

History as Cosmic Education: The Time Line of Life

The Time Line of Life depicts evolution on a long pictorial chart about 6 feet long and 2 feet tall. Across the top are colored strips that name and represent the eras—Paleozoic, Mesozoic, Cenozoic, and squeezed into the end, a tiny slot for the Neozoic Era. Additional titles below each of those epochs are further designations of time such as the “Age of Invertebrates.” Animal and plant species are colorfully illustrated across the time line, with red lines showing the rise and fall of each. Some species dominate the landscape of life briefly before disappearing or being subsumed by the next evolving species. Some of the red lines, such as one associated with sea sponges, continue horizontally across the full length of the line.

In many Montessori elementary classrooms, there is a “hands-on” material consisting of a “titles-only” Time Line of Life accompanied by numerous folders containing the pictures from each epoch. Students can rehearse the stories as they place the pictures for each era on the line.

The lessons described in this section suggest two presentations of the Time Line of Life, moving from the first simple introduction to a presentation with more details, richer stories, and some philosophical interpretations. In fact, the Montessori guide usually brings the Time Line of Life out for inspection, interpretation and elaboration many times. Students do, too.

THE TIME LINE OF LIFE

Materials

1. The time line of life.
2. A colored elastic band that stretches the length of the time line, the colors first corresponding to those on the strip of time and then, when stretched, corresponding to the length of the time line of life.

Presentation #1: The General Plan of the time line

1. Use the elastic band to show how we have expanded the time indicated in the four hours of the strip of time to the longer Time Line of Life which we now explore.
2. Begin with the first row of titles, those denoting the eras which the child knows. Review the names and characteristics:

The Paleozoic Era is shown with this blue strip at the top. It is the era of the old animals and it is the longest because it was the widest on our clock of time.

The Mesozoic Era comes next, and in it we have the animals of the middle period.

Then comes the Cenozoic Era (also called the Tertiary Era for third) and this is the era of the new animals.

Last comes the new new animals in the Neozoic Era or Quaternary Era (fourth). This very new animal is man. It is a very little section and it is red.

3. Analyze the next row of titles: the children must have been previously introduced to the two invertebrate and vertebrate charts at this point to understand the presentation.

NOTE: Show the vertebrate and invertebrate charts again at this juncture in the study of the time line. Ask: which are the vertebrates and which the invertebrates? Review. THEN

First we see the Age of the Invertebrates. On our time line, then, we see that up to this point, all the animals were invertebrates.

Then comes the Age of Fish. Where are the fish on our charts?

The fish is the first of the vertebrates to appear on the time line of life.

Then the Age of the Amphibians. Where are the amphibians on the chart?
What does amphibian mean?

Then, during all the time up to this point, all the life has been in the water. But now, with the amphibians, the young live in the water, but the adults are able to live on land.

The Age of Reptiles. Here are the first animals that live entirely on land. The reptiles become the real lords of the land.

The Age of Mammals. The birds are included here. And the last one included here, the last to appear, is man.

4. Analyze the next row of titles.

Here we have the Age of the Trilobites. This is the first part of the long Age of the Invertebrates. During this period the trilobites are the most important organism, and the strongest. They populate the earth.

THE TIME LINE OF LIFE. . .

First General Presentation. . .

4. the third row of titles. . .

Then comes the Age of the Sea Lilies (Crenons). These animals covered the bottom of the ocean. They are called lilies because for a long time, having found the skeletons of these lilies, men believed they were flowers. Eventually they discovered that they had been animals. These animals belong to the echinoderm group.

NOTE: Be sure that the children have met these animals on the animal charts previous to the introduction here. This is true as we proceed with the introduction of further points of the time line. . . they must first meet the animal always on the charts.

5. Note with the children that there are other titles on the time line, and that we will explore them later.
6. Examine the ice ages:
Look at this ice cycle after the trilobites. We can find three more on the time line: four in all.
These ice cycles represent a time of great ice. Every so many million years the earth and almost the whole ocean is covered with ice. These are called Glacial Periods.
7. Note the significance of the red lines:
Notice the red lines that go up and down on the time line. Some of the red lines end. Others go on and on. These lines represent the appearance, the existence, the decline and the death of animals. This is the fate of the trilobites---their red line ends. BUT some red lines start way back in time, and those animals go on living, perhaps modified, but still living---and so those red lines are very long.
8. Note the mountains:
Notice the mountains here---and here. These mountains signify the earth's constantly changing crust. . . we'll find out when those mountains appeared, and why.

Presentation #2: Proceeding to the Details

To be introduced when the children know well the titles introduced so far, the meaning of the lines, etc.

1. Analyze the last set of titles:

The Cambrian Period. The name of this period comes from the region where the first fossils of this period were discovered. . . a place in Wales called Cambria.

Which are the animals shown here that we know?

- 1) the worm
- 2) the coelenterates (the jellyfish)
- 3) the porifera (sponge)
- 4) the snail (mollusk, univalve)
- 5) mollusk - bivalve
- 6) crustacean
- 7) arthropoda
- 8) protozoan (shown at the top)

AND the trilobites. Let's look at these. There are so many. We don't have these on our charts because they don't exist any more. They belong to the crustacean group. . . to arthropoda.
Look at the trilobite red line---where does it end? During the red line, these trilobites were in great numbers---the biggest was 30 cm. long.

THE TIME LINE OF LIFE. . .

Presentation #2. . .

1. . .the last set of titles. . .

Trilobites. . .

The trilobites had no enemies, so they multiplied fast. Why did they disappear? They were very strong. We don't know exactly why, but it began to happen during the glacial period. The trilobites were not prepared for an enemy like the cold. Perhaps they weren't strong enough to resist it. . .they became weaker and died.

There were also plants during this period. All the animals lived in the water, but some plants grew on the land.

In the water were very important plants called algae. . .they say we'll end up eating it if the algae doesn't die first.

The Ordovician Period. Coming after the first Glacial Period, this period takes its name from another place in England where the first fossils of the period were found. During this period the line of the trilobites begins to decline. Their kingdom is finished.

Now we find huge mollusks----the horseshoe crab.

crustaceans

echinoderm----large sea scorpions.

The masters of the period were the crinoids, the sea lilies (echinoderm). These animals completely covered the ocean floor.

There were also smaller echinoderm, the "graptoliti," which looked like a bunch of grapes. They, too, disappeared.

During this period, the plant life is dominated by the sea algae.

The Silurian Period. Again named for the place in England, inhabited by the Siluris, where the first fossils of the period were found. There is here only a short period which precedes the second Glacial period.

During this period, the glacier started. The ocean begins to freeze, the water recedes, more land is exposed. And so plants (algae) and animals begin to develop who live in the swamps. NOTE: the small green spots on the chart are the first land algae.

Algae begins to grow and thrive in the sand.

The first plants here can be compared to moss. . .still primitive, simple plants. . .with stem and leaves, but still no roots. (Children must have, at this point, seen the botany nomenclature so that they know the parts of the plants) The plants here still root in the water; and that part of them in the water absorbs for the plant whatever it needs without having actual roots.

These mosses represent progress, a more complex development than the algae. The plants grow towards the light, stimulated to grow towards any possible absorption of light.

Fish are important here----small fish with cartilaginous skeletons: the first animal which appears with an internal skeleton. (Use the animal charts)

The Devonian Period. This period starts with a Glacial period. The first fossils were found in a place in England where lived the Devons. This new period begins during the Age of Fishes. The masters of the period are those fish which have an external skeleton. They are called armoured fish. By the end of the period, fish had developed internal skeletons: half bone and half cartilage: Ganoidei.

Some fish appear with specialties, such as the split-fin tail. It is a period of fish dominance.

The first insects appear on the land. Cockroaches: Orthoptera, meaning "straight wings." This strong, resistant animal still exists.

THE TIME LINE OF LIFE. . .

Second Presentation. . .

1. . .analysis of the last set of titles. . .

The Carboniferous Period. Here we are in the Age of the Amphibians. We see a black and brown rectangle. That represents the transformation of wood into carbon: During this period, the waters of the ocean kept receding and covering the land. The result was an exuberant development of vegetation. Enormous forests developed, special trees with enormous trunks and very few leaves at the top. Ferns of giant size formed in the dense part of the forests. Other big plants, cicadae, horetails, and even smaller plants grew to great sizes. Then, when the water again covers this land as a result of the oceans swelling, the wood transforms into carbon. . . over a long period of time, through the decay of those enormous trunks of the trees.

Up to the carboniferous period, we see great progress in the plants:

- 1) algae, 2) sand algae, 3) moss, 4) moss developing with stem and leaves, 5) big trees, trunks with roots, but no flowers and few leaves.

The black rectangle represents the carbon; the brown rectangle represents iron, for during this period, much iron is formed. The ferrous material, taken apart from rock in our mines today, belongs to this period. We do not know for sure how iron is formed: perhaps through a process of oxidation, a chemical reaction of rocks in the sun. Or maybe some microscopic organism fixed iron in rock, just as some fix calcium.

During this period, high mountain ranges formed in Europe and America, some of which are now only rolling hills.

The amphibians are the new masters of this period.

Insects are developing, too. The wings of the dragonflies reach a spread of 60 cm. Cockroaches still abound and the hymenoptera and the termite.

The last period in the Paleozoic Era is the Permian period, called this because of the fossils found in the area of Perma. Beginning this period is another Glacial period. It marks a great change. The big amphibians of the previous period begin to disappear. Today those amphibians still in existence are completely different and very small.

A small new being appears here which will become the master of the mesozoic era: the reptile. It appears during the third Glacial period.

During this period, volcanoes appear: the earth is undergoing many transformations. We have the first great deserts. Waters which fill in the lowlands form the first deposits of salt. There is the beginning of the complete metamorphosis of insects: eggs, larvae, the formation of the cocoon, and the insect.

The Mesozoic Era: Triassic Period, the first during which the earth is formed of three layers.

The Jurassic period, during which the Jura mountains of France are formed.

Cretaceous period, meaning clay.

This whole period, after the Glacial period, is characterized by the great development of reptiles who were vegetarians. The reptile here, is the master, and it occupies all the available space on earth. The reptile lives on land, some in the water, and others developed wings similar to that of the bats, and became flying reptiles. During the middle of the Jurassic period, a reptile develops, not only with wings, but also covered with feathers. The biggest reptile was as large as a five-floore house. The animals had strange heads and bodies. There were some carnivorous, some ferocious. During the Triassic period, the first plant with real seeds develops, The coniferous plant. This had no corolla, no ovary to enclose the egg, but the male and female organs are present and the seed is free. NOTE: show the pine cone with enclosed seeds.

Here also the first mammal appears: mid-Jurassic: the platypus (Monotremata) who lays eggs.

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GEOLOGICAL PERIODS for the "TIME LINE OF LIFE"

CAMBRIAN PERIOD:

The name comes from a part of England once called Cambria in Latin and now known as Wales. The first fossils were found here. All life was in the waters. There were many invertebrate animals: protozoa, porifera, coelenterates, worms, arthropods, mollusks and echinoderms. The most important animals of this period were the trilobites who were crustaceans belonging to the arthropods. They were the most plentiful and powerful animals at that time, filling the seas and oceans because they had no enemies. The only plants were the algae.

ORDOVICIAN PERIOD:

The name comes from an ancient tribe of people known as the Ordovices who lived in a part of England where the first fossils of this period were found.

An enemy appeared for the trilobites - the cold. Many of the seas which had once been warm were now covered with ice, causing the trilobites to become less abundant. Other animals which developed were large cephalopods, star fishes (echinoids), scorpions, and the most important of all, "sea lilies". These "sea lilies" or crinoids transformed the bottom of the seas into huge gardens. Although they appeared to be flowers, they were really animals, belonging to the echinoderms. All of these animals consumed great amounts of calcium, thus cleaning the waters.

SILURIAN PERIOD:

The name comes from an ancient tribe of people called the Silures who lived in a part of England where the first fossils of this period were found. Many animals disappeared while others appeared. The corals were now the great consumers of calcium. The first vertebrates also appeared, the so-called "armored fish" because their bodies were covered by a protective bony, shell-like covering.

DEVONIAN PERIOD:

The name comes from a part of England called Devon where the first fossils of this period were found. In this period the oceans receded and seas were formed between the different areas of land. Animals and plants remained in the muddy bottoms and had to learn how to live in their new surroundings. The algae grew longer and covered themselves with little leaves. Then the swamp lands began to dry up and plants had to put down roots in order to hold themselves upright and to go in search of water. The fish developed a true vertebral column and began to race swiftly in the seas. Some fish learned to live out of water for short periods of time, transforming their swim bladders into lungs. These lungfish were called Dipnoides (dual respiration) and still exist today.

CARBONIFEROUS PERIOD:

The land plants developed greatly but they still did not have flowers or fruits. The lowlands were covered with strange forests which became great swamps when the shallow seas flooded and receded. Buried under water, the trees would die and after centuries and centuries of being buried, would turn into coal. For this reason it is called the Carboniferous Period. Iron deposits were also being formed in the earth.

Now that the air had been purified by the plants, some animals were able to leave the water and learn to live on land. These were the amphibians. At this time there were also many insects and

PERMIAN PERIOD:

The name comes from a part of Russia called Perm, situated at the foot of the Ural Mountains, where the first fossils of this period were found. It was a very cold period. Some amphibians returned to the water to live while others learned to live entirely on land by evolving into reptiles. In the beginning these reptiles were very small, but having no enemies they became the masters of the land, continually multiplying and growing larger and larger until they were transformed into true giants. Instead of depositing their eggs in water, they now laid them in the sand where the rays of the sun could warm them. By this time many plants and animals lived on land and the Paleozoic Era came to a close.

TRIASSIC PERIOD:

The name of this period means three, because its rock sediments are divided into three strata. It also marked the beginning of the Mesozoic Era, also called the Age of Reptiles because these animals over-shadowed all the other inhabitants of the earth. Having no enemies, these reptiles were able to multiply and develop into giant dinosaurs. They could resist the heat of the sun due to their armor-like skin covering. There were both vegetarian and carnivorous reptiles. The carnivorous ones had terrible teeth.

JURASSIC PERIOD:

The name comes from the Jura Mountains where the first fossils of this period were found. It also marked the appearance of the flying reptiles. Among these was one with feather covered wings, the Archaeopteryx, from which birds are believed to have descended.

Some reptiles returned to water, including some who took the shape of fish. In this period the first mammals appeared, giving milk to their young but still reproducing by eggs. New plants to appear were the conifers, pines and fir-trees.

CRETACEOUS PERIOD:

The name comes from the chalk deposits where the most fossils of this period were found.

New plants appeared that had flowers and corollas. There were many, many insects at this time, including butterflies. But toward the end of this period the earth was once again covered by ice to a great extent.

What happened to the great reptiles, once such powerful masters of the land, without any enemies? They could not stand the freezing cold and gradually disappeared.

CENOZOIC ERA:

It is called the Age of Mammals and is divided into four parts: Eocene, Oligocene, Miocene, Pliocene. All four of these words have almost the same meaning - new period.

In the beginning most mammals were very different from the ones that we know today. Then gradually they acquired the modern form as we now know them. Compare the earliest horse to the modern one. Other animals similar to the ones today were fish, birds, amphibians, and

THE TIME LINE OF LIFE: Second Presentation

INTRODUCTION: For the Teacher

The first presentation of the Time Line of Life is very simple; the first overall view is given as a scope of evolution from the geological point of view. Only a short time ago, the history of life was approached from a biological point of view with regard to the material needs of nutrition, defense, the survival of the individual and the species. It was viewed as something completely separate from the history of the earth and the universe, and pertained only to the biological consideration of the separate species. Dott.sa Montessori described this as a way of approaching life that was linear, this separation of life from the history of the universe. She said that it was similar to ancient man's concept of a flat earth.

Instead, the concept of life as a geological phenomenon shows life itself in larger dimensions, in its vastness; and as something completely united to the rest of the universe. Geology has given us the proofs of evolution, showing that life is a constant progression: that life which passes from the water to the land, from the invertebrate to the vertebrate, from the cold-blooded creature to the warm-blooded one, from the nearly insensitive organism to those with highly developed nervous systems. The remains found in rocks enable the imagination to reconstruct past times; they are called fossils. Fossils have been found everywhere. Rock sediments form a long stair, looking like steps that are one on top of the other. Each step corresponds to a certain period. An excellent visual example of this is the Grand Canyon. In the deepest layers where a few remains of living beings have been found is the pre-Cambrian granite. During this long period which is represented on the Clock of Eras in yellow from the hours of 4 till 10, life was formed. Many iron deposits which exist in the United States are believed to have formed during this period. It is thought that the iron may have been fixed by a certain type of algae with a particular capacity for fixing iron as the corals fix the calcium. In the strata of calcareous rock (composed of calcium carbonate, calcium or limestone) it is evident that animal life existed. The formation of this rock is always linked with living organisms. But it is still a mystery HOW life was formed.

It is strangest that this great mystery of life is enclosed in something very tiny, something that looks like a little bit of water. This microscopic organism is called the CELL and the substance of which it is made is called PROTOPLASM. This tiny cell, by trying a host of different means and modes, originated the many forms of life. From a tiny protozoan and an algae, life developed always more and better until we have the complicated convolutions of the human brain. All plant and animal life come from that cell, so tiny and simple. But it works and constructs, obeying the immaterial command that IT CARRIES IN ITSELF. And it is like a faithful servant. It does not betray its secret. We do not know that secret which is enclosed in the cell. The tiny cell is endowed with a strong sensitivity and energy which has been called by Maria Montessori "spirituality." By the term "spirituality" she means that unknown energy and sensitivity which exists in the non-physical part, the psychic part of the organism or cell, and which pushes the cell towards development in a particular way. And this is the HORME, the drive which overcomes all obstacles. It explores all environments, carrying life to the most unknown places. It looks for the means necessary to protect its consequences and to survive.

Evolution, seen from the geological point of view, shows the progression of intelligence. And the progression of reproduction; the sexual part moves towards perfection. It also shows us the laws of life which are inexorable laws. There are species who work, obeying, without every becoming powerful. And in this way they continue. But there are other species which become very powerful so that they believe they cannot be defeated. But, at a certain point, conditions change and the powerful beings find themselves unable to adapt, unable to start again; and they disappear from the realms of life. And the sovereignty of the earth passes to those beings which are apparently weaker. However, they are animals endowed with a psychic energy and vitality, strong enough to face the new environment

During evolution, we witness a great increase in the intelligence which moves towards

THE TIME LINE OF LIFE. . .Second Presentation. . .
Introduction. . .

point of view gives us the moral sense of life. What is this unconscious charity? Dott.sa Montessori says that it is the service that each being gives in order to maintain equilibrium in the environment and to improve it for those who come after. Why does she call the charity "unconscious?" Because there is also a self-conscious, egoistic, aspect of this: to take as much as possible, to occupy as much space as possible, to eat as much and to procreate as much as possible. The conscious part of life serves the conscious vegetative functions as a result of hunger, etc. Another aspect is the unconscious altruistic one, keeping a natural equilibrium in nature, keeping a balance for those that come after. This aspect is called the "cosmic work;" an exchange of services. Therefore **the unconscious charity and the cosmic work are the same thing.**

"Each expression of everything that exists has a cosmic sense; and the union of all the cosmic finalities not only maintains the level of life, but increases it. Each being answers the special call which is beyond its understanding, but which makes all beings participants in creation. All creatures consciously work for themselves, but the real aim of life is the **absolute obedience and the unconscious obedience to the great laws which govern the universe.** All the powers working in the cosmos have a special role. Physical powers, chemical powers and vital powers, all unconsciously collaborate in this great cosmic work." (Maria Montessori)

The individual's aim is not to have a better way of living for himself, but to create better conditions for all. Each one in life has a function which he is not aware of. . .and which is linked to the well-being of everyone. This is the cosmic education that Montessori speaks of. And this is the fundamental part which regards the history of life, the universe and man. The great law which governs life in the cosmos is that of collaboration. It has existed from the beginning of time.

