, political, or socio-economical theories.

Our aim is thus to see the history of the theory of evolution. On the scientific side, see how the scientific community's has understood evolution from Darwin to now. On the non-scientific side, see how Darwin's theory has (ab)used when applied to other domains of knowledge.

16.3 Darwinism

16.3.1 Characteristics of Darwinism

Darwinism can be characterized by the following claims:

1. **Struggle for existence** (The phrase is Wallace's) – There is constant competition between species and, even more strongly, between the individuals of a same species. Why?

- (a) **Population Increase** – any species – however low their reproduction is – produce so much offspring that it could in principle saturate the Earth – not only rabbits, elephants too...

- (b) **Scarcity of Resources** – the increase of resources (food, water etc) is much slower than the increase of the population.

→ *The result is a constant competition for means of survival, which is the struggle for existence.*

2. **Natural Selection** – the mechanism of evolution goes through the following “algorithm”:

- (a) **Endless Variations** – Variations appear in species individuals: these variations are very small, occur randomly but endlessly.

- (b) **Favorable Variations** – Some of these variations happen to be favorable, given the environment. *There is such thing as an absolutely favorable trait.* Whether some trait is favorable or not depend on the *infinitely complex relationships* that an individual entertains with its environment (which comprises not only the resources for survival, but also the other species and the other individuals within the species)

- (c) **Survival of the Fittest** – The individual possessing a favorable variation is able to have better access to means of survival (food, water, shelter) and means of reproduction (mates)
- (d) **Inheritance** – Traits are inherited, and when, favorable, a trait will be spreading more quickly than unfavorable ones. The laws of inheritance are unknown but it is clear from empirical observations that there is at least a non-trivial probability that traits are passed onto the offspring.

→ *The result is natural selection: the blind selection of favorable variations over the less favorable ones.*

3. **Divergence of character** – the mechanism of speciation

Even if the variations are very small and gradual, the result is that we have very distinct species and not a continuum of species. The reason for this is the mechanism of divergence of character:

- (a) Animals that are close to one another will compete more – they are fighting for the same resources with the same “tools”
- (b) In these circumstances, traits which give the individual a different way to get some food / water / shelter is better off
- (c) This way, the extremes in a given character are going to be more successful than any kind of middle ground
- (d) Because of this, the characters selected are the divergent ones, and speciation occurs.

For example, imagine a group of horses. They all live in a common environment including an immense sand desert and some rocky mountains. Among these horses, some will be faster on sand (which requires small hoofs) and some will be steadier on rocks (which requires large hoofs). Darwin claims that what will prove favorable in these circumstances is to have either very small hoofs or very large hoofs. Gradually, the swift horses will take over the sand desert, while the steady ones will take over the mountains. Everything in the middle (both the common ancestors and the intermediary species) is doomed to extinction. Gradually, this two kinds of horses will differ so much that no mating is possible anymore: speciation has occurred.

→ *The divergence between species comes from the fact that natural selection will favor the extremes.*

→ **Important to remember:** *within Darwinism, there is branching, and not linear progression. This means that all actual species are equally evolved. There are no species that are more evolved than others. Similarly, there is no progress in the process of evolution.*

NOTE ON SEXUAL SELECTION – sexual selection and natural selection function in the same way. Of course, what is “favorable” for sexual success may or may not correspond to

what is “favorable” for survival (typically, bright colors are good for finding a mate, but also to get caught by a predator). That said, there is no fundamental differences between the two processes.

16.3.2 Darwin’s arguments for Darwinism

Analogy between Natural Selection and selection in domestic Breeding – The main argument that Darwin gives in the *Origin of Species* is an argument by analogy. The analogy is between natural selection and artificial selection in domestic breeding.

