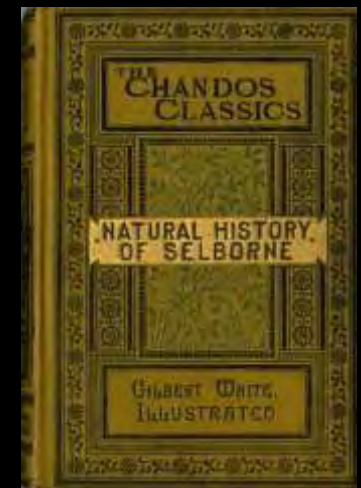
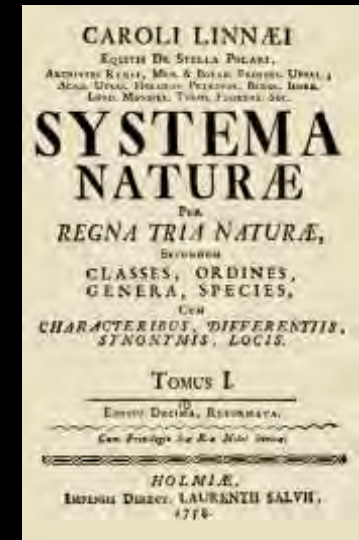
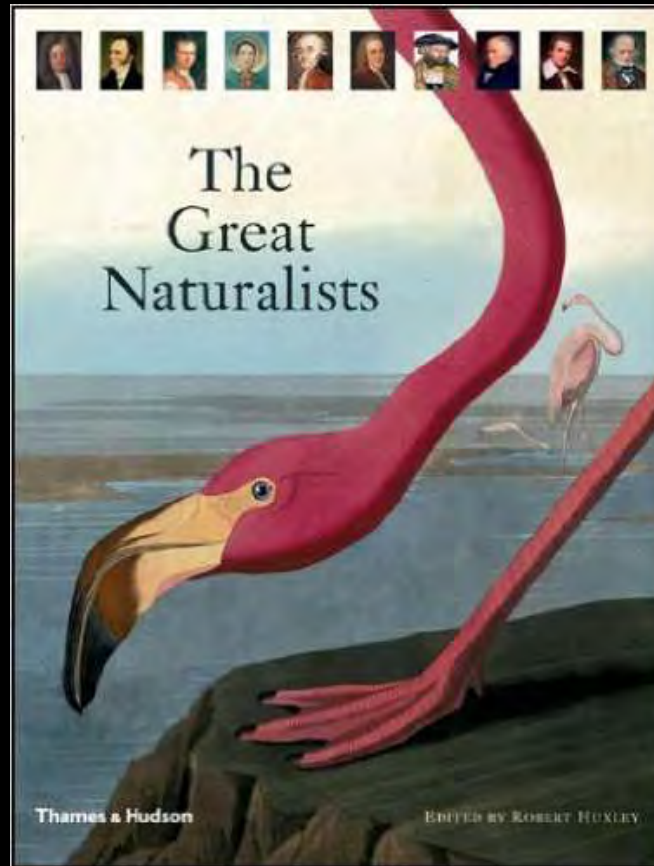


The Study of Nature: Natural History and the Creation of Nature

Kevin M. Anderson

Austin Water - Center for Environmental Research



Natural History

Natural history is the study of plants and animals leaning more towards observational rather than experimental methods.

Understanding whole organisms in context

An ecological understanding



Themes

- Observation
- Description
- Classification
- Encyclopedias
- Biogeography
- Collecting
- Amateurs to Professionals
- Naturalists to Biologists
- Artists as Naturalists
- Natural History as Literature



The Study of Nature – Origins

The Greeks and Romans

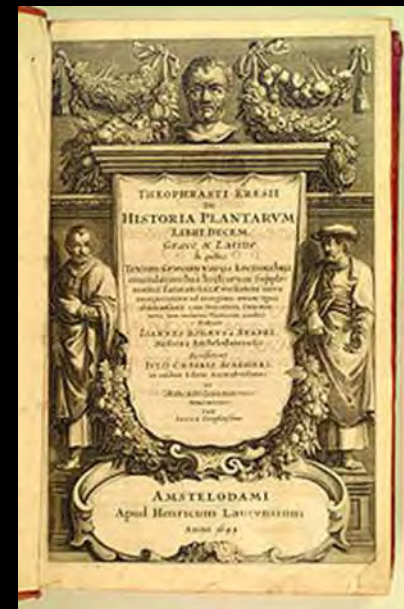
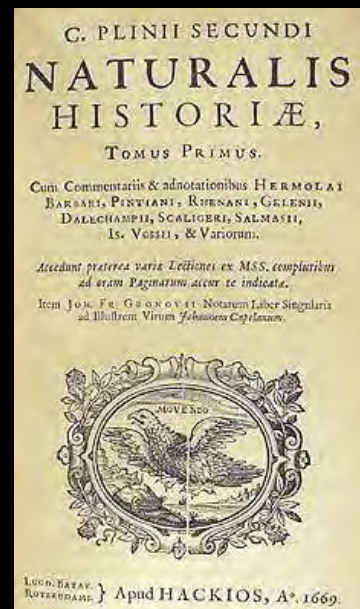
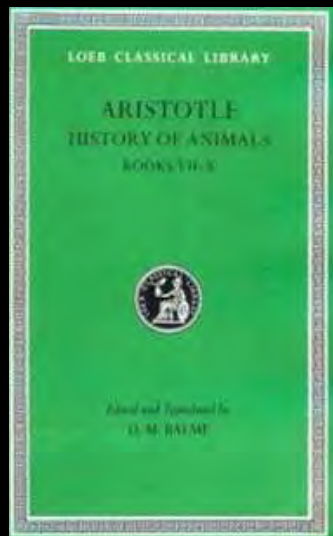
The originators of natural history were not scientists.

