Classification of life in light of evolution and the child's psychology: an essay

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Questions

Last year, we celebrated Darwin's 150 anniversary of the publication of his masterpiece: On the Origin of the Species. This work has transformed our way of looking at the living world. From his observations, he explained that all the living species are only the resulting bud of billions of years of evolution. On the other hand, we have to acknowledge the recent great revolutionary advances made in molecular biology in the last 30 years that have transformed the domain of biology dramatically, and established definitively the baseline and techniques to actually study evolution and its dynamic process. Classification cannot be the same anymore and it creates sadness to some knowledgeable biologists like Yoon (2009) who shows how estranged from nature one may become when one knows that to understand it, one can only use information not available to the naked eye. If scientists have made great stride in our knowledge of the dynamic of life, the question of classification of life has become an issue for the common people and children.

Classification has always been a human preoccupation from the dawn of humanity. How could survival be ever achieved without knowing about plants and animals good to eat or to use for medicinal reasons? Aristotle (350 BCE) is acknowledged as providing us with the first systematic classification of animals which he expressed in a form of ladder from the simplest forms to the most complex. An interesting aspect of his approach is that he simply gathered and studied, with the means of his time, those animals and plants that were around

him. He classified more than 500 living organisms from his systematic observation and disection.

Young children are always fascinated with life forms surrounding them. In fact, their presence of bacteria, animals and plants are necessary for the development of their immune system. Up to recently, we have always lived in the company of animals thus the symbiosis with the animal world. (We have made them somewhat estranged from that presence and research shows that it causes a large part of the increase of allergenic syndromes). Plants not only provide us with food, but also shade and pleasure from their sheerpresence. Who is not moved to observe the plants and tree budding in the Spring or the fruits given to us later on? The child will naturally question the nature of animals and plants. It has always been a natural question.

And today we are faced with new challenges because the unprecedented number of human beings on Earth with the industrial activities that sustain our way of living have become a menace to the rest of the living world. Not a day or an hour without a new warning about what we are doing to stifle life on the planet. Is our food secure and safe? What is the next pandemic illness coming from? …

Our own survival is at stake and it is not the first time. Biologists indicate that maybe only 5000 individuals may have remained on Earth in prehistoric times. The difference today is that our industrial activity threatens our own species. Acknowledging it and doing something about it will be the challenge of the XXIst century, no doubt. Our children are our hope and promise for a more respectful future if we are to meet this challenge as a species.

The Montessori approach to life

Maria Montessori has amply demonstrated how through the continuum of human development, the child transforms herself dramatically from one plane to the next. She indicated that to help the child's spontaneous development, the environment we provide as caretaker must account for the particular psychology and needs of the child. The overarching principle coloring the educational environment provided to the child during this period is "Cosmic Education", education to the harmonious order of the universe to refer to the original ancient Greek meaning of the expression. In this phrase is integrated the finalist notion that all things are interrelated and that each accomplishes its own tendency toward perfection, but also contributes indirectly to the perfecting of the whole. She called evolution this process of perfecting (Montessori, M, 2003: p. 19). Maria Montessori (2003: p. 26) endorsed the geologist's view of evolution as "... an advance on the biologist's which formerly held the field." She says (Montessori, 2003, p. 20) about the geological point of view: "It is not that life needs to attain perfection for itself, but being an intrinsic part of creation, it does its part in transforming the world, its variations being more related to the earth's needs than to its own urge to perfection.". Should we equate spiritual term "perfection" with the biological one "adaptation"?

This provides the larger perspective that can only explain the order of the universe which fascinates the elementary child. With this position, the Montessori approach parallels that of the proponents of the most complete explanation of the phenomenon of life and evolution.