Domestic Breeding	Natural Selection
No matter how pure a race is, tiny variations occur at every new generations	Tiny variations must occur at every generations
No matter how tiny the variations are, careful selection can produce great changes	Tiny variations can add up to produce great changes when consistently selected
At the end of the process, the races are so different that breeders cannot conceive that races are but varieties all descending from a common ancestor now disappeared	At the end of the process, the species are so different that naturalist cannot conceive that species are but varieties all descending from a common ancestor now disappeared

→ *The most important goal of the analogy is to defend the idea that formation of species through evolutionary process is not impossible (Darwin never he proved it is true). If humans can make such a big difference by selecting traits, then surely nature can make a big difference in selecting in a slow and gradual manner over very long periods of time.*

Evidence – Darwin does not have direct evidence for his theory (he did not produce a new species). Instead, he provides some evidence to show the *explanatory power* of his theory.

He notices that the theory of Evolution with descent explains:

- the homologies (similarity of structure) between animals in different species / genera
- the similarities between embryos – this argument will be used (and abused) by Haeckel later on
- the distribution of species on Earth – Wallace will become the champion of biogeography, explaining how the distribution of species (on islands in particular) is well explained by the ideas of isolation and speciation
- the existence of non perfect adaptations and of rudimentary organs: among many examples: some geese with webbed feet never go on water etc. / tailbone in humans

→ In all these cases, Darwin's point is that his theory fares better than the alternative one. i.e. creationism. Creationism may have an explanation for the first two in terms of rational order in God's minds. Concerning the last two however, creationism is unable to provide any kind of explanation: why different species for the same environment? why non-adaptive characters?

Conclusion :

In sum, Darwin has three kinds of argument in the *Origin*:

1. An argument that his theory is plausible: Struggle for existence, natural selection and divergence seem to be together sufficient to make the formation of species possible
2. An argument that his theory has a lot of explanatory power, giving satisfactory explanations for a large range of phenomena across various domains of science
3. An argument that his theory succeeds in domains in which the competitive theory fails

16.3.3 Problems remaining

The theory of evolution was commonly accepted a few decades after the publication of Darwin's *Origin*. That said, Darwinism faced several problems, which caused its almost complete disappearance as a promising theory of evolution. Four other candidates fared better for explaining the mechanism through which evolution occurs.

Missing Links – The main problem was that Darwin did not have the sufficient evidence for the gradual character of evolution due to the lack of evidence for the existence of intermediary species. The actual animal realm did not seem to feature any intermediary species. Most of all, the fossil record presented some profound gaps.

- One answer to this problem is to appeal to the imperfection of the fossil record, due to the fact that it is extremely hard to have all the conditions for fossils to form (rapid burial (without oxygen) and possession of hard parts are minimum conditions)
- Another answer is to give some plausible scenarios of how evolution can have occurred. Darwin does this in the case of the evolution of bats, appealing to flying squirrels.
- The last answer is to do some research and complete our knowledge of species, actual and past.

In the actual animal realm, one can consider lancelets, lungfish and marsupials as intermediaries between vertebrates and invertebrates, between fish and terrestrial animals, and between oviparous and viviparous animals (eggs vs babies alive), respectively

In the past history of species, Huxley, Marsh and Gaudry are among the great researchers and discoverers: of the Jurassic reptile-birds in Solnhofen (Bavaria) and of the tree or four-toed horse in the US.

→ *Still, there was no reluctance to follow Darwin on the idea of a gradual and linear process for evolution. The theory of **saltationism**, i.e. the idea that evolution proceeds by large variations populations wide instead of by minute variation in an individual, seemed more compatible with the available evidence*

Ignorance of the law of inheritance – Darwin explicitly admits that he does not know the laws of inheritance. That said, he also says that there is enough evidence to support the thesis that some but not all of the parents’ traits are inherited by the offspring.

Darwin’s theory of pangenesis – Darwin developed a proto-theory of heredity, the so-called *pangenesis*, which has three main aspects:

1. the bearers of hereditary characters are *material*: he calls them “gemmules”: heredity proceeds by transmission of these material bearers through the reproductive process;
2. Darwin distinguishes between dominant and dormant characters, the latter being able to re-appear after one or more generation;
3. the process of heredity consists in character’s *blending*, that is to say, very roughly, mixing a tall dog with a small dog will result in a dog of middle size.

