PLANTS AND ANIMALS IN ANTIQUITY: A DETECTIVE STORY*

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The title "Plants and Man in Antiquity" might suggest that I will be talking of such topics as plants in mythology in ancient Greece and Rome, sacred plants, plants and literature, and plants and collective imaginary. This is not the case, however. I will discuss a much less poetic topic, probably much more similar to the science the Academy and its Fellows and Members are interested in: the scientific approach to plants as products for human consumption in the context of the cultures of the Mediterranean World in Antiquity, with a broad spectrum of uses: not only food but also medicine, cosmetics, and poisons. I will present the research I am currently conducting at the Department of Botany of the National Museum of Natural History at the Smithsonian Institution in Washington DC, also mentioning current research by other scholars.

It is not my purpose either to verify the exactness of ancient uses of plants, and their alimentary or pharmacological value, including their toxicity, or to claim that all of modern pharmaco-chemistry was already contained in ancient scientific texts, and that the science pretending to be modern just repeats the discoveries of ancient science. My scientific activity proceeds from a rather different viewpoint: it aims at understanding how ancient Mediterranean cultures discovered the properties of plants, how they explained them, how they recorded and preserved the knowledge they produced, if such knowledge was transmitted to other cultures, and, should it be the case, how did this process happen. Finally what role and impact—if any—did ancient knowledge have in the development of world science.

* Adapted from the Address given at the Annual Meeting and Banquet of the Washington Academy of Sciences, Meadowlark Gardens, May 2004.

I will briefly characterize first the material at my disposal to study the topic above; secondly, I will define the methods I use in my research, including the main difficulties I meet; thirdly, I will illustrate the results of my work with several typical examples; and, finally, I will address the question of why I study such a topic.

The Sources

Let's start with the primary sources for my research. They can be divided into four major groups:

1 Texts

2 Plant representations

3 Plant and biological remains

4 Ethnological data

Traditionally, texts have been the main, if not the only, source of research on the history of ancient botany, with the treatises by such scientists as Theophrastus, Pliny, and Dioscorides, which recorded theoretical botanical knowledge. Modern scholars and scientists have usually focused on the identification of the plants mentioned in these texts with currently known genera and species as defined by contemporary botanical science. In recent years, interest shifted somehow to the therapeutic uses of some plants, as ancient knowledge seemed to contain interesting data for new pharmacological research. The title of a book published in 1996 illustrated well this new trend: *Prospecting for New Drugs in Ancient and Medieval European Texts,* by B.K. Holland.

In several manuscripts of such treatises—I shall discuss later what a manuscript is—texts also contain color representations of plants. These pictures are highly problematic: it is not known if they date back to the authors of the works; if they are not original, we ignore where, when and by whom they were created and added to the texts they are associated with. Similarly, their style is still debated: was it realistic at the origin and gradually transformed so as to become schematic? Anyway, such plant representations complemented with plant motifs in frescos and mosaics, have been included in research for a long time, particularly because they seemed to usefully complete textual information in the attempt to identify the plants dealt with in the ancient treatises.

Books and manuscript sources have been complemented by archeological material only in the last decades of the twentieth century. The American archeologist Wilhelmina Jashemski working in close collaboration with the botanist Frederick Meyer, excavated the exceptionally well conserved site of Pompeii, buried under the pumice and ashes from the eruption of Vesuvius in 79 A.D. These two scientists brought to light plenty of plant material, from carbonized entire plants, fruits and seeds, to pollen, traces of roots in the soil, and even entire cultivated fields and gardens. Such contribution had the potential to dramatically change the question of the identifications of plants in Antiquity: information from texts is always fragmentary and never provides contemporary botanists with all the data they wish to properly identify plants. Archeological remains, instead, are the actual plants and thus open the way to indisputable identifications. Besides this archeology of a new kind, characterized by its scale (which I would deem accordingly as macro-archeology), there also is and has been before what I would call by contrast micro-plant archeology. It deals with plant material found in tombs, Egyptian mummies and sarcophagi, for instance, temples and ritual places. More recently, the transfer to archeology of laboratory research methods—particularly molecular biology—has transformed a traditional object of archeology in a new category of sources: human bones, animal dung, residues of medicines in containers and organic deposits in jars, for example, when submitted to a DNA analysis reveal data not previously accessible to researchers. This contributes to answering such questions as the diet or the diseases of ancient populations, in a way not attested by any other kind of source.