What aspects, dimensions, and parts of biology are of interest to the child? Essentially, all life that surrounds him. But then, what in particular? Mario Montessori could not be clearer about the answer than when he explained his Kodaikanal experience

(Montessori, Mario 1998b, pp. 34-43). In an interview with David Kahn, he indicated how cosmic education meant to go out to observe nature directly, to identify the particulars of any life form, but then to question the child about what other function this life was accomplishing. He answered Kahn's question: "What did you do with these children?", with

> "I did a bit of everything. I went outside to visit with them, to interest them in nature. How did the tree grow? We had a little garden that was worked by the children. They took care of the flowers. They cultivated the plants. We had every variety of species to enhance classification. We went to the garden to observe – many times just to see." (Mario Montessori, 1998b, p. 36)

Direct access is of primary importance at this stage of development and going out is one essential strategy in the perspective of experiencing and abstracting knowledge about nature. Terrariums were made and as far as their purpose was concerned, Mario Montessori (1998b, p. 37) said:

> "Biology includes not only plants, it includes animals. It involves relationships. I wanted to show the children the possibilities of survival within a reconstructed environment. So we created these terrariums to show the collaboration between plants and animals. We would catch one animal at a time, observe them in our constructed surroundings, and then return them to nature after a while. When the curiosity of the children seemed satisfied, we would move on to a different animal and a different concept."

From these live experiences, the child would be placed in front of facts so as to abstract not only direct knowledge about the needs of plants or animals, but that "there must be some force to calibrate the surplus" produced by nature, in this case, those prey that can

move in the air (Montessori, Mario, 1998b, p. 38). In this way "animals and plants were attached to nature in all sorts of ways." (Montessori, Mario, 1998b, p. 38). Thus, the child becomes aware that it is not sufficient to limit our knowledge to the immediate needs of the living but that another interrelated purpose or force or task is at play. Here the art of the teacher becomes essential.

To convey the overwhelming importance of life and its constructive effort in nature, Montessori appeals to the child's imagination when the great fable of life is presented. Maria Montessori (2003) told that story in To Educate the Human Potential, essentially in chapters 5, 6, 8 and 9. In these pages is an example of how the grand scale of life is played out and its evolution toward perfecting nature is presented to the child. All the characters of nature are at play and their dedicated work and sacrifice build up gradually the life that we contribute to nowadays. Life comes, develops, reproduces, and goes.

The relationships help the child to reason and practically, we break down the living into categories so as to appeal to her reasoning mind. Biology epitomizes the intellectual process of classification: the names of plants and their parts, come from a classification scheme just like those of animals and other living kingdoms. We mentioned earlier that the "Grand Chain of Being" is in itself a classification of the gradual complexity of living entities. To be able to reason, the child needs to have a wealth of detailed information about the living and she will have access to it from the contents of the activities presented.

These activities, researches and projects lend themselves to the gregarious instinct of children this age in the midst of constructing their social personalities. Group work or outings are respected and encouraged as long as they lead to actual engagement by the child. Typically, working with live plants or animals is somewhat messy, but the elementary

child is not reluctant on this matter. Along with these traits, children are looking for actions that are right. These endeavors require the stamina that children start showing on this plane of development.

How to approach the living? It is one thing to be in the presence of living beings, another one to understand something about them. We may ask the larger questions such as: why do the trees produce oxygen? But to understand the answer, the child needs to know how it happens, and the aspects of the trees involved with the production of this oxygen. "When we wish to consider the study of living beings, the most important is first to establish the classification." said Montessori (2004, p. 22). So the domain is divided into categories all through the most elemental dimension, while never losing sight of the cosmic whole. The living organisms are classified into kingdoms; the animal kingdom is further differentiated into phyla; animals are classified along their different characteristics (animals stories), plants are studied by looking at each part and the function each of these part accomplishes (nomenclature and experiments), There are classifications of the body function of animals and of the role of the different systems of the human body. Classification is the golden road to understanding the elements, the relationships and the interrelatedness of all that constitute the living. It provides the baseline for deeper studies of life's manifestations.

To bring to the child of elementary age the classification of life is an answer to his thirst for knowledge about what surrounds him. It must covey in parallel this never ending effort of humans to find and/or to establish the order of all life forms. What we bring to children with classification is engagement in this quest, a quest that is absolutely natural for them as their eternal curiosity about living things is a testimony.

For a mind to understand, it needs an eye able to discriminate. The Montessori approach has prepared the ground at the primary level: plants and animals were looked at in the children's house; names of parts of plants, flowers, animals, participated in enriching the child's vocabulary as well as writing and reading skills. But at the elementary level, when the child looks for answers to the why and how of phenomena, activities are proposed in order to help her construct her understanding while structuring her observation skills. Once the large scope fable of life and timeline of life have been presented to establish a context as wide as possible and to inflame her sense of quest, experimental activities are made available about the needs of plants. While doing those, the child will be led to note aspects that determine the life of plants. Living organisms eat, grow and reproduce; with the experiments on plants, children will observe that light, warmth, water and minerals determine the eating and growth aspects. They will also have access to nature walks whose main purpose is for the guide to train observation skills about leaves, stems, flowers, parts of flowers, fruit seeds, roots, habitats, and what else…In class, they will find definition material to put a name on all this.

