

# Chapter 20

## *The Origin of Species, II:* Natural Selection and Divergence of character

### 20.1 Readings and Homework assignment

**Readings** Chapter IV – Selections Darwin pp.111-35

**Homework** Write a one paragraph long answer to the following question on the basis of your readings:

- Natural Selection is defined as the preservation of favorable characters over the generations. What does count as favorable character? Do you think there are some characters that are always favorable, or always disadvantageous?
- Does Darwin present natural selection as a mere eliminative mechanical process or as a positive force?
- What is common to natural and sexual selection? What is the difference? Can they conflict with one another?
- How does Darwin explain that the existent species are so different from one another? Why is there no species between cats and dogs?
- Darwin provides only “imaginary illustrations”, not actual experimental results, as evidence for his theory. To what extend is this

acceptable from the point of view of the scientific method according to you?

## 20.2 Natural Selection

### 20.2.1 What does Darwin to argue for to complete his argument?

**We have:** 1. Variations (large amount and endless)  
 2. Hereditary tendency (Strong)  
 3. Struggle

**Two rhetorical questions:** Given Struggle for existence:

- (a) Probability of the apparition of favorable variations is not equal to zero;
- (b) (if (a) actualized) Probability of the perpetuation of favorable variations (and elimination of injurious variations) is significant.

These corresponds to the two claims which were announced in the introduction.

**Definition:** Natural selection is this “preservation of favorable variations and the rejection of injurious variations”

**The issue of the favorable variations** The passage from (a) to (b) is easy, given the struggle for existence and the inheritance principle. What we need now is a stronger argument for (a). **For this, we have first to define in what sense there are such things as favorable variations.** Natural selection is thus not reducible to: variations + inheritance + struggle. We need *favorable* variations, that is, an account of the *normative* aspect of variations that is central to the process of the natural selection.

The analogy with breeding is of limited help for the main reason that artificial selection is the selection of traits that are favorable to the breeders, and the survival is also secured by the breeders (think of the milk-cows...). So we have to find a way to understand “favorable” so that selection can be “natural”.

That said, Darwin makes sure from the beginning to insist on the fact that conscious selection in breeding is not the most important aspect. Unconscious and pervaded selection might of a higher efficiency (selection and intercrossing vs. unconscious continuous preference for the best specimens).

We have to understand in what sense certain variations can be “favorable” to the animal itself.

### 20.2.2 Infinitely Complex Interdependence

It is an important feature of Darwin’s notion of natural selection that it involves “*interaction between a variable, heritable feature of an organic system and the environment of that system*” (Lennox, idem).

The main point of the chapter is that what is favorable is not so in a isolated way. **What is favorable is favorable in the context of infinitely complex relations between individuals members of a given species and the entire environment, including individuals from other species.**

This is why Darwin starts with the idea that **a sudden and important change in climate will have consequences on the population of a wide range of species**, not only on the population of a species that would go extinct.

That said, he does not want to suggest that the process of evolution takes place only under extreme circumstances. Quite the contrary: it is a permanent, slow and gradual process.

However slow and gradual, the process is very powerful. Indeed, “nature” has on its side, to improve the power of selection:

- geological time scale
- struggle for ever
- entanglement of species and conditions of life

The third element is what this chapter adds to the picture we had up to now.

So that, contrary to breeding (113), the slightest variation can be a huge advantage. Again, this is true because of the claim that there is an infinitely complex interdependence.

This could amount to say that natural selection really implies an interaction, is really a force, or cause of the preservation

### 20.2.3 Natural Selection as a positive force

This is the sense in which natural selection is not merely the “survival of the fittest”. Natural selection is *active*: see paragraph p.113! and throughout the chapter.

**Natural selection is not reducible to the quantitative measure of the evolution of population. Darwin is giving a causal account of this evolution: there is a force and an interaction.**

Lennox proposes to compare this with the distinction between **kinematics** and **dynamics** in physics.

Can you think of other, modern account, of evolution, which would not be darwinian in this sense?

a. accounts in which to be “favorable” are reduced to the measure of reproductive success in the population.

b. accounts in which selection operates only on genes, and not on the level of the global interaction with the conditions of living.