They were philosophers and writers who studied nature and wrote *historia*

This Greek word is closer to *investigation* or *research* rather than our word “history”

But the books of their nature research were titled “Natural History” in English

...and the rest, as they say, is history.



Aristotle

384-322 BC

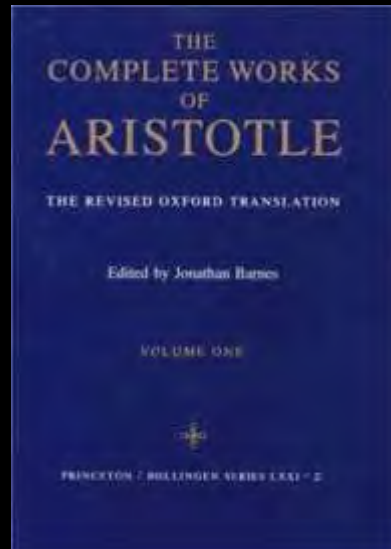
Philosopher of Nature

Natural Philosophy

In Aristotle's terminology, "natural philosophy" is a branch of philosophy examining the phenomena of the natural world, and includes fields that would be regarded today as physics, biology and other natural sciences.

"Natural Philosophy" was the term used for science until the "Scientific Revolution" in the 1600s – although the English word "scientist" was not coined until the 1800s

Observation before theory



Plato (left) and Aristotle (right), a detail of The School of Athens, a fresco by Raphael.

Aristotle gestures to the earth, representing his belief in knowledge through empirical observation and experience.

Plato gestures to the heavens, representing his belief in The Forms.

Classification of Living Things – *History of Animals*

The Great Chain of Being



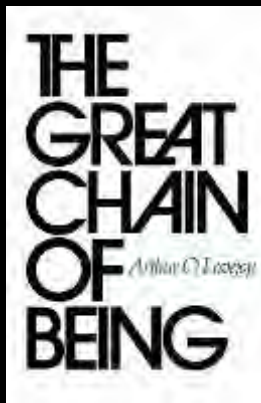
Aristotle's classification of living things contains some elements which still existed in the 19th century. What the modern zoologist would call vertebrates and invertebrates, Aristotle called 'animals with blood' and 'animals without blood'

Aristotle sets out to investigate the existing facts (what), prior to establishing their causes (why).

Aristotle investigates four types of differences between animals: differences in particular body parts (Books I to IV); differences in ways of life and types of activity (Books V, VI, VII and IX); and differences in specific characters (Book VIII)

Aristotle's *History of Animals* classified organisms in relation to a hierarchical "Ladder of Life" (*scala naturae*), placing them according to complexity of structure and function so that higher organisms showed greater vitality and ability to move.

This was the Great Chain of Being.



Arthur O. Lovejoy (1964. First published 1936), *The Great Chain of Being: A Study of the History of an Idea*, Cambridge, Massachusetts: Harvard University Press

On the Causes of Plants

Theophrastus

371 – 287 BC

The Father of Botany

Studied in Plato's school and after Plato's death, he was Aristotle's student. Aristotle bequeathed to Theophrastus his writings and designated him as his successor at the Lyceum

The most important of his books are two large botanical treatises, *Enquiry into Plants*, and *On the Causes of Plants*, which constitute the most important contribution to botanical science during antiquity and the Middle Ages, the first systemization of the botanical world.

On the Causes of Plants was originally eight books, of which six survive.

A horticultural work:

- the growth of plants;
- the influences on their fecundity;
- the proper times they should be sown and reaped;
- the methods of preparing the soil, manuring it, and the use of tools;
- and of the smells, tastes, and properties of many types of plants.



The Enquiry into Plants

Theophrastus

The Father of Taxonomy

The Enquiry into Plants was originally ten books, of which nine survive. The work is arranged into a system whereby plants are classified according to their modes of generation, their localities, their sizes, and according to their practical uses such as foods, juices, herbs, etc.

Another of his innovations was to classify plants using a hierarchical arrangement with an attention to defining characteristics based on –

- morphology [external and internal form – trees, shrubs, under-shrubs, herbs]
- Their localities
- mode of reproduction
- response to environmental factors



Collector of Knowledge

Pliny the Elder

23 – 79 AD (Died at the eruption of Vesuvius)