To be useful to humans and in particular to children, classification has to begin with observation. But it also and mainly involves the work of the reasoning mind to distinguish differences and abstract generalities. This is a very basic process of the reasoning mind. Mario Montessori (1998: p. 12) wrote: "Observation, classification, abstraction, and symbolism are essential elements of the human mind." As these apply to the human mind at any age, the reasoning mind of the elementary child requires objects of observation related to why and how nature functions, not merely what it is. Thus the experiments on plants, the nature walks and/or how animals live in their habitat. Yoon (2009) highlights an aspect of

our relationship with nature: "Because once you start noticing organisms, once you have a name for particular beasts, birds and flowers, you can't help seeing life and the order in it, just where it has always been, all around you."

The Montessori approach will provide the child with all the necessary activities for his optimal and natural development in relation to nature and life, particularly in the early years when he starts on the path of the second plane. Below is a table synthesizing what will be covered from a classification of life in the environment of the child and the larger environment of the Earth. We may consider this approach as part of the Cosmic approach to biology.

Table 1
Content of Cosmic education for biology

Story of Life **Timeline of life**		
	Plant Kingdom	**Animal Kingdom**
	Story of Plant - reproduction	
From concrete to abstract	Needs of the Plant	Story card material for animal-what do animals do
	Botany Commands	Aspects of simple classification for animals: Live, reproduce, move, care for offspring's, eat
Observational base	Botany nomenclature	
	Observation	
	Categories	
	Observable aspects of the plants	
Functions related to adaptation	Plant vegetative: roots, leaves, stems	Body functions of animals
	Functions	Internal differentiation of vertebrates
	Functions influenced by adaptation	
	Plant reproductive: flowers, fruits, seeds	
	Functions	
	Functions influenced by adaptation	
Synthesis of previous activities	Simple classification	Animal classification
Hierarchy of taxons	Structure of taxons	Structure of taxons

Classifying a plant-animal	Key	Key
	Habitats	Human body
		Special case of vertebrate-mammal
		Systems are from preceding categories.
All of life is interrelated	Ecology Interdependency	

Evolution and molecular biology

Contemporary molecular biology dramatically transformed how life is looked at in terms of classification. With the means of his time, Aristotle classified life around himself, his close environment, but he did it not from speculations but from observation and dissections with his own eyes. He did it powerfully by presenting the diverse elements of life in an order progressing from the simple to the more complex at the pinnacle of which were human beings. The diverse degree of complexity present in varied life forms could be position as if on different level of a ladder from the very simple invertebrates to the top of the ladder was human beings could be found. Two principles had been established: 1. Direct observation of the structure of living organisms and 2. The classification of these life forms in terms of degrees of complexity.

Along the way, Aristotle determined that there were two kingdoms that presented all life forms: the plant kingdom and the animal kingdoms, this last one divided into those simple animal forms that had no blood and those that did, closely resembling the later invertebrate- vertebrate division. He was working with the means of his days, obviously, all the more remarkable was classification effort. With this approach, he was able to classify more than 500 animal species. It was an extraordinary intellectual feat and his approach

was good enough to last 2000 years, until Linnaeus showed up. We may note that Linnaeus took Aristotle's idea of systematic classification and lifted it to a higher level

As Yoon (2009) indicated, by the time Linnaeus arrives on the scene, there was a number of problems with Aristotle's classification system. For example, observation was not rigorously used and new phantasmagorical animals were classified with the others like the multi headed hydra for example. On the other hand, there were many more life forms identified than he had observed. Then there were a number of different ways of classifying mostly based on authoritative statement instead of systematic observation. As to plants, Linnaeus (Yoon: 2009, pp.25-52) was able to demonstrate that they could be classified by observing how their reproductive parts presented themselves and were structured. The solution he established to classify species of living organisms, is still in use and developing today. Such was the originality and practicality of his proposed system: a binary mode of naming using Latin as a common language for all to understand. The first part gives the genus, the larger group to which belongs the particular species; the second part gives the particular species involved. *Canis lupus* is a good example: the wolf belongs to the genus *Canis*, which include the fox, the coyote, the dog, etc. and it constitutes a particular species of that group, *lupus*.