Arguably, such accounts are not Darwinian.

## 20.3 Sexual Selection

### 20.3.1 The text

*The following is a reproduction of parts of Prof. Schmaus’ course notes:*

A. depends on a struggle among individuals of one sex, typically males, for possession of the other sex

1. rather than a struggle in relation to physical conditions or other species
2. result is not death, but few or no offspring

B. types:

1. males may actually battle one another, with various natural weapons (e.g., horns) and defenses (e.g., lion’s mane) providing an advantage
2. or the struggle may be more peaceful, as in the case of birds which try to attract females through beautiful singing or plumage (116)

C. generally, sexual selection explains the differences between males and females that otherwise have the same way of life (116)

N.B. today, biologists do not recognize sexual selection as distinct from natural selection

*End of Prof. Schmaus’ course notes.*

### 20.3.2 Comments

**Sexual selection and natural selection are fundamentally the same:**

- it was not implied before that natural selection necessarily provokes the death of individuals, but the extinction of the lineage presenting the injurious trait because of lesser offspring.
- this is exactly what is said here
- that said, sexual attraction brings about another criteria for favorable variation. Favorable traits are not only these traits that are better survival tools for an individual and its offsprings. Traits that make the individual sexually attractive, and more attractive, count as much as traits that protect against death and predators.

**Two examples for fun** - how do to live with horns...From Gould

Long story about the extinction of the misnamed Irish Elk (*Megaceros*).

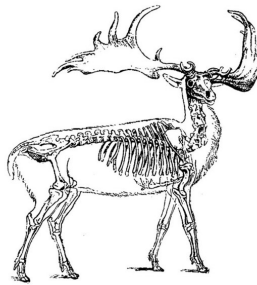


Figure 20.1: The Irish Elk, or Megaceros was equipped with 90-pound antlers that were 11 feet across

- Safe Sex: Endler's guppies:

From <http://naturalsciences.sdsu.edu/classes/lab2.8/map.html>

John Endler at Princeton (1996): observation in various pools and streams in south America (Venezuela, Margarita Island, Trinidad, and Tobago). The subject is a fish called the guppy and the trait is its spotted coloration which is inherited.

1. In pools where there are no predators, male guppies are very brightly colored. They have black, blue, red, yellow, green and iridescent spots. Endler observed that bright colors attract females and increase the

chances of mating and reproduction. The gaudier the male, the better his sex life.

2. In pools where predators abound, male guppies have smaller, paler spots and they blend into the background better. Pale males are caught by predators less frequently than bright-colored males.

3. Guppy predators range from the most dangerous, a cichlid fish which eats about three guppies per hour, to the least dangerous, a fish called *Rivulus hartii*, which eats about one guppy every five hours. The more aggressive the guppies' enemies, the smaller and fainter the guppies' spots.

4. In pools where the predators are prawns, male guppies have bright red spots. Prawns are generally attracted by bright colors but are red-color-blind.

## 20.4 Illustrations

### 20.4.1 The text

- Swift-running wolves will be selected when swift-running deer are the prey, bulky wolves when sheep are the prey
- Analogy with breeding greyhounds by methodical selection
- Extended discussion of how flowering plants and the insects that fertilize them may become adapted to each other(119)

### 20.4.2 The issue of the level of selection: Darwinism is about individuals

There is an ambiguity in the text on the **issue whether natural selection occurs at the level of populations or at the level of the individuals.**

- Modern theory of evolution arguably takes the point of view of populations, and frequency.
- Darwin, however, seems to conceive of natural selection as an interaction between individuals and their conditions of life.

**Darwinism** holds that:

- natural selection, again, is really an interaction between individuals and their conditions of life, not simply a statistical measure over populations.

- The selection occurs at the level of individuals
- The sum of these individual interactions makes natural selection significant at the level of population

But *natural selection is NOT a mere quantitative measure of populations growth*. There is a real interaction between the conditions of life and individuals. Again, this distinguishes Darwinism from our actual theory of evolution.

The problem is that there is an **ambiguity** in the text, and Darwin from time to time speaks about populations, pointing to the direction of the importance of frequency of variations in natural selection.