To study deeper this law means to work for the triumph of the union among people--- and therefore the triumph of human civilization. Only a school that takes into consideration the real human reality and the needs of our times can insure a society of men who are capable of carrying out the union among peoples which the humanity of our times so much desires.

Another important point of emphasis is the relationship of love. Dott.sa Montessori says that everything moves along a path towards greater perfection. For a long time it was believed that the struggle for life was won by the strong. Today it is thought. . . it is known that it is not the strongest, but the most intelligent. **And that the intelligence is revealed in the ability to discover the means to protect the offspring.** Intelligence and love mark the progress of life.

We cannot tell the children this in specific terms; but we can tell them that it is not strength which wins. For a long time education was based in this principle, an education based on struggle and strength. If these two factors are at the base of the history of life, then it follows that they must also be the fabric of social life. And thus history is a series of wars, leaving out the real important phenomena which continues in progress throughout the centuries. And---if the struggle is most important in life, then our education also will be based in struggles and suffering. The old methods all reflect this concept: they are based on the difficulties it is necessary to overcome in order to learn. Thus is born an obligation to work, hard discipline, self-denial. . . As science progressed, by observing vital phenomena in a vast scope, the struggle as a key concept in evolution was cancelled. It was discovered that at the base of life is **THE PROTECTION OF THE OFFSPRING.** And the possibilities the offspring receive in order to develop in a harmonious way. This progression of love marks the real evolution. Montessori says that nature evolves, reinforcing that which has been a weak point in the preceding being. This great force called love keeps progressing during the history of life.

In this new presentation of the history of life we no longer talk about the periods

The Great Fable of Evolution

We have studied for three years the history of life, of the earth, of the universe, of man. We could say that we are finished. But this long story has much to teach us. When we tell a fable, we always find at the end of it a moral. Usually the bad one loses and the good one wins. This fable has a moral that we must discover. The moral that governs the earth is formed of several inexorable (unchangeable) laws:

- 1) Absolute obedience in evolution.
- 2) Universal intelligence as a guide of evolution.
- 3) The force of love in evolution.
- 4) The cosmic work.

Absolute obedience. (A difficult concept for the children)

During all the history of the cosmos, the living and non-living matter behave in a special way, as though there were secret commands which oblige it, in that given specific moment, to follow a given specific road. From the moment in which the particles collided and started to burn and the light was formed, there has been a constant succession of facts which seem to be guided by a logical and precise order. From this mass of light to the galaxies; and from the galaxies to the stars; from the stars to the planets; from **one single element, hydrogen**, to many more than 100 elements which, combining in many different ways, gave origin to an infinite number of minerals. (The experiments aid in the understanding of this phenomenon of the elements combining.) These minerals, the result of different combinations of elements, have different properties from the properties of the elements of which they are formed.

We are near the wonderful world, but it is still non-living; it is the mineral kingdom. The earth is formed of rocks and water. Then, there was the great cosmic phenomenon. The main elements were present in the atmosphere: hydrogen, carbon, nitrogen, and oxygen. And there were the sun's strong radiations penetrating that atmosphere. And there was the heat of thunder, lightening and volcanoes. In the midst of all this, the elements gave origin to the first organic matter: **the amino acids, the raw material of proteins**. That is, the main substance of living organisms; and therefore, the raw material of the cell, of this cell which forms a wonderful world full of secret commands which guide it through an infinite number of experiences in order to create strange wonders which inhabit our earth and very probably also other planets. (Now the possibility of life on Jupiter is a reality according to the space explorer voyages which transmit information of space phenomena.) And all these substances, when they are formed, follow the precise chemical and physical laws.

There are moments when it seems that chaos reigns, but in the vast length of time, these are merely instants and then order and equilibrium are regained. It seems that the Archaic (Archeozoic) period was one of these moments of chaos. In those times there existed many unicellular organisms which filtered the water by allowing it to pass through their bodies, retaining the salts and then giving back the purified water. (A good comparison: a man would have to drink 30 litres of water every second for his whole life to compare to the great quantity which these tiny organisms filtered.) This myriad of workers was not enough. The rainwater ran down the earth formed of rocks (there was nothing but rocks; the earth was barren). And the water was capable of dissolving the rock because of the force of the water as it rushed down and because of a certain chemical reaction, the water containing an acid capable of dissolving rock. As the rain falls, it absorbs a great amount of carbon dioxide which, when mixed with the water becomes carbonic acid. ($\text{CO}_2 + \text{H}_2\text{O}$ Carbonic acid.) Thus all this calcium from the rock which was brought to the ocean threatened life and the equilibrium.

Tiny beings appeared that each constructed for themselves a little shell. When the animal died, the shell went to the bottom of the ocean and began to accumulate---or deposited along the beaches, a phenomenon which occurred in Africa near Tripoli. The shells themselves were as tiny as grains of sand. Each of these tiny beings could reproduce in ten days ten million new beings. And so a great army is formed in this way to purify the water of calcium. And the corals perform

The Great Fable of Evolution. . .

Little by little, the unicellular beings multiplied and occupied the oceans until they were living everywhere. And in this way new species arrived, each species more intelligent than the preceding one, each with a greater power to adapt. Each species tried to occupy as much space as possible, to eat as much as possible, each one tried to become the most powerful. Dott.sa Montessori remarks that among animals as among men, certain laws are forgotten which all must obey. When the species becomes more powerful, the decline for them starts. Sometimes the decline is a fast one due to cataclysm or epidemic; or a decline may be slow, during which the species gradually start to disappear.

TAKE THE TIME LINE OF LIFE: We show how this phenomena repeats periodically: the trilobites, the sea lilies, the sea scorpions, the cephalopods, (only one remains now of this group: the chambered nautilus, a very small member of the species: use maybe here the poem "The Chambered Nautilus" -- Oliver Wendell Holmes.). Then the big fish (armoured fish), the big amphibians, the big reptiles. All of them, due to various reasons, had to abandon the throne of power; and some ceased to exist. They have to leave their place to beings who bring something new. In each of the moments when there is great change, it seems there is great chaos; it seems that obedience is forgotten. But the laws which govern the universe are absolute; equilibrium and obedience come back. He who didn't obey, who tried to become stronger than the others, was punished and disappeared.

This is true for man. We are living in one of these moments in which man has believed he can live without consideration for these laws. Will he find the strength to obey? If not, he will gradually destroy himself and maybe the life of other beings which inhabit the earth. And at that point the earth would become barren as it started: without plants and animals. But the earth would continue around the sun and there will be new life. (A note on nuclear reactors: the wastes they produce are dangerous for 25,000 years. An attempt was made to put these wastes in stainless steel boxes. In 20 years the wastes had completely deteriorated the containers and seeped out.)

Universal intelligence in evolution.

During the history of life there have been glacial and inter-glacial periods: cold and warm. During each warm period there is a species that develops greatly and when the cold period comes, it disappears. During that warm period it is the species most intelligent, most able to adapt, that develops because it is thus that it succeeds in conquering the environment.

USE NOW THE TIME LINE OF LIFE TOGETHER WITH THE VERTEBRATE-INVERTEBRATE ANIMAL CHARTS AND THE MATERIAL OF THE PHYSIOLOGICAL FUNCTIONS. We use these materials as needed as we proceed with the discussion.

We notice that the part which develops most is the nervous system. The earth is made of this intelligence and this spirituality. Each being, overcoming hard difficulties, makes new conquests. Little by little, through the environmental experience of the living beings, the experiences become part of the being itself. And these experiences which become part of the being composes the mneme, the instinct in animals which is formed according to those experiences made in the environment in order to survive; and those are transmitted from generation to generation. (NOTE on the mneme from The Formation of Man: . . . an unconscious memory which retains its fixed images even through generations and minutely reproduces the characteristics of the species. . . . The mneme, with its infinite gradations, penetrates into the very facts of life and eternity. Once this has been ascertained, it is easy to recognize in the mind of the four-year-old child, a phase of psychic development in which the mneme stands on the very threshold of conscious memory, almost on the point of merging with it, yet manifesting itself as the last trace of a phenomenon with very deep roots. That last trace of the mneme came from afar.) So the instinct becomes a guide which cannot be put aside because it is a conquest made over a period of thousands of years. The species does not have the option of change; instead of changing the instinct, it dies. These conquests help the species to survive.

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The salmon live in the ocean, but they lay their eggs in the rivers. They make an extraordinary trip upstream, swimming against the currents, until they find a particular place to lay their eggs. Some turtles live in the ocean; and they make a long trip to a special island, called the Island of Turtles, where they lay their eggs. It is such a long and tiring trip to the island that many die from exhaustion on arrival. But they lay their eggs first. The mystery of migration in animals has not been discovered yet. It has not been discovered why the long trip is made.

We have seen, in the fish and the amphibians and the reptiles, that already they have begun to protect the young. This protection becomes very wonderful in birds and mammals. Each bird constructs a specific kind of nest, a nest built over and over again in the same way through the years. Birds may lay eggs at the very top of trees or inside the trunks of trees. Swallows build their nests below roofs; storks build their nests in chimneys. In constructing nests, the male and female help each other: often the male makes the most difficult part and the female the easy part. But they work together. The nest is the symbol of the happy family. While building their nests, many couples isolate themselves. Other birds, such as the sea birds, get together in one place and form real colonies.

How many eggs do birds lay? Much fewer than insects. . . fewer than the invertebrates and the preceding vertebrates. Because they take greater care with their nests, they protect the young, they brood them with their own body warmth, and they feed them until they can feed themselves. But the number of eggs varies greatly from one bird to the next. The small songbirds lay eggs three times a year (canary) because they have many enemies such as cats. (A Bergamo classic: Tweety and Silvester) The eagle build one nest every year and lays one egg. (Nature did not calculate man's damages.)

In order to brood the eggs, both birds cooperate. Some birds stay together only during brooding and during the first life of the young. Other couples remain together throughout life: they never fight and they help each other with their work. It has been noticed that when the female and the male brood together, the male sits on the eggs during the night when his bright feathers will not attract attention, and the female does the work during the day when her dullness of coloring will be least noticed. Other birds during brooding time do not eat. The ostrich is one of these. Some birds do not construct a very deep nest, but in order to keep the eggs from rolling out, they lay eggs in the shape of pears. The female rolls the eggs periodically so that all parts of the egg will heat evenly. The work of the mother to feed the little ones is very tiring: some birds eat 140 times a day. (Birds generally eat daily three times their weight.) Among the carnivorous birds, the male brings the meat and the female grinds it. (raven) The parents, besides feeding the little birds, teach them how to look for food, how to defend themselves, how to fly.

The mammals also prepare special nests to receive their young. Because, as we know, the offspring of the mammals are born alive. Only the platypus, belonging to the order monotremata, lays eggs. The nests of mammals are carefully and well prepared: the nests are their houses and they live in them all year round. But when they have offspring, the nests are prepared in a special way. For example, the rodents prepare the nests with the hair of their own bodies to make it soft. Of the mammals, the most beautiful nest is that of the squirrel. It is built in the hole of a tree trunk; the nests are very soft; and the squirrel puts a cover over it. The inside of the nest looks like a little room.

Among the mammals something strange happens. In the birds the male and the female form a working family. In the mammals the female does most of the work, and the male's work decreases. He becomes a little selfish. Only in a few cases, the male teaches the young how to find their own food. The mammals are the most intelligent species on the scale of evolution. In them instinct is strong, but it is more flexible and they are more adaptable to the environment. Besides instinct, there is also a high degree of experience. (They have greater freedom of action; and can learn new things.)

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is based on the struggle. **The protection for the offspring is the real mark in the progress of evolution.** Nature progresses, making stronger that part which was weak in the preceding being. So we notice constant progress of the intelligence and love. Therefore, the great power and energy which constantly keeps increasing during evolution, has been the **energy of intelligence and the energy of love.**

The COSMIC WORK: A Conclusion

NOTE: We talk about the cosmic work in all the work of history although with the children we have not always called it the cosmic work. As with out work in every Montessori progression, there is a particular point at which the child consciously recognizes what he has learned. And this is that **point of consciousness** regarding the cosmic work. We begin with the history of creation again, and NOW THE CHILDREN MAY HELP RETELL IT.

So many many millions of years ago there was a terrible coldness and darkness. In this coldness and darkness was there really nothing? No. There were tiny particles of **hydrogen. . .moving.** And we know that suddenly particles collided and there was a great explosion. In this way life was formed: like a huge **nebulae. Matter became physical.** And in this way the history of the cosmos started. The stars appeared: some were huge, some much smaller. Among those stars were our sun and our earth, a tiny star. Our earth was, in the beginning, a star: an incandescent mass. This incandescent matter, through a series of chemical reactions, formed many other substances.

And what was happening in those times is still happening: new stars are formed and old ones die. Now we know better the history of our star which gradually cooled and became a beautiful planet. But the substances on our earth kept transforming; and in these transformations the inorganic substances were transformed into organic substances---and life began. In the very beginning, the forms of life were simple. And these forms gradually became more and more complex until they reached human perfection. How many changes have followed since that dark cold night of remote times?

The history of all these changes is called evolution. Evolution shows us the progression of non-living and living matter. But it also shows us another aspect, maybe one that is much more important. This aspect is the cosmic work of all matter and all living beings. The vital chemical and physical powers unconsciously collaborate in that which Maria Montessori calls the "cosmic work."

Let's look for examples of "cosmic work." Those tiny particles which floated in the infinite darkness were particles of hydrogen. When they collided, the light was formed. What is light? We know that it is a **combustion.** And when there is a combustion, a chemical phenomenon takes place. After the explosion takes place, the hydrogen is no longer only hydrogen. A new element is formed: a transformation is always a result of a chemical phenomenon. In the incandescent stars, combustions follow one after the other in rapid succession. It is still going on in the stars. Gradually all the elements were formed. The substances can be called **elements, simple bodies, or metals.** All the universe is formed of these elements, our earth included. (Use CHART OF ELEMENTS HERE with their corresponding symbols. A good EXPERIMENT: to demonstrate the different elements, we can show that when they burn, each element produces a different colored flame. All the colors of the spectrum appear.)

Metals, or simple bodies, uniting in different ways, form the different minerals which, uniting again and cooling, form the rocks which form the crust of our earth. Rocks may be simple when formed of one mineral; or they may be compound when formed of several minerals. (STOP---Needed here is a good collection of rocks. An expert in geology is a real help here, too, to give a lesson on rocks. And an outing is appropriate during which the children collect rocks and identify them according to the three basic types: Igneous, Sedimentary, Metamorphic and further identify them if possible.)

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To overcome the difficulties of the environment, something new was necessary. We choose from among the invertebrates those beings which seem the most intelligent, those which were able to form societies, etc. And these are the **insects**. They, among the invertebrates, reached the maximum development in the nervous system. We can say that they arrived at the greatest level of development. In order to overcome environmental difficulties, however, something was needed: the **vertebral column**, the internal skeleton which supports the being and allows further development. And the **circulatory system** with the closed circuit. With the fish, the circulatory system does appear, the nervous system is more complex and the **cerebellum appears**. The cerebellum governs the senses; and is more developed in the animals than in man.

And so far, life has only existed in the water. But now life is able to develop on the land. But the earth has a great enemy: the cold. The climate always becomes colder and colder: and so new discoveries are made: hair, feathers, warm blood. These enable the beings to survive and defend themselves from the cold. So the birds and the mammals appear which, together with other new things, bring a new **cerebrum**.

It is constantly seen in evolution that it is not the size, dimension; but the specialization: of the organs and of reproduction. This is true both for animals and plants: the tree of evolution can be constructed for both kingdoms. It is a cycle which constantly repeats during the history of life. It can be deduced that it is not the most powerful that win, but those endowed with the most perfectly developed nervous system which corresponds to a greater intelligence, thus to the better protection of the offspring. That is, to a greater power of love.

We can conclude, says Maria Montessori, with the words of St. Paul: "God chooses the weak beings of the earth in order to confound the powerful."

The Power of Love

Together with intelligence, there is another force which develops pallelly: the force of love. The intelligence helps beings to discover new possibilities in order to preserve life. And the power of love helps beings to discover new means to safeguard the species. The more intelligence increases, the more the protection of the offspring increases. Nature creates new beings, trying to help them survive by protecting them. This instinct (intelligence) for the protection of the offspring exists not only in animals, but in plants.

In the beginning of life there was a plant cell which divided; or two cells which met and united. In this way, new lives were created. There was no protection for the species, but there was the possibility to create in a very short time, a great number of new organisms. And so, even though a great quantity of the young died, the species survived. Next came two different cells: male and female cells. The male cell looks for the female cell. And for its trip, the cell uses that means of transportation that nature offers it. When at last the two cells meet, they unite and they originate a certain seed called a spore. From this spore the new plant will start developing. There is no real protection for the species at this point; but the cell, destined to originate a new life, is Kept in humidity, enclosed by a very light sac which is both very resistant and waterproof. This sac is compared to a hard skin which might be compared to the shell of an egg. In this way the seed is kept alive for a very long time. When it finds the proper conditions, it starts to germinate.

Then intelligence develops further. We come to the great conifers: the male cell is the pollen and the female cell is the egg. There are trees which produce only the pollen and those which only produce the tiny eggs. The pollen, in order to reach the egg, is transported by the wind. And so a great quantity of pollen is necessary. During the trip, a great part of the pollen is lost. When the pollen reaches the egg, it unites with the egg and from this union the seed is formed. The seeds are protected in a strange, little house with many chambers: it has the shape of a cone and it is called a "pine cone." So these trees are called "**conifers**."

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brings the insects to the flowers? They do not consciously say, "Here I am, dear flower, to help you." But the bright colors and the perfume of the flower attract the insect. . .and at the bottom of the calyx they find the sweet liquid which they feed on: nectar. It is so sweet that mythology tells us that the only food of the gods was nectar. While the insects seek the nectar, the pollen attaches to their bodies and legs. And thus the pollen is transported from one place to another. When the pollen reaches the stigma of the pistil, it puts out a small tail and by moving the small tail, it makes its way down into the ovary where it reaches the egg and fecundates the egg.

Each grain of pollen fecundates one egg. When all the eggs are fecundated, the petals of the corolla fall. (Florists close the ovaries of the flowers in order to prevent fecundation and thus to preserve the longer life of the flower.) When the eggs have been fecundated, the corolla has served its purpose. The ovary is the new protection for the seed. From the ovary the fruits are created; the fruit is the swollen ovary. Men and animals eat the fruit; and thus the seeds of the fruit are disseminated everywhere.

In the plants we cannot talk about a real kind of love; but we see that nature is endowed with a special kind of sensitivity which becomes ever stronger to insure the continuation of the species and to improve the qualities.

Love Among Animals. At the beginning there was no protection for the offspring of the animals. In the protozoans, the porifera, the coelenterates, there is no protection for the offspring. And then, in contrast to these first animals, there are those animals whose main role in life is to take care of their offspring. The simplest form of protection is the laying of eggs. Each oviporous animal has the unmistakable instinct of laying eggs in the right place for the young ones to develop. First there were eggs WITHOUT a shell, or with a very very thin one. For these eggs, water is the best place. If there is no water, the animals look for mud: a place where there is land and water. Mollusks and insects lay their eggs in humid places. Certain animals know that besides humidity, warmth is important. So they look for warmth, found often among plant matter in a state of decomposition. (Decaying matter is a good source of heat.) Or they look for humid places where there is sunlight. Some arthropoda carry their eggs on their backs. Other animals collect their eggs in a little ball and carry it around in the thorax: some spiders and scorpions. Other spiders lay their eggs in nests, but they remain close to the nests to care for and protect the eggs. The greatest builders of nests are the insects: the bees, the wasps, the carpenter bees. These insects are very smart: they have organized classes of workers, whose role is to feed the larvae. This is their only work. And the mothers' role is to lay the eggs: she is the queen. When she stops laying eggs, she is killed and the group looks for a new queen.

