

The Origin of Species, "Chapter Thirteen: Mutual Affinities of Organic Beings: Morphology: Embryology: Rudimentary Organs" (1859), by Charles R. Darwin

"Mutual Affinities of Organic Beings: Morphology: Embryology: Rudimentary Organs" is the thirteenth chapter of Charles Darwin's book *The Origin of Species*, first published in England in 1859. The book details part of Darwin's argument for the common ancestry of life and natural selection as the cause of speciation. In this chapter, Darwin summarizes the evidence for evolution by connecting observations of development in organisms to the processes of natural selection. Darwin shows how the theory of special creation, which claims that God directly created all organisms in their current form, is inferior to the theory of natural selection for its ability to explain the diversity of life. In this chapter, Darwin also discusses classification and homology as they relate to natural selection.

On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life was published by John Murray III of the John Murray publishing house in London, England, on 24 November 1859. At that time, Darwin lived in Kent, England. Since the first edition, five subsequent editions appeared, and the title of the book endured slight variations. The sixth and final edition, published on 19 February 1872, appeared with the shortened title *The Origin of Species*.

Chapter thirteen is part of a group of chapters in which Darwin shows how natural selection can explain facts from several different fields of biology. In chapters nine through twelve, Darwin details facts from geology, archeology, and biogeography. In chapter thirteen, he discusses the fields of classification, morphology, and embryology. Darwin claims that the theory of evolution by natural selection can explain many phenomena, including the patterns emerging from the classification of organisms, the tendency of embryos to look similar to each other and then diverge from each other as their development progresses, and the presence of useless or vestigial organs. Furthermore, Darwin says that the alternative theory of special creation has less explanatory power over these observations.

The first section of chapter thirteen discusses the classification of organisms. Darwin argues that classifying organisms gives a clue about their ancestry and relationships to each other. He explains how biologists organize species into groups according to the characters of organisms within species. These groups are then put into broader groups according to their more general characters. This process continues until there is just one group. For example, dogs belong to a group called canines, but they also belong to a larger and more general group called Carnivora. Additionally, they belong to an even more general group called mammals, which belongs to the group of vertebrates. This process creates a descending pattern from the largest most general groups to the smallest most distinct groups, a system Carl Linné developed in the eighteenth century in Sweden.

Darwin then ties these classifications to his theory of evolution by natural selection. He notes that individuals of the same species vary from each other. Additionally, he says that these individuals will compete with each other for resources and, because of their variations, different individuals may be able to exploit slightly different resources. Through the pressures of natural selection those organisms will diverge into separate populations throughout many generations. Like the different groups within classification, these now separate populations will vary from each other in their specialized characters, and yet retain the general characteristics of the larger original population. According to Darwin, the patterns emerging from classification parallel the process of

speciation.

Next, Darwin argues that the processes by which biologists classify species rely on common ancestry rather than on special creation. He argues that, if God uniquely created organisms, then biologists should classify organisms according to the type of habitats the organisms live in or according to all external similarities between organisms. But, Darwin says, biologists don't in fact classify organisms with those principles. For instance, biologists do not classify large fish with whales even though they share very similar external characters and habitats. When looking at organisms through the scope of common ancestry, however, biologists can explain why they don't classify whales and fish together. Whales and fishes look similar because both of their ancestors have been put under the same pressure to survive and reproduce in an aquatic habitat, but in their basic parts they are very different. For example, whales breathe air and give birth to live young, while fishes extract oxygen from the water and lay eggs.

In the next section, labeled "Morphology," Darwin discusses the unity of life on earth. He calls upon homology of basic structures as evidence of evolution from a common ancestor. Darwin defines homologies as structures that seem to be of the same type across very different groups of animals, even though they may differ from each other in their forms or in how they function. He notes the similarities in bone structures between the limbs of organisms across different genera of animals used for different purposes, such as the hands of humans used for grasping, the wings of birds used for flight, and the paddles of porpoises used for swimming. The limbs are made of the same basic components: similar bones, in a similar order, from a similar pattern. According to Darwin, this phenomenon indicates a shared ancestor whose original body-plan has been modified over time, and supports the claim that species have not been uniquely created.

The third section of chapter thirteen, "Embryology," is about developmental processes and phenomena. He notes that embryos from different classes of animals, such as birds and mammals, look very similar to one another in early development. He tells a story about Louis Agassiz, a biologist who was at Harvard University in Cambridge, Massachusetts. Agassiz, upon receiving new specimens of embryos, forgot to put a label on one embryo. Later, when returning to the embryos he could not tell if the unlabeled embryo was a bird, a mammal, or a reptile because they all looked so remarkably similar. Historians later argued that Darwin mistakenly attributed the story to Agassiz, and that Darwin meant to name Karl von Baer, an embryologist at Königsberg University, in Königsberg, Germany, who developed von Baer's Laws of development in the early half of the nineteenth century.

