UNIVERSIDADE DE SÃO PAULO

Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto
14040-901 – Ribeirão Preto – SP – Fone (16) 3602-3813 – FAX: (16) 3602-4886
Laboratório de Biologia Comparada e Abelhas eduardo@ffclrp.usp.br

INTERCONTINENTAL ACADEMIA
UBIAS - UNIVERSITY-BASED INSTITUTES FOR ADVANCED STUDY
INSTITUTO DE ESTUDOS AVANÇADOS (IEA), UNIVERSIDADE DE SÃO PAULO

Ribeirão Preto, 30 August 2014

I herein express my interest for the opportunity of participating in the Intercontinental Academia meetings and discussions about the notion of time. I am a biologist, assistant professor of Zoology, and my research is primarily focused on the description of biodiversity. In the following paragraphs I am going to introduce the field of science that constitutes my major interest, before proceeding with my personal introduction and description of my interest in the Intercontinental Academia.

After centuries of explorations and documentation of biological diversity, humans have given names to roughly two million species of organisms. This is an astounding number, but still small when we face the number of species not yet encountered or even the little knowledge about what is yet to be discovered (estimates vary between 5 and 100 million species in total). The words usually employed to describe the array of forms in the biological world is "*diversity*" or, more specifically, "*biodiversity*".

In contrast with the remarkable diversity of life, the biological world is a realm of regularities. By means of recognizing regularities of forms, behaviors or any kind of traits, human beings label anything that seems to be the 'same' with the *same name*. Some millions of flowers that looked singularly similar could be called "roses", and the practice has been alike for dandelions, legumes, mallows and many others. Even the most naïve observer could agree that all roses shall continue to be named "roses". Although apparently ingenuous, this practice results from a very sophisticated process of reasoning and categorizing the world we live in—an exercise of looking at countless objects around us followed by finding order and patterns that are key for survival and scientific endeavors.

Ultimately, every topic of investigation in the Life Sciences falls into the understanding of diversity in conjunction with its regularities. These seemingly antithetical facets of biology are woven into one another, and are essential for the appreciation of biology as a meaningful science. For the study of organisms to be successful, comparisons are desirable both among living beings (all 5-100 million species and their very representative individuals) as well as with all the ancestors of the diversity at present in the planet. A *Comparative Biology* is needed, and this is also a *Historical Biology*, because the temporal dimension is key for the integral comprehension of biodiversity. Time and history are key foundations to provide cohesion to so wide a field of investigation.

History, in biological terms, is not restricted to the linear notion of 3.8 billion years covered since the dawn of life on Earth, but it also encompasses an immense network of genealogical relationships that unites each and every individual living organism to their ancestors. The time arrow has left traces that are the basis for comparisons that ultimately result in inductions, predictions and explanations so essential for any science to thrive. The debates of how to reconstruct this network and the genealogical mesh therein, how to describe diversity in the historical tangle of biodiversity, and how to make all the resulting knowledge useful have been central themes in Comparative Biology since the time of Greek philosophers. The field is attractive to practicing biologists for utilitarian as well as for the challenges offered, but it has also attracted the interest of historians, linguists, artists, anthropologists, computer scientists, philosophers, geographers, economists, and mathematicians. The interaction has been undoubtedly enriching for this interdisciplinary field.

There are four main time scales that can be used to conceptualize the biological world. The first and shortest lies in the realm of physical interactions among molecules related to life, and can be described (by and large) by chemical and biochemical principles. The other three are exclusive of living organisms, listed in a generally increasing average time-span: (1) the life of an individual organism, comprising various developmental changes, behaviors and cycles; (2) the principles that describe populations of organisms and small scale genetic changes (often referred to as "micro-evolution"); (3) origin of new species, evolutionary novelties (whether biochemical, behavioral, morphological, or of some other nature) and larger changes that might happen in the time-spans of hundreds to several million years—the so-called "macro-evolution". The time elapsed during the embryological development of a multicellular organism makes one think about the refinement of an intricate pattern of events. The development of a human being from a single-celled embryo is an extraordinary process, which takes the time for several cellular divisions, reorganization of sides, layers, organs, and connections that give rise to a complex multicellular being. More astounding is that for millions of years the principles for a complex program that allows development to happen are successfully inherited by offspring of individuals, as well as by descendants of any species. Even more so is the fact that small and big changes accumulated in these complex programs, altering the fate of development, gave rise to the millions of species that exist and have existed. Given enough time, one life form can leave descendants that will have varying levels of differences in contrast to their ancestors. In the closing words of Charles Darwin's most important oeuvre, "The Origin of Species", the beauty of biological diversity lies on the simplicity of its history:

> *There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.*

Personally, I feel fortunate to conduct my research on the understanding the genealogical relationships among organisms. I am primarily interested in the description of biodiversity using the tools offered by three branches of Comparative Biology: taxonomy (study of classification), systematics (genealogical or evolutionary relationships among organisms) and biogeography (study of the distribution of life on the planet and the historical events responsible for the occurrence of each species in a given region). These fields allow me to make inferences about the degree of familial relationships between any two organisms or classes of organisms (i.e., *taxa*); estimate how long ago taxa may have diverged apart from each other; make generalizations about their traits, evolutionary origins of observed

characteristics and their modifications over time; classify organisms in ways that contribute to the assessment of biodiversity; discuss the relationship between the distribution of groups of organisms and the history of the planet itself; just to list some of goals of Comparative Biology. Roughly speaking, this field grants us with power to reconstruct what the past was like, and to test hypotheses about how the past could have given rise to the present.

My primary empirical research focuses on insects, particularly bees—a fascinating group comprising about 19,000 species and an evolutionary history that dates back to the Early Cretaceous. These are organisms with a long tradition of human investigation, but with a wealth of research topics yet to be explored. I am also interested in the broader conceptual and theoretical aspects of various fields of Comparative Biology, which I exercise in post-graduate courses I have taught for the last seven years, as well as in my research agenda. I have been in contact with various philosophers and historians since my first years as graduate student as a means to mature a conceptual perspective on science. More than anyone, Professor Richard Boyd at Cornell University was a fabulous mentor for sharing his time and curiosity to weekly discuss themes of Comparative Biology through his very sophisticated standpoint of scientific realism.

The opportunity of debating *Time* in different fields of human endeavors in the Intercontinental Academia genuinely interests me. Having the notion of time conceptualized in many distinct ways in the Life Sciences makes it a natural choice to integrate my views on this theme with the ideas of scholars of many fields. If selected to participate on the Intercontinental Academia, I expect to share my enthusiasm for the empirical, historical, and philosophical underpinnings of biology as a historical science with the other participants of this project, and be benefited from the wealth of ideas arising from the discussions.

Yours truly,

Eduardo A. B. Almeida