His superb ability to actually classify numerous species gave him the authority necessary to impose his scientific approach to classification. In his time, and because of his reputation, as well as his conception of life as springing up all at once at God's will to occupy the whole earth, he provided the motivation to try to classify all the living species existing on Earth then. This lofty endeavor encouraged all the explorers that had started to roam the world with the incentive to bring with them naturalists who would find specimens for

home bound botanists or zoologists to classify. Linnaeus himself has been able to classify more or less 10,000 species. His system kept the ladder allegory for all classification from the simplest to the most complex but extended it past human beings to reach God, the perfect entity, thus a notion of nature having a finality of perfection. Life was to be explained as having the finality of perfecting itself, human beings being the most complex known, thus the closest to perfection, God.

But the explorers and their naturalists also showed the crack in this system. Classifying all the actual living forms in order of progressive complexity was not sufficient to explain life. The approach could not explain fossils of ancient long gone organisms. And the explorers brought more and more of these artifacts. Up came Darwin (and Wallace) on the horizon. From years of observation and pondering the question of the origin of life, he stunned (and still provoques lively debates 150 years later) with his explanation of "The Origin of the Species" (title of his book) by natural selection. This revolutionary idea found its ultimate recognition with the great leap of scientific discoveries made by molecular biology following the identification of the DNA code, the makeup of life. The last 30 years have seen a Copernican revolution as to how life, its makeup and origin are to be considered. These advances question a number of given tenets explaining life.

Let's see how Richard Dawkins (2009) approaches this new vision in relation to the old Linnaeus one.

1. Because an organism is the result of the expression of its genetic code, evolution study is about relating species to common ancestors, the originator of that genetic code. As a consequence, two living animals today may share a common ancestor but cannot have evolved one from the other. For example, the idea that monkeys evolved

from earthworms is false. Just like it is false that humans evolved from chimpanzees. "Monkeys and earthworms share a common ancestor" (Dawkins, 2009, p. 156). Branching is the way evolution operates and eventually, if we can go very far back, all life forms have a common ancestor, the original cell from which all life forms branched out to eventually produce present day life. Our montessorian fable of life and related studies do not contradict this observation. On the contrary, our great fable does indeed indicate that all life started from a single cell appearing on earth, cell with the cosmic task of eating, developing and reproducing. It did that so well that it evolved in the great, rich and astonishing diversity that we observe in our world today.

2. "... and it is obviously true that some modern animals are more primitive in this sense than others." (Dawkins, 2009, p. 156) This means that when two species are compared as to their common ancestor, the more primitive of the two has changed less than the other one. Because "All species, without exception, share a common ancestor if you go back far enough" (Dawkins, 2009, p. 156), an important correlate is that no modern animal should be more important than any other. (Dawkins, 2009, p. 157). Herewith is established the idea that species on balance are equals. As far as life is concerned, evolution is a great equalizer. We, as humans, are not more important than other life forms; and we may even disappear (as 6 other humanoid species already did) and life will continue on, as the Canadian biologist David Suzuki clearly expressed.

As to this aspect, and because of the knowledge of the time, one should be careful to put the focus on the diversity of life forms, and its aim, not to reach

perfection in terms of complexity, but to achieve the best adaptation possible given the circumstances. Indeed these circumstances are changing constantly, sometimes too fast thus resulting in the extinction of a species. At other times, the dynamic of evolution powered by the actual availability of food, and/or the actual conditions of growth in a given habitat and/or the particular patterns of reproduction, will transform a species little step by little step, more or less quickly into either something of the same species but with peculiarities (like Darwin's finches), or transform itself into a new species, thus splitting from the original. Our Montessori timeline of life expresses this branching out as it is related to the phyla, although mainly the chordate.