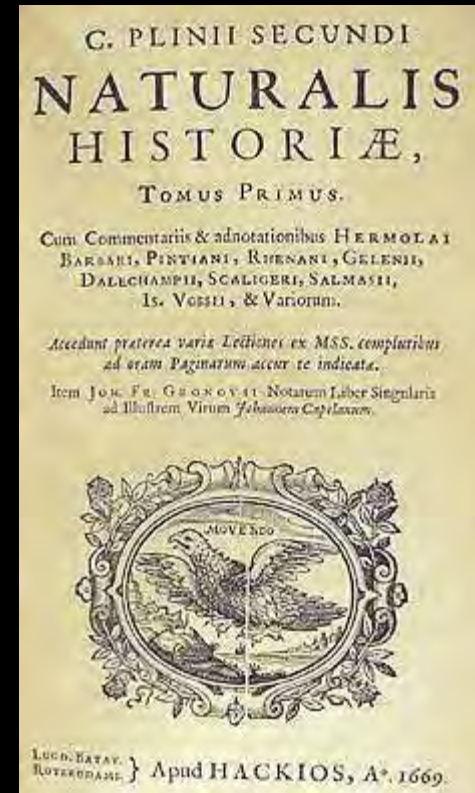
Naturalis Historia (Study of Nature)

Spending most of his spare time studying, writing or investigating natural and geographic phenomena in the field, he wrote an encyclopedic work, *Naturalis Historia*, which became a model for all natural histories and encyclopedias written subsequently, in terms of the breadth of subject matter examined, the need to reference original authors, and a comprehensive index list of the contents.

The *Naturalis Historia* is one of the largest single works to have survived from the Roman empire and purports to cover the entire field of ancient knowledge, based on the best authorities available to Pliny.

It encompasses the fields of botany, zoology, astronomy, geology and mineralogy as well as the exploitation of those resources.

“My subject is a barren one – the world of nature, or in other words life; and that subject in its least elevated department, and employing either rustic terms or foreign, nay barbarian words that actually have to be introduced with an apology.”



“take the question to nature”

The Scientific “Revolution”

- Nicolaus Copernicus *On the Revolutions of the Heavenly Sphere* 1546

Francis Bacon 1561 – 1626

English philosopher, statesman, lawyer, and pioneer of the scientific method

In *Novum Organum*, (1620) or "new instrument", Francis Bacon argued “take the question to nature”

“Men have sought to make a world from their own conception and to draw from their own minds all the material which they employed, but if, instead of doing so, they had consulted experience and observation, they would have the facts and not opinions to reason about, and might have ultimately arrived at the knowledge of the laws which govern the material world.”

Scholastic philosophy at the time mainly used deductive syllogisms to interpret nature, mainly owing to Aristotle's logic.

The philosopher should instead proceed through inductive reasoning from fact to axiom to physical law and learn by observation and experiment



Converse with Nature

Botanical Classification and Natural Theology

John Ray 1627 – 1705

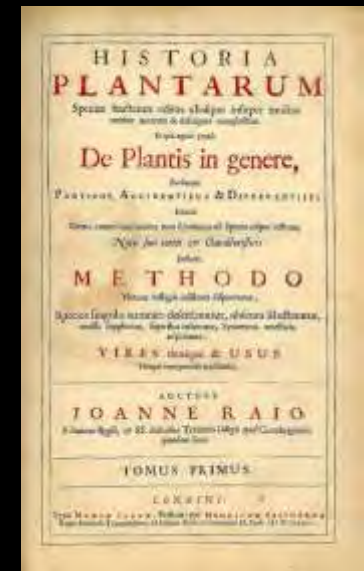
The father of English natural history, Ray published important works on botany, zoology, and natural theology.

“Let us not suffice to be book-learned, to read what others have written and to take upon trust more falsehood than truth, but let us ourselves examine things as we have opportunity and converse with Nature as well as with books.”

His classification of plants in his *Historia Plantarum*, was an important step towards modern taxonomy.

Ray rejected the system of dichotomous division by which species were classified according to a pre-conceived, either/or type system, and instead classified plants according to similarities and differences that emerged from observation. Thus, he advanced scientific empiricism against the deductive rationalism of the scholastics, but he still believed a natural theology that empirical study of Nature revealed divine order and design in the world.

He was the first to give a biological definition of the term species



The Natural History of the Microcosmos

Robert Hooke (1635-1703)

Hooke devised the compound microscope and illumination system and used it in his demonstrations at the Royal Society's meetings. *Micrographia* (1665) was an accurate and detailed record of his observations, illustrated with magnificent drawings.

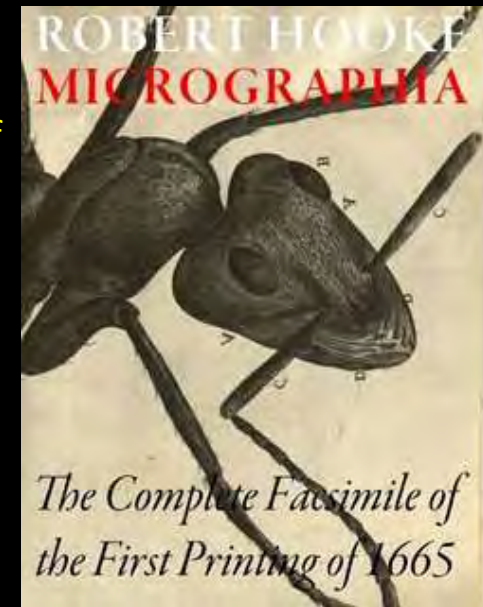
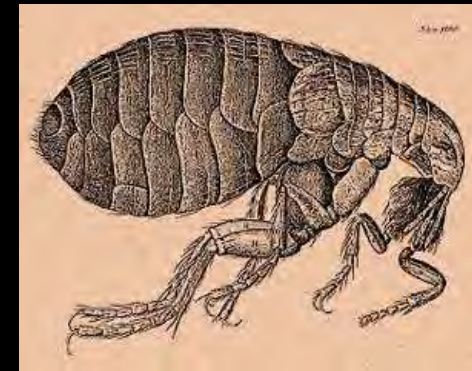