As it is, the theory is vulnerable to the following **objections**:

- It is very unlikely that a slight variation at the level of an individual can be inherited because of intercrossing
- Even if it is, it is highly likely not to be further preserved, since it is now an “intermediate form”
- And in any case, it is likely to disappear, simply because of free and repeated intercrossing.

**These objections were formulated by Jenkins.** The point is to insist on the importance of the frequency of the advantage.

Darwin answered in the late editions of the *Origin*. He talks then of individuals, not frequency. This is taking a clear stance in the ambiguity between the level of individuals or the level of populations as the relevant level of application of natural selection.

**This does not, however, answer to the problem of intercrossing being a force counter-balancing natural selection. Darwin will argue later about this.**

### 20.4.3 What’s the point of the imaginary illustration

**It seems that the imaginary illustrations cannot be taken as evidence for confirmation of the theory:** evidence for a scientific theory is not imaginary! Lennox argues in his paper, *Darwinian Thought Experiments*, that they are “thought experiments”

- Examples of thought experiments: Galileo’s boat, Einstein’s train and elevator

- Now, what role have thought experiments in science? This is debated in the literature.

- In the case of Darwin and according to Lennox: **the imaginary illustrations serve at proving the explanatory potential of the theory**: look at the use of modalities in the text. The point is to show that the theory CAN explain some phenomena, even the phenomena of the kind that the theory seems not to be able to explain.

## 20.5 Power of Natural Selection

### 20.5.1 How can natural selection work?

Darwin tries to determine in what conditions Natural Selection can be significant. The problem here, it seems to me, is the discrepancy between

1. the power which Darwin is going to attribute to Natural Selection when defending the divergence of character, and
2. the gradualistic character of natural selection

The challenge is to argue that some conditions can make a very subtle and very slow process extremely powerful over a long amount of time.

### 20.5.2 The text

*From Warren Schmaus:*

A. although he thinks isolation is important, he thinks that a large area is more important (121-2)

1. a larger area will support a larger population which will increase the chances of new variations appearing (122)

2. also, in a larger area, there is greater complexity of life due to the presence of more species

B. as evidence for these claims,

1. he points to how Australian species, coming from a smaller continent, do not compete well with Eurasian species that have been introduced into Australia

2. also, how in smaller bodies of water we find more ancient types of fish (122-3)

C. the most favorable situation is that of a large continent that rises and sinks, sometimes becoming islands that afford isolation for speciation to



occur (123)

– in ch. IX, he suggests that Europe may have once looked like the Malay archipelago

*End of Prof. Schmaus's notes*

**The problem here is that every condition that seems to be favorable to natural selection's efficiency is also favorable to intercrossing' efficiency.** It is very difficult for Darwin to go around the objection. It seems that there is only one passage where he clearly states why he claims that natural selection will be more efficient than its counter-balancing force.

### 20.5.3 Tempo of natural selection

Extreme slowness of natural selection, due to the extreme slowness of the processes underlying its main causal factors:

- extreme slowness of physical changes, which are causally relevant to selection.

- extreme slowness of the variation process

- moreover retarded by intercrossing

Darwin claims that this is not sufficient to render natural selection insignificant. He gives two arguments:

1. Appeal to geological time scale.

Already p.119: Lyell's method and natural selection

- geological time scale

- uniform cause all along

- actual observable effects

2. Analogy: if human, at human time scale, can do what they do with breeding, the power of natural, geological time scaled selection has "no limit"

## 20.6 Divergence of Character

### 20.6.1 What's next?

The process of the natural selection seems to be in place now. We have:

1. Variations

2. Population increase

3. Limited resources

4. favorable co-adaptations

5. inheritance
6. survival and offspring

Further, Darwin has argued that:

- the nature of natural selection is one of a positive force, cause of a creative interaction between individuals and their conditions of life
- however slow and gradual, the power of natural selection is without limit, partly because of the geological time scale, partly because of the infinite complexity of the relations between individuals and their conditions of life.

**It remains to argue that natural selection can produce different species.** The paradox is the following:

- On the one hand, species come from a gradual and continuous process of variation and selection
- On the other hand, species greatly differ

The process of natural selection, as described until now, would have nature constituted of **a continuous chain of slightly different organisms**. Now this is not what we can observe. So the question that the theory of divergence of character is going to answer is the following: where do the species, or what we call species, come from?

