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MIDDLE MIOCENE (Serravallian)

UPPER MIOCENE (Tortonian)

GLOSSARY
Theory Book

The Aegean Archipelago, an active evolutionary biology lab

UPPER MIOCENE (Messinian)

PLIOCENE

GLOSSARY Theory Book

The Aegean Archipelago, an active evolutionary biology lab

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Aegeis: It is the land region during the Lower Miocene, which included the today' s Greece, together with the Aegean archipelago, as well as the western coasts of Turkey. At the same period, the climate was much warmer than today, and Aegeis was covered by extensive forests and savannas with freshwater lakes.

Archipelago: It is an area that contains a chain or group of islands scattered in the ocean or a lake, e.g., the Solentiname Archipelago in the lake Cocibolca – Nicaragua, the Aegean Archipelago at the Mediterranean sea, Galapagos Archipelago in the Pacific ocean, etc.

Balanced fauna: A fauna is considered as balanced when not any trophic level is missing, i.e., it consists of herbivores and carnivores.

Biodiversity: It is also called biological diversity. It is the variety of life found in a place on Earth or, often, the total variety of life on Earth. A common measure of this variety, called species richness, is the number of species in an area. Biodiversity also encompasses the genetic variety within each species and the variety of ecosystems that species create.

Biodiversity patterns: Biodiversity usually follows certain patterns. Darwin has observed three characteristic patterns of biodiversity: (1) The species vary worldwide: species that live in similar ecosystems but in different parts of the world, are quite similar to each other and have similar behaviors, such as e.g. the Emu birds of Australia, with the Rhea of South America and the Ostriches of Africa (they are all birds that do not fly). (2) The species vary locally, depending on the conditions prevailing in each area. For example, the Galapagos Islands are a group of islands relatively close to each other, but with different environmental conditions in each. Darwin has observed differences between the shape of the turtle shell and the beak of the finches on different islands, relative to those conditions. (3) The species vary over time: from fossil studies, it has been found that some species were huge versions of modern species, such as e.g. the fossils of the glyptodont (3 meters long) are very similar to the modern armadillo (50 cm long), but much bigger. Basic biodiversity standards depend on latitude, altitude, and species-area relationships. Species diversity also fluctuates in patterns over time, such as seasonally and sequentially.

Bioinformatics: a hybrid science that links biological data with techniques for information storage, distribution, and analysis to support multiple areas of scientific research (Biology with Informatics, Statistics and Mathematics), including biomedicine.

Biology: The word biology is derived from the Greek words "bios" meaning "life" and "logos" meaning "study" and it is defined as the science of life and living organisms. Aspects of biological science range from the study of molecular mechanisms in cells, to the classification and behaviour of organisms, how species evolve as well as interaction between ecosystems.

Bipedalism: a major type of locomotion, involving movement on two feet, especially in primates, to stand and walk on their two hind limbs.

Carnivorous animals: They are organisms eating other animals.

Climate: It is the average weather of an area, which results from the long-term observations of various meteorological elements. Climate, therefore, is something different from the weather, characterized as a natural state of the atmosphere over a short period of time. Climate plays a very important role, both in the plant and animal kingdom. Climate defines vegetation zones as well as the distribution of animals and humans on earth. The predominant types of climates are tropical, subtropical, desert, mediterranean, temperate, continental and polar.

Computer Science: It studies the theoretical basis and nature of information, algorithms, and calculations, as well as their technological applications in automated computer systems.

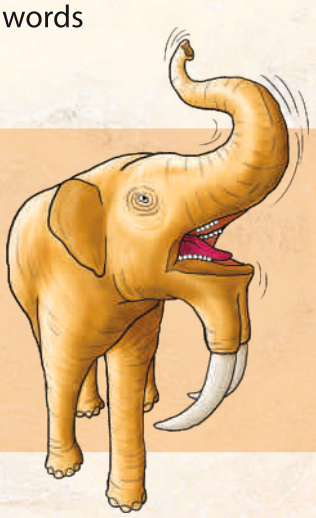
Computational Phylogeny: Hypothesis testing and statistical analysis in Phylogeny (i.e., the study of the evolutionary history of different organisms).

Continental/Volcanic islands: They are islands that are close to or geologically related to a continent, while oceanic or volcanic islands are those created by volcanic eruptions in the oceans. Continental islands in Greece are Crete, Rhodes, Kythira, and many more, while some islands of the Greek Volvanic Arc (Giali and Misyros) are volcanic.) are volcanic.