Plant "cells"

Perhaps his most famous microscopical observation was his study of thin slices of cork,

... I could exceedingly plainly perceive it to be all perforated and porous, much like a Honey-comb, but that the pores of it were not regular. . . . these pores, or cells, . . . were indeed the first microscopical pores I ever saw, and perhaps, that were ever seen, for I had not met with any Writer or Person, that had made any mention of them before this. . .

Hooke had discovered plant cells and coined the term "cells": the boxlike cells of cork reminded him of the cells of a monastery.



The Natural History of the Microcosmos

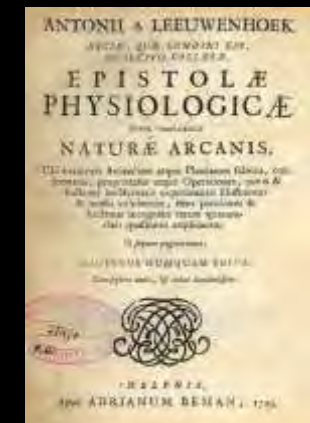
Antony van Leeuwenhoek 1632 – 1723
Father of Microbiology

The first to see bacteria

Looking at this water...the motion of most of these animalcules was so swift, and so various – upwards, downwards, and round about, that twas wonderful to see.

Until the day Leeuwenhoek put a glass phial of lake water in front of his microscope lens, no one had any idea of the extent of the world's microbial populations.

Single lens not compound like Hooke - This incredible instrument has a magnification factor of about 275x (even considering a scratch on the lens) with a resolution approaching one micron.

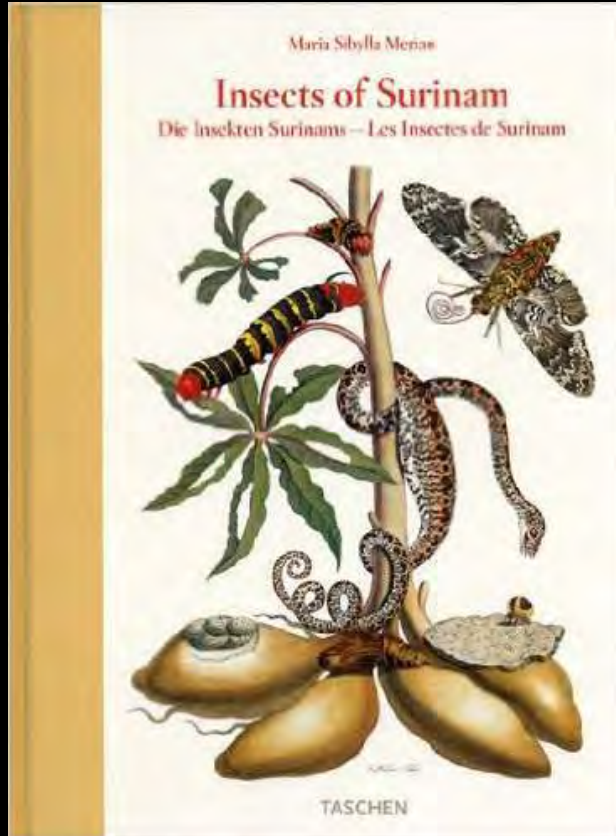


The Natural History of Insects
Maria Sibylla Merian 1647-1717

Artist Naturalist

The Caterpillars' Marvelous Transformation
and Strange Floral Food 1679

Metamorphosis Insectorum Surinamensium 1705



Voyages and Collections

[April Lunchtime Lecture – The Nature Collectors]

Hans Sloane 1660-1753

Natural History of Jamaica 1707

The Great Collector – founding core of British Museum



The museum first opened to the public on 15 January 1759, in Montagu House

Joseph Banks 1743-1820

Founds the Royal Botanic Gardens at Kew

Leads the Royal Society – major patron of collecting



Classification and Identification - Is it animal, vegetable or mineral?

Carl Linnaeus 1707 – 1778

Swedish botanist, professor of botany at Uppsala who laid the foundations for the modern scheme of binomial nomenclature.

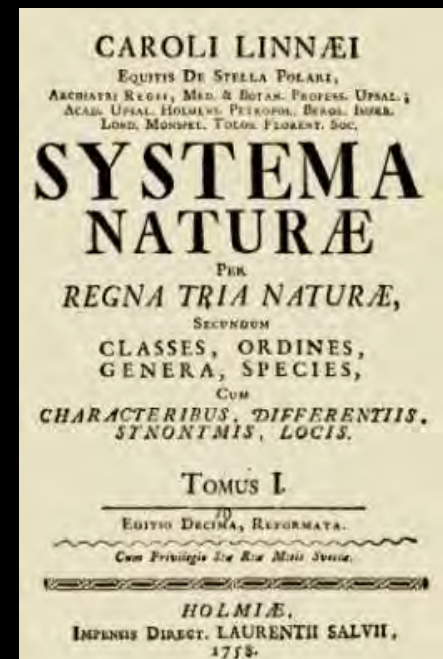
Systema Naturae 1735.