Next come the vertebrates. It is believed that all fish abandon their eggs, but some take care of their eggs. There is a little fish called **rhodeus** that looks for empty bi-valves, carries the shell up and opens it. Then the male fish pushes the female in and obliges her to lay the eggs there. Once the "she-fish" has laid the eggs, the male goes in and fertilizes the eggs. Another fish, the **spinarello**, constructs a beautiful nest. It is always the male who makes the nest. The fish makes a hole in the sand, smoothing it to make a very nice room; and then he brings different colored algae and covers all the walls of the hole. Then the male looks for the female and pushes it into the hole: there the female lays the eggs. Then she runs away and the male fertilizes the eggs and stays to care for the eggs until they are born. (There are also some ovoviviporous species of fish: the young hatch within the female and are born alive. The female fish still lays the eggs, but retains them in the oviduct until they hatch. The species is the **guppy**: and they eat their young, so the matter of protection is questionable. Found in particularly warm waters.)

There are certain animals which mate and reproduce only after a very long trip. The eel lays the eggs in the water.

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Creation starts so many many millions of years ago, but it still goes on. Creation is not a moment, but a continual development, a process which goes on and on.

But that is not all. All the elements and celestial bodies are arranged according to their weight: the heaviest at the center of the earth and the lighter ones farther away from the center. In this way they exert a force of attraction, one on another. And this is another cosmic law: **the force of attraction avoids the dispersion of the elements;** it has made it possible for the water to remain in the low parts of our earth to form the oceans and the lakes. This force **of gravity** has also made it possible for the atmosphere to envelop our earth.

There is another law which shows the cosmic work: all the celestial bodies exert a strong attraction one upon the other. They exert, at the same time, **a force of attraction and one of repulsion.** These forces maintain all the bodies in equilibrium, preventing them from crashing into one another or escaping. So **"maintenance" of equilibrium** in the universe is another cosmic rule.

And there is yet another. **All the celestial bodies constantly rotate around themselves and revolve around another celestial body.** Our earth has these two special movements: rotation and revolution. (USE THE GEOGRAPHY CHARTS.) The movement of rotation prevents our earth from burning on one side and freezing on another. This is another part of the cosmic work: the rotation of the earth that makes life possible.

During that faraway period called the Arcaic Era, in a certain perfect moment, with the right amount of heat and humidity and in the presence of a special combination of substances, life began. **Due to a marvelous chemical phenomenon, the first living cell was born.** It is believed that the first living cell was a plant cell. In the water there was a great deal of carbon dioxide; and only plants can assimilate CO₂ and give off oxygen. Even today 75% of the oxygen in the air is produced by the unicellular beings which live in the water (algae). Therefore, **the first cosmic work of the living being was to absorb CO₂ and to give out oxygen in such a way as to make life possible for the animals which came afterwards.** Animal cells came after the plant cells; and the newly formed cells started a quantity of new experiments. The first animal cells were the protozoans. The tiny beings lived in the oceans and reproduced greatly. Huge amounts of calcium were constantly brought to the ocean by the rainwater. Animals need calcium, for the formation of bones. And the rainwater was doing its cosmic work, taking the calcium from the rocks and bringing it to the ocean. But, at a certain point, great quantities of calcium are not good. Life was endangered. But a myriad of tiny beings appeared: animals which built themselves a tiny shell. These animals absorbed and fixed a large amount of calcium and purified the water. When the little animal died, the tiny house deposited at the bottom of the ocean or on the beaches. (This is called diatomaceous earth; formed of tiny crystals, the skeletons of diatoms.) After these tiny beings, other animals came to help: porifera, coelenterates, echinoderms, arthropoda, mollusks. All joined in the work of fixing calcium. In order to develop their skeletons, external or internal, they fixed great amounts of calcium. In order to develop their own bodies, they did this work---not because they were conscious of their role. They had to fix the calcium in order to survive and to protect themselves. These beings never became conscious that their work made life possible for thousands of other animals.

Many of these animals are seen on the Time Line of Life. (ASK THE CHILDREN to name the animals they know on the Time Line.) In this way, all the animals together created the proper conditions to receive new kinds of animals. So far life was only in the water. But all of a sudden, the water began to recede; and many animals found themselves in dry places. Many died, but some adapted to the new environment. And once more the tiny unicellular algae covered the swamps of the earth. Now there was a new **cosmic work: purifying the air for new animals to live on the earth.**

Next came the lizens which attached to the rocks and, little by litte, broke down

All of these plants reproduced greatly because they were obeying another law: eat as much as possible, occupy as much space as possible, reproduce as much as possible. Then we come to the carboniferous period, characterized by the great forests. The great forests were used as food by the first animals who came to live on the land. The huge trunks deposited, decayed and formed the carbon that we now use to heat out houses. They were obeying the cosmic law. So huge plants developed, according to the law: **occupy as much space as possible, grow as much as possible, reproduce as much as possible.** At the same time they were being used as food by the other animals. But they were also in the process of forming carbon and iron which we use. (NOTE the rectangle of black and brown.) It is thought that the great deposits of carbon were formed during this period. There are, from this time, layers of rocks which contain iron. This iron was the result of special tiny animals who, absorbing substances from the earth in order to nourish and construct their own bodies, fixed iron in a special way just as other tiny animals fixed the calcium.

Think of all the cosmic work we have witnessed. **The huge forests of the carboniferous period provided food for the huge reptiles, primarily vegetarians.** And so the reptiles developed greatly. The eggs of the reptiles and the huge trees provided food and protection for the birds and the mammals. At the same time, the birds and the mammals prepared the environment for the last animal to arrive: man. In this way, we have followed the path of evolution, looking at it from the aspect of cosmic work.

All creatures work selfishly for themselves, but the real aim is still the unconscious obedience to the great cosmic plan. We have only looked at a few of the many examples of this cosmic work. (The children can find many others) Another good example of cosmic work is done by what Maria Montessori calls "the janitors of the earth." These are the ants, the hyenas, the great birds called condors, all of whom are usually despised or considered insignificant; but whose work is very important. **We must look at life in a profound way: to look superficially, we see only greedy and selfish beings, but this form of greediness and selfishness brings equilibrium in life.** Each being takes what is disposed of by another. That which is poisonous for one, often causing death, represents for another life. Each being, in one way or another, gives his contribution to the progress of evolution: the progress of life.

Maria Montessori explained: "Each expression of everything that exists has a cosmic sense, and the union of these cosmic finalities not only maintains the level of life, but increases it. Each being answers a special call which is beyond our possibilities to understand or comprehend; but which renders everything a participant of creation."

THE MEANING OF THE APPEARANCE OF MAN: Second Presentation

We could give this chapter a different title, using Maria Montessori's expression from To Educate the Human Potential "Man as Creator and Revealer."

In order to understand man, we must first put him in relation to the rest of the universe; and with the source of energy which exists in the universe guiding all the evolutive processes. Man is not isolated from the rest of the cosmos. He is an integral part of it. We have seen the expansion of the universe, an infinite expansion which the human intelligence is not able to grasp. Then we have seen how the earth appeared and was formed; then how life began; then the evolution of the different living groups. And we have seen those principles which rule evolution. What are these rules, these guiding principles of evolution?

- 1) The apparently selfish and conscious struggle for survival; and the unconscious cosmic work.
- 2) Some privileged species become very powerful, decline and disappear.
- 3) Forms of life which are less visible, but more vital and more intelligent, occupy the place left by those beings which disappear.

THE TIME LINE OF LIFE. . .

Second Presentation. . .

1. . .analysis of the last set of titles. . .

The Mesozoic Era. . .

During the Cretaceous period, the first complete flower appears---with leaves transformed into a corolla. And with it, the butterfly, who transports the pollen, makes its appearance to feed on the nectar of the flower.

During the Cretaceous period, great mountains are raised: the Alps and the Himalayans.

Then comes the final Glacial period. And all the great reptiles disappear. For them it is a natural disaster. But it seems that, in nature, there is a law that when one being becomes too powerful, too strong, there is a cataclysmic event which destroys it. Small beings, apparently insignificant, are seemingly endowed with something special: a nervous system highly developed which allows them to survive.

The Cenozoic Era, the Tertiary period, we have the era of new animals. Mammals now occupy the land, the water and the air and become the master. During the last million years of this age, man appears. And it is here, in the Quaternary (Neozoic) Era, we move to a new time line which tells the story of man.

2. The children now work with the time line, using a blank time line on which they place cut-out pictures and labels correctly.

- NOTE: A later second presentation deals with the moral implications of the time line.
- NOTE: It is difficult to find the evolutionary links because they are probably microscopic and few in number. But we are able to note some of the fascinating links.

Today we know this much: tomorrow perhaps we will discover something new: maybe you.

NOTES: An interesting set of two tables: one noting the eras, the corresponding time spans as minutes, hours; and as years:

Formative Era: (ARCHEOZOIC ERA):	4 hours	1,000,000,000 years
Arcaic Era (ARCHEOZOIC ERA):	6 hours	1,500,000,000 years
Paleozoic Era:	1 hour, 12 min.	300,000,000 years
Mesozoic Era:	33 min., 36 sec.	140,000,000 years
Cenozoic Era:	14 min., 9 6/10 sec.	59,000,000 years
Neozoic Era:	14 4/10 sec.	1,000,000 years

The second table gives the length of time each era extends from hour and minute on each section of the clock.

The ~~four~~ periods of the Cenozoic Era: Eocene, Oligocene, Miocene, Pliocene

The Arcaic (Archeozoic Era): "despite all the adversities, life was not destroyed."

The IClock represents the entire history of the earth from the time it was a mass of gases to the appearance of man. The Time Line illustrates the Appearance and Evolution of Life in relation to the variations of the environment during the geological eras.

GEOLOGICAL PERIODS for the "TIME LINE OF LIFE"

CAMBRIAN PERIOD:

The name comes from a part of England once called Cambria in Latin and now known as Wales. The first fossils were found here. All life was in the waters. There were many invertebrate animals: protozoa, porifera, coelenterates, worms, arthropods, mollusks and echinoderms. The most important animals of this period were the trilobites who were crustaceans belonging to the arthropods. They were the most plentiful and powerful animals at that time, filling the seas and oceans because they had no enemies. The only plants were the algae.

ORDOVICIAN PERIOD:

The name comes from an ancient tribe of people known as the Ordovices who lived in a part of England where the first fossils of this period were found.

An enemy appeared for the trilobites - the cold. Many of the seas which had once been warm were now covered with ice, causing the trilobites to become less abundant. Other animals which developed were large cephalopods, star fishes (echinoids), scorpions, and the most important of all, "sea lilies". These "sea lilies" or crinoids transformed the bottom of the seas into huge gardens. Although they appeared to be flowers, they were really animals, belonging to the echinoderms. All of these animals consumed great amounts of calcium, thus cleaning the waters.

SILURIAN PERIOD:

The name comes from an ancient tribe of people called the Silures who lived in a part of England where the first fossils of this period were found. Many animals disappeared while others appeared. The corals were now the great consumers of calcium. The first vertebrates also appeared, the so-called "armored fish" because their bodies were covered by a protective bony, shell-like covering.

DEVONIAN PERIOD:

The name comes from a part of England called Devon where the first fossils of this period were found. In this period the oceans receded and seas were formed between the different areas of land. Animals and plants remained in the muddy bottoms and had to learn how to live in their new surroundings. The algae grew longer and covered themselves with little leaves. Then the swamp lands began to dry up and plants had to put down roots in order to hold themselves upright and to go in search of water. The fish developed a true vertebral column and began to race swiftly in the seas. Some fish learned to live out of water for short periods of time, transforming their swim bladders into lungs. These lungfish were called Dipnoides (dual respiration) and still exist today.

CARBONIFEROUS PERIOD:

The land plants developed greatly but they still did not have flowers or fruits. The lowlands were covered with strange forests which became great swamps when the shallow seas flooded and receded. Buried under water, the trees would die and after centuries and centuries of being buried, would turn into coal. For this reason it is called the Carboniferous Period. Iron deposits were also being formed in the earth.

Now that the air had been purified by the plants, some animals were able to leave the water and learn to live on land. These were the amphibians. At this time there were also many insects and

PERMIAN PERIOD:

The name comes from a part of Russia called Perm, situated at the foot of the Ural Mountains, where the first fossils of this period were found. It was a very cold period. Some amphibians returned to the water to live while others learned to live entirely on land by evolving into reptiles. In the beginning these reptiles were very small, but having no enemies they became the masters of the land, continually multiplying and growing larger and larger until they were transformed into true giants. Instead of depositing their eggs in water, they now laid them in the sand where the rays of the sun could warm them. By this time many plants and animals lived on land and the Paleozoic Era came to a close.

TRIASSIC PERIOD:

The name of this period means three, because its rock sediments are divided into three strata. It also marked the beginning of the Mesozoic Era, also called the Age of Reptiles because these animals over-shadowed all the other inhabitants of the earth. Having no enemies, these reptiles were able to multiply and develop into giant dinosaurs. They could resist the heat of the sun due to their armor-like skin covering. There were both vegetarian and carnivorous reptiles. The carnivorous ones had terrible teeth.

JURASSIC PERIOD:

The name comes from the Jura Mountains where the first fossils of this period were found. It also marked the appearance of the flying reptiles. Among these was one with feather covered wings, the Archaeopteryx, from which birds are believed to have descended.

Some reptiles returned to water, including some who took the shape of fish. In this period the first mammals appeared, giving milk to their young but still reproducing by eggs. New plants to appear were the conifers, pines and fir-trees.

CRETACEOUS PERIOD:

The name comes from the chalk deposits where the most fossils of this period were found.

New plants appeared that had flowers and corollas. There were many, many insects at this time, including butterflies. But toward the end of this period the earth was once again covered by ice to a great extent.

What happened to the great reptiles, once such powerful masters of the land, without any enemies? They could not stand the freezing cold and gradually disappeared.

CENOZOIC ERA:

It is called the Age of Mammals and is divided into four parts: Eocene, Oligocene, Miocene, Pliocene. All four of these words have almost the same meaning - new period.

In the beginning most mammals were very different from the ones that we know today. Then gradually they acquired the modern form as we now know them. Compare the earliest horse to the modern one. Other animals similar to the ones today were fish, birds, amphibians, and

THE TIME LINE OF LIFE: Second Presentation

INTRODUCTION: For the Teacher

The first presentation of the Time Line of Life is very simple; the first overall view is given as a scope of evolution from the geological point of view. Only a short time ago, the history of life was approached from a biological point of view with regard to the material needs of nutrition, defense, the survival of the individual and the species. It was viewed as something completely separate from the history of the earth and the universe, and pertained only to the biological consideration of the separate species. Dott.sa Montessori described this as a way of approaching life that was linear, this separation of life from the history of the universe. She said that it was similar to ancient man's concept of a flat earth.

Instead, the concept of life as a geological phenomenon shows life itself in larger dimensions, in its vastness; and as something completely united to the rest of the universe. Geology has given us the proofs of evolution, showing that life is a constant progression: that life which passes from the water to the land, from the invertebrate to the vertebrate, from the cold-blooded creature to the warm-blooded one, from the nearly insensitive organism to those with highly developed nervous systems. The remains found in rocks enable the imagination to reconstruct past times; they are called fossils. Fossils have been found everywhere. Rock sediments form a long stair, looking like steps that are one on top of the other. Each step corresponds to a certain period. An excellent visual example of this is the Grand Canyon. In the deepest layers where a few remains of living beings have been found is the pre-Cambrian granite. During this long period which is represented on the Clock of Eras in yellow from the hours of 4 till 10, life was formed. Many iron deposits which exist in the United States are believed to have formed during this period. It is thought that the iron may have been fixed by a certain type of algae with a particular capacity for fixing iron as the corals fix the calcium. In the strata of calcareous rock (composed of calcium carbonate, calcium or limestone) it is evident that animal life existed. The formation of this rock is always linked with living organisms. But it is still a mystery HOW life was formed.

It is strangest that this great mystery of life is enclosed in something very tiny, something that looks like a little bit of water. This microscopic organism is called the CELL and the substance of which it is made is called PROTOPLASM. This tiny cell, by trying a host of different means and modes, originated the many forms of life. From a tiny protozoan and an algae, life developed always more and better until we have the complicated convolutions of the human brain. All plant and animal life come from that cell, so tiny and simple. But it works and constructs, obeying the immaterial command that IT CARRIES IN ITSELF. And it is like a faithful servant. It does not betray its secret. We do not know that secret which is enclosed in the cell. The tiny cell is endowed with a strong sensitivity and energy which has been called by Maria Montessori "spirituality." By the term "spirituality" she means that unknown energy and sensitivity which exists in the non-physical part, the psychic part of the organism or cell, and which pushes the cell towards development in a particular way. And this is the HORME, the drive which overcomes all obstacles. It explores all environments, carrying life to the most unknown places. It looks for the means necessary to protect its consequences and to survive.

Evolution, seen from the geological point of view, shows the progression of intelligence. And the progression of reproduction; the sexual part moves towards perfection. It also shows us the laws of life which are inexorable laws. There are species who work, obeying, without every becoming powerful. And in this way they continue. But there are other species which become very powerful so that they believe they cannot be defeated. But, at a certain point, conditions change and the powerful beings find themselves unable to adapt, unable to start again; and they disappear from the realms of life. And the sovereignty of the earth passes to those beings which are apparently weaker. However, they are animals endowed with a psychic energy and vitality, strong enough to face the new environment

During evolution, we witness a great increase in the intelligence which moves towards

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point of view gives us the moral sense of life. What is this unconscious charity? Dott.sa Montessori says that it is the service that each being gives in order to maintain equilibrium in the environment and to improve it for those who come after. Why does she call the charity "unconscious?" Because there is also a self-conscious, egoistic, aspect of this: to take as much as possible, to occupy as much space as possible, to eat as much and to procreate as much as possible. The conscious part of life serves the conscious vegetative functions as a result of hunger, etc. Another aspect is the unconscious altruistic one, keeping a natural equilibrium in nature, keeping a balance for those that come after. This aspect is called the "cosmic work;" an exchange of services. Therefore **the unconscious charity and the cosmic work are the same thing.**

"Each expression of everything that exists has a cosmic sense; and the union of all the cosmic finalities not only maintains the level of life, but increases it. Each being answers the special call which is beyond its understanding, but which makes all beings participants in creation. All creatures consciously work for themselves, but the real aim of life is the **absolute obedience and the unconscious obedience to the great laws which govern the universe.** All the powers working in the cosmos have a special role. Physical powers, chemical powers and vital powers, all unconsciously collaborate in this great cosmic work." (Maria Montessori)

The individual's aim is not to have a better way of living for himself, but to create better conditions for all. Each one in life has a function which he is not aware of. . .and which is linked to the well-being of everyone. This is the cosmic education that Montessori speaks of. And this is the fundamental part which regards the history of life, the universe and man. The great law which governs life in the cosmos is that of collaboration. It has existed from the beginning of time.

To study deeper this law means to work for the triumph of the union among people--- and therefore the triumph of human civilization. Only a school that takes into consideration the real human reality and the needs of our times can insure a society of men who are capable of carrying out the union among peoples which the humanity of our times so much desires.

Another important point of emphasis is the relationship of love. Dott.sa Montessori says that everything moves along a path towards greater perfection. For a long time it was believed that the struggle for life was won by the strong. Today it is thought. . . it is known that it is not the strongest, but the most intelligent. **And that the intelligence is revealed in the ability to discover the means to protect the offspring.** Intelligence and love mark the progress of life.