Cyclops: Mythical one-eyed giants, who are mentioned in Greek and Roman mythology. The origin of the Cyclops' myth may refer to the attempt of our ancestors to explain the origin of some fossilized skulls. These skulls have had large nostrils in the cuticle, and belonged to proboscideans, like dwarf elephants and deinotheriums, which had disappeared from the Greek area long before humans appear there.

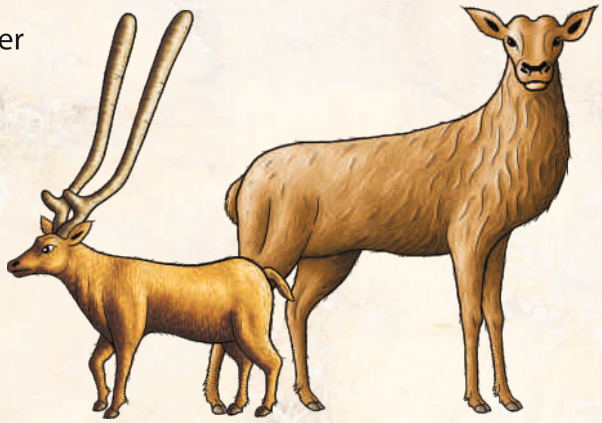
DNA: is a biochemical composition of 2 chains that coil around each other. Each chain is composed of four different compounds, the ***bases***. Each base is sympolized by a single letter: G, A, C, T. DNA is like a book of information and bases G, A, C, T are like the letters that are randomly combined to make up the words in this book.

Deinotherium: It was a mammal, resembling modern elephants, and lived from the Middle Miocene to the Pleistocene. It was distributed in Asia, Africa and Europe. An important difference with today's elephant species is that its tusks were curved downwards and back, rooted in the lower jaw.

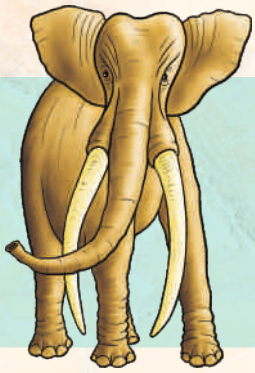


Dinosaurs: They were reptiles that thrived worldwide for nearly 180 million years. They first appeared roughly 230 million years ago. Most of them were extinct by the end of the Cretaceous Period, about 66 million years ago. Nevertheless, many lines of evidence show that one lineage evolved into birds about 155 million years ago.

Dwarfism-Gigantism: Island organisms are quite often much larger (gigantism) or much smaller (dwarfism) than their relatives on the mainland. Gigantism and dwarfism, such as dwarf elephants, dwarf hippos, and giant owls on Mediterranean islands, appear to be the result of environmental pressures on various species. For example, bigger individuals can take advantage of more types of resources, produce more offspring, compete successfully with other species, and have greater energy and water reserves. On the other hand, smaller individuals have less resource requirements and are more specialized in exploiting them, while at the same time they can find more shelters to avoid predators and adverse conditions.



Generally, the following rule seems to apply to island mammals: when found isolated in islands, large mammals, such as large carnivores and herbivores, tend to shrink in size, possibly due to limited island resources (food, shelter, etc.), while small mammals, such as rodents, insectivores, etc., tend to increase it. Another factor that contributes to the increase or decrease in the body size of some mammals is the absence of predators.



Elephant: It is a proboscidean mammal and the largest living terrestrial animal today, characterized by its long trunk (elongated upper lip and nose), with a weight that can reach up to eight tons. Today, it lives in Asia and Africa. During the Pleistocene, elephants also lived in Greece.

Endemism: The designation "Endemic" for a taxon, i.e., a taxonomic group like species, genus, family etc., describes its exclusive presence in a geographical area and nowhere else in the world. This area can be very small (e.g. the spider *Hoplopholcus minous*, endemic to a cave in Karpathos isl., or the plant *Nepeta shakiotika*, endemic to the Lefka Ori Mountains at just a few square meters at an altitude of 2000m), or larger such as an island (e.g. the *scorpion Iurus dekanum, endemic* to Crete isl.) or very large (e.g. the Cactaceae Family, endemic to the American Continent). The endemicity of a designated area is a very important quality element for its flora/fauna. For example, the flora of Crete is considered very important as it has ~ 180 endemic plant species out of the total ~ 1800 it hosts. That is, 10% of the plant species of Crete are found there and **nowhere else in the world**.

Euboictis: A small carnivorous mammal of the Miocene. Its fossils have been found in Aliveri-Greece, dating about 21 million years ago.