The classification was based on five levels: kingdom, class, order, genus, and species

His “sexual system” of taxonomy used the flower and its reproductive parts to structure the taxonomy. Count the number of stamens (male organs) to determine the class, and the number of pistils (female organs) to determine the order.

It was remarkably useful for the practical purposes of identification but inconsistent for animal classification.

1. *Mammalia* comprised the mammals. Humans in primates
2. *Aves* comprised the birds.
3. *Amphibia* comprised amphibians, reptiles, and assorted fishes
4. *Pisces* comprised the bony fishes.
5. *Insecta* comprised all arthropods.
6. *Vermes* comprised the remaining invertebrates, roughly divided into "worms", molluscs, and hard-shelled organisms



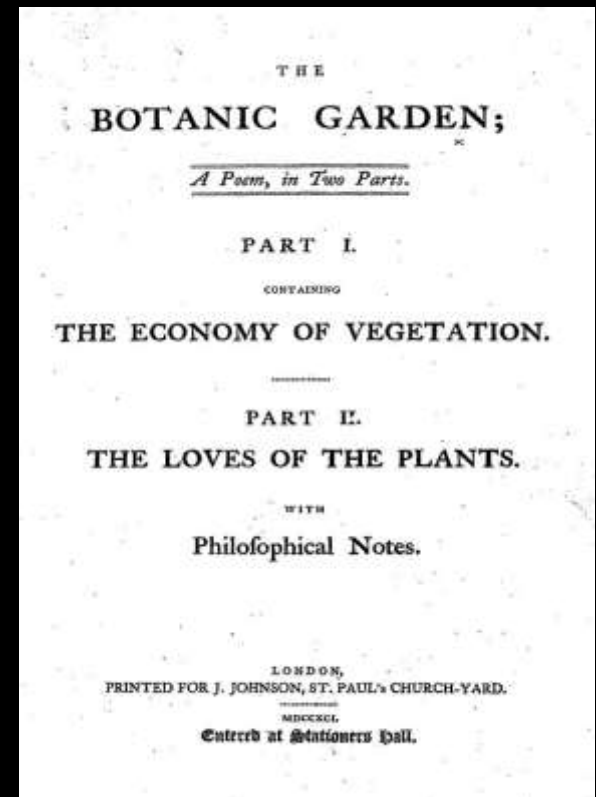
"to Inlist Imagination under the banner of Science"
Evolutionary Beginnings

Erasmus Darwin 1731 – 1802
English physician, poet, and naturalist
Grandfather of Charles Darwin

The Botanic Garden (1791) is a set of two poems, *The Economy of Vegetation* and *The Loves of the Plants*.

Loves of the Plants promotes, revises and illustrates Linnaeus's classification scheme for plants.

Sexual reproduction was at the heart of evolutionary change and progress, in humans as well as plants



Classification and Natural Diversity

Encyclopedia of Life

Comte de Buffon 1707–1788

French naturalist, mathematician, cosmologist, and encyclopedic author.

Buffon published thirty-six quarto volumes of his *Histoire naturelle*

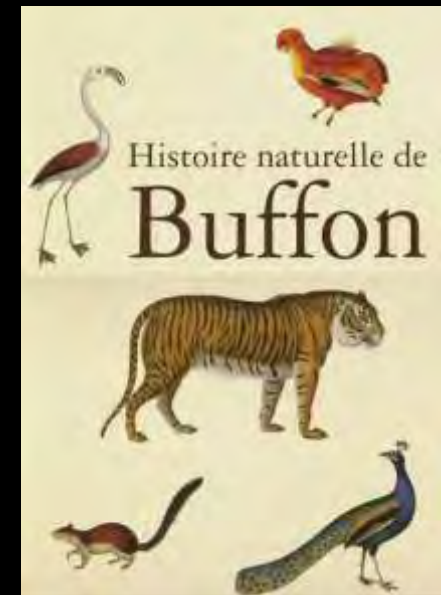
Histoire naturelle 1749–1788 - Buffon questioned the usefulness of mathematics, criticized Carl Linnaeus's taxonomical approach to natural history.

In contrast to Linnaeus, Buffon was less concerned with identification and more interested in vividly illustrating plenitude, diversity, and continuity of animal species.

Buffon insisted we “must make use of all parts of the object” for classification, including internal anatomy, behavior, and distribution.

Biogeography - In the course of his examination of the animal world, Buffon noted that despite similar environments, different regions have distinct plants and animals, a concept later known as Buffon's Law.

He was not an evolutionist, yet he was the father of evolutionism. He made the suggestion that species may have both "improved" and "degenerated" after dispersing from a center of creation.