Weismann’s germ plasm – Weismann was the first to observe chromosomes with a microscope, and theorized that these chromosomes are made of “germ plasm”, bearer of hereditary information, present in every cell. According to Weismann (and against Lamarckist theories), only the variations in the germ plasm can be inheritable (not the ones acquired after birth).

Weismann also cut the tails of mice for generations, in order to disprove Lamarckism.

→ *Still, none of these theories were satisfactory. The result is that many biologists, like for example Asa Gray in the United States, hoped to fill our ignorance with an appeal to God. The theory of **theistic evolution** was the view that God is ruling which variations occur and whether they get inherited.*

Tempo of evolution – Two main objections were raised against the idea that evolution proceeds by gradual steps:

Lord Kelvin’s age of the Earth – Kelvin objected that the Earth could not be old enough to allow for gradual evolution to occur. Based on the theory of thermodynamics and the idea that the Earth cooled off from a original state of fusion, Kelvin’s calculations gave the Earth an age of approximately 100 million years (vs 4.5 billion now) which is far too short.

Jenkin’s swamping – Jenkin objected that minute variations in an individual would never be able to “survive” within a population, however adaptive these variations may be. The problem is that of interbreeding: an exceptional individual will reproduce with non-exceptional ones, and given the theory of *blending*, his or her

exceptional character will get swamped or overcome by the normal characters within two generations.

—→ *Both these objections point to the gradualistic aspect of evolution within Darwinism. It would seem that we would need a way to accelerate the tempo of evolution to make sense of the data. Again, the theory of **saltationism** seemed to be more satisfactory.*

Non-adaptation – It seemed that some non-adaptive traits were not counter-selected. Rather, a former adaptive trait could, in some cases, continue to develop, even if it is not adaptive any more:

- Example: The Irish Elk : neither irish, nor an elk, but what can you do... his latin name: *Megaloceros* – big horns. Indeed: it was provided with 90 pound antlers that were 11 feet across – lived around 11,000 years ago.

This example was for a long time taken as a case of mis-adaptation. In fact, Gould has shown that the size of the antlers are commensurate with the size of the beast.

—→ *That said, in the 19th century, the megaloceros was taken as evidence that some adaptive variations possess some kind of inertia. This was the theory of **orthogenesis**, that is to say, the theory that developmental trends, once ingrained in species, would continue to develop, regardless of their adaptive value.*

Conclusion – The Result of all this is that, before the development of genetics and the modern synthesis, Darwinism, that is, the theory that natural selection is the prominent mechanism of evolution, was largely dismissed. Instead, saltationism, theistic evolution, orthogenesis, or even new forms of lamarkism were favored within the scientific community.

16.4 The Descent of Man

The descent of the human body – At first, people are not ready to believe that humans have a common ancestor with apes, but, with the evidence piling up, there is no controversy that at least our body is coming from evolution:

- 1891 Dubois – Homo erectus – small brain and human thigh: the upright position came before the big brain

- 1924 Dart – Australopithecus in South Africa

- 70's Lucy discovered by Donald Johanson in Ethiopia

- with the discovery of DNA by Crick and Watson, there is no doubt anymore that all living being have a common ground.

What is more problematic: the “soul” – Humans have been taken to be special for their *reasoning and moral abilities*. By contrast, non-human animals were taken to be *determined in their action by their instinct*.

Reason – Modern philosophers (in particular Descartes) had warned that we should not take some of the animals’ behavior as a sign of reasoning. Here is the argument:

Some animals may do many specific things better than we do:

- spider and its web
- bees and the hive

That said, this is a “one-output-only skill”: they would not be able to use their skill in a different situation than the specific one in which their instinct can function.

By contrast, reason is universal: reason is so versatile that any human is able to deal with an infinity of situations, and respond rationally to it.