Evolutionary Biology: It is a subfield of Biology that studies the evolutionary processes in nature, like endemism, extinctions, speciation, etc.

Fauna: All species of animal organisms (Vertebrates and Invertebrates) found in an area.

Flora: All species of plant organisms found in an area.

Fossils: They are the preserved remains of organisms whose bodies were buried in sediments, such as sand and mud, under ancient seas, lakes and rivers. Fossils also include any preserved trace of life that is typically more than 10000 years old. The scientists who study fossils are called Paleontologists.

Genetic code: is a set of 3-letter combination of the bases of DNA and the amino acids of proteins, produced by the coding of these bases. It is NOT the DNA itself or the genotype.

Geology: It is the science that studies the structure, evolution and dynamics of the Earth and its natural mineral and energy resources. It investigates the processes that have shaped the Earth through its its approximately 4500 million years' history and uses the rock record to unravel that history.

Erathem / Era	System / Period	Series / Epoch	Stage / Age	Numerical Age (Ma)
Cenozoic	Quaternary	Holocene	Meghalayan	0
			Northgrippian	0.0042
			Greenlandian	0.008276
		Pleistocene	Stage 4	0.0117
			Chibanian	0.129
			Calabrian	0.774
			Gelasian	1.8
	Neogene	Pliocene	Piacenzian	2.58
			Zanclean	3.6
		Miocene	Messinian	5.333
			Tortonian	7.246
			Serravallian	11.63
			Langhian	13.82
			Burdigalian	15.97
			Aquitanian	20.44
	Paleogene	Oligocene	Chattian	23.03
			Rupelian	27.82
		Eocene	Priabonian	33.9
			Bartonian	37.8
			Lutetian	41.2
			Ypresian	47.8
				56

Geological chronological scale: It is the global standards (periods, epochs and age) for the fundamental scale for expressing the history of the Earth, by combining geology, archeology and other sciences. The board game "*Giants and Dwarfs"* and the card game *"Aegean's settlers" refer mainly to* period from 23 million years ago (Lower Miocene) to today. The timescale of geological periods in the table at the previous page agrees with the dates and the naming of the International Stratigraphy Committee (www.stratigraphy.org).

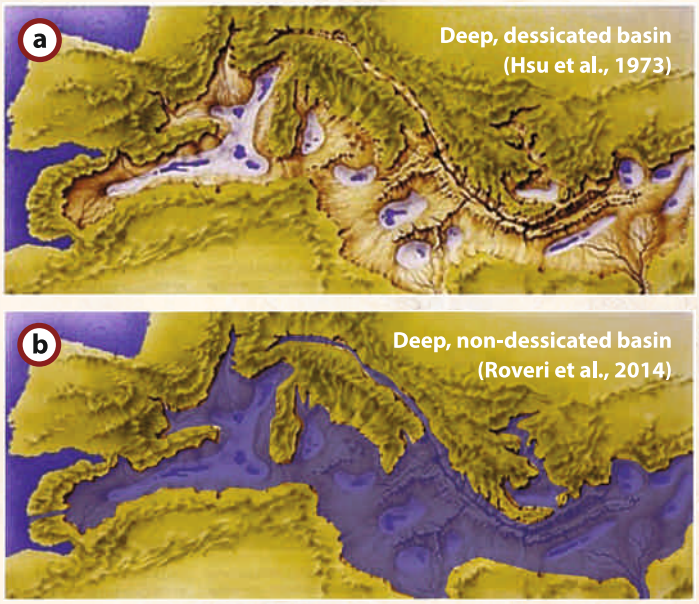
Hippopotamus: It is a large omnivorous mammal that lives in wetlands, now only in Africa. During the Pleistocene, dwarf hippos lived in various parts of the Mediterranean, such as Crete, Sicily, Cyprus and elsewhere.

Mammals: They are vertebrate animals. Some of the characteristics that distinguish them from other vertebrates, i.e. fish, reptiles, amphibians and birds, are: the presence of hair on the skin, although in many whales it has disappeared except in the fetal stage; three ossicles in the middle ear; the young are nourished with milk from special mammary glands of the mother.

Mammoth: It is an extinct group of elephants, (*genus Mammuthus*), in the order of trunked mammals called proboscideans. The various species of mammoths were usually equipped with long, curved tusks and the northern species were covered with long hair (wooly mammoth). They lived from the Pleistocene to the Holocene about 4,000 years ago. Their species were found in Africa, Europe, Asia and North America. A mammoth belongs to the Elephantidae family, which also contains two genera of modern elephants and their ancestors. Mammoths are more closely related to today's Asian elephants than to African elephants.