From Classification to Theory of Life

Evolution

Jean-Baptiste Lamarck 1744-1829

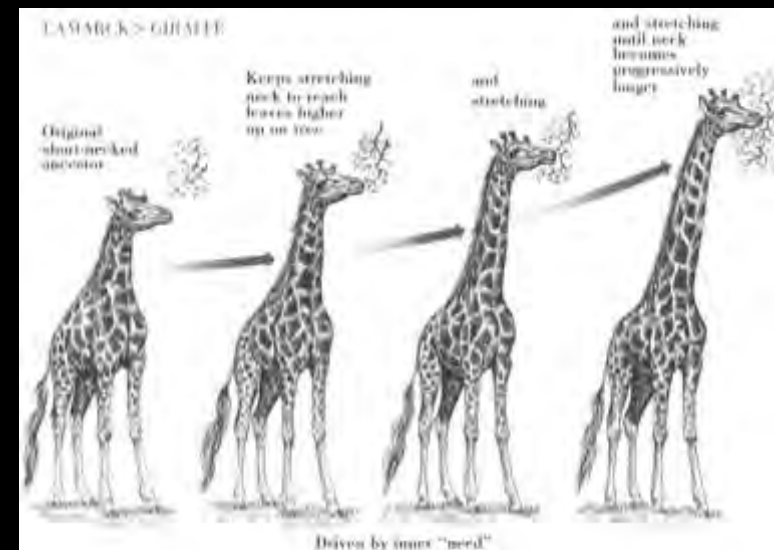
Gradual transmutation of one form into another

Lamarckian evolution - the environment gives rise to changes in animals.

Lamarck is usually remembered for his belief in the inheritance of acquired characteristics, and the use and disuse model by which organisms developed their characteristics. Lamarck incorporated this belief into his theory of evolution, along with other more common beliefs of the time, such as spontaneous generation.

“A change in the environment brings about change in needs, resulting in change in behavior, bringing change in organ usage and development, bringing change in form over time – and thus the gradual transmutation of the species”

La Philosophie zoologique - Jean Baptiste Lamarck (1809)



Father of Paleontology – Extinction and the Animal Kingdom Georges Cuvier 1769-1832

Cuvier was instrumental in establishing the fields of comparative anatomy and paleontology through his work in comparing living animals with fossils.

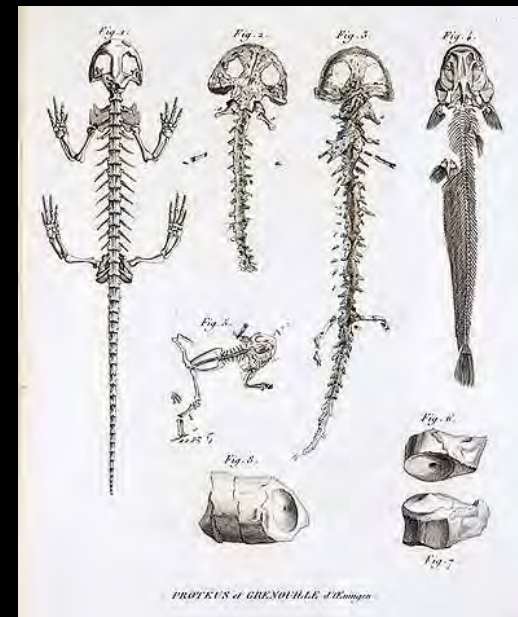
He expanded Linnaean taxonomy by grouping classes into phyla and incorporating both fossils and living species into the classification.

Cuvier is also known for establishing extinction as a fact—at the time, extinction was considered by many of Cuvier's contemporaries to be merely speculation.

Cuvier was critical of the evolutionary theories proposed by Lamarck which involved the gradual transmutation of one form into another.

Gradualism "rested on two arbitrary suppositions; the one, that it is the seminal vapor which organizes the embryo; the other, that efforts and desires may engender organs. A system established on such foundations may amuse the imagination of a poet; a metaphysician may derive from it an entirely new series of systems; but it cannot for a moment bear the examination of anyone who has dissected a hand, a viscus, or even a feather."

Cuvier believed there was no evidence for the evolution of organic forms, but rather evidence for successive creations after catastrophic extinction events.



The Natural History of the New World Artist Naturalist in North America

Mark Catesby 1683-1749
Botany and Ornithology

Natural History of Carolina, Florida, and the Bahama Islands
(Two volumes 1732-43)

He was the first to depict birds, in conjunction with environmentally relevant plants.

1747, "Of birds of passage" one of the first people to describe bird migration.