We cannot tell the children this in specific terms; but we can tell them that it is not strength which wins. For a long time education was based in this principle, an education based on struggle and strength. If these two factors are at the base of the history of life, then it follows that they must also be the fabric of social life. And thus history is a series of wars, leaving out the real important phenomena which continues in progress throughout the centuries. And---if the struggle is most important in life, then our education also will be based in struggles and suffering. The old methods all reflect this concept: they are based on the difficulties it is necessary to overcome in order to learn. Thus is born an obligation to work, hard discipline, self-denial. . . As science progressed, by observing vital phenomena in a vast scope, the struggle as a key concept in evolution was cancelled. It was discovered that at the base of life is **THE PROTECTION OF THE OFFSPRING.** And the possibilities the offspring receive in order to develop in a harmonious way. This progression of love marks the real evolution. Montessori says that nature evolves, reinforcing that which has been a weak point in the preceding being. This great force called love keeps progressing during the history of life.

In this new presentation of the history of life we no longer talk about the periods

The Great Fable of Evolution

We have studied for three years the history of life, of the earth, of the universe, of man. We could say that we are finished. But this long story has much to teach us. When we tell a fable, we always find at the end of it a moral. Usually the bad one loses and the good one wins. This fable has a moral that we must discover. The moral that governs the earth is formed of several inexorable (unchangeable) laws:

- 1) Absolute obedience in evolution.
- 2) Universal intelligence as a guide of evolution.
- 3) The force of love in evolution.
- 4) The cosmic work.

Absolute obedience. (A difficult concept for the children)

During all the history of the cosmos, the living and non-living matter behave in a special way, as though there were secret commands which oblige it, in that given specific moment, to follow a given specific road. From the moment in which the particles collided and started to burn and the light was formed, there has been a constant succession of facts which seem to be guided by a logical and precise order. From this mass of light to the galaxies; and from the galaxies to the stars; from the stars to the planets; from **one single element, hydrogen**, to many more than 100 elements which, combining in many different ways, gave origin to an infinite number of minerals. (The experiments aid in the understanding of this phenomenon of the elements combining.) These minerals, the result of different combinations of elements, have different properties from the properties of the elements of which they are formed.

We are near the wonderful world, but it is still non-living; it is the mineral kingdom. The earth is formed of rocks and water. Then, there was the great cosmic phenomenon. The main elements were present in the atmosphere: hydrogen, carbon, nitrogen, and oxygen. And there were the sun's strong radiations penetrating that atmosphere. And there was the heat of thunder, lightening and volcanoes. In the midst of all this, the elements gave origin to the first organic matter: **the amino acids, the raw material of proteins**. That is, the main substance of living organisms; and therefore, the raw material of the cell, of this cell which forms a wonderful world full of secret commands which guide it through an infinite number of experiences in order to create strange wonders which inhabit our earth and very probably also other planets. (Now the possibility of life on Jupiter is a reality according to the space explorer voyages which transmit information of space phenomena.) And all these substances, when they are formed, follow the precise chemical and physical laws.

There are moments when it seems that chaos reigns, but in the vast length of time, these are merely instants and then order and equilibrium are regained. It seems that the Archaic (Archeozoic) period was one of these moments of chaos. In those times there existed many unicellular organisms which filtered the water by allowing it to pass through their bodies, retaining the salts and then giving back the purified water. (A good comparison: a man would have to drink 30 litres of water every second for his whole life to compare to the great quantity which these tiny organisms filtered.) This myriad of workers was not enough. The rainwater ran down the earth formed of rocks (there was nothing but rocks; the earth was barren). And the water was capable of dissolving the rock because of the force of the water as it rushed down and because of a certain chemical reaction, the water containing an acid capable of dissolving rock. As the rain falls, it absorbs a great amount of carbon dioxide which, when mixed with the water becomes carbonic acid. ($\text{CO}_2 + \text{H}_2\text{O}$ Carbonic acid.) Thus all this calcium from the rock which was brought to the ocean threatened life and the equilibrium.

Tiny beings appeared that each constructed for themselves a little shell. When the animal died, the shell went to the bottom of the ocean and began to accumulate---or deposited along the beaches, a phenomenon which occurred in Africa near Tripoli. The shells themselves were as tiny as grains of sand. Each of these tiny beings could reproduce in ten days ten million new beings. And so a great army is formed in this way to purify the water of calcium. And the corals perform

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Little by little, the unicellular beings multiplied and occupied the oceans until they were living everywhere. And in this way new species arrived, each species more intelligent than the preceding one, each with a greater power to adapt. Each species tried to occupy as much space as possible, to eat as much as possible, each one tried to become the most powerful. Dott.sa Montessori remarks that among animals as among men, certain laws are forgotten which all must obey. When the species becomes more powerful, the decline for them starts. Sometimes the decline is a fast one due to cataclysm or epidemic; or a decline may be slow, during which the species gradually start to disappear.

TAKE THE TIME LINE OF LIFE: We show how this phenomena repeats periodically: the trilobites, the sea lilies, the sea scorpions, the cephalopods, (only one remains now of this group: the chambered nautilus, a very small member of the species: use maybe here the poem "The Chambered Nautilus" -- Oliver Wendell Holmes.). Then the big fish (armoured fish), the big amphibians, the big reptiles. All of them, due to various reasons, had to abandon the throne of power; and some ceased to exist. They have to leave their place to beings who bring something new. In each of the moments when there is great change, it seems there is great chaos; it seems that obedience is forgotten. But the laws which govern the universe are absolute; equilibrium and obedience come back. He who didn't obey, who tried to become stronger than the others, was punished and disappeared.

This is true for man. We are living in one of these moments in which man has believed he can live without consideration for these laws. Will he find the strength to obey? If not, he will gradually destroy himself and maybe the life of other beings which inhabit the earth. And at that point the earth would become barren as it started: without plants and animals. But the earth would continue around the sun and there will be new life. (A note on nuclear reactors: the wastes they produce are dangerous for 25,000 years. An attempt was made to put these wastes in stainless steel boxes. In 20 years the wastes had completely deteriorated the containers and seeped out.)

Universal intelligence in evolution.

During the history of life there have been glacial and inter-glacial periods: cold and warm. During each warm period there is a species that develops greatly and when the cold period comes, it disappears. During that warm period it is the species most intelligent, most able to adapt, that develops because it is thus that it succeeds in conquering the environment.

USE NOW THE TIME LINE OF LIFE TOGETHER WITH THE VERTEBRATE-INVERTEBRATE ANIMAL CHARTS AND THE MATERIAL OF THE PHYSIOLOGICAL FUNCTIONS. We use these materials as needed as we proceed with the discussion.

We notice that the part which develops most is the nervous system. The earth is made of this intelligence and this spirituality. Each being, overcoming hard difficulties, makes new conquests. Little by little, through the environmental experience of the living beings, the experiences become part of the being itself. And these experiences which become part of the being composes the mneme, the instinct in animals which is formed according to those experiences made in the environment in order to survive; and those are transmitted from generation to generation. (NOTE on the mneme from The Formation of Man: . . . an unconscious memory which retains its fixed images even through generations and minutely reproduces the characteristics of the species. . . . The mneme, with its infinite gradations, penetrates into the very facts of life and eternity. Once this has been ascertained, it is easy to recognize in the mind of the four-year-old child, a phase of psychic development in which the mneme stands on the very threshold of conscious memory, almost on the point of merging with it, yet manifesting itself as the last trace of a phenomenon with very deep roots. That last trace of the mneme came from afar.) So the instinct becomes a guide which cannot be put aside because it is a conquest made over a period of thousands of years. The species does not have the option of change; instead of changing the instinct, it dies. These conquests help the species to survive.

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The salmon live in the ocean, but they lay their eggs in the rivers. They make an extraordinary trip upstream, swimming against the currents, until they find a particular place to lay their eggs. Some turtles live in the ocean; and they make a long trip to a special island, called the Island of Turtles, where they lay their eggs. It is such a long and tiring trip to the island that many die from exhaustion on arrival. But they lay their eggs first. The mystery of migration in animals has not been discovered yet. It has not been discovered why the long trip is made.

We have seen, in the fish and the amphibians and the reptiles, that already they have begun to protect the young. This protection becomes very wonderful in birds and mammals. Each bird constructs a specific kind of nest, a nest built over and over again in the same way through the years. Birds may lay eggs at the very top of trees or inside the trunks of trees. Swallows build their nests below roofs; storks build their nests in chimneys. In constructing nests, the male and female help each other: often the male makes the most difficult part and the female the easy part. But they work together. The nest is the symbol of the happy family. While building their nests, many couples isolate themselves. Other birds, such as the sea birds, get together in one place and form real colonies.

How many eggs do birds lay? Much fewer than insects. . . fewer than the invertebrates and the preceding vertebrates. Because they take greater care with their nests, they protect the young, they brood them with their own body warmth, and they feed them until they can feed themselves. But the number of eggs varies greatly from one bird to the next. The small songbirds lay eggs three times a year (canary) because they have many enemies such as cats. (A Bergamo classic: Tweety and Silvester) The eagle build one nest every year and lays one egg. (Nature did not calculate man's damages.)

In order to brood the eggs, both birds cooperate. Some birds stay together only during brooding and during the first life of the young. Other couples remain together throughout life: they never fight and they help each other with their work. It has been noticed that when the female and the male brood together, the male sits on the eggs during the night when his bright feathers will not attract attention, and the female does the work during the day when her dullness of coloring will be least noticed. Other birds during brooding time do not eat. The ostrich is one of these. Some birds do not construct a very deep nest, but in order to keep the eggs from rolling out, they lay eggs in the shape of pears. The female rolls the eggs periodically so that all parts of the egg will heat evenly. The work of the mother to feed the little ones is very tiring: some birds eat 140 times a day. (Birds generally eat daily three times their weight.) Among the carnivorous birds, the male brings the meat and the female grinds it. (raven) The parents, besides feeding the little birds, teach them how to look for food, how to defend themselves, how to fly.

The mammals also prepare special nests to receive their young. Because, as we know, the offspring of the mammals are born alive. Only the platypus, belonging to the order monotremata, lays eggs. The nests of mammals are carefully and well prepared: the nests are their houses and they live in them all year round. But when they have offspring, the nests are prepared in a special way. For example, the rodents prepare the nests with the hair of their own bodies to make it soft. Of the mammals, the most beautiful nest is that of the squirrel. It is built in the hole of a tree trunk; the nests are very soft; and the squirrel puts a cover over it. The inside of the nest looks like a little room.

Among the mammals something strange happens. In the birds the male and the female form a working family. In the mammals the female does most of the work, and the male's work decreases. He becomes a little selfish. Only in a few cases, the male teaches the young how to find their own food. The mammals are the most intelligent species on the scale of evolution. In them instinct is strong, but it is more flexible and they are more adaptable to the environment. Besides instinct, there is also a high degree of experience. (They have greater freedom of action; and can learn new things.)

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is based on the struggle. **The protection for the offspring is the real mark in the progress of evolution.** Nature progresses, making stronger that part which was weak in the preceding being. So we notice constant progress of the intelligence and love. Therefore, the great power and energy which constantly keeps increasing during evolution, has been the **energy of intelligence and the energy of love.**

The COSMIC WORK: A Conclusion

NOTE: We talk about the cosmic work in all the work of history although with the children we have not always called it the cosmic work. As with out work in every Montessori progression, there is a particular point at which the child consciously recognizes what he has learned. And this is that **point of consciousness** regarding the **cosmic work.** We begin with the history of creation again, and NOW THE CHILDREN MAY HELP RETELL IT.

So many many millions of years ago there was a terrible coldness and darkness. In this coldness and darkness was there really nothing? No. There were tiny particles of **hydrogen. . .moving.** And we know that suddenly particles collided and there was a great explosion. In this way life was formed: like a huge **nebulae. Matter became physical.** And in this way the history of the cosmos started. The stars appeared: some were huge, some much smaller. Among those stars were our sun and our earth, a tiny star. Our earth was, in the beginning, a star: an incandescent mass. This incandescent matter, through a series of chemical reactions, formed many other substances.

And what was happening in those times is still happening: new stars are formed and old ones die. Now we know better the history of our star which gradually cooled and became a beautiful planet. But the substances on our earth kept transforming; and in these transformations the inorganic substances were transformed into organic substances---and life began. In the very beginning, the forms of life were simple. And these forms gradually became more and more complex until they reached human perfection. How many changes have followed since that dark cold night of remote times?

The history of all these changes is called evolution. Evolution shows us the progression of non-living and living matter. But it also shows us another aspect, maybe one that is much more important. This aspect is the cosmic work of all matter and all living beings. The vital chemical and physical powers unconsciously collaborate in that which Maria Montessori calls the "cosmic work."

Let's look for examples of "cosmic work." Those tiny particles which floated in the infinite darkness were particles of hydrogen. When they collided, the light was formed. What is light? We know that it is a **combustion.** And when there is a combustion, a chemical phenomenon takes place. After the explosion takes place, the hydrogen is no longer only hydrogen. A new element is formed: a transformation is always a result of a chemical phenomenon. In the incandescent stars, combustions follow one after the other in rapid succession. It is still going on in the stars. Gradually all the elements were formed. The substances can be called **elements, simple bodies, or metals.** All the universe is formed of these elements, our earth included. (Use CHART OF ELEMENTS HERE with their corresponding symbols. A good EXPERIMENT: to demonstrate the different elements, we can show that when they burn, each element produces a different colored flame. All the colors of the spectrum appear.)

Metals, or simple bodies, uniting in different ways, form the different minerals which, uniting again and cooling, form the rocks which form the crust of our earth. Rocks may be simple when formed of one mineral; or they may be compound when formed of several minerals. (STOP---Needed here is a good collection of rocks. An expert in geology is a real help here, too, to give a lesson on rocks. And an outing is appropriate during which the children collect rocks and identify them according to the three basic types: Igneous, Sedimentary, Metamorphic and further identify them if possible.)

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To overcome the difficulties of the environment, something new was necessary. We choose from among the invertebrates those beings which seem the most intelligent, those which were able to form societies, etc. And these are the **insects**. They, among the invertebrates, reached the maximum development in the nervous system. We can say that they arrived at the greatest level of development. In order to overcome environmental difficulties, however, something was needed: the **vertebral column**, the internal skeleton which supports the being and allows further development. And the **circulatory system** with the closed circuit. With the fish, the circulatory system does appear, the nervous system is more complex and the **cerebellum appears**. The cerebellum governs the senses; and is more developed in the animals than in man.

And so far, life has only existed in the water. But now life is able to develop on the land. But the earth has a great enemy: the cold. The climate always becomes colder and colder: and so new discoveries are made: hair, feathers, warm blood. These enable the beings to survive and defend themselves from the cold. So the birds and the mammals appear which, together with other new things, bring a new **cerebrum**.

It is constantly seen in evolution that it is not the size, dimension; but the specialization: of the organs and of reproduction. This is true both for animals and plants: the tree of evolution can be constructed for both kingdoms. It is a cycle which constantly repeats during the history of life. It can be deduced that it is not the most powerful that win, but those endowed with the most perfectly developed nervous system which corresponds to a greater intelligence, thus to the better protection of the offspring. That is, to a greater power of love.

We can conclude, says Maria Montessori, with the words of St. Paul: "God chooses the weak beings of the earth in order to confound the powerful."

The Power of Love

Together with intelligence, there is another force which develops pallelly: the force of love. The intelligence helps beings to discover new possibilities in order to preserve life. And the power of love helps beings to discover new means to safeguard the species. The more intelligence increases, the more the protection of the offspring increases. Nature creates new beings, trying to help them survive by protecting them. This instinct (intelligence) for the protection of the offspring exists not only in animals, but in plants.

In the beginning of life there was a plant cell which divided; or two cells which met and united. In this way, new lives were created. There was no protection for the species, but there was the possibility to create in a very short time, a great number of new organisms. And so, even though a great quantity of the young died, the species survived. Next came two different cells: male and female cells. The male cell looks for the female cell. And for its trip, the cell uses that means of transportation that nature offers it. When at last the two cells meet, they unite and they originate a certain seed called a spore. From this spore the new plant will start developing. There is no real protection for the species at this point; but the cell, destined to originate a new life, is Kept in humidity, enclosed by a very light sac which is both very resistant and waterproof. This sac is compared to a hard skin which might be compared to the shell of an egg. In this way the seed is kept alive for a very long time. When it finds the proper conditions, it starts to germinate.

Then intelligence develops further. We come to the great conifers: the male cell is the pollen and the female cell is the egg. There are trees which produce only the pollen and those which only produce the tiny eggs. The pollen, in order to reach the egg, is transported by the wind. And so a great quantity of pollen is necessary. During the trip, a great part of the pollen is lost. When the pollen reaches the egg, it unites with the egg and from this union the seed is formed. The seeds are protected in a strange, little house with many chambers: it has the shape of a cone and it is called a "pine cone." So these trees are called "**conifers**."

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brings the insects to the flowers? They do not consciously say, "Here I am, dear flower, to help you." But the bright colors and the perfume of the flower attract the insect. . . and at the bottom of the calyx they find the sweet liquid which they feed on: nectar. It is so sweet that mythology tells us that the only food of the gods was nectar. While the insects seek the nectar, the pollen attaches to their bodies and legs. And thus the pollen is transported from one place to another. When the pollen reaches the stigma of the pistil, it puts out a small tail and by moving the small tail, it makes its way down into the ovary where it reaches the egg and fecundates the egg.

Each grain of pollen fecundates one egg. When all the eggs are fecundated, the petals of the corolla fall. (Florists close the ovaries of the flowers in order to prevent fecundation and thus to preserve the longer life of the flower.) When the eggs have been fecundated, the corolla has served its purpose. The ovary is the new protection for the seed. From the ovary the fruits are created; the fruit is the swollen ovary. Men and animals eat the fruit; and thus the seeds of the fruit are disseminated everywhere.

In the plants we cannot talk about a real kind of love; but we see that nature is endowed with a special kind of sensitivity which becomes ever stronger to insure the continuation of the species and to improve the qualities.

Love Among Animals. At the beginning there was no protection for the offspring of the animals. In the protozoans, the porifera, the coelenterates, there is no protection for the offspring. And then, in contrast to these first animals, there are those animals whose main role in life is to take care of their offspring. The simplest form of protection is the laying of eggs. Each oviporous animal has the unmistakable instinct of laying eggs in the right place for the young ones to develop. First there were eggs WITHOUT a shell, or with a very very thin one. For these eggs, water is the best place. If there is no water, the animals look for mud: a place where there is land and water. Mollusks and insects lay their eggs in humid places. Certain animals know that besides humidity, warmth is important. So they look for warmth, found often among plant matter in a state of decomposition. (Decaying matter is a good source of heat.) Or they look for humid places where there is sunlight. Some arthropoda carry their eggs on their backs. Other animals collect their eggs in a little ball and carry it around in the thorax: some spiders and scorpions. Other spiders lay their eggs in nests, but they remain close to the nests to care for and protect the eggs. The greatest builders of nests are the insects: the bees, the wasps, the carpenter bees. These insects are very smart: they have organized classes of workers, whose role is to feed the larvae. This is their only work. And the mothers' role is to lay the eggs: she is the queen. When she stops laying eggs, she is killed and the group looks for a new queen.

Next come the vertebrates. It is believed that all fish abandon their eggs, but some take care of their eggs. There is a little fish called **rhodeus** that looks for empty bi-valves, carries the shell up and opens it. Then the male fish pushes the female in and obliges her to lay the eggs there. Once the "she-fish" has laid the eggs, the male goes in and fertilizes the eggs. Another fish, the **spinarello**, constructs a beautiful nest. It is always the male who makes the nest. The fish makes a hole in the sand, smoothing it to make a very nice room; and then he brings different colored algae and covers all the walls of the hole. Then the male looks for the female and pushes it into the hole: there the female lays the eggs. Then she runs away and the male fertilizes the eggs and stays to care for the eggs until they are born. (There are also some ovoviviporous species of fish: the young hatch within the female and are born alive. The female fish still lays the eggs, but retains them in the oviduct until they hatch. The species is the **guppy**: and they eat their young, so the matter of protection is questionable. Found in particularly warm waters.)