3. An unwarranted statement is also that monkeys are cleverer (or prettier, or have larger genomes, or more complicated body plans, etc. etc...) than earthworms (Dawkins, 2009, p. 157). Why is this unwaranted? Because, depending on the ladder used, an animal or organism may be higher or lower than another. Dawkins, to demonstrate his point, indicates that mammals may have larger brains than salamanders, but they have smaller genomes than some salamanders. Again, animals and organisms for that matter are comparable without needing to be placed on a ladder of least to more. Do we need to view and present the complexity of structures with a moral outlook, that is to link it with superior complexity versus inferior simplicity? This differentiation based on complexity should not lead to value judgments linked with higher formal knowledge about animals and plants, because it doesn't correspond to reality as molecular biology has demonstrated.

4. Here is an assertion commonly used to indicate that human beings are the standard by which to compare all species: "Monkeys are more like humans than earthworms are." (Dawkins 2009, p. 158). He adds, "Despite the Great Chain of Being's traditional ranking of humans between animals and angels, there is no evolutionary justification for the common assumption that evolution is somehow "aimed" at humans, or that humans are "evolution's last word" (Dawkins, 2009, p. 158) This statement address us directly as Montessorians preparing stories and activities to answer the elementary child's needs. Our traditional great fable of life tends to present the evolution of life as preparing the Earth for the arrival of human beings, instead of simply indicating that human beings could adapt to conditions provided by the African habitats of a few million years ago. Classification with its emphasis on observation (with the naked eye) of life forms appeals to the natural interest of children and presents them with the difference in their structural complexity. It is easy to present this scheme to them in such a way or with such explanations that the conclusion that all evolution leads to the ultimate complexity of perfection. But we have indicated that life does not work that way. May we say that the study of complexity is interesting but does not lead necessarily to perfection? Let's not put aside the necessity for the child to grasp an idea of what life encompasses before becoming interested to how the dynamic mechanisms explains its evolution. This psychological necessity the child demonstrates requires a mind reasoning on concrete naked eye observations and differentiations. As Yoon (2009, p. 14) says: "Why wouldn't we have evolved exactly that: a stereotyped, hard-wired way of looking at and ordering the living world?" Her assertion is based on studies

psychologists made of children's natural ability to classify animals and plants. This ability is universal because it found in any culture as anthropological studies have shown.

5. Finally, Dawkins (2009, p. 158) underline that under the current knowledge we have about the evolution of life, no animal is better at surviving than any other. Some complex ones like the golden tamarinds are dangerously facing extinction while lower animals like earthworms, rats and cockroaches flourish. To synthesized, ranking modern species on a ladder is nonsense as far as evolution is concerned. But our classification based on a complexity scheme is a means to help the child in his natural tendency to classify life. The study of evolution can only come after, thus the idea that the child in his ontological voyage of development reproduces the ascent of our human intellectual discoveries: from the sorcerer or medicine woman of the tribe to Aristotle systematizing classification through observation to Linnaeus extending this process to all contemporary life forms to Darwin explaining the dynamics of the evolution of all life forms that ever existed.

As Montessori indicates, we have to follow the child who naturally reconstructs the genesis of the knowledge humanity have accumulated over time. So through the elementary years, that child is looking at something she can put her mind to, that is observing the visible structure of organisms. When this is done, differentiating in terms of degrees of complexity is pragmatic and efficient while it provides a base for the child to further study life and its dynamics. While Montessorians provide classification for the reasoning mind of the child on that plane of development, it is not yet what is

most illuminating about evolution. The dynamic mechanism of evolution is what is most interesting.

A Copernican Revolution

What molecular biology has uncovered are basic tenets explaining evolution, thus the dynamic of life. Let's try to synthesize these tenets:

- Evolution is determined at the molecular, cellular, genetic level, not directly observable to the naked eye.
- Extensive classification has to account for the new facts that molecular biology has provided us. This is what Margulis & Chapman (2009) do while still using the more traditional dimensions of the structure actually visible.
- Structures are mostly determined by the necessities of adapting to the surrounding habitat and its resources.
- Evolution does not aim necessarily at more complexity. It does tend toward the best adaptation based on availability of food, conditions of growth and necessity of reproduction.
- Complexity is a local particular response to the necessity of adaptation to a local habitat. More or less of it is thus determined.
- Human beings are not on top of a ladder of classification in relation to other life forms. Life does not care about such hierarchies.
- Classification along "tree of life" models à la Linnaeus does not correspond to classification à la Darwin. The later would rather take the analogy of the reticulate network form that a coral shows to indicate that life forms are interrelated and intertwined.