The Natural History of the New World - Artist Naturalist in North America

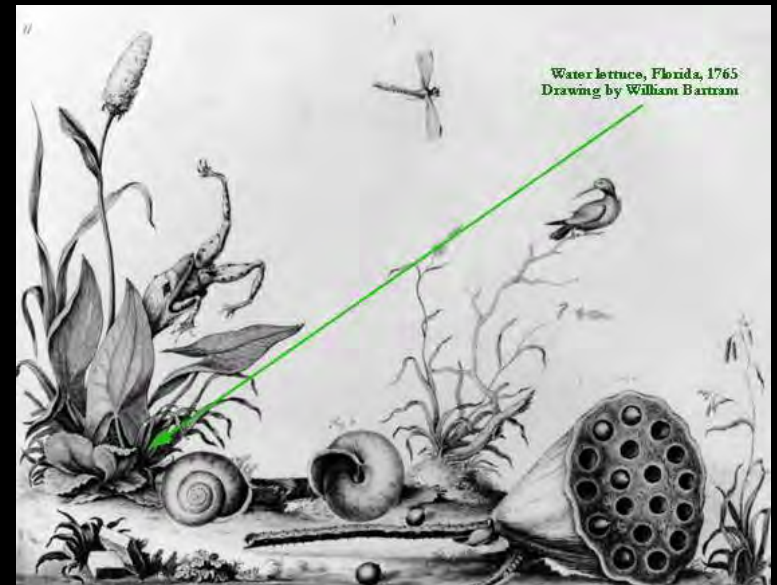
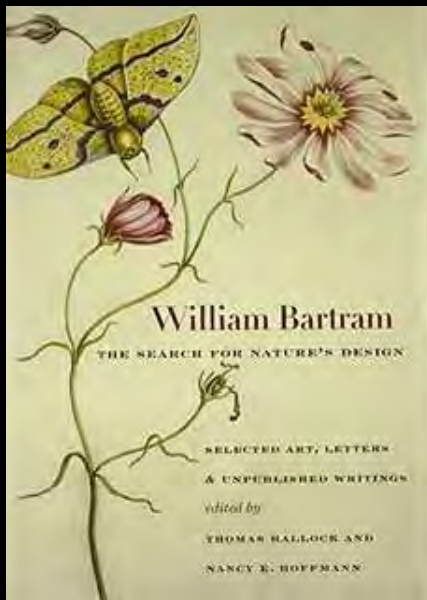
William Bartram 1739-1823 (son of John Bartram 1699-1777)

Travels through North and South Carolina, Georgia, East and West Florida (1791)

An aesthetic appreciation of nature with an accurate recording of data based on long term observations

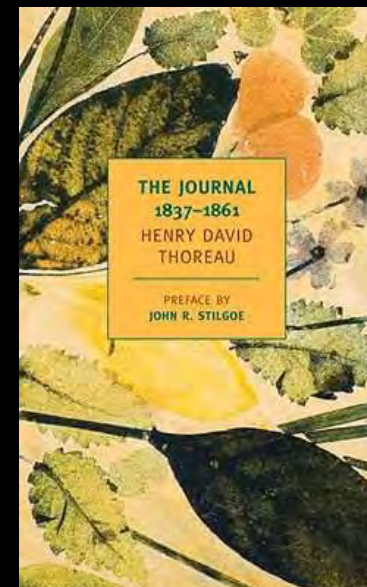
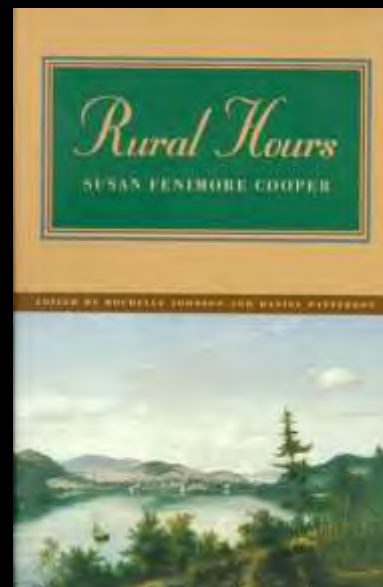
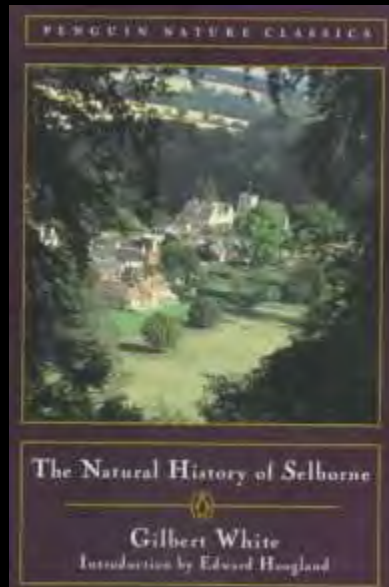
"It was now after noon; I approached a charming vale, amidst sublimely high forests, awful shades! Darkness gathers around, far distant thunder rolls over the trembling hills; the black clouds with august majesty and power, moves slowly forwards, shading regions of towering hills, and threatening all the destructions of a thunderstorm; all around is now still as death, not a whisper is heard, but a total inactivity and silence seems to pervade the earth; the birds afraid to utter a chirrup, and in low tremulous voices take leave of each other, seeking covert and safety; every insect is silenced, and nothing heard but the roaring of the approaching hurricane..."

Admiration for Native American culture, Quaker/Pantheist – interconnection and underlying harmony



Natural History and Literature

The Literary Naturalists



The Literary Turn – English Literary Natural History

Gilbert White 1720 – 1793

Long-term “Ecological” study

English clergyman and first literary naturalist

Born in his grandfather's vicarage at Selborne in Hampshire

The Natural History and Antiquities of Selborne (1789), still in print and over 300 editions.

Includes human impacts “antiquities”

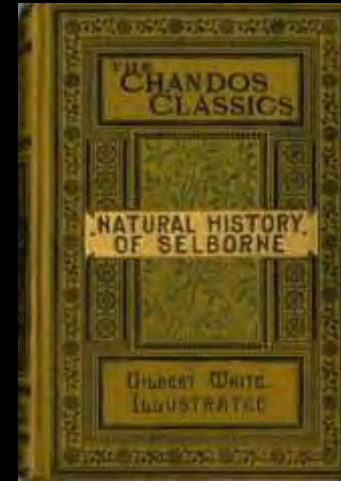
Modern Literary Natural History

- 'Naturalist's Calendar' comparing observations made by White and William Markwick of the first appearances in the year of different animals and plants

- observations of natural history organized more or less systematically by species and group

He said of the earthworm:

Earthworms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm. [...] worms seem to be the great promoters of vegetation, which would proceed but lamely without them...