There are certain animals which mate and reproduce only after a very long trip. The eel lays the eggs in the water.

The Great Fable of Evolution. . .

Creation starts so many many millions of years ago, but it still goes on. Creation is not a moment, but a continual development, a process which goes on and on.

But that is not all. All the elements and celestial bodies are arranged according to their weight: the heaviest at the center of the earth and the lighter ones farther away from the center. In this way they exert a force of attraction, one on another. And this is another cosmic law: **the force of attraction avoids the dispersion of the elements;** it has made it possible for the water to remain in the low parts of our earth to form the oceans and the lakes. This force **of gravity** has also made it possible for the atmosphere to envelop our earth.

There is another law which shows the cosmic work: all the celestial bodies exert a strong attraction one upon the other. They exert, at the same time, **a force of attraction and one of repulsion.** These forces maintain all the bodies in equilibrium, preventing them from crashing into one another or escaping. So **"maintenance" of equilibrium** in the universe is another cosmic rule.

And there is yet another. **All the celestial bodies constantly rotate around themselves and revolve around another celestial body.** Our earth has these two special movements: rotation and revolution. (USE THE GEOGRAPHY CHARTS.) The movement of rotation prevents our earth from burning on one side and freezing on another. This is another part of the cosmic work: the rotation of the earth that makes life possible.

During that faraway period called the Arcaic Era, in a certain perfect moment, with the right amount of heat and humidity and in the presence of a special combination of substances, life began. **Due to a marvelous chemical phenomenon, the first living cell was born.** It is believed that the first living cell was a plant cell. In the water there was a great deal of carbon dioxide; and only plants can assimilate CO₂ and give off oxygen. Even today 75% of the oxygen in the air is produced by the unicellular beings which live in the water (algae). Therefore, **the first cosmic work of the living being was to absorb CO₂ and to give out oxygen in such a way as to make life possible for the animals which came afterwards.** Animal cells came after the plant cells; and the newly formed cells started a quantity of new experiments. The first animal cells were the protozoans. The tiny beings lived in the oceans and reproduced greatly. Huge amounts of calcium were constantly brought to the ocean by the rainwater. Animals need calcium, for the formation of bones. And the rainwater was doing its cosmic work, taking the calcium from the rocks and bringing it to the ocean. But, at a certain point, great quantities of calcium are not good. Life was endangered. But a myriad of tiny beings appeared: animals which built themselves a tiny shell. These animals absorbed and fixed a large amount of calcium and purified the water. When the little animal died, the tiny house deposited at the bottom of the ocean or on the beaches. (This is called diatomaceous earth; formed of tiny crystals, the skeletons of diatoms.) After these tiny beings, other animals came to help: porifera, coelenterates, echinoderms, arthropoda, mollusks. All joined in the work of fixing calcium. In order to develop their skeletons, external or internal, they fixed great amounts of calcium. In order to develop their own bodies, they did this work---not because they were conscious of their role. They had to fix the calcium in order to survive and to protect themselves. These beings never became conscious that their work made life possible for thousands of other animals.

Many of these animals are seen on the Time Line of Life. (ASK THE CHILDREN to name the animals they know on the Time Line.) In this way, all the animals together created the proper conditions to receive new kinds of animals. So far life was only in the water. But all of a sudden, the water began to recede; and many animals found themselves in dry places. Many died, but some adapted to the new environment. And once more the tiny unicellular algae covered the swamps of the earth. Now there was a new **cosmic work: purifying the air for new animals to live on the earth.**

Next came the lizens which attached to the rocks and, little by litte, broke down

GEOLOGICAL PERIODS for the "TIME LINE OF LIFE"

CAMBRIAN PERIOD:

The name comes from a part of England once called Cambria in Latin and now known as Wales. The first fossils were found here. All life was in the waters. There were many invertebrate animals: protozoa, porifera, coelenterates, worms, arthropods, mollusks and echinoderms. The most important animals of this period were the trilobites who were crustaceans belonging to the arthropods. They were the most plentiful and powerful animals at that time, filling the seas and oceans because they had no enemies. The only plants were the algae.

ORDOVICIAN PERIOD:

The name comes from an ancient tribe of people known as the Ordovices who lived in a part of England where the first fossils of this period were found.

An enemy appeared for the trilobites - the cold. Many of the seas which had once been warm were now covered with ice, causing the trilobites to become less abundant. Other animals which developed were large cephalopods, star fishes (echinoids), scorpions, and the most important of all, "sea lilies". These "sea lilies" or crinoids transformed the bottom of the seas into huge gardens. Although they appeared to be flowers, they were really animals, belonging to the echinoderms. All of these animals consumed great amounts of calcium, thus cleaning the waters.

SILURIAN PERIOD:

The name comes from an ancient tribe of people called the Silures who lived in a part of England where the first fossils of this period were found. Many animals disappeared while others appeared. The corals were now the great consumers of calcium. The first vertebrates also appeared, the so-called "armored fish" because their bodies were covered by a protective bony, shell-like covering.

DEVONIAN PERIOD:

The name comes from a part of England called Devon where the first fossils of this period were found. In this period the oceans receded and seas were formed between the different areas of land. Animals and plants remained in the muddy bottoms and had to learn how to live in their new surroundings. The algae grew longer and covered themselves with little leaves. Then the swamp lands began to dry up and plants had to put down roots in order to hold themselves upright and to go in search of water. The fish developed a true vertebral column and began to race swiftly in the seas. Some fish learned to live out of water for short periods of time, transforming their swim bladders into lungs. These lungfish were called Dipnoides (dual respiration) and still exist today.

CARBONIFEROUS PERIOD:

The land plants developed greatly but they still did not have flowers or fruits. The lowlands were covered with strange forests which became great swamps when the shallow seas flooded and receded. Buried under water, the trees would die and after centuries and centuries of being buried, would turn into coal. For this reason it is called the Carboniferous Period. Iron deposits were also being formed in the earth.

Now that the air had been purified by the plants, some animals were able to leave the water and learn to live on land. These were the amphibians. At this time there were also many insects and

PERMIAN PERIOD:

The name comes from a part of Russia called Perm, situated at the foot of the Ural Mountains, where the first fossils of this period were found. It was a very cold period. Some amphibians returned to the water to live while others learned to live entirely on land by evolving into reptiles. In the beginning these reptiles were very small, but having no enemies they became the masters of the land, continually multiplying and growing larger and larger until they were transformed into true giants. Instead of depositing their eggs in water, they now laid them in the sand where the rays of the sun could warm them. By this time many plants and animals lived on land and the Paleozoic Era came to a close.

TRIASSIC PERIOD:

The name of this period means three, because its rock sediments are divided into three strata. It also marked the beginning of the Mesozoic Era, also called the Age of Reptiles because these animals over-shadowed all the other inhabitants of the earth. Having no enemies, these reptiles were able to multiply and develop into giant dinosaurs. They could resist the heat of the sun due to their armor-like skin covering. There were both vegetarian and carnivorous reptiles. The carnivorous ones had terrible teeth.

JURASSIC PERIOD:

The name comes from the Jura Mountains where the first fossils of this period were found. It also marked the appearance of the flying reptiles. Among these was one with feather covered wings, the Archaeopteryx, from which birds are believed to have descended.

Some reptiles returned to water, including some who took the shape of fish. In this period the first mammals appeared, giving milk to their young but still reproducing by eggs. New plants to appear were the conifers, pines and fir-trees.

CRETACEOUS PERIOD:

The name comes from the chalk deposits where the most fossils of this period were found.

New plants appeared that had flowers and corollas. There were many, many insects at this time, including butterflies. But toward the end of this period the earth was once again covered by ice to a great extent.

What happened to the great reptiles, once such powerful masters of the land, without any enemies? They could not stand the freezing cold and gradually disappeared.

CENOZOIC ERA:

It is called the Age of Mammals and is divided into four parts: Eocene, Oligocene, Miocene, Pliocene. All four of these words have almost the same meaning - new period.

In the beginning most mammals were very different from the ones that we know today. Then gradually they acquired the modern form as we now know them. Compare the earliest horse to the modern one. Other animals similar to the ones today were fish, birds, amphibians, and

THE TIME LINE OF LIFE: Second Presentation

INTRODUCTION: For the Teacher

The first presentation of the Time Line of Life is very simple; the first overall view is given as a scope of evolution from the geological point of view. Only a short time ago, the history of life was approached from a biological point of view with regard to the material needs of nutrition, defense, the survival of the individual and the species. It was viewed as something completely separate from the history of the earth and the universe, and pertained only to the biological consideration of the separate species. Dott.sa Montessori described this as a way of approaching life that was linear, this separation of life from the history of the universe. She said that it was similar to ancient man's concept of a flat earth.

Instead, the concept of life as a geological phenomenon shows life itself in larger dimensions, in its vastness; and as something completely united to the rest of the universe. Geology has given us the proofs of evolution, showing that life is a constant progression: that life which passes from the water to the land, from the invertebrate to the vertebrate, from the cold-blooded creature to the warm-blooded one, from the nearly insensitive organism to those with highly developed nervous systems. The remains found in rocks enable the imagination to reconstruct past times; they are called fossils. Fossils have been found everywhere. Rock sediments form a long stair, looking like steps that are one on top of the other. Each step corresponds to a certain period. An excellent visual example of this is the Grand Canyon. In the deepest layers where a few remains of living beings have been found is the pre-Cambrian granite. During this long period which is represented on the Clock of Eras in yellow from the hours of 4 till 10, life was formed. Many iron deposits which exist in the United States are believed to have formed during this period. It is thought that the iron may have been fixed by a certain type of algae with a particular capacity for fixing iron as the corals fix the calcium. In the strata of calcareous rock (composed of calcium carbonate, calcium or limestone) it is evident that animal life existed. The formation of this rock is always linked with living organisms. But it is still a mystery HOW life was formed.

It is strangest that this great mystery of life is enclosed in something very tiny, something that looks like a little bit of water. This microscopic organism is called the CELL and the substance of which it is made is called PROTOPLASM. This tiny cell, by trying a host of different means and modes, originated the many forms of life. From a tiny protozoan and an algae, life developed always more and better until we have the complicated convolutions of the human brain. All plant and animal life come from that cell, so tiny and simple. But it works and constructs, obeying the immaterial command that IT CARRIES IN ITSELF. And it is like a faithful servant. It does not betray its secret. We do not know that secret which is enclosed in the cell. The tiny cell is endowed with a strong sensitivity and energy which has been called by Maria Montessori "spirituality." By the term "spirituality" she means that unknown energy and sensitivity which exists in the non-physical part, the psychic part of the organism or cell, and which pushes the cell towards development in a particular way. And this is the HORME, the drive which overcomes all obstacles. It explores all environments, carrying life to the most unknown places. It looks for the means necessary to protect its consequences and to survive.

Evolution, seen from the geological point of view, shows the progression of intelligence. And the progression of reproduction; the sexual part moves towards perfection. It also shows us the laws of life which are inexorable laws. There are species who work, obeying, without every becoming powerful. And in this way they continue. But there are other species which become very powerful so that they believe they cannot be defeated. But, at a certain point, conditions change and the powerful beings find themselves unable to adapt, unable to start again; and they disappear from the realms of life. And the sovereignty of the earth passes to those beings which are apparently weaker. However, they are animals endowed with a psychic energy and vitality, strong enough to face the new environment

During evolution, we witness a great increase in the intelligence which moves towards

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point of view gives us the moral sense of life. What is this unconscious charity? Dott.sa Montessori says that it is the service that each being gives in order to maintain equilibrium in the environment and to improve it for those who come after. Why does she call the charity "unconscious?" Because there is also a self-conscious, egoistic, aspect of this: to take as much as possible, to occupy as much space as possible, to eat as much and to procreate as much as possible. The conscious part of life serves the conscious vegetative functions as a result of hunger, etc. Another aspect is the unconscious altruistic one, keeping a natural equilibrium in nature, keeping a balance for those that come after. This aspect is called the "cosmic work;" an exchange of services. Therefore **the unconscious charity and the cosmic work are the same thing.**

"Each expression of everything that exists has a cosmic sense; and the union of all the cosmic finalities not only maintains the level of life, but increases it. Each being answers the special call which is beyond its understanding, but which makes all beings participants in creation. All creatures consciously work for themselves, but the real aim of life is the **absolute obedience and the unconscious obedience to the great laws which govern the universe.** All the powers working in the cosmos have a special role. Physical powers, chemical powers and vital powers, all unconsciously collaborate in this great cosmic work." (Maria Montessori)

The individual's aim is not to have a better way of living for himself, but to create better conditions for all. Each one in life has a function which he is not aware of. . .and which is linked to the well-being of everyone. This is the cosmic education that Montessori speaks of. And this is the fundamental part which regards the history of life, the universe and man. The great law which governs life in the cosmos is that of collaboration. It has existed from the beginning of time.

To study deeper this law means to work for the triumph of the union among people--- and therefore the triumph of human civilization. Only a school that takes into consideration the real human reality and the needs of our times can insure a society of men who are capable of carrying out the union among peoples which the humanity of our times so much desires.

Another important point of emphasis is the relationship of love. Dott.sa Montessori says that everything moves along a path towards greater perfection. For a long time it was believed that the struggle for life was won by the strong. Today it is thought. . . it is known that it is not the strongest, but the most intelligent. **And that the intelligence is revealed in the ability to discover the means to protect the offspring.** Intelligence and love mark the progress of life.

We cannot tell the children this in specific terms; but we can tell them that it is not strength which wins. For a long time education was based in this principle, an education based on struggle and strength. If these two factors are at the base of the history of life, then it follows that they must also be the fabric of social life. And thus history is a series of wars, leaving out the real important phenomena which continues in progress throughout the centuries. And---if the struggle is most important in life, then our education also will be based in struggles and suffering. The old methods all reflect this concept: they are based on the difficulties it is necessary to overcome in order to learn. Thus is born an obligation to work, hard discipline, self-denial. . . As science progressed, by observing vital phenomena in a vast scope, the struggle as a key concept in evolution was cancelled. It was discovered that at the base of life is **THE PROTECTION OF THE OFFSPRING.** And the possibilities the offspring receive in order to develop in a harmonious way. This progression of love marks the real evolution. Montessori says that nature evolves, reinforcing that which has been a weak point in the preceding being. This great force called love keeps progressing during the history of life.

In this new presentation of the history of life we no longer talk about the periods

The Great Fable of Evolution

We have studied for three years the history of life, of the earth, of the universe, of man. We could say that we are finished. But this long story has much to teach us. When we tell a fable, we always find at the end of it a moral. Usually the bad one loses and the good one wins. This fable has a moral that we must discover. The moral that governs the earth is formed of several inexorable (unchangeable) laws:

- 1) Absolute obedience in evolution.
- 2) Universal intelligence as a guide of evolution.
- 3) The force of love in evolution.
- 4) The cosmic work.

Absolute obedience. (A difficult concept for the children)

During all the history of the cosmos, the living and non-living matter behave in a special way, as though there were secret commands which oblige it, in that given specific moment, to follow a given specific road. From the moment in which the particles collided and started to burn and the light was formed, there has been a constant succession of facts which seem to be guided by a logical and precise order. From this mass of light to the galaxies; and from the galaxies to the stars; from the stars to the planets; from **one single element, hydrogen**, to many more than 100 elements which, combining in many different ways, gave origin to an infinite number of minerals. (The experiments aid in the understanding of this phenomenon of the elements combining.) These minerals, the result of different combinations of elements, have different properties from the properties of the elements of which they are formed.

We are near the wonderful world, but it is still non-living; it is the mineral kingdom. The earth is formed of rocks and water. Then, there was the great cosmic phenomenon. The main elements were present in the atmosphere: hydrogen, carbon, nitrogen, and oxygen. And there were the sun's strong radiations penetrating that atmosphere. And there was the heat of thunder, lightening and volcanoes. In the midst of all this, the elements gave origin to the first organic matter: **the amino acids, the raw material of proteins**. That is, the main substance of living organisms; and therefore, the raw material of the cell, of this cell which forms a wonderful world full of secret commands which guide it through an infinite number of experiences in order to create strange wonders which inhabit our earth and very probably also other planets. (Now the possibility of life on Jupiter is a reality according to the space explorer voyages which transmit information of space phenomena.) And all these substances, when they are formed, follow the precise chemical and physical laws.

There are moments when it seems that chaos reigns, but in the vast length of time, these are merely instants and then order and equilibrium are regained. It seems that the Arcaic (Archeozoic) period was one of these moments of chaos. In those times there existed many unicellular organisms which filtered the water by allowing it to pass through their bodies, retaining the salts and then giving back the purified water. (A good comparison: a man would have to drink 30 litres of water every second for his whole life to compare to the great quantity which these tiny organisms filtered.) This myriad of workers was not enough. The rainwater ran down the earth formed of rocks (there was nothing but rocks; the earth was barren). And the water was capable of dissolving the rock because of the force of the water as it rushed down and because of a certain chemical reaction, the water containing an acid capable of dissolving rock. As the rain falls, it absorbs a great amount of carbon dioxide which, when mixed with the water becomes carbonic acid. ($\text{CO}_2 + \text{H}_2\text{O}$ Carbonic acid.) Thus all this calcium from the rock which was brought to the ocean threatened life and the equilibrium.

Tiny beings appeared that each constructed for themselves a little shell. When the animal died, the shell went to the bottom of the ocean and began to accumulate---or deposited along the beaches, a phenomenon which occurred in Africa near Tripoli. The shells themselves were as tiny as grains of sand. Each of these tiny beings could reproduce in ten days ten million new beings. And so a great army is formed in this way to purify the water of calcium. And the corals perform

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Little by little, the unicellular beings multiplied and occupied the oceans until they were living everywhere. And in this way new species arrived, each species more intelligent than the preceding one, each with a greater power to adapt. Each species tried to occupy as much space as possible, to eat as much as possible, each one tried to become the most powerful. Dott.sa Montessori remarks that among animals as among men, certain laws are forgotten which all must obey. When the species becomes more powerful, the decline for them starts. Sometimes the decline is a fast one due to cataclysm or epidemic; or a decline may be slow, during which the species gradually start to disappear.

TAKE THE TIME LINE OF LIFE: We show how this phenomena repeats periodically: the trilobites, the sea lilies, the sea scorpions, the cephalopods, (only one remains now of this group: the chambered nautilus, a very small member of the species: use maybe here the poem "The Chambered Nautilus" -- Oliver Wendell Holmes.). Then the big fish (armoured fish), the big amphibians, the big reptiles. All of them, due to various reasons, had to abandon the throne of power; and some ceased to exist. They have to leave their place to beings who bring something new. In each of the moments when there is great change, it seems there is great chaos; it seems that obedience is forgotten. But the laws which govern the universe are absolute; equilibrium and obedience come back. He who didn't obey, who tried to become stronger than the others, was punished and disappeared.

This is true for man. We are living in one of these moments in which man has believed he can live without consideration for these laws. Will he find the strength to obey? If not, he will gradually destroy himself and maybe the life of other beings which inhabit the earth. And at that point the earth would become barren as it started: without plants and animals. But the earth would continue around the sun and there will be new life. (A note on nuclear reactors: the wastes they produce are dangerous for 25,000 years. An attempt was made to put these wastes in stainless steel boxes. In 20 years the wastes had completely deteriorated the containers and seeped out.)

Universal intelligence in evolution.