Mathematical algorithm: It is a series of mathematical formulas or commands that have a beginning and an end, are definite and aim to solve a mathematical problem. In simple words, it is the way to solve a problem. The human brain "runs" several algorithms stimultaneously.

Mediterranean Messinian Salinity Crisis: In the 1970s, most scientists considered it to be a geological event during the Upper Miocene, where the Mediterranean Sea dried up almost completely and turned into a desert with some (salty) lakes (figure A). Today, most agree that at that time, the Mediterranean was transformed into a shallow salt lake, with several land passages between areas that are now islands (figure B) (Krijgsman et al., 2018). The closure of the Mediterranean in the Upper Miocene, was the result of the collision of the southwestern Europe and northwestern Africa. (Duggen et al. 2003, Rouchy & Caruso 2006).



Miocene: It is the earliest major division of the Neogene Period that extended from 23 to 5.3 million years ago. The Miocene followed the Oligocene and was succeeded by the Pliocene. It was a time when the Earth's climate gradually began to cool, ending in the Ice Age. The beginning of Miocene was marked by a rise in sea level, which reached its highest peak in the Mediterranean Sea, during the Middle Miocene. At the same time, the alpine orogeny continued at a more intense rate, resulting in the final formation of the North American and European [Alpine, Dinarides, Albanides, Hellenides, etc.] mountain ranges. Volcanic activity was also intense. Finally, the climate in Central and Mediterranean Europe gradually changed from tropical to subtropical and eventually temperate, which was warmer than it is today.

Monitor lizards: They are large lizards of the genus *Varanus*. About 50 species of *Varanus* are recognized in the subfamily Varaninae. They are found in Africa, south of the Sahara, in southern and southeastern Asia, in Australia, and on islands of the southwestern Pacific ocean. In Greece, fossils of Monitor lizards (*Varanus marathonensis*, *Varanus amnhophilis*) have been found in Pikermi, Samos and elsewhere, dating to the Middle and Upper Miocene.

Paleogeographic map: It is a map, which depicts the geological divisions of the geological past, such as the distribution of land and sea, rivers and lakes, the nature of the continental terrain, the distribution of glaciers and the boundaries of natural zones, etc.

Phylogenetic tree: It is the reconstruction of the phylogenetic relations of species and their representation in a "tree", studying their inherited characteristics and other historical evidence.

Phylogeny: It is the study of the evolutionary history of different organisms.

Phylogeography: It is a scientific area inextricably linked to Phylogeny. It deals with the study of the geographical distribution of genealogical lines within a species or between closely related species. It includes the identification of phylogenetic kinships and their geographical mapping, in order to highlight the evolutionary origin and biogeographical history of the studied populations, subspecies or species.

Pikermi fauna: The animals that lived in Greece during the Upper Miocene, whose fossils were found on the banks of the torrent Megalo Rema, near Pikermi. This fauna includes large proboscideans, such as mastodons (the ancestors of elephants) and the *Deinotherium*, tridactylid horses (*Hipparion*) (the ancestors of horses), rhinos, antelopes, giraffes, deer, monkeys, pigs, ostriches, carnivores, such as monitor lizards, saber-toothed cats, lions, hyenas, dogs and panthers, etc. This fauna has also been found in other areas of Greece, such as Crete.

Pliocene: It is the geological epoch from 5.3 to 2.5 million years ago. It is the second and newest timespan of the Neogene period of the Cenozoic Era. It is located between the Miocene and Pleistocene Epochs. Some typical events of this era were the following: the South America was connected to the North America through the Isthmus of Panama, enabling the exchange of species between the two continents; the formation of the isthmus affected global temperatures as warm equatorial ocean currents were cut off and the cooling cycle of

the Atlantic ocean from the waters of the Arctic and Antarctic Oceans began; the "*Mediterranean Messinian salinity crisis*" is placed between the Miocene and the Pliocene; the average temperature during the Middle Pliocene was 2-3 °C higher than today and the sea surface was 25 meters higher; the Mediterranean climate was established, which was characterized by hot and dry summers and cool and wet winters; at the end of the Pliocene, the first *Australopithecus* hominids appeared.