American Literary Natural Histories

The Beginning of American Nature Writing

Susan Fenimore Cooper 1813-1894

The eldest daughter of American novelist James Fenimore Cooper, was an amateur naturalist and a successful author in her own right. Her nature diary, *Rural Hours* (1850), covering two years in Cooperstown, New York, was consulted by Henry David Thoreau while he was composing *Walden*

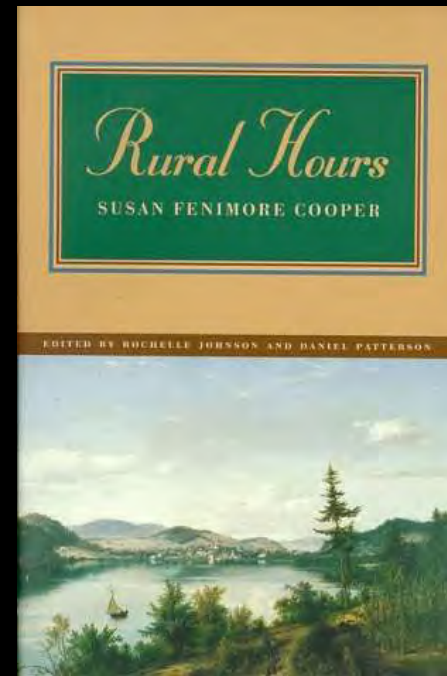
In the preface to *Rural Hours*, Cooper describes her book as "the simple record of those little events which make up the course of the seasons in rural life. . . . In wandering about the fields, during a long, unbroken residence in the country, one naturally gleans many trifling observations on rustic matters."

Human impacts on the environment

"While observing, this afternoon, the smooth fields about us, it was easy, within the few miles of country in sight at the moment, to pick out parcels of land in widely different conditions, and we amused ourselves by following upon the hill-sides the steps of the husbandman, from the first rude clearing, through every successive stage of tillage, all within range of the eye at the same instant.

...

But, there are softer touches also, telling the same story of recent cultivation. It frequently, happens, that walking about our farms, among rich fields, smooth and well worked, one comes to a low bank, or some little nook, a strip of land never yet cultivated, though surrounded on all sides by ripening crops of eastern grains and grasses. One always knows such places by the pretty native plants growing there."



Observation of Nature

Natural History as Literature and Science

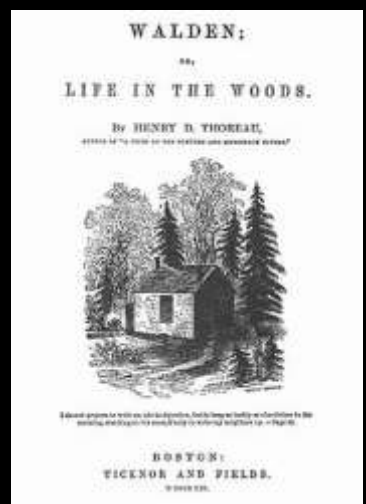
Henry David Thoreau 1817-1862

He kept detailed observations of nature around Concord, recording everything from how the fruit ripened over time to the fluctuating depths of Walden Pond and the days certain birds migrated.

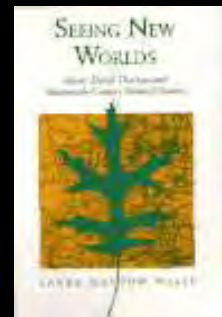
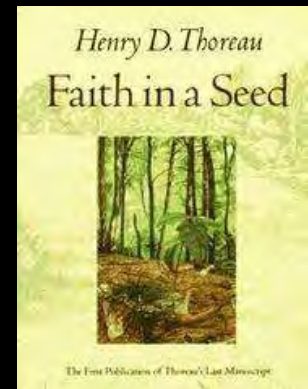
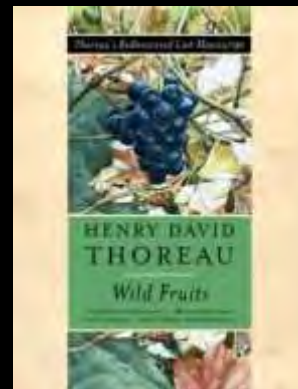
He became a land surveyor and continued to write increasingly detailed natural history observations about the Concord area in his journal, a two-million word document he kept for 24 years. He also kept a series of notebooks, and these observations became the source for Thoreau's late natural history writings, such as *Autumnal Tints*, *The Succession of Trees*, and *Wild Apples*, an essay lamenting the destruction of indigenous and wild apple species.

Until the 1970s, literary critics dismissed Thoreau's late pursuits as amateur science.

With the rise of environmental history and ecological literary criticism a new perception emerged, showing Thoreau to be both a writer and an analyst of ecological patterns in Concord's fields and woods – a naturalist.



Published 1854



Themes

- Observation
- Description
- Classification
- Encyclopedias
- Biogeography
- Collecting
- Amateurs to Professionals
- Naturalists to Biologists
- Artists as Naturalists
- Natural History as Literature