Finally, ethnological botanical data. Although I have said I do not specifically study the literary world of plants, I include into my research the data coming from this field. A good example is mythology. The story of Apollo killing Hyakinthos/Iakinthos, for example, can be read as a narrative expressing the exact knowledge of the flowering and withering of the iris to which the plant is identified (*Iris cretica*). According to the tale, Apollo involuntarily killed his dear friend Hyakinthos/Iakinthos when engaged in sports together, among others, throwing the disk. The tale can be read in astronomical terms: the sun (personified by Apollo, the sunny god) kills the plant iris (here personified as a friend of the sun, since it needs the help of weak wintery sun to grow) with its disk, that is, when the warmth of the sun has become too strong. Read in this way, the tale is almost a horticultural calendar composed before the earliest written record of early Greek society, that is, well before the poems by Homer, who supposedly lived during the 8th century B.C. Even though I do not specialize in this type of study, I integrate into my research the data it produces, particularly because they witness an early science not attested by any explicit source.

Methods of Analysis

As for the methods to be used in the analysis of primary sources, they are as different as the material itself. In all fields, however, they present a similar pattern. Research proceeds in two main phases: the collection of data, and its analysis and interpretation. Collection of data is of fundamental importance: the broader it is, the more significant, and possibly also the more detailed the results will be. Though an apparently obvious and easy task, this is maybe the most daunting one in the research. The data to be dealt with by the historian are not created in the laboratory, as is the case in experimental sciences, but must be gathered from collections and archeological digs all over the world. Not even such obvious and traditionally studied material as texts and plant representations in books, for example, have been gathered in a unique, coherent and easily accessible corpus.

The constitution of a textual corpus is a complex problem. No original of ancient works has survived: that is, the actual manuscript written by the author himself, with his own hand. Only later copies, sometimes extremely numerous, have escaped destruction. Creating a corpus does not consist in getting the text to be studied, as is the case for printed works, but in tracing all extant copies of such text and, on this basis, in reconstituting the original of the text in a way that I will explain shortly. Yet handwritten versions of ancient texts became pieces of antiquarianism after the appearance of the printing press, and became objects of collections. They thus had the changing fate of the collections they belonged to, and often changed owners across the world. Until they end in a collection where they are properly catalogued, they can escape the attention of researchers. That this is not a theoretical case is demonstrated by a 16th century illustrated manuscript of Dioscorides' work in Greek, which was totally unknown before it recently appeared on the antiquarian market!

Nowadays, vast collections of data can no longer be created without the computer. Databasing has become an important role in my job, and databases of different kinds definitely pertain to my research environment. Specific historical databases that I have created include data not only in different languages (be they ancient or modern), but also in different ancient alphabets, Greek and Arabic, for instance. Databases can also be of a more technical nature like the *Index Kewensis*, of Kew Botanical Gardens, in the United Kingdom, which catalogs all plant binomial names published in scientific literature after Linnaeus. Another database is Medusa, created with the support of the European Union and devoted to the traditional uses of medicinal plants in contemporary Mediterranean countries, or the so-called Napralert database developed by the University of Illinois in Chicago and recording the references to contemporary literature on medicinal plants.

The second phase of research, the analysis and interpretation of data, is no less problematic. Again, let's take the example of texts because it perfectly exemplifies the nature of the problems to be dealt with. I have mentioned that we no longer have any original of ancient texts, but only later copies. In the pre-printing age, all such copies were produced by hand and constituted a chain across generations and centuries. In such a transmission, texts were gradually and cumulatively transformed. Contrary to a widely diffused opinion, however, they were not impoverished by ignorant monks who constantly introduced new mistakes; they were rather repeatedly updated by their readers, scientists and physicians who annotated and enriched the texts they were reading on the basis of their personal experience. The problem the historian of botany has to deal with consists in identifying the different layers of accretions deposited on the texts, and in taking them off one by one - peeling the texts in a certain way - until their most ancient possible substratum can be reached in a way that is very similar to monumental archeology and has generated the expression of textual archeology.