These observations defy daily observation of life forms around us. They even challenges us as human beings. For example, it tells us that there are more bacteria (not observable with the naked eye) in our bodies than there are cells constituting it. (Dawkins, 2009). This view of life is hard to accept as Yoon (2009) shows brilliantly in her book because it goes against our hard wired tendency and necessity to classify what we see around us. This new view about life changes the common world view. It is not sufficient anymore to indicate as we have done since Darwin, that different earlier life forms found as fossils have existed before our contemporary age. Now, we are challenged to accept that birds are descendent of flying reptiles, that we, human beings, are closer to some fish than we are to other mammals (Dawkins, 2009). How to accept that the blue whale, this most gigantic of mammals is a descendent of the still living hippopotamus following a series of branching out regulated by the necessities of adaptation? (Dawkins, 2009, p. 171)

Just like Galileo Galilei ideas were fought very seriously, (he was almost executed because he told us the Earth was not the center of the universe, or even at the center of the solar system), Likewise, Darwin's discoveries forced him to take extraordinary precautions before publishing them and they remain still very controversial today (40% of Americans refuting them). But unfortunately for the naysayer, molecular biology's latest extraordinary advances are taking us much past that. Man is not the pinnacle of life forms; it is a form like any other. It is so much so that our own survival is threatened by our industrial activities. Not recognizing this fact may lead us as the Canadian biologist David Suzuky says, to our dismissal from life on Earth, but life itself will do just fine. This threat on our species results from the great influence we exercise

on the living conditions on the planet. We have to care and become more responsible about this influence.

What does it mean for us educators of elementary aged children? We all know that children are, from a young age, fascinated with animals and plants. The objectivity and perspective of this fascination have been observed, studied and transformed into educational principles by Maria and Mario Montessori. And both indicated that we should look into children themselves to give us answers as to how to bring the world and culture to them. How are we to meet the challenge of this new paradigm that molecular biology bring to our attention?

Through the early years, children are Aristotelician: they are fascinated by the living forms they observe, touch and relate with. The object of their fascination are creatures living concretely and are observable with the naked eye. This proximity with living organisms is a physical necessity for the development of their immune system. As human beings, we have always been in the proximity of other life forms like these until our modern era, haven't we not?

At a later age, on the second plane of development, from the age of reason and before adolescence, children are curious and eager to roam the world , at least through their imagination, and discover all kinds of observable life forms that present an aspect or other of interest. No species escape the child's scrutiny. The habits of animals, their living means, their feats, their appearances, attributes, external and internal, feed their imaginative fascination. Reasoning and making connections about all this remain their main mental endeavor. And just like the moral lessons that one may abstract from the ways of human life, a sense of responsibility ensues, just like a sense of belonging.

If imagination may help indeed the elementary child to be attuned to the drama of the polar bear (which he probably has never seen directly) who is getting out of hunting ground for the loss of the polar ice sheet, his interest is generally concrete. That child, in Linnaeus fashion, is interested to all contemporary life forms, and is ready, willing, interested and eager to reason about them.

She is not uninterested to the ancestors of today's life forms but as long as these are attached somehow to what exist in this world. Has anyone ever met a child not interested in dinosaurs? The child has adapted to her culture in her early years and wants to engage in her society in these elementary years. Likewise, is it fair to say that this society, in a larger sense, includes the living world?

The challenge of evolution for educators

We have years of experience with helping the child who naturally remains engaged with and curious about nature. We should not discard this experience because it would seem outdated. Our task is still to help children observe, experiment and classify nature based on its complexity. The psychology of the child shows that it is not outdated but rather a necessity. But revolutionary knowledge was brought to our attention? We cannot fail the child by ignoring it. Could the opposition between what we knew before the advances of molecular biology and our current understanding of life bee only apparent? We may note that if species have an origin, one has first to know the species in order to be interested in its origin. If we "follow the child" as Maria Montessori invited us to do and observe how development expresses itself, we cannot but simply find the solution to the riddle. The child may be our leader because his development

follows immutable rules since the dawn of our species and we know those rules of development as they lead to maturity.