Example: language is universally applicable (you invent many sentences every day)

Moral abilities – Unlike animals, humans are taken to be *rational, free agents* able to make choices and act upon their own decision.

Again, any animal behavior that resemble something like a moral behavior (guilt / love of the dog, protection of the youth within a group) is attributed to instincts. The view was so strong that, according to some philosophers (Descartes again), animals should really be seen as *mere machines*. For example, the shriek of a beaten dog is nothing more than the noise that a machine makes when there is something wrong with the mechanism (too much friction or something of the like). Now, do you feel pity for your car when it shrieks?

—> *So, the point is: for a long time, humans and non-human animals were considered as pertaining to two completely different realms due to the latter’s reasoning and moral abilities*

Darwin’s answer – Darwin does not talk about humans in the *Origin*. That said, he published an entire book devoted to the subject: *The Descent of Man*. In this book:

Concerning reasoning capacities :

- He describes at length how animals can be seen as having some proto-forms of reasoning: for example: a dog is able to find water in the lowest part of some hilly landscape
- He explains that some humans (the savage and the hard working wife) do not show reasoning capacities that are much better than the dog’s.

Concerning moral abilities :

- He describes at length how animals can show some proto-moral and proto-religious abilities – faithful dog, wolf devoted to the moon (!)
- He gives a story of how humans can have developed a sense of morals:
 1. Humans are endowed (like animals) with feelings – pain and pleasure – and emotions – joy, anger, fear etc.

3. Humans live in groups. Social living goes with the possibility of social recognition / ostracism (reward and banishment from the group)
4. Internalization of the sense of social recognition: this would be what we call our conscience (no need for the others: we watch ourselves)
 —→ *Darwin's ideas are not completely stupid of course, but the problem is that he lacks evidence for his claims. The evidence he gives is obviously guilty of naive anthropomorphism.*

So, could reason and morality have evolved? – Some people are still not ready to accept it, but more and more research shows that it is the case:

- Reasoning: chimps and bonobos have reasoning abilities far beyond the simple instinctive action - reaction
- Morality: It is rather easily shown that cooperative and / or altruistic behavior are favorable from an evolutionary point of view. Some also argue that some of our moral values are the result of natural selection:

Examples:

- In general, being cooperative with the member of your family promotes the propagation of your genes : this is called *kin selection*. One can also argue that being altruistic within a group is another way to promote the protection and propagation of one's genes.
- Incest – universally tabooed in human societies – there is an easy evolutionary explanation for this: inter-family breeding leads to more birth defect and malformations.
- Dietary taboos: pork for example is one of the most dangerous meats when not properly handled due to the parasite *Trichinella spiralis*.
 —→ *There is no doubt that we are social animals and that some of our social behaviors are the result of the evolutionary process.*

Biological determinism vs Potentiality – All this being said, we want to be careful about not falling into the radical belief that we are *determined by our biological or physiological background*. The controversy since the 60's is between *Wilson* and *Gould*.

- Wilson is the father of the so-called sociobiology and evolutionary psychology. He aims at explaining psychological and social behavior in terms of the evolutionary process.
- Gould does never deny that we are animals and that our social and psychological behaviors are grounded in biology. What Gould rejects, however, is the idea of *biological reductionism*, i.e., the idea that biology is all there is to psychological and social behaviors.
- Gould is right here, in particular in the light of the last 20 years of research in genetics. The old dream of the 20th century that a “genetic program” was simply encoded in our “genes”, taken as unit-bearer of information has been shown to be false. For

example, there is no one to one correspondence between genes and traits. One gene can express itself in different ways, and one trait can result from the expression of several combination of genes.

- Besides the above argument from the recent research in biology, one can give a common sense argument against biological and / or genetic reductionism: it is simply the case that we can change our psychological, social and cultural behavior during our lifetime. This would not be possible if these were part of a mythic genetic program.