Pleistocene: it is the geological epoch that includes the time period from 2,588,000 to about 11,700 years ago. Together with the Holocene, they form the Quaternary period. It is placed between the Holocene and the Pliocene. Towards the end of the Pleistocene, hot (interglacial) and cold (glacial) periods, known as the "*Ice Age*", alternated. Scientists distinguish four large glacial periods, during which the size of the glaciers increased and the sea level dropped, thus creating land bridges that allowed the easier movement of many species.

Reptiles: It is a group of air-breathing vertebrates that have epidermal scales covering part or all of their body. They are oviparous (lay eggs) or ovoviviparous (produce eggs, but instead of laying them, the eggs develop and hatch inside the mother's body and remain there for a time). They have internal fertilization. They inhabit all continents except Antarctica.

Sirenia: They are aquatic mammals, known also as sea cows. They have no legs, but fins to swim. Today well-known sirens are dugongs and manatees. There are many species that have gone extinct and we find them as fossils. The Sirenia of the genus *Metaxytherium* were a common marine mammal of the Mediterranean basin that lived near the coasts, mainly during the Miocene, in Italy, France, Catalan Spain, Mallorca, Portugal, Hungary, Germany, Slovakia, Austria and Greece. In Greece, so far, they have been found only in Crete.

Speciation: It is the formation of new and distinct species in the process of evolution.

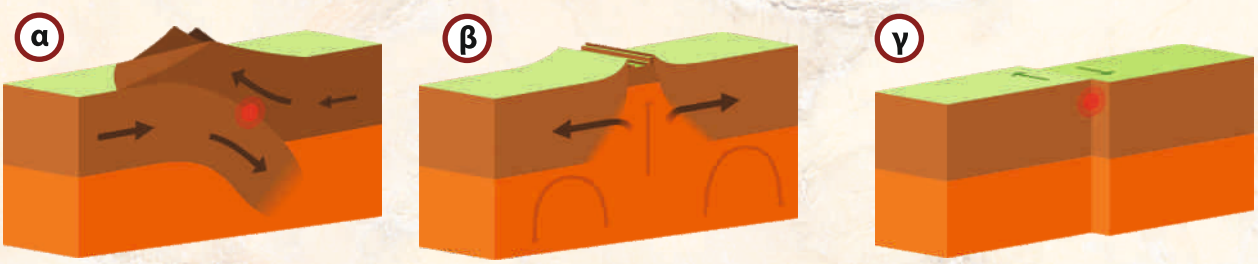
Species (biological species): It is a group of organisms that have structural, functional and developmental similarities and are capable of interbreeding producing fertile offspring. It is the first level of the classification (taxon) of organisms

Species (paleontological species): It is a collection of forms of similar geological age. As they have similar morphological features, they are recognized as unique. However, they do contain characters that differentiate them from other species. In the paleontological species the reproduction process cannot be identified.

Systematics: In a broad sense, it is the science of classification, but more strictly, it is the classification of living and extinct organisms, based on their characteristics.

Tectonic or Lithospheric Slabs/Plates: According to the theory of tectonic or lithospheric plates, developed in the late 1950s, the Earth's lithosphere is divided into a small number of tectonic plates, which are in contact and move "floating" on its mantle. They are in constant motion during geological time, an indication of the living nature of the planet. Most of the Earth's seismic activity occurs near the boundaries of these plates. The outer lithosphere of the Earth is composed of about twelve large plates and several smaller ones. Within the delimitation of each plate, the rocks of the earth's crust move as a single rigid body with little bending and few volcanic or seismic manifestations. The boundaries of the plates are defined by narrow zones, on which 80% of volcanic and seismic activity occurs.

The movements of tectonic or lithospheric plates: Slabs can move as follows: a) they **converge**, when adjacent lithospheric plates approach each other, at which point crust is destroyed because one plate sinks beneath the other in the subduction zones, b) they **diverge**, when the adjacent lithospheric plates draw away from each other, at which point a crust is produced, since new material comes out from the gap between the two plates and cools, thus giving new crust and c) they **slide laterally**, when there is lateral movement between the lithospheric plates without production or destruction of crust.



Unbalanced fauna: It is a fauna where a trophic level is missing, e.g. it is devoid of terrestrial mammals, such as carnivores.

Weather: The general term "weather" refers to the state of the atmosphere at a particular place during a short period of time. It involves atmospheric phenomena such as temperature, humidity, precipitation (type and amount), air pressure, wind, and cloud cover and whatever other phenomenon accompanies them, on land, at sea or in the air of the same place. The science that examines the weather is Meteorology.

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CONVENTION ON BIOLOGICAL DIVERSITY. 5th NATIONAL REPORT of Greece
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