Darwin then discusses how similarities between embryos of different species can persist in later stages of development, and even after birth. As an example, he talks about how many species of cats have stripes and spots. Lions lack these characters as adults, but the stripes and spots are still present in newborn lion cubs. This observation leads Darwin to argue that the time when variation occurs during cats' development can differ across species.

Whether or not differentiation of organisms occurs in early or in late development, Darwin says that offspring will develop traits in the same developmental stages that their parents developed those traits. He supports his claim with examples of hereditary diseases. Darwin notes that an inherited disease will generally develop in the offspring at the same age it afflicted the parent. Darwin uses this observation to support his hypothesis of heritable variation.

Darwin next discusses one reason why embryos of animals from very different species look so similar to each other. He states that the stages of development when embryos look similar to each other are also the stages in which embryos generally do not interact with the outside environment. At these stages, embryos are largely dependent on their mother's wombs or on the egg, and they hardly interact with the outside environment. Darwin says that differentiation between embryos of different species will occur increasingly as the organisms are exposed to the outside environment and as they become more independent. The increasing divergence of embryos is because natural selection occurs during the time when organisms are interacting with their outside environment. Embryos of different species look similar because they share a common ancestor, and because they do not have to face as much selective pressure as adult organisms do. It is the adults that are subjected to their environment the most, and therefore selected.

According to Darwin, natural selection also explains a theory in developmental biology that says that the stages in an organism's development parallel the adult forms of other animals that were its ancestors. According to this theory, called recapitulation theory, the stage at which human embryos exhibit gill slits parallels the adult forms of our fish ancestor species. This theory came from the observation that embryos exhibit stages in development in which they resemble the adult forms of other animals. Darwin tried to explain these phenomena with the theory of natural selection. He explains that, although the results of natural selection enable researchers to conclude that animals replay their ancestry during development, the hypothesis of recapitulation is an exaggeration of the truth. Embryology can indicate evolutionary relationships between groups of organisms only because embryos have undergone less change than adults. Thus, biologists can see those structures that are similar between species at early stages of development. However, Darwin argues that not every stage of development corresponds to the form of its adult ancestor.

The last section of this chapter, labeled "Rudimentary Organs" addresses the vestigial structures in animals, and it shows that only natural selection can account for these features. Darwin defines vestigial structures as structures that persist within a species but have lost their function. They are usually smaller than their homologues in other species, and are sometimes described as atrophied. However, Darwin's definition differs from the definition of vestigial structures used by later biologists.

Throughout chapter thirteen, Darwin cites examples to support his conclusions on vestigial organs. One of those examples includes the remnants of legs on snakes. Snakes do not use legs to move, yet some of them possess structures similar to legs; they are in the same location as the legs of other species, and they are composed of the same basic parts, although smaller. Naturalists correlated the rudimentary legs of snakes and the functional legs of lizards.

Darwin uses these examples to critique the theory of creationism. Darwin asks: why would individually and uniquely created species have useless structures? Darwin says that, if we accept creationism to explain the origin of species, then we must accept that there is no rational explanation for these parts. In contrast, natural selection explains those phenomena. Organisms possess vestigial structures because they have an ancestor that also possessed these structures. Those structures in descendent species adapted for different functions, or disappeared due to selective environmental pressures, which their ancestors did not experience.

Darwin's embryological arguments for evolution influenced the study of the relationships between evolution and development. For example, after the publication of *The Origin*, Ernst Haeckel in Jena, Germany, used Darwin's arguments in support of his biogenetic law or recapitulation, which stated that organisms replay their evolutionary ancestry while developing from embryos to adults. Many biologists accepted Haeckel's biogenetic law until the 1890s.

Sources

1. Baer, Karl Ernst von. *Über Entwicklungsgeschichte der Thiere. Beobachtung und reflexion.* [On the Developmental History of the Animals. Observations and Reflections]. Königsberg: Gebrüder Bornträger 1828. <http://www.biodiversitylibrary.org/item/28306> (Accessed April, 12 2014).
2. Bowler, Peter J. *Evolution: The History of an Idea.* Berkeley and Los Angeles: University of California Press, 1984.
3. Costa, James T. *The Annotated Origin.* Cambridge: Harvard University Press, 2009.
4. Darwin, Charles R. *On the Origin of Species by Means of Natural Selection, or the Preservation Of Favoured Races in the Struggle for Life.* London: John Murray Publishing House, 1859. <http://darwin-online.org.uk/content/frameset?pageseq=1&itemID=F373&viewtype=text> (Accessed March 6, 2014).
5. Linnaeus, Carl. *Systema Naturae* [System of Nature], 12th edition. Holmiae: Laurentii Salvii, 1766-68. <http://dx.doi.org/10.5962/bhl.title.68927> (Accessed January 14, 2014).
6. Gould, Stephen J. *Ontogeny and Phylogeny.* Cambridge: Harvard University Press, 1977.

7. Haeckel, Ernst. *Generelle morphologie der organismen*. [General Morphology of the Organisms]. Berlin: G. Reimer, 1866. <http://www.biodiversitylibrary.org/item/22319#page/11/mode/1up> (Accessed April 12, 2014).