→ *While our psychological, social, cultural and moral behaviors are clearly rooted in our biological constitution, they are not determined by it. There is some potentiality.*

The idea of a universal grammar – Steven Pinker, in his NYT article “The moral instinct” develops an interesting idea. Just like we may have a universal grammar for language learning (this is the theory of Noam Chomsky), we may have a universal grammar for morality learning.

From a universal framework composed of five basics:

1. No direct harm to humans
2. Fairness
3. Loyalty to the group
4. Respect of authority
5. Seeking purity

All of them are somewhat important, and are part of moralities over human societies. None of them are absolutely good though: many of them could be used as excuses for wrong deeds. Pinker’s idea is that we develop our own morality by putting different emphasis on these 5 elements.

For more details, see the NYT article: <http://www.nytimes.com/2008/01/13/magazine/13Psychology-t.html?pagewanted=all>

→ *Pinker’s point is not to give a definitive scientific theory of moral development. Pinker is a philosopher, not a biologist. The point is to give a framework which allows for both the biological roots and the potentiality of morality.*

16.5 Darwinisticism

The facts – Darwin’s theory has been used and abused in support of various normative theories on human societies:

- Francis Galton (Darwin’s cousin) – strict heredity principal factor – eugenics – 1883 *Inquiries into human faculty on its development*
- Dugdal (1877 – The Jukes), Lombroso: – strict heredity principal factor – heredity in criminology – born criminals?

- Haeckel, Lapouge – strict heredity principal factor– straight racism – segregation laws in the US, Sterelization laws (60,000 in the US, 300,000 Germany) – of course, Nazi regime

But also:

- Spencer, Carnegie – competition is the principal factor – *laissez faire* economy
- Wallace – environmental influence as principal factor – redistributive policies (give a little education + money to the poor, they’ll stop being criminals)
- Kropotkin – cooperation more important than competition – anarchism

→ *Note that whenever someone wants to ground his or her values in science, the values can greatly differ according to the way in which you understand the science. Depending on whether you take cooperation or competition to be the most important factor of evolution, the policies you support differ greatly.*

See Larson:

The contrasting cases of Wallace and Haeckel give the lie to any simplistic conclusion about the social implications of evolutionary science. Evolutionary thought nurtured and sustained the formers egalitarian pacism as readily as the latters proto-Nazi militarism (Larson p. 119)

As Larson suggests, that opposite views on social and political policies have been defended in the name of Darwinism suggests that Darwinism, by itself, does not support any of them!

The naturalistic fallacy :

- IS / OUGHT: *normative* theories give us *norms*: they tell us what we *ought to do*, while *descriptive* theories do not tell us anything about what ought to be done: instead, they give a description of *the way things are*
- To commit the *naturalistic fallacy* consists in trying to ground a normative theory – about what ought to be done – in a descriptive theory – about the way things are. To put it bluntly: it is not because things are one way that they ought to be that way.

Examples:

- “This is good for you: it is all natural” – nature is neither good or bad by itself: there are tons of natural stuff that are bad for us, starting with diseases, viruses, and amanita phalloide
- “We have to let nature follow its course” – same problem: if that’s true, then why would you ever call a doctor and take medication?
- If you take seriously the idea that your values, the way you want to live your live, should match the way nature works, then stop studying, and start on propagating yourself as much as possible...

—→ *We cannot justify our values by appealing to the laws of nature as described by the laws of science. Science tells us about the way things are. The way things are is not our best guide for the way things ought to be.*

Social Darwinism – Let’s take a little time on this, since this is still alive. The view is coming from Spencer, who ground his preference of a *laissez faire* economy on a scientific background, which includes:

1. Darwinism – natural selection
2. Thermodynamics – any physical system reaches equilibrium

According to him, we can consider the capitalist western society as the result of the evolutionary process applied to human society, with the capitalist business man as the best fit within this environment. Spencer sees evolution as progressive, so that the capitalist western society is the best achievement of human civilization (and the business the most progressive version of man). Spencer thinks that the process has reached its “thermodynamical” equilibrium: nothing will change from now.