During the history of life there have been glacial and inter-glacial periods: cold and warm. During each warm period there is a species that develops greatly and when the cold period comes, it disappears. During that warm period it is the species most intelligent, most able to adapt, that develops because it is thus that it succeeds in conquering the environment.

USE NOW THE TIME LINE OF LIFE TOGETHER WITH THE VERTEBRATE-INVERTEBRATE ANIMAL CHARTS AND THE MATERIAL OF THE PHYSIOLOGICAL FUNCTIONS. We use these materials as needed as we proceed with the discussion.

We notice that the part which develops most is the nervous system. The earth is made of this intelligence and this spirituality. Each being, overcoming hard difficulties, makes new conquests. Little by little, through the environmental experience of the living beings, the experiences become part of the being itself. And these experiences which become part of the being composes the mneme, the instinct in animals which is formed according to those experiences made in the environment in order to survive; and those are transmitted from generation to generation. (NOTE on the mneme from The Formation of Man: . . . an unconscious memory which retains its fixed images even through generations and minutely reproduces the characteristics of the species. . . . The mneme, with its infinite gradations, penetrates into the very facts of life and eternity. Once this has been ascertained, it is easy to recognize in the mind of the four-year-old child, a phase of psychic development in which the mneme stands on the very threshold of conscious memory, almost on the point of merging with it, yet manifesting itself as the last trace of a phenomenon with very deep roots. That last trace of the mneme came from afar.) So the instinct becomes a guide which cannot be put aside because it is a conquest made over a period of thousands of years. The species does not have the option of change; instead of changing the instinct, it dies. These conquests help the species to survive.

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The salmon live in the ocean, but they lay their eggs in the rivers. They make an extraordinary trip upstream, swimming against the currents, until they find a particular place to lay their eggs. Some turtles live in the ocean; and they make a long trip to a special island, called the Island of Turtles, where they lay their eggs. It is such a long and tiring trip to the island that many die from exhaustion on arrival. But they lay their eggs first. The mystery of migration in animals has not been discovered yet. It has not been discovered why the long trip is made.

We have seen, in the fish and the amphibians and the reptiles, that already they have begun to protect the young. This protection becomes very wonderful in birds and mammals. Each bird constructs a specific kind of nest, a nest built over and over again in the same way through the years. Birds may lay eggs at the very top of trees or inside the trunks of trees. Swallows build their nests below roofs; storks build their nests in chimneys. In constructing nests, the male and female help each other: often the male makes the most difficult part and the female the easy part. But they work together. The nest is the symbol of the happy family. While building their nests, many couples isolate themselves. Other birds, such as the sea birds, get together in one place and form real colonies.

How many eggs do birds lay? Much fewer than insects. . . fewer than the invertebrates and the preceding vertebrates. Because they take greater care with their nests, they protect the young, they brood them with their own body warmth, and they feed them until they can feed themselves. But the number of eggs varies greatly from one bird to the next. The small songbirds lay eggs three times a year (canary) because they have many enemies such as cats. (A Bergamo classic: Tweety and Silvester) The eagle build one nest every year and lays one egg. (Nature did not calculate man's damages.)

In order to brood the eggs, both birds cooperate. Some birds stay together only during brooding and during the first life of the young. Other couples remain together throughout life: they never fight and they help each other with their work. It has been noticed that when the female and the male brood together, the male sits on the eggs during the night when his bright feathers will not attract attention, and the female does the work during the day when her dullness of coloring will be least noticed. Other birds during brooding time do not eat. The ostrich is one of these. Some birds do not construct a very deep nest, but in order to keep the eggs from rolling out, they lay eggs in the shape of pears. The female rolls the eggs periodically so that all parts of the egg will heat evenly. The work of the mother to feed the little ones is very tiring: some birds eat 140 times a day. (Birds generally eat daily three times their weight.) Among the carnivorous birds, the male brings the meat and the female grinds it. (raven) The parents, besides feeding the little birds, teach them how to look for food, how to defend themselves, how to fly.

The mammals also prepare special nests to receive their young. Because, as we know, the offspring of the mammals are born alive. Only the platypus, belonging to the order monotremata, lays eggs. The nests of mammals are carefully and well prepared: the nests are their houses and they live in them all year round. But when they have offspring, the nests are prepared in a special way. For example, the rodents prepare the nests with the hair of their own bodies to make it soft. Of the mammals, the most beautiful nest is that of the squirrel. It is built in the hole of a tree trunk; the nests are very soft; and the squirrel puts a cover over it. The inside of the nest looks like a little room.

Among the mammals something strange happens. In the birds the male and the female form a working family. In the mammals the female does most of the work, and the male's work decreases. He becomes a little selfish. Only in a few cases, the male teaches the young how to find their own food. The mammals are the most intelligent species on the scale of evolution. In them instinct is strong, but it is more flexible and they are more adaptable to the environment. Besides instinct, there is also a high degree of experience. (They have greater freedom of action; and can learn new things.)

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is based on the struggle. **The protection for the offspring is the real mark in the progress of evolution.** Nature progresses, making stronger that part which was weak in the preceding being. So we notice constant progress of the intelligence and love. Therefore, the great power and energy which constantly keeps increasing during evolution, has been the **energy of intelligence and the energy of love.**

The COSMIC WORK: A Conclusion

NOTE: We talk about the cosmic work in all the work of history although with the children we have not always called it the cosmic work. As with out work in every Montessori progression, there is a particular point at which the child consciously recognizes what he has learned. And this is that **point of consciousness** regarding the cosmic work. We begin with the history of creation again, and NOW THE CHILDREN MAY HELP RETELL IT.

So many many millions of years ago there was a terrible coldness and darkness. In this coldness and darkness was there really nothing? No. There were tiny particles of **hydrogen. . .moving.** And we know that suddenly particles collided and there was a great explosion. In this way life was formed: like a huge **nebulae. Matter became physical.** And in this way the history of the cosmos started. The stars appeared: some were huge, some much smaller. Among those stars were our sun and our earth, a tiny star. Our earth was, in the beginning, a star: an incandescent mass. This incandescent matter, through a series of chemical reactions, formed many other substances.

And what was happening in those times is still happening: new stars are formed and old ones die. Now we know better the history of our star which gradually cooled and became a beautiful planet. But the substances on our earth kept transforming; and in these transformations the inorganic substances were transformed into organic substances---and life began. In the very beginning, the forms of life were simple. And these forms gradually became more and more complex until they reached human perfection. How many changes have followed since that dark cold night of remote times?

The history of all these changes is called evolution. Evolution shows us the progression of non-living and living matter. But it also shows us another aspect, maybe one that is much more important. This aspect is the cosmic work of all matter and all living beings. The vital chemical and physical powers unconsciously collaborate in that which Maria Montessori calls the "cosmic work."

Let's look for examples of "cosmic work." Those tiny particles which floated in the infinite darkness were particles of hydrogen. When they collided, the light was formed. What is light? We know that it is a **combustion.** And when there is a combustion, a chemical phenomenon takes place. After the explosion takes place, the hydrogen is no longer only hydrogen. A new element is formed: a transformation is always a result of a chemical phenomenon. In the incandescent stars, combustions follow one after the other in rapid succession. It is still going on in the stars. Gradually all the elements were formed. The substances can be called **elements, simple bodies, or metals.** All the universe is formed of these elements, our earth included. (Use CHART OF ELEMENTS HERE with their corresponding symbols. A good EXPERIMENT: to demonstrate the different elements, we can show that when they burn, each element produces a different colored flame. All the colors of the spectrum appear.)

Metals, or simple bodies, uniting in different ways, form the different minerals which, uniting again and cooling, form the rocks which form the crust of our earth. Rocks may be simple when formed of one mineral; or they may be compound when formed of several minerals. (STOP---Needed here is a good collection of rocks. An expert in geology is a real help here, too, to give a lesson on rocks. And an outing is appropriate during which the children collect rocks and identify them according to the three basic types: Igneous, Sedimentary, Metamorphic and further identify them if possible.)

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To overcome the difficulties of the environment, something new was necessary. We choose from among the invertebrates those beings which seem the most intelligent, those which were able to form societies, etc. And these are the **insects**. They, among the invertebrates, reached the maximum development in the nervous system. We can say that they arrived at the greatest level of development. In order to overcome environmental difficulties, however, something was needed: the **vertebral column**, the internal skeleton which supports the being and allows further development. And the **circulatory system** with the closed circuit. With the fish, the circulatory system does appear, the nervous system is more complex and the **cerebellum appears**. The cerebellum governs the senses; and is more developed in the animals than in man.

And so far, life has only existed in the water. But now life is able to develop on the land. But the earth has a great enemy: the cold. The climate always becomes colder and colder: and so new discoveries are made: hair, feathers, warm blood. These enable the beings to survive and defend themselves from the cold. So the birds and the mammals appear which, together with other new things, bring a new **cerebrum**.

It is constantly seen in evolution that it is not the size, dimension; but the specialization: of the organs and of reproduction. This is true both for animals and plants: the tree of evolution can be constructed for both kingdoms. It is a cycle which constantly repeats during the history of life. It can be deduced that it is not the most powerful that win, but those endowed with the most perfectly developed nervous system which corresponds to a greater intelligence, thus to the better protection of the offspring. That is, to a greater power of love.

We can conclude, says Maria Montessori, with the words of St. Paul: "God chooses the weak beings of the earth in order to confound the powerful."

The Power of Love

Together with intelligence, there is another force which develops pallelly: the force of love. The intelligence helps beings to discover new possibilities in order to preserve life. And the power of love helps beings to discover new means to safeguard the species. The more intelligence increases, the more the protection of the offspring increases. Nature creates new beings, trying to help them survive by protecting them. This instinct (intelligence) for the protection of the offspring exists not only in animals, but in plants.

In the beginning of life there was a plant cell which divided; or two cells which met and united. In this way, new lives were created. There was no protection for the species, but there was the possibility to create in a very short time, a great number of new organisms. And so, even though a great quantity of the young died, the species survived. Next came two different cells: male and female cells. The male cell looks for the female cell. And for its trip, the cell uses that means of transportation that nature offers it. When at last the two cells meet, they unite and they originate a certain seed called a spore. From this spore the new plant will start developing. There is no real protection for the species at this point; but the cell, destined to originate a new life, is Kept in humidity, enclosed by a very light sac which is both very resistant and waterproof. This sac is compared to a hard skin which might be compared to the shell of an egg. In this way the seed is kept alive for a very long time. When it finds the proper conditions, it starts to germinate.

Then intelligence develops further. We come to the great conifers: the male cell is the pollen and the female cell is the egg. There are trees which produce only the pollen and those which only produce the tiny eggs. The pollen, in order to reach the egg, is transported by the wind. And so a great quantity of pollen is necessary. During the trip, a great part of the pollen is lost. When the pollen reaches the egg, it unites with the egg and from this union the seed is formed. The seeds are protected in a strange, little house with many chambers: it has the shape of a cone and it is called a "pine cone." So these trees are called "**conifers**."

The Great Fable of Evolution. . .

brings the insects to the flowers? They do not consciously say, "Here I am, dear flower, to help you." But the bright colors and the perfume of the flower attract the insect. . .and at the bottom of the calyx they find the sweet liquid which they feed on: nectar. It is so sweet that mythology tells us that the only food of the gods was nectar. While the insects seek the nectar, the pollen attaches to their bodies and legs. And thus the pollen is transported from one place to another. When the pollen reaches the stigma of the pistil, it puts out a small tail and by moving the small tail, it makes its way down into the ovary where it reaches the egg and fecundates the egg.

Each grain of pollen fecundates one egg. When all the eggs are fecundated, the petals of the corolla fall. (Florists close the ovaries of the flowers in order to prevent fecundation and thus to preserve the longer life of the flower.) When the eggs have been fecundated, the corolla has served its purpose. The ovary is the new protection for the seed. From the ovary the fruits are created; the fruit is the swollen ovary. Men and animals eat the fruit; and thus the seeds of the fruit are disseminated everywhere.

In the plants we cannot talk about a real kind of love; but we see that nature is endowed with a special kind of sensitivity which becomes ever stronger to insure the continuation of the species and to improve the qualities.

Love Among Animals. At the beginning there was no protection for the offspring of the animals. In the protozoans, the porifera, the coelenterates, there is no protection for the offspring. And then, in contrast to these first animals, there are those animals whose main role in life is to take care of their offspring. The simplest form of protection is the laying of eggs. Each oviporous animal has the unmistakable instinct of laying eggs in the right place for the young ones to develop. First there were eggs WITHOUT a shell, or with a very very thin one. For these eggs, water is the best place. If there is no water, the animals look for mud: a place where there is land and water. Mollusks and insects lay their eggs in humid places. Certain animals know that besides humidity, warmth is important. So they look for warmth, found often among plant matter in a state of decomposition. (Decaying matter is a good source of heat.) Or they look for humid places where there is sunlight. Some arthropoda carry their eggs on their backs. Other animals collect their eggs in a little ball and carry it around in the thorax: some spiders and scorpions. Other spiders lay their eggs in nests, but they remain close to the nests to care for and protect the eggs. The greatest builders of nests are the insects: the bees, the wasps, the carpenter bees. These insects are very smart: they have organized classes of workers, whose role is to feed the larvae. This is their only work. And the mothers' role is to lay the eggs: she is the queen. When she stops laying eggs, she is killed and the group looks for a new queen.

Next come the vertebrates. It is believed that all fish abandon their eggs, but some take care of their eggs. There is a little fish called **rhodeus** that looks for empty bi-valves, carries the shell up and opens it. Then the male fish pushes the female in and obliges her to lay the eggs there. Once the "she-fish" has laid the eggs, the male goes in and fertilizes the eggs. Another fish, the **spinarello**, constructs a beautiful nest. It is always the male who makes the nest. The fish makes a hole in the sand, smoothing it to make a very nice room; and then he brings different colored algae and covers all the walls of the hole. Then the male looks for the female and pushes it into the hole: there the female lays the eggs. Then she runs away and the male fertilizes the eggs and stays to care for the eggs until they are born. (There are also some ovoviviporous species of fish: the young hatch within the female and are born alive. The female fish still lays the eggs, but retains them in the oviduct until they hatch. The species is the **guppy**: and they eat their young, so the matter of protection is questionable. Found in particularly warm waters.)

There are certain animals which mate and reproduce only after a very long trip. The eel lays the eggs in the water.

The Great Fable of Evolution. . .

Creation starts so many many millions of years ago, but it still goes on. Creation is not a moment, but a continual development, a process which goes on and on.

But that is not all. All the elements and celestial bodies are arranged according to their weight: the heaviest at the center of the earth and the lighter ones farther away from the center. In this way they exert a force of attraction, one on another. And this is another cosmic law: **the force of attraction avoids the dispersion of the elements;** it has made it possible for the water to remain in the low parts of our earth to form the oceans and the lakes. This force **of gravity** has also made it possible for the atmosphere to envelop our earth.

There is another law which shows the cosmic work: all the celestial bodies exert a strong attraction one upon the other. They exert, at the same time, **a force of attraction and one of repulsion.** These forces maintain all the bodies in equilibrium, preventing them from crashing into one another or escaping. So **"maintenance" of equilibrium** in the universe is another cosmic rule.

And there is yet another. **All the celestial bodies constantly rotate around themselves and revolve around another celestial body.** Our earth has these two special movements: rotation and revolution. (USE THE GEOGRAPHY CHARTS.) The movement of rotation prevents our earth from burning on one side and freezing on another. This is another part of the cosmic work: the rotation of the earth that makes life possible.

During that faraway period called the Arcaic Era, in a certain perfect moment, with the right amount of heat and humidity and in the presence of a special combination of substances, life began. **Due to a marvelous chemical phenomenon, the first living cell was born.** It is believed that the first living cell was a plant cell. In the water there was a great deal of carbon dioxide; and only plants can assimilate CO₂ and give off oxygen. Even today 75% of the oxygen in the air is produced by the unicellular beings which live in the water (algae). Therefore, **the first cosmic work of the living being was to absorb CO₂ and to give out oxygen in such a way as to make life possible for the animals which came afterwards.** Animal cells came after the plant cells; and the newly formed cells started a quantity of new experiments. The first animal cells were the protozoans. The tiny beings lived in the oceans and reproduced greatly. Huge amounts of calcium were constantly brought to the ocean by the rainwater. Animals need calcium, for the formation of bones. And the rainwater was doing its cosmic work, taking the calcium from the rocks and bringing it to the ocean. But, at a certain point, great quantities of calcium are not good. Life was endangered. But a myriad of tiny beings appeared: animals which built themselves a tiny shell. These animals absorbed and fixed a large amount of calcium and purified the water. When the little animal died, the tiny house deposited at the bottom of the ocean or on the beaches. (This is called diatomaceous earth; formed of tiny crystals, the skeletons of diatoms.) After these tiny beings, other animals came to help: porifera, coelenterates, echinoderms, arthropoda, mollusks. All joined in the work of fixing calcium. In order to develop their skeletons, external or internal, they fixed great amounts of calcium. In order to develop their own bodies, they did this work---not because they were conscious of their role. They had to fix the calcium in order to survive and to protect themselves. These beings never became conscious that their work made life possible for thousands of other animals.

Many of these animals are seen on the Time Line of Life. (ASK THE CHILDREN to name the animals they know on the Time Line.) In this way, all the animals together created the proper conditions to receive new kinds of animals. So far life was only in the water. But all of a sudden, the water began to recede; and many animals found themselves in dry places. Many died, but some adapted to the new environment. And once more the tiny unicellular algae covered the swamps of the earth. Now there was a new **cosmic work: purifying the air for new animals to live on the earth.**

Next came the lizens which attached to the rocks and, little by litte, broke down

All of these plants reproduced greatly because they were obeying another law: eat as much as possible, occupy as much space as possible, reproduce as much as possible. Then we come to the carboniferous period, characterized by the great forests. The great forests were used as food by the first animals who came to live on the land. The huge trunks deposited, decayed and formed the carbon that we now use to heat out houses. They were obeying the cosmic law. So huge plants developed, according to the law: **occupy as much space as possible, grow as much as possible, reproduce as much as possible.** At the same time they were being used as food by the other animals. But they were also in the process of forming carbon and iron which we use. (NOTE the rectangle of black and brown.) It is thought that the great deposits of carbon were formed during this period. There are, from this time, layers of rocks which contain iron. This iron was the result of special tiny animals who, absorbing substances from the earth in order to nourish and construct their own bodies, fixed iron in a special way just as other tiny animals fixed the calcium.

Think of all the cosmic work we have witnessed. **The huge forests of the carboniferous period provided food for the huge reptiles, primarily vegetarians.** And so the reptiles developed greatly. The eggs of the reptiles and the huge trees provided food and protection for the birds and the mammals. At the same time, the birds and the mammals prepared the environment for the last animal to arrive: man. In this way, we have followed the path of evolution, looking at it from the aspect of cosmic work.

All creatures work selfishly for themselves, but the real aim is still the unconscious obedience to the great cosmic plan. We have only looked at a few of the many examples of this cosmic work. (The children can find many others) Another good example of cosmic work is done by what Maria Montessori calls "the janitors of the earth." These are the ants, the hyenas, the great birds called condors, all of whom are usually despised or considered insignificant; but whose work is very important. **We must look at life in a profound way: to look superficially, we see only greedy and selfish beings, but this form of greediness and selfishness brings equilibrium in life.** Each being takes what is disposed of by another. That which is poisonous for one, often causing death, represents for another life. Each being, in one way or another, gives his contribution to the progress of evolution: the progress of life.

Maria Montessori explained: "Each expression of everything that exists has a cosmic sense, and the union of these cosmic finalities not only maintains the level of life, but increases it. Each being answers a special call which is beyond our possibilities to understand or comprehend; but which renders everything a participant of creation."

THE MEANING OF THE APPEARANCE OF MAN: Second Presentation

We could give this chapter a different title, using Maria Montessori's expression from To Educate the Human Potential "Man as Creator and Revealer."