The study of the material I have qualified as micro-archeological proceeds in quite a different way: it requires highly sophisticated and sometimes extremely expensive laboratory analysis by means of state-of-the-art instruments, including access to hyper-specialized databases. A good example is the DNA amplification and identification in remains containing organic material. Such equipment is rarely present in human sciences departments, a fact that requires the historian of botany to associate to the research scientific laboratories of very different natures. This is all the more so because the range of disciplines to be included in the research has become so large that it can no longer be mastered by any normally constituted human. Interdisciplinary work, which I prefer to qualify as trans-disciplinary, requires the collaboration of specialists of such different fields as philology, history of book and scientific illustrations, field and laboratory archeology, ethno- and anthropology, botany *stricto sensu*, biology and molecular biology, chemistry and bio-chemistry, and even medicine, pathology and epidemiology, and pharmacology and pharmaco-chemistry in the case of the medicinal plants, that is, a set of specialties that are rarely associated in the current structure of academia. It is truly exceptional—if not unique—for a historian of botany as I am to be hosted in such an environment as the National Museum of Natural History at the Smithsonian Institution, with not only a Department of Botany and another of Anthropology, but also a constellation of world class scientific laboratories duly equipped.

As a result the historian of medicinal plants is no longer—if he has ever been—an erudite confined in his ivory tower with no other presence than his beloved and dusty books. He has probably more to do with the Renaissance alchemist, whose study was also a laboratory, with this fundamental difference, however, that the instruments are no longer the pen and parchment, a collection of old books of secrets, an alembic and a distiller, and a pigeon for the mail. My environment includes books, of course, but also computers and databases, and is not limited to my study, but expands to the field—libraries, museums and archeological sites—and to many laboratories, both within the country and abroad. As for my pigeon, it has became electronic and is called Internet and email, and allows me to be instantly in contact with a broad range of colleagues in all the disciplines possibly involved in my research.

Some Points in My Research

What kind of knowledge results from the methods I have presented, which I would define as laboratory history if such an expression were not somehow contradictory? I will illustrate in some detail four significant points:

1 The acquisition of the knowledge of medicinal plants

2 The development of learned Greek medicine

3 The classification of plants

4 The assimilation of ancient data into Western science.

The Acquisition of the Knowledge of Medicinal Plants

A question that has long been, and still is, debated among scientists: how did Humankind discover that a particular plant exerts an effect on human physiology? According to one generally admitted theory, knowledge was transmitted from the animal to the human world. Indeed, when chimpanzees, which are the closest species to *Homo sapiens*, are sick, they are able to select the plants that exert the right therapeutic activity to treat their disease. And they normally recover. Such knowledge is supposed to have been transmitted through evolution in a vertical inter-specific way.

The application of the methods I have highlighted above—particularly, but not only—the transfer of analytical ethnobotany to the history of botany, throws some new light on such a question. Let's take the case of the *Corpus Hippocraticum*, a group of more than 60 treatises attributed to the Father of Medicine, Hippocrates (460 - between 375 and 351 B.C.). First of all, philological and historical analyses have convincingly demonstrated that this series of writings results from the artificial assemblage of pieces dating from the 5th century B.C. to the 2nd A.D. Whatever their origin, all such treatises contain 3,100 formulas of medicines with a total number of 380 plants. A detailed analysis of the formulas and their ingredients gives the following results:

- Almost half of the formulas (ca. 1,500) were made with only 45 plants,
- About a third of the formulas (1,100) used a total of 80 different plants,
- In the remaining 500 formulas, 255 plants were used.

In the context of my first question (the creation of the knowledge of medicinal plants), I will focus now only on the first line. The important fact is that the great majority of these 45 plants have very characteristic features: their general shape (this is particularly the case of the Apiaceae), their taste (for example garlic and leek), their perfume (myrrh, which is the one with the highest number of attestations) or the color and shape of the flower (the so-called black hellebore, poppy heads, cyclamen and pomegranate, for instance). Furthermore, crops (*Hordeum* and *Triticum*) are included in this list, as well as such an invasive of crops as *Nigella sativa*, and quite a number of domesticated plants. In other words: there is nothing that does suggest a transfer from the animal to the human world; on the contrary, these are all plants typical of a human selection or of a human environment and activity. I thus suggest that the discovery of the therapeutic properties of plants does not result from an inter-specific vertical transmission in the tree of life, but from an horizontal discovery within the species of *Homo sapiens* species according to methods still to be clarified.