**This involves two problems:**

Darwin has to “account for so habitual and large amount of difference” between varieties, and between species.

1. differences are large: what happened to the intermediates?
2. differences are habitual: how were the differences somewhat fixed?

## 20.6.2 Divergence in domestic breeding

**In domestic breeding**, slight differences between individuals are turned to great differences defining different breeds by the selection of the extreme characters by the breeders.

- Key of the argument: extremes are the best
- Example of swift vs. strong horses
- Further calls “intermediate animals” “inferior”

Thus: principle of divergence of character causes “differences, at first barely appreciable, steadily to increase, and the breeds to diverge in character both from each other and from their parents”

**Discussion question:**

1. Is it true that humans always select the extremes?

2. Even if so, how would that be comparable to nature? The problem is that breeding selection is for the advantage of humans, not of the animals. This might be a reason for us to choose the extreme character, but it might be that the advantage of the breeder and the advantage of the animal do not overlap.

An example? what about milk cows again??? what about these dogs that are so small that they are barely able to reproduce?

Not only the argument is disputable, but also, it is very hard to see how the analogy is going to work this time.

### 20.6.3 Divergence in Nature

**The thesis:**

**Diversification of character among individuals of a species is an advantage in nature:** fitting with more diverse conditions of life. That is, whenever a species has increased as much as the resources permit it, the only way remaining for further increase is diversification, so that the divergent individuals can migrate and take possession of other territories and resources.

The point is thus that the more divergent the individuals become, the more opportunities they will have to find themselves co-adapted with new conditions of life.

Then usual argument of the time scale.

- Examples:

*From Prof. Schmaus:*

Observations that support this principle:

a. more grass on a given plot of ground if it is sown with several kinds rather than only one

b. same for wheat

c. small islands or ponds will have more life the more different kinds of things there are (126)

d. farmers find they can raise the most food if they rotate their crops with plants of different orders

e. naturalization of plants (q.v.)

(1) on the creationist assumption, one might have expected the plants that were most like the native ones God designed for the place to have the best chance of being naturalized (126)

(2) but on the contrary, plants of different genera than the native have an advantage

E. for Darwin, the "physiological division of labor" among organs of the same body also confers advantages

1. again, the term reflects the analogy with economics
2. animals with diverse structures out-compete those without
3. Example of Australian marsupials: example of incomplete evolution

*End of Prof. Schmaus's notes*

**Diagram:**

The diagram is not meant to represent the history of real, empirical species. It is only meant to help understand how natural selection can work over thousands of generations, and explain what we can observe.

The points that the diagram is supposed to illustrate are the following:

- The **apparition** of new species
- The "general rule" that "the more **diversified** descendants from any one species can be rendered, the more places they will be enabled to seize on, and the more their modified progeny will be increased."
- **Extinction of the intermediate forms** – conquered and exterminated by the later and improved form of living.
- **Extinction of the original species** that did not evolve as (A) and (I) did.

The extinction of both the intermediate form of living in the process of evolution and of the original intermediate forms of living makes it that in the end, "the six new species descended from (I) and the eight descended from (A), will have to be ranked as very distinct genera, or even as distinct sub-families"

**The extinction of original and intermediate forms is essential to give an account of what we can observe in nature. In the end, the difference between the final surviving branches appears considerable.** Presumably, it would be hard to imagine that they had anything in common in the past. This is of course Darwin's point.

So one of the main points of Darwin here is to explain how his theory of evolution can give an account of the classification of genera and species actually observable in nature. The fact of the matter is: we have not a series of gradually and continuously varying forms of living. The extinction of the intermediate is thus of high importance.

**It is of high importance to understand that Darwin does not pretend to have proven that natural selection occurs in nature.** The point of the chapter was ONLY to prove the plausibility of the hypothesis.

Darwin did not provide any evidence for his theory: only imaginary illustrations and hypotheses of mechanism. The point is to convince the reader of the **explanatory potential** of the theory (cf. J. Lennox, *Darwinian Thought Experiments*).