In order to understand man, we must first put him in relation to the rest of the universe; and with the source of energy which exists in the universe guiding all the evolutive processes. Man is not isolated from the rest of the cosmos. He is an integral part of it. We have seen the expansion of the universe, an infinite expansion which the human intelligence is not able to grasp. Then we have seen how the earth appeared and was formed; then how life began; then the evolution of the different living groups. And we have seen those principles which rule evolution. What are these rules, these guiding principles of evolution?

- 1) The apparently selfish and conscious struggle for survival; and the unconscious cosmic work.
- 2) Some privileged species become very powerful, decline and disappear.
- 3) Forms of life which are less visible, but more vital and more intelligent, occupy the place left by those beings which disappear.

THE TIME LINE OF LIFE. . .

Second Presentation. . .

1. . .analysis of the last set of titles. . .

The Mesozoic Era. . .

During the Cretaceous period, the first complete flower appears---with leaves transformed into a corolla. And with it, the butterfly, who transports the pollen, makes its appearance to feed on the nectar of the flower.

During the Cretaceous period, great mountains are raised: the Alps and the Himalayans.

Then comes the final Glacial period. And all the great reptiles disappear. For them it is a natural disaster. But it seems that, in nature, there is a law that when one being becomes too powerful, too strong, there is a cataclysmic event which destroys it. Small beings, apparently insignificant, are seemingly endowed with something special: a nervous system highly developed which allows them to survive.

The Cenozoic Era, the Tertiary period, we have the era of new animals. Mammals now occupy the land, the water and the air and become the master. During the last million years of this age, man appears. And it is here, in the Quaternary (Neozoic) Era, we move to a new time line which tells the story of man.

2. The children now work with the time line, using a blank time line on which they place cut-out pictures and labels correctly.

- NOTE: A later second presentation deals with the moral implications of the time line.
- NOTE: It is difficult to find the evolutionary links because they are probably microscopic and few in number. But we are able to note some of the fascinating links.

Today we know this much: tomorrow perhaps we will discover something new: maybe you.

NOTES: An interesting set of two tables: one noting the eras, the corresponding time spans as minutes, hours; and as years:

Formative Era: (ARCHEOZOIC ERA):	4 hours	1,000,000,000 years
Arcaic Era (ARCHEOZOIC ERA):	6 hours	1,500,000,000 years
Paleozoic Era:	1 hour, 12 min.	300,000,000 years
Mesozoic Era:	33 min., 36 sec.	140,000,000 years
Cenozoic Era:	14 min., 9 6/10 sec.	59,000,000 years
Neozoic Era:	14 4/10 sec.	1,000,000 years

The second table gives the length of time each era extends from hour and minute on each section of the clock.

The ~~four~~ periods of the Cenozoic Era: Eocene, Oligocene, Miocene, Pliocene

The Arcaic (Archeozoic Era): "despite all the adversities, life was not destroyed."

The IClock represents the entire history of the earth from the time it was a mass of gases to the appearance of man. The Time Line illustrates the Appearance and Evolution of Life in relation to the variations of the environment during the geological eras.

GEOLOGICAL PERIODS for the "TIME LINE OF LIFE"

CAMBRIAN PERIOD:

The name comes from a part of England once called Cambria in Latin and now known as Wales. The first fossils were found here. All life was in the waters. There were many invertebrate animals: protozoa, porifera, coelenterates, worms, arthropods, mollusks and echinoderms. The most important animals of this period were the trilobites who were crustaceans belonging to the arthropods. They were the most plentiful and powerful animals at that time, filling the seas and oceans because they had no enemies. The only plants were the algae.

ORDOVICIAN PERIOD:

The name comes from an ancient tribe of people known as the Ordovices who lived in a part of England where the first fossils of this period were found.

An enemy appeared for the trilobites - the cold. Many of the seas which had once been warm were now covered with ice, causing the trilobites to become less abundant. Other animals which developed were large cephalopods, star fishes (echinoids), scorpions, and the most important of all, "sea lilies". These "sea lilies" or crinoids transformed the bottom of the seas into huge gardens. Although they appeared to be flowers, they were really animals, belonging to the echinoderms. All of these animals consumed great amounts of calcium, thus cleaning the waters.

SILURIAN PERIOD:

The name comes from an ancient tribe of people called the Silures who lived in a part of England where the first fossils of this period were found. Many animals disappeared while others appeared. The corals were now the great consumers of calcium. The first vertebrates also appeared, the so-called "armored fish" because their bodies were covered by a protective bony, shell-like covering.

DEVONIAN PERIOD:

The name comes from a part of England called Devon where the first fossils of this period were found. In this period the oceans receded and seas were formed between the different areas of land. Animals and plants remained in the muddy bottoms and had to learn how to live in their new surroundings. The algae grew longer and covered themselves with little leaves. Then the swamp lands began to dry up and plants had to put down roots in order to hold themselves upright and to go in search of water. The fish developed a true vertebral column and began to race swiftly in the seas. Some fish learned to live out of water for short periods of time, transforming their swim bladders into lungs. These lungfish were called Dipnoides (dual respiration) and still exist today.

CARBONIFEROUS PERIOD:

The land plants developed greatly but they still did not have flowers or fruits. The lowlands were covered with strange forests which became great swamps when the shallow seas flooded and receded. Buried under water, the trees would die and after centuries and centuries of being buried, would turn into coal. For this reason it is called the Carboniferous Period. Iron deposits were also being formed in the earth.

Now that the air had been purified by the plants, some animals were able to leave the water and learn to live on land. These were the amphibians. At this time there were also many insects and

PERMIAN PERIOD:

The name comes from a part of Russia called Perm, situated at the foot of the Ural Mountains, where the first fossils of this period were found. It was a very cold period. Some amphibians returned to the water to live while others learned to live entirely on land by evolving into reptiles. In the beginning these reptiles were very small, but having no enemies they became the masters of the land, continually multiplying and growing larger and larger until they were transformed into true giants. Instead of depositing their eggs in water, they now laid them in the sand where the rays of the sun could warm them. By this time many plants and animals lived on land and the Paleozoic Era came to a close.

TRIASSIC PERIOD:

The name of this period means three, because its rock sediments are divided into three strata. It also marked the beginning of the Mesozoic Era, also called the Age of Reptiles because these animals over-shadowed all the other inhabitants of the earth. Having no enemies, these reptiles were able to multiply and develop into giant dinosaurs. They could resist the heat of the sun due to their armor-like skin covering. There were both vegetarian and carnivorous reptiles. The carnivorous ones had terrible teeth.

JURASSIC PERIOD:

The name comes from the Jura Mountains where the first fossils of this period were found. It also marked the appearance of the flying reptiles. Among these was one with feather covered wings, the Archaeopteryx, from which birds are believed to have descended.

Some reptiles returned to water, including some who took the shape of fish. In this period the first mammals appeared, giving milk to their young but still reproducing by eggs. New plants to appear were the conifers, pines and fir-trees.

CRETACEOUS PERIOD:

The name comes from the chalk deposits where the most fossils of this period were found.

New plants appeared that had flowers and corollas. There were many, many insects at this time, including butterflies. But toward the end of this period the earth was once again covered by ice to a great extent.

What happened to the great reptiles, once such powerful masters of the land, without any enemies? They could not stand the freezing cold and gradually disappeared.

CENOZOIC ERA:

It is called the Age of Mammals and is divided into four parts: Eocene, Oligocene, Miocene, Pliocene. All four of these words have almost the same meaning - new period.

In the beginning most mammals were very different from the ones that we know today. Then gradually they acquired the modern form as we now know them. Compare the earliest horse to the modern one. Other animals similar to the ones today were fish, birds, amphibians, and

THE TIME LINE OF LIFE: Second Presentation

INTRODUCTION: For the Teacher

The first presentation of the Time Line of Life is very simple; the first overall view is given as a scope of evolution from the geological point of view. Only a short time ago, the history of life was approached from a biological point of view with regard to the material needs of nutrition, defense, the survival of the individual and the species. It was viewed as something completely separate from the history of the earth and the universe, and pertained only to the biological consideration of the separate species. Dott.sa Montessori described this as a way of approaching life that was linear, this separation of life from the history of the universe. She said that it was similar to ancient man's concept of a flat earth.

Instead, the concept of life as a geological phenomenon shows life itself in larger dimensions, in its vastness; and as something completely united to the rest of the universe. Geology has given us the proofs of evolution, showing that life is a constant progression: that life which passes from the water to the land, from the invertebrate to the vertebrate, from the cold-blooded creature to the warm-blooded one, from the nearly insensitive organism to those with highly developed nervous systems. The remains found in rocks enable the imagination to reconstruct past times; they are called fossils. Fossils have been found everywhere. Rock sediments form a long stair, looking like steps that are one on top of the other. Each step corresponds to a certain period. An excellent visual example of this is the Grand Canyon. In the deepest layers where a few remains of living beings have been found is the pre-Cambrian granite. During this long period which is represented on the Clock of Eras in yellow from the hours of 4 till 10, life was formed. Many iron deposits which exist in the United States are believed to have formed during this period. It is thought that the iron may have been fixed by a certain type of algae with a particular capacity for fixing iron as the corals fix the calcium. In the strata of calcareous rock (composed of calcium carbonate, calcium or limestone) it is evident that animal life existed. The formation of this rock is always linked with living organisms. But it is still a mystery HOW life was formed.

It is strangest that this great mystery of life is enclosed in something very tiny, something that looks like a little bit of water. This microscopic organism is called the CELL and the substance of which it is made is called PROTOPLASM. This tiny cell, by trying a host of different means and modes, originated the many forms of life. From a tiny protozoan and an algae, life developed always more and better until we have the complicated convolutions of the human brain. All plant and animal life come from that cell, so tiny and simple. But it works and constructs, obeying the immaterial command that IT CARRIES IN ITSELF. And it is like a faithful servant. It does not betray its secret. We do not know that secret which is enclosed in the cell. The tiny cell is endowed with a strong sensitivity and energy which has been called by Maria Montessori "spirituality." By the term "spirituality" she means that unknown energy and sensitivity which exists in the non-physical part, the psychic part of the organism or cell, and which pushes the cell towards development in a particular way. And this is the HORME, the drive which overcomes all obstacles. It explores all environments, carrying life to the most unknown places. It looks for the means necessary to protect its consequences and to survive.

Evolution, seen from the geological point of view, shows the progression of intelligence. And the progression of reproduction; the sexual part moves towards perfection. It also shows us the laws of life which are inexorable laws. There are species who work, obeying, without every becoming powerful. And in this way they continue. But there are other species which become very powerful so that they believe they cannot be defeated. But, at a certain point, conditions change and the powerful beings find themselves unable to adapt, unable to start again; and they disappear from the realms of life. And the sovereignty of the earth passes to those beings which are apparently weaker. However, they are animals endowed with a psychic energy and vitality, strong enough to face the new environment

During evolution, we witness a great increase in the intelligence which moves towards

THE TIME LINE OF LIFE. . .Second Presentation. . .
Introduction. . .

point of view gives us the moral sense of life. What is this unconscious charity? Dott.sa Montessori says that it is the service that each being gives in order to maintain equilibrium in the environment and to improve it for those who come after. Why does she call the charity "unconscious?" Because there is also a self-conscious, egoistic, aspect of this: to take as much as possible, to occupy as much space as possible, to eat as much and to procreate as much as possible. The conscious part of life serves the conscious vegetative functions as a result of hunger, etc. Another aspect is the unconscious altruistic one, keeping a natural equilibrium in nature, keeping a balance for those that come after. This aspect is called the "cosmic work;" an exchange of services. Therefore **the unconscious charity and the cosmic work are the same thing.**

"Each expression of everything that exists has a cosmic sense; and the union of all the cosmic finalities not only maintains the level of life, but increases it. Each being answers the special call which is beyond its understanding, but which makes all beings participants in creation. All creatures consciously work for themselves, but the real aim of life is the **absolute obedience and the unconscious obedience to the great laws which govern the universe.** All the powers working in the cosmos have a special role. Physical powers, chemical powers and vital powers, all unconsciously collaborate in this great cosmic work." (Maria Montessori)

The individual's aim is not to have a better way of living for himself, but to create better conditions for all. Each one in life has a function which he is not aware of. . .and which is linked to the well-being of everyone. This is the cosmic education that Montessori speaks of. And this is the fundamental part which regards the history of life, the universe and man. The great law which governs life in the cosmos is that of collaboration. It has existed from the beginning of time.

To study deeper this law means to work for the triumph of the union among people--- and therefore the triumph of human civilization. Only a school that takes into consideration the real human reality and the needs of our times can insure a society of men who are capable of carrying out the union among peoples which the humanity of our times so much desires.

Another important point of emphasis is the relationship of love. Dott.sa Montessori says that everything moves along a path towards greater perfection. For a long time it was believed that the struggle for life was won by the strong. Today it is thought. . . it is known that it is not the strongest, but the most intelligent. **And that the intelligence is revealed in the ability to discover the means to protect the offspring.** Intelligence and love mark the progress of life.

We cannot tell the children this in specific terms; but we can tell them that it is not strength which wins. For a long time education was based in this principle, an education based on struggle and strength. If these two factors are at the base of the history of life, then it follows that they must also be the fabric of social life. And thus history is a series of wars, leaving out the real important phenomena which continues in progress throughout the centuries. And---if the struggle is most important in life, then our education also will be based in struggles and suffering. The old methods all reflect this concept: they are based on the difficulties it is necessary to overcome in order to learn. Thus is born an obligation to work, hard discipline, self-denial. . . As science progressed, by observing vital phenomena in a vast scope, the struggle as a key concept in evolution was cancelled. It was discovered that at the base of life is **THE PROTECTION OF THE OFFSPRING.** And the possibilities the offspring receive in order to develop in a harmonious way. This progression of love marks the real evolution. Montessori says that nature evolves, reinforcing that which has been a weak point in the preceding being. This great force called love keeps progressing during the history of life.

In this new presentation of the history of life we no longer talk about the periods

The Great Fable of Evolution

We have studied for three years the history of life, of the earth, of the universe, of man. We could say that we are finished. But this long story has much to teach us. When we tell a fable, we always find at the end of it a moral. Usually the bad one loses and the good one wins. This fable has a moral that we must discover. The moral that governs the earth is formed of several inexorable (unchangeable) laws:

- 1) Absolute obedience in evolution.
- 2) Universal intelligence as a guide of evolution.
- 3) The force of love in evolution.
- 4) The cosmic work.

Absolute obedience. (A difficult concept for the children)

During all the history of the cosmos, the living and non-living matter behave in a special way, as though there were secret commands which oblige it, in that given specific moment, to follow a given specific road. From the moment in which the particles collided and started to burn and the light was formed, there has been a constant succession of facts which seem to be guided by a logical and precise order. From this mass of light to the galaxies; and from the galaxies to the stars; from the stars to the planets; from **one single element, hydrogen**, to many more than 100 elements which, combining in many different ways, gave origin to an infinite number of minerals. (The experiments aid in the understanding of this phenomenon of the elements combining.) These minerals, the result of different combinations of elements, have different properties from the properties of the elements of which they are formed.

We are near the wonderful world, but it is still non-living; it is the mineral kingdom. The earth is formed of rocks and water. Then, there was the great cosmic phenomenon. The main elements were present in the atmosphere: hydrogen, carbon, nitrogen, and oxygen. And there were the sun's strong radiations penetrating that atmosphere. And there was the heat of thunder, lightening and volcanoes. In the midst of all this, the elements gave origin to the first organic matter: **the amino acids, the raw material of proteins**. That is, the main substance of living organisms; and therefore, the raw material of the cell, of this cell which forms a wonderful world full of secret commands which guide it through an infinite number of experiences in order to create strange wonders which inhabit our earth and very probably also other planets. (Now the possibility of life on Jupiter is a reality according to the space explorer voyages which transmit information of space phenomena.) And all these substances, when they are formed, follow the precise chemical and physical laws.

There are moments when it seems that chaos reigns, but in the vast length of time, these are merely instants and then order and equilibrium are regained. It seems that the Archaic (Archeozoic) period was one of these moments of chaos. In those times there existed many unicellular organisms which filtered the water by allowing it to pass through their bodies, retaining the salts and then giving back the purified water. (A good comparison: a man would have to drink 30 litres of water every second for his whole life to compare to the great quantity which these tiny organisms filtered.) This myriad of workers was not enough. The rainwater ran down the earth formed of rocks (there was nothing but rocks; the earth was barren). And the water was capable of dissolving the rock because of the force of the water as it rushed down and because of a certain chemical reaction, the water containing an acid capable of dissolving rock. As the rain falls, it absorbs a great amount of carbon dioxide which, when mixed with the water becomes carbonic acid. ($\text{CO}_2 + \text{H}_2\text{O}$ Carbonic acid.) Thus all this calcium from the rock which was brought to the ocean threatened life and the equilibrium.

Tiny beings appeared that each constructed for themselves a little shell. When the animal died, the shell went to the bottom of the ocean and began to accumulate---or deposited along the beaches, a phenomenon which occurred in Africa near Tripoli. The shells themselves were as tiny as grains of sand. Each of these tiny beings could reproduce in ten days ten million new beings. And so a great army is formed in this way to purify the water of calcium. And the corals perform

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Little by little, the unicellular beings multiplied and occupied the oceans until they were living everywhere. And in this way new species arrived, each species more intelligent than the preceding one, each with a greater power to adapt. Each species tried to occupy as much space as possible, to eat as much as possible, each one tried to become the most powerful. Dott.sa Montessori remarks that among animals as among men, certain laws are forgotten which all must obey. When the species becomes more powerful, the decline for them starts. Sometimes the decline is a fast one due to cataclysm or epidemic; or a decline may be slow, during which the species gradually start to disappear.

TAKE THE TIME LINE OF LIFE: We show how this phenomena repeats periodically: the trilobites, the sea lilies, the sea scorpions, the cephalopods, (only one remains now of this group: the chambered nautilus, a very small member of the species: use maybe here the poem "The Chambered Nautilus" -- Oliver Wendell Holmes.). Then the big fish (armoured fish), the big amphibians, the big reptiles. All of them, due to various reasons, had to abandon the throne of power; and some ceased to exist. They have to leave their place to beings who bring something new. In each of the moments when there is great change, it seems there is great chaos; it seems that obedience is forgotten. But the laws which govern the universe are absolute; equilibrium and obedience come back. He who didn't obey, who tried to become stronger than the others, was punished and disappeared.

This is true for man. We are living in one of these moments in which man has believed he can live without consideration for these laws. Will he find the strength to obey? If not, he will gradually destroy himself and maybe the life of other beings which inhabit the earth. And at that point the earth would become barren as it started: without plants and animals. But the earth would continue around the sun and there will be new life. (A note on nuclear reactors: the wastes they produce are dangerous for 25,000 years. An attempt was made to put these wastes in stainless steel boxes. In 20 years the wastes had completely deteriorated the containers and seeped out.)

Universal intelligence in evolution.

During the history of life there have been glacial and inter-glacial periods: cold and warm. During each warm period there is a species that develops greatly and when the cold period comes, it disappears. During that warm period it is the species most intelligent, most able to adapt, that develops because it is thus that it succeeds in conquering the environment.

USE NOW THE TIME LINE OF LIFE TOGETHER WITH THE VERTEBRATE-INVERTEBRATE ANIMAL CHARTS AND THE MATERIAL OF THE PHYSIOLOGICAL FUNCTIONS. We use these materials as needed as we proceed with the discussion.