The implicit classification of the chordate and structure of the plant-flower presented to the young child will be replaced with a generalization of this underlying intellectual structure (Aristotelician) to all animals and plants (Linnean). What the child needs on the second plane is first and foremost an intellectual paradigm adapted to her psychology. This paradigm need not be apparent at first glance. For example of this indirect approach, we have experiments for the needs of the plants to highlight the role of each observable parts, or observation and/dissection as well as stories to approach any form of animal. We are still in a two kingdoms paradigm (three if fungi are included) but we give access to all. Only when the child has a good idea of all life observable is she in a position to wonder where all this comes from, and how it was all determined. Only then is the child ready to enter surefooted into the dynamic realm of what evolution means. Only then is the child ready to leave the necessary security of the living world that her species dominate by her complex and powerful mind and wisdom (sapiens).

Facing the dynamic of the laws of evolution is somewhat humbling, and it is necessary so. Only if we consider ourselves as members and only participating members of the community of life can we respect it. The key word here is dynamic, just like there are static mathematic operations and dynamic ones, or static physical geographical entities like river, mountains, lakes, and dynamic ones like tectonic plates, or climatology or again descriptive geometric concepts like line or shape and dynamic ones like Pythagorean theorem or volumetry, the study of life invites us to expand what we already have towards basic concepts of evolution. We already have a head start with the

study of ecology, interdependencies, the spread of vegetation on the globe, our Great River fable. The challenge is to develop materialized abstractions to help the child engage his natural interest in this dynamic realm, that of evolution.

Questions to the educator-guide

Here are a few questions to consider if we are to face and answer this challenge:

- Our timeline of life leads to the appearance of human beings on earth. This metaphor is necessary for the young elementary child in order to help him find his place in the grand scheme of things. Does it need to be revisited to adjust it with some elements lately found about evolution?
- Is our Fable of Life adequate? Certainly necessary since it answers the psychological needs of the young elementary child. Being anthropomorphic is fine for this story and others of the same structure as long as the facts it refers to as true, as Maria Montessori admonished us. Aren't we anthropomorphic with our Great River Story, and aren't we true also?
- We have a chart of the spread of vegetation on Earth that is most useful to link with the animals which adapted to these different created habitats. Should we develop more material to offer a deeper look into the role of habitats on adaptation of species? Isn't adaptation to habitat a root of evolution?
- Could we develop activities or materials as an introduction to the dynamic of evolution? What if we were to present the known evolution of actual animals that are still living today, like the horse, or the whale evolving from the hippopotamus?

- Could we show how the availability of water and food determines vital functions through successive reproduction of structures more adapted to the changing conditions (Dawkins, 2009, pp. 112-141).
- Are there simple experiments that could be identified to illustrate a particular aspect of the evolution processes like how local rules determine growth or how genes determines structural traits (Mendel)? Should we be concerned about how genes become active or not, express themselves or not, what the new field of epigenetics is interested in (Cloud, 2010). Or the role of cross gender attraction as it explains the evolution of traits and/or structures adopted by one gender to better interact in the reproductive process with the other gender?
- If the molecular biologists and evolutionists talk about the "Coral of Life" instead of the "Tree of Life", is there any basic diagramming that could be developed as a material to illustrate the branching principle used to follow the lineage of different species? Maybe we should look at what is already available and developed for children (Spears, 2008)

Life: the greatest show on Earth

Life has always been fascinating and will remain so. The knowledge about it has dramatically changed in the last few decades and poses a challenge for those who accompany children in their development. There is no doubt that these children will ask questions and that they will be eager to look for answers through their own research. Our challenge is how to accompany them with pertinent activities and a prepared environment that foster this engagement. It is also to strike their imagination, to

trigger their mind to reason, to awaken their moral sense as to how intricate all life forms accomplish their cosmic task.

This is an essay about this new challenge brought to us educators as a Copernican revolution that just happened under our very eyes in the last 30 years. It is about how to approach life and its intricacies. Those children who have constructed in their early years a base of knowledge about the living world (as it actually exist today) would be obviously curious and eager to dig for its origin, its history with its many expressions. Wouldn't Maria and Mario Montessori's deep and profound ideas about evolution, not only of life but of the cosmos, guide us into developing ways to 1. add to our existing and efficient didactic materials and cosmic ambiance. 2. Find ways to extend those to the new discoveries explaining the dynamics of the evolution of life? Isn't this part of Cosmic Education that our children are engaging themselves into in this XXIst century?

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