So, what’s wrong with this?

1. Social Darwinism is guilty of the naturalistic fallacy – see above
2. Social Darwinism relies on a misunderstanding of Darwinism:
 - (a) There is no progress in Darwinism : branching, not linear development
 - (b) There is no beings more advanced or evolved than others: branching ! humans are not more evolved than viruses and snakes
 - (c) There is no absolute favorable trait in Darwinism: because the environment is constantly changing, no single trait will be always favorable. If anything, only a *maximum variety* is universally favorable!!! because it would allow the species to face a maximal number of environmental changes.
 - (d) There is no equilibrium in a perfect state in Darwinism – evolution never stops
 - (e) If we take seriously the (misguided) idea that Darwin’s theory of evolution tells us about the “most fit men” around the world, it seems that the third world is much more efficient in terms of propagating their genes while the capitalistic societies have dying populations.

—→ *The point is not to say that capitalism or socialism is good or bad, quite the opposite! The point here is that, whatever your preference is in terms of social, economic or political policies are, you cannot justify this preference by appealing to laws of nature, including Darwin’s natural selection. You will need another kind of justification*

16.6 Evolutions of the Theory of Evolution

Where we were left – We have seen that by the end of 19th century, the idea of evolution is accepted, but Darwinism (that natural selection is the mechanics through which evolution occurs) is not, because of two main objections:

1. Swamping
2. Tempo

The alternative theories that were favored were:

- a. Saltationism
- b. Orthogenetics
- c. Lamarckism
- d. Theistic evolution

So, before the modern synthesis, Darwinism was almost dead.

The birth of Genetics :

Mendel – priest, peasant stock, science teacher, will never be aware of the importance of his work on peas

- Research on 30,000 pea plants, 7 pairs of traits from 1856 to 1863
- Study of the hybrids and of their progeny:
 - 1st generation – 1 trait for each pair is passed on and 1 trait only : ex: all tall, or all have their flower on the tip
 - Notion dominating trait on a pair
 - No blending
 - 2d generation: 3/4 dominant, 1/4 recessive
 - Still no blending
 - Recessive character can strike back
- When two pairs of traits are studied together: no correlation
 - Separate segregation between pairs.

Galton, Weisman and de Vries – all three defend a form of eugenism, but this is not what we are concerned with here. Instead, we are interested in the fact that they shifted the study of evolution from the level of individuals to the level of populations, in developing and applying statistical methods to evolutionary processes.

This opened the eyes of scientists on the importance of Mendel's work.

Wilhem Johannson – Danish botanist – notion of “genes” located on chromosomes – birth of “genetics” — plus advocates idea of mutation

→ *The idea that traits are passed on discontinuously as full units can replace the idea of continuous, incremental variations and blending. This allows to solve the problem of swamping: mutations don't get lost in the future generation because of the blending with other characters. A dominant mutant can take over, and a recessive mutant can survive.*

Theodor Boven and Walter Sutton – 1902 – idea of genes as material carriers on chromosomes

Morgan – Columbia U 1910's – study of fruit flies (1 generation every 12 days)

- was unhappy with both Darwinism and Lamarckism, because of the lack of precise laws of inheritance
- obtain 1 mutation within 1 year : eye which is white instead of red
- breeds the mutant with non-mutants – obtains the same proportion as Mendel + link with the sex of the individual
- *The mechanism of Mendelian Inheritance*, 1915 – mature classical genetics
- Morgan dismissed natural selection in favor of mutation only as the mechanism of evolution

→ *Morgan did not go as far as the modern synthesis will go. But Morgan is the founding father of classical genetics.*

The Modern Synthesis – Darwinism meets genetics

The Peppered Moth – England, industrial revolution

- 1st black moth observed in 1848
- 98% black by 1896
- Amazing evidence for the theory of evolution as the association of mutations, inheritance, and selection.