Learned Medicine in Ancient Greece

The second point I wish to illustrate is the development of learned medicine in Greece. Modern erudition claims that it was the merit of the Hippocratic physicians to create rational medicine by denouncing magic and other irrational processes from which sickness was supposed to result. In doing so, Greek physicians distanced themselves from their Near Eastern colleagues, considered as largely dominated by superstition and the like. If we return to the small table I presented earlier, we discover that among the 45 most used plants, the great majority are of Near-Eastern origin. They include crops which were possibly domesticated in the Fertile Crescent. It thus becomes hard to believe that the therapeutic uses of plants were a discovery of Greek physicians. The Near-Eastern origin of many of the 45 plants most used by Hippocratic physicians suggests rather that in Greece learned medicine absorbed a previous body of knowledge coming from the Near East. A closer look at history and previous historical literature in the West reveals that the theory of the Greek origin of learned medicine was first created in Antiquity, precisely toward the end of the 5th century B.C., after Greek troops defeated the Persian invaders and shaped their self-identity by rejecting any element that could have recalled any trace of Oriental origin. Then such theory was repeatedly affirmed in history, be it during the Renaissance or in the 19th century, when a racist and anti-Semitic interpretation of ancient Mediterranean history was taking shape.

The fact that the use of such plants is explained by means of a perfectly Greek rational system as the theory of the four humors does not prove a Greek origin. According to this system, indeed, the good physiological state of a human body resulted from the equilibrated presence and action of four basic compounds, the supposed humors or vital fluids. Conversely, disease was due to the imbalance or dysfunction of one of these elements. Such therapeutic agents as medicinal plants acted because they restored the equilibrium or the function of these supposed physiological compounds. The explanation of the action of medicinal plants according to this system does not indicate that the use of plants according to such system was a Greek discovery. It just shows that previous uses of plants were assimilated into learned medicine and explained by means of the systems of learned medicine at that time.

Later on, the study of the action of medicinal plants proceeded in a different way. From the 3rd to the 2nd century B.C., physicians in the Eastern Mediterranean world observed the action of venoms. These clearly were substances introduced into the body which modified its function. No physiological system was available to account for the transformations induced by venoms. A philosophical explanation was thus created: venoms were supposedly a force that was transformed when it entered a determined milieu, in our case the human physiological environment; they then were mutated in such way to invade the entire body and stop its function. Once such theory had been shaped, it was transferred by analogy to the action of medicinal plants, probably during the 1st century B.C.

A similar speculative approach applied to poisons led to the construction of a different model in the understanding of the action of external substances introduced into the body. During the 2nd century B.C., the king of Pergamon cultivated plants with toxic activity and studied their effect on human physiology to better understand the action of therapeutic substances. Somehow later, during the period 2nd - 1st century B.C., in Pontos, a small kingdom on the Northern shore of Asia Minor on the Black Sea, Mithridates the King specialized this kind of research by regularly absorbing some poisons. He started with sub-toxic doses, hypothesizing that they would not provoke any physiological trouble, and gradually habituated his body to such substances. Then he increased the doses until he was able to absorb without any trouble highly toxic and even lethal doses of poisons. At the end, he associated all possible poisons in a unique mixture aimed at defending him against all the possible attempts of assassination that his politics provoked. This method further led to the creation of the most famous medicine of history, the theriac, that is, a medicine composed of a high number of ingredients aimed at treating all possible ailments. Though totally speculative in appearance, such method was probably more effective than has previously been considered. Recent research by W. Lewis has demonstrated indeed that the association of several compounds in a medicine is probably the best solution to avoid resistance of pathologic agents to medicines! If a pathogens is resistant to one therapeutic substance, it would probably not be to so to another medical substance.

During the 2nd century B.C., the data of such research gave rise to a piece of literature generally considered the most curious of ancient Greek literature: poems on venoms and poisons by Nicander of Colophon, in Asia Minor. The work is less strange than traditional erudition affirms: it equates the fight of victims of poisons and venoms to the war of Greek heroes against Trojan warriors. The effect is powerful and even magnificent: venoms and poisons are insidious enemies against which man fights in a heroic combat. Such works illustrated well the status taken by toxicology not only in medical research as a tool for further investigation, but also in life as a highly suggestive theme.

After the 1st century B.C., toxicology had a minor role in medical research. This is understandable: it was overdeveloped as it constituted a good observatory to build explanatory models to be further used for the understanding of the action of other substances. After such transfer had happened, it was reduced so as to occupy in medical practice a place proportional to the actual frequency and importance of venom and poisons cases to be treated by physicians in their daily practice.