We notice that the part which develops most is the nervous system. The earth is made of this intelligence and this spirituality. Each being, overcoming hard difficulties, makes new conquests. Little by little, through the environmental experience of the living beings, the experiences become part of the being itself. And these experiences which become part of the being composes the mneme, the instinct in animals which is formed according to those experiences made in the environment in order to survive; and those are transmitted from generation to generation. (NOTE on the mneme from The Formation of Man: . . . an unconscious memory which retains its fixed images even through generations and minutely reproduces the characteristics of the species. . . . The mneme, with its infinite gradations, penetrates into the very facts of life and eternity. Once this has been ascertained, it is easy to recognize in the mind of the four-year-old child, a phase of psychic development in which the mneme stands on the very threshold of conscious memory, almost on the point of merging with it, yet manifesting itself as the last trace of a phenomenon with very deep roots. That last trace of the mneme came from afar.) So the instinct becomes a guide which cannot be put aside because it is a conquest made over a period of thousands of years. The species does not have the option of change; instead of changing the instinct, it dies. These conquests help the species to survive.

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The salmon live in the ocean, but they lay their eggs in the rivers. They make an extraordinary trip upstream, swimming against the currents, until they find a particular place to lay their eggs. Some turtles live in the ocean; and they make a long trip to a special island, called the Island of Turtles, where they lay their eggs. It is such a long and tiring trip to the island that many die from exhaustion on arrival. But they lay their eggs first. The mystery of migration in animals has not been discovered yet. It has not been discovered why the long trip is made.

We have seen, in the fish and the amphibians and the reptiles, that already they have begun to protect the young. This protection becomes very wonderful in birds and mammals. Each bird constructs a specific kind of nest, a nest built over and over again in the same way through the years. Birds may lay eggs at the very top of trees or inside the trunks of trees. Swallows build their nests below roofs; storks build their nests in chimneys. In constructing nests, the male and female help each other: often the male makes the most difficult part and the female the easy part. But they work together. The nest is the symbol of the happy family. While building their nests, many couples isolate themselves. Other birds, such as the sea birds, get together in one place and form real colonies.

How many eggs do birds lay? Much fewer than insects. . . fewer than the invertebrates and the preceding vertebrates. Because they take greater care with their nests, they protect the young, they brood them with their own body warmth, and they feed them until they can feed themselves. But the number of eggs varies greatly from one bird to the next. The small songbirds lay eggs three times a year (canary) because they have many enemies such as cats. (A Bergamo classic: Tweety and Silvester) The eagle build one nest every year and lays one egg. (Nature did not calculate man's damages.)

In order to brood the eggs, both birds cooperate. Some birds stay together only during brooding and during the first life of the young. Other couples remain together throughout life: they never fight and they help each other with their work. It has been noticed that when the female and the male brood together, the male sits on the eggs during the night when his bright feathers will not attract attention, and the female does the work during the day when her dullness of coloring will be least noticed. Other birds during brooding time do not eat. The ostrich is one of these. Some birds do not construct a very deep nest, but in order to keep the eggs from rolling out, they lay eggs in the shape of pears. The female rolls the eggs periodically so that all parts of the egg will heat evenly. The work of the mother to feed the little ones is very tiring: some birds eat 140 times a day. (Birds generally eat daily three times their weight.) Among the carnivorous birds, the male brings the meat and the female grinds it. (raven) The parents, besides feeding the little birds, teach them how to look for food, how to defend themselves, how to fly.

The mammals also prepare special nests to receive their young. Because, as we know, the offspring of the mammals are born alive. Only the platypus, belonging to the order monotremata, lays eggs. The nests of mammals are carefully and well prepared: the nests are their houses and they live in them all year round. But when they have offspring, the nests are prepared in a special way. For example, the rodents prepare the nests with the hair of their own bodies to make it soft. Of the mammals, the most beautiful nest is that of the squirrel. It is built in the hole of a tree trunk; the nests are very soft; and the squirrel puts a cover over it. The inside of the nest looks like a little room.

Among the mammals something strange happens. In the birds the male and the female form a working family. In the mammals the female does most of the work, and the male's work decreases. He becomes a little selfish. Only in a few cases, the male teaches the young how to find their own food. The mammals are the most intelligent species on the scale of evolution. In them instinct is strong, but it is more flexible and they are more adaptable to the environment. Besides instinct, there is also a high degree of experience. (They have greater freedom of action; and can learn new things.)

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is based on the struggle. **The protection for the offspring is the real mark in the progress of evolution.** Nature progresses, making stronger that part which was weak in the preceding being. So we notice constant progress of the intelligence and love. Therefore, the great power and energy which constantly keeps increasing during evolution, has been the **energy of intelligence and the energy of love.**

The COSMIC WORK: A Conclusion

NOTE: We talk about the cosmic work in all the work of history although with the children we have not always called it the cosmic work. As with out work in every Montessori progression, there is a particular point at which the child consciously recognizes what he has learned. And this is that **point of consciousness** regarding the cosmic work. We begin with the history of creation again, and NOW THE CHILDREN MAY HELP RETELL IT.

So many many millions of years ago there was a terrible coldness and darkness. In this coldness and darkness was there really nothing? No. There were tiny particles of **hydrogen. . .moving.** And we know that suddenly particles collided and there was a great explosion. In this way life was formed: like a huge **nebulae. Matter became physical.** And in this way the history of the cosmos started. The stars appeared: some were huge, some much smaller. Among those stars were our sun and our earth, a tiny star. Our earth was, in the beginning, a star: an incandescent mass. This incandescent matter, through a series of chemical reactions, formed many other substances.

And what was happening in those times is still happening: new stars are formed and old ones die. Now we know better the history of our star which gradually cooled and became a beautiful planet. But the substances on our earth kept transforming; and in these transformations the inorganic substances were transformed into organic substances---and life began. In the very beginning, the forms of life were simple. And these forms gradually became more and more complex until they reached human perfection. How many changes have followed since that dark cold night of remote times?

The history of all these changes is called evolution. Evolution shows us the progression of non-living and living matter. But it also shows us another aspect, maybe one that is much more important. This aspect is the cosmic work of all matter and all living beings. The vital chemical and physical powers unconsciously collaborate in that which Maria Montessori calls the "cosmic work."

Let's look for examples of "cosmic work." Those tiny particles which floated in the infinite darkness were particles of hydrogen. When they collided, the light was formed. What is light? We know that it is a **combustion.** And when there is a combustion, a chemical phenomenon takes place. After the explosion takes place, the hydrogen is no longer only hydrogen. A new element is formed: a transformation is always a result of a chemical phenomenon. In the incandescent stars, combustions follow one after the other in rapid succession. It is still going on in the stars. Gradually all the elements were formed. The substances can be called **elements, simple bodies, or metals.** All the universe is formed of these elements, our earth included. (Use CHART OF ELEMENTS HERE with their corresponding symbols. A good EXPERIMENT: to demonstrate the different elements, we can show that when they burn, each element produces a different colored flame. All the colors of the spectrum appear.)

Metals, or simple bodies, uniting in different ways, form the different minerals which, uniting again and cooling, form the rocks which form the crust of our earth. Rocks may be simple when formed of one mineral; or they may be compound when formed of several minerals. (STOP---Needed here is a good collection of rocks. An expert in geology is a real help here, too, to give a lesson on rocks. And an outing is appropriate during which the children collect rocks and identify them according to the three basic types: Igneous, Sedimentary, Metamorphic and further identify them if possible.)

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To overcome the difficulties of the environment, something new was necessary. We choose from among the invertebrates those beings which seem the most intelligent, those which were able to form societies, etc. And these are the **insects**. They, among the invertebrates, reached the maximum development in the nervous system. We can say that they arrived at the greatest level of development. In order to overcome environmental difficulties, however, something was needed: the **vertebral column**, the internal skeleton which supports the being and allows further development. And the **circulatory system** with the closed circuit. With the fish, the circulatory system does appear, the nervous system is more complex and the **cerebellum appears**. The cerebellum governs the senses; and is more developed in the animals than in man.

And so far, life has only existed in the water. But now life is able to develop on the land. But the earth has a great enemy: the cold. The climate always becomes colder and colder: and so new discoveries are made: hair, feathers, warm blood. These enable the beings to survive and defend themselves from the cold. So the birds and the mammals appear which, together with other new things, bring a new **cerebrum**.

It is constantly seen in evolution that it is not the size, dimension; but the specialization: of the organs and of reproduction. This is true both for animals and plants: the tree of evolution can be constructed for both kingdoms. It is a cycle which constantly repeats during the history of life. It can be deduced that it is not the most powerful that win, but those endowed with the most perfectly developed nervous system which corresponds to a greater intelligence, thus to the better protection of the offspring. That is, to a greater power of love.

We can conclude, says Maria Montessori, with the words of St. Paul: "God chooses the weak beings of the earth in order to confound the powerful."

The Power of Love

Together with intelligence, there is another force which develops pallelly: the force of love. The intelligence helps beings to discover new possibilities in order to preserve life. And the power of love helps beings to discover new means to safeguard the species. The more intelligence increases, the more the protection of the offspring increases. Nature creates new beings, trying to help them survive by protecting them. This instinct (intelligence) for the protection of the offspring exists not only in animals, but in plants.

In the beginning of life there was a plant cell which divided; or two cells which met and united. In this way, new lives were created. There was no protection for the species, but there was the possibility to create in a very short time, a great number of new organisms. And so, even though a great quantity of the young died, the species survived. Next came two different cells: male and female cells. The male cell looks for the female cell. And for its trip, the cell uses that means of transportation that nature offers it. When at last the two cells meet, they unite and they originate a certain seed called a spore. From this spore the new plant will start developing. There is no real protection for the species at this point; but the cell, destined to originate a new life, is Kept in humidity, enclosed by a very light sac which is both very resistant and waterproof. This sac is compared to a hard skin which might be compared to the shell of an egg. In this way the seed is kept alive for a very long time. When it finds the proper conditions, it starts to germinate.

Then intelligence develops further. We come to the great conifers: the male cell is the pollen and the female cell is the egg. There are trees which produce only the pollen and those which only produce the tiny eggs. The pollen, in order to reach the egg, is transported by the wind. And so a great quantity of pollen is necessary. During the trip, a great part of the pollen is lost. When the pollen reaches the egg, it unites with the egg and from this union the seed is formed. The seeds are protected in a strange, little house with many chambers: it has the shape of a cone and it is called a "pine cone." So these trees are called "**conifers**."

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brings the insects to the flowers? They do not consciously say, "Here I am, dear flower, to help you." But the bright colors and the perfume of the flower attract the insect. . .and at the bottom of the calyx they find the sweet liquid which they feed on: nectar. It is so sweet that mythology tells us that the only food of the gods was nectar. While the insects seek the nectar, the pollen attaches to their bodies and legs. And thus the pollen is transported from one place to another. When the pollen reaches the stigma of the pistil, it puts out a small tail and by moving the small tail, it makes its way down into the ovary where it reaches the egg and fecundates the egg.

Each grain of pollen fecundates one egg. When all the eggs are fecundated, the petals of the corolla fall. (Florists close the ovaries of the flowers in order to prevent fecundation and thus to preserve the longer life of the flower.) When the eggs have been fecundated, the corolla has served its purpose. The ovary is the new protection for the seed. From the ovary the fruits are created; the fruit is the swollen ovary. Men and animals eat the fruit; and thus the seeds of the fruit are disseminated everywhere.

In the plants we cannot talk about a real kind of love; but we see that nature is endowed with a special kind of sensitivity which becomes ever stronger to insure the continuation of the species and to improve the qualities.

Love Among Animals. At the beginning there was no protection for the offspring of the animals. In the protozoans, the porifera, the coelenterates, there is no protection for the offspring. And then, in contrast to these first animals, there are those animals whose main role in life is to take care of their offspring. The simplest form of protection is the laying of eggs. Each oviporous animal has the unmistakable instinct of laying eggs in the right place for the young ones to develop. First there were eggs WITHOUT a shell, or with a very very thin one. For these eggs, water is the best place. If there is no water, the animals look for mud: a place where there is land and water. Mollusks and insects lay their eggs in humid places. Certain animals know that besides humidity, warmth is important. So they look for warmth, found often among plant matter in a state of decomposition. (Decaying matter is a good source of heat.) Or they look for humid places where there is sunlight. Some arthropoda carry their eggs on their backs. Other animals collect their eggs in a little ball and carry it around in the thorax: some spiders and scorpions. Other spiders lay their eggs in nests, but they remain close to the nests to care for and protect the eggs. The greatest builders of nests are the insects: the bees, the wasps, the carpenter bees. These insects are very smart: they have organized classes of workers, whose role is to feed the larvae. This is their only work. And the mothers' role is to lay the eggs: she is the queen. When she stops laying eggs, she is killed and the group looks for a new queen.

Next come the vertebrates. It is believed that all fish abandon their eggs, but some take care of their eggs. There is a little fish called **rhodeus** that looks for empty bi-valves, carries the shell up and opens it. Then the male fish pushes the female in and obliges her to lay the eggs there. Once the "she-fish" has laid the eggs, the male goes in and fertilizes the eggs. Another fish, the **spinarello**, constructs a beautiful nest. It is always the male who makes the nest. The fish makes a hole in the sand, smoothing it to make a very nice room; and then he brings different colored algae and covers all the walls of the hole. Then the male looks for the female and pushes it into the hole: there the female lays the eggs. Then she runs away and the male fertilizes the eggs and stays to care for the eggs until they are born. (There are also some ovoviviporous species of fish: the young hatch within the female and are born alive. The female fish still lays the eggs, but retains them in the oviduct until they hatch. The species is the **guppy**: and they eat their young, so the matter of protection is questionable. Found in particularly warm waters.)

There are certain animals which mate and reproduce only after a very long trip. The eel lays the eggs in the water.

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Creation starts so many many millions of years ago, but it still goes on. Creation is not a moment, but a continual development, a process which goes on and on.

But that is not all. All the elements and celestial bodies are arranged according to their weight: the heaviest at the center of the earth and the lighter ones farther away from the center. In this way they exert a force of attraction, one on another. And this is another cosmic law: **the force of attraction avoids the dispersion of the elements;** it has made it possible for the water to remain in the low parts of our earth to form the oceans and the lakes. This force **of gravity** has also made it possible for the atmosphere to envelop our earth.

There is another law which shows the cosmic work: all the celestial bodies exert a strong attraction one upon the other. They exert, at the same time, **a force of attraction and one of repulsion.** These forces maintain all the bodies in equilibrium, preventing them from crashing into one another or escaping. So **"maintenance" of equilibrium** in the universe is another cosmic rule.

And there is yet another. **All the celestial bodies constantly rotate around themselves and revolve around another celestial body.** Our earth has these two special movements: rotation and revolution. (USE THE GEOGRAPHY CHARTS.) The movement of rotation prevents our earth from burning on one side and freezing on another. This is another part of the cosmic work: the rotation of the earth that makes life possible.

During that faraway period called the Arcaic Era, in a certain perfect moment, with the right amount of heat and humidity and in the presence of a special combination of substances, life began. **Due to a marvelous chemical phenomenon, the first living cell was born.** It is believed that the first living cell was a plant cell. In the water there was a great deal of carbon dioxide; and only plants can assimilate CO₂ and give off oxygen. Even today 75% of the oxygen in the air is produced by the unicellular beings which live in the water (algae). Therefore, **the first cosmic work of the living being was to absorb CO₂ and to give out oxygen in such a way as to make life possible for the animals which came afterwards.** Animal cells came after the plant cells; and the newly formed cells started a quantity of new experiments. The first animal cells were the protozoans. The tiny beings lived in the oceans and reproduced greatly. Huge amounts of calcium were constantly brought to the ocean by the rainwater. Animals need calcium, for the formation of bones. And the rainwater was doing its cosmic work, taking the calcium from the rocks and bringing it to the ocean. But, at a certain point, great quantities of calcium are not good. Life was endangered. But a myriad of tiny beings appeared: animals which built themselves a tiny shell. These animals absorbed and fixed a large amount of calcium and purified the water. When the little animal died, the tiny house deposited at the bottom of the ocean or on the beaches. (This is called diatomaceous earth; formed of tiny crystals, the skeletons of diatoms.) After these tiny beings, other animals came to help: porifera, coelenterates, echinoderms, arthropoda, mollusks. All joined in the work of fixing calcium. In order to develop their skeletons, external or internal, they fixed great amounts of calcium. In order to develop their own bodies, they did this work---not because they were conscious of their role. They had to fix the calcium in order to survive and to protect themselves. These beings never became conscious that their work made life possible for thousands of other animals.

Many of these animals are seen on the Time Line of Life. (ASK THE CHILDREN to name the animals they know on the Time Line.) In this way, all the animals together created the proper conditions to receive new kinds of animals. So far life was only in the water. But all of a sudden, the water began to recede; and many animals found themselves in dry places. Many died, but some adapted to the new environment. And once more the tiny unicellular algae covered the swamps of the earth. Now there was a new **cosmic work: purifying the air for new animals to live on the earth.**

Next came the lizens which attached to the rocks and, little by litte, broke down

All of these plants reproduced greatly because they were obeying another law: eat as much as possible, occupy as much space as possible, reproduce as much as possible. Then we come to the carboniferous period, characterized by the great forests. The great forests were used as food by the first animals who came to live on the land. The huge trunks deposited, decayed and formed the carbon that we now use to heat out houses. They were obeying the cosmic law. So huge plants developed, according to the law: **occupy as much space as possible, grow as much as possible, reproduce as much as possible.** At the same time they were being used as food by the other animals. But they were also in the process of forming carbon and iron which we use. (NOTE the rectangle of black and brown.) It is thought that the great deposits of carbon were formed during this period. There are, from this time, layers of rocks which contain iron. This iron was the result of special tiny animals who, absorbing substances from the earth in order to nourish and construct their own bodies, fixed iron in a special way just as other tiny animals fixed the calcium.

Think of all the cosmic work we have witnessed. **The huge forests of the carboniferous period provided food for the huge reptiles, primarily vegetarians.** And so the reptiles developed greatly. The eggs of the reptiles and the huge trees provided food and protection for the birds and the mammals. At the same time, the birds and the mammals prepared the environment for the last animal to arrive: man. In this way, we have followed the path of evolution, looking at it from the aspect of cosmic work.

All creatures work selfishly for themselves, but the real aim is still the unconscious obedience to the great cosmic plan. We have only looked at a few of the many examples of this cosmic work. (The children can find many others) Another good example of cosmic work is done by what Maria Montessori calls "the janitors of the earth." These are the ants, the hyenas, the great birds called condors, all of whom are usually despised or considered insignificant; but whose work is very important. **We must look at life in a profound way: to look superficially, we see only greedy and selfish beings, but this form of greediness and selfishness brings equilibrium in life.** Each being takes what is disposed of by another. That which is poisonous for one, often causing death, represents for another life. Each being, in one way or another, gives his contribution to the progress of evolution: the progress of life.

Maria Montessori explained: "Each expression of everything that exists has a cosmic sense, and the union of these cosmic finalities not only maintains the level of life, but increases it. Each being answers a special call which is beyond our possibilities to understand or comprehend; but which renders everything a participant of creation."

THE MEANING OF THE APPEARANCE OF MAN: Second Presentation

We could give this chapter a different title, using Maria Montessori's expression from To Educate the Human Potential "Man as Creator and Revealer."

In order to understand man, we must first put him in relation to the rest of the universe; and with the source of energy which exists in the universe guiding all the evolutive processes. Man is not isolated from the rest of the cosmos. He is an integral part of it. We have seen the expansion of the universe, an infinite expansion which the human intelligence is not able to grasp. Then we have seen how the earth appeared and was formed; then how life began; then the evolution of the different living groups. And we have seen those principles which rule evolution. What are these rules, these guiding principles of evolution?

- 1) The apparently selfish and conscious struggle for survival; and the unconscious cosmic work.
- 2) Some privileged species become very powerful, decline and disappear.
- 3) Forms of life which are less visible, but more vital and more intelligent, occupy the place left by those beings which disappear.