Haldane, Fisher, and Wright – inventors of population genetics and the modern synthesis

- Haldane: “In a series of ten highly mathematical papers published between 1924 and 1934, Haldane sought to show that the natural selection of genetic variations transmitted in Mendelian ratios could produce adaptive change in populations. In short, he argued, Darwinism plus Mendelism equals evolution” (Larson p. 223)
- Fisher: “Beginning with a 1918 paper on correlations among relatives and culminating in his 1930 book, *Genetical Theory of Natural Selection*, Fisher showed that a Darwinian selection process acting on a large, genetically varied population subject to Mendelian laws of inheritance favored the diffusion of beneficial genes. The greater the benefit conferred by these genes in a given environment, the faster their frequency would increase within the population, he calculated. Change the environment such that different genes conferred benefits, and gene frequencies would shift accordingly.” (Larson p. 223)
- Wright – notions of adaptive landscape and genetic drift (p. 229) – suggests that small, isolated populations are the seeds of new species

Finches – All this is perfectly well confirmed when studying the finches in the Galapagos

→ *“From the shift of gene frequencies within population through the origin of similar species to the divergence of biological kingdoms, modern neo-Darwinian theory relies on the cumulative selection of favorable genetic variations over innumerable generations to account for life’s diversity.” (Larson p. 242*

After the Modern Synthesis :

- Crick and Watson: DNA shared by all, comparison possible

- Watson and Wilson: the battle between molecular biology and evolutionary biology: how much do the genes determine? how much room for the environment?

→ *The birth of reductionism: the idea that most of the characters of an individual are determined in a straightforward way by its gene. This view was very important during the 20th century but has been falsified over the past 20 years (see for example Evelyn Fox Keller The century of the gene*

- Gould and Eldredge – take seriously the problem of the fossil record and challenge the idea of gradualism: theory of punctuated equilibrium. This theory is compatible with Darwinism and the modern synthesis: it only changes the tempo of the process of evolution, in allowing “quick” accelerations and long periods of stagnation

- Lateral Gene Transfer – great amount of evidence shows that the idea of a tree of life, in which all gene transfers are vertical, is too simplistic: there are some lateral transfer between mature species. 3 examples from Larson: West Nile Virus, anthrax bacterium, bird flu.

→ *As any other theory, the theory of evolution is in a process of constant refinement. And there is no reasons to believe it will ever end.*

16.7 Conclusion

Important distinctions – In this chapter, we have clearly distinguished between:

1. The theory of Evolution
2. Darwinism
3. Darwinisticism

Darwinism is the theory of evolution in which natural selection plays a major role. Darwin did not provide a definitive theory of evolution.

For one, the kind of support he gives to his theory is peculiar: Darwin does not provide direct empirical confirmation of the predictions of his theory, but, instead, provides thought experiments, analogies and argument for the superior explanatory and unificatory power of his theory over Creationism.

Second, there were problems remaining, which turned into severe objections, and almost cost death to the idea of natural selection:

- Jenkin's swamping
- Kelvin's tempo

Darwinisticism flawed – application of Darwinism to other domains than the evolution of species is most of the time problematic:

- Socio-biology – the idea that our social behavior, our morality and religious beliefs are the result of evolutionary processes : If sociobiology is just claiming that we are animals and that human behaviors and ideas are rooted in the process of evolution, then fine. The problem arises when sociobiologists try to *reduce* human behaviors and ideas to genetics and evolution. *Genetic Reductionism is easily shown to be false.* Instead, we can think in terms of the association of both the genetic heritage, natural selection and biological potentiality as the best explanation for our social and cultural behaviors
- Social Darwinism – The most important thing to remember here is that most of the theories which try to give a scientific rationale to specific social or moral rules are guilty of the naturalistic fallacy: Science tells us (at best) about the way things are, not about how they ought to be.

The theory of evolution evolves – The modern synthesis is an important landmark in the history of the theory of evolution. The future is still open to further research...