The Classification of Plants

Theophrastus (372-70 - 288-286 B.C.), a student of Aristotle and his successor, analyzed the plant world in his *Enquiry into Plants*. To this end, he used the same method of description as his teacher, proceeding in two phases: by similarities and differences. Similarities allowed to individuals with common features to constitute coherent groups, and differences made it possible to distinguish individuals within such groups. The principle of grouping gradually led to the highest division of the *regnum vegetale* (or Plant Kingdom) in four ultimate categories: trees, shrubs, under-shrubs, and herbs.

During the 1st century A.D., the Greek Dioscorides, from Anazarba in Asia Minor, described in *De Materia Medica* all the plants and natural substances used at his time for therapeutic purposes. Each such substance, whatever its nature, is dealt with in a monographic chapter that mainly included the description of the substance, its therapeutic properties, and the medical conditions for the treatment of which such substance could be used. For the description of the plants, Dioscorides used the same method as Theophrastus—comparisons and differences. In the use of comparisons, however, he slightly modified the method: in many cases, indeed, he compared the same element of plants—principally the leaf—and referred to the same plants: ivy, olive tree, garden rocket, and ruta. In other words: he classified plants according to the shape of their leaves with four main types: polygonal (ivy), oblong and entire (olive tree), oblong and cut (garden rocket), and small (ruta). Similarly, he reproduced the four main categories of plants of Theophrastus and increased their number with intermediary groups.

In *De Materia Medica* another classification was superimposed to this one of a mere cultural nature. Such a second system was organized in two levels: at the first, plants were gathered in coherent groups according to such changing parameters as their structure, their supposed therapeutic property or properties, or their smell and taste. At the second level, these very groups were organized according to a scale of properties, which requires some explanation. The first group contained the plants used for the preparation of perfumes, starting with the iris. The last group contained the matters used for the treatment of dermatological pathologies, mainly minerals. These two groups were opposed from all points of view: perfumed plants were supposedly warm, while minerals were cold; as such they were light and heavy respectively; and, to quote just a few, perfumed and warm plants treated the excess of humidity in the body, while minerals, as cold, were efficacious against excessive warmth. The very first and very last groups were thus opposed by all their elements and created a bipolar axis within *De Materia Medica*.

To these supposedly objective properties of such groups, were superimposed subjective values, linked with the perception of the qualities of the two groups. Warm and perfumed matters were seen as positive, while cold and heavy minerals were negative in ancient Greek culture. Also, the very first and very last matters of the whole work were totally opposed in their colors: the iris presented all the colors of the rainbow as Dioscorides himself stated, and the last matter was *the black substance with which we write*, as Dioscorides said, that is, soot. Yet in the chromatic system of ancient Greece, colors were not defined by their nature but by their perception, that is, their luminosity. In this context, black was not a color, but the absence of any color. As such, it was opposed to the rainbow. In other words: from the iris to soot, there was a shift from all the colors to their total absence, from all the positive qualities to their absence, that is, from one thing to its opposite.

On this basis, we discover that all the groups between these two poles were ordered according to the degree of their supposed positive or negative value, that is, the degree of their warmth or cold property or any other property that took place between the two fundamental ones. Such a classification relying on the intensity of the positive or negative qualities constituted a scale, with a gradual reduction of positive qualities (warm, perfumed, colored, etc) and a parallel increase of negative qualities (cold, unscented, and black, etc). In other words: a *scala mundi* or *naturae*. As a result, classification of plants was transformed from a botanical system with Theophrastus to a medical system with Dioscorides..

An important point in such classification is that it implicitly contained a theory about evolution. The shift from positively connoted substances to their opposite seems, indeed, to refer to a theory of evolution dominated by entropy, that is, by the loss of characteristics, rather than by the acquisition of new ones. Such interpretation is confirmed by some passages where Dioscorides mentioned that wild plant species resulted from the degeneration of the other one, which was normally qualified not with the adjective domesticated (since it would refer to a process of acquisition of properties), but *kêpaios*, that is, *of* or *from the garden* or, in other words, from human environment.

The Assimilation of Ancient Data in Western Science

Ancient Greek science had an exceptional fortune in the Old World: it was transmitted, received, assimilated, and reworked by all the cultures that flourished around the Mediterranean Sea from Antiquity to the dawn of Modern Times. First transmitted from Greece to Rome and translated into Latin, it was then perpetuated in Byzantium. From there, it passed to the Syriac world - a group of heterodox Christians living at the edges of the Byzantine and Persian empires - and, from them, to the Arabic world during the 9th century. After the Greek heritage was reworked and expanded by Arab and Arabic speaking scientists, it was transmitted not only to the Western Latin world but also back to Byzantium, in a return of influence. Finally, after the Fall of Constantinople in May 1453, Greek science was massively imported into the West and, according to a traditional picture, contributed to the birth and development of the Renaissance.

This is the big picture of the influence of Greek heritage in World science. Things are different, as you can imagine, particularly in the Renaissance. This will be the last point I wish to illustrate.

The assimilation of Greek science did not proceed in a linear way of constant and cumulative progress. In a very first time, such scholars as the Byzantine Theodoros Gaza translated into Latin Greek scientific treatises, including Theophrastus' *Historia Plantarum*. Because he did not know the exact Latin equivalent of many Greek technical terms, he simply kept such terms in Greek and wrote them in Latin alphabet, thus transliterating them. Another scholar, the Italian Giorgio Valla, who had one of the most significant collection of manuscripts containing Greek scientific texts, made a similar work. One of the many texts he translated was the Byzantine translation of the treatise on smallpox by the 9th century Arabic physician Râzî. To fully understand this translation, I must remind you that syphilis appeared at that time and quickly spread throughout Europe as the "French" or the "Italian" disease. Among its symptoms was a cutaneous eruption, which was compared to that of smallpox. Hence, the reasoning made by physicians and by Giorgio Valla that, because of the external similarity of the two diseases, they should result from the same pathological mechanisms; hence, the agents to treat one could be used to treat the other, by a logical transfer. This is why Valla translated Râzî's work, using a simple term by term correspondence as a translation method.

In 1492, Nicolao Leoniceno, another Italian scholar who was also a physician, published a small book traditionally considered a criticism of earlier science. A closer study reveals, however, that its objective was rather to clearly define the meaning of technical terms and to avoid the simple term by term method of translation used by Giorgio Valla. As a result, Leoniceno's work simply stopped any new publication in the field of medical botany until the 1530s, that is, until Latin botanical and medical lexicon was fully mastered by his contemporaries. Once this was the case, scientific production was abundant and quickly led to the development of a new science. It thus is not correct to consider that Renaissance proceeded in a linear way and that early modern science resulted from the simple assimilation of previous Greek science, even though such science actually did influence Pre-Modern science. The model of constant linear evolution is a recent one that has been projected *a posteriori* on history and transformed the reality of facts. Science did not—and probably still does not—proceed according to a model of constant and uniform progress, by addition of data in a cumulative way.

Why Do I Study This Topic?

Such considerations on the methods of science and scientific progress lead me to my conclusion and the last question I wish to address: why do I study the topics I have briefly evoked and why should we do so? A simple answer would be that my research illustrates the roots of modern science and introduces some perspective into the field. I do not think, however, that such a theoretical justification would suffice to justify the enormous investment that my research requires, all the more because such research has more practical applications. It deals, as I have tried to briefly show, indeed, with a repository of knowledge that was gradually created over the millennia from the dawn of Humankind. Yet such knowledge is threatened with disappearance, not only because the plant species dealt with could become extinct, but also because the very awareness of the ancient texts that constitute this repository of knowledge is disappearing, as is also the knowledge of their contents, of their languages and of the history they are related to. Not to speak of the fact that ancient manuscripts themselves, which are the only surviving witnesses of ancient knowledge, are disappearing: the fire of the library of Alexandria repeated several times in World history, and even recently.

Knowledge of medicinal plants and of ancient texts on such substances is a legacy of Humankind threatened with disappearance. And this not a historical and patrimonial consideration: it is a very practical matter. Data from ancient texts can greatly contribute to the protection of bio-diversity and environment, and to the creation of a new policy for a sustainable development. In such perspective, they certainly can help to the reactivation of the cultures of local plant species traditionally used for therapeutic purposes in the so-called emerging countries. Such renewed traditional cultures could alleviate both the ailments of their populations and their economies, heavily impoverished by the costs of highly sophisticated and extremely expensive Western medicines.

Besides such a practical application, research like that I have been trying to present today and to conduct over the past three decades creates a unique tool for the understanding of the tree of life. Not only does it provide hard scientists with data to be integrated into their research, but also—if not above all—it gives them conceptual models that certainly can be transferred to hard sciences. A good example is the genealogical tree of manuscripts, the methods of creation of which exactly correspond to those used in the development of the tree of life. It thus seems that there is a point where human sciences meet hard sciences, in a space that is beyond any scientific discipline and encompasses all.